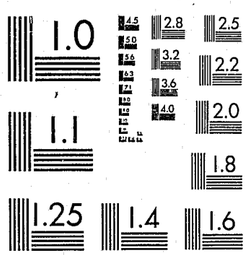

DRAFT SYSTEM IMPLEMENTATION PLANS FOR PARTICIPATING COMMUNITIES

PROJECT 16B

of the

ASSOCIATED PUBLIC-SAFETY COMMUNICATIONS OFFICERS, INC.

Prepared by

BOOZ•ALLEN & HAMILTON, INC.

LAW ENFORCEMENT ASSISTANCE ADMINISTRATION

Grant No.: 79-SS-AX-0013

November 15, 1980

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ACKNOWLEDGEMENT

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The professional competence and dedication to the public's service shown by all of the participants in this project reflect great credit upon the telecommunications profession.

APCO wishes to express its appreciation to the following individuals for their contributions to the field of public safety:

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Gerald W. Bernas	Project Manager

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I. INTRODUCTION - VOLUME II

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I. INTRODUCTION

A major objective of APCO Project 16B is to assist the participating communities in the development of their individual plans for the implementation of a digitally addressed trunked communication system (DATCS). It is the responsibility of the Project Director in each community to generate these plans and to go forward with their implementation. The System Implementation Planning Guidelines, developed under APCO Project 16B, were used as a guide. The responsibility of APCO and its contractor, Booz, Allen and Hamilton Inc., is to assist the individual Project Directors during the grant period to the limit of available project funds.

This report contains the draft copies of the System Implementation Plan (SIP) for Lexington, Kentucky; the State of Oklahoma, Phoenix, Arizona, and Salt Lake County, Utah. An SIP for Bucks County, Pennsylvania was not developed under this program. Time prevented these SIP documents from receiving final review and approval by the respective governmental bodies although the major supporting parts of each SIP was reviewed in depth by each community in the course of the project.

1. SCHEDULE OF ACTIVITIES

The project was initiated in each community by developing a formal Support Agreement and Work Plan. This agreement was characterized by a Master Schedule of Activities for each community, a sample of this schedule typical of the schedules developed in each of the five participating communities, is shown as EXHIBIT I-1. This was the first step in the planned ten step program.

Data collection is implemented in two parts; the review of existing documentation, and personal interviews with potential users of DATCs. To provide maximum efficiency in collecting and recording only the data needed, interview guides were developed for each community. These guides also serve as permanent data records which can be varified in response to time dependent system changes and/or user attitudes. These data were collated and reduced to a written report reflecting the communication system and its inventory as it existed in each community. This report, in its entirety, appears as an Appendix to each SIP.

As part of the data collection activity, selected performance data for the existing communication system was acquired. These data served two purposes; they served as a guide for specifying the DATCs system design, and they provide benchmarks for later evaluating performance improvements achieved by the DATCS. These data elements were collected mainly by the potential users and provided to the Project 16B group.

The documented data base highlighted existing and potential communications system problems. It also provided a list of requirements the potential user had for any communication system and for DATCS in particular. Each problem and each requirement has been addressed in each community and, where possible, a series of alter-

PROJECT 16B - MASTER SCHEDULE OF ACTIVITIES

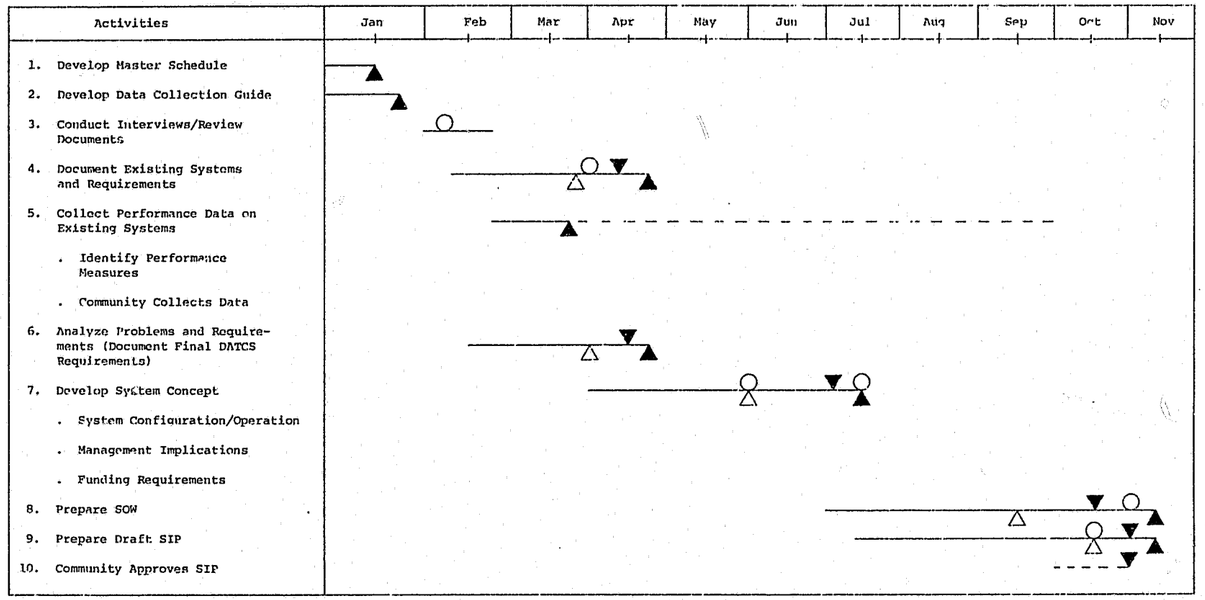

EXHIBIT I-1

native solutions was documented. A draft problem analysis report was developed for each community. This report was submitted for review and each community selected the preferred solution to each problem. A draft problem analysis report, typical of the similar report in each community, appears as Appendix A to this report. The selected preferred solutions to the problems in each community appears as an Appendix to each of the community SIPs.

The DATCS system concept for each community has been developed from the individual data bases and from the selection of preferred solutions to potential problems and system requirements. This system concept is unique to each community but has a high degree of similarity among the four conceptual DATCS systems. A draft report of the system concept was reviewed by each community and the system concept which resulted from this review is presented in its entirety as Part II of each SIP in this report.

A draft Statement of Work (SOW) for each community has been developed from the instructions set forth in the System Implementation Planning Guidelines. These draft SOWs are shown as Appendices to individual SIPS in this report.

The early review of the radio communication system problems and requirements for Bucks County, Pennsylvania led to their decision to pursue a conventional upgrade of their radio system and defer DATCS planning at this time. A final project report for Bucks County appears as Appendix B to this report.

2. ORGANIZATION OF THIS REPORT

Each draft SIP contained in this report retains the integrity of the draft System Implementation Plan (SIP) submitted to each participating community. Section II contains the Lexington, Kentucky draft SIP, Section III contains the State of Oklahoma, draft SIP, Section IV contains the Phoenix, Arizona draft SIP, and Section V contains the Salt Lake County, Utah draft SIP. Appendix A presents an example Problem Analysis Report of the draft reports presented to each community. Appendix B contains the final project report to Bucks County, Pennsylvania.

II. LEXINGTON, KENTUCKY

System Implementation Plan - Draft

Submitted to:

Sgt. William C. W. Lisanby
Division of Police
Lexington-Fayette Urban County Police
1409 Forbes Road
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DIGITALLY ADDRESSED TRUNKED COMMUNICATION SYSTEM

SYSTEM IMPLEMENTATION PLAN

LEXINGTON-FAYETTE URBAN COUNTY GOVERNMENT

November 17, 1980

BOOZ · ALLEN & HAMILTON Inc.

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TINTON FALLS, NEW JERSEY 07724
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AREA CODE 201

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I. INTRODUCTION

1.1 PROJECT BACKGROUND

For the past three years, the Association of Public-safety Officers (APCO) has been pursuing a program funded by the Law Enforcement Assistance Association (LEAA) to evaluate and implement a digitally addressed, trunked communications systems (DATCS)*. This program is the direct result of both the Federal Communications Commission (FCC) action to relieve the problem of frequency congestion in the public-safety community and the LEAA's efforts to improve law enforcement techniques. The frequency congestion problem along with the FCC proceedings on this issue is addressed in FCC docket No. 1862. This document opened radio channels for "trunked" radio systems in the 800 MHz band to public-safety users. The LEAA recognized that the FCC action provided needed channels, and that trunked technology has the potential to provide enhanced radio service to public safety users. As a result the LEAA has funded Project 16 to further investigate trunked systems. This "Project 16B" effort has been undertaken as part of a five phase program:

- Feasibility determination (Project 16A - completed)
- Functional requirements development (Project 16A completed)
- Implementation program (Project 16B - ongoing)
- Test and evaluation
- Technology transfer.

When APCO Project 16 was initiated the Lexington Police Communications Division was seeking ways to upgrade or replace the current mobile radio system. Members of the communications division monitored the progress of Project 16 closely to evaluate the possibility that DATCS could meet the city's police communications needs. As Project 16 evolved it became apparent that a DATCS system was a possible way to meet not only the needs of the police department, but also the needs of other city agencies that use mobile radio.

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* The DATCS concept involves the sharing of radio channels by all mobile radio users in the City of Lexington. The number of user groups is larger than the number of channels in the system, and any of the available channels can be assigned to any user group as their need for communications arises, but no group will be able to listen to the conversations of other user groups. The sharing of the channel "pool" in DATCS is similar to the sharing of a number of long distance circuits in a telephone system. In a DATCS system, a large number of radio channels will be available to all users in Lexington instead of the several small isolated systems currently existing.

The Mayor, recognizing the potential of DATCS, asked APCO to consider Lexington as a model city for developing a system implementation plan (SIP) under APCO Project 16B. To assist Lexington in developing this SIP, APCO provided the city with a consultant (Booz, Allen & Hamilton, Inc.) experienced in the design and implementation of technically advanced communications systems. The Lexington project director, Sergeant William Lisanby of the Police Communications Technical Unit with the assistance of Booz, Allen identified Lexington's mobile radio requirements. These requirements were analyzed along with the current system's ability to meet them. This analysis showed that DATCS is not only technically feasible but also the best solution to Lexington's mobile radio problems. A DATCS system concept for Lexington has been defined, reviewed, and favorably received by the City's users of mobile radio.

This system implementation plan describes the steps Lexington must take to procure, implement and evaluate the operation of a DATCS system. This document is a guide for the management team to use in implementing an advanced land-mobile communications system. It is being delivered to the city in draft form because it is a working document therefore, updated information will cause additions and changes to this document. Where options for implementation strategy are available, this document reflects strategies based on the best information available at this time. As a result of available information, the level of detail contained here varies.

1.2 PROJECT DIRECTOR AND PARTICIPATING AGENCIES

The Lexington project is under the direction of:

- SGT. William C. W. Lisanby, Division of Police
- Charles L. McGill, Division of Police

Participating agencies include:

- Division of Police
- Division of Fire
- Fayette County Sheriff
- Fayette County Jailor
- Fayette School Security
- Public Works
- Park and Recreation
- Division of Housing Services
- Building Inspection.

1.3 SUMMARY OF CURRENT STATUS OF IMPLEMENTATION

The purpose of this section is to report progress to date in implementing Lexington's DATCS system concept.

To date, a DATCS system concept for Lexington has been defined, reviewed, and agreed to in principle by the users of mobile radio.

However, operational boundary issues will need to be resolved to obtain universal agreement on the PSCC system concept. To continue the project the City of Lexington should first agree in principle that the DATCS system concept is the way to resolve the city's mobile radio communications deficiencies. This agreement does not require that Lexington fund hardware at this time.

The next step will be to appoint an implementation advisory committee consisting of city commissioners. The commissioners would represent those city agencies that will be users of the system.

At this point, it will be necessary to form an implementation project management team. This team would include Lexington personnel skilled in specific areas of: procurement, finance, personnel, operations planning, communications system design and facilities design. This team should be formed as soon as possible so that project momentum from the planning phase is not lost.

On November 15, 1980, APCO's financial support for Project 16 along with the consulting support attached to it will end. At this time Lexington will need to find funds to continue the project. Immediate needs for funding are:

- Management team
- Continuing technical support

Continued funding for these areas will ensure Project continuity and allow for further progress in DATCS system implementation.

II. SYSTEM CONCEPT

This system concept describes how each performance requirement (Appendix B) will be satisfied and the level of participation by each agency. Cost estimates based on the system concept are also included.

2.1 SYSTEM OPERATION

This section presents the proposed system operation of Lexington's future mobile radio system. It is proposed that:

- Current operations be largely unaltered in the new system, except as necessary to accommodate improvements to resolve major deficiencies or new technology where found to be highly desirable
- Lexington develop a commonly owned and jointly managed public-safety communications center (PSCC) to serve Lexington police, fire, and EMS communications
- Certain principles of operation be adopted to preclude mutual interference and maintain radio discipline.

These elements of the system operation are described in greater detail in the following paragraphs.

2.1.1 PHILOSOPHY OF OPERATION

The proposed mobile radio system for Lexington has been conceived to closely replicate current operations, except where basic improvements are appropriate. The previous report* noted that there exist certain major deficiencies in the present mobile radio system and that DATCS offers some highly desirable new capabilities through technological advancement. It is the philosophy of the proposed operation, therefore, to suggest changes in present operation only to the extent that the previously noted deficiencies will be overcome and that new technology will be adopted, where applicable.

Lexington's major mobile radio deficiencies are an inadequate number of radio channels and insufficient interagency communications. Operations will be changed therefore, only to the extent that fewer number of users will be assigned to each "channel"** and that communications among agencies and within departments will be significantly increased by the development of DATCS.

---

* "Identification of Mobile Radio System Deficiencies for Lexington-Fayette Urban County Government, May 29, 1980."

** "Channel" in the sense used in DATCS is not equivalent to a channel in a conventional mobile radio system. In a DATCS, the number of "channels" exceeds the number of frequency (pairs), which is impossible in a conventional system.

Because DATCS also offers a few "highly desirable" features and options such as dynamic flexibility (reassignment of channels from a central location) and commonality of equipment, communications management will be able to respond to large-scale events of mutual concern in ways heretofore impossible. For example, in the event of a downed aircraft, selected public-safety units from Lexington Police, Fire, EMS, and Blue Grass Airport could be assigned to a common channel(s) for the duration of the event. Afterwards, each unit would return to its previously assigned channel. As a result, routine operations would be unaffected by the incident.

Similar flexibility is applicable to public works, for example, where snow plow activity would ordinarily disrupt day-to-day operations, but through channel segmentation made possible by DATCS, snow cleanup and removal could be coordinated separately. Also, because of equipment commonality made necessary by DATCS, mobile radio units among all city agencies would be unit-for-unit compatible and therefore interchangeable.

2.1.2 DEVELOPMENT OF A COMMONLY OWNED AND JOINTLY MANAGED PUBLIC SAFETY COMMUNICATION CENTER (PSCC)

At this time it is still unresolved whether Lexington will develop a commonly owned and jointly managed public safety communications center or will continue to operate complaint reception and dispatch individually and uncoordinated among Lexington Police, Fire, CD and EMS. For the purpose of the proposed system concept of operation, we have assumed that Lexington will elect to develop a communication center for public safety. Development of such a center is the only significant physical deviation from present operations recommended for the DATCS system.

This recommendation is based on the desirable objective to develop the universal telephone number 911 for all public safety. Also made possible by the development of central communications center is the development of computer-aided dispatch (CAD) in the future to assist in complaint reception, ranking of priority calls, management of field resources, and status monitoring of all the units. Development of 911 for Lexington is currently being pursued at this time, but not directly as part of this effort.

Development of a commonly owned and jointly managed public safety communication center will require the establishment of a separate management structure to oversee and operate communications for Lexington Police, Fire, CD and EMS. Planning should begin soon to develop a management structure acceptable to all users. In addition to operating the communication center, management could also have responsibility for radio maintenance for all agencies in Lexington. Establishment of a centralized radio maintenance capability would represent a large step towards eliminating the present fragmented arrangement for radio maintenance.

2.1.3 PRINCIPLES OF OPERATION

The principles described in this section are based on the assumption that complaint reception and dispatch for Lexington Police, Fire, CD and EMS and radio network control for all users will be conducted from a central location. The facilities required to support the operations associated with central communications are discussed in Section IV.

The principles of operation are expressed in terms of:

- Group addresses or channels
- Dynamic assignment of primary group address
- Accessibility to all appropriate channels by each dispatch location.

Each agency will be provided one or more unique channels or group addresses according to their specific requirements. The initial allocation of group addresses by agency is articulated in Section III - System Description. Mobile radio units will operate in a manner similar to today's operation, but there will be fewer mobile radio units per assigned channel. Only mobile radio units with a common purpose will share a particular channel. Mobile radios will possess generally one, but as many as five channels, with at least one channel capable of being dynamically reprogrammed from central network control. In general, supervisory persons will have more than one channel whereas line personnel will have access to only one channel, with the capability to change that channel on request.

Each agency with a dispatch location or access point will be equipped with all channels associated with its mobiles. In this way, each agency will be able to communicate with all of its mobiles regardless of which particular channel they maybe assigned. Each fixed access point will be also given access to the system operator (central network control) to make a request for change of channel.

The system operator will be responsible for maintaining discipline, managing the mobile unit changes of group addresses to preclude interference, and following agreed-to policies regarding the procedures to effect changes in the group address. In this way, the changes to an agency's radio configuration will not occur without the expressed approval of the particular agency. The dispatchers will not have the capability themselves to change group addresses. This will insure that dispatchers perform a dispatching function and not a computer operator function, which will be associated with the system operator.

2.2 SYSTEM DESCRIPTION

This section describes the future DATCS mobile radio system based upon Lexington's requirements. Specifically, addressed are

the performance requirements, external interfaces, control functions, radio spectrum and FCC licensing implications, and ancillary items associated with the central communication center. These are discussed individually in the following paragraphs.

2.2.1 PERFORMANCE REQUIREMENTS

This section specifies the performance requirements that must be satisfied to implement a DATCS system in Lexington. Specific performance requirements that are discussed include:

- DATCS capacity
- Intra- and inter-agency communications
- Mobile control head characteristics
- Two-part digital address
- Dynamically assignable group address
- Talk-around capability
- Interface with conventional portable radios
- Radio coverage
- Managment information
- System protection measures.

2.2.1.1 DATCS Capacity

The DATCS system design must be able to support eventually 2,000 individual mobile and/or portable units. The specific number of frequency pairs that will be initially installed will be based upon the 70-percent-loading-within-five-years-of-licensing criteria established by the FCC. For example, if it is projected that there will be 365 mobile radio units on the air within five years, then seven radio frequency pairs will be developed, based on 75 mobile units per frequency pair corresponding to full loading.

The system must also be capable of supporting 150 unique group addresses with as few as one to as many as 100 individual units assigned to a specific group address. It is not clear at this time to what extent the interfacing of conventional portables can be considered legitimate loading for the purposes of meeting the FCC criteria.

2.2.1.2 Intra- and Inter-agency Communications

Intra- and inter-agency communications will be accomplished, depending upon specific circumstance, by one of three methods:

- Limited Selection of Group Addresses - Supervisory level mobile radio users will be equipped with the group address of other users, in instances where access to other group addresses would be routinely required. This method provides selected users the option of operating on other group addresses without dispatcher initiative. It is expected that user-initiated access to other group addresses will be limited to supervisors and administrative personnel.

- Cross Patching - Will be provided to most dispatchers. The dispatcher will be able to crosspatch two or more group addresses on an as-needed basis. In this way, the dispatcher can make or break a cross-patch arrangement, thereby maintaining channel discipline. Patching will be conducted generally among only those channels available to a particular agency; cross-patching between different public-safety agencies is not proposed.

- Reassignment of Group Addresses - This method of inter-agency communications will be initiated only by network control personnel (system operator) when users need to temporarily become part of another group. It is anticipated that reassignment of group addresses will be used to respond to large-scale events of mutual responsibility and therefore, will probably occur infrequently. The reassignment of group addresses will be accomplished by one of two ways:

  - Change in group address from a regularly assigned to an already existing group address of another user group

  - Creation of a "phantom" group whereby individual units would be assigned to an entirely new group address created to meet a temporary, one time need.

2.2.1.3 Mobile Control Head Characteristics

The mobile control head will be provided a variety of operational features, as determined by the specific needs of each agency. There will be two classes of mobile control heads:

- Supervisory Control Head - will provide a mobile radio user with up to five unique group addresses for inter-agency communications. Access to these group addresses will be user selectable. The primary group address, at the very least, will be dynamically reassignable, whereas the four other group addresses will be essentially fixed (but reprogrammable by maintenance technicians, if necessary).

- Non-Supervisor Control Head - will provide a mobile radio user a single group address, dynamically assigned by the user's agency. If a user requires access to another group address, the user's dispatcher will request a change-in-group-address status via the control operator or will cross-patch the user to the appropriate group address.

To improve dispatcher effectiveness, automatic reporting of user status* will be provided for Lexington police and optional for all other participants in DATCS. The status reporting capability will be incorporated external to the control head in a module specifically designed to convey status information; in this way, status reporting can be added or removed without major control head modification. A minimum of five status messages will be provided.

Occasionally the user may not be able to immediately access the desired channel because all channels will be temporarily allocated in which case, a "channel busy" indication will be provided. The user will also automatically enter a queue set up by the controller to seize the next available channel, in the order of requests.

2.2.1.4 Two-part Digital Address

As a minimum, each unit will both be uniquely identified (unalterable) and identified as a member of a group address (alterable). The unit identification will be an integral part of the mobile unit, not readily changeable. On the other hand, the affiliated group address will be dynamically programmable to be able to satisfy changing needs.

The Lexington DATCS must have a capacity eventually for 2,000 individual mobiles and portables and 150 unique group addresses. Although current equipment offerings typically provide three levels of address (i.e., unit, subfleet, and fleet), no need exists to segment Lexington operations beyond the unit and subfleet level.

2.1.1.5 Dynamically Assignable Group Address

The capability will be provided to dynamically assign and change at least one group address of the mobile units from a central location; each agency will individually decide which group address (among field of five) will be dynamically assignable. However, this capability will only reside at a single location (network control) in the communications center. In this way, effective network control can be exercised.

The system operator, who performs the function of network control, will have available two options to dynamically assign a group address:

* Status reporting includes all typical responses frequently made by a unit to the dispatcher: in service, out of service, in car, out of car, on scene, acknowledge, etc.

- Modify a particular unit's regularly assigned group address to an already existing group address (i.e., Streets and Roads to Traffic Engineering, etc.)

- Create a "phantom" group, not regularly assigned, which will be dissolved when the need for its continued existance disappears; units will then return to the regularly assigned group address.

Changes in group addresses will follow firmly established operational procedures to maintain strict control; these procedures are best established jointly by the administrator of the PSCC and management board (composed of representatives of the user agencies (i.e., Police, Fire, Public Works, etc.)

2.2.1.6 Talk-around Capability

Mobile units require communications independent of the base station facilities when beyond radio range or when the dispatcher is not involved in a message between close mobiles. This talk-around capability should be provided through a channel specifically set aside for the purpose of direct simplex communications (talk-around).

Talk-around will be mobile-user selectable as currently exists with the present radio systems. However, unlike the present systems, all units desiring to use talk-around must agree in advance to switch to talk-around; if only one unit switches communications will not be possible. While DATCS could provide automatic switching to talk-around under specific conditions (i.e., sense of "out-of-range" condition), manual switching is preferred to maintain predictable communications.

2.2.1.7 Interface With Conventional Portable Radios

Although industry estimates vary for the introduction of trunked portable radio (3-6 years), there are no assurances that trunked portable radios will ever be available at an affordable cost or compatible with DATCS. Also, there is concensus that any type of trunked portables will not be available sooner than three years. For these reasons, a method is therefore required which will provide Lexington continued access to portable radio operations.

To provide for portable operations in the interim, the current existing conventional portable radio systems will be crossbanded with appropriate group addresses in the trunked systems; crossbanding will be under the control (enabling/disabling) of the appropriate dispatcher responsible for the particular group address. Conventional channels anticipated to be interfaced with DATCS are:

- Lexington Police (operations)

- Fire (operations)

- Public Works

- Sheriff

- Bluegrass Airport (public safety).

Because the possibility exists that all DATCS channels will be busy ("all channels busy") when a portable radio attempts to communicate over the DATCS system, the need exists to give priority access (first available channel) to the group address associated with the conventional portable. In any event, the portable communications will be received by the appropriate dispatcher regardless of the availability of the appropriate DATCS channel. This anomaly of an interface between conventional and trunked radio systems is a characteristic that can not be easily removed.

2.2.1.8 Mobile Radio Coverage

Reliable mobile radio coverage will be provided throughout Fayette County, at least to the same or greater reliability than currently realized by the existing Lexington Police mobile radio system. Quantitatively, mobile radio coverage reliability is proposed to exceed 95-97 percent, which is considered very good by industry standards.

It is not clear at this time whether more than one quality (high-elevation) site will be required to provided the required coverage. If more than one site will be necessary, then the Lexington's selected system engineer will be responsible for:

- Indicating the need for the remote site(s)

- Specifying which site and its necessary characteristics

- Assisting Lexington procure the remote site (i.e., buy, lease, etc.), if necessary.

It is appropriate, however, to describe three alternative approaches to county-wide coverage, assuming that more than one quality site is necessary:

- Simulcasting - mobiles receive identical radio communications from one or more sites simultaneously. This technique has the advantage that a mobile is assured of receiving a communication regardless of its location in the jurisdictional area. Conversely, there are disadvantages of high cost, technical complexity, and conspicuous use of frequency spectrum.

- Separate Trunked Systems - mobiles would communicate with the trunked system associated with the mobile's specific location. This approach is simpler and less costly than simulcasting, but special measures are required to communicate over the entire jurisdiction simultaneously and to properly use the control channels.

- Hybrid Trunked/Conventional System - same as the "Separate Trunked Systems" except a conventional radio system(s) would be used to cover remote, infrequently traveled areas of the county. However, FCC licensing eligibility is uncertain because of an absence of well-defined regulations.

2.2.1.9 Management Information

Management information in the form of system performance data will be the primary tool to determine, on an ongoing basis, how well the DATCS system is meeting Lexington's mobile radio needs. System performance data will be provided to management of the DATCS in the following forms:

2.2.1.10 System Protection

One major intent of developing a DATCS for Lexington is to offer a mobile communication system which exhibits a very high degree of availability*, significantly improved over the present collection of individual systems. For example, loss of a single DATCS base station will only slightly reduce a mobile's chance for obtaining a channel, on request. Whereas today, loss of a single base station (or land lines, tower, antenna, etc.) completely inhibits further communications until repair.

In the event of the loss of a major component (i.e., controller or equivalent component), the DATCS system will revert to a conventional mode in which mobiles would be directed to pre-assigned channels. To accomplish this, the SOW will impose a number of system protection measures that must be satisfied to adequately insure Lexington against the consequences of catastrophic system failure.

Regarding alarm features, network control will be automatically alerted of subsystem and component failure. In this way, immediate action can be taken by the system operator, probably even before the field units notice any discernable change in performance.

Time-out timers will be provided on the mobiles to preclude inadvertent capture of the system for extended periods as well as on the base stations since unnecessarily long-duration conversations tend to deny channel access to other DATCS users. Long-duration conversations could potentially be a problem since the mobile radio user could falsely perceive that DATCS is a completely private, always clear-channel radio system which is unlikely to deny channel access to other users because of one's own usage.

2.2.2 EXTERNAL INTERFACES

This section describes the interfaces between DATCS and the systems external to DATCS:

---

* Percentage of time the system is functional at full capability.

- Telephone
- Conventional portable radio
- Computer-aided dispatch (CAD).

An interface between DATCS and the switched public telephone network will be established. As a minimum: administrative lines will be provided for the PSCC mangement and staff; 911* will be developed, if technically and cost feasible; and existing emergency telephone lines will be retained and re-terminated into the PSCC, at least until the public is familiar and confident in 911. A patch between DATCS and the telephone network is proposed at the system operator console.

Conventional portable radios are to be interfaced with the proposed DATCS system to enable portable radio users to communicate with DATCS mobiles, as necessary. A crossband connect between the DATCS and conventional repeaters, under the control of the appropriate dispatching agency, is proposed to accomplish this function. This solution is the least disruptive approach to dealing with a lack of trunked portable radios, for the interim. Each agency will decide individually to what extent their existing portable radio system will interface with DATCS on a routine basis; decisions may be different. For example, Lexington Police will probably elect to routinely cross connect whereas Bluegrass Airport may elect to cross connect only on an exception basis, because of differences in operations.

An interface with CAD will be established, provided CAD is developed for Police, Fire, CD and EMS in the future. If CAD is developed, then DATCS will interface in two ways:

- Use of automatic status reporting in the mobiles will apprise the CAD system of an individual's degree of availability to handle new complaints
- At the DATCS radio console, the CAD will provide the dispatcher the most current information on:
  - Complaints and their priority and status
  - Available resources to respond to new complaints.

Additional interfaces could be provided for the Sheriff, Jailer, School Security, etc. if the need arises during the course of further discussion and study.

* An independently conducted effort is expected to be initiated soon to solicit a proposal from GTE of Kentucky.

2.2.3 NETWORK CONTROL FUNCTIONS

Network control represents the only other significant change in operations, besides development of the Lexington PSCC. However, unlike the development of the PSCC which is elective, establishment of a network control function is mandatory for DATCS. This is because monitoring system performance and managing a commonly owned, citywide mobile communication system must be centrally performed and cannot be distributed among several departments.

The responsibilities of a network control function will be divided into two categories:

- Policy - responsible for: establishing guidelines for the use of DATCS, accommodating demands from various independent agencies impartially, and ensuring that day-to-day operations are appropriately performed
- System Operations - responsible for the day-to-day operations of the network. The new or existing (system operations) agency would respond to the policies and guidelines established by the parent group. For example, system operations would handle requests for group address changes, but would not dictate under what circumstances a request for change in group address may be honored, since that is a matter of policy.

For further study, it is preliminarily proposed that policy be established by an all-new Management Board created to serve this specific function, comprised of representatives of the user agencies. System Operations, on the other hand, could be vested in an existing agency or developed independently. These choices warrant the closest attention.

2.2.4 DISPATCHING

Each agency that presently performs a dispatching function for itself or other agencies will be provided a dispatch capability under DATCS. As a minimum, individual agencies will be provided a desk-top type console containing all group addresses of responsibility and, in some cases, group addresses of mutual interest with other agencies/departments. These consoles will be capable of: radio patching among the channels of access; selecting the desired area coverage (if made necessary by multiple sites); communications with network control to request changes in group address; and receiving all messages from mobiles of responsibility. In addition, communications will be possible with at least two group addresses simultaneously; some agencies may have the capability to communicate with three or more group addresses simultaneously.

2.2.5 RADIO SPECTRUM AND FCC LICENSING

Presently, DATCS is only feasible at 800 MHz, which previously was a television-only band, but recently reallocated for mobile radio. For the foreseeable future, at least, sufficient 800 MHz spectrum will be available in the Lexington area to support DATCS.

Another favorable aspect is the current FCC demeanor which regards these kind of mobile radio systems with favor and something to be promoted. Therefore, if any negotiations are required with the FCC in the future to resolve regulatory issues (i.e., multiple base station sites, etc.) favorable rulemaking can be anticipated.

It is advisable, however, to begin establishing rapport with appropriate FCC staff to help "smooth the path" to successful licensing.

2.2.6 ANCILLARY ITEMS

Ancillary items for the purpose of the Lexington System Concept of Operation include the following:

- Emergency Power
- Maintenance.

Emergency power will be necessary for: the primary, downtown site; the remote site(s) in the periphery of the County (if necessary); and the CCC. Depending on the inherent emergency power capabilities of the downtown site, emergency power may not be required. However, emergency power will be necessary for both the remote site(s) and the CCC. Hydrocarbon-type fuel generators are proposed because of the substantial power requirements of each base station (1000 watts continuous each).

The maintenance strategy for the DATCS system in Lexington is two fold:

- Initial Contract Maintenance - Initially maintain the DATCS system under a maintenance contract with a commercial shop, at least until a self-maintenance capability is established and sufficient confidence in the DATCS system has been achieved. This period will provide the primary basis for Lexington maintenance staff to acquire the appropriate new skills required.

2.3 FACILITIES AND PERSONNEL

This section describes the required facilities and personnel associated with the development of DATCS together with an all-new PSCC in Lexington.

2.3.1 FACILITIES

Lexington's physical facility requirements consist of two parts.

2.3.1.1 Public Safety Communications Center (PSCC)

This section describes the characteristics of the PSCC as well as provides estimated building interior square footage that will be required. The PSCC will possess sufficient space to accommodate the transfer of Lexington's current communications services as well as the new space requirements of DATCS. Lexington's PSCC will have the capability to service emergency calls via the emergency number "911", and to accommodate computer-aided dispatch (CAD) in the future*. Lexington's major public safety agencies of Police, Fire, Civil Defense (CD) and Emergency Medical Services (EMS) will be the primary agencies served by the center. The cost estimates, based on the square footage estimates included in this section, are provided in Section 2.4 and are intended for budgeting. A decision by Lexington as to whether to proceed in forming a PSCC should be based in part on these cost estimates. Many of the inputs used to estimate square footage for a PSCC have been provided by the Lexington Community Project Director (CPD).

Formation of a PSCC will enable Lexington to improve the delivery of emergency services to the public, minimize the cost of accommodating growth in services, and possibly lower ongoing costs. Lexington's public-safety agencies currently provide complaint reception and dispatch on an individual, agency-by-agency basis. By combining certain functions, such as complaint reception, system maintenance, and system management, and collocating dispatch, communications operations will be streamlined*.

The services that are proposed to be provided by the Lexington PSCC are:

- Public Safety Complaint Reception and Dispatch - will be provided for all Lexington public safety agencies. The facility will be designed to eventually accommodate 911 as well as CAD. Introduction of 911 by Lexington for combined complaint reception will assure that citizens' request for assistance will be received by an operator who can offer assistance from one or all of Lexington's public-safety agencies. Moreover, overall response time for such centers has been shown to be reduced since confusion has been eliminated as to which agency to call and which responding agency is most appropriate. For calls involving multiple-agencies, savings in time will be dramatic. Future implementation of CAD will automatically route complaint information between the complaint operators and the appropriate Police, Fire, CD or EMS dispatch personnel, thus eliminating the manual complaint card system. CAD will also allow Lexington's public-safety agencies to adopt multiple zone dispatch with greater ease. CAD will route the call to the appropriate dispatcher or, if multiple agency services are needed, to the correct dispatchers.

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* Development of CAD in Lexington will rqquire a separate planning effort.

** It is important to clarify that complaint reception is proposed to serve all public-safety agencies, whereas dispatch will be performed by personnel dedicated to a particular agency (e.g., fire). Other configurations are also conduct the initial dispatch, but these should be examined on a cases-by-case basis.

- Radio Maintenance, Citywide - will be provided for all agencies participating in DATCS. The inherent characteristics of DATCS, such as sharing of common equipment and compatible mobile radios make radio maintenance on a citywide basis highly desirable. System-level coordination of maintenance will be required regardless of whether Lexington decided to develop a PSCC.

- Communications System Mangement and Administration - DATCS will integrate Lexington's uncoordinated, independent mobile radio systems into a coordinated, single mobile radio system. Presently each conventional system is managed on an individual system basis. However, the nature of DATCS a PSCC demands that management and administration of communications be centrally conducted. Therefore, for convenience, these functions should be located in the same physical facility. If a PSCC is developed the role of communications system management and administration would be commensurately increased. Since the proposed PSCC and DATCS concepts of operation are strongly linked, management should be located in the same facility.

The following estimates of the required square footage of building space have been prepared for budgeting and are, therefore based on a preliminary analysis of PSCC size, review of existing operations, and experience with similar systems. When a decision to proceed with development of a PSCC is made a more detailed analysis will be required. The analysis to date indicates that Lexington's PSCC must meet the following minimum functional requirements:

- Sufficient floor space for city-wide complaint reception, estimated at 560 square feet for 8 positions.

- Floor space for combined dispatch operations estimated at 1120 square feet for 8 positions.

- Floor space for radio maintenance estimated at 432 square feet for 3 work bench positions.

- Floor space for storage areas (spare radios, parts inventory, special equipment, etc.) estimated at 200 square feet.

- Floor space for installations and readio changes estimated at 1215 square feet for 3 vehicle bays.

- Administrative and overhead* office space to accommodate an estimated 6 staff members and support staff, requiring 1058 square feet.

* Closets, restroom, hallways, etc.

- Sufficiently secure from unauthorized public access and sabotage.

- Backup emergency power to protect from commercial power outages.

These minimum requirements represent the concept to date. Clearly, additional analysis and planning will be required to move from the present concept of a PSCC to a smoothly operating PSCC.

Implementation of DATCS and a Public Safety Communications Center simultaneously is a worthy objective for Lexington. It is advantageous to combine the planning of DATCS and integrated dispatch and complaint reception at this time since many of the issues of DATCS are relevant to the PSCC.

2.3.1.2 Radio Sites

The unique propagation characteristics of radio signals at 800 MHz make selection of an appropriate site critical. A suitable site should be identified, prior to bid release, that will enable Lexington-Fayette County to receive extensive land area coverage from a single site. The key radio site facility to be selected must provide adequate floor space, limit unauthorized access, and be available for long-term lease or purchase.

Based on these site selection constraints the following specific requirements must be considered during the site selection process:

- The site shall be located downtown, preferably on one of Lexingtons tallest buildings.

- There must be sufficient floor space to accommodate at least 20 base station repeaters, control logic unit, spare units, and maintenance work area; 400 square feet of floor space is estimated.

- The antenna elevation should be at least 400 feet above average terrain (AAT).

- For security reasons the site should have limited access by the public.

- A long-term lease to the site should be available and obtained soon.

An additional site(s) in the periphery of the county may be necessary to assure reliable county-wide coverage or, in the future, to provide reliable coverage for trunked portable radios, anticipated to be available in 3-6 years. However, whether additional sites will be required cannot be predicted at this time since the specific coverage realized by Lexington will depend on the specific vendor offering at time of bid. Since the acquisition of these remote sites can be appropriately made the responsibility of the vendor, a decision therefore on the necessity of a peripheral site(s) is not necessary at this time.

2.3.2 PERSONNEL

Personnel staffing will be critical to successful PSCC operation. Certain decisions regarding personnel are, however, not appropriate at this time. These are:

- Specific qualifications
- Salary
- Organizational structure
- Sources for staffing.

Decisions in these areas are best made at a future time, nearer to PSCC implementation.

However, decisions concerning the management structure of the PSCC should be addressed in the immediate future. Lexington's existing pool of communications managers should be an integral part of the new PSCC management team. Accordingly, definition of a PSCC management structure will be one of the first planning elements of Implementation Plan (Section III).

Also known at this time is that:

- About 61 persons will be needed to staff the center (shown in Exhibit II-1)
- Most of the persons staffing the center will be drawn from existing communications personnel who are already qualified and therefore will require training only for new procedures/techniques associated with DATCS and combined dispatch.

Minimum staffing requirements for the PSCC are based on analysis of need, review of existing systems, and experience with similar systems. Personnel will be, in the long-term, the most significant ongoing cost item of Lexington's PSCC. The major personnel categories, including narrative description, are as follows:

- Complaint Personnel - responsible for recording telephone complaints, routing complaints to the proper dispatcher and handling service calls not requiring public-safety agency response. Lexington will require an estimated 27 persons to staff complaint positions on a 24-hour, 7-days-a-week basis.
- Dispatch Personnel - responsible for accurately disseminating complaint information to field units, and dispatching specialized equipment and personnel under emergency conditions. Eighteen persons are estimated to meet dispatch requirements on a 24-hour, 7-days-per-week basis.

EXHIBIT II-1
Proposed Lexington
PSCC Personnel Requirements

CATEGORY	NUMBER
Complaint Reception	27
Dispatcher	18
Supervisors	5
Management	2
Administrative	4
Maintenance	5
	61

- Supervisory Personnel - responsibile for supervising day-to-day operations of complaint, reception and dispatch operations. Five supervisory personnel are estimated, one per shift.

- Management Personnel - responsible for overall PSCC operations by executing the directives and policies established by the Lexington Management Board or City Council, as appropriate. These responsibilities specifically include budgeting, staffing, adherence to procedures, maintenance, and productivity. Two persons are estimated to meet the management requirements.

- Administrative Personnel - responsible for providing support services to management. Four persons are estimated.

- Maintenance Personnel - responsible for the installation and maintenance of all DATCS and related electronic equipment for all city participants.

It is important to note that these staff requirements were derived for budgeting and therefore do not necessarily reflect an exhaustive list. Therefore, a key part of implementation will require that an accurate appraisal of job requirements be performed.

2.4 COST ESTIMATE

This section presents cost estimates associated with implementing a commonly owned digitally addressed trunked communications system (DATCS). Cost estimates for forming and operating a public safety communications center (PSCC) to meet the complaint reception and dispatch requirements associated with DATCS are also included.

These cost estimates present the best information available at this time. To arrive at these estimates a number of assumptions were formed, based on experience, discussions with the vendor community, and Lexington's present operations, staffing levels, and salaries. Many of the assumptions were provided by the Lexington Community Project Director (CPD).

These cost estimates will be adjusted as new information becomes available. Although hardware similar to DATCS is now commercially available, Lexington's requirements suggest that technically feasible modifications will be required. Therefore, pinpointing cost is difficult. Moreover, the vendor's degree of determination to pursue this market will, in the final analysis, determine the cost of DATCS equipment.

Costs are presented in two parts:

- Non-recuring costs - one-time capital investment costs

- Recurring costs - ongoing costs associated with operating and maintaining the DATCS system and operating the PSCC facility.

2.4.1 NON-RECURRING COSTS

Non-recurring costs are defined as one-time, initial costs associated with start-up. The estimated costs presented in this section are related to acquisition and installation of equipment and construction of the PSCC facility. Also included are one-time costs for maintenance equipment peculiar to the DATCS radio system.

Non-recurring costs are presented in terms of:

- Radio Hardware
  - Fixed Site
  - Mobiles
  - Control
  - Conventional Portable Radio System Interface
- Maintenance Equipment
- Facility Construction

2.4.1.1 Radio Hardware

Fixed Site - one-time costs associated with the fixed site include: base station repeaters, tower structures, feedlines, antennas, transmitter combiners, receiver combiners, and system controller as well as installation costs. These costs are shown in Exhibit II-2.

The assumptions associated with Exhibit II-2 include:

- A single site will be sufficient to provide reliable county-wide mobile radio coverage at 800 MHz.

- A central downtown location will be selected, atop one of Lexington's tallest buildings, which will contain sufficient indoor space to house all base station equipment.

- Only mobiles will count toward channel loading, based on FCC criteria.

- Seven hundred mobile units will be operational within five years of FCC licensing; twelve radio frequency pairs will therefore be developed.

Most equipment items are off-the-shelf, resulting in a high confidence level in cost.

Mobiles - one-time costs associated with mobile radio equipment include antennas, antenna feedlines, and installation, as well as the mobile radio itself and status package. These costs are shown in Exhibit II-3.

Major Equipment Categories*	Initial Quantity	Cost ($)
. Repeaters - $9,500	12	114,000
. Tower Structure - $5,000	2	10,000
. Antennas - $600	4	2,400
. Transmitter Combiners - $5,500	2	11,000
. Receiver Combiners - $1,000	2	2,000
. System Controller - $40,000	1	40,000
Total	N/A	$179,400

* Includes installation

EXHIBIT II-2
Fixed Site Costs

Agency	Initial Quantity of Mobiles			
	Status Reporting ($300)	Supervisory ($2300)	Non-Supervisory ($2000)	Total Cost $
. Public Works	0			
- Engineering		15	10	54,500
- Sanitary Sewers		10	20	63,000
- Streets and Roads		5	20	51,500
- Sanitation		5	23	57,500
- Traffic Engineering		10	10	43,000
- Vehicle Maintenance		9	0	
. Lexington Police	425	445	0	1,151,000
. Fire	0			
- Fire		90	0	207,000
- EMS		6	0	13,800
- Civil Defense		0	0	0
. Sheriff	0	51	0	117,300
. Jailer	0	0	0	0
. Bluegrass Airport	0	6	0	13,800
. Fayette School Security	0	0	26	52,000
. Division of Housing Services	0	26	0	59,800
. Building Inspector	0	17	0	39,100
. Parks Department	0	11	39	103,300
	425	706	148	2,026,600

EXHIBIT II-3
Initial Mobile Costs

There will be two types of mobile units, which will be identical except with respect to the control head:

- Supervisor-Control Heads - will provide for at least one dynamically reprogrammable group address and four fixed group addresses. All five group addresses will be operator selectable

- Non-Supervisory Control Heads - will provide a single group address that can be dynamically reprogammed.

The cost estimates are based on the present cost of off-the-shelf trunked mobiles. This assumption seems valid because of the large quantity purchase and the favorable competitive environment. Regarding the status reporting equipment, the standard equipment offerings is suitable, independent of DATCS. Therefore, cost of status reporting is predictable.

Caution is urged in using the mobile radio costs in Exhibit II-3 because of the special nature of the public safety requirements. It is important to note therefore that the cost of each unit could be higher because of Lexington's special requirements, or could be lower because of the competition factor.

Control Equipment - one-time costs associated with control equipment are in two categories:

- Control stations

- Consoles for PSCC.

Control stations will be provided to agencies requiring access to their mobile radio units from a fixed location. These units, which are currently available off-the-shelf, will contain features comparable to the proposed supervisory-type mobile, only fixed in location. Each control station will have, as a minimum, access to all group addresses of responsibility and the system operator (to request change in group address assignments). In some cases, access will be provided to group addresses of common interest, dispite lack of direct responsibility.

Desk top, modular consoles will be provided the PSCC facility for Lexington Police, Fire, CD and EMS, as well as system control. Existing EMS consoles will be relocated at the new PSCC. However, the cost of relocating fire alarms to the PSCC if necessary, has not been estimated.

There will be two types of consoles: non-supervisory and supervisory (system operator). The non-supervisory console will provide for access of up to five group addresses, one of which will be dynamically reprogrammable. Interface of the conventional portable radio system with DATCS will be controlled by the appropriate dispatcher at a non-supervisory console. There will be one supervisory

console/position which will have the capability to access all group addresses within the system, including those used by non-public safety. This position will be the only position capable of dynamically programming group addresses. This position will also receive alarm and system performance status information. Control equipment costs as well as management information system hardware and software costs are included in Exhibit II-4.

Conventional Portable Radio System Interface - non-recurring costs associated with equipment required to interface conventional portables with DATCS are shown in Exhibit II-5.

Conventional portable interfaces will initially be established for Lexington Police, Fire and Sheriff. For Police three channels will be interfaced: dispatch (operations), information, and detective bureau. For Fire and the Sheriff, one channel each will be interfaced.

Those Lexington agencies which are currently portable-only systems (Bluegrass Airport and Fayette School Security) will access the trunked systems through their own dispatcher; since no mobiles are initially planned for these agencies, a portable radio interface will suffice.

2.4.1.2 Maintenance

There will be initial costs associated with developing a self-maintenance capability, as shown in Exhibit II-6. Shown are the major cost items required to develop three maintenance bench positions.

2.4.1.3 PSCC Facility Construction

The costs shown in Exhibit II-7 reflect the minimum square footage requirements outlined in Section 2.3.1.1 - Required Facilities and Personnel, for the following operating areas in the PSCC:

- Complaint Reception

- Dispatch

- Maintenance

- Maintenance Storage Areas

- Vehicle Bays

- Administratative.

Construction industry figures for estimating the cost of these facilities per square foot, as shown in Exhibit II-7 were obtained from Lexington-area contractors and architects. The costs for the PSCC are the only major capital construction cost anticipated with DATCS implementation. A summary of non-recurring costs are shown in Exhibit II-8.

Agency	Control Equipment				
	Control Station $4,000**	Non-Supervisory Control Console $25,000***	Supervisory Control Console $50,000***	Software, Printer, Keyboard - $12,000	Total
. Public Works					
- Engineering	5				20,000
- Sanitary Sewers	2				8,000
- Streets and Roads	1				4,000
- Sanitation	1				4,000
- Traffic Engineering	7				28,000
- Vehicle Maintenance	2				8,000
. Cooperative Communication Center*		5	1	1	187,000
. Sheriff	1				4,000
. Jailer	1				4,000
. Bluegrass Airport	2				8,000
. Fayette School Security	1				4,000
. Division of Housing Services	1				4,000
. Building Inspector	1				4,000
. Parks Department	3				12,000
	28	5	1	1	299,000

* Lexington Public Safety Agencies Dispatch Police, Fire, EMS
** Includes antenna line and installation
*** Includes installation

EXHIBIT II-4
Control Equipment Costs

Number of Control Station				
Existing Radio System	Existing Conventional Channel	Interfaces - $4,500 Pr Interface	Group Address	Total Cost
Public Works	Operations	Not Required	N/A	N/A
Police	Dispatch	1	. Dispatch	4,500
	Information	1	. Information	4,500
	Administration	1	.Detective Bureau/ Administration	4,500
Fire	Dispatch	1	Dispatch or Fire Ground	4,500
Sheriff/Jailer	Dispatch	1	Dispatch	4,500
Bluegrass Airport	Dispatch Talk-Around	1	Dispatch Talk-Around Interagency Administration Maintenance	4,500
Fayette School/Security	Dispatch Talk-Around	3	Dispatch Talk-Around Interagency	13,500
Division of Housing Services	Dispatch	Not Required	N/A	N/A
Building Inspection	Dispatch	2	Dispatch Interagency	9,000
Parks & Recreation	Dispatch	1	Dispatch	4,500
		12		$54,000

EXHIBIT II-5
Conventional Portable
Radio Interface

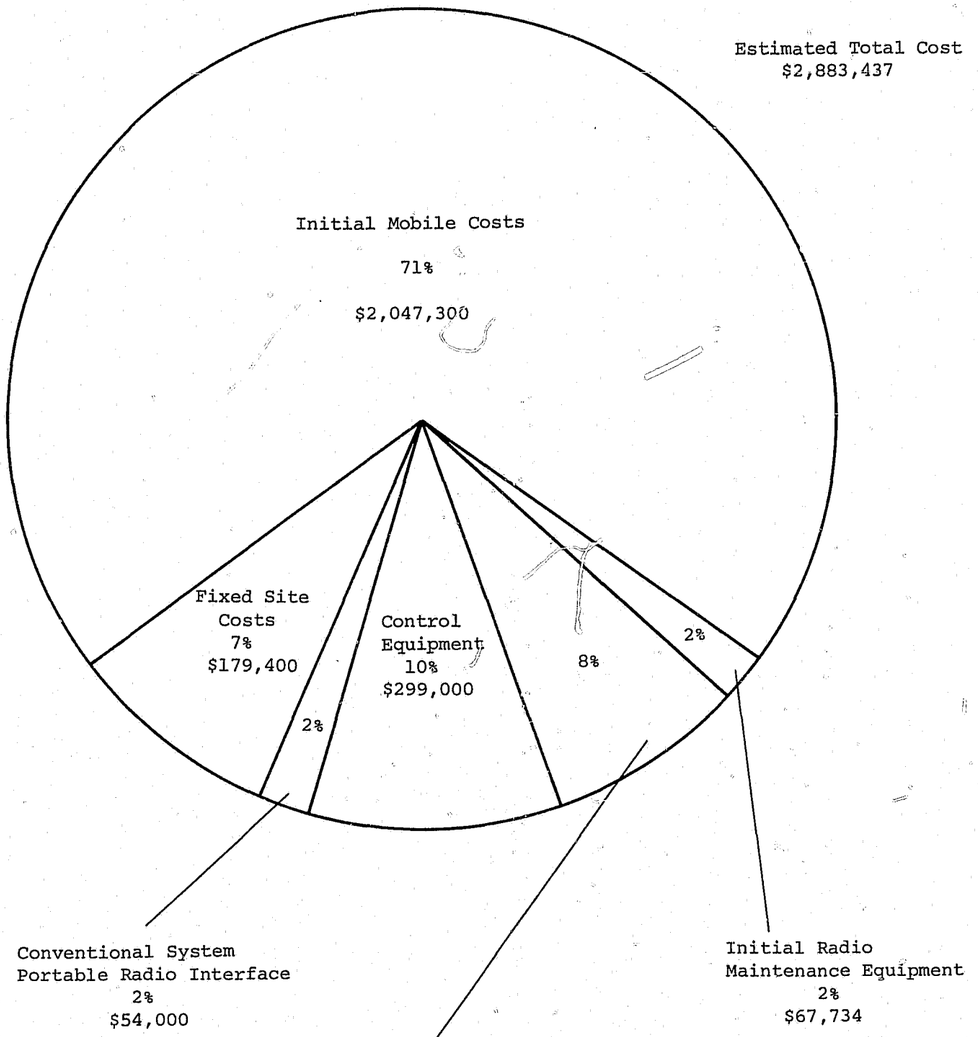
Equipment Per Work Station	Quantity Needed	Total Cost ($)
Service Monitor	3	$21,000
SINAD Meter	1	186
Signal Generator	1	3,552
Audio Oscillator	1	306
AC Voltmeter	3	1,050
VOM	3	1,200
RF Multimeter	3	3,600
Scope	3	12,000
DC 12 Volt Power Supply	3	1,800
Wattmeter	3	300
Set of Elements	3	420
Dummy Load	3	390
Portable Test Set	3	1,500
Cable	3	180
Microwave Adapter	3	45
Universal Control Panel	3	750
Digital Test Set	1	4,275
Logic Probe	1	180
Spectrum Analyzer	1	15,000
Total		$67,734

EXHIBIT II-6
Initial Radio Maintenance
Equipment Costs

Area Description	Square Feet (Cost per ft)	Square Feet	Total Cost
Complaint Reception	55	560	30,800
Dispatch	55	1120	61,600
Maintenance	48	432	20,736
Maintenance Storage	45	200	9,000
Vehicle Bays	45	1215	54,675
Administrative	55	1058	58,192
Total			235,003

EXHIBIT II-7
Common Owned Communications
Center Facility Cost

EXHIBIT II-8
Summary of Non-Recurring Costs



2.4.2 RECURRING COSTS

This section indicates total recurring costs related to operating the Lexington PSCC and DATCS mobile radio system. The recurring costs shown in Exhibit II-9 cannot be evaluated alone since many of these costs are already reflected in current operating budgets, including:

- Dispatcher/complaint operator salaries
- Utilities
- Maintenance Contracts
- Supplies.

Recurring costs, shown in Exhibit II-9, are presented in the following categories:

- Personnel
  - Dispatchers
  - Complaint Operators
  - Maintenance Technicians
  - Management
  - Administration
- Utilities
  - Telephone
  - Energy
- Lease
- Parts.

In evaluating the recurring costs, it is important to consider the new capabilities gained and the improved ability to meet increasing demands for service as well as the elimination of redundant service. These cost estimates should be refined as more detailed information becomes available.

EXHIBIT II-9
Estimated Annual Recurring Cost

Major Recurring Costs	Quantity	Average Cost/ Unit*	Total Annual Cost	Current Cost	Partial Cost	New Cost
Personnel						
. 911 Operator	18	18,000	324,000		X	
. Complaint Operators	27	20,000	540,000		X	
. Maintenance Technicians	4	25,000	100,000		X	
. Management	1	30,000	30,000			X
. Administration	4	25,000	100,000			X
. Support Staff	2	8,000	16,000			X
Utilities						
. Telephone		10,000	120,000		X	
. Energy		5,000	60,000			X
. Antenna Site			10,000			X
Replacement Parts			50,000		X	
Overhead		10,000	120,000			X
Total			1,470,000			

* Burdened

III. REQUIRED IMPLEMENTATION ACTIVITIES

3.1 IMPLEMENTATION PROJECT MANAGEMENT

The purpose of this section is to discuss the actions Lexington must take to assemble an implementation management team, and the roles and responsibilities for members of the management team.

The management and direction of the implementation project should be vested in the project director, supported by staff and an advisory committee. The project director should have overall authority for planning and directing the implementation management team.

Continuity between the planning phase and the implementation phase is desirable. Consequently, management staff should be drawn from persons involved in the planning phase. These persons need to be appointed as soon as possible so progress to date is not lost as a result of the project being dormant for any length of time. Expeditious appointments will also guarantee that momentum of the project will continue to build.

The project director will need to complete, at this time, five tasks:

- Work with the DATCS advisory committee to draft a charter that defines the members roles and responsibility
- Completely define the work that needs to be accomplished during the implementation phase; this SIP will serve as an outline in defining the work
- Define management responsibility and authority over the resources needed to accomplish all tasks
- Prepare time dependent schedules to ensure that progress towards implementation can be measured at all times
- Recommend persons to fill positions in the implementation management team.

Staffing for the implementation team can be from Lexington's existing labor pool. All of the staff need not be assigned to the project director on a full time basis, but should be assigned on a fixed hourly basis per week or month. There are six areas (Exhibit III-1) that need to be staffed:

- Finance - responsibilities include financial planning, developing a detailed schedule of financial milestones, budget management for on-going implementation activities, management of grants and planning for the operations budget.

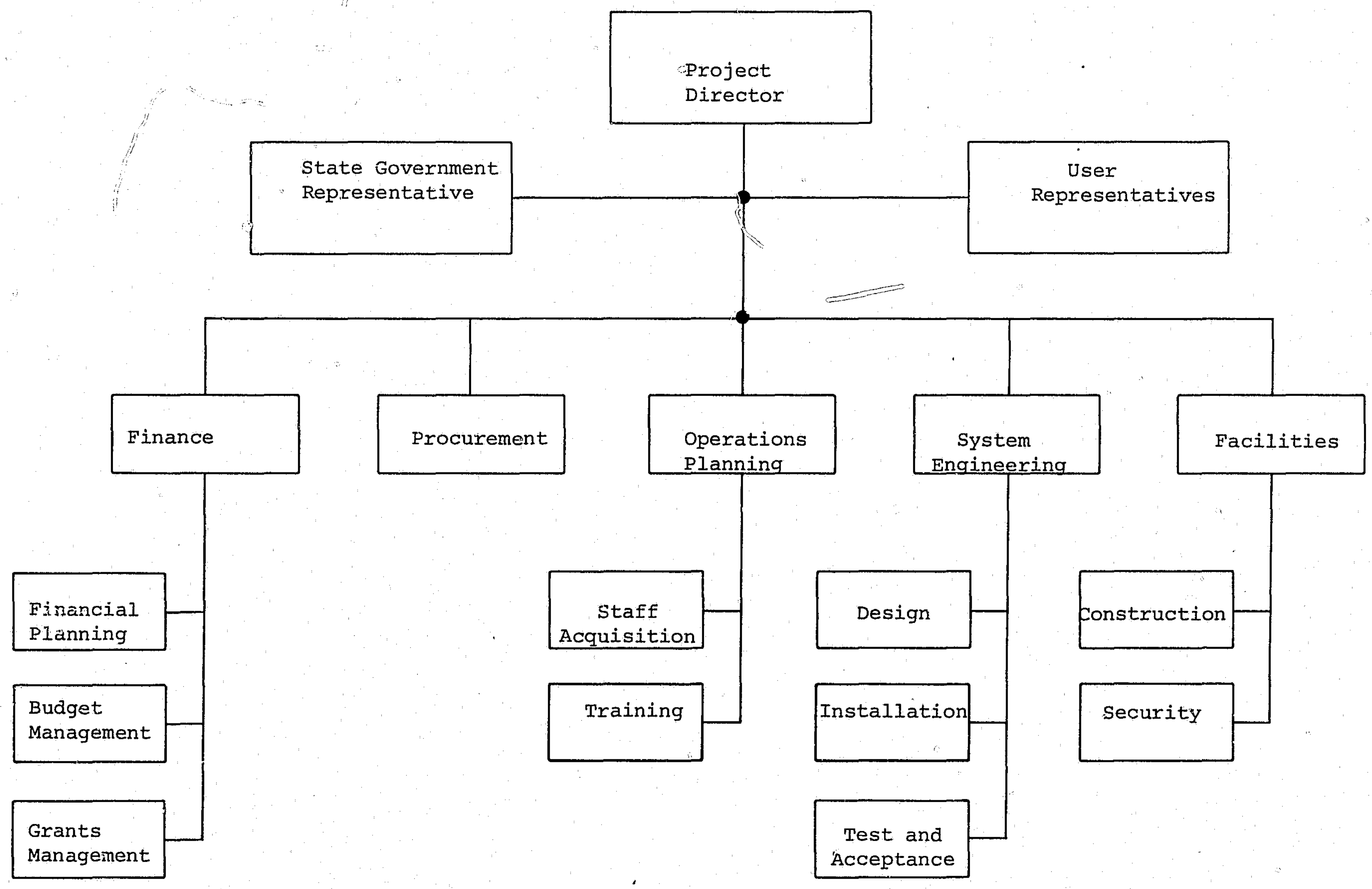


EXHIBIT III-1
Implementation Management Organization

- Operations Planning - responsibilities will be to develop a management concept that will be expanded into a detailed management plan as this plan will identify the roles, responsibilities, qualifications, and number of operations personnel needed

- Procurement - responsibilities will be to develop a bid package to be presented to the vendors, to evaluate vendor's proposals and make recommendations regarding vendor selection

- Systems Engineering - responsibilities include working closely with the technical consultant in designing the DATCS system, preparing the FCC license monitoring the progress of the installation and performing system test and acceptance

- Facilities - be responsible for working closely with the technical consultant in identifying physical plant requirements, building design, and building security.

3.2 AGENCY AGREEMENTS

The purpose of this section is to report the current status of agency agreements and to recommend items that need to be included as part of an agency agreement.

At this time, agency agreement have not been necessary and depending on Lexington's approach in terms of participation, implementation, funding, and management, individual agency agreements on these matters may not be needed. However, Federal Communications Commission regulations require a copy of a basic agreement under which the shared operation of a radio system will take place (Section (90.359). Therefore, a document that describes the roles and responsibilities of users will be prepared. Items that should be part of the agreement are:

- Services to be provided to the participants
- Support provided by the user agency to the system agency
- Facilities and/or equipment the system agency is obligated to provide user agencies
- Funding or cost sharing by agencies
- Conditions under which the agreement can be modified
- Authority of the project director.

3.3 FUNDING

The purpose of this section is to identify potential sources for funding, define the role/responsibility of management in securing funds and to outline a strategy of approaching funding sources.

The success of Lexington's implementation of DATCS will depend on the city's success in locating funds. These funds are needed for equipment, facilities, and on-going expenses.

Possible sources for one-time capital expenses are:

- State grants-in-aid
- Federal grants
- Grants from private sources
- Bond issues for capital expenses
- Gifts from private sources.

Possible funding sources for on-going costs are:

- Taxes
- Shared revenue from state government
- Other municipal revenues.

The overall responsibility for securing funds will rest with the management team. This responsibility will involve the development of a strategy that will include:

- Identifying sources of funds
- Targeting key individuals in state and federal agencies, that will be approached for funds
- Follow through on leads, commitments, and delivery.

Development of the funding strategy should be coordinated with the State Law Enforcement Communications Coordinator (LECC) as his active interest has been instrumental in the success Lexington has had in receiving funds.

3.4 OPERATING MANAGEMENT, PERSONNEL AND TRAINING

The purpose of this section is to identify the planning needed for system operation in terms of management, personnel resources, staffing, training and system manuals. It is not appropriate at this time to draft a detailed operations plan since many areas have not been defined, including the PSCC concept*. The level of staffing, staff qualifications and needed staff experience to implement PSCC concept of operation.

* This concept involves the combining of certain public safety communications features such as complaint reception, system maintenance, system management and collocating dispatch in such a way each division is in control of its respective operation.

To insure project continuity members of the implementation management team should be given first preference when staffing the operations management team.

Staffing of all positions will most likely be accomplished through the city's existing labor pool. Therefore, the staffing plan should be drawn up with the assistance of the city's personnel people. The role of the personnel people will be to assure that civil service requirements are met and city personnel procedures are followed.

The PSCC concept of operation will set the baseline for estimates of categories and quantity of personnel needed to staff the PSCC. This concept of operation will be followed up by a detailed personnel plan. The personnel plan will include organization and information flow charts that detail the categories and quantity of persons needed, as well as the qualifications needed for each staff position. The major source of personnel is the existing labor pool. It is desirable for the city to draw on these experienced people for staffing.

A training plan will need to be developed using the PSCC concept of operation, the DATCS system concept, and information provided by the vendor of choice for each piece of hardware. The training plan will be in two parts:

- Operations
- Maintenance.

These plans will address both initial training and refresher training. It is best to have the vendor develop training plans under the guidance of a member of the management team since the vendor is familiar with the equipment being supplied as well as the installation. The training manual will be the operating procedures manual, prepared by the vendor in accordance with the equipment purchase and the system installation with significant input from Lexingtons management team. It is expected that the procedures manual will be updated as the system is put through the test and acceptance phases. The manual will be further updated as hands on experience is gained by users and as the system configuration changes. Maintenance training also will be conducted by the vendor. Ideally, maintenance personnel should participate in regular service training courses given by the vendor factory representative. Training will be ongoing due to personnel replacement and the need for regular refresher courses.

3.5 PUBLIC SAFETY COMMUNICATIONS CENTER (PSCC)

The purpose of this section is to point out the progress to date on planning and implementation of the PSCC. At this time Lexington needs to develop a concept of operation and an implementation plan for a PSCC. There are three areas that need to be addressed:

- Facility
- "911"
- Computer Aided Dispatch (CAD).

The Lexington Project Director will need to define the requirements, concepts, and implementation plan for the PSCC. Assistance from an outside professional firm experienced in system and facility design will be desirable at this point. This assistance will assure Lexington that the requirements and concept of operations will precisely match the city's needs and industry offerings.

The time table for completion of the PSCC is uncertain at this time. The date of completion will be dependent on Lexington's start of development of the PSCC requirements, availability of funds, rate of hardware development, the completion of physical plant facilities, systems installation system test and acceptance.

3.6 FCC LICENSING

A signed contract defining the equipment to be purchased and the quantity of that equipment will provide sufficient information to file applications with the FCC for system licenses. Present FCC practice for licensing 800 MHz trunked system requires the following minimum submission:

- Form 400 for each license requested (Section 90.357)
- Agreements with each user agency relative to control of the system (Section 90.179)
- Agreements with each user agency relative to cost-sharing of installation and operation (Section 90.179)
- Financial plan showing the serivce will be provided to user agencies at cost (Section 90.359)
- System description and specification (Section 90.359, Section 90.371, Section 90.375, and Section 90.379)
- Eligibility statement for each user (Section 90.359)
- Evidence of purchase orders placed for the equipment.

It is probable that FCC waivers will have to be asked to extend the number of years for phased implementation of the system (Section 90.375).

Technical support for negotiating system licenses with the FCC will be requested for the engineering consultant and from the system contractor.

3.7 PROCUREMENT AND POST IMPLEMENTATION SUPPORT

The purpose of the section is to present a "theoretical" time table for procurement, discuss the current status of the Statement of Work (SOW) and articulate post implementation support activities.

At this time there are still too many uncertainties to define an exact procurement time table. However, a time table has been prepared that shows a "wish list" for start and completion of each task necessary for procurement of an advanced communications system Exhibit III-2. Facility construction milestones, along with 911 and CAD milestones are shown on this time table to the extent that they effect implementation of DATCS (i.e., the construction of the PSCC must be completed before installation of the DATCS, 911 and CAD hardware begins).

A functional SOW has been prepared and is contained in Appendix C. The major elements of a high technology SOW are described therein.

During the implementation phase post implementation support activities will be defined in terms of continued funding, personnel needs, training and system evaluation. This role will fall to the implementation team members as appropriate.

Continued funding sources should also be defined. Recurring costs usually cannot be funded by State or Federal sources and the city will likely have to pay these costs from its operations budget. These costs will include: personnel facilities maintenance, equipment maintenance, equipment replacement, leases or rents, utilities, supplies, and training.

Post implementation evaluation is usually required for projects in which Federal grant funds are used. Evaluation is recommended for those systems not funded by federal grants. This evaluation plan should be prepared during implementation the plan will detail the data to be recorded, method of data collection, procedures for measuring data when the data is to be recorded, and evaluation report format and distribution.

The evaluation report should be results oriented. The report will include both system financial effectiveness and management effectiveness. This report, if thoughtfully constructed, can be an important management tool. In addition, the report can significantly enhance the city's position when applying for additional Federal funds.

EXHIBIT III-2
Implementation Schedule

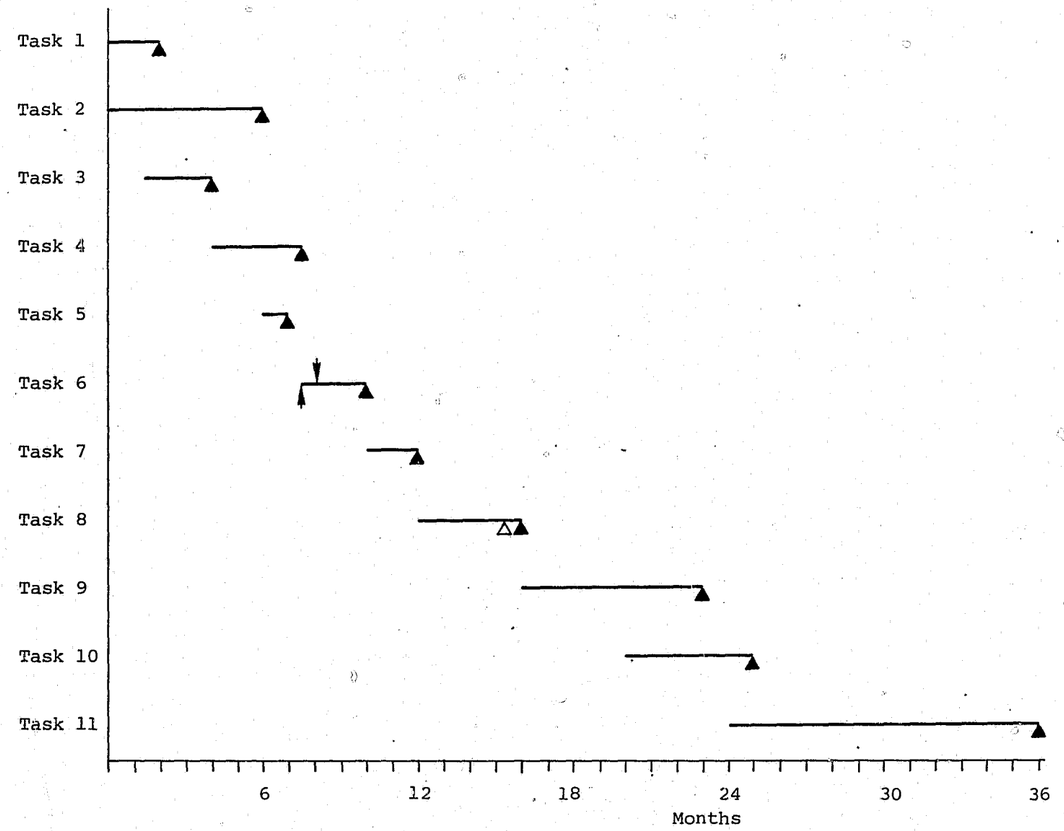


EXHIBIT III-2.1

Task 1 - Appoint an advisory committee, appoint members of the management team, secure outside technical assistance, prepare agency agreements.

Task 2 - Develop and implement a funding strategy, have commitments for funding of the system.

Task 3 - Document and analyze, PSCC, 911 and CAD requirements, develop a concept of operation from the analysis and a system design concept for advisory submission to the FFCC.

Task 4 - Develop a complete statement of work for DATCS, PSCC, 911 and CAD.

Task 5 - Revise the final system concept to correspond with FCC regulations.

Task 6 - Solicit bids for the system, conduct bidders conference, receive bids.

Task 7 - Proposal evaluation and contract award.

Task 8 - Equipment ordering, system license, PSCC physical plant complete.

Task 9 - Equipment Delivery Installation of DATCS, 911, and CAD

Task 10 - System test, acceptance and personnel training

Task 11 - System cutover and evaluation

APPENDIX A

CURRENT SYSTEM INVENTORY

Lexington's present mobile radio communications systems consist of the following seven separate, individual operating systems and one system in development:

- Metro Police
- Fire Department
- Fayette County Sheriff's Department
- Public Works
- Fayette County School Security
- Bluegrass Airport
- Emergency Medical Services (EMS)
- Lextran (proposed bus system).

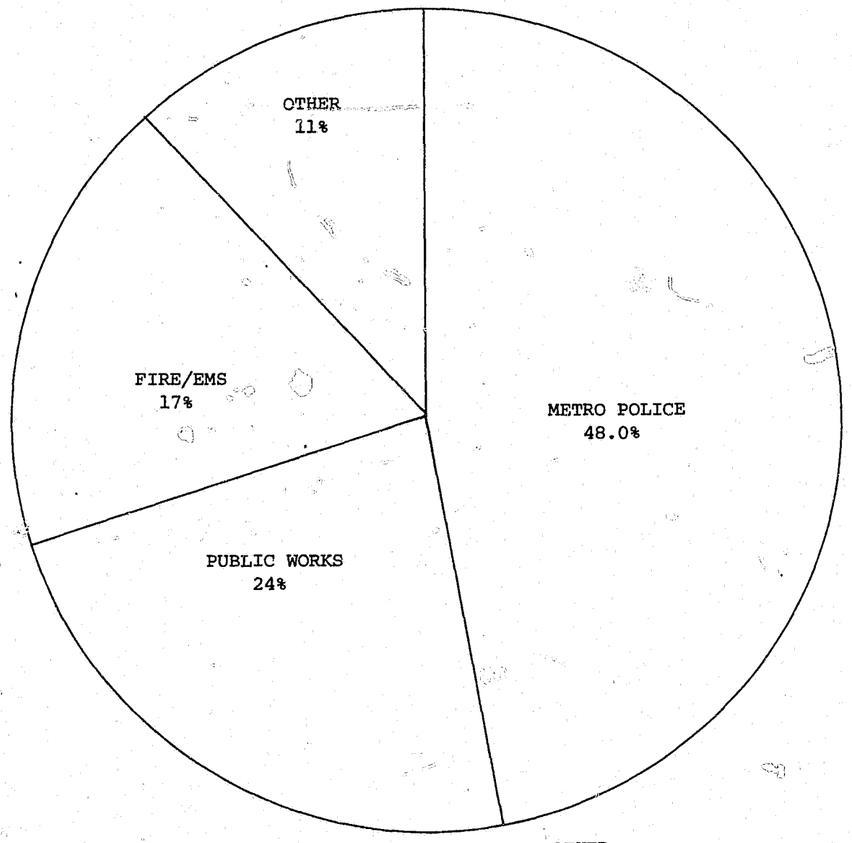
Exhibit A-1 summarizes the current situation of each radio system.
Exhibit A-2 shows the current radio equipment distribution in Lexington.

EXHIBIT A-1
Lexington's Present Mobile Radio
Communications Systems

System Title	Number of Channels	Number of Mobiles	Number of Portables	Number of Control Stations	Total Number of Units
. Police	4	340	134	4	478
. Fire	2				185
- Fire		84	65	15	
- EMS	*	6	0	0	
- Civil Defense		0	0	15	
		90	65	30	
. Sheriff	3				73
- Sheriff's Department		44	16	1	
- Jailer		6	5	1	
		50	21	2	
. Public Works	1				238
- Engineering		24	0	5	
- Sanitary Sewers		22	8	2	
- Streets & Roads		24	1	1	
- Sanitation		28	0	4	
- Traffic Engineering		16	2	7	
- Vehicle Maintenance		5	0	1	
- Parks & Recreation		45	5	4	
- Housing Services		18	0	1	
- Building Inspection		13	0	2	
		195	16	27	
. Fayette School Security	2	0	28	1	29
. Bluegrass Airport	2				17
- Police		2	5	0	
- Fire		3	1	1	
- Administration		0	1**	0	
- Maintenance		4	0	0	
		9	7	1	
TOTAL	14				1020

* Does not include number of EMS channels
** Vehicular mounting

EXHIBIT A-2
Lexington's Present Radio
Equipment Distribution



OTHER:

- Sheriff/Jailer
- Airport
- Fayette County
  School Security

APPENDIX B

LEXINGTON DATCS SYSTEM REQUIREMENTS

1. FUTURE MOBILE RADIO REQUIREMENTS OF INDIVIDUAL AGENCIES

The information presented in this appendix is based on interviews with key department heads. The interviews focused on each agency's future mobile radio needs in terms of the question: What minimum capabilities and features of a mobile radio system are necessary to support your present and future business function and to what extent would additional capabilities enhance your department's effectiveness or safety of personnel?

In summarizing the finding of the interviews, the future mobile radio system* should:

- Be adaptable to allow for growth in services as necessary to accommodate a rapidly expanding population (Exhibit B-1)
- Be flexible since the exact growth in any specific agency is difficult to predict
- Provide for a high degree of interagency communications to an extent not realized today
- Immediately provide additional channels to relieve channel congestion
- Serve as a management tool for monitoring the status of all resources and be able to deploy resources when necessary, thus enhancing departmental efficiency and, in the case of public-safety, also enahncing officer safety.

Exhibit B-2 depicits a summary of Lexington's future requirements in terms of number of channels, mobiles, and portables for each agency. The future requirement of each agency addressed in this section encompass immediate needs as well as future needs projected for Lexington-Fayette Urban County within the next five years.

1.1 Metro Police

The present Metro Police radio system is dependent upon a single channel to dispatch all city and county patrol units as well as to communicate instructions to non-patrol personnel (i.e., detective, juvenile, etc.). Because the number of mobile units on this channel is already large (340 mobiles and growing), the future Metro Police radio system should be capable of segmenting police communications into:

EXHIBIT B-1
Population Projection for
Lexington-Fayette Urban County

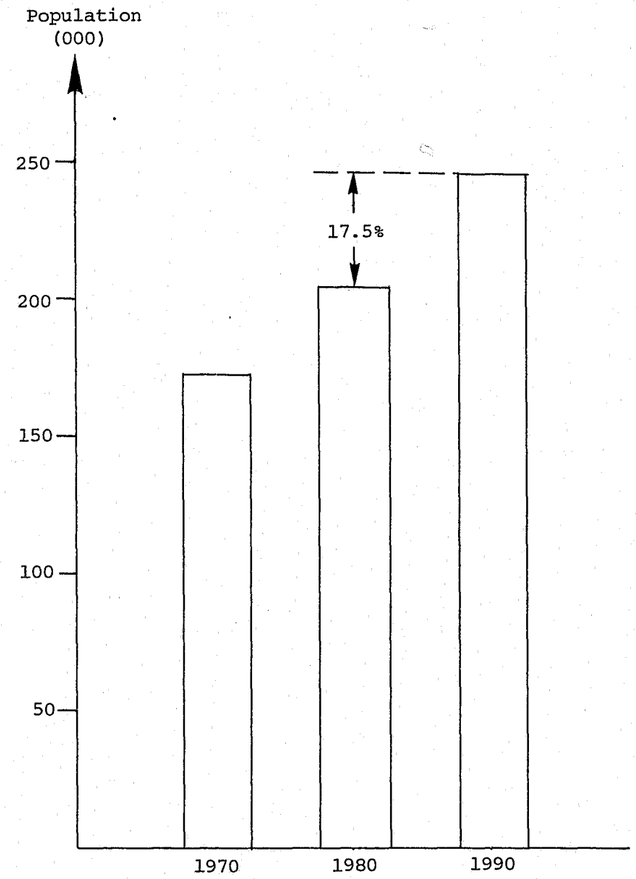


EXHIBIT B-2
Lexington's Projected
Five Year Requirements

Agency	Number of Channels	Number of Mobiles	Number of Portables	Number of Control Stations	Total Number of Units
. Police	5	445	284	5	734
. Fire					
- Fire	4	90	55	17	162
- EMS	0	6	0	1	7
- Civil Defense	0	0	0	15	15
	4	96	55	33	184
. Sheriff	2	51	16	1	68
. Jailer	1	0	20**	1	21
	3	51	36	2	89
. Public Works					
- Engineering	1	25	4	5	34
- Sanitary Sewers	1	30	2	2	34
- Streets & Roads	1	25	0	1	26
- Sanitation	1	28	7	1	36
- Traffic Engineering	1	20	2	7	29
- Vehicle Maintenance	1	9	0	2	11
	6	137	15	18	170
. Fayette School Security	1	6	37	1	44
. Bluegrass Airport					
- Police	1	0	8		10
- Fire		0	4	2	4
- Administration	1	0	1		1
- Maintenance		0	4		4
	2	0	17*	2	19

* To include vehicular charges
** 12 are vehicular units

Agency	Number of Channels	Number of Mobiles	Number of Portables	Number of Control Stations	Total Number of Units
. Division of Housing Services	1	26	0	1	27
. Building Inspection	1	17	1	1	19
. Parks and Recreation	1	50	5	3	58
TOTAL	24	828	450	66	1344

EXHIBIT B-2 (Cont'd)
Lexington's Projected
Five Year Requirements

- Three sector channels, one channel for each sector
- Non-patrol operations channel, to serve detective bureau, traffic bureau, administrative, etc.
- Tactical channel, to localize communications concerning a single event.

Presently, an officer reports status information verbally (i.e., 10-7 10-8, etc.), often in competition for air time with more urgent information. To separate low priority status reporting communications from more urgent, priority dispatch, the future system should have the capability to automate status reporting, possibly via pushbutton. In this way, each dispatcher will realize the status of each unit through a visual indication. This capability will become critically important as Metro's fleet size expands beyond the human ability to manage resources by conventional, manual techniques.

Presently, the Metro Police force has 130 portable radios, or approximately one portable for every three patrol officers. Because of concern for officer safety and demand for improved police efficiency, there is an on-duty patrol officer, and in many instances, with selected non-patrol personnel. Growth in the use of portable radios by Lexington from 55 in 1975 to 130 in 1980 demonstrates that it is reasonable to expect 200 to 250 protable radios by 1985. The limiting factor on their complete adoption for patrol by police administration is their 25 percent cost premium over a mobile and almost double maintenance cost, although the trend is toward lowering this cost differential.

At present, there is no mobile-to-mobile communications capability between Metro Police and other Urban County public-safety agencies. However, there is a definite need for Metro Police to communicate directly with:

- Fayette County Sheriff
- Jailer
- Airport Public-safety
- Fayette County School Security
- Fire
- Emergency Medical Services (EMS).

The future mobile radio system should permit mobile-to-mobile communications between Metro Police and these agencies when a dispatcher determines that mutual coordination is required.

As with most municipal mobile radio systems in the United States, a management structure does not exist for dealing with large-scale events involving multiple public-safety agencies (i.e., plane crash, hostage situation, etc.). Even if Metro police could communicate directly with the Sheriff's Department, Fire Department, EMS, Airport Police, etc., a mechanism is not presently in existence for managing all resources at the scene. Accordingly, the future

system should posses a management structure which permits a single entity (i.e., Emergency Operating Center (EOC)) to coordinate all resources at the scene, without interfering with each agency's discretionary influence. Feasibility of establishing such a structure is partly technical (availability of a clear channel for coordination) and partly procedural (articulation of policies). If Lexington evolves toward an EOC-type arrnagement in the future, both technical and procedureal issues must be thoroughly considered during the planning process.

1.2 Fire Department

The present Fire Department system utilizes a single dispatch channel and a single fire ground channel, neither of which provides interagency communications with other public-safety agencies. The future communications system should also provide a single dispatch channel, but must be capable of several "fire ground" operations simultaneously. In this way, several fire events can be managed independently, without interference. While no firm requirement was expressed for a common coordination channel with Metro Police, the future communications system should provide the capability to directly communicate with Metro Police and other public-safety agencies when the need arises, as determined by a dispatcher.

In the same manner as Metro Police, the Fire Department is also trending toward increased portable communications for "fire ground" operations and the conduct of routine inspections. As a result, the future system must accomodate possibly 100 percent portable operations. High initial purchase and ongoing maintenance costs are still considered the primary limiting factors to increased adoption of portables.

1.3 Fayette County Sheriff and Jailer

The present Sheriff's Department radio system mutually serves the Sheriff's Department and the jailer via three channels, although dispatch and alerting are performed on only one of the three channels. The future radio system should provide separate channels for jailer and sheriff operations, but with the capability of switching between channels for interagency communications. Because of the need for frequency assistance, the sheriff and the jailer should also be equipped with the primary channels of the following agencies in order of priority: fire/EMS dispatch, Metro Police information, and Metro Police portable radios for the jailer, the future mobile radio system should accommodate multichannel portables.

1.4 Public Works

The Public Works system presently utilizes a single-channel radio system to support the services of nine separate divisions, six of which are divisions of Public Works. The future Public Works radio system will provide a radio channel dedicated for each division of Public Works will be accommodated separately in the future system. In this way, for example, communications among the Streets and Roads Division will not interfere with Traffic Engineering.

Because there is frequent need for divisions to intercommunicate at the supervisor level, selected units within each division should be capable of communicating directly with units in any division on an "as-needed" basis; non-supervisory units, on the other hand, should be capable of communicating with units only within their respective division.

Each division headquarters should be capable of communicating directly with not only their own respective units, but also with units/headquarters of all other divisions within Public Works.

The addition of several operating channels will have the clear effect of reducing the time required to access a channel, minimize user frustration, and encourage each user to be more attentive toward each radio message since most irrelevant communications will be eliminated.

To enhance channel discipline and insure accurate understanding of each unit's identification, every unit will automatically transmit the identification of the unit upon each transmission.

1.5 Airport Public-safety Agencies

The current airport radio system does not provide radio communications directly with Urban County public-safety agencies. Consequently, operations requiring mutual aid are hampered by the lack of coordination capability. The future system will provide radio communications between the airport and Lexington public-safety agencies when required, particularly Metro Police, Fayette County Sheriff, and the Fire Department.

Because of the nature of airport operations, portable radios will continue to be the dominant means of communications. The future radio system must provide multichannel portable radios if the airport is to participate fully. If portable radios are not available, then a public-safety radio interface must be established at the Airport Control Center.

1.6 Fayette County School Security

School Security is proposing an additional shift to meet the need for night security. Security officers added to the existing department will each require a portable radio. Presently, school security dispatch has direct radio communications with the Fire Department on Fire Channel to provide quick response to fire and first aid calls reported to School Security Dispatch; an interface with fire must be continued, referably to the extent that field security could report an incident directly to fire. The future system should also provide an interagency communications capability to field personnel on an "as-needed" basis; contact with EMS and Metro Police are the most critical.

1.7 Division of Housing Services

Presently, Housing Services shares the use of the Public Works radio system as a matter of convenience to Housing Services. The future radio system should provide communications not necessarily with Public Works, but rather with several other agencies with whom Housing Services have expressed a need to communicate directly:

- Division of Building Inspection
- Fire Inspection Division, Fire Protection Bureau.

A channel dedicated for Housing Services should be provided. Future plans to improve communications within Housing Services may have to be approved by Community Development, within Housing Urban Development (HUD) if HUD is to finance a prorated share of the conversion costs.

1.8 Division of Building Inspection

As with Housing Services, Building Inspection also shares the use of the Public Works radio system. The future radio system should provide communications with only selected divisions and a few public-safety agencies with which day-to-day interfaces exist, as listed below:

- Public Works, Division of:
  - Engineering
  - Traffic Engineering
  - Metro Police (dispatch)
  - Fire (dispatch)
  - Housing Services.

1.9 Parks and Recreation

Parks and Recreation also presently shares the Public Works radio system. The future system should provide a channel dedicated to Parks and Recreation with the additional capability to directly communicate with the following Divisions of Public Works on an "as-needed"basis:

- Streets and Roads
- Sanitary Sewers
- Sanitation.

The future operation is anticipated to continue to be assisted predominately by mobile radio.

2. FUTURE MOBILE RADIO SYSTEM REQUIREMENTS

The preceeding section described the mobile radio requirements of individual agencies. Requirements also exist at the system level. This section describes those system requirements which are critical to each agency's operation, but which have been developed based on a broad perspective of the overall operation of all agencies combined.

The following system requirements, which fall into several categories, should be satisfied regardless of whether the city decides to refurbish existing equipment or develop a commonly owned, city-wide communications system:

- Management
  - Overall communications system management responsibility must be defined.
  - System management guidelines, controls, and operational policies should be established for the next generation system(s)
- Configuration
  - The system must be initially capable of providing at least nine dispatch points, geographically distributed, with several dispatch positions at some locations
  - The system must be expandable to include new user agencies
- Land Area Coverage
  - The system must provide radio coverage throughout Fayette County, including all fringe areas
  - The system must be expandable to provide portable radio coverage, if required
- Addressing
  - The system must be capable of supporting a minimum of 2,000 mobile and portable units
  - The system must provide for at least 30 individual "channels"*
  - The system must be software adaptable to include or exclude specialized groups or discrete units or to recognize the group addresses
- Performance
  - The time to access a channel by any user should not exceed 0.5 seconds under normal busy hour traffic conditions
  - The system must permit any group of mobile units to be transferred to any dispatch position within the system

* Not necessarily of channels.

- Voice privacy should be enhanced to the extent practical

Interconnectivity

- The system should be able to interconnect with the public telephone network
- The system should permit the use of conventional portable radios

Reliability

- Redundancy of key facilities will be provided
- Failed equipment will be automatically indicated at a central control facility.

APPENDIX C

FORWARD

The recommended elements of the Statement of Work are described as a major part of the System Procurement subsection in Section III of the SIP Guide. This appendix is intended as a topical outline of a typical Statement of Work (SOW) for quick reference by the planner or system procurement manager. The SIP Guide provides supporting material for this topical outline.

The following outline adheres to the recommended order of topics for a high technology system SOW. The planner or system procurement manager is cautioned to employ only those elements of the outline which relate to the specific procurement and which can be accurately evaluated or measured.

STATEMENT OF WORK

I. INTRODUCTION

The Introduction to the Statement of Work (SOW) should provide a general overview of the project to enable a better understanding by the responders. The key elements of this appendix are outlined in the following subsections.

1. Background of the Project

A brief historical description of the origin of the procurement and the constraints imposed on the design.

2. Objective of the Procurement

A brief discussion of the main system objectives to be achieved by the procurement.

3. Scope of the Procurement

A basic and brief outline of the hardware, software, and services that are being purchased. These may include, for example:

- Hardware
- Software
- System Design
- Installation
- Testing
- Training
- Maintenance.

II. INSTRUCTIONS TO BIDDERS

This section of the SOW will provide the bidders with all the information needed to respond correctly to the bid request.

1. Procurement Schedule

The schedule time and dates for responding to the bid request will include:

- Time and place of the pre-bid conference
- Time and place bids and proposals are due

- Bid and proposal opening time, date, and place
- Proposed contract award date
- Expected date of contract completion.

2. Authorized Contracts

The persons who are authorized to respond to bidders' requests will be identified prior to bid opening. These may be restricted to the:

- Procuring officer
- Technical consultant.

The statement should be made regarding how the issues raised by these contacts will be reported to the other bidders.

3. Bid and Proposal Requirements

Each of the items to be submitted as part of a responsive bid will be defined. Any limitations should be included in the description. These items would include, for example:

- Itemized cost proposal
- Technical proposal
- Management proposal
- Provisions for alternate proposals
- Proposal limitations regarding page count, standardized forms (cost proposal), proposal size, unnecessary artwork, and number of copies to be submitted.

4. Qualifications of the Bidders

The contractor for a high technology system must be qualified, technically and financially, to complete the required work. These qualifications should be expressed in the SOW by requiring reasonable responses to limits imposed on:

- Bidders' facilities and financial resources
- Performance history in terms of references and a list of similar and recent contract work
- Support facilites such as field maintenance shops, training facilities, and spare parts replacement depots
- The quality and availability of personnel for management, supervision, and technical staff.

5. Proposal Evaluation Criteria

Criteria should be established for the comparative evaluation of:

- Technical proposals
- Cost proposals
- Management proposals.

These criteria should be clearly defined in the SOW so that each bidder will understand the emphasis placed on the requirements of the RFP.

6. Contract Award

The SOW will identify the type of contract to be awarded the successful bidder whether or not this contract will be awarded without pre-contract discussions.

7. Indemnification

The purchaser should require indemnification against damages imposed through intentional or unintentional acts of the contractor. High technology system procurements will need indemnification against the improper use of patented items or processes. All procurements which include services such as installation and test will be well advised to require indemnification from damages resulting from the actions of contractors' employees or agents.

8. Titles and Rights

Rights of the purchaser and ownership of titles will be clearly defined by the SOW. These items include statements related to:

- The transfer of title to equipment and software
- Rights to data and software developed or provided as part of the contract
- Rights and title to the submitted proposals
- The right to reject proposals
- The right to negotiate with any bidder
- The right to cancel negotiations or the contract.

Legal counsel should be consulted for the scope, content, and wording of this subsection of the SOW.

9. Bonds, Insurance, and Warranty

Each governmental entity will have its own limits for, and description of, the bonds, insurance and warranty provisions for contractor provided material and services. Frequently there will be state regulations which also must be adhered to. These requirements will provide for:

- Performance bonds
- Workman's compensation
- Comprehensive liability insurance
- Warranty on workmanship and materials.

The purchasing department of the major governmental agency included in the program will provide counsel as to how these requirements are to be included in the SOW.

10. Costs of Proposal Preparation

The SOW should state clearly that any costs related to the preparation of bids or proposals can not be included in the proposed cost of the project or billed back to the purchaser in any manner.

11. Contract Disputes

At the option of legal counsel, the SOW may indicate the means by which the governmental agency resolves contract disputes. This will be a function of the governmental body and will not be an option of project management. These provisions may include:

- The procedure and method of resolving contract disputes
- Termination of contracts for cause
- The assessment of liquidating damages
- The identity of the court of jurisdiction.

12. Applicable Federal/State Laws and Regulation

When State or Federal laws/regulations affect the system design, its operation, or allowable use, these laws or regulations should be identified in the SOW.

III. SCOPE OF WORK

This section of the SOW defines the items of work expected of the contractor; the specific tasks required by the contractor are described in detail.

1. Services to be Provided

High technology systems will require professional services to be performed by the system contractor in addition to the delivery of hardware and software items. Typical services to be provided are:

- System design which can include system engineering, radio propagation engineering, software development, and hardware development.
- Installation and debugging of hardware and software.
- Assistance in procuring required licenses and permits.
- Developing and conducting performance tests and acceptance tests.
- The preparation of sites and facilities which can include construction, HVAC, emergency power, lighting, installation of utility services, etc.

2. Deliverable Items

Each deliverable item should be identified in the SOW. Deliverable items include hardware, software, and services. The list will be unique to the complexity of the system to be procured. However, there will be some items common to all lists such as:

- Each item of electronic or radio hardware
- Each item of computer software
- Maintenance support
- Spare parts and spare module provisions
- Towers, buildings and other structures
- Manuals and documentation such as test plans, test procedures, maintenance manuals, operators manuals, user manuals, training aids, installation drawings, and test reports
- Progress reports and deficiency reports.

3. Delivery Schedules

Each deliverable item should be supported by a delivery schedule. The SOW will require a formal and contractually obligated schedule for:

- Each item of electronic or radio hardware
- Each item of computer software
- Each tower or building
- The completion of all facility preparations
- Delivery of all manuals and documents
- The time and place of technical progress reviews
- The delivery of reports including progress reports, test reports, discrepancy reports, and the final report or acceptance test report.

IV. SYSTEM SPECIFICATION

The system specification is a complete technical system description which includes the system performance, system interfaces, and system configuration. It places technical limits on these parameters and adds reliability and/or maintainability requirements where appropriate.

1. Hierarchy of Specification and Standards

Industry or regulatory specifications or standards frequently apply to the specification of a system. These should be identified. The hierarchy of these documents, as they apply to the system specification, should be defined so that conflicts between them can be resolved.

2. System Description

The system description includes the configuration of the system elements and their interconnection with each other. It is recommended that this be done graphically with supporting written clarification. The system description is derived from the system concept design.

3. System Interfaces and Supporting Services

The means by which the system interconnects with the world outside of the system should be fully described. These interfaces are relatively unique to each individual system, but some key interfaces will include:

- External communication systems such as mobile radios, private telephone systems, data processing, digital data systems, alarms, microwave transmission systems, and similar facilities
- Utility systems such as public access telephone systems commercial power systems, and water supplies

- Emergency operations such as emergency power services, fire protection, emergency medical services, and civil disaster prevention operations.

4. System Software

The system specification will include a complete description of the operations software and the applications software required to provide the needed system performance.

5. System Operation and Performance

The specification of system operation and performance is tailored to meet individual system requirements as developed in the system concept. Typically these specifications will include a complete description of:

- The functional modes of system operation for routine system performance, emergency system performance and allowable fail-safe or degraded levels of performance.
- The calculated levels of personnel staffing for the operating staff, maintenance staff, and system management.

6. Expansion Requirements

Frequently, limitations on funding or other resources will prevent the initial implementation of a sophisticated system from realizing the full potential of system operation, scope, and performance. When these expansion requirements are part of the initial system procurement, they must be fully described in the system specification.

7. System Licenses and Approvals

High technology systems may exceed the apparent limits of Federal or state licensing regulations and extraordinary procedures may be needed to acquire the necessary permits or licenses. These requirements should be clearly defined in the system specification. They will be unique to each specific system configuration and intended operation.

V. EQUIPMENT SPECIFICATIONS

The equipment specifications define the quality and performance characteristics of each item of hardware and software needed to meet the system specifications. The identity of each hardware and software item is derived from the system configuration diagram which was developed as part of the system concept.

1. General

This subsection of the equipment specifications accumulates all items of the individual equipment specifications requirements that are common among all items of equipment or software. It also defines the quality and quantity of each item of hardware and software that is required to meet the system configuration. Typical items that would appear under the general heading are:

- Applicable industry standards or publications and their hierarchy for this program
- Standard environmental conditions such as temperature, humidity, primary power, vibration, shock, dust, and dirt
- Deliverable equipment lists showing the quantity required of each item including spares
- The required level of quality and workmanship for each hardware item.

2. Individual Item Specifications

Each equipment item will have an individual technical specification which reflects its construction and performance as required to meet the system specification. These are derived individually from the severe than those needed to meet the system performance specifications. Software specifications are typically combined with the equipment specification for the computer subsystem or the switching subsystem in which they are resident.

III. STATE OF OKLAHOMA

System Implementation Plan - Draft

Submitted to:

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SYSTEM IMPLEMENTATION PLAN FOR THE STATE OF OKLAHOMA DIGITALLY ADDRESSED TRUNKED COMMUNICATION SYSTEM

November 15, 1980

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I. INTRODUCTION

This system implementation plan for a digitally addressed trunked communication system (DATCS) for the State of Oklahoma was prepared by Booz, Allen and Hamilton and the Associated Public-Safety Communication Officers (APCO) in response to LEAA Grant No. 79-SS-AX-0013.

1. BACKGROUND AND OBJECTIVES

The Second Report and Order in the proceedings related to Docket No. 18262, published by the Federal Communication Commission (FCC) in 1974, promised relief of the increasingly more difficult problems of frequency congestion in the public-safety community. These proceedings allocated 200 channels in the 800 MHz portion of the spectrum for "trunked" systems. In February 1977, LEAA recognized that many technical, economic, and management questions about the applications of this newly available spectrum to public-safety operations must be answered before the potential benefits inherent in trunked systems could be made available. Under LEAA Grant No. 77-SS-6009 APCO was requested to analyze these problems, make appropriate recommendations for future actions, and describe a program to demonstrate the potential capabilities of these new concepts.

A series of programs under APCO Project 16 were initiated. The first of these (Project 16) resulted in an analysis of the technical and regulatory factors affecting the applicability of the 800 MHz portion of the radio spectrum to law-enforcement communication system problems. A second program (Project 16A) identified the specific operational capabilities and functional requirements that should be incorporated into a public-safety trunked communication system. The third program (Project 16B) provided specific planning assistance to two cities (Lexington, KY and Phoenix, AZ), two counties (Bucks Co., PA and Salt Lake County, UT), and the State of Oklahoma for the feasibility study and implementation plan for DATCS demonstration systems.

Since February 1980, Oklahoma has been participating in Project 16B as one of the demonstration areas. The key objectives to be achieved are:

- To determine the feasibility of DATCS to relieve statewide radio channel congestion
- To establish the potential of DATCS to accommodate future statewide radio communications needs
- To address the solution of the complex command/ control problems confronting the public-safety agencies
- To develop a common DATCS to support all public-safety and/or other governmental communications requirements within the State of Oklahoma
- To provide a solution to interagency radio connectivity between governmental agencies appropriate to their mission responsibilities.

Other advantages of operational flexibility are inherent in a dynamically programmed digitally addressed communication system. These have been evaluated as DATCS capabilities determining the system requirements.

2. PROJECT DIRECTION AND PARTICIPANTS

The project was under the direction of Lt. Kent Rasmussen, Director of Federal Projects, Oklahoma Department of Public-Safety.

The potential DATCS participants in the State of Oklahoma include the following:

- Oklahoma Highway Patrol
- Office of the Chief Medical Examiner
- State Fire Marshal
- Oklahoma Alcoholic Beverage Control
- U.S. Drug Enforcement Agency*
- Federal Bureau of Investigation*
- U.S. Secret Service*
- U.S. Department of Alcohol, Tabacco & Firearms*
- Oklahoma State Board of Investigations
- Oklahoma Department of Health**
- Oklahoma State Bureau of Narcotics*
- Department of Wildlife Conservation
- Department of Agriculture, Forestry Division
- Department of Corrections*
- State Civil Defense.*

Each of the above listed public-safety and public service agencies have been active participants in the program, contributing to the interagency and intra-agency communications analysis and the requirements analysis for the DATCS concept design.

It has been the responsibility of the Project Director to develop this System Implementation Plan (SIP) with the technical assistance of Booz, Allen as engineering consultants to APCO. The cooperation of all participating agencies and their personnel has

* Participation limited to maintaining interface with Oklahoma Highway Patrol.

** Extent of participation will be determined by outcome of Oklahoma EMS/DATCS interface study.

been voluntary. There have been no binding commitments required of the State of Oklahoma or any of the other participating governmental bodies.

II. SYSTEM CONCEPT

It is the objective of this section to document the proposed system concept of operation. This has been accomplished by describing, in a conceptual sense, how each performance requirement (previously documented) will be satisfied. It is important to note that the proposed system concept of operation documents the thinking to date and, as a result, there remain a few elements of the system concept still unresolved. These unresolved elements are expected to be removed through the course of approving the system concept.

The basic DATCS land mobile radio system for Oklahoma has been conceived to replicate current state radio system operations as closely as possible. The difference in function and response between conventional radio systems now in use and DATCS radio system should be nearly transparent to the mobile operator except co-channel sharing will appear to the operator to have been eliminated.

This philosophy directs that operations which require a unique skill of the mobile operator be minimized. It also directs the avoidance of subsystem interfaces in which trunked technology or switching requirements might degrade the operation of existing communications systems when used in conjunction with DATCS. For example, the recommendation to interface portable radio operations at the dispatch console instead of automatic cross-banding with DATCS is based on this philosophy rather than the lack of technical feasibility.

The DATCS offers features and options related to digital control functions and programming that enable operational flexibility not previously available. Some of these features include:

- Privacy of communication with or between field units
- Dynamic reallocation of field forces
- Interagency communication
- Automatic identification of individual field units
- Automatic queueing of units requesting system access.

Implementation of these have been concentrated at the regional control points and/or dispatch points to minimize the complexity of the mobile equipment.

2.1 SYSTEM OPERATION

The basic principle of DATCS operation is the shared use of a common base station network and a pool of frequencies (numbering from five to twenty, in present systems) by a number of independent radio system users. Under trunked system operation, the number of independent users can exceed the number of available frequencies.

Each system user (independent agency) is assigned an operating "channel*" for its routine use. Communications among mobile units of any given agency can be conducted on any one of the system frequencies; choice of the particular frequency for a communication is made by the system hardware, independent of operator control, and the selection is made from among the unused frequencies. In this manner, more efficient use of frequency spectrum is accomplished, as channel assignments are based on demand and the availability of channels.

The remainder of this section presents the proposed operation of Oklahoma's future trunked mobile radio system. It is proposed that:

- Current complaint reception and dispatch methods be largely unaltered in the new system
- DATCS will be transparent to user agencies, except that additional capabilities and system improvements will be readily apparent.
- Independent agencies or departments within agencies will share channels not based on the constraints of conventional radio systems, but rather based on the need to intercommunicate
- Network control will be established only to the degree necessary to preclude mutual interference and maintain overall system performance.

These elements of system operation are described in greater detail in the following paragraphs.

2.1.1 Philosophy Of Operation

The proposed statewide trunked mobile radio system for Oklahoma is intended to replicate current system operations, except where basic improvements are appropriate. The first report* identified certain major deficiencies in present mobile radio systems and indicated that DATCS offers an opportunity to overcome many of these deficiencies. It is the philosophy of the proposed operation to suggest only those changes in the present operations that will overcome the previously noted deficiencies.

Oklahoma's major mobile radio deficiencies are a statewide lack of channelization, a trend toward increased fragmentation in state systems and insufficient radio coverage for many systems. Mobile radio operations will be changed, therefore, only in that fewer

* "Channel" in the sense used in DATCS is not equivalent to a channel in a conventional mobile radio system. In a DATCS, the number of "channels" exceeds the number of frequency (pairs), which is impossible in a conventional system.

* "Documentation of Oklahoma Mobile Radio Systems and Requirements", July 3, 1980.

users will be assigned to each channel (enhancing intercommunications within and among agencies), a statewide uniform level of communications capability will be provided and radio coverage will be enhanced statewide by attention to engineering detail during system design stages.

DATCS also offers increased capabilities for accomodating communications among independent agencies which occasionally may need to respond to events of mutual concern. These capabilities are provided through dynamic channel flexibility (reassignment of channels from one or more fixed locations) and commonality of equipment. For example, during an event involving the Oklahoma Highway Patrol and the FBI, selected units from both agencies could be assigned to a common channel for the duration of the event. Afterwards, each unit would return to its previously assigned channel. As a result, both agencies could intercommunicate only to the extent necessary for the event and routine operations would remain unaffected.

Similar flexibility is applicable to all other DATCS users, as all mobile radio units in the system would be compatible.

2.1.2 Datcs Network Control

The concept of network control for a commonly owned and operated statewide communication system represents the only significant deviation from present operations. Network control should take the form of a two-tier management structure:

- An advisory group should be established, responsible for policy and planning issues
- An existing organization should be identified to take responsibility for day-to-day operation of the new system.

The advisory group would plan system implementation, identify sources of funding, generate operating policies and plan ongoing system expansion consistent with increased participation by local agencies and changes in operations of existing users. The organization responsible for day-to-day operations should be responsible for the following:

- Responding to requests for change in group address. Individual agencies requiring non-routine communications with other agencies would indicate their needs to network control, which would have the capability of temporarily reassigning individual mobile units to other groups and forming (or dissolving) special groups, as needed.
- Monitoring system performance. The failure of base station network components and degradation of performance in any part of the common network will be noted by the day-to-day system management organization.
- Coordination of Maintenance. The responsibility for system maintenance includes planning routine maintenance and coordinating service for failed or degraded system components.

The day-to-day network control could be conducted at both a regional and state level:

- Regional Level - monitor system performance and respond to requests for temporary changes in group address
- State Level - plan and coordinate maintenance of common equipment.

The Department of Public Safety (DPS) is best suited to function as the day-to-day network control organization. The DPS is a statewide organization which currently functions on a state and regional level, and it has established regional facilities in all areas throughout Oklahoma.

2.1.3 Principles Of Operation

The principles described in this section are based on the assumption that complaint reception and dispatch for all participating agencies will be conducted from existing dispatch locations. The configuration of a statewide DATCS is such that all users can maintain their independent dispatch facilities although the base station network is common to all users.

The principles of operation are expressed in terms of:

- Group addresses or "channels"
  - Dynamic assignment of primary group address
  - Accessibility to all appropriate channels by each dispatch location.
- Portable Radio Interface
- Priority Calling
- Network Control.

2.1.3.1 Group Address or "Channels"

Each agency will be provided one or more unique "channels" or group addresses according to its specific requirements. These group addresses will be recognized according to instructions provided by network control. The mobile radios will operate in manner similar to today, but fewer mobile units will be assigned to each "channel." Only those mobiles which associate routinely will share a particular channel.

Each mobile will contain from one to five "channels", with at least one channel capable of being dynamically programmed from network control. Each agency and dispatch point will have access to all group addresses of its associated mobiles and network control to request changes in group address.

2.1.3.2 Portable Radio Interface

Conventional portable radios will be used in two possible ways: maintain routine operation of existing portable radio systems independent of DATCS and interface conventional portables via a single cross-band vehicular repeater (for OHP mobile command post operations only). The use of portable radios in the Oklahoma DATCS is further detailed in Section III - System Description.

2.1.3.3 Priority Calling

The capability of priority calling will not be provided in the initial system implementation. This feature, which represents a modification of existing trunked hardware is not a major requirement at this time. The software of the initial system implementation, however will allow for future implementation of priority calling.

2.1.3.4 Network Control

The function of network control is to execute the policies established by the advisory group, including:

- Managing and executing requested changes in mobile group addresses
- Ensuring that changes are with the expressed approval of all agencies involved
- Ensuring that dispatchers will not be overburdened with requests for changes in group address.

2.2 System Description

This section describes the future DATCS mobile radio system based upon Oklahoma's requirements. Specifically, addressed are the performance requirements, external interfaces, control functions, radio spectrum and FCC licensing implications, and ancillary items associated with fixed facilities. These are discussed individually in the following paragraphs.

2.2.1 Performance Requirements

This section specifies the performance requirements that must be satisfied to implement a DATCS in Oklahoma. Specific performance requirements that are discussed include:

- DATCS capacity
- Intra- and inter-agency communications
- Mobile control head characteristics
- Two-part digital address
- Dynamically assignable group address
- Talk-around capability

- Interface with conventional portable radios
- Radio coverage
- Management information
- System protection measures.

2.2.1.1 DATCS Capacity

The DATCS system design must be able to support eventually 2,500 to 3,000 state mobile units. This number can be expected to increase if local government agencies participate in the future. Initially, the DATCS must be able to support 1,200 units. The system must also be capable of supporting 150 unique group addresses with as few as one to as many as 100 individual units assigned to a specific group address.

The specific number of frequency pairs that will be initially planned will be based upon the channel loading criteria established by the FCC. Present loading criteria is based solely on single site trunked system implementations, which will not be representative of a trunked implementation for Oklahoma. It is uncertain at this time what loading criteria the FCC might apply to a statewide trunked system, as the specific method of achieving statewide coverage is as yet undetermined and will likely influence the FCC's decision. Further, it is not clear at this time to what extent the interfacing of conventional portables will be considered legitimate channel loading.

2.2.1.2 Intra- and Inter-agency Communications

Intra- and inter-agency communications will be accomplished, depending upon specific circumstances, by one of three methods:

- Limited Selection of Group Addresses - Supervisory level mobile radio users will be equipped with the group address of other users, in instances where access to other group addresses would be routinely required. This method provides selected users the option of operating on other group addresses without dispatcher initiative. It is expected that user-initiated access to other group addresses will be limited to supervisors and administrative personnel of selected agencies.

- Cross Patching - Will be provided to most dispatchers. The dispatcher will be able to cross-patch two or more group addresses on an as needed basis. In this way, the dispatcher can make or break a cross-patch arrangement, thereby maintaining channel discipline. Patching will be conducted generally among only those channels available to a particular agency; cross patching between different public-safety agencies is not proposed.

- Reassignment of Group Addresses - This method of inter-agency communications will be initiated only by network control personnel (system operator) when users need to temporarily become part of another group. It is anticipated that reassignment of group addresses will be used to respond to large-scale events of mutual responsibility and therefore, will probably occur infrequently. The reassignment of group addresses will be accomplished by one of two ways:

  - Change in group address from a regularly assigned to an already existing group address of another user group

  - Creation of a "phantom" group whereby individual units would be assigned to an entirely new group address created to meet a temporary, one time need.

2.2.1.3 Mobile Control Head Characteristics

The mobile control head will be provided a variety of operational features, as determined by the specific needs of each agency. There will be two classes of mobile control heads:

- Supervisory Control Head - will provide a mobile radio user with up to five unique group addresses for interagency communications. Access to these group addresses will be user selectable. The primary group address, at the very least, will be dynamically reassignable, whereas the four other group addresses will be essentially fixed (but reprogrammable by maintenance technicians, if necessary).

- Non-Supervisory Control Head - will provide a mobile radio user a single group address, dynamically assigned by the user's agency. If a user requires access to another group address, the user's dispatcher will request a change-in-group-address status via the control operator or will cross-patch the user to the appropriate group address.

Occasionally the user may not be able to immediately access the desired channel because all channels will be temporarily allocated in which case, a "channel busy" indication will be provided. The user will also automatically enter a queue set up by the controller to seize the next available channel, in the order of requests; when a channel becomes available to a mobile in the queue, the mobile operator will be notified by an audible and/or visual indication.

2.2.1.4 Two-part Digital Address

As a minimum, each unit will both be uniquely identified (unalterable) and identified as a member of a group address (alterable). The unit identification will be an integral part of the mobile unit, not readily changeable. On the other hand, the affiliated group address will be dynamically programmable to be able to satisfy changing needs.

The Oklahoma DATCS must have a capacity eventually for 3,500 individual mobiles and 150 unique group addresses. Although current equipment offerings typically provide three levels of address (i.e., unit, subfleet, and fleet), no need currently exists to segment Oklahoma's operations beyond the unit and subfleet level.

2.2.1.5 Dynamically Assignable Group Address

The capability will be provided to dynamically assign and change at least one group address of the mobile units from a central or regional location; each agency will individually decide which group address (among field of five) will be dynamically assignable. However, this capability will only reside at fixed locations (regional network control). In this way, effective network control can be exercised.

The regional system operators, who perform the function of network control, will have available two options to dynamically assign a group address:

- Modify a particular unit's regularly assigned group address to an already existing group address (i.e., Department of Corrections to OHP etc.)

- Create a "phantom" group, not regularly assigned, which will be dissolved when the need for its continued existance disappears; units will then return to the regularly assigned group address.

Changes in group addresses will follow firmly established operational procedures to maintain strict control; these procedures are best established jointly by the advisory group (composed of representatives of the user agencies (i.e., OHP, Department of Corrections, etc.)

2.2.1.6 Talk-around Capability

Mobile units require communications independent of the base station facilities when beyond radio range or when the dispatcher is not involved in a message between close mobiles. This talk-around capability should be provided through a non-DATCS channel specifically licensed and set aside for the purpose of direct simplex communications (talk-around).

Talk-around will be mobile-user selectable as currently exists with the present radio systems. However, unlike the present systems, all units desiring to use talk-around must agree in advance to switch to talk-around and must secure dispatcher permission; if only one unit switches communications will not be possible. While DATCS could provide automatic switching to talk-around under specific conditions (i.e., sense of "out-of-range" condition), manual switching is preferred to maintain predictable communications.

2.2.1.7 Interface with Conventional Portable Radios

Although industry estimates vary for the introduction of a trunked portable radio (3-6 years), there are no assurances that trunked portable radios will ever be available at an affordable cost or compatible with DATCS. Also, there is concensus that any type of trunked portables will not be available sooner than three years. For these reasons, a method is therefore required which will provide Oklahoma continued access to portable radio operations.

To provide for portable operations in the interim there are two methods which are proposed for Oklahoma:

- Maintain existing portable systems for on-scene, tactical operations independent of DATCS

- Interface through a single vehicular repeater for command post operations (OHP only).

There are currently only two potential DATCS candidates whose operations are portable intensive: the Department of Corrections (DOC) and the Oklahoma Bureau of Narcotics and Dangerous Drugs (OBNDD). Both these agencies presently use portable radios for on-scene communications (communications within a correctional facility compound for DOC and local surveillance for OBNND) and do not present a driving requirement for conventional portable interface with DATCS. OHP, however, does require conventional portable interface with DATCS to maintain their present level of mobile command post communications.

The interface of mobile command post portables with DATCS will be accomplished with a single vehicular repeater which will be part of the command post and utilized only for the duration of tactical operations. The vehicular repeater will receive portable transmissions and will retransmit them over the DATCS "channel" or group address associated with the mobile command post. Because the possibility exists that all DATCS channels will be busy when a portable attempts to communicate over the DATCS, unique operational procedures are required of the portable operator, and current portable operations cannot be replicated with DATCS at this time (the operational implications of crossbanding conventional portables with DATCS are detailed in "Analysis of Problems and Requirements Associated with Implementation of a Statewide DATCS for Oklahoma," September 30, 1980. Vehicular repeaters for portable interface are proposed only for OHP mobile command post operations and are not recommended for day-to-day operations.

The eventual adoption of a trunked portable for use in Oklahoma will require enhanced radio coverage through those areas of the state where portables are required. The enhanced coverage will likely be provided by satellite receiver systems similar to those used to support conventional portable radio systems, and the Oklahoma DATCS must be capable of integrating a satellite receiver system in the future.

2.2.1.8 Mobile Radio Coverage

Reliable mobile radio coverage will be provided throughout Oklahoma, at least to the same or greater reliability than currently realized by the existing statewide mobile radio systems. Quantitatively, mobile radio coverage reliability is proposed to exceed 90-97 percent, which is considered very good by industry standards.

Several options are available to achieve wide-area coverage for Oklahoma, including:

- Simultaneous broadcast of identical information on common channels
- Simultaneous broadcast of identical information on different channels
- Separate trunked systems for each site
- Hybrid trunked/conventional system.

Each option was detailed and analyzed in the previous report. No single method of achieving wide-area coverage stands out as a preferred choice over the others, and it is proposed that each vendor outline his preferred method in the bid response submitted to Oklahoma. The choice of specific sites that will be necessary to achieve the required radio coverage throughout the state will be the vendor's responsibility. The successful vendor will also be responsible for:

- Indicating the need for the remote sites, and the justification for their selection
- Specifying the characteristics of each site
- Assisting Oklahoma procure the remote sites (i.e., buy, lease, etc.), if necessary.

Since each vendor's approach to state-wide coverage may vary no action on the part of Oklahoma to acquire remote sites is required until time of bid.

It is appropriate, however, to describe alternative approaches to state-wide coverage:

- Simulcasting (both on identical and separate channels) - mobiles receive identical radio communications from one or more sites simultaneously. This technique has the advantage that a mobile is assured of receiving a communication regardless of its location in the jurisdictional area. Conversely, there are disadvantages of high cost, technical complexity, and conspicuous use of frequency spectrum.

- Separate Trunked Systems - mobiles would communicate with the trunked system associated with the mobile's specific location. This approach is simpler and less costly than simulcasting, but special measures are required to communicate over the entire jurisdiction simultaneously and to properly use the control channels.
- Hybrid Trunked/Conventional System - same as the "Separate Trunked Systems" except a conventional radio system(s) would be used to cover remote, infrequently traveled areas of the state. However, FCC licensing eligibility is uncertain because of an absence of well-defined regulations, although discussions with the FCC indicate a hybrid approach may be required.

2.2.1.9 Management Information

Management information in the form of system performance data will be the primary tool to determine, on an ongoing basis, how well the DATCS system is meeting Oklahoma's mobile radio needs. System performance data will be provided to management of the DATCS in the following forms:

- Activity printout
  - User (group address and individual identifier)
  - Time (initial access time and duration)
  - Sample utilization of common facilities (adjustable sample rate)
- User profile, according to category
  - Agency
  - Group address
  - Individual identifier
  - Site/base station
- Status of specific group addresses, on command (i.e., "in use," currently idle, etc.).
- Status of key components to pinpoint failure
  - Base stations
  - Site controllers

2.2.1.10 System Protection

One major intent of developing a DATCS for Oklahoma is to offer a mobile communication system which exhibits a very high degree of availability* which would be significantly improved over the present

* Percentage of time the system is functional at full capacity.

collection of individual systems. For example, loss of a single DATCS base station will only slightly reduce a mobile's chance for obtaining a channel, on request. Whereas today, loss of a single base station (or land lines, tower, antenna, etc.) completely inhibits further communications until repair.

In the event of the loss of a major component (i.e., controller or equivalent component), the DATCS system will revert to a conventional mode in which mobiles would be directed to pre-assigned channels. To accomplish this, the SOW will impose a number of system protection measures that must be satisfied to adequately insure Oklahoma against the consequences of catastrophic system failure. Vendors will be obligated to submit a specific plan on their approach to dealing with failed site components (plan subject to approval by Oklahoma).

Regarding alarm features, network control (central or regional) will be automatically altered of subsystem and somponent failure. In this way, immediate action can be taken by the system operator, probably even before the field units notice any discernable change in performance.

Time-out timers will be provided on the mobile to preclude inadvertent capture of the system for extended periods as well as on the base stations since unnecessarily long-duration conversations tend to deny channel access to other DATCS users. Long-duration conversations could potentially be a problem since the mobile radio user could falsely perceive that DATCS is a completely private, always clear-channel radio system which is unlikely to deny channel access to other users because of one's own usage. The use of time-out timers on base station equipment however, will present operational problems to potential EMS DATCS users which transmit telemetry. A means of accommodating EMS and at the same time affording the system protection against prolonged channel usage has yet to be determined.

2.2.2 External Interfaces

The section describes the interface between DATCS and the systems external to DATCS:

- Telephone
- Conventional portable radio

An interface between DATCS and the switched public telephone network will not be established at this time. The APCO Project 16A document did however, include this requirement for a DATCS. If an interface in the future, it must confirm to FCC rules and regulations in effect at that time.

Conventional portable radios are to be interfaced with the proposed DATCS system to enable portable radio users to communicate with DATCS mobiles, but only for OHP mobile command post operations. A crossband connect between the DATCS and conventional repeaters, under the control of the mobile command post operator, is proposed

to accomplish this function. This solution is the least disruptive approach to dealing with a lack of trunked disruptive approach to dealing with a lack of trunked portable radios, for the interim. The remaining agencies will maintain their existing portable radio systems and will interface with DATCS through dispatcher-controlled cross-patching, where necessary.

2.2.3 Network Control Functions

Network control represents the only other significant change in operations. The establishment of a network control function is mandatory for DATCS. This is because monitoring system performance and managing a commonly owned, statewide mobile communication system must be centrally performed and cannot be distributed among several departments.

The responsibilities of a network control function will be divided into two categories:

- Policy - responsible for: establishing guide-lines for the use of DATCS, accommodating demands from various independent agencies impartially, and ensuring that day-to-day operations are appropriately performed
- System Operations - responsible for the day-to-day operations of the network. The new or existing (system operations) agency would respond to the policies and guidelines established by the parent group. For example, system operations would handle requests for group address changes, but would not dictate under what circumstances a request for change in group address may be honored, since that is matter of policy.

For further study, it is preliminaryily proposed that policy be established by an all-new Advisory Group created to serve this specific function, comprised of representatives of the user agencies. System Operations, on the other hand, could be vested in an existing agency or developed independently. These choices warrant the closest attention.

2.2.4 Dispatching

Each agency that presently performs a dispatching function for itself or other agencies will be provided a dispatch capability under DATCS. As a minimum, individual agencies will be provided a desk-top type console containing all group addresses of responsibility and, in some cases, group addresses of mutual interest with other agencies/departments. These consoles will be capable of: radio patching among the channels of access; selecting the desired area coverage; communications with network control to request changes in group address; and receiving all messages from mobiles of responsibility. In addition, communications will be possible with at least two group addresses simultaneously; come agencies may have the capability to communicate with three or more group addresses simultaneously.

2.2.5 Radio Spectrum and FCC Licensing

Presently, DATCS is only feasible at 800 MHz, which previously was a television-only band, but recently reallocated for mobile radio. For the foreseeable future, at least, sufficient 800 MHz spectrum will be available in Oklahoma to support DATCS.

Another favorable aspect is the current FCC demeanor which regards these kind of mobile radio systems with favor and something to be promoted. Therefore, if any negotiations are required with the FCC in the future to resolve regulatory issues (i.e., multiple base station sites, etc.) favorable rulemaking can be anticipated.

It is advisable, however, to begin establishing rapport with appropriate FCC staff to help "smooth the path" to successful licensing.

2.2.6 Ancillary Items

Ancillary items for the support of the Oklahoma System Concept of Operation include the following:

- Emergency Power
- Maintenance.

Emergency power will be necessary for the mobile sites throughout the state and the regional network control centers. Depending on the inherent emergency power capabilities of the individual network control sites, emergency power may not be required. However, emergency power will be necessary for the remote sites. Hydrocarbon-type fuel generators are proposed because of the substantial power requirements of each base station (1000 watts continous each).

The maintenance strategy for the DATCS system in Oklahoma is two fold:

- Initial Contract Maintenance - Initially maintain the DATCS system under a maintenance contract with a commercial shop, at least until a self-maintenance capability is established and sufficient confidence in the DATCS system has been achieved. This period will provide the primary basis for Oklahoma's maintenance staff to acquire the appropriate new skills required.
- Future Self-maintenance - Anticipated only after adequate training, reallocation of staff resources, and development of a management structure. Development of a competent self-maintenance capability for DATCS is a large task and therefore will be a major component of the System Implementation Plan (SIP).

III. REQUIRED IMPLEMENTATION ACTIVITIES

Implementation of the system concept will proceed only after thorough review by the potential user agencies and their department heads. After this has been achieved and the implementation plan has been officially sanctioned, another critical milestone must be met before procurement activities can be initiated.

Federal Communications Commission (FCC) licensing requirements for large scale 800 MHz trunked radio systems in the local government radio service have not been clearly defined or tested at this time. The initial implementation activity following agency approval must be directed toward satisfying all of the elements needed to secure reasonable assurance from the FCC that the trunked radio system, as planned and approved, can be licensed.

3.1. State Agency Approvals

State agency approvals will be achieved in three steps, the securing of user agency agreements, the development of funding agreements to implement and operate the system, and the legally binding commitment of the state agencies to participate in and support the system.

3.1.1 Agency Agreements

Signed agreements by each agency planning to participate in the trunked radio system must be acquired. These agreements will conform with FCC requirements (Section 90.359 and 90.179). As a minimum they will include:

- Agreements regarding the supervision and control of the trunked system operation
- Method of cost-sharing and pro-rating of costs among all cooperating parties
- Responsibility for maintaining system operation records and filing reports with the FCC (Section 90.391).

In addition to the items needed for FCC licensing, the agency agreements will also include provisions for:

- Management authority over the system staff and equipment
- Centralized maintenance of system components
- Property, equipment and facilities provided by the user agencies
- Modification and/or termination of the agreement as subject to FCC Rules and Regulations (Section 90.391).

Agency agreements will be the key element in securing the funding agreements and government approvals.

3.1.2 Funding Agreements

The acquisition of agency agreements will provide dimensions for revised cost estimates needed to establish funding requirements. These requirements will include estimates of non-recurring implementation costs and recurring operations costs. The following elements of cost will be identified:

- Implementation Costs
  - Planning Activities
  - Professional Services
  - Hardware/Software
  - Facilities
  - Installation/Test/Acceptance
  - Personnel Staffing and Training
- Operating Costs
  - Personnel Salary and Overhead
  - Supplies
  - Maintenance of Hardware/Software
  - Equipment Replacement
  - Continued Training

The distribution of these costs among the funding sources will be decided and firm commitments and/or agreements acquired. These funding sources will include:

- Federal and State Grants Funds
- In-kind Services, Equipment or Facilities
- User Agency Cost Sharing Assessments
- Grants from Private Foundations
- Gifts from private sources.

The funding agencies must approve and be committed to the funding plan before final and binding commitments will be sought from the state of Oklahoma and participating agencies.

3.1.3 Government Approvals

Based on the agency agreements and funding agreements reached, firm commitments will be required from the State government to assure continued project support and to respond to Federal and State grants requests. These approvals will be requested in the form of resolutions or other legally binding documents.

3.2 Preliminary Licensing Considerations

The licensing of multiple base station wide-area trunked radio systems in state and local government service and public safety service is not clearly defined by present FCC Rules and Regulations. Waivers to the present FCC Rules and Regulations may be required, particularly Section 90.375 which defines time limits for phased implementation. It is probable that waivers to Section 90.379 which limits power and antenna height will also be needed.

Before hardware and software commitments are made, preliminary discussions will be held with the FCC. An expression of assurance will be sought indicating that the trunked system, as planned and approved by the user agencies and their governmental authorities will receive favorable licensing consideration from the FCC when formal applications for licenses are submitted.

3.3 Implementation Schedule

The detailed implementation schedule will be developed following assurances from the FCC that the trunked radio concept will be licensable under FCC Rules and Regulations and that any revisions to the concept required by FCC evaluation of the system design has met the approval of the user agencies and the state government. The implementation schedule will consist of two key interrelated parts; a system implementation schedule and a corresponding financial schedule.

3.3.1 System Implementation Schedule

The system implementation schedule will be a time-dependent schedule. The project will be defined in terms of separate tasks with clearly defined milestones indicating the completion of each task and definitive measurable milestones leading to the completion of each task or project element. Major tasks include:

- Project Planning and Reporting
- Engineering Services
- Preparation of Specifications
- Preparation and Approval of Statement of Work
- Solicitation of Bids
- Contract Award

- Facility Preparation
- System Licensing
- Equipment Delivery/Installation
- Test and Acceptance
- Personnel Training
- System Cut-over
- System Evaluation.

Each major task will be supported by task break-down schedules which define the subtasks needed to achieve the completion of each major task.

3.3.2 Financial Schedule

The financial schedule will be coordinated with the system implementation schedule. This schedule will be based upon the funding agreements and will include the following major elements:

- Milestones showing each major commitment of funds
- The date and amount funds will be made available to the project from all sources
- The schedule dates for the submission of financial reports.

The submission and distribution of financial reports will be elements of the financial agreements and governmental approvals.

3.4 System Management and Operation

The management and direction of the implementation program will be the responsibility of the Program Director. The Program Director will be supported by a full-time and part-time staff representing each key function of the implementation program. These functions include:

- System Engineering - this staff function will be assisted by consulting engineers and the engineering staff of the successful system contractor
- Procurement - this staff function will be assisted by the purchasing and procurement personnel of the state of Oklahoma
- Finance - this staff function will be a part-time service provided by the State of Oklahoma

- Facilities - this staff function related to the acquisition and preparation of special facilities for the equipment and personnel of the project will be provided part-time by the State of Oklahoma
- Personnel - the project staff personnel are under the direct supervision of the Program Director; personnel activities such as job descriptions, salary determination, and benefits administration will be under the direction of the State of Oklahoma unless the person is on loan from another agency under the state government.

In addition to the project staff reporting to the Program Director, two advisory groups will be responsible for overall project policy with the Project Director serving as chairperson for each advisory group. These groups consist of:

- User Representatives - this group is composed of appointed representatives of each user agency; they provide direct liason between the project organization and their respective agencies
- Government Representatives - this group is composed of appointed representatives of each state government section which has an operational or financial interest in the program.

It is the intention that this management group be carried over in form and function to the operation of the trunked radio system after it has been installed, tested, and accepted. Additional personnel needed to operate the system from a central location will be added to the Facility function of the project staff. At that time the Facility function will become a full-time staff position under the Program Director.

3.5 Procurement

The procurement of the trunked system will proceed in two sequential activities; system engineering and purchasing.

3.5.1 System Engineering

Technical assistance will be required to develop the engineering design of the trunked radio system based on the system concept. Key questions to be resolved before procurement specifications are prepared include:

- Radio Propagation Analysis - engineering analysis of 800 MHz radio propagation from candidate base station sites will be conducted to determine radio coverage of the state and to establish antenna pattern characteristics. FCC Rules and Regulations (Section 90.379) clearly limit the effective radiated power and antenna elevation at each proposed site and engineering analysis will be required if waivers are needed from these FCC rules and regulations

- Switching Logic - the switching logic for the master controller, site controller, mobile stations, and control station will be engineered to be compatible with available vendor hardware offerings

- Software Management - the system software for the master controller and site controller will be engineered to allow efficient software management from a master terminal

Based upon the results of these technical activities, system engineering will prepare detailed system specifications and equipment specifications for competitive procurements.

3.5.2 Purchasing

The purchasing function will consist of three key activities; developing a Statement of Work (SOW), soliciting competitive bids, and awarding a system contract.

- Statement of Work (SOW) - the SOW is a precise description of the materials and services required of the contractor and the time domain in which delivery is to be made. The key elements of the SOW will be:

  - Background and Objectives of the project
  - Required qualifications of successful bidders
  - Services and Support to be provided
  - Quantities of each equipment to be provided
  - Schedule for all deliverable items - hardware, software, services, and support items

Soliciting Competitive Bids - competitive bids from all qualified vendors will be solicited by means of a procurement package which will include:

- State legal requirements
- Statement of Work
- System Specification
- Equipement Specifications.

A one-step solicitation is anticipated in which each bidder will provide a technical proposal and a firm fixed price cost proposal for the complete installation of an operating digitally addressed trunked radio system.

- Award the System Contract - the combined technical proposal and cost proposal must advantageous to the State of Oklahoma and associated user agencies will identify the successful bidder. A firm fixed price contract without cost escalation is anticipated.

3.6 Licensing

The signed contract defining the equipment to be purchased and the quantity of that equipment will provide sufficient information to file applications with the FCC for system licenses. Present FCC practice for licensing 800 MHz trunked system requires the following minimum submission:

- Form 400 for each license requested (Section 90.357)
- Agreements with each user agency relative to control of the system (Section 90.179)
- Agreements with each user agency relative to cost-sharing of installation and operation (Section 90.179)
- Financial plan showing the service will be provided to user agencies at cost (Section 90.359)
- System description and specification (Section 90.359, Section 90.371, Section 90.375, and Section 90.379)
- Eligibility statement for each user (Section 90.359)
- Evidence of purchase orders placed for the equipment.

It is probable that FCC waivers will have to be requested to extend the number of years for phased implementation of the system (Section 90.375) and for the limitations on effective power and antenna height.

Technical support for negotiating system licenses with the FCC will be requested from the engineering consultant and from the system contractor.

3.7 Facilities Acquisition and Preparation

It is the responsibility of the Program Director to provide adequate facilities for the equipment and staff of the trunked radio system. Subject to revision by the engineering study, the following facilities will be required:

- Base Station Sites equipment shelters for five to twenty 800 MHz repeaters, trunked switching logic, ancillary equipment for the antenna subsystem, emergency power facilities, climatic control equipment, and antenna support structure for two to six antennas, as required.

- Network Control Center equipment shelter for master control terminal, alarm equipment, recorders, printers, microwave terminations and other items of equipment associated with the central control function. Staff facilities for a Program Director, Facilities Manager, Engineering (Software/Hardware Manager, and programmer/operators) will also be required

- Regional Network Control Centers equipment shelters for regional control terminal, alarm equipment, recorders, printers, microwave terminals and other items associated with the regional control function. Facilities for terminal operations will also be required.

Centralized Maintenance will also require special facilities which must be provided by the State of Oklahoma.

It will be the responsibility of the Facilities Manager on the staff of the Program Director to obtain these facilities and prepare them in a timely manner.

3.8 Personnel and Training

Personnel for the management and operation of the trunked radio system will be identified and prepared for their assignments in coordination with equipment installation and test. It is intended that the Project Director and staff will continue their roles after the trunked radio system has been installed and accepted. The additional people required to operate the system will be recruited and trained during the system installation test so that the experience gained can serve as on-the-job training before the system becomes operational.

Job descriptions for staff positions will be developed by the Program Director and the personnel offices of the State of Oklahoma. Recruiting will be by public announcement of available job openings. It is anticipated that the positions will be filled by transfer of presently employed and skilled personnel.

The training and certification of all operating personnel, maintenance technicians, and management personnel will be a contractual obligation of the system contractor.

3.9 Post Implementation Support

The post implementation support program will address the funding and staffing needed for sustained operation of the trunked radio system.

3.9.1 Post Implementation Funding

The recurring costs of continued operation include the following major items:

- Personnel - salary and benefits

- Maintenance - maintenance of the facilities and system hardware/software after the warranty and first-year maintenance contract

- Supplies - all expendable materials used in operating and managing the system

- Training - refresher training and replacement training

- Utilities - power, telephone, and other services provided by an outside agency

- Equipment Replacement - periodic replacement of worn or obsolete equipment; equipment that can no longer be repaired economically.

These costs will have been identified and submitted to the FCC as part of the licensing requirements. They will be reviewed periodically. These will be billed to the user agencies in accordance with a formula developed and reported in each agency agreement.

3.9.2 Personnel Replacement and Training

The replacement of personnel and the up-dating of staff personnel will be a recurring problem. There will be labor turnover. Recruiting of personnel will be by suitable public announcement of job openings and the testing of applicants. Probationary employees will be trained by the technical staff.

3.9.3 Support Staff

The system will have the full time services of equipment maintenance personnel and software system personnel. At least one senior system programmer/analyst will be required. It is anticipated that a full time staff of specially trained maintenance technicians will be required and qualified control operators will also be required to provide 24 hour service to the user agencies.

APPENDIX A

SYSTEM REQUIREMENTS

The system requirements (as reported through the system survey data) present some major system problems which must be resolved if a trunked system is to be considered feasible. There are other system considerations which, although of serious concern, can be accommodated more routinely. These are addressed individually in the following subsections.

1. MAJOR SYSTEM PROBLEMS

The following problem areas and their proposed solutions are presented as being critical to the successful implementation of a trunked radio system in the State of Oklahoma. The potential solutions offered reflect state-of-the-art system technology and hopefully do not seriously violate the state-of-the-art hardware and software offerings that can be made available in the near future when competitive procurement documentation has been developed.

(1) Wide Area Coverage

Present vendor offerings in trunked system hardware and current FCC licensing procedures provide only for single-site trunked system implementations. The statewide radio coverage requirement for Oklahoma's trunked radio system will present unique hardware and regulatory considerations for implementation of a multi-site system.

(2) Operation with Portable Radios

The availability of trunked portable radios will depend upon the successful development of a technically acceptable frequency synthesizer and associated control system switching logic each of small size and with small power requirements. These circuits together with the usual 800 MHz portable radio subassemblies, and a battery pack with sufficient capacity to permit at least 8 hours of high performance service, must be made available in a small hand held portable radio case. Estimates by industry sources place the earliest availability of such a unit in the 1983-85 time frame. Until such portable radios are available, trunked radio system equipment configurations will include only base stations, control stations and mobile stations.

Statewide radio systems in Oklahoma are not generally portable radio intensive. However, a few are heavily dependent upon hand held portable radios. This significant investment in existing portable radio equipment must be protected. These existing equipments must be permitted to operate with the trunked radio system with no modification or, at the most, a very minimum of modification.

One alternative would be to have these conventional portables interface with the trunked radio system through a cross-band repeater. This repeater would have a two frequency half duplex VHF channel on one side and a frequency synthesized trunked radio control station on the other side. In the trunked system logic the cross-band repeater would have a single unit address for a cluster of portable radios all sharing the same VHF channel.

Trunked systems can not pass the system control information through to a cross banded portable. Therefore, the portable would not be able to detect an "all channels busy" signal and would not know why a channel request has been denied. To correct this the trunked control station side of the cross band repeater can cause an audible tone to be sent on the receive channel of the cluster of portables when trunked channel access has been denied. The denied request for channel access from a portable radio should not be placed in the queue for the trunked system (if a waiting queue is possible) even if a "channel available" signal is also transmitted to the cluster of portables. Because the cross-band repeater can not individually address each portable in the cluster, the portable radio queue would have to be a contention queue. Since all portables are in a contention queue for trunked channel access, the portable radio would have to manually repeat the request for a channel whether or not a "channel available" signal is provided.

The users of portable radios cross-banding into a trunked system would also have to learn to "quick call" the system for a channel request and wait for the request to be acknowledged before they start to speak. Also the "hold time" of the repeater/ base station combination will require special adjustment to prevent dropping the trunked channel during normal press-to-talk switching through the repeater. These techniques have proved troublesome for field personnel to master.

A preferred solution to VHF/UHF portable operation is to continue using the portable radios on conventional VHF/UHF radio channels and manually cross patch these channels into the trunked system at the dispatcher's console when cross band coordination is required. Until trunked portable radios become available and have been field tested, the recommended solution for portable interface is to keep the conventional VHF and/or UHF frequencies for portable radio operation and use the trunked system for the mobile radios. The Oklahoma Highway Patrol, however, has expressed a requirement for cross-band portable interface with DATCS for mobile command post use.

(3) Satellite Voting Receivers

Radio propagation experience with 800 MHz trunked systems indicates that base-to-mobile and mobile-to-base coverage has been similar. The effective radiated power of the two types of stations is very much the same when the installation of both has been well engineered. Therefore, a base station/ control

station/mobile trunked system without trunked portables would likely need no satellite receivers or possibly need only one or two remote satellite receiver sites to correct a unique trouble spot and to vote with the base station receivers in a transmitter steering configuration. It will be the obligation of the system contractor to conduct radio propagation tests to minimize the need for any satellite voting receivers.

If trunked portable radios are eventually added to the system, the need for satellite receiver installations throughout Oklahoma will have to be reexamined.

(4) Multiple Dispatch Points

The State of Oklahoma land mobile radio system, with participation by all appropriate agencies, will require a large number of dispatch points to maintain the existing level of command over the field units. The assignment of an individual mobile unit to a specific dispatch point will be information that resides only in the system control equipment and can not be changed or initiated from the mobile unit.

In concept, the mobile unit in transmitting a request to access the trunked system would only transmit its own identity and possibly its assigned group address. From this address code, the controller can determine from its data file which agency the mobile belongs to, the dispatch point the mobile reports to at that particular time, and the group (or subgroup) the mobile will be permitted to include in its call-up. It is also conceived that some mobiles will have the limited capability of modifying the group request; this feature should be permitted for the singular purpose of reducing the dispatcher work load.

To respond to an incident which calls for a mobile command post and a mix of public safety/public service agencies responsible to that command post, the system controller can create a phantom group and the mobile units can be attached to that group by software instructions based on the mobile address codes.

(5) System Control Failure

An individual base station repeater is installed for each channel licensed to the trunked system at each appropriate base station site. Radio coverage problems may require the installations of repeaters for all channels at all base station sites. These individual repeaters are interconnected and controlled by a controller. If the controller fails completely, the repeaters can operate independently as conventional repeaters. They can be accessed by mobile stations and control stations that are operating on the assigned frequency for each channel of the trunked system. The mobile stations can be preprogrammed to home on an assigned channel if there is a loss of control signal or idle tone (depending upon the trunked system selected);

the available conventional mode 800 MHz channels will be distributed among the mobile fleet units according to need and coordination requirements. Access to the repeater from the dispatch point can be achieved by control station, wireline, or microwave.

Conversion to conventional mode of operation from a trunked operation can however result in a severe shortage of frequency resources needed to conduct routine public safety operations.

Failure of the control system in any mode other than a total catastrophic failure should result in a graceful degradation of the system capability. The failure should be limited to the loss of control over individual channels. This limited failure mode should be transparent to the system users. The loss of one or more channels should not effect the operation of the remaining channels.

(6) Time-out-Timers

A repeater configured land mobile radio system such as a trunked system can be paralyzed by accidental or intentional prolonged mobile or control station transmissions. To protect the trunked system from this failure mode, all transmitters of the base stations, control stations, crossband repeaters, and mobile stations must be equipped with time-out timers similar to the timers used in conventional repeater type systems. If Oklahoma's EMS systems are incorporated into DATCS, however, the use of time-out-timers on base station equipment must be carefully considered. Time-out-timer operation may interfere with transmission of the telemetry used in advanced life-support systems. Two categories of timing circuits should be specified; the first permitting an absolute maximum time to hold the channel with or without modulation, the second should provide a limited channel hold time without modulation.

(7) Distributed Logic Failure

The inboard logic functions assigned to control stations and mobile stations should be minimized; critical system logic and data files must be concentrated at the fixed site locations. Failure of the logic functions or RF functions at the mobile or control station should effect only that individual unit; such failures need not be alarmed to a control point.

(8) System Testing and Alarming

The complexity of a trunked radio system that will provide adequate communication servies for the State of Oklahoma will require a built-in capability to evaluate the individual channel quality and alarm back to a control point any degradation in channel quality below established threshold limits or other significant system degradations. This requirement is not unlike the remote testing and alarm capability used routinely in private microwave systems.

(9) Channel Quality Evaluation

To minimize catastophic channel failures, individual channel quality should be continuously monitored by one of the following methods:

- Idle Channel noise threshold (no signal)
- Busy Channel $\frac{S+N}{N}$ threshold (signal or idle tone).

Departure from a predetermined threshold limit will be alarmed to a control point.

(10) System Test

The ability of the trunked system to respond to mobile/control stations and to process their message content should be tested periodically. It is recommended that programmable frequency synthesized test transmitters with known radiation characteristics and test message content (multifrequency tone and/or digital message) be positioned throughout the State at locations that provide maximum 800 MHz coverage to the high density population areas. These test transmitters can be programmed to transmit test signals on each trunked radio channel sequentially and the received test signal at each fixed receiver location in the area can be compared by quality and message content with a standard. The standard can be established at the time the test transmitter system is installe. Any degradation below established limits will be alarmed to a control point. It is preferable that this test system be peripheral to the trunked radio system.

(11) Test Alarms

The alarm system that alerts to any element of degraded performance should also provide preliminary diagnostic information. This level of diagnosis may be limited to the identity of the offending unit of equipment and the kind of offense being observed. This requirement should be part of the system procurement specification and its characteristics proposed by the system contractor.

(12) Emergency Priority/Ruthless Preemption

The trunked radio system operating in a public safety environment should have the future capability of providing prompt channel access to mobile units exposed to life threatening situations or other incidents which require the immediate response of emergency services.

The general approaches to emergency priority capability for a trunked radio system are discussed in the following paragraphs. The conditions under which initiation of any of these priority functions would be authorized include all of the following:

- A routine request for channel has been denied by the trunked system because all channels are in use and

- There has been a waiting queue established by emergency priority level for the next available channel (dedicated control channel systems only) and

- The activation of the priority function has been a conscionable decision; i.e., there has been a manual switch closure by the user requesting a priority.

These conditions presume the implementation of a dedicated control channel type of trunked radio system. If all channels are in use in a distributed logic system, the mobile will be in a frequency search mode and will have no capability of addressing the controller; there will be no capability of requesting emergency priority considerations and there will be no capability of developing a waiting queue with or without priority. Therefore, the following three basic emergency priority alternatives of Ruthless Preemption, Dispatcher Alert, and Waiting Queue Priority refer only to a dedicated control channel trunked system.

Ruthless Preemption will result in the seizure of any radio channel (except the Control Channel) from its current user. For a reasonable and automated decision to be made, the assumptions must be that:

- The controller has a position indication that the seized channel was not carrying equally urgent emergency traffic at the time it was seized

- The controller is able to select a channel carrying non-critical traffic.

There is no way of assuring that these assumptions can be realized. The normal mobile/control station identifier or preamble will contain only the unit address. There is no information in the identifier that would signify the urgency of a give communication even among those mobile units who, by their identifier, are known by the controller to have preemption capability.

To permit the ruthless preemption of an in-use channel appears to be a very difficult equipment problem, programming problem, and operational problem. This approach to emergency priority is not recommended.

The activation of a unique and manually initiated emergency priority request can be recongnized by the controller. An alert alarm message will be directed to the dispatch point assigned to the mobile unit making the request; this message will also contain the identity of the mobile unit. It is concievable that this dispatch point will have one or more of the system channels in use at that time the priority alert is received and can release one of these channels to the mobile that requested the priority. This assumes that:

- The dispatcher has information relative to the identity of the trunked radio channel being used by his agency and can identify this channel to the Controller so that the mobile can be instructed to move to that specific radio channel and

- The dispatcher can "freeze" the channel long enough so that the mobile can be switched into it before the system drops the channel (otherwise the next mobile in the waiting queue will capture the idle channel).

It is possible to meet those requirements through hardware and software development. The complexity and estimated cost of the development constrains the recommendation of this method of enabling an emergency priority.

A more easily implemented approach to emergency priority is to move the priority request for channel access to the top position in the waiting queue without attempting to seize a channel. The success of this method depends upon the following assumptions:

- The trunked system is properly engineered and, in complying with FCC licensing criteria, the probability of blockage at peak busy hours in minimal

- Channel discipline is such that channel "hold time" for the average communication transaction is no greater than a few seconds (hopefully less than 5 seconds).

This type of emergency priority is inexpensive to implement in a dedicated control channel trunked system when compared to the other alternatives. Channel access to a well managed trunked system will normally be made within a few seconds even when the first call has been blocked. The Waiting Queue Priority system will insure that additional lost time is not incurred due to the size of the waiting queue. The assumption is that an emergency priority request from an agency will move that request to the first position in the queue unless there is already an emergency priority request in the queue. This method of emergency priority is recommended for the Oklahoma trunked system.

APPENDIX B

SUGGESTED AGENCY AGREEMENTS

I. INTRODUCTION

The agreement by two or more local government public-safety agencies to enter into a joint enterprise which provides a mutual service of value to the participants is best documented by written agreements between the parties. By their nature, these agreements are highly individual, tailored to specific requirements of each program in each locality. This appendix to the System Implementation Planning Guide (SIP) is intended to suggest only a general outline of such agreements. The details and the order of presentation will depend upon each kind of enterprise contemplated, its complexity, and the immediate cooperative environment. Legal counsel should be consulted.

1. Purposes of the Agreement

The purpose of a written agreement is to describe the reason for the cooperative effort and the results that are expected to be achieved through mutual participation. By reducing this to a clear and unambiguous written statement, the involved parties will fully understand their mutual participation. Equally important, the governing bodies, of which the participants are a part, will be able to determine the true nature of the program and the expected results and thereby provide their support.

2. Scope of the Agreement

The agreement should define the dimensions within which the terms of the agreement apply. The responsibilities and liabilities of each of the participants should be clearly documented. There should be no unwritten understandings between the parties.

The following model outline of an agreement form provides a series of topical considerations to be evaluated during the development of an interagency agreement. The precise form of a specific agreement, and the language to be used in each case, should be provided by legal counsel. In many cases, standard legal form and substance is required by State or Federal regulation.

II. SUGGESTED MODEL OUTLINE

The following topics and items are intended to delineate key considerations in the preparation of an interagency agreement.

1. General Terms and Legal Base

The general terms will include the following as a minimum:

- The identification of each participating agency
- The requirements to be imposed on those agencies that may wish to participate at a later date
- The concise purpose of the joint enterprise and the mutually advantageous results that are expected to be achieved
- A statement of the legal authority under which the public agencies are able to contract with each other for the stated purpose; this may be a state law, a local government act, a series of resolutions passed by the local governmental authorities, or similar authorization.

2. Services to be Provided

The services provided by each agency and to each agency will be defined. These include the following considerations:

- Definition of the services to be provided by each agency to the mutual system; these services could include, for example, equipment maintenance, equipment, facilities, operating manpower, support services, and similar items of value to the system.
- Definition of services the system will provide to each participating agency; such services could include the dispatching of field forces, management reports, statistical data, and similar items of value to the agency.
- The definition of the quantity or extent of each service to be provided.
- The responsibility each agency has for delivering its service and the responsibility the mutual operation has for delivering its services to each agency.
- The extent of any back-up or redundancy to assure that services are delivered in a timely manner throughout the life of the agreement.

3. Liability

A key element of the agreement between two or more public agencies is a clear definition of the liability each of the agencies has for the actions of other parties to the

agreement. This is particularly true if one or more of the agencies provides public services on behalf of the other agencies. Agreements to limit the liability exposure of participating agencies would include the following considerations.

- Responsibility for defending the provider agency in potential lawsuits.
- Indemnification of the providing agency against liability judgements against a participating agency.
- Indemnification of the participating agency against legal actions or liability judgements against the provider agency arising from the normal provision of agreed-to services.

4. Amount and Manner of Payment

The providing agency must be reimbursed for the expenses of the service it provides to the participating agencies. A portion of this obligation will fall to the individual participating agencies. The agreement between the agencies must be specific regarding this individual responsibility and will be definitive of the following considerations:

- The specific services to be provided and the cost of each service
- The method by which the cost and value of each service is calculated
- The means of payment for example: cash, in-kind services, cash equivalent in material or equipment, and any other valuable consideration agreeable to the parties to the agreement
- The time and manner that payments are to be made
- The use of outside funding sources such as grants or gifts.

5. Fiscal Procedures

Sound fiscal planning is key to the successful implementation of public agency cooperative programs. The responsibility of the provider agency for financial integrity must be defined in the agency agreements. The agreement will specify the following elements:

- The type of financial records and how they are maintained
- The contents of the periodic financial reports and the schedule for submitting these reports to higher authority and to participating agencies
- Access to the financial records by each participating agency
- Certification and/or audit of the records and financial reports
- Terms and conditions relative to the periodic reassessment of rates charged for each service provided.

6. Administration

The administrative structure of the cooperative program should be defined in the agency agreements. The authority and responsibility of each agency for participation in policy administration and the authority and responsibility for day-to-day operation should be included. Some of the key elements in the agreement are:

- The identification of the person(s) authorized to sign the agreement on behalf of each party to the agreement
- The identity of the person(s) who will represent the participating agency and providing agency in policy matters
- The responsibility and authority of the providing agency to supervise project personnel and establish personnel policy
- The responsibility and authority of the providing agency over joint-use facilities and equipment
- The retention by participating agencies of control, responsibility, and authority over their personnel, facilities and equipment that may be used in the cooperative project
- Identity and authority of persons responsible for the review of the agreements and for the determination of compliance.

These and other administrative elements suitable to the unique environment and nature of the proposed project should be negotiated between the parties and made part of the written agreement to participate.

7. Real Property and Equipment

The cost-effective implementation of a multi-agency cooperative program should make maximum use of facilities, property and equipment available from the participating agencies. The agreement should identify these properties and materials; it should establish the rules under which the properties and materials are to be used. Some key considerations are:

- Identify each item of property and equipment that is to be transferred to the use of the cooperative system
- Establish the value of the property and/or equipment and show the method used to establish the value
- Provide for the return of the property and equipment upon termination or cancellation of the agreement
- Define the method to be used to establish the value of property and material to be returned to the original supplier upon the termination, modification, or cancellation of the agreement.

8. Duration, Termination, and Amendments

The agency agreement must provide for modification to the agreement during its term. It must also define the duration of the agreement, make provisions for cancellation of the agreement, and disclose how the agreement is to be terminated. The following items should be included:

- The term of the agreement
- The circumstances under which the agreement can be terminated during its intended duration
- The terms under which the agency can withdraw from the agreement
- The circumstances under which either party can cancel the agreement
- Procedures for amending the agreement during its intended term
- Disposition of property and equipment upon termination or cancellation.

9. Other Provisions

The agency agreement is a custom document generated to reflect the unique needs of the specific circumstance and the environment in which the mutual agreement is being generated. Each agreement will include terms and conditions of an individual nature. Key among these are the following suggestions:

- Method of resolving disputes; for example, arbitration, application of appropriate State or Federal laws, etc.
- Identity of the court of jurisdiction for adjudicating disputes.
- Definition of terms used in the agreement.
- Statutory status and filing of the agreement.
- Interrelationship of agreements.

* * * * *

The drawing of interlocal contracts and agreements to provide public services or hold public property for the mutual advantage of multiple governmental organizations may be subject to local, state, or Federal regulations and/or laws. These documents should be drawn up under the advice of legal counsel to insure their status as legal instruments.

APPENDIX C

STATEMENT OF WORK

APPENDIX C

STATEMENT OF WORK

I. INTRODUCTION

The Introduction to the Statement of Work (SOW) should provide a general overview of the project to enable a better understanding by the responders. The key elements of this appendix are outlined in the following subsections.

1. Background of the Project

A brief historical description of the origin of the procurement and the constraints imposed on the design.

2. Objective of the Procurement

A brief discussion of the main system objectives to be achieved by the procurement.

3. Scope of the Procurement

A basic and brief outline of the hardware, software, and services that are being purchased. These may include, for example:

- Hardware
- Software
- System Design
- Installation
- Testing
- Training
- Maintenance.

II. INSTRUCTIONS TO BIDDERS

This section of the SOW will provide the bidders with all the information needed to respond correctly to the bid request.

1. Procurement Schedule

The schedule time and dates for responding to the bid request will include:

- Time and place of the pre-bid conference
- Time and place bids and proposals are due

- Bid and proposal opening time, date, and place
- Proposed contract award date
- Expected date of contract completion.

2. Authorized Contracts

The persons who are authorized to respond to bidders' requests will be identified prior to bid opening. These may be restricted to the:

- Procuring officer
- Technical consultant.

The statement should be made regarding how the issues raised by these contacts will be reported to the other bidders.

3. Bid and Proposal Requirements

Each of the items to be submitted as part of a responsive bid will be defined. Any limitations should be included in the description. These items would include, for example:

- Itemized cost proposal
- Technical proposal
- Management proposal
- Provisions for alternate proposals
- Proposal limitations regarding page count, standardized forms (cost proposal), proposal size, unnecessary artwork, and number of copies to be submitted.

4. Qualifications of the Bidders

The contractor for a high technology system must be qualified, technically and financially, to complete the required work. These qualifications should be expressed in the SOW by requiring reasonable responses to limits imposed on:

- Bidders' facilities and financial resources
- Performance history in terms of references and a list of similar and recent contract work
- Support facilites such as field maintenance shops, training facilities, and spare parts replacement depots

- The quality and availability of personnel for management, supervision, and technical staff.

5. Proposal Evaluation Criteria

Criteria should be established for the comparative evaluation of:

- Technical proposals
- Cost proposals
- Management proposals.

These criteria should be clearly defined in the SOW so that each bidder will understand the emphasis placed on the requirements of the RFP.

6. Contract Award

The SOW will identify the type of contract to be awarded the successful bidder whether or not this contract will be awarded without pre-contract discussions.

7. Indemnification

The purchaser should require indemnification against damages imposed through intentional or unintentional acts of the contractor. High technology system procurements will need indemnification against the improper use of patented items or processes. All procurements which include services such as installation and test will be well advised to require indemnification from damages resulting from the actions of contractors' employees or agents.

8. Titles and Rights

Rights of the purchaser and ownership of titles will be clearly defined by the SOW. These items include statements related to:

- The transfer of title to equipment and software
- Rights to data and software developed or provided as part of the contract
- Rights and title to the submitted proposals
- The right to reject proposals
- The right to negotiate with any bidder
- The right to cancel negotiations or the contract.

Legal counsel should be consulted for the scope, content, and wording of this subsection of the SOW.

9. Bonds, Insurance, and Warranty

Each governmental entity will have its own limits for, and description of, the bonds, insurance and warranty provisions for contractor provided material and services. Frequently there will be state regulations which also must be adhered to. These requirements will provide for:

- Performance bonds
- Workman's compensation
- Comprehensive liability insurance
- Warranty on workmanship and materials.

The purchasing department of the major governmental agency included in the program will provide counsel as to how these requirements are to be included in the SOW.

10. Costs of Proposal Preparation

The SOW should state clearly that any costs related to the preparation of bids or proposals can not be included in the proposed cost of the project or billed back to the purchaser in any manner.

11. Contract Disputes

At the option of legal counsel, the SOW may indicate the means by which the governmental agency resolves contract disputes. This will be a function of the governmental body and will not be an option of project management. These provisions may include:

- The procedure and method of resolving contract disputes
- Termination of contracts for cause
- The assessment of liquidating damages
- The identity of the court of jurisdiction.

12. Applicable Federal/State Laws and Regulation

When State or Federal laws/regulations affect the system design, its operation, or allowable use, these laws or regulations should be identified in the SOW.

III. SCOPE OF WORK

This section of the SOW defines the items of work expected of the contractor; the specific tasks required by the contractor are described in detail.

1. Services to be Provided

High technology systems will require professional services to be performed by the system contractor in addition to the delivery of hardware and software items. Typical services to be provided are:

- System design which can include system engineering, radio propagation engineering, software development, and hardware development.
- Installation and debugging of hardware and software.
- Assistance in procuring required licenses and permits.
- Developing and conducting performance tests and acceptance tests.
- The preparation of sites and facilities which can include construction, HVAC, emergency power, lighting, installation of utility services, etc.

2. Deliverable Items

Each deliverable item should be identified in the SOW. Deliverable items include hardware, software, and services. The list will be unique to the complexity of the system to be procured. However, there will be some items common to all lists such as:

- Each item of electronic or radio hardware
- Each item of computer software
- Maintenance support
- Spare parts and spare module provisions
- Towers, buildings and other structures
- Manuals and documentation such as test plans, test procedures, maintenance manuals, operators manuals, user manuals, training aids, installation drawings, and test reports
- Progress reports and deficiency reports.

3. Delivery Schedules

Each deliverable item should be supported by a delivery schedule. The SOW will require a formal and contractually obligated schedule for:

- Each item of electronic or radio hardware
- Each item of computer software
- Each tower or building
- The completion of all facility preparations
- Delivery of all manuals and documents
- The time and place of technical progress reviews
- The delivery of reports including progress reports, test reports, discrepancy reports, and the final report or acceptance test report.

IV. SYSTEM SPECIFICATION

The system specification is a complete technical system description which includes the system performance, system interfaces, and system configuration. It places technical limits on these parameters and adds reliability and/or maintainability requirements where appropriate.

1. Hierarchy of Specification and Standards

Industry or regulatory specifications or standards frequently apply to the specification of a system. These should be identified. The hierarchy of these documents, as they apply to the system specification, should be defined so that conflicts between them can be resolved.

2. System Description

The system description includes the configuration of the system elements and their interconnection with each other. It is recommended that this be done graphically with supporting written clarification. The system description is derived from the system concept design.

3. System Interfaces and Supporting Services

The means by which the system interconnects with the world outside of the system should be fully described. These interfaces are relatively unique to each individual system, but some key interfaces will include:

- External communication systems such as mobile radios, private telephone systems, data processing, digital data systems, alarms, microwave transmission systems, and similar facilities
- Utility systems such as public access telephone systems commercial power systems, and water supplies
- Emergency operations such as emergency power services, fire protection, emergency medical services, and civil disaster prevention operations.

4. System Software

The system specification will include a complete description of the operations software and the applications software required to provide the needed system performance.

5. System Operation and Performance

The specification of system operation and performance is tailored to meet individual system requirements as developed in the system concept. Typically these specifications will include a complete description of:

- The functional modes of system operation for routine system performance, emergency system performance and allowable fail-safe or degraded levels of performance.
- The calculated levels of personnel staffing for the operating staff, maintenance staff, and system management.

6. Expansion Requirements

Frequently, limitations on funding or other resources will prevent the initial implementation of a sophisticated system from realizing the full potential of system operation, scope, and performance. When these expansion requirements are part of the initial system procurement, they must be fully described in the system specification.

7. System Licenses and Approvals

High technology systems may exceed the apparent limits of Federal or state licensing regulations and extraordinary procedures may be needed to acquire the necessary permits or licenses. These requirements should be clearly defined in the system specification. They will be unique to each specific system configuration and intended operation.

V. EQUIPMENT SPECIFICATIONS

The equipment specifications define the quality and performance characteristics of each item of hardware and software needed to meet the system specifications. The identity of each hardware and software item is derived from the system configuration diagram which was developed as part of the system concept.

1. General

This subsection of the equipment specifications accumulates all items of the individual equipment specifications requirements that are common among all items of equipment or software. It also defines the quality and quantity of each item of hardware and software that is required to meet the system configuration. Typical items that would appear under the general heading are:

- Applicable industry standards or publications and their hierarchy for this program
- Standard environmental conditions such as temperature, humidity, primary power, vibration, shock, dust, and dirt
- Deliverable equipment lists showing the quantity required of each item including spares
- The required level of quality and workmanship for each hardware item.

2. Individual Item Specifications

Each equipment item will have an individual technical specification which reflects its construction and performance as required to meet the system specification. These are derived individually from the severe than those needed to meet the system performance specifications. Software specifications are typically combined with the equipment specification for the computer subsystem or the switching subsystem in which they are resident.

Submitted to:

Mr. John E. Simmons
Project Director
Phoenix Fire Department
620 West Washington St.
Phoenix, Arizona 85003

DIGITALLY ADDRESSED TRUNKED COMMUNICATION SYSTEM

SYSTEM IMPLEMENTATION PLAN

PHOENIX, ARIZONA

November 15, 1980

BOOZ · ALLEN & HAMILTON Inc.

776 SHREWSBURY AVENUE
TINTON FALLS, NEW JERSEY 07724
747-9303
AREA CODE 201

TABLE OF CONTENTS

I. INTRODUCTION

This system implementation plan for a digitally addressed trunked communication system (DATCS) for the Phoenix, Arizona area was prepared by Booz, Allen and Hamilton and the Associated Public-safety Communications Officers, Inc. (APCO) in response to LEAA Grant No. 79-SS-AX-0013.

1. BACKGROUND AND OBJECTIVES

The Second Report and Order in the proceedings related to Docket No. 18262, published by the Federal Communications Communication (FCC) in 1974, promised relief for the increasingly more difficult problems of frequency congestion in the public-safety community. These proceedings allocated 200 channels in the 800 MHZ portion of the spectrum for "trunked" systems. In February 1977, LEAA recognized that many technical, economic, and management questions about the application of this newly available spectrum to public-safety operations must be answered before the potential benefits inherent in trunked systems could be made available. Under LEAA Grant No. 77-SS-99-6009, the Associated Public-safety Communications Officers, Inc. (APCO) was requested to analyze these problems, make appropriate recommendations for future actions, and describe a program to demonstrate the potential capabilities of these new concepts.

A series of programs under APCO Project 16 was initiated. The first of these (Project 16) resulted in an analysis of the technical and regulatory factors affecting the applicability of the 800 MHZ portion of the radio spectrum to law-enforcement communication system problems. A second program (Project 16A) identified specific operational capabilities and functional requirements that should be incorporated into a public-safety trunked communication system. The third program (Project 16B) provided specific planning assistance to two cities (Lexington, KY and Phoenix, AZ), two counties (Bucks, PA and Salt Lake County, UT), and the State of Oklahoma for a feasibility study and basic implementation plan for DATCS demonstration systems.

Since November 1979, Phoenix has been participating in Project 16B as one of the demonstration cities. The key objectives to be achieved are:

- To determine if DATCS can relieve municipal radio channel congestion in the Phoenix area
- To establish the potential of DATCS to accomodate future municipal radio communications needs of a rapidly growing metropolitan area
- To address the solution of the complex command/ control problems confronting the public-safety agencies
- To develop a common DATCS to support all public safety and/or other governmental communications requirements within the Phoenix metropolitan area

- To provide a solution to interagency radio connectivity between governmental agencies appropriate to their mission responsibilities.

Other advantages of operational flexibility are inherent in a dynamically programmed digitally addressed communication system. These have been evaluated as DATCS capabilities in determining the system requirement.

2. PROJECT DIRECTION AND PARTICIPANTS

The project was under the direction of:

- John E. Simmons, Project Director
  Phoenix Fire Department

- Paul W. Salter, Deputy Project Director
  Equipment Management Division, City of Phoenix

The participating public-safety agencies include the following:

- Phoenix Police Department, Chief Seth Allen
- Mesa Police Department, Mr. Robert Gates
- Glendale Police Department, Capt. Jerry Eldridge
- Scottsdale Policy Department, Mr. William F. Jordan
- Tempe Policy Department, Mr. Bill Pardee
- Phoenix Fire Department, Chief Thomas F. Sawer
- Mesa Fire Department, Mr. Robert Gates
- Tempe Fire Department, Chief R. E. Stayner
- Glendale Fire Department, Chief Bob Gilbreath
- Special Emergency (EMS), Chief Thomas F. Sawer

Other participating governmental and public service departments and services include:

- Phoenix Building Safety, Mr. Max P. Wold
- Phoenix Civic Plaza, Mr. Dave Schupback
- Phoenix Human Resources Department, Mr. Marvin Boles
- Phoenix Aviation Department, Mr. Robert Erickson
- Phoenix Public Transit Administration, Mr. Ed Colby
- Phoenix Engineering, Mr. William S. Wood
- Phoenix Parks and Recreation, Mr. Cecil P. Mason
- Phoenix Traffic Engineering, Mr. Bill Bain
- Phoenix Traffic Signals, Mr. Walt Cicioni
- Phoenix Facilities Maintenance, Mr. Norman Smith
- Phoenix Streets Maintenance, Mr. Dick Shine
- Phoenix Sanitation Department, Mr. Harry I. Kelman
- Phoenix Equipment Management, Mr. Sam Collett
- Phoenix Sewers Department, Mr. Robert B. Steytler
- Phoenix Water Distribution, Mr. Lyle E. Orr
- Phoenix Water Customer Service, Mr. Jack Blaha
- Phoenix Water Production, Mr. Ken Daly
- Mesa Public Works, Mr. Robert Gates
- Glendale General Services, Mr. Dave Hall
- Tempe Public Works, Mr. Bill Pardee
- Tempe Sanitation/Refuse, Mr. Bill Pardee

Each of the above listed public-safety and public service agencies have been active participants in the program, contributing to the interagency and intra-agency communications analysis and also the requirements analysis for the DATCS concept design.

It has been the responsibility of the Project Director to develop this System Implementation Plan (SIP) with the technical assistance of Booz, Allen as engineering consultants to APCO. The cooperation of all participating agencies and their personnel has been voluntary. There have been no binding commitments required of the City of Phoenix or any of the other participating governmental bodies.

II. SYSTEM CONFIGURATION

The basic DATCS land mobile radio system for the Phoenix area has been conceived to replicate current governmental radio system operations as closely as possible. The difference in function and response between the conventional radio system configuration now in use and the DATCS radio system should be nearly transparent to the mobile operator except that co-channel sharing will appear to have been eliminated.

This philosophy directs that operations which require a unique, trained skill on the part of the mobile operator be minimized in the system concept. It also directs the avoidance of subsystem interfaces in which trunked technology or switching requirements might result in a degraded performance of existing communications systems.

The configuration of the Phoenix area DATCS is based in part on the system requirements discussed in the previous reports and in part on information provided by existing suppliers of trunked radio systems. It is noted that the equipments described as part of this DATCS radio configuration are not standard production items and have not been previously provided by the vendors in this definitized form. Further study by the vendor community may modify the final hardware and software offerings. This could result in changes to the system configuration.

1. PARTICIPATING AGENCIES

Candidate agencies for participation in DATCS include those who are mobile radio intensive (full participation) and those who are portable radio intensive (partial participation). At this time, there is also a question regarding the participation of the communities adjacent to Phoenix - a question that has not been resolved. The following subsections will discuss these groups individually.

1) Phoenix Public Service Agencies

The following list includes those City of Phoenix government agencies that are mobile radio intensive and who would, by their method of operation, profit most from DATCS features:

Engineering

Parks and Recreation

Traffic Engineering

Traffic Signals

Facility Maintenance

Human Resources

Equipment Management

Sanitation

Streets Maintenance

Job Stimulus Program

Building Inspection

Sewers

Water Production

Water Distribution

Water Customer Service.

Together, these 15 agencies report having 1,087 mobile units.

2) Phoenix Public Safety Agencies

The Phoenix Police Department and the Phoenix Fire Department are portable radio intensive and plan to expand the use of mobile data terminals (MDT at UHF). This restricts the use of DATCS to those police and fire mobiles engaged in field operations or command operations in which the portable radio is not the primary means of communications. It is estimated that DATCS mobile radios could be installed in approximately 25 percent of the police and fire vehicles - a potential total of 230 vehicles.

2. NON-PARTICIPATING PHOENIX AGENCIES

in DATCS because of unique requirements or limitations imposed on their radio systems:

Aviation Department

Public Transit Administration

Special Emergency (EMS)

Civic Plaza.

3. ADJACENT COMMUNITY PUBLIC SERVICE AGENCIES

Thefollowing agencies are mobile radio intensive and, by their method of operation, would profit most from DATCS features. However, at this time the question of their participation with Phoenix is unresolved.

Glendale General Service

Mesa Public Works

Mesa Public Sanitation

Tempe Public Works

Tempe Sanitation and Refuse.

Together, these agencies report having 623 mobile units.

4. ADJACENT COMMUNITY PUBLIC SAFETY AGENCIES

The public safety agencies adjacent to Phoenix are portable radio intensive, and it is assumed unlikely that they will participate in DATCS. These agencies include:

Glendale Police

Glendale Fire

Mesa Police

Mesa Fire

Scottsdale Police

Tempe Police

Tempe Fire.

If interagency coordination required the installation of DATCS in the above public safety mobile units, it is estimated that no more than 10 percent of the public safety vehicles would be included - approximately 20 mobiles, maximum.

5. BASE STATION CONFIGURATION

The proposed DATCS base station configuration for Phoenix and adjacent communities is shown in Figure II-1. The selection of base station locations at North Mountain, Thompson Peak, and South Mountain is driven by radio propagation experience at 450 MHZ; 800 MHZ tests have yet to be initiated.

The sites at North Mountain and Thompson Peak transmit and receive control channel information. Details of these installations are shown in Figure II-2. The site at South Mountain receives control channel information from the mobiles but does not transmit it. Details of this installation are shown in Figure II-3.

The site controller at each site is fully programmable and capable of operating independently based on control channel instructions. The two control channels transmit the same information simultaneously on different frequencies. Mobiles will home on one control channel until the signal is lost then seek and lock-on the other control channel.

FIGURE II-1
Phoenix DATCS
Base Stations

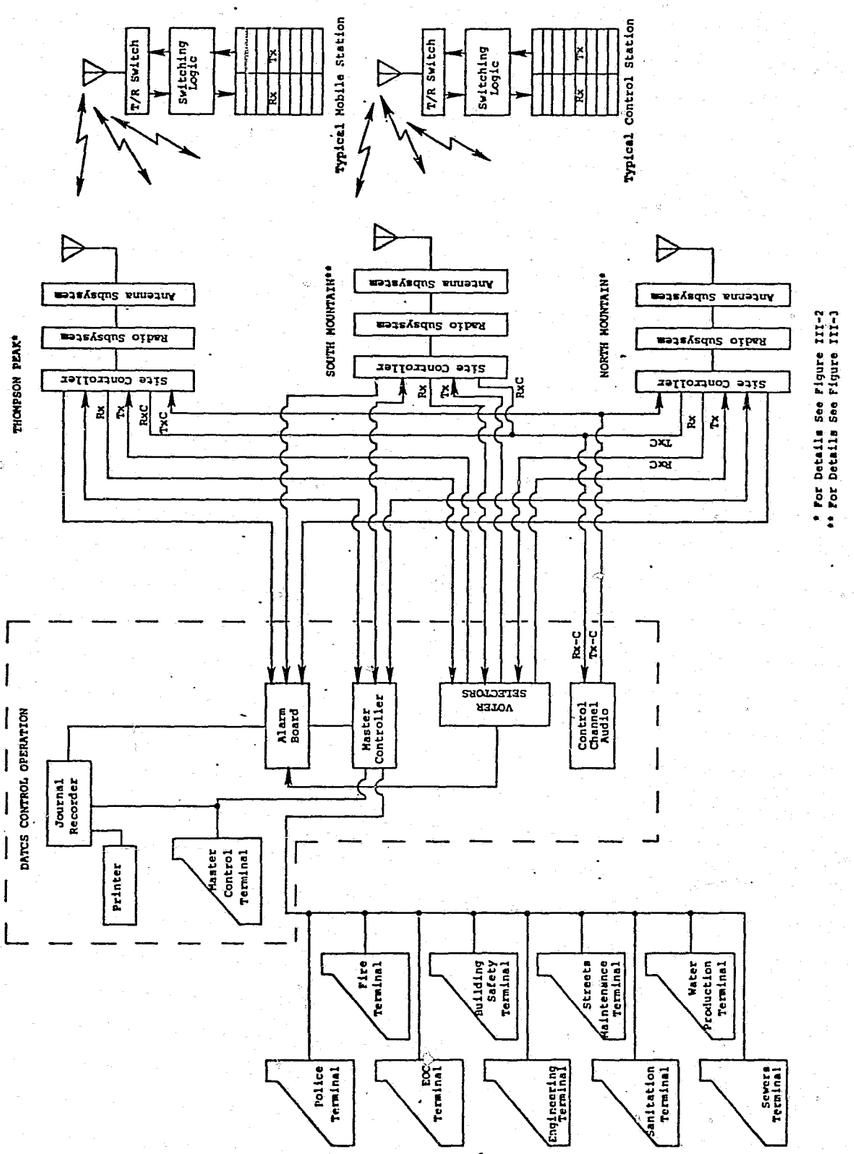


FIGURE II-2
Phoenix Base Site
Control Channel Transmission

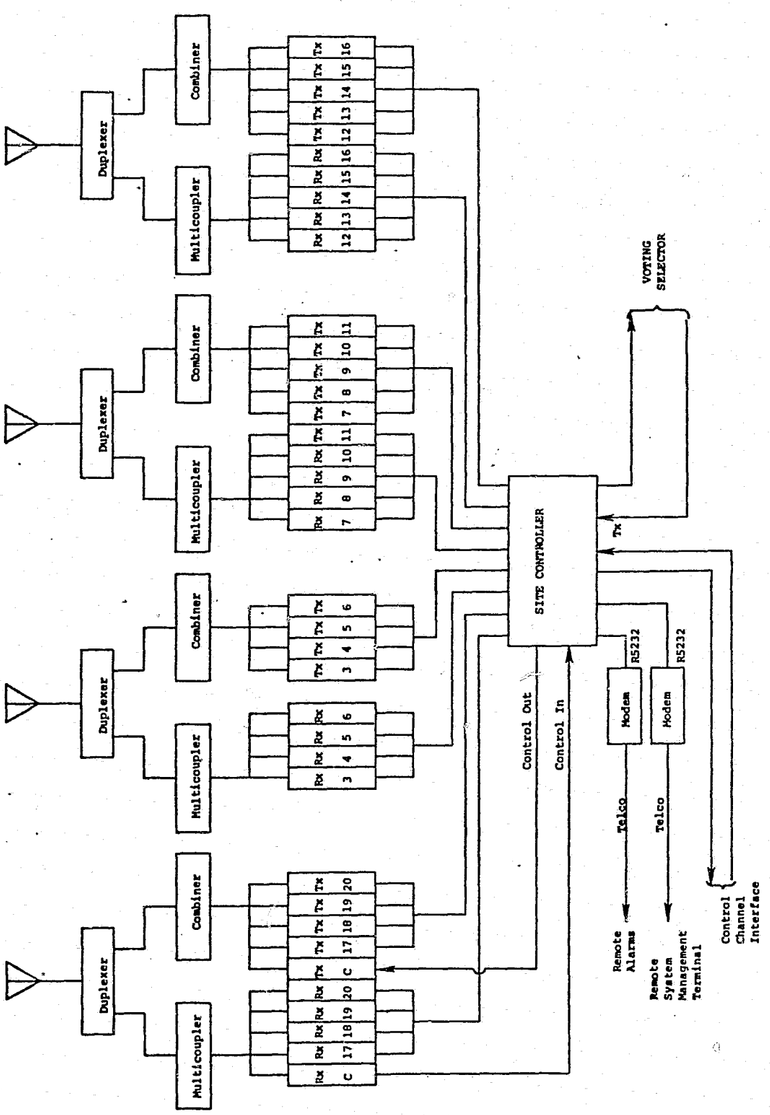
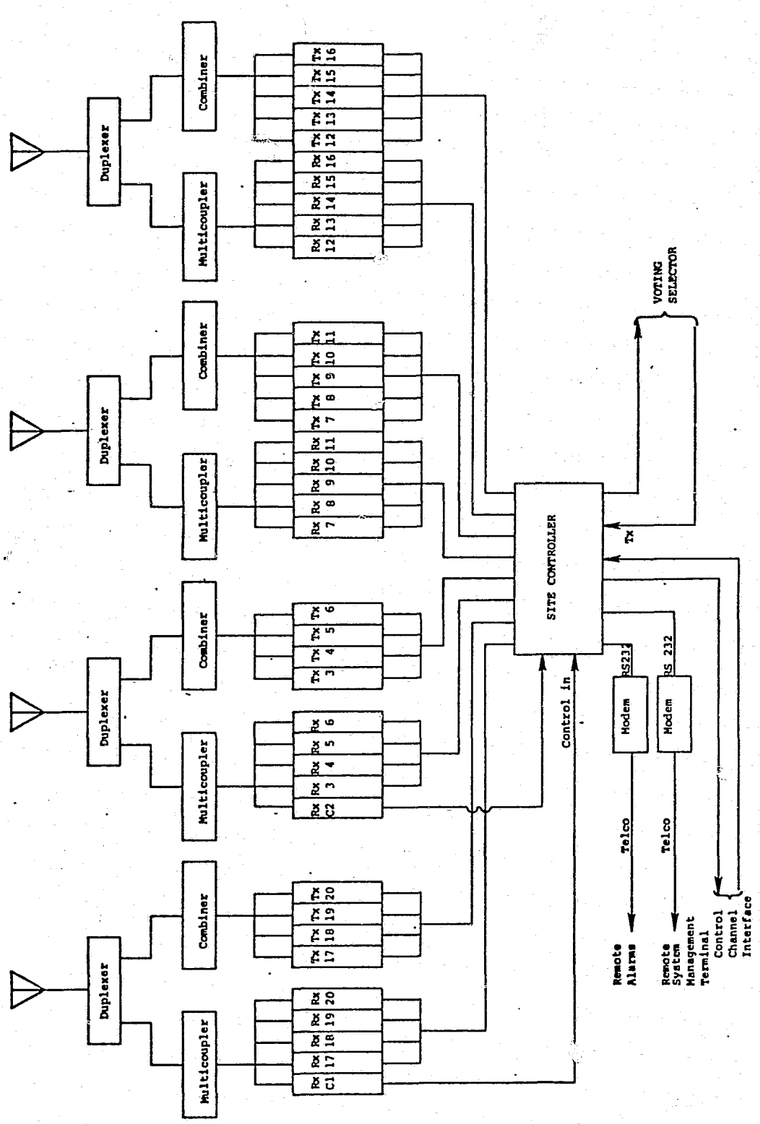


FIGURE II-3
Phoenix Base Site
No Control Channel Transmission



The site controllers are connected through modems and an RS-232 interface to the master controller and master control terminal at DATCS control operation center. This terminal can make program changes in the site controllers, selectively turn off or turn on individual channels, key up individual transmitters, change the address code responses, and perform interagency coordination interface switching as required.

Alarm functions generated by the site controller are connected through modems and an RS-232 interface to the alarm board in DATCS control operation center.

Receiver voting and transmitter steering information from each DATCS voice channel at each site are brought to the voter selector equipment at the DATCS control operation center. The control channels are not voted; voting is suspended from the back-up control channels when they are selected by the site controller.

Audio signals into and out of the control channel receiver and transmitter at each site are interconnected at the control channel audio unit in the DATCS control operation center. Any bridging, amplification, attenuation, or balancing required is done by this unit.

The DATCS control operation center coordinates and controls the operation of the three base station sites and provides an interface for the restricted control terminals located at user agency locations. The master controller provides logic and switching for the multiple drop circuit to the agency terminals, and routes management information generated by site controllers to the journal recorder. The master controller is commanded by the master control terminal which can address the programming and coding of the master controller and the site controllers.

The journal recorder is a magnetic tape transport that records all management information generated by site controllers, alarm board, and master control terminal. It prints out selective reports on its printer on command of the master controller. It is intended that most management reports, except for spot reports, will be generated off-line from the journal recorder tapes.

6. FREQUENCY PLAN

A proposed frequency plan for a 20-channel area DATCS for Phoenix is shown in Figure II-4. The reported number of public service mobile units in Phoenix and adjacent communities are more than enough for 70 percent loading of a 20-channel mixed service group trunked radio system under present FCC Rules and Regulations (Part 90, Section 90.375).

The distribution of channels for North Mountain, Thompson Peak, and South Mountain is shown in Figure II-4. Channel 3 is the back-up control channel for North Mountain, and channel 4 is the back-up control channel for Thompson Peak. If a control channel failure (or deactivation) will require the use of channel 3 or 4 as a control channel, the transmitters and receivers for the back-up channel selected will be exempt from voting and transmitter steering.

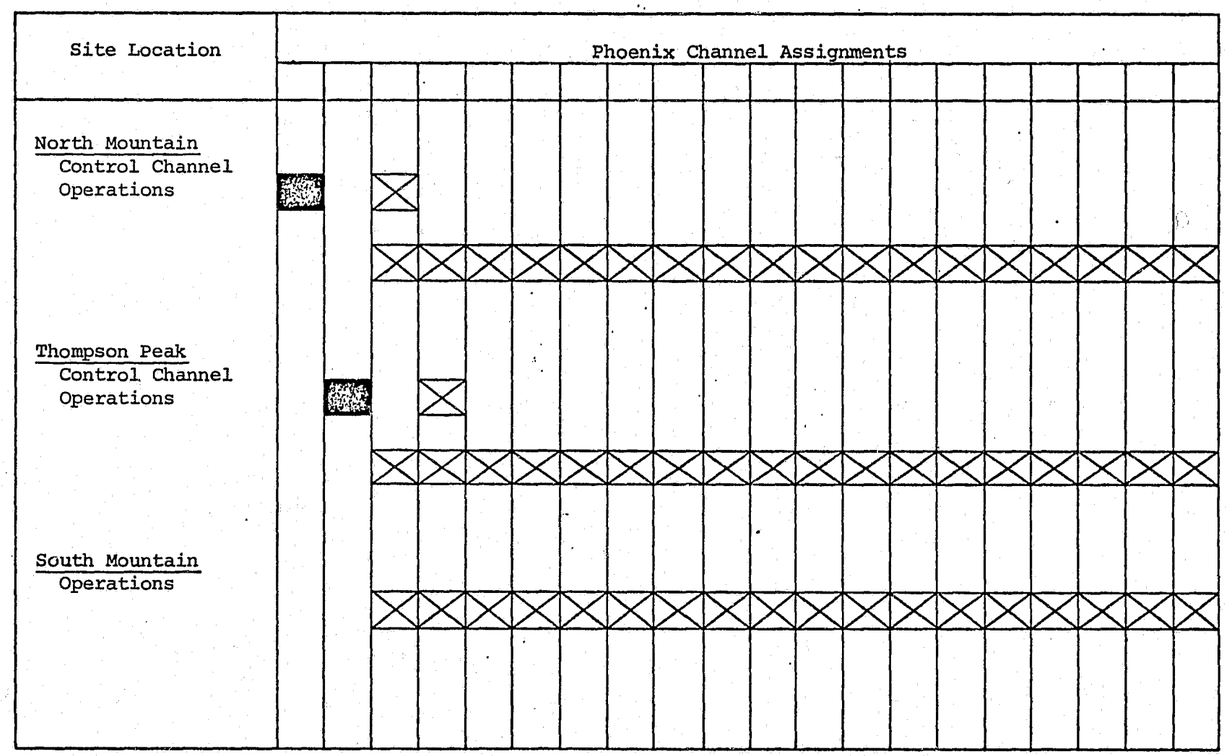


FIGURE II-4
DATCS Frequency Plan

7. ADDRESS CODES

The digital address of all mobile units and control station units has two parts, an individual unique address and a group address. The combination of these two address codes informs the site controllers and the master controller which control stations and mobiles to include in the request for a channel. Under normal mode operation, all mobiles assigned to a control station (group dispatch point) will be included in any group call. Mobile-to-mobile communication within the group is achieved as in any repeater type conventional radio system. If temporary modification is required such as interagency coordination, intergroup mobile-to-mobile communication, the individual address portion of the address code enables unique routing by agency terminal or master terminal instruction to the controllers. Similarly, an individual mobile or control station can be denied access to DATCS.

8. MOBILE/CONTROL STATIONS

Radio access to DATCS is accomplished by mobile stations and control stations. Direct wireline control to the site controller is not contemplated; the mode of operation is similar to a conventional repeater type radio system.

1) Mobile Stations

The configuration of all mobile stations is shown symbolically in Figure II-1. The frequency selection for transmission and reception is determined by frequency synthesis constrained to the licensed channels by a programming plug or PROM. Switching logic decodes the information provided by the control channel, activating the channel change switching and displays if the address assigned to the unit is recognized. The mobile unit has a half-duplex configuration, using a T/R switch instead of a duplexer.

Mobile displays include the following:

- Handshake indicating a request for channel has been received by the system
- Indication that the request has been accepted and a channel has been made available
- Indication that the request has been placed in queue
- Indication that the mobile unit has gone beyond the control channel range.

The mobile radio has no external control over its programmed address code and has no capability to add additional codes. However, the mobile can have multiple program plugs or PROMs switchable from the control center.

2) Control Stations

Control stations are the means by which control points and dispatch points access DATCS. There are no wireline or microwave control links to the base station site controllers. The configuration of control stations is shown symbolically in Figure III-1; it is identical to the configuration of a mobile station.

The displays at the control station differ from those of the mobile station. The control station displays include the mobile station displays in addition to the following:

- Code identity of the mobile unit in communication with the control station
- Code identity of units in the "calls waiting" queue for that control station
- Identity of any mobile in the "calls waiting" queue which has exercised an emergency priority
- Status data display of units assigned to the control station which has a status encoder.

The control station may have the capacity to change its group address or to receive traffic from more than one group. This can be achieved by switching program plugs or PROMs. By exercising this option, a control station can change dispatch responsibilities to accommodate after-hour coverage.

9. CONTROL POINTS

The configuration for DATCS results in two types of control points: the master system control at DATCS control operation center and the control point at each agency.

1) Master Control

The master control is located at DATCS control operation center as shown in Figure III-1. The function of the master control is to monitor system operation as reported by the equipment status and alarm data provided by site controllers and to respond to alarm status with corrective action.

By means of the master control terminal, the programming of the master controller and site controllers can be modified to achieve required changes to system operation. A journal recorder and printer delivers hard copy of system spot status and changes initiated by master control.

The alarm board will alert the master control to faulty operation of any major unit at any of the three base station sites. Faulty operation of the master controller and the voting selectors on each voice channel is also shown on the alarm board.

This position is viewed as being manned 24 hours a day.

2) Agency Control Points

Agency control points are identified as control stations and, in some cases, control terminals on a drop-line circuit to the master controller. Some agencies may have multiple control points colocated at a single dispatch center. The police and fire dispatch centers in Phoenix may have access to a control station at each dispatch position. Other public service agencies may have separate control stations at several locations reflecting the multiple control point configuration of their command and control operation.

Those agencies that would probably have control stations and the estimated number of control stations that each would have is shown in the following listing:

Agencies	Number of Control Stations
Phoenix:	
EOC	7
Police	6
Fire	4
Engineering	4
Traffic Engineering	1
Traffic Signals	1
Facility Maintenance	2
Human Resources	1
Equipment Management	1
Sanitation	4
Street Maintenance	2
Job Stimulus Program	1
Building Inspection	2
Sewers	2
Water Distribution	2
Water Customer Service	1
Parks and Recreation	2
Glendale:	
Fire	1
Police	2
General Service	2
Mesa:	
Police/Fire	3
Public Works	6
Public Sanitation	4
Scottsdale:	
Police	1
Tempe:	
Police	2
Fire	2
Public Works	3
Sanitation/Refuse	1

The agency data terminals are restricted to those agencies that have the need to change fleet assignments frequently and have the technical skills to operate a computer terminal. Each terminal would be restricted by software protection to the activities of the agency in which it is installed. Candidate agencies for terminals include:

- Phoenix Police
- Phoenix Fire
- Phoenix EOC
- Phoenix Engineering
- Phoenix Streets Maintenance
- Phoenix Water Production
- Phoenix Water Distribution
- Mesa Police/Fire
- Mesa Public Works
- Scottsdale Police
- Glendale Police
- Tempe Police
- Tempe Public Works

10. SYSTEM OPERATION

The philosphy of system operation requires that the current command and control procedures of the participating agencies be largely unaltered in DATCS operation and, to the degree possible, the functions of DATCS will be transparent to the mobile radio operators. The system concept and operation are based on that philosophy except to resolve existing deficiencies or to employ digital system technology where it is found to be desirable. The following subsections will address DATCS operation only and will not review the existing operating procedures of the candidate agencies.

1) Control Station/Mobile Station Operation

The half-duplex configuration of control stations and mobile stations is symbolized in Figure II-1. The main difference is the degree of control each can exercise and differences in the output displays. Each responds to control channel commands and each accesses the control channel(s) in the same way. Both have frequency synthesizers which span the entire 800 MHz trunked radio spectrum and are constrained to the licensed channels by a replaceable code plug or PROM. The code plug or PROM will also determine the unit address and the group address.

. Control Stations

The control station is the means by which the dispatch center or control point accesses DATCS for communication with its mobile fleet and possibly other control stations. There is no need for wireline or microwave control links between the dispatch points and the base station sites.

The control station idles on the system control channel. When initiating a call, the control station will be switched to an unoccupied channel together with all mobile units or control stations having the same group address. A mobile unit or control station in the same group initiating a call will cause the control station to switch to the same unoccupied voice channel assigned by the site controller.

The displays of a control station will include:

- Handshake indicating a request for channel has been received by the system
- Indication that a requested channel has been assigned
- Indication that a channel request has been placed in the waiting queue
- Code identity of the mobile unit in communication with the control station
- Indication that there are units in the "calls waiting" queue
- Indication that a unit in the "calls waiting" queue has exercised an emergency priority request.

If the control station is part of a dispatch center for public safety operations, the following displays should be added:

- Status display for those mobile units provided with a status encoder
- Code identity of the units in a "call waiting" queue
- Code identity of a unit which is exercising an emergency priority request and is either in the "call waiting" queue or in communication with the control station.

The control stations will have more control flexibility than the mobile stations. This flexibility includes manual switching of code plugs or PROMs to effect changes in fleet configuration or for interagency coordination. The public safety control stations will also have an emergency priority request capability.

- Mobile Stations

Mobile stations are similar in configuration and function to control stations. Displays are limited to the following:

- Handshake indicating a request for channel has been received by the system
- Indication that a requested channel has been assigned
- Indication that a channel request has been placed in the waiting queue
- Indication that the mobile is beyond the range of a system base station.

Mobile controls and switching capability are limited. The mobile will not be able to change its address codes or group assignment. Mobiles can be provided with multiple code plugs or PROMs which can be switched by the master controller. Mobiles can also be provided with a "repeater talk-around" switch for use outside the Phoenix area; public safety mobiles can be provided with an emergency priority switch. Those agencies with a central dispatch and/or CAD can also add a unit status reporting encoder to their mobiles to drive a status display at the dispatch center and update the CAD status displays.

2) Base Station Operation

Base station operation is similar to conventional radio repeater type operation except for the site controller functions. There is a conventional repeater installation for each DATCS voice channel at each base station site. There is a conventional repeater installation for the control channel at North Mountain and Thompson Peak. A digital site controller manages the DATCS functions at each site. The basic functions of the site controller are:

- Recover and decode inbound control channel requests
- Select and assign unoccupied voice channels as requested
- Generate and encode outbound control channel signals directing system users to assigned channels
- Monitor voice channel activity
- Generate subaudible or digital code information on voice channels to unmute authorized receivers
- Control base station repeaters

- Identify all base station repeaters in accordance with FCC regulations for transmitting station identification
- Monitor and report to alarm panels all base station abnormal conditions
- Provide system management interface for the master controller and master control terminal.

The remote master controller and master control terminal will have a wide range capability to modify the applications program in the site controller.

3) Mobile-to-Mobile Operation

Mobile-to-mobile communication is inherent in a repeater type operation. Within the group address, all mobiles will hear and be in communication with all other mobiles in the same address group. Intergroup mobile-to-mobile communication can be initiated by the dispatcher or master control terminal using the individual unit address. These one-time intermobile links can be set up by keyboard entry or by cross-channel patching.

4) Mobile Talk-Around

The ability of the mobile to talk around the repeater car-to-car in a half-duplex operation (single frequency simplex in both directions) is a manually selected option of the mobile control head. The option is automatically disabled within the range of a control channel signal. Outside the range of a control channel signal, the option (if selected manually) will place the mobile in a single frequency half-duplex mode on a frequency previously programmed from among the frequencies available through the program code plug or PROM. The intent of this option is to enable the possibility of minimal communications between Phoenix area mobiles while they are out of range of the Phoenix DATCS.

5) Portable Radio Interface

Estimates by industry sources place the very earliest availability of a technically acceptable frequency synthesized trunked portable radio in the 1983-85 time frame. Until such portable radios are available, trunked radio system equipment configurations will include only base stations, control stations, and mobile stations.

Public safety radio systems in Phoenix, Glendale, Mesa, and Tempe are portable radio intensive. The significant investment in this mix of VHF high band/UHF portable radio equipment must be protected. These existing equipments must be permitted to operate without modification with the trunked radio system.

The public safety agencies will continue using the portable radios on conventional VHF/UHF radio channels and manually cross patch these channels into the trunked system at the dispatcher's console when crossband coordination is required. Conventional VHF/UHF frequencies will be retained for portable radio operation and the trunked system will be used for the mobile radios.

6) MDT/CAD Interface

Public safety agencies in Phoenix and adjacent communities plan a continuing expansion of mobile data terminals (MDT) and expanded computer aided dispatch (CAD) operations. In-depth technical studies will be needed to investigate the effects of digital communications transmis sion characteristics of 800 MHz on MDT operations, particularly as these relate to data error rate limitations, permissible data rates, error detection and correction codes, and message retransmission limitations. These questions are unresolved at this time, and a judgement has been made to continue MDT operations on UHF until more definitive technical studies can be provided.

Manually activiated status encoders can be installed in public safety vehicles and interfaced with the DATCS mobile radio. This status information can be decoded at the public safety dispatch centers, displayed on a status board, and passed on to the CAD computer to update the CAD status displays.

7) Interagency Communication

Interagency communication in the DATCS concept can be accomplished by the following key methods:

- Radio channel cross patching or phone patching at the dispatch consoles.
- The pattern of interagency coordination connectivity can be programmed into the controllers and activated by terminals installed at key dispatch centers of agencies where flexibility in fleet programming is required (see Figure II-1).
- Routine and frequently activated cross-agency communication routes can be programmed into the control station code plug or PROM, and these code plugs or PROMs can be manually switched.
- The provisions for mobile radio interconnect to the Phoenix Centrex telephone system will enable any mobile so equipped to communicate with any municipal agency which is on the Centrex system.

Any individual method or combination can be configured into the vendor's proposal as best suited to his hardware and software offerings.

8) Phantom Groups

Temporary one-time needs for multi-agency response or intra-group limited response can be satisfied by creating a software "phantom group" to which individual vehicles can be assigned by their unit address code. This assignment will not alter the fixed unit address code or group address code of the involved mobile. Cancellation of the "phantom group" will return all mobile units to their original group.

9) Degraded Operation

The DATCS system redundancy offered by the three-base station site configuration makes it unlikely that the Phoenix area DATCS will ever revert to a conventional radio channel operation due to controller failure. In general, the results of the key catastrophic system element failures indicate some coverage loss if North Mountain or Thompson Peak are shut down and some loss of talk-back capability if South Mountain is shut down. Only an extreme catastrophic failure of both North Mountain and Thompson Peak simultaneously will prevent the system from operating in a trunked mode.

10) Intersystem Considerations

The two types of intersystem operations to be considered are operations with other conventional radio systems and operations with other trunked radio systems.

. Conventional Radio Systems

Conventional radio system operations within the Phoenix area can be interfaced with DATCS by cross patching at the control consoles. Automatic cross band repeaters will not be used for interconnection.

Conventional radio system operations from outside the Phoenix area will not be interfaced with DATCS unless they are both terminated at the same dispatch center in the Phoenix area. Mutual aid police and fire channels at 155.475 MHz and 154.280 MHz could be included in this category, but it is unlikely that mobile units from outside Phoenix would require interconnection with Phoenix DATCS.

. Trunked Radio Systems

There is no requirement placed on the Phoenix area DATCS for interconnectibility with any other planned or anticipated DATCS system outside the area. At this time, the hardware and software offerings of the key vendors of trunked radio systems are incompatible with each other. The signaling and control methodology and protocols are incomprehensible among the competitors' equipment. Mobile equipment supplied by the same vendor for a system outside

of the Phoenix area would be unable to access the Phoenix control channel unless it was by chance licensed for the same group of 800 MHz frequencies as Phoenix. The control channel search range would also have to include the Phoenix control channel frequencies.

Unless Federal standards for control methodology and protocols are established, an attempt to achieve regional or statewide standardization to permit Arizona intersystem connectivity appears to be well beyond the scope or expectations of this project.

11. FAACILITIES AND PERSONNEL

In keeping with the philosophy of minimum change in operations and procedures to implement DATCS, there will be no change in the dispatch or control point locations now used by any participating agency. Control stations will replace the need for a telephone line or microwave channel between the control points and the base station sites. Some dispatch console modifications will be required to accommodate the DATCS control functions along with the conventional radio channel controls currently installed. Some modification of CAD software and hardware may be needed to accept status reporting codes. Facilities and personnel requirements unique to DATCS are discussed in the following paragraphs.

1) Facilities

Unique facilities at the base station sites and at the DATCS control operations center will be a consideration. Specialized maintenance facilities will be required.

- Base Station Sites

It is intended to use existing equipment shelters and power systems at North Mountain, Thompson Peak, and South Mountain. Tower space and intermodulation studies may require the erection of a separate antenna support structure at each of the three locations.

- DATCS Control Operations Center

Space must be provided for the DATCS control operations center. This will require a computer environment for housing the master controller and the peripheral alarm board, journal recorder, printer, and master control terminal. The voter selector installation and the control channel audio integration equipment are also a part of the center but need not be colocated with the computer controller. The area must include personnel space for manning the center 24 hours a day and should also provide office space for the system manager.

- Maintenance Facilities

Special maintenance facilities for the DATCS should be included. A full- time maintenance program is anticipated to keep all of the DATCS system elements functioning at a level of quality needed to minimize performance differences between the multiple channels. This facility must store special parts/modules and will feature special tools and test equipment.

2) Personnel

Personnel considerations include management personnel, system personnel, operating personnel, and maintenance personnel. Personnel staffing will be critical to the success or failure of the DATCS concept.

- Management

It is suggested that DATCS be managed by an organization separate from the user organizations. The high technology requirements of DATCS calls for specialized telecommunications management which can not usually be spared from the individual user organizations. Auser group should be formed to set policy and review operations but day-to-day management should be vested in a dedicated manager. The existing pool of communications managers in the Phoenix area should provide the resources for selecting the DATCS manager.

- System Maintenance Personnel

Software maintenance and hardware maintenance will be a full-time occupation to keep the quality of this high technology system to an expected standard. Thorough understanding of the system operation, operation software, and applications software will be required, suggesting the need for a systems analyst who can maintain the software and provide needed modifications.

Hardware maintenance will require special skills to obtain and retain 800 MHz integrity. Maintenance personnel skilled in computer operations, terminals, and displays will be required. It is assumed that providing training for these skills will be part of the vendor obligations. The existing pool of systems personnel and hardware maintenance personnel responsible for the CAD and MDT systems should be an integral part of this staff.

- Operating Personnel

The DATCS control operation center is conceived as a 24-hour-a-day operation. One terminal operator/ controller per shift would appear to be adequate. This could be a shared responsibility once DATCS has become operational and debugged. This would require approximately five specially trained persons, probably drawn from the existing CAD/MDT staff.

Support services such as purchasing, financial control, audits, benefits administration, facility maintenance, and the like are assumed to be provided by the City of Phoenix using existing municipal facilities.

12. ESTIMATED COSTS

This section presents engineering cost estimates associated with implementing a digitally addressed trunked communications system (DATCS) in the Phoenix area. The configuration of the DATCS is described in the system concept report dated September 15, 1980. Costs are presented in two parts:

- Non-Recurring Costs - One-time capital investment cost
- Recurring Costs - Ongoing costs associated with owning, operating, and maintaining the system

These cost estimates represent the best information available at this time. Much of the hardware and software has not been produced in the specific form and function required by the system concept. Therefore, a number of assumptions were required based on engineering experience, discussions with the vendor community, and representative cost experience of commercial trunked system owners.

The cost estimates will also need adjustment as new information becomes available. No attempt has been made to factor in the inflationary pressures or to extend the value of these funds into some future date when implementation of DATCS is more probable. The degree of determination on the part of the vendor community to pursue the trunked system market and the competitive posture of that market at the time of implementation will be the final arbiter of these estimated costs.

1) Summation of Estimated Non-recurring Cost

The following summation includes the estimated initial one-time cost for fixed installations and mobile installations for Phoenix area DATCS. The break-down of these estimated costs is shown in the following subsection.

- Fixed Installations

North Mountain	$ 322,000
Thompson Peak	345,000
South Mountain	312,000
Control Operations	299,200
Maintenance Equipment	77,000
Control Stations (Phoenix)	246,500
Control Stations (Adjacent Cities)	121,500
SUBTOTAL - FIXED INSTALLATIONS	$1,723,200

- Mobile Installations

Phoenix Public Service	$2,486,300
Phoenix Public Safety	529,000
Adjacent Community Public Service	1,432,900
Adjacent Community Public Safety	46,000
SUBTOTAL - MOBILE INSTALLATION	$4,494,200

- Engineering Services $ 125,000

TOTAL ESTIMATED NON-RECURRING COSTS $6,342,400

2) Cost Detail - Estimated Non-recurring Cost

The following cost estimates assume that the 12 GHz microwave system at North Mountain and South Mountain has sufficient channel capacity to accommodate the DATCS requirements for centralized control. If this is not the case, additional microwave terminals will have to be added to the estimated cost of North Mountain, South Mountain, and Control Operations. It is also assumed the Maricopa County microwave system to Thompson Peak does not have the spare channel capacity to accommodate DATCS. Therefore 6 GHz microwave terminals are added to the estimated costs for Thompson Peak and Control Operations. The exact configuration of the DATCS transmission system will be an output of the required engineering study.

North Mountain Estimated Costs

Repeaters $9,500	qty. 19	$ 180,500
Multicouplers/Combiners $10,600	qty. 4	42,400
Duplexers $600	qty. 4	2,400
Antennas/Transmission Lines $800	qty. 4	3,200
Site Controller $45,000	qty. 1	45,000
Modems $300	qty. 2	600
Tower 50' X $110/ft	qty. 1	5,500
Microwave Interface Modules $300	qty. 45	13,500
22 Channel MUX $615/ch	qty. 1	13,500
Installation (5%)		15,400
		$ 322,000

Thompson Peak Estimated Costs

Repeaters $9,500	qty. 19	$ 180,500
Multicouplers/Combiners $10,600	qty. 4	42,400
Duplexers $600	qty. 4	2,400
Antennas/Transmission Lines $800	qty. 4	3,200
Site Controller $45,000	qty. 1	45,000
Modems $300	qty. 2	600
Tower 50' X $110/ft	qty. 1	5,500
Microwave Interface Modules $300	qty. 45	13,500
22 Channel MUX $615/ch	qty. 1	13,500
6 GH Microwave Terminal $22,000	qty. 1	22,000
Installation (5%)		16,400
		$ 345,000

South Mountain Estimated Costs

Repeaters $9,500	qty. 18	$ 171,000
Receives $750	qty. 2	1,500
Multicouplers/Combiners $10,600	qty. 4	42,400
Duplexers $600	qty. 4	2,400
Antennas/Transmission Lines $800	qty. 4	3,200
Site Controller $45,000	qty. 1	45,000
Modems $300	qty. 2	600
Tower 50' X $110/ft	qty. 1	5,500
Microwave Interface Modules $300	qty. 42	12,600
21 Ch MUX $615/ch	qty. 1	12,900
Installation (5%)		14,900
		$ 312,000

Control Operations Estimated Cost

Master Controller $40,000	qty. 1	40,000
Alarm Board $12,000	qty. 1	12,000
Voter Selectors $2,200	qty. 18	39,600
Journal Recorder $17,000	qty. 1	17,000
Master Terminal $3,500	qty. 1	3,500
Agency Terminals $2,700	qty. 9	24,300
Printer $4,500	qty. 1	4,500
Audio Subassembly $1,500	qty. 1	1,500
Microwave Interface Modules $200	qty. 132	26,400
65 ch MUX $615/ch	qty. 1	40,000
6 GH Microwave Terminal $22,000	qty. 1	22,000
Modems $300	qty. 6	$ 1,800
Applications Software		30,000
Telco Installation $125/line	qty. 200 lines	25,000
Radio Installation (5%)		11,600
		$ 299,200

Maintenance Equipment/Spares Estimated Cost

Digital Test Sets $1,450	qty. 2	$ 2,900
Portable Digital Analyzer $1,500	qty. 4	6,000
Logic Probes $100	qty. 4	400
Spectrum Analyzer $5,000	qty. 2	10,000
800 MHz Signal Generator $1,200	qty. 2	2,400
Spare Repeaters $9,500	qty. 3	28,500
Microwave Interface Modules $300	qty. 12	3,600
Spare Multicouplers/Combiners $10,606	qty. 1	10,600
Spare Modems $300	qty. 1	300
Spare Voter/Selectors $2,200	qty. 1	2,200
Spare Terminal Keyboards $1,100	qty. 1	1,100
Spare Boards and Modules (5%)		9,000
		$ 77,000

Control Stations (Phoenix) Estimated Costs

Control station costs are estimated at $4,500 each, installed. The following tabulation estimates the number of control stations needed, their distribution, and the cost distribution.

EOC		
Police	qty. 7	$ 31,500
Console Modifications	qty. 6	27,000
Fire	qty. 14	14,000
Console Modifications	qty. 4	18,000
Engineering	qty. 12	12,000
Traffic Engineering	qty. 4	18,000
Traffic Signals	qty. 1	4,500
Facility Maintenance	qty. 1	4,500
Human Resources	qty. 2	9,000
Equipment Management	qty. 1	4,500
Sanitation	qty. 1	4,500
Streets Maintenance	qty. 4	18,000
Job Stimulus	qty. 2	9,000
Building Inspection	qty. 1	4,500
Sewers	qty. 2	9,000
Water Production	qty. 2	9,000
Water Distribution	qty. 6	27,000
Water Customer Service	qty. 2	9,000
Parks and Recreation	qty. 1	4,500
	qty. 2	9,000
		$ 246,500

Control Stations (Adjacent Cities) Estimated Cost

Glendale Fire	qty. 1	$ 4,500
Glendale Police	qty. 2	9,000
Glendale General Services	qty. 2	9,000
Mesa Police/Fire	qty. 3	13,500
Mesa Public Works	qty. 6	27,000
Mesa Public Sanitation	qty. 4	18,000
Scottsdale Police	qty. 1	4,500
Tempe Police	qty. 2	9,000
Tempe Fire	qty. 2	9,000
Tempe Public Works	qty. 3	13,500
Tempe Sanitation/Refuse	qty. 1	4,500
		$ 121,500

Mobile Stations (Phoenix Public Service) Estimated Cost

Mobile station costs are estimated at $2300 each, installed. The tabulations in this subsection and the following subsections related to mobile stations reflect the quantity of mobiles reported during the data surveys of February and April 1980. The number of mobile units listed for public safety agencies will also relect the limitations of DATCS due to portable radio operations and the interface problems with MDT users.

Engineering	qty. 119	$ 273,700
Parks and Recreation	qty. 64	147,200
Traffic Engineering	qty. 27	62,100
Traffic Signals	qty. 12	27,600
Facility Maintenance	qty. 52	119,600
Human Resources	qty. 32	73,600
Equipment Management	qty. 57	131,100
Sanitation	qty. 92	211,600
Streets Maintenance	qty. 89	204,700
Job Stimulus	qty. 26	59,800
Building Inspection	qty. 72	165,600
Sewers	qty. 74	170,200
Water Production	qty. 114	262,200
Water Distribution	qty. 150	345,000
Water Customer Serivce	qty. 101	232,300
		$2,486,300

Mobile Stations (Phoenix Public Safety) Estimated Cost

Phoenix Police (25%)	qty. 170	$ 391,000
Phoenix Fire (25%)	qty. 60	138,000
		$ 529,000

Mobile Stations (Adjacent Community Public Service) Estimated Cost

Glendale General Service	qty. 130	$ 299,000
Mesa Public Works	qty. 163	374,900
Mesa Public Sanitation	qty. 60	138,000
Tempe Public Works	qty. 230	529,000
Tempe Sanitation/Refuse	qty. 40	92,000
		$1,432,900

Mobile Stations (Adjacent Community Public Safety) Estimated Cost

Glendale Police (10%)	qty. 8	$ 18,400
Glendale Fire (10%)	qty. 3	6,900
Mesa Police (10%)	qty. 4	9,200
Tempe Police (10%)	qty. 2	4,600
Tempe Fire (10%)	qty. 2	4,600
Scottsdale Police (10%)	qty. 1	2,300
		$ 46,000

Engineering Services Estimated Cost

The estimated cost for engineering services is based upon the need for technical assistance as anticipated at this time. As better information becomes available, this need will change. The following items of technical assistance are considered vital to the implementation of DATCS:

- Radio propagation testing and analysis
- Technical evaluation of vendor proposals
- Monitoring DATCS hardware/software implementation
- Evaluation of implementation debugging tests
- Analysis of acceptance test data.

Adequate engineering support for the above is estimated at $125,000.

3) Estimate Recurring Costs

The estimate of recurring costs does not include the cost of operating the existing communications system by each participating agency. It is assumed that this cost would not change as a result of implementing DATCS as a equivalent transmission system. It is an objective of DATCS to minimize and change to the accepted operating procedures and practices of the participating user organizations.

The estimate of recurring cost does include the extra staffing and facilities needed to centralize the control and maintenance of the unique DATCS equipment. There is no existing DATCS configuration similar to the configuration and functions required of this proposed system. Therefore, there is no reliable cost experience to reference and assumptions are made based on experience with other digitally controlled, computer operated telecommunications systems. These estimated costs are summarized as follows:

Maintenance Technicians $22,500*	qty. 4	$ 90,000*
Control Operator (24 hrs) $25,000*	qty. 4	100,000*
Administrator $31,250*	qty. 1	31,250*
SUBTOTAL - ESTIMATED LABOR		$221,250*
Maintenance Parts Replacement		$110,000
Maintenance Training,		3,000
EDP Services (Management Reports)		3,900
Equipment Up-Dating		180,000
Utilities (Telephone/power)		12,000
SUBTOTAL - SERVICE COST		$ 308,900
TOTAL - ESTIMATED ANNUAL RECURRING COST		$ 530,150

* These estimated costs include full burden.

These estimated costs assume that Phoenix or an equivalent governmental organization will take full responsibility for system operation and maintenance for the benefit of all DATCS users. These costs also assume that early life failures and basic debugging of the software are covered by warranty.

III. REQUIRED IMPLEMENTATION ACTIVITIES

The implementation of the system concept will proceed only after thorough review by the potential user agencies, their department heads, and the public safety director of each participating municipality. After this has been achieved and the implementation plan has been officially sanctioned by each participating municipality, the satisfaction of licensing requirements is another critical milestone that must be met before procurement activities can be initiated.

Federal Communications Commission (FCC) licensing requirements for large-scale 800 MHx trunked radio systems in local government service have not been clearly defined or tested at this time. Following local government approval, the initial implementation activity must be directed toward satisfying all of the elements needed to secure reasonable assurance from the FCC that the trunked radio system, as planned and approved, can be licensed.

1. LOCAL GOVERNMENT APPROVALS

Local government approvals will be achieved in three steps: securing of user agency agreements, development of funding agreements to implement and operate the system, and the legally binding commitment of the municipalities to participate in and support the system.

1) Agency Agreements

Signed agreements by each agency planning to participate in the trunked radio system must be acquired. These agreements will conform with FCC requirements (Sections 90.359 and 90.179). As a minimum they will include:

- Agreements regarding the supervision and control of the trunked system operation
- Method of cost sharing and prorating of costs among all cooperating parties
- Responsibility for maintaining system operation records and filing reports with the FCC (Section 90.391).

In addition to the items needed for FCC licensing, the agency agreements will also include provisions for:

- Management authority over the system staff and equipment
- Centralized maintenance of system components
- Property, equipment and facilities provided by the user agencies and municipalities
- Modification and/or termination of the agreement as subject to FCC Rules and Regulations (Section (90.391).

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Agency agreements will be the key element in securing the funding agreements and municipal government approvals.

2) Funding Agreements

The acquisition of agency agreements will provide dimensions for revised cost estimates needed to establish funding requirements. These requirements will include estimates of non-recurring implementation costs and recurring operations costs. The following elements of cost will be identified:

- Implementation Costs
  - Planning activities
  - Professional services
  - Hardware/software
  - Facilities
  - Installation/test/acceptance
  - Personnel staffing and training
- Operating Costs
  - Personnel salary and overhead
  - Supplies
  - Maintenance of hardware/software
  - Equipment replacement
  - Continued training.

The distribution of these costs among the funding sources will be decided, and firm commitments and/or agreements acquired. These funding sources will include:

- Federal and state grants funds
- Local municipal funds
- In-kind services, equipment, or facilities
- User agency cost sharing assessments
- Grants from private foundations
- Gifts from private sources.

The funding agencies must approve and be committed to the funding plan before final and binding commitments will be sought from the participating municipalities.

3) Municipal Government Approvals

Based on the agency agreements and funding agreements achieved, firm commitments will be required from the municipal governments to assure continued project support and to respond to Federal and state grants requests. These approvals will be required in the form of resolutions or other legally binding documents.

2. PRELIMINARY LICENSING CONSIDERATIONS

The licensing of multiple base station wide-area trunked radio systems in local government service and public-safety service is not clearly defined by present FCC rules and regulations. Waivers to the present FCC rules and regulations may be required, particularly to Section 90.389 which restricts interconnection with telephone wire facilities and Section 90.375 which defines time limits for phased implementation.

Before hardware and software commitments are made, preliminary discussions will be held with the FCC. An expression of assurance will be sought indicating that the trunked system, as planned and approved by the user agencies and their municipal governments, will receive favorable licensing consideration from the FCC when formal applications for licenses are submitted.

3. IMPLEMENTATION SCHEDULE

The detailed implementation schedule will be developed following assurances that the trunked radio concept will be licensable under FCC rules and regulations and that any revisions to the concept required by FCC evaluation of the system design has met the approval of the user agencies and the participating municipal governments. The implementation schedule will consist of two key interrelated parts, a system implementation schedule and a corresponding financial schedule.

1) System Implementation Schedule

The system implementation schedule will be a time-dependent schedule. The project will be defined in terms of separate tasks with clearly defined milestones indicating the completion of each task and definitive measurable milestones leading to the completion of each task or project element. Major tasks include:

- Project planning and reporting
- Engineering services
- Preparation of specifications
- Preparation and approval of statement of work

- Solicitation of bids
- Contract award
- Facility preparation
- System licensing
- Equipment delivery/installation
- Test and acceptance
- Personnel training
- System cut-over
- System evaluation.

Each major task will be supported by task breakdown schedules which define the subtasks needed to achieve the completion of each major task.

2) Financial Schedule

The financial schedule will be coordinated with the system implementation schedule. This schedule will be based upon the funding agreements and will include the following major elements:

- Milestones showing each major commitment of funds
- The amount of funds from all sources and the date of their availability to the project
- The schedule dates for the submission of financial reports.

The submission and distribution of financial reports will be elements of the financial agreements and governmental approvals.

4. SYSTEM MANAGEMENT AND OPERATION

The management and direction of the implementation program will be the responsibility of the program director. The program director will be supported by a full-time and part-time staff representing each key function of this implementation program. These functions include:

- System Engineering - this staff function will be assisted by consulting engineers and the engineering staff of the successful system contractor
- Procurement - this staff function will be assisted by the purchasing and procurement personnel of the City of Phoenix

- Finance - this staff function will be a part-time service provided by the City of Phoenix, Division of Management and Budget
- Facilities - this staff function related to the acquisition and preparation of special facilities for the equipment and personnel of the project will be provided on a part-time basis by the City of Phoenix
- Personnel - the project staff personnel are under the direct supervision of the program director; personnel activities such as job descriptions, salary determination, and benefits administration will be under the direction of the City of Phoenix unless the person is on loan from another municipal jurisdiction.

In addition to the project staff reporting to the program director, two advisory groups will be responsible for overall project policy with the project director serving as chairperson for each advisory group. These groups consist of:

- User Representatives - this group is composed of appointed representatives of each user agency; they provide direct liaison between the project organization and their respective agencies.
- Government Representatives - this group is composed of appointed representatives of each municipality and state or county government sections which have an operational or financial interest in the program.

It is intended that this management group be carried over in form and function to the operation of the trunked radio system after it has been installed, tested, and accepted. Additional personnel, needed to operate the system from a central location, will be added to the facility function of the project staff. At that time, the facility function will become a full-time staff position under the program director.

5. PROCUREMENT

The procurement of the trunked system will proceed in two sequential activities, system engineering and purchasing.

1) System Engineering

Technical assistance will be required to develop the engineering design of the trunked radio system based on the system concept. The key issues to be resolved before the procurement specifications can be prepared include:

- Radio Propagation Analysis - engineering analysis of 800 MHz radio propagation from the three candidate base station sites will be conducted to determine radio coverage of the Phoenix area and to establish antenna patter characteristics. FCC Rules and Regulations (Section 90.379) clearly limit the effective radiated power and antenna elevation at each proposed site.

- Switching Logic - the switching logic for the master controller, site controller, mobile stations, and control stations will be engineered to be compatible with expected vendor hardware offerings.

- Software - the system software for the master controller and site controller will be engineered to enable effecient software management from a master terminal.

- Digital Data - an engineering study will be conducted to establish the technical feasability of integrating the existing mobile data terminals (MDT) into the 800 MHz trunked radio system without degradation of the present MDT capability.

Based upon the results of these technical activities, systems engineering will prepare detailed system specifications and equipment specifications for competitive procurement.

2) Purchasing

The purchasing function will consist of three key activities: developing a statement of work (SOW), soliciting competitive bids, and awarding a system contract.

- Statement of Work (SOW) - the SOW is a precise description of the materials and services required of the contractor and the time domain in which delivery is to be made. The key elements of the SOW will be:

  - Background and objectives of the project
  - Required qualifications of successful bidders
  - Services and support to be provided

  - Quantities of each equipment to be provided
  - Schedule for all deliverable items - hardware, software, services, and support items

- Soliciting Competitive Bids - competitive bids from all qualified vendors will be solicited by means of a procurement package which will include:

  - State and city legal requirements
  - Statement of work
  - System specification
  - Equipment Specifications.

  A one-step solicitation is anticipated in which each bidder will provide a technical proposal and a firm, fixed-price cost proposal for the complete installation of an operating digitally addressed trunked radio system.

- Awarding the System Contract - the combined technical proposal and cost proposal most advantageous to the City of Phoenix and associated municipalities will identify the successful bidder. A firm, fixed-price contract without cost escalation is anticipated.

6. LICENSING

The signed contract defining the equipment to be purchased and the quantity of that equipment will provide sufficient information to file applications with the FCC for system licenses. Present FCC practice for licensing 800 MHz trunked system requires the following minimum submission:

- Form 400 for each license requested (Section 90.357)
- Agreements with each user agency relative to control of the system (Section 90.179)
- Agreements with each user agency relative to cost sharing of installation and operation (Section 90.179)
- Financial plan showing the service will be provided to user agencies at cost (Section 90.359)
- System description and specification (Sections 90.359, 90.371, 90.375, and 90.379)
- Eligibility statement for each user (Section 90.359)
- Evidence of purchase orders placed for the equipment.

It is probable that FCC waivers will have to be asked to extend the number of years for phased implementation of the system (Section 90.375) and for the provisions for interconnecting with wire line telephone systems (Section 90.389).

Technical support for negotiating system licenses with the FCC will be requested of the engineering consultant and from the system contractor.

7. FACILITIES ACQUISITION AND PREPARATION

It is the responsibility of the program director to provide adequate facilities for the equipment and staff of the trunked radio system. Subject to revision by the engineering study, the following facilities will be required:

- North Mountain - equipment shelter for twenty 800 MHz repeaters, a site controller, ancillary equipment for the antenna subsystem, antenna support structure for four antennas, and appropriate power/climatic control equipment
- South Mountain - equipment shelter similar to North Mountain
- Thompson Peak - equipment shelter similar to North Mountain
- Phoenix Pbulic Safety Building - equipment shelter for the master controller/terminal, alarm equipment, recorders, printers, microwave terminations and other items of equipment associated with the central control function. Staff facilities for a program director, facilities manager, engineering, software/hardware manager, and programmer/operators will also be required.

Controlled maintenance will also require special facilities which are intended to be part of the Communications Section, Equipment Management Division, City of Phoenix. It will be the responsibility of the facilities manager on the staff of the program director to obtain these facilities and prepare them in a timely manner.

8. PERSONNEL AND TRAINING

Personnel for the management and operation of the trunked radio system will be identified and prepared for their assignments in coordination with equipment installation and test. It is intended that the project director and staff will continue in their positions after the trunked radio system has been installed and accepted. The additional people required to operate the system will be recruited and trained during the system installation test so that their services can be used as much needed test personnel, and the experience gained can serve as on-the-job training before the system becomes operational. It is anticipated that the following additional personnel will be required:

- Maintenance technicians Qty. 4
- Control operators Qty. 4

- System programmer/analyst Qty. 1
- Facilities administrator Qty. 1

Job descriptions for these positions will be developed by the program director and the personnel divisions of the City of Phoenix. Recruiting will be by public announcement of available job openings. It is anticipated that the positions will be filled by transfering presently employed, skilled personnel of the municipalities.

The training and certification of all operating personnel, maintenance technicians, and management personnel will be a contractual obligation of the system contractor.

9. POST IMPLEMENTATION SUPPORT

The post implementation support program will address the funding and staffing needed for sustained operation of the trunked radio system.

1) Post Implementation Funding

The recurring costs of continued operation include the folloiwng major items:

- Personnel - salary and benefits
- Maintenance - maintenance of the facilities and system hardware/software after the warranty and first-year maintenance contract
- Supplies - all expendable materials used in operating and managing the system
- Training - refresher training and replacement training
- Utilities - power, telephone, and other services provided by an outside agency
- Equipment Replacement - periodic replacement of worn or obsolete equipment, i.e., equipment that can no longer be repaired economically.

These costs will have been identified and submitted to the FCC as part of the licensing requirements; they will be reviewed periodically. The costs will be billed to the user agencies in accordance with a formal developed and reported in each agency agreement.

2) Personnel Replacement and Training

The replacement of personnel and the updating of staff personnel will be a recurring problem because there will be labor turnover. Recruiting of personnel will be by suitable public announcement of job openings and the testing of applicants. Probationary employees will be trained by the technical staff.

3) Support Staff

The system will have the full-time services of equipment maintenance personnel and software system personnel. At least one senior system programmer/ analyst will be required. It is anticipated that a full-time staff of four specially trained maintenance technicians will be required. Four qualified control operators will also be required to provide 24-hour service to the user agencies.

APPENDIX A

SUGGESTED AGENCY AGREEMENTS

APPENDIX A

SUGGESTED AGENCY AGREEMENTS

I. INTRODUCTION

The agreement by two or more local government public safety agencies to enter into a joint enterprise which provides a mutual service of value to the participants is best documented by written agreements between the parties. By their nature, these agreements are highly individual tailored to the specific requirements of each program in each locality. This appendix to the System Implementation Planning Guide (SIP) is intended to suggest only a general outline of such agreements. The details and the order of presentation will depend upon each kind of enterprise contemplated, its complexity, and the immediate cooperative environment. Legal counsel should be consulted.

1. Purposes of the Agreement

The purpose of a written agreement is to describe the reason for the cooperative effort and the results that are expected to be achieved through mutual participation. By reducing this to a clear and unambiguous written statement, the involved parties will fully understand their mutual participation. Equally important, the governing bodies of which the participants are a part will be able to determine the true nature of the program and the expected results and thereby provide their support.

2. Scope of the Agreement

The agreement should define the dimensions within which the terms of the agreement apply. The responsibilities and liabilities of each of the participants should be clearly documented. There should be no unwritten understandings between the parties.

The following model outline of an agreement form provides a series of topical considerations to be evaluated during the development of an interagency agreement. The precise form of a specific agreement and the language to be used in each case should be provided by legal counsel. In many cases, standard legal form and substance is required by state or federal regulation.

II. SUGGESTED MODEL OUTLINE

The following topics and items are intended to delineate key considerations in the preparation of an interagency agreement.

1. General Terms and Legal Base

The general terms will include the following as a minimum:

- The identification of each participating agency

- The requirements to be imposed on those agencies that may wish to participate at a later date

- The concise purpose of the joint enterprise and the mutually advantageous results that are expected to be achieved

- A statement of the legal authority under which the public agencies are able to contract with each other for the stated purpose; this may be a state law, a local government act, a series of resolutions passed by the local governmental authorities, or similar authorization.

2. Services to be Provided

The services provided by each agency and to each agency will be defined. These include the following considerations:

- Definition of the services to be provided by each agency to the mutual system; these services could include, for example, equipment maintenance, equipment, facilities, operating manpower, support services, and similar items of value to the system..

- Definition of the services the system will provide to each participating agency; such services could include the dispatching of field forces, management reports, statistical data, and similar items of value to the agency

- The definition of the quantity or extent of each service to be provided

- The responsibility each agency has for delivering its service and the responsibility the mutual operation has for delivering its services to each agency

- The extent of any back-up or redundancy to assure that services are delivered in a timely manner throughout the life of the agreement.

3. Liability

A key element of the agreement between two or more public agencies is a clear definition of the liability each of the agencies has for the actions of other parties to the agreement. This is particularly true if one or more of the agencies provides public services on behalf of the other agencies. Agreements to limit the liability exposure of participating agencies would include the following considerations.

- Responsibility for defending the provider agency in potential lawsuits

- Indemnification of the providing agency against liability judgements against a participating agency

- Indemnification of the participating agency against legal actions or liability judgements against the provider agency arising from the normal provision of agreed-to services.

4. Amount and Manner of Payment

The providing agency must be reimbursed for the expenses of the service it provides to the participating agencies. A portion of this obligation will fall to the individual participating agencies. The agreement between the agencies must be specific regarding this individual responsibility and will be definitive of the following considerations:

- The specific services to be provided and the cost of each service

- The method by which the cost and value of each service is calculated

- The means of payment: for example, cash, in-kind services, cash equivalent in material or equipment, and any other valuable consideration agreeable to the parties to the agreement

- Time and manner payments are to be made

- Use of outside funding sources such as grants or gifts.

5. Fiscal Procedures

Sound fiscal planning is key to the successful implementation of public agency cooperative programs. The responsibility of the provider agency for financial integrity must be defined in the agency agreements. The agreement will specify the following elements:

- The type of financial records and how they are maintained

- The contents of the periodic financial reports and the schedule for submitting these reports to higher authority and to participating agencies

- Access to the financial records by each participating agency

- Certification and/or audit of the records and financial reports

- Terms and conditions relative to the periodic reassessment of rates charged for each service provided.

6. Administration

The administrative structure of the cooperative program should be defined in the agency agreements. The authority and responsibility of each agency for participation in policy administration and the authority and responsibility for day-to-day operation should be included. Some of the key elements in the agreement are:

- The identification of the person(s) authorized to sign the agreement on behalf of each party to the agreement
- The identity of the person(s) who will represent the participating agency and providing agency in policy matters
- The responsibility and authority of the providing agency to supervise project personnel and establish personnel policy
- The responsibility and authority of the providing agency over joint-use facilities and equipment
- The retention by participating agencies of control, responsibility, and authority over their personnel, facilities and equipment that may be used in the cooperative project
- Identity and authority of persons responsible for the review of the agreements and for the determination of compliance.

These and other administrative elements suitable to the unique environment and nature of the proposed project should be negotiated between the parties and made part of the written agreement to participate.

7. Real Property and Equipment

The cost-effective implementation of a multi-agency cooperative program should make maximum use of facilities, property and equipment available from the participating agencies. The agreement should identify these properties and materials; it should establish the rules under which the properties and materials are to be used. Some key considerations are:

- Identify each item of property and equipment that is to be transferred to the use of the cooperative system

- Establish the value of the property and/or equipment and show the method used to establish the value
- Provide for the return of the property and equipment during the term of the agreement and upon termination or cancellation of the agreement
- Define the method to be used to establish the value of property and material to be returned to the original supplier upon the termination, modification, or cancellation of the agreement.

8. Duration, Termination, And Amendments

The agency agreement must provide for modification to the agreement during its term. It must also define the duration of the agreement, make provisions for cancellation of the agreement, and disclose how the agreement is to be terminated. The following items should be included:

- The term of the agreement
- The circumstances under which the agreement can be terminated during its intended duration
- The terms under which the agency can withdraw from the agreement
- The circumstances under which either party can cancel the agreement
- Procedures for amending the agreement during its intended term
- Disposition of property and equipment upon termination or cancellation.

9. Other Provisions

The agency agreement is a custom document generated to reflect the unique needs of the specific circumstance and the environment in which the mutual agreement is being generated. The individual terms and conditions of each agreement should include the following:

- Method of resolving disputes, for example: arbitration, application of appropriate state or Federal law, etc.
- Identity of the court of jurisdiction for adjudicating disputes
- Definition of terms used in the agreement
- Statutory status and filing of the agreement
- Interrelationship of agreements.

* * * * *

The drawing of inter-local contracts and agreements to provide public services or hold public property for the mutual advantage of multiple governmental organizations may be subject to local, state, or Federal regulations and/or laws. These documents should be drawn up under the advice of legal counsel to insure their status as legal instruments.

APPENDIX B

DATCS SYSTEM REQUIREMENTS

This appendix has been derived from the review of the Task 6 Report "Analysis of Problems and Requirements" by Phoenix project staff. The contents of this appendix are also contained in the Task 7 Report "DATCS Design Concept" dated September 19, 1980.

APPENDIX B

SYSTEM REQUIREMENTS

The system requirements have been developed from the review of the Task 6 report "Analysis of Problems and Requirements" dated June 15, 1980. The summation of this review was developed during a meeting of Phoenix on July 23, 1980 and is reflected in the following subsections.

1. WIDE AREA COVERAGE

Radio coverage experience at UHF in the Phoenix area precludes any reasonable expectation that a single 800 MHz base station site will provide adequate coverage.

(1) City of Phoenix

The growth of Phoenix north to the Deer Valley area and northeast to Paradise Vally indicates North Mountain as a primary base station site covering both Phoenix and the northern communities.

North Mountain has notable shadow effects from Squaw Peak, Phoenix Mountain, and Camelback which indicates a second base station at Thompson Peak would be required.

A probable third base station site at South Mountain is indicated to ensure reliable talk-back coverage in areas where North Mountain has proved to be less than fully reliable on talk-back.

(2) Suburban Participation

The coverage of Glendale should be adequate from North Mountain and South Mountain.

Control channel coverage of Scottsdale, Tempe, and Mesa should be adequate from North Mountain and Thompson Peak. Talk-back coverage should be improved from Tempe and Mesa from the South Mountain site.

Separate control channels at North Mountain and Thompson Peak will be selected by each mobile station according to the readability of each base station site control channel at the mobile receiver. All DATCS voice channels at the three base station locations will be voted for signal quality from the mobile and the transmitters will be steered by the voter selectors for each trunked channel. There will be no simulcasting of multiple transmitters on the same channel frequency.

2. MULTIPLE DISPATCH POINTS

The existing local government radio services in Phoenix and adjacent communities consists largely of independent radio channels, each agency having its own command and control requirements over its own fleet of mobiles. In its operation, CATCS will be replica of this configuration. Therefore, the DATCS concept will not only provide for a multitude of fleet and/or subfleet addresses but must also be programmed to direct these subfleets to their individual dispatch points by means of their address.

The number of individual dispatch points for the City of Phoenix could include the following:

- Phoenix Police (12 positions)
- Phoenix Fire/Ambulance (12 positions in new system)
- Engineering
- Parks and Recreation
- Traffic Engineering
- Traffic Signals
- Facility Maintenance
- Human Resources
- Equipment Management
- Sanitation
- Streets Maintenance
- Job Stimulus Program
- Building Inspection
- Sewers
- Water Production
- Water Distribution
- Water Customer Service.

This list assumes that the Phoenix Bus/Transportation, Aviation, Civic Plaza, and EMS remain outside of DATCS due to unique requirements of their communications systems and also functions such as the Radio Shops and Purchasing can be accommodated.

The adjacent communities, if they participate in DATCS, have the potential of adding at least the following dispatch points:

- Glendale Police
- Glendale Fire
- Glendale General Services
- Mesa Police/Fire
- Mesa Public Works
- Mesa Public Sanitation
- Scottsdale Police
- Tempe Police
- Tempe Fire
- Tempe Public Works
- Tempe Sanitation/Refuse.

In the final configuration, each dispatch point must be independent of any other dispatch point without incidental interaction between them except on command of the central controller. The mobile will not have the capability to modify his address code and thereby change his dispatch point.

To respond to an incident that calls for a mobile command post and a mix of public safety/public service agencies responsible to the command post, the system controller can create a phantom group, and the mobile units can be attached to that group control point by software instructions based on the mobile address codes. There would be no change needed in the mobile logic to create the phantom group or to return the units to their original group and control point assignment.

3. INTERAGENCY COORDINATION

The survey of Phoenix area agencies* resulted in a pattern of interagency coordination connectivity though by the agencies to be appropriate to their operating needs. This pattern of permissible connectivity between the agencies will be programmed into the controller software and provisions made for it to be modified by program instruction as needed.

The need for interagency communication coordination other than police and fire mutual aid channels, was not expressed by the local government agencies of the communities adjacent to Phoenix. If these communities elect to participate in DATCS, the programming of the controller will accommodate their interagency conductivity requirements as needed.

It is expected that regional public safety and public service interagency coordination plans will include the regional disaster assistance plan developed in accordance with Federal Act PK93-288 (Disaster Relief Act of 1974) as amended.

4. PUBLIC SAFETY INTERFACES

In accordance with the system philosophy adopted for DATCS, public safety communications systems, as now configured in the Phoenix area, would not fully participate in the DATCS concept. The key exceptions are described in the following subparagraphs.

(1) Portable Radio Interfaces

Public safety radio systems in Phoenix are portable radio intensive, and present plans are to increase the number of portable radios used by police and fire. This policy is also endorsed by police and fire in Glendale, Mesa, and Tempe. The Scottsdale police also plan to increase their use of portable radios. There is a significant investment in relatively new VHF high-band and UHF portable radio equipment which must be protected. There is also a question of the availability and cost of trunked radio portables. A judgement has been made to continue the operation of police and fire portable radios on conventional radio system channels where they now operate and provide any required coordination with the DATCS by cross patching at the appropriate police and fire dispatch console.

(2) CAD/MDT Interface

Mobile data terminals (MDT) at UHF are now installed in Phoenix police and Mesa public works vehicles. An expansion in the use of MDT is being implemented by Phoenix police and the installation of MDT equipment is being planned by Phoenix Fire and the fire departments of Glendale, Mesa, and Tempe. The police of Glendale, Mesa, and Scottsdale also intend to install MDT equipment.

Questions relative to the compatability of the digital switching architecture of DATCS and MDT systems include consideration of:

- Data rate error limitations
- Error detection, error correction, retransmission codes

- Allowable tandem switching delays

- Modifications to CAD to recognize DATCS address codes.

The judgement at

The judgement at this time is to continue the operation and planning of MDT as a conventional UHF system. Coordination between MDT and DATCS will occur at the appropriate dispatch centers.

5. EMERGENCY ACCESS PRIORITY

The capability for prompt access to DATCS under conditions which justify the exercise of channel access priority when the DATCS system is fully occupied would be limited to public safety mobiles and possibly certain selected public officials. The exercise of a priority access function when DATCS is fully occupied requires a system frequency plan which designates at least one DATCS radio channel for control information or dedicates one radio channel for emergency signaling. The dedicated control channel configuration is recommended.

The waiting queue priority method has been selected as the means of emergency access to the fully occupied DATCS. When denied access to DATCS, those mobiles with emergency access priority capability can activate this function manually and thereby move their request for channel access to the top of the waiting queue, but not ahead of an emergency request already in the queue. The activiation of this emergency function will be recorded by the central controller along with the identity of the mobile unit making the request and this information will also be displayed at the dispatch points. The central controller will cause the first available DATCS channel to be assigned to the priority request that is first in the queue.

6. MOBILE-TO-MOBILE COMMUNICATION

Mobile-to-mobile communication is inherent in the repeater configured trunked radio system. Each mobile is assigned an individual address and a group address. The controller software determines what group code or codes will be accessed by each mobile on an initial call-up. A mobile is programmed to communicate with any other mobile in the group through the repeater. By means of the individual address assigned to each mobile, the controller can also be instructed to activate individual units within the group and exclude all other units with the same group address.

If intergroup or interagency flexibility is needed, the dispatcher or terminal operator can, through software instruction to the controller, enable the mobile unit to call up any individual address, group address, or subgroup address within the total capability of the trunked system. Certain paths of connectivity may be specifically prohibited by software programming.

7. TELEPHONE INTERFACE

The survey of existing radio system facilities in the greater Phoenix area* identifies 152 desk top remote control units throughout the total area excluding any remote control units used by police and fire. There are 82 of these units within the City of Phoenix used by city public service agencies, and 70 reported in the communities adjacent to Phoenix.

The reported use of desk top remote control units is mainly for person-to-person communication between an individual mobile unit and the supervisor at a fixed-office location. These office locations in Phoenix also have telephones which are part of the Centrex telephone system serving the Phoenix local government. A DATCS/Centrex interconnect will remove the need for a majority of the 82 City of Phoenix desk top remote radio control units. The interconnect will allow a mobile to access the Centrex telephone system and, by keying the four digit Centrex number on a touch tone pad, the supervisor can access the mobile either by telephone patch at a control point or by a direct radio access touch tone code followed by the mobile unit address code keyed on the telephone touch tone pad.

8. SYSTEM FAILURE MODES

A DATCS must inherently protect itself against common failure modes. The following paragraphs address system features required for system failure protection.

(1) Central Control Failure

The total failure of the master controller at the central location or any of its terminals should not be apparent to field operations. The switching and control logic is resident in the site controllers. The central controller monitors the site controllers and initiates any changes or corrections. In the event of central controller failure, the journal recorder should be switched to the output of the site controllers and any voter selector interfaces with the master controller should be deactivated.

(2) Site Controller Failure

The failure of a site controller should permit full DATCS operations in a degraded mode using the remaining two base station sites. There should be no need to switch the DATCS to conventional radio channel operation or "fail soft" operation. A failure of the

site controller at North Mountain or Thompson Peak will be evident to the users as a temporary reduction in coverage due to shadow effect; the failure of the site controller at South Mountain will probably create some talk-back problems in Phoenix. The failed base station site should also be muted to prevent interference on the voice channels.

(3) Voting Selector Failures

The failure of a voting selector should not be apparent to the field operations; one voice channel will be disabled and its traffic will be distributed automatically among the remaining DATCS voice channels (control channels are not voted). A total failure of the voter selector system affecting all voice channels should enable the DATCS to function in a degraded mode using one base station site, North Mountain or Thompson Peak, whichever proves to have the greater area coverage. The remaining two sites should be muted.

(4) Base Site Repeater Failure

The failure of the repeater at any base site should be transparent to field operations. The failed repeater will not be voted in the DATCS sequence of operation until it is repaired and returned to service. It should not be necessary to take any DATCS voice channel out of service due to the failure of any one of its three repeaters.

(5) Antenna Subsystem Failure

The antenna subsystem at each base station site shall be configured so that a catastrophic failure of any one antenna, combiner, filter, or multicoupler will have a minimum effect on DATCS operations in the Phoenix area. To the degree possible, these antenna subsystem elements will be standardized so that repairs can be made by replacement or interchanging elements.

(6) Control Channel Failure

The DATCS concept includes two separate control channels, one on North Mountain and one on Thompson Peak. The failure of either channel will cause the site controller to assign a back-up voice channel at the site as a substitute control channel. The mobiles or control stations will not require programming modification to accept this substitution. If the loss of a voice channel is not desired due to traffic loads, a degraded mode of operation can be tolerated using a single control channel from either North Mountain or Thompson Peak. The selection of the mode of operation can be made at the master terminal.

Failure or degradation of individual control stations or mobile stations will not degrade DATCS system performance.

9. SYSTEM TESTING AND ALARMS

An alarm panel will be installed at the master control terminal location. This alarm panel shall provide failure alarms (performance below acceptable thresholds) for at least the following:

- Excessive VSWR in any antenna subsystem transmission line
- Loss or reduction in output power of any transmitter
- Loss or reduction in sensitivity of any receiver
- Unauthorized carrier on any channel
- Loss of site controller integrity
- Degradation in repeater receiver interface
- Degradation in repeater transmitter interface
- Failure of degradation of a voting selector.

The alarm system that alerts to any element of degraded performance should also provide preliminary diagnostic information. This level of diagnosis may be limited to the identity of the offending unit of equipment and the kind of offense being observed.

10. SYSTEM MANAGEMENT AND CONTROL

The high technology features of DATCS are centralized and required integrated control. This implies central management and control for sustaining operations on behalf of the user organizations. Key management requirements are discussed in the following subsections.

(1) Journal Recorder/Printer

System operations, as reported by the site controllers and the voting selector, are recorded on a magnetic tape transport. This information will include:

- System activity by each user agency control station
- System activity by each mobile station
- Total channel activity time
- Channel use profile by hour, day, week, month
- Use of special features such as emergency priority

- Use of telephone interconnect
- System queue population and holding time in the queue by hour, day, week, month
- All alarms by hour, day, week, month.

Additional information entered manually by the master control terminal can include:

- User complaint reports
- Channel down time for routine maintenance
- Channel down time due to failure
- Maintenance reports-time/cost.

Selected reports from the journal file can be programmed by the master controller and printed out periodically on the system printer. Other reports can be programmed and printed out off-line by off-line batch process EDP operations.

(2) Centralized System Control

Overall DATCS operations on behalf of the multiple users will be controlled from a master control terminal at a central location. This control point will be responsible for sustaining the quality of system operation, providing limited access to the address code structure from user agency terminals, making programming changes, and implementing temporary program modifications such as interagency coordination and setting up phantom address groups.

(3) Centralized Maintenance

The maintenance of the DATCS must be uniform and standardized. The performance quality of each voice channel should be uniform with every other voice channel regardless of which of the three base station sites is used for each transaction. The skill and training required to achieve this calls for a highly skilled, and centrally managed maintenance staff.

(4) Management

The recurring costs of operating, maintaining and expanding DATCS over a phased implementation program, and the high level of performance required of the system required a dedicated and centralized management organization. This management should be at the level of a Division or Department in order to exercise the needed authority.

APPENDIX C

CURRENT SYSTEM INVENTORY

FORWARD

The following data is derived from the Task 4 Report "Documentation of Existing Radio Systems and Reported System Requirements" initially prepared January 10, 1980 and reissued on July 15, 1980. The revised report added Glendale, Mesa, Scottsdale, and Tempe to the data acquired from Phoenix.

I. INTRODUCTION

This report, prepared by Booz, Allen under contract to APCO, complies with Task 4 of the "Support Agreement and Work Plan for Phoenix, Arizona Under APCO Project 16B" dated January 10, 1980. The data reported herein is a direct result of the successful conclusion of Task 2 (Data Collection Guide) and Task 3 (document reviews and interviews). This revision includes the additional survey data resulting from the decision by the cities of Glendale, Mesa, Scottsdale, and Tempe to join with Phoenix in the Project 16B Program.

1. PURPOSE OF THE REPORT

The ultimate purpose of this report is to provide a body of information and data upon which to develop the system concept for an effective digitally addressed trunked communications system (DATCS) for the City of Phoenix and its suburbs. To achieve this purpose, the report includes the following:

- Configuration of existing municipal and suburban radio systems
- The present operation and interfaces of the radio systems
- Deficiencies of the existing systems
- Plan for system improvement
- DATCS functional requirements.

Section II of the report discusses and illustrates the status of the present radio systems including problems with existing systems. Section III of the report addresses the functions which will be required to satisfy the communications needs of the community of users as discussed during the interviews. Section III also identifies those DATCS functions which appear most appropriate to the greater Phoenix area DATCS concept.

2. APPROACH TO DATA ACQUISITION

The centralized management and maintenance of radio system resources employed by the City of Phoenix permitted an efficient approach to the collection of the required data. This process consisted of the following steps:

- Determination of the kind of data to be acquired
- Review of available radio system documentation
- Interviews with department and division communications personnel.

The type and elements of data needed was decided by mutual agreement with the project director for Phoenix and Booz, Allen project personnel. These decisions were transformed into a written data collection guide which was used to record the needed data during the review of documents and during the personal interviews.

The review of appropriate documents was confined to three key documents:

- A City of Phoenix radio system configuration manual created and maintained by the Communications Project Section of the Equipment Management Division
- The computerized inventory of radio equipment owned by the City of Phoenix
- The records of annual billing to the City of Phoenix municipal departments and divisions for radio equipment maintenance and replacement.

These records enabled the determination of the City of Phoenix radio equipment inventory, equipment locations, radio system control points, and radio system configurations prior to the interviews.

Personal interviews were then conducted with all principal City of Phoenix department and division communications personnel. The one-hour interviews were conducted to:

- Confirm previously recorded equipment inventory equipment locations and system configurations
- Define the mode of operation for each of the radio systems
- Identify present radio system problems and alleged defects
- Identify plans for improving individual radio systems
- Identify DATCS functions that could improve agency radio operations.

The data from the document reviews and the personal interviews was consolidated and summarily recorded in data collection guides for each agency. One set of these guides is held by Booz, Allen, and a copy is held by the deputy project director in Phoenix.

At a later date, the suburban communities of Mesa, Scottsdale, Glendale, and Tempe elected to participate in the Project 16B program. Personal interviews were then conducted with representatives of the following agencies:

- Mesa Police and Fire
- Mesa Public Works
- Scottsdale Police
- Glendale Police
- Glendale Fire
- Glendale General Services
- Tempe Police and Fire
- Tempe Public Works and Sanitation/Refuse.

Data from these interviews was consolidated with the data compiled for the City of Phoenix. The input data is recorded in data collection guides for each agency, one copy of which is held by Booz, Allen, and a duplicate copy is held by the deputy project director in Phoenix.

II. STATUS OF PRESENT SYSTEM

The status of the present radio system is described in the following paragraphs. This information evolves from the data base developed from interviews and from computerized data believed to be accurate. It is subject to inevitable change and although it represents the status at the time the data was acquired, the data should be reconfirmed with the originators before being used for subsequent planning.

1. RADIO SYSTEMS

The survey data shows 21 municipal activities in the City of Phoenix sharing six VHF high-band channels and four UHF frequency pairs. In addition to these 10 shared radio systems, there are five dedicated radio systems serving the police, fire, city transit buses, aviation, and rescue/EMS functions. Table II-1 shows the distribution of radio channels among the 26 City of Phoenix activities.

TABLE II-1

Phoenix Radio Channel Distribution

No. Agencies	Facility	VHF	UHF	Special
21	Shared Channels	6	4	
5	Dedicated Channels			
	Police	9	8	
	Fire	7	1	
	Rescue/EMS		10	
	Transportation (Bus)		2	
	Aviation	1	____	6 VHF Aviation AM

The Phoenix police department uses approximately 35 percent of the total radio frequency resouces available to the City of Phoenix, and the fire department uses approximately 38 percent of the radio frequency resources, assuming rescue/EMS channels and fire channels are considered together as fire assignment channels.

The suburban Phoenix area radio systems are predominately VHF high-band and tend toward dedicated channel operation with each agency operating on its own frequency with the exception of mutual aid channels. The channels configuration is mainly dual frequency repeater operation. The survey data shows that among the 16 departments of the 11 participating suburban agencies the following is the radio channel distribution.

TABLE II-2

Suburban Phoenix Radio Channel Distribution

	Dual Frequency VHF	Single Frequency VHF	UHF
Police	8	7	4
Fire	2	1	0
Public Works	5	2	2

This table does not include area mutual aid operational frequencies or repeater talk-around channels. It shows a need for 40 individual VHF high-band frequencies and six UHF pairs to serve the 16 user organizations. Of these, the police departments use approximately 58 percent of the VHF resources and 67 percent of the UHF resources; the fire departments use approximately 12 percent of the VHF resources and no UHF resources.

(1) Radio Channels and Assignments

The VHF high-band radio channel frequencies and their activity assignments are shown in Tables II-3 and II-4. The UHF radio channel frequencies and their activity assignments are shown in Tables II-5 and II-6. It is noted that in Table II-3 the Streets #2 radio channel had no activity assignment at the time the data was taken. Earlier use of this frequency resulted in adjacent channel interference which is believed to have been corrected. However, tests are still being run by simulcasting Streets #1 and Streets #2 channels, and Streets #2 channel has remained unassigned until the test results are conclusive.

Table II-3 (City of Phoenix VHF Assignments) does not include the six VHF Aviation Services frequencies used by the Phoenix Aviation Department in addition to their local government radio channel. These frequencies are:

- 121.70 MHz Litchfield ground control
- 121.80 MHz Deer Valley ground control

TABLE II-3
CITY OF PHOENIX VHF ASSIGNMENTS

ACTIVITY	RADIO CHANNEL	FREQUENCY	MOBILES	PORTABLES
Equipment Management	STREETS #1	157.290 MHz	48	0
Sanitation			92	0
Streets Maintenance			89	0
Purchasing			6	0
			235	0
Building Maintenance	BUILDING SAFETY	155.145 MHz	1	1
Crisis Intervention			26	-
Job Stimulus			-	-
Planning			-	-
City Attorney			72	-
Building Inspection			99	1
Water Production	WATER #1	158.130 MHz	114	0
Sewers			74	0
			188	0
Water Distribution	WATER #2	158.775 MHz	150	0
Water Customer Service	WATER #3	153.680 MHz	101	0
Aviation	AVIATION	155.760 MHz	115	29
Fire	Fire I	154.190 MHz	230	
	Fire II	154.250 MHz		
	Fire III	154.070 MHz		
	Fire IV	154.280 MHz		
	Fire V	153.830 MHz	0	147
	Fire VI	154.310 MHz		
	Fire VII	154.145 MHz		
			230	147
Police	Chase 100	154.890 MHz		
	Information 200	154.755 MHz		
	Detectives 300	155.790 MHz		
	South 400	155.370 MHz	636	977
	Central Talk 500	155.070 MHz		
	North 600	155.640 MHz		
	East 700	155.520 MHz		
	West 800	155.430 MHz		
	Interagency	155.475 MHz		
(Unassigned)	STREETS #2	156.180 MHz	0	0

TABLE II-4-1
PHOENIX SUBURBAN VHF ASSIGNMENTS

Activity	RADIO CHANNEL	FREQUENCY	MOBILES	PORTABLES
Mesa Police	Main Outgoing	155.010 MHz 159.030 MHz	27	126
	Main Incoming	155.130 MHz 159.150 MHz		
	Detectives	154.815 MHz 158.850 MHz		
Mesa Fire	Main Fire	154.340 MHz 154.010 MHz	15	14
	Mutual Aid	154.280 MHz		
	Civil Defense	47.660 MHz		
Mesa Public Works	Utility Ops	155.820 MHz 153.920 MHz	163	37
	Streets/Parks	156.015 MHz 153.815 MHz		
	Electrical Dept.	153.470 MHz		
Scottsdale Police	Operations	155.850 MHz 154.845 MHz	80	61
	Back-Up Ops	155.550 MHz 155.725 MHz		
	Talk-around	155.550 MHz		
	Mobile-Inter	155.475 MHz		
	Mobile Only	156.030 MHz		
	Mobile Only	155.730 MHz		
	Local Govt	153.860 MHz		
Glendale Police	Operations	156.210 MHz 154.830 MHz	0	60
	Talk-around	156.210 MHz		
	Talk-back	155.670 MHz		
Glendale Fire	Main Operations	154.310 MHz	30	30
	Mutual Aid	154.280 Mhz		
Glendale General Services	Operations	158.830 MHz 153.785 MHz	130	0
	Dial-a-Ride	154.995 MHz		
Tempe Public Works	Operations	154.965 MHz 155.880 MHz	230	20
	Talk-around	154.965 MHz		
Tempe Sanitation/ Refuse	Operations	158.865 MHz 153.740 MHz	40	30

TABLE II-4-2
PHOENIX SUBURBAN VHF ASSIGNMENTS (Continued)

ACTIVITY	RADIO CHANNEL	FREQUENCY	MOBILES	PORTABLES
Tempe Police	Operations	155.835 MHz 154.800 MHz	5	110
	Operations	155.685 MHz 154.710 MHz		
	Investigation	155.685 MHz		
	State NARC	155.445 MHz		
	Mutual Aid	155.475 MHz		
	Public Works	155.880 MHz 154.965 MHz		
Tempe Fire	Operations	154.145 MHz 153.770 MHz	18	25
	Fire-Ground	154.145 MHz		
	Mutual Aid	154.280 MHz		
	Phoenix Fire	154.190 MHz		
	Phoenix Fire	154.250 MHz		
	Phoenix Aid	154.070 MHz		
	Mesa Fire	154.010 MHz 154.340 MHz		
	Mesa Talk-around	154.340 MHz		

TABLE II-5
CITY OF PHOENIX UHF ASSIGNMENTS

ACTIVITY	RADIO CHANNEL	FREQUENCY	MOBILES	PORTABLES
Engineering Parks and Recreation Traffic Engineering	LOCAL GOV'T.#1	453.500 MHz 458.500 MHz	119 64 27 210	6 9 0 15
Traffic Signals Facility Maintenance	LOCAL GOV'T.#2	453.950 MHz 458.950 MHz	12 52 64	4 2 6
Human Resources	HUMAN RESOURCES	453.875 MHz 458.875 MHz	32	1
Communications Maint. Civic Plaza	COMM. MAINT.	453.625 MHz 458.625 MHz	9 0 9	12 25 37
Transportation	CITY BUS #1 CITY BUS #2	452.625 MHz 457.625 MHz 452.725 MHz 457.725 MHz	253	2
Fire	FIRE UHF	460.575 MHz 465.575 MHz	15	33
Police	450-1 450-2 450-3 450-4 450-5 Interagency MDT-1 MDT-2	453.100/458.100 453.200/458.200 453.450/458.450 453.600/458.600 453.800/458.800 460.375/465.375 460.525/465.525 460.550/465.550	27	246
Rescue - EMS	Med-1 State Med-2 State Med-3 Phoenix Med-4 State Med-5 State Med-6 Phoenix Med-7 Phoenix Med-8 Phoenix Med-9 Phoenix Med-10 State Mobile Repeater 1 Mobile Repeater 2	463.000/468.000 463.025/468.025 463.050/468.050 463.075/468.075 463.100/468.100 463.125/468.125 463.150/468.150 463.175/468.175 462.950/467.950 462.975/467.975 460.550/468.775 460.550/468.175	10 (1) (1)	17

TABLE II-6
PHOENIX SUBURBAN UHF ASSIGNMENTS

ACTIVITY	RADIO CHANNEL	FREQUENCY	MOBILES	PORTABLES
Mesa Police	Detectives Detectives Administration MDT	453.325 MHz 458.325 MHz 453.375 MHz 458.375 MHz 453.750 MHz 458.750 MHz 453.775 MHz 458.775 MHz	8	42 not yet in service
Mesa Public Works	Sanitation Utility Data (MDT)	453.350 MHz 458.350 MHz 453.900 MHz 458.900 MHz	60 27 87	

- 121.90 MHz Sky Harbor ground control
- 122.95 MHz Unicom - Sky Harbor/Deer Valley
- 123.00 MHz Litchfield Unicom
- 123.50 MHz Instructional.

Due to the FCC restrictions related to permissable communications on these frequencies and the type of radio service in which they are employed, it is assumed that these channels would not be integrated with any other municipal radio service. Therefore, these radio channels have not been included in the tables of frequencies.

For similar reasons, any General Mobile Radio Service or Personal Radio Services (Citizens Band Radio Service) channel or frequency that may now be used by a governmental activity has not been included in these tables.

City-wide paging within the City of Phoenix is also assigned to the Phoenix building safety radio channel (155.145 MHz). The data base indicates approximately 125 paging receivers may be in service on this channel.

(2) Mobiles and Portables

The distribution of mobiles and portables among the participating governmental activities and radio channels is also shown in Tables II-3 and II-4 for VHF high-band and in Tables II-5 and II-6 for UHF. The data base indicates the following summation:

	Mobiles	Portables
Phoenix VHF hi-band	1,754	1,154
Suburb VHF hi-band	738	513
Phoenix UHF	620	357
Suburb UHF	95	42
	3,207	2,066

Of the total number of mobile radios operated by the surveyed agencies, the police use approximately 25 percent, and the fire departments (including rescue units) use approximately 10 percent. Of the total number of hand-held portables (not including CB units) operated by the surveyed agencies, the police use approximately 79 percent, and the fire departments use approximately 13 percent. The City of Phoenix accounts for approximately 74 percent of all mobile and portable municipal radio equipment in use in the surveyed area.

(3) Base Stations and Fixed Stations

Most primary base station installations for the City of Phoenix radio systems are located on North Mountain and South Mountain. Only the Phoenix transit radio system (bus communication) does not have a base station on North Mountain, but plans indicate that this installation will be made in the near future.

In addition to the primary base stations, there are 38 fixed stations at selected locations in Phoenix. These stations serve as stand-by facilities or operational facilities for local use. There are five UHF repeaters included in the 38 fixed stations which account for an additional nine fixed control stations.

The distribution of City of Phoenix base stations, control stations, and other fixed stations is shown in Table II-7.

The suburban Phoenix area communities have a wider distribution of base station/repeater locations. The number of these in each community, as reported during the survey, is shown in Table II-8. The location of each base station as reported by each community is shown in Table II-9.

(4) Satellite Receivers

Satellite voting receivers are used extensively by the City of Phoenix and the four participating suburban communities for police operations because of the hand-held portable configuration of police communications. It is planned to expand the use of satellite voting receivers for City of Phoenix fire and rescue (EMS) communications. Nearly all of this City of Phoenix expansion is in the process of being completed.

Satellite voting receivers are also extensively used by the police in the four participating suburban Phoenix communities. Glendale, Mesa, and Tempe report plans to expand Satellite receiver coverage for their public safety operations. Tempe also reports plans to extend Satellite receiver coverage for Public Works and Sanitation.

A summation of all planned satellite receiver locations in the City of Phoenix and the radio channels they serve is shown in Table II-10. The table shows there are 295 receivers at 29 locations which vote 10 police channels, three fire channels, and five EMS radio channels. At the present time, there are 165 receivers installed and operating; 92 percent of these are used on the 10 police channels, and eight percent of these are used in fire channels, mainly Fire III.

CITY OF PHOENIX COMMAND AND CONTROL TABLE II-7

ACTIVITY	ACCESS				FIXED STATIONS		
	DISPATCH CENTER	REMOTE CONTROLS	CONTROL STATIONS	EOC REMOTE	NORTH MT.	SOUTH MT.	OTHER
Engineering		5	2	X	XR	XR	1R
Parks and Recreation		3	1				
Traffic Engineering		7	2				
Traffic Signals		2	1		XR	XR	
Facilities Maintenance		1					1R
Equipment Management		3					
Sanitation		5					
Street Maintenance		2		X	X	X	2
Purchasing							
Building Maintanance							
Job Stimulus (JSP)							
Building Safety		4		X	X	X	1
Human Resources		2			XR	XR	1R
Communications Maint		4	3		XR		
Civic Plaza							
Transportation	1	3					
City Bus 1					(X)		1R
City Bus 2							1R
Water Production		14		X	X	X	5
Sewers		3					
Water Distribution		4		X	X	X	2
Water Customer Service		4			X	X	4
Aviation	1	12			(X)	(X)	6
Sky Harbor							
Litchfield							1
Deer Valley							1
Police	2						
Chase 100					X	X	1
Information 200					X	X	
Detectives 300					X	X	
South 400				X	X	X	
Central Talk 500					X	X	1
North 600				X	X	X	1
East 700				X	X	X	1
West 800				X	X	X	2
Interagency VHF							
450-1		3			X	X	
450-2					X	X	
450-3					X	X	
450-4					X	X	
450-5					X	X	
Interagency UHF							
MDT-1					X	X	
MDT-2					Rec	X	
Fire	1						
Fire I				X	X	X	2
Fire II				X	X	X	1
Fire III					X	X	1
Fire IV					X	X	
Fire V							
Fire VI							1
Fire VII							
Fire UHF							
Rescue							
Med-1 Thru Med-10	1	10			X	X	Med-9
Mobile Repeaters					Rec	Rec	2

PHOENIX SUBURB COMMAND AND CONTROL TABLE II-8

ACTIVITY	ACCESS				FIXED STATIONS		
	DISPATCH CENTER	REMOTE CONTROLS	CONTROL STATIONS	EOC REMOTE	REPEAT-ER	BASE STATION	OTHER
Mesa Police	1	0	0	0	7	0	0
Mesa Fire	-	0	0	0	2	0	0
Mesa CD	-	0	0	-	0	1	0
Mesa Public Works	1	57	0	0	4	1	
Scottsdale Police	1	2			2	2	0
Glendale Police	1	0	0	1	2	2	0
Glendale Fire	1	0	0	1	0	1	0
Glendale General Svc	2	3	0	1	1	1	0
Tempe Police	1	0	0	0	3	0	0
Tempe Fire	1	0	4	0	1		4
Tempe Public Works	0	8	0	0	1	0	0
Tempe Sanitation	0	1	0	0	1	0	0

TABLE II-9
SUBURB BASE STATION LOCATIONS

LOCATION	MESA								SCOTTSDALE			GLENDALE					TEMPE				
	Police #1	Police #2	Police #3	Fire #1	Civil Defense	Utilities	Streets/Parks	Electric	Sanitation	Police #1	Police #2	Local Govt	Police #1	Police #2	Fire	Gen Svcs	Dial-A-Ride	Police #1	Police #2	Fire	Public Works	Sanitation
MESA																						
300 E. 6th	X	X	X			X	X	X														
130 N. Robson	X				X																	
340 E. 6th		X																				
20 E. Main				X																		
13 W. 1st St.				X																		
425 S. Belleview			X			X			X													
SCOTTSDALE																						
3739 Civic Plaza										X	X											
City Yard												X										
GLENDALE																						
63rd/Northern													X	X	X	X						
59th/Grand																	X					
TEMPE																						
Tempe Butte																		X	X	X	X	X

SATELLITE RECEIVER LOCATIONS-PHOENIX FIRE, POLICE, AMBULANCE

TABLE II-10

	FIRE I	FIRE II	FIRE III	MED-3 TELEM	MED-6 TELEM	MED-7 TELEM	MED-8 TELEM	MED-9 COORDINATION	CHASE 100-POLICE	INFO 200-POLICE	POLICE 300	POLICE 400-SOUTH	POLICE 500-CENTRAL	POLICE 600-NORTH	POLICE 700-EAST	POLICE 800-WEST	POLICE 450 - 1	POLICE 450 - 2
FIRE STA 4			X						X	X	X	X	X		X	X	X	X
FIRE STA 8	X	X	X	X	X	X	X	X										
FIRE STA 12	X	X	X	X	X	X	X	X	X	X	X		X		X		X	X
FIRE STA 13															X			
FIRE STA 14	X	X	X						X	X			X			X	X	X
FIRE STA 18	X	X	X						X	X	X		X	X	X		X	X
FIRE STA 19												X	X					
FIRE STA 20	X	X	X						X	X	X			X	X		X	X
FIRE STA 21	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X
FIRE STA 22	X	X	X						X	X	X	X	X				X	X
FIRE STA 23	X	X	X	X	X	X	X	X	X	X	X	X	X				X	
FIRE STA 27	X	X	X	X	X	X	X	X	X	X	X			X			X	X
FIRE STA 31	X	X	X	X	X	X	X	X	X	X	X			X			X	X
FIRE STA 34	X	X	X						X	X	X	X				X	X	X
FIRE STA 42	X	X	X	X	X	X	X	X	X	X	X			X				
COUNTY HOSP	X	X	X	X	X	X	X	X	X	X	X	X	X		X		X	X
MUNI BLDG	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X
CIVIL DEFENSE	X	X	X	X	X	X	X	X	X	X	X	X	X		X		X	X
MT. BELL ROOF	X	X	X	X	X	X	X	X	X	X	X		X		X		X	X
MARYVALE BRIEFING STA									X	X	X		X			X	X	X
NORTH BRIEFING STA	X	X	X	X	X	X	X	X	X	X	X			X			X	X
PUMP STA-75th AVE	X	X	X	X	X	X	X	X	X	X	X		X			X	X	X
DEER VALLEY WATER	X	X	X	X	X	X	X	X	X	X	X						X	X
SQUAW PEAK WATER PLT	X	X	X	X	X	X	X	X	X	X	X			X	X		X	X
SKY HARBOR BR STA												X						
S. MT. RESERVOIR												X						
CAPT. GALLEY REST													X					
EAST WING BAGGAGE-SKY HARB.													X					
NORTH W. BRIEFING STA	X	X	X	X	X	X	X	X										

A summation of all reported satellite receiver locations for Mesa, Scottsdale, Glendale, and Tempe is shown in Table II-11. There are 36 receivers at 13 locations which vote nine police channels, two fire channels, and a civil defense radio channel.

2. SYSTEM OPERATION

The following discussion of system operations is derived from the interview data and from available documentation. It is believed that these discussions fairly represent system operations as they are known to the radio system users at this time.

(1) Interagency Communications

Interagency communication is crucial to the coordination of municipal services and to the coordination of public safety emergency services. The present interagency communications links, as reported by the City of Phoenix personnel interviews are shown in Table II-12.

The City of Phoenix interagency coordination matrix shown in Table II-12 is [illegible] in part by factors not necessarily related to the need for functional coordination. Incidental coordination is forced on some City of Phoenix activities by their being co-channel users. Other activities achieve coordination through equipment and controls installed for after-hours monitoring of their working radio channel by other municipal services. The City of Phoenix responders to the interview questions set forth a revised set of interagency communication links that they felt to be more appropriate to their needs. This set of interagency communications links is shown in Table II-13.

Interagency communication in Mesa, Scottsdale, Glendale, and Tempe is mainly limited to the regional police mutual aid mobile radio channel and the regional fire mutual aid mobile radio channel. Mesa dispatches fire and police from the same dispatch center which provides automatic coordination of these two agencies. Tempe also has direct mobile radio communications on Mesa fire and Phoenix fire frequencies. Tempe police have a remote control for the Tempe Public Works base station, and Mesa Police/Fire dispatch center has a remote control for the Civil Defense base station. Any other suburban interagency communication is limited to the use of telephones according to the survey responses.

(2) Dedicated Systems

The radio systems that are dedicated to the service of one City of Phoenix municipal agency include police, fire, transit, aviation, and rescue/EMS. The need for dedicated service in the City of Phoenix is determined by the requirements of public safety emergency operations and by high radio channel loading. The characteristics of these City of Phoenix radio systems are

TABLE II-11
SUBURB SATELLITE RECEIVER LOCATIONS

LOCATION	MESA					SCOTTSDALE		GLENDALE			TEMPE	
	Police #1	Police #2	Police #3	Fire #1	Civil Defense	Police #1	Police #2	Police #1	Police #2	Fire #1	Police #1	Police #2
MESA												
8300 E. Main	X	X	X	X								
300 E. 6th	X	X	X	X								
1400 S. Dobson	X	X	X	X								
20 E. Main					X							
SCOTTSDALE												
Airport						X	X					
Miller/Kellips						X	X					
GLENDALE												
67th and Bell								X	X	X		
115th Ave								X	X	X		
2040 W. Camelback								X	X	X		
7601 N. 63rd								X	X			
32nd and Greenway								X	X	X		
69th and Bethany								X	X	X		
TEMPE												
South Station											X	X

PRESENT INTERAGENCY COMMUNICATION LINKS - PHOENIX, ARIZONA

TABLE II-12

REPORTING AGENCY		REPORTED COMMUNICATION LINK																												
AGENCY	RADIO SYSTEM	Police	Fire	Ambulance	Comm. Projects	Civic Plaza	Bldg. Safety	Human Resources	Aviation	Public Transit	Engineering	Parks	Traffic Eng.	Facilities Maint.	Streets Maint.	Sanitation	Equipment Mgt.	Water Prod.	Sewers	Water Dist.	Water Svc.	County Sheriff	DPS	Public Utilities	Civil Defense	Regional Police	Regional Fire	Regional Hosp.	Regional Airports
POLICE	POLICE	X	X	X																		X	X	X	X	X			
FIRE	FIRE	X	X	X	X				X													X	X		X		X		
AMBULANCE	FIRE/EMS	X	X	X					X													X	X		X		X	X	
COMM. PROJECTS	RADIO SHOP		X		X	X																X	X		X		X		
CIVIC PLAZA	RADIO SHOP				X	X																							
BUILDING/SAFETY	BLDG/SAFETY						X	X																					
HUMAN RESOURCES	HUMAN RESOURCES							X																					
AVIATION	AVIATION								X																				X
PUBLIC TRANSIT	CITY BUS	X	X	X						X			X		X														
ENGINEERING	LG #1										X	X	X		X	X													
PARKS/RECREATION	LG #1										X	X	X																
TRAFFIC ENG.	LG #1										X	X	X																
TRAFFIC ENG (Signals)	LG #2										X	X	X																
FACILITIES MAINT.	LG #2												X	X	X														
STREETS MAINT.	STREETS #1														X	X	X								X				
SANITATION	STREETS #1														X	X	X												
EQUIP. MGT.	STREETS #1														X	X	X												
WATER PROD.	WATER #1																	X	X	X	X				X				
SEWERS	WATER #1																	X	X										
WATER DISTR.	WATER #2																	X	X	X					X				
WATER CUST.SVC.	WATER #3																	X	X	X	X								
CITY ATTY.	BLDG.SAFETY						X	X																					
PLANNING DEPT.	BLDG.SAFETY						X	X																					

TABLE II-13

DESIRED INTERAGENCY COMMUNICATION LINKS | REPORTED COMMUNICATION LINK

REPORTING AGENCY		Police	Fire	Ambulance	Comm. Projects	Civic Plaza	Bldg. Safety	Human Resources	Aviation	Public Transit	Engineering	Parks	Traffic Eng.	Facilities Maint.	Streets Maint.	Sanitation	Equipment Mgt.	Water Prod.	Sewers	Water Dist.	Water Svc.	County Sheriff	DPS	Public Utilities	Civil Defense	Regional Police	Regional Fire	Regional Hosp.	Regional Airports
AGENCY	RADIO SYSTEM																												
POLICE	POLICE	X	X	X					X													X	X	X	X	X	X		
FIRE	FIRE	X	X	X					X													X	X		X		X	X	
AMBULANCE	FIRE/EMS	X	X	X																					X			X	
COMM. PROJECTS	RADIO SHOP		X		X																								
CIVIC PLAZA	RADIO SHOP	X	X			X																							
BUILDING/SAFETY	BLDG/SAFETY						X																	X	X				
HUMAN RESOURCES	HUMAN RESOURCES	X	X	X				X																					
AVIATION	AVIATION	X	X						X		X				X														X
PUBLIC TRANSIT	CITY BUS	X	X	X						X			X		X											X	X		
ENGINEERING	LG #1								X		X				X	X								X					
PARKS/RECREATION	LG #1	X	X								X	X	X							X									
TRAFFIC ENG.	LG #1	X											X		X														
TRAFFIC ENG (Signals)	LG #2	X	X										X		X														
FACILITIES MAINT.	LG #2	X												X	X														
STREETS MAINT.	STREETS #1	X	X												X									X					
SANITATION	STREETS #1	X									X		X		X	X	X												
EQUIP. MGT.	STREETS #1											X		X			X	X	X	X									
WATER PROD.	WATER #1																	X		X				X					
SEWERS	WATER #1																		X	X									
WATER DISTR.	WATER #2		X															X	X	X				X					
WATER CUST.SVC.	WATER #3																	X	X	X	X								
CITY ATTY.	BLDG.SAFETY																												
PLANNING DEPT.	BLDG.SAFETY																												

shown in Table II-14. The radio frequencies and channel designations are shown in Table II3 and Table II-5.

The City of Phoenix transit radio system is a unique system specifically developed for city bus operations. It is vendor engineered, vendor supplied, and vendor maintained.

The Phoenix aviation radio system includes three airports: Sky Harbor, Deer Valley, and Litchfield.

The Phoenix rescue/EMS radio system is operated by the City of Phoenix Fire Department from the fire radio dispatch center.

The municipal radio systems for the communities of Mesa, Scottsdale, Glendale, and Tempe are all dedicated radio channel systems. The summation of these system characteristics is shown in Table II-15.

(3) Shared Systems

The radio systems for the City of Phoenix that are shared by more than one user include streets, building safety, water, local government, human resources, and communications. These systems are generally characterized by having no central dispatch facility relying instead on a multiple of desk top type remote controls for access to their radio system. The characteristics of these radio frequencies, co-channel users, and general configurations are shown in Table II-3, Table II-5, and Table II-7.

The City of Phoenix Water radio system has three dedicated channels: Water #1, Water #2, and Water #3. Because of the different characteristics of these three channels, they are discussed separately in Table II-16.

The City of Phoenix Building Safety radio system is unique in that it also provides city-wide paging.

(4) Operating Costs

The radio equipment used by the City of Phoenix activities is controlled by the Equipment Management Division. Each City of Phoenix division and department is billed periodically for the operation and maintenance of the equipment each uses according to the computerized inventory report. An additional charge is also made periodically for the replacement of the radio equipment of each division and department.

Table II-17 shows the anticipated 1980 annual charges based upon the extension of billed 1979 charges (approximately 10 percent increase).

TABLE II-14-1

CITY OF PHOENIX DEDICATED SYSTEMS-OPERATING CHARACTERISTICS

RADIO SYSTEM	CITIZEN ACCESS	COMMAND AND CONTROL	DATA SYSTEM ACCESS	CHANNEL ACTIVITY	PLANNED GROWTH
POLICE RADIO	-Telephone; 7 digit emergency number- -25 Lines; 10 more in reserve -8 complaint takers -CAD input	-24 hour dispatch center at PPSB -Backup dispatch at North Mt. -Remotes on 450-1 only -CAD assisted	-CAPRI -ACIC -NCIC -NLETS	-Monthly activity report available on all channels -All VHF channels heavily loaded -Peak load 4PM to midnight	-2 new police districts by 1982 -MDT growth from 27 units to 505 units -New tactical UHF channel needed -911 system
FIRE RADIO	-Telephone; 7 digit emergency number -6 trunks direct to dispatchers	-24 hour dispatch center at FAHQ -Dispatch Fire and Rescue/EMS	-No data system access at this time	-Not recorded;random 100 call samples taken each month -Peak load 4PM to midnight	-New dispatch center with advanced CAD being implemented PPSB -Experimenting with portable replacement for mobile radios
TRANSIT RADIO	-No routine citizen access	-16Hr/day; 6 days a week dispatch center at terminal -Bus radios have failure alarms and silent alarms	-No data system access	-Not recorded -Peak load reported at rush hours AM and PM	-New dispatch center planned for Bank Bldg. -New base station on North Mt. -CAD/AVL being considered
AVIATION RADIO	-No routine citizen access	-24Hr dispatch center at Sky Harbor security -12 remote controls in Sky Harbor operations & maintenance -Dispatch Fuel Trucks,Airport Security, & Airport Fire/ Crash/Rescue	-Security data system only	-Not recorded -Reported overloaded by fuel trucks operations during daylight hours -Peak load is random	-New base station on North Mt. -Separate VHF channel for fuel trucks -Expand digital security system -Add radio tech.

TABLE II-14-2
CITY OF PHOENIX DEDICATED SYSTEMS-OPERATING CHARACTERISTICS

RADIO SYSTEM	CITIZEN ACCESS	COMMAND AND CONTROL	DATA SYSTEM ACCESS	CHANNEL ACTIVITY	PLANNED GROWTH
RESCUE EMS RADIO	-Telephone; 7 digit emergency number -6 trunks direct to EMS dispatcher	-24 hr. dispatch center at FAHQ -Dispatch Fire & Rescue/EMS	-No data system access at this time	-Not recorded; random 100 call sample taken each month -Peak load 4PM to midnight	-New dispatch center with advanced CAD being implemented PPSB -Experimenting with vehicle portables to replace mobile radios

TABLE II-15-1
SUBURB DEDICATED SYSTEMS-OPERATING CHARACTERISTICS

RADIO SYSTEM	CITIZEN ACCESS	COMMAND AND CONTROL	DATA SYSTEM ACCESS	CHANNEL ACTIVITY	PLANNED GROWTH
MESA Police/Fire	-Telephone; 7 digit emergency numbers -12 Lines police; 5 lines to fire -2 complaint takers per shift	-24 hr dispatch center; police/fire -No remotes -Dispatch Fire, Police, Rescue	-NCIC -ACIC -City Utility Files	-Not recorded -Sample taken each shift every 6 mo -Peak 5pm to 11pm -65-75% EMS/police	-Plan CAD with MDT -New fireground frequency -More Satellite receivers
MESA Public Works	-Telephone; 7 digit number -3 lines rotary -6 dispatchers/ complaint takers	-2 shift operation -Police dispatches on 3rd shift -57 Remote Controls	-City Utility Files	-Not recorded	-Plan for satellite receiver -Plan for MDT
SCOTTSDALE Police	-Telephone-7digit emergency number -8 lines rotary -4 dispatchers/ complaint takers per shift	-24 hr dispatch Center-Civic Plaza -2 Remotes in PDHQ	-NCIC -CAPRI	-Total activity from counters -Peak load 4pm to midnight	-Plan to use Phoenix MDT -More satellite receivers
GLENDALE Police	-Telephone; 7 digit emergency number plus Centrex -5 emergency lines on rotary & Centrex -2 Complaint takers per shift	-24 hr dispatch at PDHQ -1 Remote to EOC -Simulcast on General Service Channel	-NCIC -CAPRI -COM 10 -NLETS	-Not recorded -Peak load 4pm to 8pm and 10pm to 12 pm	-Plan to use Phoenix MDT -More satellite receivers
GLENDALE Fire	-Telephone-7 digit emergency number -4 emergency lines on rotary; 2 more in Alarm Room -1 dispatch/complaint taken per shift	-24 hr dispatch at Alarm HQ -1 Remote to EOC -Remote Control of Public Works base Station	-None	-Not routinely recorded -Peak load 6pm to 11pm	-Plan integration with Phoenix Fire CAD/MDT -Plan separate fire ground channel

TABLE II-15-2
SUBURB DEDICATED SYSTEMS-OPERATING CHARACTERISTICS

RADIO SYSTEM	CITIZEN ACCESS	COMMAND AND CONTROL	DATA SYSTEM ACCESS	CHANNEL ACTIVITY	PLANNED GROWTH
GLENDALE General Services	-Telephone; 7 digit No. -4 lines; not rotary -1 complaint taker and 2 back-up clerks per shift	-One shift; 7am to 5pm (5 days/wk) -Dispatch Center 6210 W. Myrtle -3 remotes W. Myrtle -1 remote, EOC -Fire dispatches after hours	-None	-Not recorded -Peak load 7am to 9am and 3:30pm to 5:30 pm	-None reported
TEMPE Police	-Telephone; 7 digit emergency number -5 lines on rotary -2 to 3 complaint takers per shift	-24 hr dispatch at PDHQ -Remote control of Public Works base for off-hours	-NCIC -ACIC -CAPRI	-Calls per shift recorded from counters -Peak load 4pm to midnight -Peak channel overload	-Plan for CAD in future -Need additional radio channel
TEMPE Fire	-Telephone; 7 digit emergency number -4 lines on rotary -1 or 2 dispatcher/ complaint takers per shift	-24 hr dispatch at Fire HQ -Control Stations can dispatch from 2 Fire Houses	-None	-Not recorded -Peak load 4pm to midnight -Fireground traffic overloads radio channel	-Plan integration with Phoenix Fire CAD/MDT -Plan new channel for fireground
TEMPE Public Works	-Telephone; routine 7 digit numbers -Approx 20 lines to 7 remote control points	-No Central Dispatch -7 Remote Controls -Operates 7am to 4 pm -After hours dispatch by Tempe P.D.	-None	-Not Recorded -Peak load 7am to 9am and 3pm to 4:30pm	-Plan satellite receivers

TABLE II-15-3
SUBURB DEDICATED SYSTEMS-OPERATING CHARACTERISTICS

RADIO SYSTEM	CITIZEN ACCESS	COMMAND AND CONTROL	DATA SYSTEM ACCESS	CHANNEL ACTIVITY	PLANNED GROWTH
TEMPE Sanitation/ Refuse	-Telephone; routine 7 digit number -1 dispatcher/ complaint taker per shift	-No Central Dispatch -One shift operation 6am to 4pm 5 days/wk	-None	-Not recorded -Peak load 6am to 8:30am and 3pm to 4:30pm	-None reported

TABLE II-16-1
CITY OF PHOENIX SHARED SYSTEMS-OPERATING CHARACTERISTICS

RADIO SYSTEM	CITIZEN ACCESS	COMMAND AND CONTROL	DATA SYSTEM ACCESS	CHANNEL ACTIVITY	PLANNED GROWTH
STREETS #1 STREETS #2 RADIO (2 channels)	-Streets Maint. has 11 lines for access -Sanitation has 10 lines for access -Equip.Maint. has no routine citizen access	-No central dispatch -Distribution of local remote controls shown in Table II-7 -All operation from 5AM to 6PM	-No data system access	-Not recorded -Channel overload at peak hours 6AM to 10AM -Least daytime load 2PM to 6PM	-No growth plan reported
BUILDING SAFETY RADIO	-Bldg.Insp. has 6 tele. lines & Code-A-Phone for 24 hr coverage -Bldg.Maint. has no routine citizen access	-No central dispatch -4 local remote controls used 8AM to 5PM -Bldg.Maint. is 24 hr operation	-Utility company (SAP/APS) tele-type system	-Not recorded -Channel reported saturated 8AM to 10:30AM by Bldg. Insp. -Approx. 125 paging receivers on channel	-No growth plan reported
WATER #1 RADIO	-Water Prod. has no routine citizen access -Sewer has 2 lines rotary 24 hrs per day	-No central dispatch -Distribution of local remote controls shown in Table II-7 -Water Prod.operates 24 hrs; sewers 8 hrs	-No data system access	-Not recorded -Channel load reported to be moderate -Peak load 8AM to 9:30 AM	-No growth plan reported
WATER #2 RADIO	-Water Dist. has 10 tele.lines on rotary (3 of the 10 are an emergency number)	-No central dispatch -4 remote control units operate 24 hrs -Provide 24 hr service to WATER #1 and WATER #3	-No data system access	-Not recorded -Channel reported saturated at peak load -Peak load 8AM to 10AM	-No growth plan reported

TABLE II-16-2
CITY OF PHOENIX SHARED SYSTEMS-OPERATING CHARACTERISTICS

RADIO SYSTEM	CITIZEN ACCESS	COMMAND AND CONTROL	DATA SYSTEM ACCESS	CHANNEL ACTIVITY	PLANNED GROWTH
WATER #3 RADIO	-10 lines for customers, 3 lines for field admin; 13 complaint takers -Operate 8AM to 5PM	-No central dispatch -4 remote control stations -8hr service is normal; backed by Water Dist. 24 hrs	-No data system access	-Not recorded -Channel reported saturated at peak load hours -Peak load 8:30AM to 10AM; 1:30PM to 3PM	-No growth plan reported
LOCAL GOVT. #1 RADIO	-No routine citizen access	-No central dispatch -Numerous remote control stations shown in Table II-7 -Normally operated 6:30AM to 5:30PM	-No data system access	-Not recorded -Channel reported saturated at peak load hours -Peak load 7AM to 8:30AM; 1PM to 2:30PM	-No growth plan reported
LOCAL GOVT. #2 RADIO	-No routine citizen access	-No central dispatch -3 remote control stations operate 8 hrs a day	-Facilities Maint. accesses ASO Energy Conservation Office Computer System	-Not recorded -Channel load reported as moderate -Peak load at AM and PM rush hours	-No growth plan reported
HUMAN RESOURCES RADIO	-8 tele.lines and 3 "hot lines" for direct citizen input -Operates 8AM to 5PM	-No central dispatch -2 remote control stations -System configured for mobile-to-mobile use viz repeaters (no control stations)	-No data system access	-Not recorded -Channel load reported as light and random	-No growth plan reported
COMMUNICATIONS RADIO	-No routine citizen access	-No central dispatch -4 remote control units; 3 control stations -Repeater configured for mobile-to-mobile service 24 hrs	-No data system access	-Not recorded -Channel load reported light -Load randomly distributed	-Civic Plaza 25 portable system is planned for this channel

TABLE II-17
1980 Radio Rental Rates and
Estimated Operation/Maintenance Charges
(Projected from 1979 Rates)

CITY OF PHOENIX

Municipal Activity	Account	Operation and Maintenance	Replacement
Planning	555XX	$ 924.00	$ 884.00
Engineering	56XXX	7,194.00	8,606.00
Facilities Mgt.	572XX	5,702.00	7,036.00
Equipment Mgt.	5743X	647.00	607.00
Equipment Mgt.	5744X	2,112.00	2,059.00
Police	60XXX	438,293.00	385,836.00
Fire	615XX	123,697.00	113,084.00
Bldg. Safety	62XXX	4,554.00	4,554.00
Streets	65XXX	6,138.00	6,165.00
Traffic Eng.	66XXX	2,257.00	2,930.00
Airport	67XXX	15,748.00	12,936.00
Sanitation	70XXX	5,927.00	5,887.00
Sewers	71XXX	4,356.00	4,356.00
Parks/Recreation	73XXX	5,504.00	6,798.00
Civic Plaza	75XXX	990.00	1,333.00
Water-Cust.Svc.	794XX	5,478.00	5,478.00
Water Production	795XX	5,478.00	5,439.00
Water Distribution	796XX	5,478.00	5,320.00
Human Resources	90XXX	2,191.00	1,518.00
JSP	92XXX	1,637.00	1,505.00
		$644,305.00	$582,331.00

TABLE II-18
SUMMATION OF REPORTED COMMUNICATIONS PROBLEMS-CITY OF PHOENIX

RADIO SYSTEM	COVERAGE PROBLEM		CHANNEL OVERLOAD		MORE CHANNELS		INTERFERENCE	
	YES	WHERE/WHY	YES	WHEN	YES	WHY	YES	WHAT
POLICE	X	WEST	X	4PM-Midnite	X X X	2 new Police Districts New MDT (500) Tactical Operation		
FIRE	X	PORTABLES	X	4PM-Midnite	X	Fireground	X	Hospital IM
RESCUE/EMS	X	PORTABLES						
CIVIC PLAZA	X	INSIDE COMPLEX						
BLDG. SAFETY	X	NE					X X X	Paging Operator Police IM-SM EMS-North Side
AVIATION					X	Separate Fuel Truck	X	Fuel Trucks
CITY BUS	X	N/NE	X	Rush Hours	X	Bus Expansion		
LOCAL GOVT #1	X	NE/N	X	8AM-3PM			X	Telco IM
LOCAL GOVT #2	X	NE						
STREETS #1	X	(See Notes)	X	6AM-10AM				
WATER #1	X	NE					X	IM
WATER #2	X	NE	X	8AM-10AM				
WATER #3	X	NE/N	X	8:30-10 AM 1:30-3PM				

The maintenance costs for the City of Phoenix are influenced by the following:

- Police Department - the police department performans in-house maintenance on communications equipment contained within the PPSB headquarters including Computer Assisted Dispatch (CAD) terminals and Mobile Data Terminal (MDT) equipment. The cost is not reported in the survey data.

- Fire Department - the fire department maintenance shop performs much of its own radio maintenance; cost is reported to be $252,000 per year for fire maintenance, and $125,000 per year for EMS maintenance.

- Aviation - the aviation department performs all of its own radio maintenance in its own radio/electical shop. The cost is not reported in the survey data.

- City Bus - the city bus radio system is a vendor-installed and vendor-supported system. The maintenance cost was reported as $28,568 for 1978; more recent costs were not reported.

The cost of maintaining and replacing radio equipment has been controlled through centralized maintenance and management. The present trend in the City of Phoenix is toward decentralized maintenance.

The City of Mesa and the City of Tempe operate their own municipal radio shops. The total costs reported for radio maintenance in 1979 are:

- Mesa - $15,000
- Tempe - $70,000

Scottsdale Police and the City of Glendale contract for radio maintenance. Their reported costs for contract radio maintenance in 1979 are:

- Scottsdale Police - $18,000
- Glendale - $9,000

These are estimates of maintenance costs and are not otherwise confirmed.

3. REPORTED PROBLEM AREAS

The summation of problem areas that were reported for each City of Phoenix municipal radio system is shown in Table II-18. Appropriate notes related to these problem areas are as follows:

- Police - Additional MDT units are expected to reduce some of the channel loading problems

- Fire - Installation of the new satellite voting receivers will help solve the portable radio coverage problem. Some of the channel overload problem will be reduced by implementation of the new CAD system

- Rescue/EMS - Installation of the new satellite voting receivers will help solve the portable radio coverage problem

- Civic Plaza - Portable radios are planned to replace unsatisfactory coverage by paging receivers now used inside the Phoenix Civic Plaza complex. The portable radios will operate in the otherwise lightly loaded communication UHF repeater channel

- Building Safety - The city paging operation causes interference because the paging operator does not monitor the channel before keying. Police calls are heard from South Mountain; ambulance calls are heard from North Mountain. Building Safety reports the cost of the present radio system is too high for the service it offers

- Aviation - Fuel truck operations at Sky Harbor are very active and break up airport operations traffic. Airport operations at Sky Harbor should be separated from airport operations at Deer Valley and Litchfield

- City Bus - A new base repeater is planned for North Mountain to correct coverage problems; a new dispatch center is planned to correct security problems

- Local Government #1 - Mobile telephone traffic is heard on the channel in the morning and again in the evening - may want to vote all fixed station receivers to improve the coverage problem

- Streets #1 - A report by Sanitation that some mobiles have trouble receiving North Mountain and South Mountain is not supported by other co-channel users; an equipment problem is implied. A successful test of Streets #2 channel could help reduce the channel load on Streets #1

- Water #2 - The separation of mobile-to-mobile radio traffic from base-to-mobile radio traffic has been suggested as a means to reduce channel loading

- Water #3 - The coverage problem may be improved by voting the existing six fixed station receivers. General comments regarding the reported system problems include the following:

- Lack of radio discipline and failure to use efficient radio procedures have been cited as major causes of excessive channel air-time

- Selective voting of multiple fixed station receivers should be investigated as a means of improving reported coverage problems

The communications problem reported by the participating suburban Phoenix agencies are summarized in the following paragraphs:

. Mesa Police/Fire - A new fireground frequency is needed to relieve the congestion on the main fire frequency; there are portable radio talk-back coverage problems that are expected to be corrected by additional satellite receiver installations

. Mesa Public Works - Radio coverage will be needed southeast of Mesa toward Florence; there is interference from Florence Prison Farm mobiles operating near Mesa

. Scottsdale Police - There is interference from unidentified co-channel user; intend to change to CTCSS to see if this will help

. Glendale Police - There is co-channel interference from the University of Arizona; portable talk-back coverage problems are expected to be solved by installing additional satellite receivers

. Glendale Fire - Intermode problems with mobile telephones and co-channel user interference with Riverside California indicate the need for a separate fireground channel to separate fireground and operations traffic

. Glendale General Services - There are coverage problems on the north side of Glendale due to co-channel user interference with City of Peoria

. Tempe Police - Co-channel user interference is evident; channel load at peak traffic hours indicates the need for another police radio channel

. Tempe Fire - Additional satellite receivers will be needed to correct portable talk-back coverage south of Tempe; a fireground channel is needed to separate fireground and operations traffic

. Tempe Public Works - Portable radio talk-back coverage problems indicate the need for satellite voting receivers

. Tempe Sanitation/Refuse - Portable radio talk-back coverage problems indicate the need for satellite voting receivers.

The majority of reported radio system problems for the City of Phoenix and the four participating suburban communities appear to be generic to radio system operations at any frequency and do not seem unique to VHF, UHF, or potential 800 MHz operations.

APPENDIX D

STATEMENT OF WORK

FORWARD

This appendix is intended as a typical outline for a Statement of Work (SOW) for quick reference by planners and system procurement personnel. The planner is cautioned to employ only those elements of the outline which relate to the specific procurement and which can be accurately evaluated and measured.

APPENDIX D

STATEMENT OF WORK

I. INTRODUCTION

The introduction to the Statement of Work (SOW) should provide a general overview of the project to enable a better understanding by the responders. Key elements of this section are outlined in the following subsections of the Introduction.

1. Background of the Project

A brief historic description of the origin of the procurement and the constraints imposed on the design.

2. Objective of the Procurement

A brief discussion of the main system objectives to be achieved by the procurement.

3. Scope of the Procurement

A basic and brief outline of the hardware, software, and services that are being purchased. These may include for example:

- Hardware
- Software
- System Design
- Installation
- Testing
- Training
- Maintenance.

II. INSTRUCTIONS TO BIDDERS

This section of the SOW will provide the bidders with all the information needed to respond correctly to the bid request.

1. Procurement Schedule

The schedule time and dates for responding to the bid request will include:

- Time and place of the pre-bid conference
- Time and place bids and proposals are due

- Bid and proposal opening time, date, and place
- Proposed contract award date
- Expected date of contract completion.

2. Authorized Contracts

The persons will be identified who are authorized to respond to bidders requests prior to bid opening. These may be restricted to the:

- Procuring officer
- Technical consultant.

The statement should be made regarding how the issues raised by these contacts will be reported to the other bidders.

3. Bid and Proposal Requirements

Each of the items to be submitted as part of a responsive bid will be defined. Any limitations should be included in the description. These items would include for example:

- Itemized cost proposal
- Technical proposal
- Management proposal
- Provisions for alternate proposals
- Proposal limitation such as page count, standardized forms (cost proposal), proposal size, unnecessary artwork, and number of copies to be submitted.

4. Bidders Qualifications

The contractor for a high technology system must be qualified, technically and financially, to complete the required work. These qualifications should be expressed in the SOW by requiring reasonable responses to limits imposed on:

- Bidders facilities and financial resources
- Performance history in terms of references and a list of similar and recent contract work
- Support facilites such as field maintenance shops, training facilities, and spare parts replacement depots
- The quality and availability of personnel for management, supervision, and technical staff.

5. Proposal Evaluation Criteria

Criteria should be established for the comparative evaluation of:

- Technical proposals
- Cost proposals
- Management proposals.

These criteria should be clearly defined in the SOW so that each bidder will understand the emphasis placed on the requirements of the RFP.

6. Contract Award

The SOW will identify the type of contract to be awarded the successful bidder whether or not this contract will be awarded without pre-contract discussions.

7. Indemnification

The purchaser should require indemnification against damages imposed through intentional or unintentional acts of the contractor. High technology system procurements will need indemnification against the improper use of patented items or processes. All procurements which include services such as installation and test will be well advised to require indemnification from damages resulting from the actions of contractors' employees or agents.

8. Titles and Rights

Rights of the purchaser and ownership of titles will be clearly defined by the SOW. These items include statements related to:

- The transfer of title to equipment and software
- Rights to data and software developed or provided as part of the contract
- Rights and title to the submitted proposals
- The right to reject proposals
- The right to negotiate with any bidder
- The right to cancel negotiations or the contract.

Legal counsel should be consulted for the scope, content, and wording of this subsection of the SOW.

9. Bonds, Insurance, and Warranty

Each governmental entity will have its own limits for, and description of, the bonds, insurance and warranty provisions for contractor provided material and services. Frequently, there will be state regulations which also must be adhered to. These requirements will provide for:

- Performance bonds
- Workman's compensation
- Comprehensive liability insurance
- Warranty on workmanship and materials.

The purchasing department of the major governmental agency included in the program will provide counsel as to how these requirements are to be included in the SOW.

10. Costs of Proposal Preparation

The SOW should state clearly that any costs related to the preparation of bids or proposals can not be included in the proposed cost of the project or billed back to the purchaser in any manner.

11. Contract Disputes

At the option of legal counsel, the SOW may indicate the means by which the governmental agency resolves contract disputes. This will be a function of the governmental body and will not be an option of project management. These provisions may include:

- The procedure and method of resolving contract disputes
- Termination of contracts for cause
- The assessment of liquidating damages
- The identity of the court of jurisdiction.

12. Applicable Federal/State Laws and Regulations

When state or federal laws/regulations affect the system design, its operation, or allowable use, these laws or regulations should be identified in the SOW.

III. SCOPE OF WORK

This section of the SOW defines the items of work expected of the contractor; the specific tasks required by the contractor are described in detail.

1. Services to be Provided

High technology systems will require professional services to be performed by the system contractor in addition to the delivery of hardware and software items. Typical services to be provided are:

- System design which can include system engineering, radio propagation engineering, software development, and hardware development
- Installation and debugging of hardware and software
- Assistance in procuring required licenses and permits
- Developing and conducting performance tests and acceptance tests
- The preparation of sites and facilities which can include construction, HVAC, emergency power, lighting, installation of utility services, etc.

2. Deliverable Items

Each deliverable item should be identified in the SOW. Deliverable items include hardware, software, and services. The list will be unique to the complexity of the system to be procured. However, some common items on all lists will include the following:

- Each item of electronic or radio hardware
- Each item of computer software
- Maintenance support
- Spare parts and spare module provisions
- Towers, buildings and other structures
- Manuals and documentation such as test plans, test procedures, maintenance manuals, operators' manuals, user manuals, training aids, installation drawings, and test reports
- Progress reports and deficiency reports.

3. Delivery Schedules

Each deliverable item should be supported by a delivery schedule. The SOW will require a formal and contractually obligated schedule for:

- Each item of electronic or radio hardware
- Each item of computer software
- Each tower or building
- The completion of all facility preparations
- Delivery of all manuals and documents
- The time and place of technical progress reviews
- The delivery of reports including progress reports, test reports, discrepancy reports, and the final report or acceptance test report.

IV. SYSTEM SPECIFICATION

The system specification is a complete technical system description which includes the system performance, system interfaces, and system configuration. It places technical limits on these parameters and adds reliability and/or maintainability requirements where appropriate.

1. Hierarchy of Specification and Standards

Industry or regulatory specifications or standards frequently apply to the specification of a system. These should be identified. The hierarchy of these documents, as they apply to the system specification, should be defined so that conflicts between them can be resolved.

2. System Description

The system description includes the configuration of the system elements and their interconnection with each other. It is recommended that this be done graphically with supporting written clarification. The system description is derived from the system concept design.

3. System Interfaces and Supporting Services

The means by which the system interconnects with the world outside of the system should be fully described. These interfaces are relatively unique to each individual system, but some key interfaces will include:

- External communication systems such as mobile radios, private telephone systems, data processing, digital data systems, alarms, microwave transmission systems, and similar facilities

- Utility systems such as public access telephone systems, commercial power systems, water supplies
- Emergency operations such as emergency power services, fire protection, emergency medical services, and civil disaster prevention operations.

4. System Software

The system specification will include a complete description of the operations software and the applications software required to provide the needed system performance.

5. System Operation and Performance

The specification of system operation and performance is tailored to meet individual system requirements as developed in the system concept. Typically, these specifications will include a complete description of:

- The functional modes of system operation for routine system performance, emergency system performance, and allowable fail-soft or degraded levels of performance
- The calculated levels of personnel staffing for the operating staff, maintenance staff, and system management.

6. Expansion Requirements

Frequently, limitations on funding or other resources will prevent the initial implementation of a sophisticated system from realizing the full potential of system operation, scope, and performance. When these expansion requirements are part of the initial system procurement, they must be fully described in the system specification.

7. System Licenses and Approvals

High technology systems may exceed the apparent limits of federal or state licensing regulations, and extraordinary procedures may be needed to acquire the necessary permits or licenses. These requirements should be clearly defined in the system specification. They will be unique to each specific system configuration and intended operation.

V. EQUIPMENT SPECIFICATIONS

The equipment specifications define the quality and performance characteristics of each item of hardware and software needed to meet the system specifications. The identity of each hardware and software item is derived from the system configuration diagram which was developed as part of the system concept.

1. General

This subsection of the equipment specifications accumulates all items of the individual equipment specifications requirements that are common among all items of equipment or software. It also defines the quality and quantity of each item of hardware and software that is required to meet the system configuration. Typical items that would appear under the general heading are:

- Applicable industry standards or publications and their hierarchy for this program
- Standard environmental conditions such as temperature, humidity, primary power, vibration, shock, dust, and dirt
- Deliverable equipment lists showing the quantity required of each item including spares
- The required level of quality and workmanship for each hardware item.

2. Individual Item Specifications

Each equipment item will have an individual technical specification thatreflects its construction and performance as required to meet the system specifications. These are derived individually from the system performance requirements and should be no more severe than that needed to meet the system performance specifications. Software specifications are typically combined with the equipment specifications for the computer subsystem or the switching subsystem in which they are resident.

Submitted to:

Lt. Rex L. Vance
Project Director
Salt Lake County Sheriff's Office
6278 Glen Oaks
Salt Lake City, Utah 84107

DIGITALLY ADDRESSED TRUNKED COMMUNICATION SYSTEM

SYSTEM IMPLEMENTATION PLAN

SALT LAKE COUNTY, UTAH

November 15, 1980

BOOZ · ALLEN & HAMILTON Inc.

776 SHREWSBURY AVENUE
TINTON FALLS, NEW JERSEY 07724
747-9303
AREA CODE 201

TABLE OF CONTENTS

I. INTRODUCTION

This system implementation plan for a digitally addressed trunked communication system (DATCS) for the Salt Lake County, Utah area was prepared by Booz, Allen and Hamilton and the Associated Public-Safety Communication's Officers (APCO) in response to LEAA Grant No. 79-SS-AX-0013.

1. BACKGROUND AND OBJECTIVES

The Second Report and Order in the proceedings related to Docket No. 18262, published by the Federal Communication's Commission (FCC) in 1974, promised relief of the increasingly more difficult problems of frequency congestion in the public-safety community. These proceedings allocated 200 channels in the 800 MHZ portion of the spectrum for "trunked" systems. In February 1977, LEAA recognized that many technical, economic, and management questions about the application of this newly available spectrum to public-safety operations must be answered before the potential benefits inherent in trunked systems could be made available. Under LEAA Grant No. 77-SS-99-6009 the Associated Public-Safety Communications Officers (APCO) was requested to analyze these problems, make appropriate recommendations for future actions, and describe a program to demonstrate the potential capabilities of these new concepts.

A series of programs under APCO Project 16 were initiated. The first of these (Project 16) resulted in an analysis of the technical and regulatory factors affecting the applicability of the 800 MHZ portion of the radio spectrum to law-enforcement communication system problems. A second program (Project 16A) identified specific operational capabilities and functional requirements that should be incorporated into a public-safety trunked communication system. The third program (Project 16B) provided specific planning assistance to two cities (Lexington, KY and Phoenix, AZ), two counties (Bucks Co., PA and Salt Lake County, UT), and the State of Oklahoma for a feasibility study and basic implementation plan for DATCS demonstration systems.

Since November 1979 Salt Lake County has been participating in Project 16B as one of the demonstration participants. The key objectives to be achieved are:

- To determine if DATCS can relieve municipal radio channel congestion in the Salt Lake County/ Utah County area
- To establish the potential of DATCS to accommodate future public safety radio communications needs
- To address the solution of the complex command/ control problems confronting the public-safety agencies

- To develop a common DATCS to support multi-agency public safety and/or other governmental communications requirements within the Salt Lake County, Utah County area

- to provide a solution to interagency radio connectivity between governmental agencies appropriate to their mission responsibilities.

Other advantages of operational flexibility are inherent in a dynamically programmed digitally addressed communication system. These have been evaluated as DATCS capabilities in determining the system requirement.

2. PROJECT DIRECTION AND PARTICIPANTS

The project was under the direction of:

- Lt. Rex L. Vance, Project Director Salt Lake County Sheriff's Department

- Craig M. Jorgenson, Deputy Project Director State of Utah Department of Transportation and Public Safety

The participating public-safety agencies include the following:

- Utah Highway Patrol, Rex Hale,/Col. Robert Reid
- Salt Lake County Sheriff's Office, Lt. Rex L. Vance
- Utah County Sheriff's Control Dispatch, Sheriff Mack Holley
- Pleasant Grove Police Department, Chief Mike Ferre
- West Jordan Polic Department, Chief Robert Stockwell
- University of Utah, Public-Safety Division, Mr. Wayne Dee Shephard
- Brigham Young University, Security/Police, Mr. J. Wesley Sherwood
- Salt Lake County Fire Department, Chief David A. Barrett
- Salt Lake City Fire Department, Mr. Harold C. Newman
- Salt Lake County Attorney, Mr. Ted Cannon

Other participating governmental and public service departments and services include:

- Utah Department of Transportation, Mr. Graig M. Jorgennsen
- Salt Lake County Fleet Management, Mr. Frank L. Lear
- Salt Lake County Emergency Services Department, Mr. J. Ray Emery
- Salt Lake County Public Works, Mr. C. W. Braoly
- Salt Lake County Surveyor, Mr. Douglas H. Brammer
- Salt Lake County Division For The Aging, Mr. Monte K. Keele
- Salt Lake County Building Inspector, Mr. Rex Bronson
- Salt Lake County Security, Mr. W. O. Cowden
- University of Utah Media Services, Mr. Milton L. Davis

Each of the above listed public-safety and public service agencies have been active participants in the program, contributing to the interagency and intra agency communications analysis and also the requirements for the DATCS concept design.

It has been the responsibility of the Project Director to develop this System Implementation Plan (SIP) with the technical assistance of Booz, Allen as engineering consultants to APCO. The cooperation of all participating agencies and their personnel has been voluntary. There have been no binding commitments required of Salt Lake County, the State of Utah or any of the other participating agencies.

CONTINUED

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II. SYSTEM CONFIGURATION

The basic DATCS land mobile radio system for the Salt Lake County area has been conceived to replicate current radio system operations as closely as possible. The difference in function and response between the conventional radio system configuration now in use and the DATCS radio system should be nearly transparent to the mobile operator except co-channel sharing will appear to the operator to have been eliminated.

This philosophy directs that operations which require a unique trained skill on the part of the mobile operator be minimized in the system concept. It also directs the avoidance of subsystem interfaces in which trunked technology or switching requirements might result in a degraded performance of existing communications systems.

The configuration of the Salt Lake County/Utah County DATCS is based in part on the system requirements and in part on information provided by existing suppliers of trunked radio systems. It is noted that the equipments described as part of this DATCS radio configuration are not standard production items and have not been previously provided by the vendors in this definitized form. Further study by the vendor community may modify their final hardware and software offerings. This could result in changes to the system configuration.

1. PARTICIPATING AGENCIES

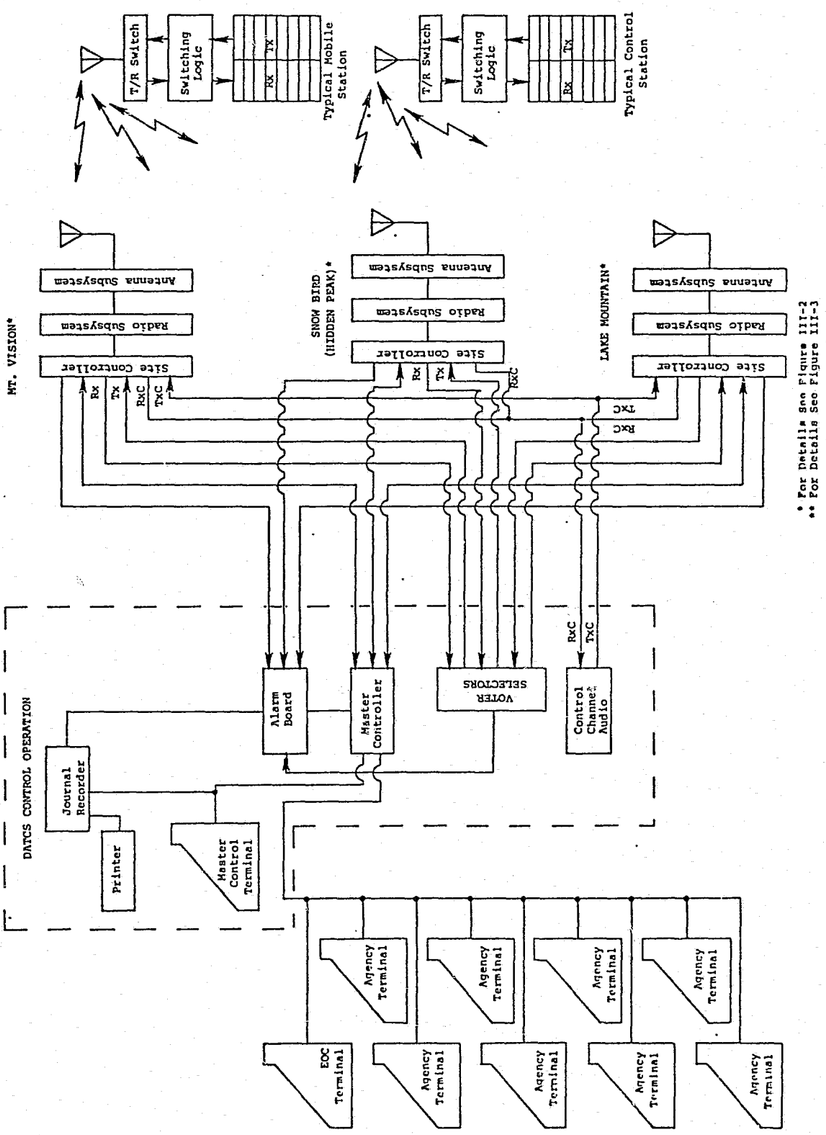
Candidate agencies for participation in DATCS include those agencies who participated in the Task 4 survey activities and provided data for the Task 4 report.* These agencies are identified in Section I, Subsection 2. From Task 4 report* it is estimated that these participants can load the DATCS with 1082 mobiles. This is adequate loading for a 15 channel mixed service group under the present FCC Rules and Regulations**.

2. BASE STATION CONFIGURATION

The proposed DATCS base station configuration for Salt Lake County/Utah County is shown in Figure II-1. The selection of base station locations at Lake Mountain, Mt. Vision, and Snowbird (Hidden Peak) is driven by radio propagation experience at these locations, and previous 800 MHz propagation tests.

The sites at Lake Mountain and Mt. Vision transmit and receive control channel information. The details of a conceptual installation at these sites is shown in Figure II-2. The site at Snowbird (Hidden Peak) receives control channel information but does not transmit it. The details pff a conceptual installation at this site is shown in Figure II-3. Radio propagation tests at 800 MHz may indicate a reversal in the roles of Mr. Vision and Snowbird (Hidden Peak).

FIGURE II-1
Base Station Configuration
Salt Lake County/Utah County



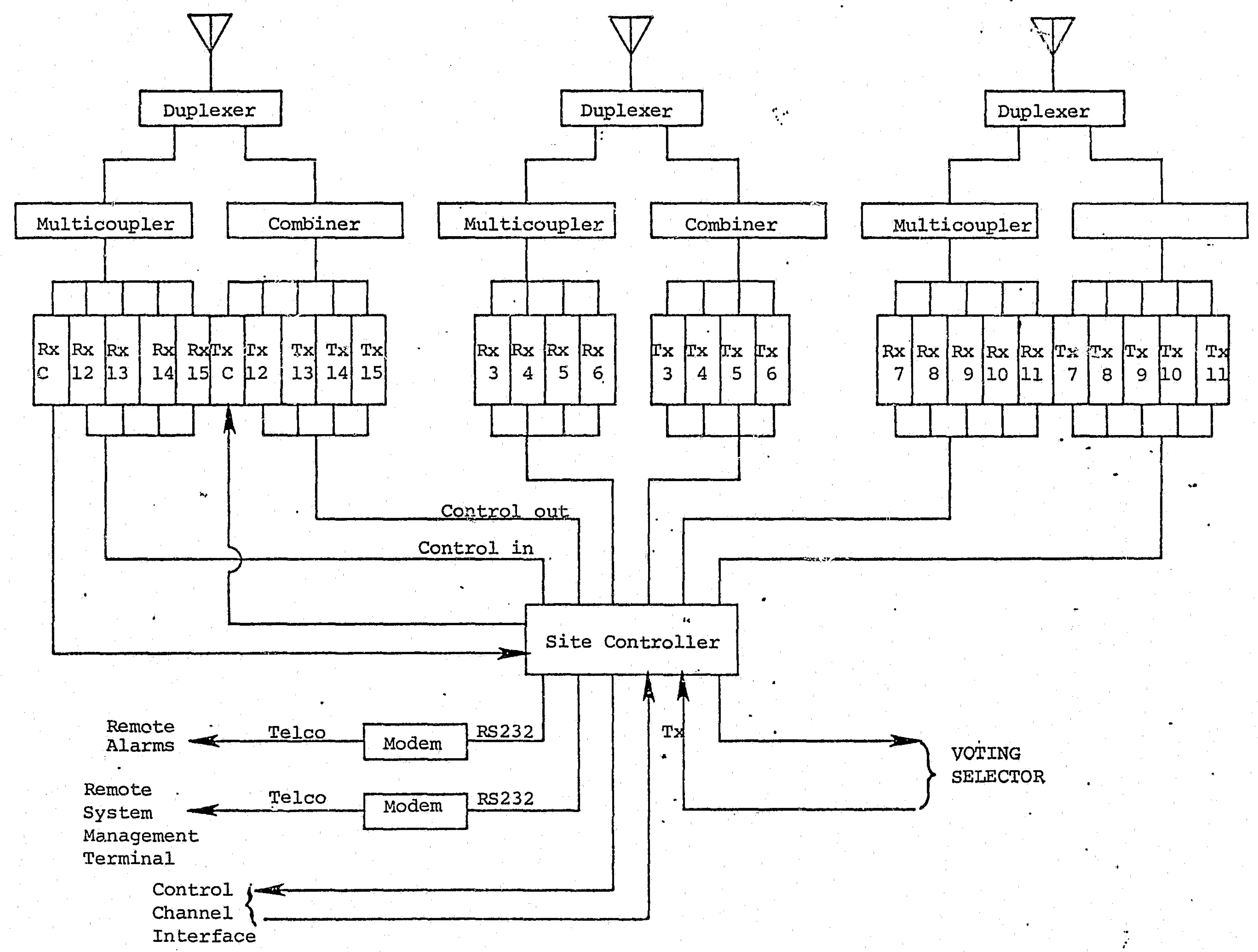


FIGURE II-2
Salt Lake/Utah Counties Base Site
Control Channel Transmission

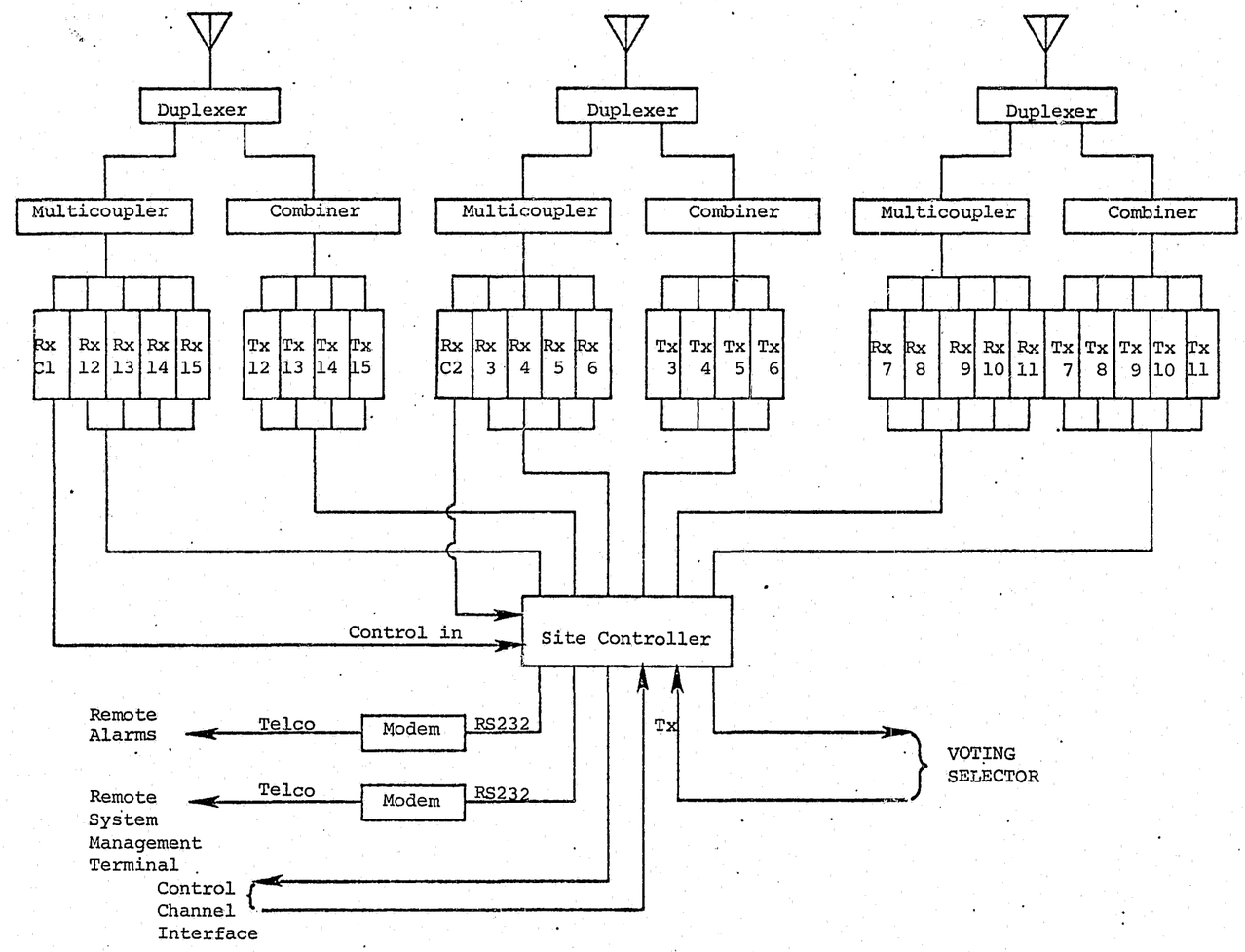


FIGURE II-3
Salt Lake/Utah Counties Base Site
No Control Channel Transmission

The site controller at each site is fully programmable and capable of operating independently based on control channel instructions. The two control channels transmit the same information simultaneously on different frequencies. Mobiles will home on one control channel until the signal is lost then seek and lock on the other control channel.

The site controllers are connected through modems and an RS-232 interface to the master controller and master control terminal at DATCS control operation center. This terminal can make program changes in the site controllers, selectively turn off or turn on individual channels, key up individual transmitters, change the address code responses, and perform interagency coordination interface switching as required.

Alarm functions generated by the site controller are connected through modems and an RS-232 interface to the alarm board in DATCS control operation center.

Receiver voting and transmitter steering information from each DATCS voice channel at each site are brought to the voter selector equipment at the DATCS control operation center. The control channels are not voted; voting is suspended from the back-up control channels if they are selected by the site controller.

Audio signals into and out of the control channel receiver and transmitter at each site are interconnected at the control channel audio unit in DATCS control operation center. Any bridging, amplification, attenuation, or balancing required is done at this unit.

The DATCS control operation center coordinates and controls the operation of the three base station sites and provides an interface for the restricted control terminals located at user agency locations. The master controller provides logic and switching for the multiple drop circuit to the agency terminals, and routes management information generated by site controllers to the journal recorder. This information is listed in Appendix B, Subsection 10. The master controller is commanded by the master control terminal which can address the programming and coding of the master controller and the site controllers.

The journal recorder is a magnetic tape transport that records all management information generated by site controllers, alarm board, and master control terminal. It prints out selective reports on its printer on command of the master controller. It is intended that most management reports, except for spot reports, will be generated off-line from the journal recorder tapes.

3. FREQUENCY PLAN

The frequency plan for a 20 channel area DATCS for Salt Lake County/Utah County is shown in Figure II-4. A count of public service and public safety mobile units, as reported by the participants in Task 4, are more than enough for 70 percent loading of a 15 channel mixed service group trunked radio system under present FCC Rules and Regulations (Part 90, Section 90.375).

Overhead burden of two control channels is approximately 13 percent of a 15 channel system. The distribution of channels for Lake Mountain, Mt. Vision, and Snowbird (Hidden Peak) is shown in Figure II-4. Channel 3 is the back-up control channel for Lake Mountain and Channel 4 is the back-up control channel for Mt. Vision. If a control channel failure (or deactivation) will require the use of channels 3 or 4 as control channels, the transmitters and receivers for the back-up channel selected will be exempt from voting and transmitter steering. Engineering analysis of system reliability based on known hardware and software components may reduce the need for back-up control channels.

A suggested frequency plan for the statewide base station locations, talk-back station locations and intermediate repeater locations, listed in Appendix B, is also shown in Figure II-4. It is noted that the control channel frequencies are reused throughout the state so that no more overhead channels are charged against a statewide system. Operations (voice) frequencies are spread beyond the first six channels in the Salt Lake County/Utah County system to minimize possible interference on the most used channels in the State Capitol area. A suggested base station site configuration is shown in Figure II-5; the talk-back station configuration is shown in Figure II-6. A suggested intermediate repeater site configuration is shown in Figure II-7.

4. ADDRESS CODES

The digital address of all mobile units and control station units has two parts; an individual unique address and a group address. The combination of these two address codes informs the site controllers and the master controller which control station and mobiles to include in the request for a channel. Under normal mode operation all mobiles assigned to a control station (group dispatch point) will be included in any group call. Mobile-to-mobile communication within the group is achieved as in any repeater type conventional radio system. If temporary modification is required such as interagency coordination or intergroup mobile-to-mobile communication, the individual address portion of the address code enables unique routing by terminal instruction to the controllers. Similarly an individual mobile or control station can be denied access to DATCS.

STATION LOCATION	CHANNEL ASSIGNMENT-STATEWIDE (C=Control Channel)																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Wasatch Front																				
Lake Mt.		C	•(C)	•	•	•	•	•	•	•	•	•	•	•	•					
Mt. Vision	C		•	•(C)	•	•	•	•	•	•	•	•	•	•	•					
Hidden Pk.			•	•	•	•	•	•	•	•	•	•	•	•	•					
Little Mt.			•	•	•	•	•	•	•	•	•	•	•	•	•					
Southwest																				
Frisco Pk.	C															•	•	•	•	
Beaver Mt.		C														•	•	•	•	
Northeast																				
Asphalt Ridge	C											•	•	•	•					
Southeast																				
Bald Mesa		C	•	•	•	•														
Adajo Pk.	C		•	•	•	•											•			
Intermediate																				
Tabby Mt.																•	•	•		
Ford Ridge															•				•	•
Cedar Mt.							•	•	•											
Dutch John			•	•	•															
Red Spur													•	•	•					
Delle																•	•	•		
Barney Top												•	•	•						
Moccasin Pk.									•	•	•									
Monroe Pk.															•				•	•
Levan Pk.																•	•			

FIGURE II-4
DATCS Frequency Plan

FIGURE II-5
Expansion DATCS Base Station
Control Channel Transmission

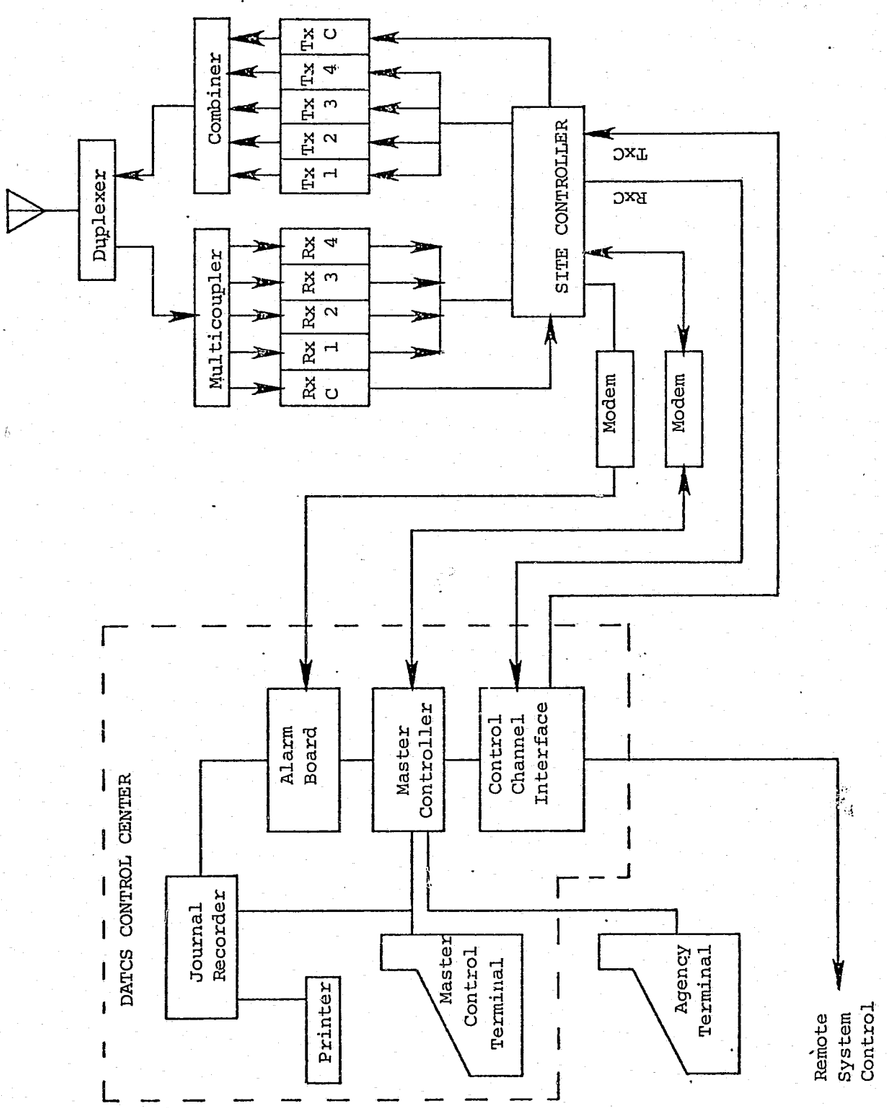


FIGURE II-6
Expansion DATCS Base Station
No Control Channel Transmission

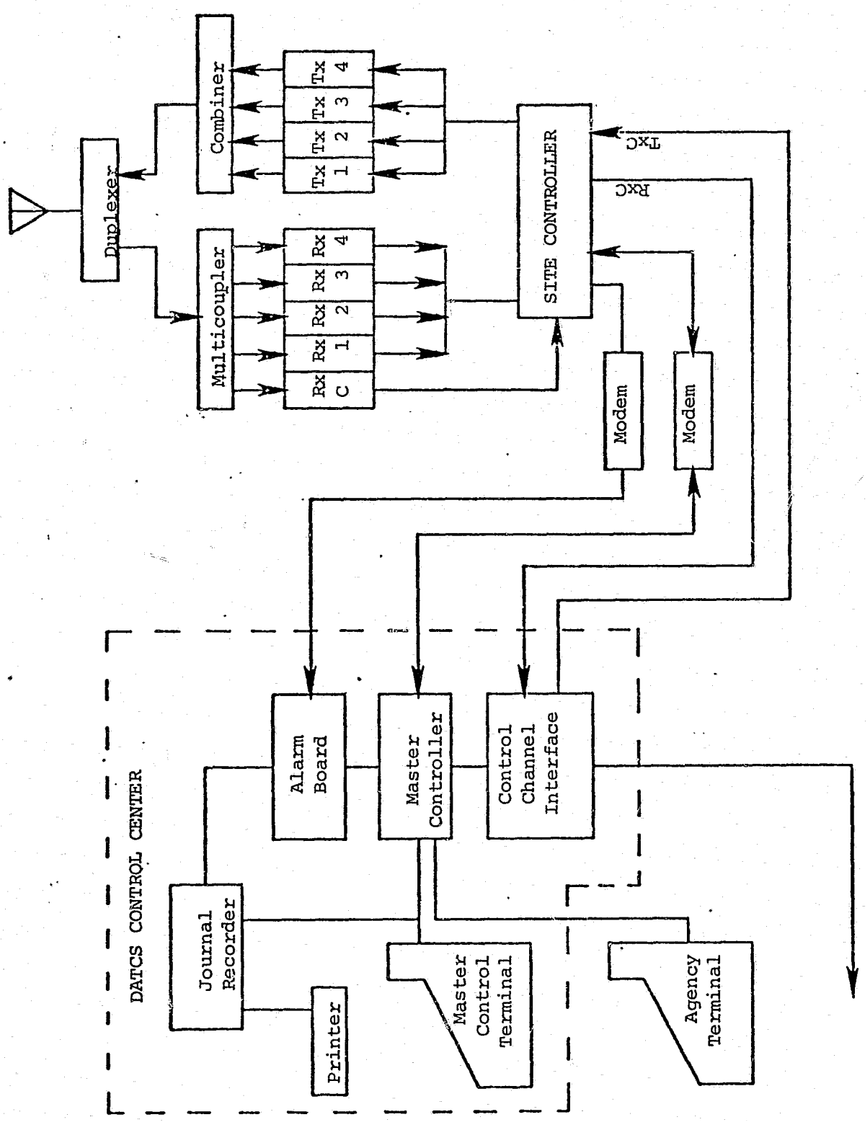
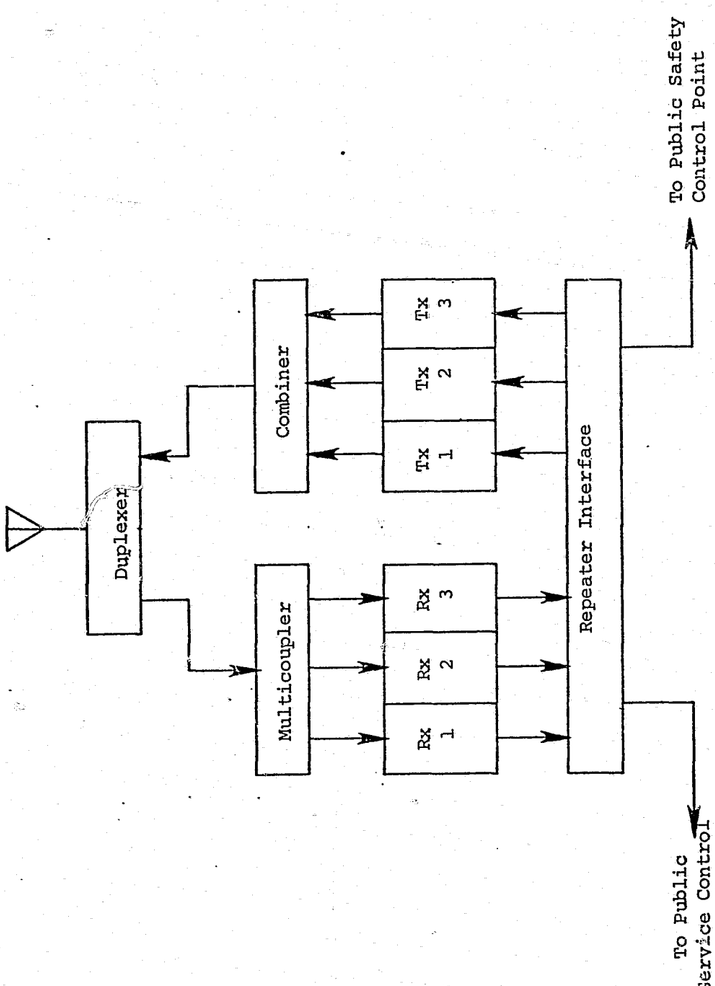


FIGURE II-7
Intermediate Repeater Site



5. MOBILE/CONTROL STATIONS

Radio access to DATCS is accomplished by mobile stations and control stations. Direct wireline control to the site controller is not contemplated; the mode of operation is similar to a conventional repeater type radio system.

1) Mobile Stations

The configuration of all mobile stations is shown symbolically in Figure II-1. The frequency selection for transmission and reception is determined by frequency synthesis contrainted to the licensed channels by a programming plug or PROM. Switching logic decodes the information provided by the control channel; activating the channel change switching and displays if the address assigned to the unit is recognized. The mobile unit has a half-duplex* configuration, using a T/R switch instead of a duplexer.

Mobile displays include the following:

- Handshake indication indicating a request for channel has been received by the system
- Indication that the request has been accepted and a channel has been made available
- Indication that the request has been placed in queue
- Indication that the mobile unit has gone beyond the control channel range.

The mobile radio has no external control over its programmed address code and has no capability to add additional codes.

(2) Control Stations

Control stations are the means by which control points and dispatch points access DATCS. There is no wire or microwave control links to the base station site controllers. The configuration of control stations is shown symbolically in Figure II-1; it is identical to the configuration of a mobile station.

The displays at the control station differ from those of the Mobile station. The control station displays include the mobile station displays in addition to:

- Code identity of the mobile unit in communication with the control station

- Code identity of units in the "calls waiting" queue for that control station
- Identity of any mobile in the "calls waiting" queue who has exercised an emergency priority
- Status data display of units assigned to the control station who have a status encoder.

The control station may have the capacity to change its group address or to recieve traffic from more than one group. This can be achieved by switching program plugs or PROMs. By exercising this option a control station can change dispatch responsibilities to accomodate after-hour coverage.

6. CONTROL POINTS

The configuration for DATCS results in two types of control points; the master system control at DATCS control operation center and the control point at each agency.

1) Master Control

The master control is located at DATCS control operation center. This is shown in Figures II-1, II-5, and II-6. The function of the master control is to monitor system operation as reported by the equipment status and alarm data provided by site controllers and to respond to alarm status with corrective action.

By means of the master control terminal, the programming of the master controller and site controllers can be modified to achieve required changes to system operation. A journal recorder and printer delivers hard copy of system spot status and changes initiated by master control.

The alarm board will alert the master control to faulty operation of any major unit at any of the three base station sites. Faulty operation of the master controller and the voting selectors on each voice channel is also shown on the alarm board.

This position is reviewed as being manned 24 hours a day.

2) Agency Control Points

Agency control points are identified as control stations and, in some cases, control terminals on a drop line circuit to the master controller. Some agencies may have a multiple of control points co-located in a dispatch center. Other public service agencies may have a separate control station at several locations reflecting the multiple control point configuration of their command and control operation.

The agency control terminals are restricted to those agencies that have need to change fleet assignments frequently and have the technical skills to operate computer terminals. Each terminal is restricted by security code to the activities of the agency in which it is installed.

7. CONTROL STATION/MOBILE STATION OPERATION

The half-duplex configuration of control stations and mobile stations is symbolized in Figure II-1. The main difference is the degree of control each can exercise and differences in the output displays. Each responds to control channel commands and each accesses the control channel(s) in the same way. Both have frequency synthesizers which span the entire 800 MHz trunked radio spectrum and are constrained to the licensed channels by a replaceable code plug or PROM. The code plug or PROM will also determine the unit address and the group address.

1) Control Stations

The control station is the means by which the dispatch center or control point accesses DATCS for communication with its mobile fleet and possibly other control stations. There is no need for wireline control links or microwave control links to the base station sites.

The control station idles on the system control channel and when initiating a call will be switched to an unoccupied voice channel together with all mobile units or control stations having the same group address. A mobile unit or control station in the same group initiating a call will cause the control station to switch to the same unoccuppied voice channel assigned by the site controller.

The displays of a control station will include:

- Handshake indicating a request for channel has been received by the system
- Indication that a requested channel has been assigned

- Indication that a channel request has been placed in the waiting queue
- Code identity of the mobile unit in communication with the control station
- Indication of units in the "calls waiting" queue
- Indication if any unit in the "calls waiting" queue has exercised an emergency priority request at any level priority.

If the control station is part of a dispatch center for public safety operations the following displays should be added:

- Status display for those mobile units provided with a status encoder
- Code identity of the units in a "call waiting" queue
- Code identity of a unit exercising an emergency priority request who is either in the "call waiting" queue or in communication with the control station.

The control stations will have more control head flexibility than mobile stations. This feature includes manual switching of code plugs (or PROMs) to effect changes in fleet configuration or for interagency coordination. The public safety control stations will also have an emergency priority capability.

2) Mobile Stations

Mobile stations are similar in configuration and function to control stations. Displays are limited to the following:

- Handshake indicating a request for channel has been received by the system
- Indication that a requested channel has been assigned
- Indication that a channel request has been placed in the waiting queue
- Indication that the mobile is beyond the range of a system base station.

Mobile controls and switching capability are limited. The mobile will not be able to change its address codes and thereby change its group assignment. Mobiles can be provided with an emergency priority switch. Those agencies with a central dispatch status display decoder can add a unit status reporting encoder to their mobiles to drive a status display at the dispatch center. The mobiles can have multiple PROMs switchable from the central control point.

8. BASE STATION OPERATION

Base station operation is similar to conventional radio repeater type operation except for the site controller functions. There is a conventional repeater installation for each DATCS voice channel at each base station site. There is a conventional repeater installation for the control channel at Lake Mountain and Mt. Vision. A digital site controller manages the DATCS functions at each site. The basic functions of the site controller at each site are:

- Recover and decode inbound control channel requests
- Select and assign unoccupied voice channels as requested
- Generate and encode outbound control channel signals directing system users to assigned channels
- Monitor voice channel activity
- Generate subaudible or digital code information on voice channels to unmute authorized receivers
- Control base station repeaters
- Identify all base station repeaters in accordance with FCC regualtions for transmitting station identification
- Monitor and report to alarm panels all base station abnormal conditions
- Provide system management interface for the master controller and master control terminal.

The remote master controller and master control terminal will have a wide range capability to modify the applications program in the site controller.

9. MOBILE-TO-MOBILE OPERATION

Mobile-to-mobile communication is inherent in a repeater type operation. Within the group address all mobiles will hear, and be in communication with, all other mobiles in the same address group. Intergroup mobile-to-mobile communication can be initiated by the dispatcher or master control terminal using the individual unit address. These one-time intermobile links can be set up by keyboard entry or by cross-channel patching.

10. PORTABLE RADIO INTERFACE

Estimates by industry sources place the very earliest availability of a technically acceptable frequency synthesized trunked portable radios in the 1983-85 time frame. Until such portable radios are available, trunked radio system equipment configurations will include only base stations, control stations and mobile stations.

Public safety radio systems are portable radio intensive. The significant investment in this mix of VHF high band (and/or UHF) portable radio equipment must be protected. These existing equipments must be permitted to operate with the trunked radio system without modification.

The public safety VHF portable operation is to continue using the portable radios on conventional VHF radio channels and manually cross patching these channels into the trunked system at the dispatcher's console when crossband coordination is required. The recommended solution for the Salt Lake County/Utah County area is to keep the conventional VHF frequencies for portable radio operation and trunked system will be used for the mobile radios and their control stations.

11. INTERAGENCY COMMUNICATION

Interagency communication in the DATCS concept can be accomplished by the following key methods:

- Radio channel cross patching or phone patching at the dispatch consoles
- The pattern of interagency coordination connectivity can be programmed into the controllers and activated by terminals installed at key dispatch centers of agencies where flexibility in fleet programming is required (see Figure II-1)
- Routine and frequently activated cross-agency communication routes can be programmed into the control station code plug (or PROM) and these code plugs (or PROMs) manually switched at control stations.

Any of these, or a combination of them, can be configured into the vendor's proposal as best suited to his hardware and software offerings.

12. PHANTOM GROUPS

Temporary one-time needs for multi-agency response or intra group limited response can be satisfied by creating a software "phantom group" to which individual vehicles can be assigned by their unit address code. This assignment will not alter the fixed unit address code or group address code of the involved mobile. Cancellation of the "Phantom group" will return all mobile units automatically to their original group.

13. DEGRADED OPERATION

The DATCS system redundancy offered by the three base station site configuration makes it unlikely that the Salt Lake County/Utah County DATCS will revert to a conventional radio channel operation due to contoller failure. Some key failure modes have been discussed Appendix B. In general the results of key catastrophic system element failures indicate some coverage loss if Lake Mountain or Mt. Vision are shut down and some loss of talk-back capability in the canyons if Snowbird (Hidden Peak) is shut down. Only an extreme catastrophic failure of both Lake Mountain and Mt. Vision simultaneously will prevent the system from operating at some level of efficiency in a trunked mode. In this case, automatic conversion to a planned conventional mode operation will be programmed.

14. INTERSYSTEM CONSIDERATIONS

The two types of intersystem operations to be considered are operations with other conventional radio systems and operations with other trunked radio systems.

1) Conventional Radio Systems

Conventional radio system operations within the Salt Lake County/Utah County area can be interface with DATCS at the control consoles. Automatic crossband repeaters will not be used for interconnection.

Conventional radio system operations from outside the Salt Lake County/Utah County area will not be able to interface with DATCS unless they are both terminated at the same dispatch center in the Salt Lake County/ County area. Mutual aid police and fire channels could be included in this category but it is unlikely that mobile units from outside Salt Lake County/Utah County area would require interconnection with Salt Lake County/Utah County DATCS.

2) Trunked Radio Systems in Utah

There is no immediate requirement placed on the Salt Lake County/Utah County area DATCS for interconnectibility with any other DATCS system outside the area. At this time the hardware and software offerings of the key vendors of trunked radio systems are incompatible with each other. The signaling and control methodology and protocols are incomprehensible between the competitor's equipment. To expand the Salt Lake County/Utah County DATCS to a statewide system will require the State of Utah to standardize the DATCS frequency plan (particularly the control channel frequencies), address coding, site controller functions, signaling, and control methods or protocols. This standardization is implied in this reports. The mobile radio configuration of the Salt Lake County/Utah County DATCS would then be compatible with every other DATCS implemented in Utah as long as these standards were imposed.

Assuming the standardization of signaling and control protocols in Utah, a DATCS mobile leaving the service area of a Utah DATCS will lose the control channel signal. It will automatically search for another control channel and, failing to find one, will automatically search for a "fail soft" signal. A "fail soft" signal converts the DATCS mobile to conventional mode 800MHz operation on the channel the "fail soft" signal is found. This "Fail soft" signal can be assigned to an intermediate site repeater which serves the agency to which the mobile is also assigned (separate repeaters and frequencies for Utah Highway Patrol, Utah DOT, etc.). By locating the intermediate sites at terminal points of the existing 2GHz backbone microwave system, the repeaters at the intermediate sites can be controlled by control centers for each agency thereby providing commend and control capability in addition to agency mobile-to-mobile communications within the area of the intermediate site.

When the mobile is again within the range of a Utah DATCS, the priority search capability of the Utah DATCS mobile will find a control signal and switch the mobile from conventional mode to the Utah trunked system configuration. All features of the Utah DATCS are then restored to the mobile unit.

Centralized control of a multi-cell DATCS configuration can be achieved by remote control of a Control Station in each DATCS cell. This can be accomplished through the 2GHz backbone microwave system; control from Salt Lake City can be exercised by participating state agencies if desired.

3) Trunked Radio System in Adjacent States

Outside of Utah the probability of Utah DATCS mobiles being able to communicate with any other DATCS is remote due to the lack of Federal standards and industry standards. Similarly trunked mobile equipment from outside Utah would be unable to operate in the Utah DATCS unless its frequencies and control channel protocols where compatible.

15. FACILITIES

Unique facilities at the base station sites and at the DATCS control operations center will be a consideration. Specialized maintenance facilities will also be required.

1) Base Station Sites in Salt Lake County/Utah County

It is intended to use existing equipment shelters and power systems at Lake Mountain, Mt. Vision, and Snowbird (Hidden Peak). It is assumed that tower space and intermodulation studies will require the erection of a separate antenna support structure at each of the three locations.

2) DATCS Control Operations Center

Space must be provided for the DATCS control operations center. This will require a computer environment for housing the master controller and the peripheral alarm board, journal recorder, printer, and master control terminal. The voter selector installation and the control channel audio integration equipment are also a part of the center but need not be colocated with the computer controller. The area must include personnel space for manning the center 24 hours a day and ahould also provide office space for the system manager.

3) Maintenance Facilities

Special maintenance facilities for the DATCS should be included. A full time maintenance program is anticipated to keep all of the DATCS system elements functioning at a level of quality needed to minimize performance differences between the multiple channels. This facility must store special parts/modules and will feature special tools and test equipment.

16. PERSONNEL

Personnel considerations include management personnel, system personnel, operating personnel, and maintenance personnel. Personnel staffing will be critical to the success or failure of the DATCS concept.

1) Management

It is suggested that DATCS be managed by an organization separate from but supported by the user organizations. The high technology requirements of DATCS calls for specialized telecommunications management; resources that can not usually be spared from the user organizations. A user group should be formed to set policy and review operations but day-to-day management should be vested in a dedicated manager. The existing pool of communications managers in the area should provide the resources for selecting the DATCS manager.

2) System Maintenance Personnel

Software maintenance and hardware maintenance will be a full-time occupation to keep the quality of this high technology system to an expected standard. Thorough understanding of the system operation, operation software, and applications software will be required suggesting the need for a data system analyst who can maintain the software and provide needed modifications.

Hardware maintenance will require special skills to obtain and retain 800 MHz integrity. Maintenance personnel skilled in computer operations, terminals and displays will also be required. It is assumed that developing these skills in Utah personnel will be part of the vendor obligations for training.

3) Operating Personnel

The DATCS control operation center is conceived as a 24 hour a day operation. One terminal operator/controller per shift would appear to be adequate. This could be a shared responsibility after DATCS has become operational and debugged. This would require approximately 5 specially trained persons with unique operations training; one would be the Supervisor.

Support service such as purchasing, financial control, audits, benefits administration, facility maintenance, and the like are assumed to be provided by the participating city, county or state agencies.

17. ENGINEERING COST ESTIMATE

This section presents engineering cost estimates associated with implementing a digitally addressed trunked communication system (DATCS) in Salt Lake County and Utah County. Costs are presented in two parts:

- Non-recurring costs - one-time capital investment costs
- Recurring costs - ongoing costs associated with owning, operating and maintaining the DATCS in the Salt Lake County area.

This cost estimate also presents the probable cost of the components of a statewide expansion of the Salt Lake County/Utah County DATCS.

These cost estimates present the best information available at this time. Much of the hardware and software has not been produced in the form and function required by the system concept. Therefore, a number of assumptions were required based on engineering experience, discussions with the vendor community, and representative cost experience of the commercial trunked system users.

These costs estimates will also need to be adjusted as new information becomes available. No attempt has been made to accommodate price escalation due to inflationary pressures or to extend the value of these funds into some future date when the implementation of DATCS is more probable. The degree of determination on the part of the vendors to pursue the market and the competitive posture of the market at the time of implementation will be the final arbiter of these estimated costs.

(1) Non-Recurring Costs - Salt Lake County/Utah County

Non-recurring costs are the one-time, initial acquisition costs and the costs of start-up. These costs do not include the first year maintenance costs although, at the option of the purchaser, these costs may be included in the initial purchase contract.

The following summation includes the initial one-time cost for fixed installations and mobile installations for Salt Lake County/Utah County DATCS. The break-down of these costs is shown in the subparagraphs to follow:

• Fixed Installations	
Mount Vision	$ 257,000
Lake Mountain	257,000
Snowbird (Hidden Peak)	247,400
Control Operations	253,400
Maintenance Equipment	33,100
Control Stations	162,000
Fixed Station Subtotal	$1,209,900
• Mobile Installations	$2,488,600
• Engineering Services	40,000
Total Estimated Non-recurring Costs	$3,738,500

(2) Mount Vision Estimated Costs

Repeaters $9,500	qty. 14	$ 133,000
Multicouplers/Combiners $10,600	qty. 3	31,800
Duplexers $600	qty. 3	1,800
Antennas/Transmission Lines $800	qty. 3	2,400
Site Controller $45,00	qty. 1	45,000
Modems $400	qty. 2	800
Tower 50' X $110 ft.	qty. 1	5,500
Microwave Interface Modules $200	qty. 32	6,400
2 GHz Microwave Terminals $18,000	qty. 1	18,000
Installation (5%)	qty. 1	12,300
		$ 257,000

(3) Lake Mountain Estimated Costs

Repeaters $9,500	qty. 14	$ 133,000
Multicouplers/Combiners $10,600	qty. 3	31,800
Duplexers $600	qty. 3	1,800
Antennas/Transmission Lines $800	qty. 3	2,400
Site Controller $45,000	qty. 1	45,000
Modems $400	qty. 2	800
Tower 50' X $110 ft.	qty. 1	5,500
Microwave Interface Modules $200	qty. 32	6,400
2 GHz Microwave Terminal $18,000	qty. 1	18,000
Installation (5%)	qty. 1	12,300
		$ 257,000

(4) Snowbird (Hidden Peak) Estimated Costs

Repeaters $9,500	qty. 13	$ 123,500
Receiver $600	qty. 1	600
Multicouplers/Combiners $10,600	qty. 3	31,800
Duplexers $600	qty. 3	1,800
Antennas/Transmission Lines $800	qty. 3	2,400
Site Controller $45,000	qty. 1	45,000
Modems $400	qty. 2	800
Tower 50' X $110 ft.	qty. 1	5,500
Microwave Interface Modules $200	qty. 31	6,200
2 GHz Microwave Terminal $18,000	qty. 1	18,000
Installation (5%)	qty. 1	11,800
		$ 247,400

(5) Control Operations Estimated Costs

Master Controller $40,000	qty. 1	$ 40,000
Alarm Board $12,000	qty. 1	12,000
Voter Selectors $2,200	qty. 13	28,600
Journal Tape Transport $17,000	qty. 1	17,000
Master Terminal $3,500	qty. 1	3,500
Agency Terminals $2,700	qty. 10	27,000
Printer $4,500	qty. 1	4,500
Audio Control Assembly $1,500	qty. 1	1,500
Microwave Interface Modules $200	qty. 95	19,000
Modems $400	qty. 7	2,800
2 GHz Microwave Terminals $18,000	qty. 3	54,000
Telco Installation $125/line	qty. 20	2,500
Applications Software	qty. 1	30,000
Installation (5%)		11,000
		$ 253,400

(6) Maintenance Special Tools/Test Equipment Estimated Costs

Digital Test Sets $1,450	qty. 2	$ 2,900
Special Logic Probes $150	qty. 4	600
Spectrum Analyzer $6,000	qty. 2	12,000
800 MHz Signal Generator $1,500	qty. 2	3,000
Portable Digital Analyzer $1,500	qty. 4	6,000
Transmission Test Set $4,300	qty. 2	8,600
		$ 33,100

(7) Control Stations Estimated Cost - ($4,500 Installed)

Salt Lake County Sheriff	qty. 4	$ 18,000
Utah County Central Dispatch	qty. 6	27,000
Pleasant Grove Police	qty. 1	4,500
Utah Highway Patrol	qty. 4	18,000
Salt Lake City Fire Department	qty. 2	9,000
Salt Lake County Fire Department	qty. 2	9,000
Salt Lake City/County Health Department	qty. 1	4,500
Salt Lake County Public Works	qty. 4	18,000
Salt Lake County Surveyor	qty. 1	4,500
Salt Lake County Building Inspector	qty. 2	9,000
Salt Lake County Security	qty. 2	9,000
Salt Lake County Aging Transportation	qty. 1	4,500
Utah Department of Transportation	qty. 1	4,500
Salt Lake County Fleet Management	qty. 2	9,000
Brigham Young University Police	qty. 1	4,500
Utah University Police	qty. 1	4,500
Salt Lake County Attorney	qty. 1	4,500
	36	$ 162,000

(8) Mobile Station Estimated Cost ($2,300 Installed)*

Salt Lake County Sheriff	qty. 250	$ 575,000
Utah County Central Dispatch	qty. 73	167,900
Pleasant Grove Police	qty. 19	43,700
Utah Highway Patrol	qty. 125	287,500
Salt Lake City Fire Department	qty. 75	172,500
Salt Lake County Fire Department	qty. 75	172,500
Salt Lake City/County Health Department	qty. 21	48,300
Salt Lake County Public Works	qty. 140	322,000
Salt Lake County Surveyor	qty. 25	57,500
Salt Lake County Building Inspector	qty. 20	46,000
Salt Lake County Security	qty. 1	2,300
Utah Department of Transportation	qty. 200	460,000
Salt Lake County Fleet Management	qty. 16	36,800
Brigham Young University Police	qty. 13	29,900
Utah University Police	qty. 23	52,900
Salt Lake County Attorney	qty. 6	13,800
	1082	$2,488,600

(2) Recurring Costs-Salt Lake County/Utah County

The recurring cost estimate does not include the cost of operating the existing communication system by each of the participating agencies. The DATCS concept has not changed the existing operating procedures or control locations for any participating agency and the assumption is made that no change will be required in their operating staff or facilities other than the installation of new DATCS equipment.

The recurring cost estimates include staffing and facilities needed to centralize the control and maintenance of unique DATCS equipment. There is no existing DATCS configuration similar to the configuration and functions required of this proposed system. Therefore, there is no reliable cost experience to reference and assumptions are made based on past experience with other digitally controlled, computer operated telecommunications systems. These estimated costs are summarized below:

Maintenance Technicians $22,500*	qty. 4	$ 90,000*
Control Operator (24 hrs) $25,000*	qty. 4	100,000*
Administrator $31,250*	qty. 1	31,250*
Total Estimated Annual Labor		$221,250*
Maintenance Parts (Fixed/Mobile)		$110,000
Maintenance Training (2 men) (Updating and Replacement Personnel)		3,000
EDP Services (Management Reports) (260 hrs)		3,900
Replacement Equipment (Up-dating)		179,400
Utilities (Telephone/Power)		12,000
Total Estimated Annual Service Cost		$308,300
Total Annual Estimated Recurring Cost		
Annual Labor		$221,250*
Annual Service		308,300
		$529,550

* These estimated costs include full burden.

These estimated costs assume that Salt Lake County/Utah County, or an equivalent governmental agency, will take full responsibility for system maintenance following the expiration of any warrantee provisions. The estimated costs are assumed to be average costs and do not account for early life failures of equipments or components covered by warrantee.

(3) Estimated Non-Recurring Costs-Statewide Summation

The following smmation of estimated non-recurring costs assume that DATCS for Salt Lake County/Utah County will be implemented initially and that this system will than be expanded statewide by adding DATCS base stations with intermediate repeaters. The estimated non-recurring costs for all statewide subsystems are presented in the following summation; a later section of this appendix will provide cost breakdown details for each subsystem.

WASATCH FRONT (see Section A.1 Salt Lake County/Utah County)

Lake Mountain	$ 257,000
Mt. Vision	257,000
Hidden Peak	247,400
Control Operations	253,400
Maintenance Equipment	33,100
Control Stations	162,000
Engineering Services	40,000
Mobile Installations (1082)	2,488,600
Total Subsystem	$3,738,500

SOUTHWEST

Frisco Peak	$ 132,700
Beaver Mountain	132,700
Cedar City Control	136,550
Barney Top Repeater	50,600
Moccasin Peak Repeater	50,600
Levan Peak Repeater	50,600
Monroe Peak Repeater	50,600
Engineering Services	30,000
Total Subsystem	$ 634,350

NORTHEAST

Asphalt Ridge	$ 132,700
Vernal Control	136,550
Tabby Mountain Repeater	50,600
Ford Ridge Repeater	50,600
Dutch John Repeater	50,600
Engineering Services	30,000
Total Subsystem	$ 451,050

SOUTHEAST

Bald Mesa	$ 132,700	
Adajo Peak	132,700	
Moab Control	136,550	
Cedar Mountain Repeater	50,600	
Engineering Services	30,000	
Total Subsystem	$	482,550

NORTHWEST

Little Mountain	$ 247,400	
Salt Lake City Control Expansion	30,400	
Red Spur Repeater	50,600	
Delle Repeater	50,600	
Engineering Services	25,000	
Total Subsystem	$ 404,000	
TOTAL ESTIMATED STATEWIDE DATCS COST	$5,779,450	

It is again noted that additional mobile stations have not been included in this statewide estimates.

(4) Statewide Non-Recurring Cost Detail

The implementation of DATCS statewide is assumed to follow the base station/intermediate repeater configuration described in the system concept The following estimated costs are based on that configuration and the DATCS frequency plan. The number of mobile stations which may be licensed in areas other than the Salt Lake County/Utah County is unknown, therefore, these cost estimates will include only the fixed base and fixed control station equipment.

Frisco Peak Estimated Costs

Repeaters $9,500	qty. 5	$47,500
Multicoupler/Combiner $10,600	qty. 1	10,600
Duplexer $600	qty. 1	600
Antenna/Transmission Line $800	qty. 1	800
Site Controller $40,000	qty. 1	40,000
Modems $400	qty. 2	800
Microwave Interface Module $200	qty. 12	2,400
2 GHz Microwave Terminal $18,000	qty. 1	18,000
Tower 50' X $110 ft.	qty. 1	5,500
Installation (5%)	qty. 1	6,500

Cedar City Control Estimated Costs

Master Controller $25,000	qty. 1	$ 25,000
Alarm Board $10,000	qty. 1	10,000
Voter Selectors $2,200	qty. 4	8,800
Journal Tape Transport $11,000	qty. 1	11,000
Master Terminal $3,500	qty. 1	3,500
Printer $4,500	qty. 1	4,500
Audio Control Assembly $1,200	qty. 1	1,200
Microwave Interface Modules $200	qty. 24	4,800
Modems $400	qty. 4	1,600
2 GHz Microwave Terminals $18,100	qty. 2	36,000
Telco Installation $125/Line	qty. 10	1,250
Applications Software (Transfer)	qty. 1	10,000
Control Stations $4,500	qty. 3	13,500
Installation (5%)	qty. 1	5,400
		$136,550

Asphalt Ridge Estimated Costs

(See Frisco Peak) $132,700

Vernal Control Estimated Costs

(See Cedar City Control) $136,550

Bald Mesa Estimated Costs

(See Frisco Peak) $132,700

Adajo Peak Estimated Costs

(See Frisco Peak) $132,700

Moab Control Estimated Costs

(See Cedar City Control) $136,550

Little Mountain Estimated Costs

(See Snowbird-Hidden Peak)		$247,400
Additional Control Operations Costs		
Voter Selector Modules $400	qty. 13	5,200
Microwave Interface Modules $200	qty. 32	6,400
Modems $400	qty. 2	800
2 GHz Microwave Terminals $18,000	qty. 1	18,000
Total Estimated Cost to Add Little Mountain		$277,800

Tabby Mountain Repeater Estimated Costs

Repeater $9,300	qty. 3	$ 27,900
Multicoupler/Combiner $10,600	qty. 1	10,600
Duplexer $600	qty. 1	600
Antenna/Transmission Line $800	qty. 1	800
Repeater Interface $500	qty. 3	1,500
Tower 50' X $110 ft.	qty. 1	5,500
Microwave Interface $200	qty. 6	1,200
Installation (5%)	qty. 1	2,500
		$ 50,600

Barney Top Repeater Estimated Costs

(See Tabby Mountain Repeater) $ 50,600

Moccasin Peak Repeater Estimated Costs

(See Tabby Mountain Repeater) $ 50,600

Monroe Peak Repeater Estimated Costs

(See Tabby Mountain Repeater) $ 50,600

III. REQUIRED IMPLEMENTATION ACTIVITIES

The implementation of the system concept will proceed only after thorough review by the potential user agencies, their department heads, and the Public Safety Director of each participating municipality. After this has been achieved and the implementation plan has been officially sanctioned, another critical milestone must be met before procurement activities can be initiated.

Federal Communications Commission (FCC) licensing requirements for large scale 800 MHz trunked radio systems in local government service have not been clearly defined or tested at this time. Following local government approval the initial implementation activity must be directed toward satisfying all of the elements needed to secure reasonable assurance from the FCC that the trunked radio system, as planned and approved, can be licensed.

1. LOCAL GOVERNMENT APPROVALS

Local government approvals will be achieved in three steps, securing of user agency agreements, development of funding agreements to implement and operate the system, and the legally binding commitment of the municipalities to participate in and support the system.

(1) Agency Agreements

Signed agreements by each agency planning to participate in the trunked radio system must be acquired. These agreements will conform with FCC requirements (Section 90.359 and 90.179). As a minimum they will include:

- Agreements regarding the supervision and control of the trunked system operation
- Method of cost-sharing and pro-rating of costs among all cooperating parties
- Responsibility for maintaining system operation records and filing reports with the FCC (Section 90.391).

In addition to the items needed for FCC licensing, the agency agreements will also include provisions for:

- Management authority over the system staff and equipment
- Centralized maintenance of system components

- Property, equipment and facilities provided by the user agencies and municipalities

- Modification and/or termination of the agreement as subject to FCC Rules and Regulations (Section 90.391).

Agency agreements will be the key element in securing the funding agreements and municipal government approvals.

(2) Funding Agreements

The acquisition of agency agreements will provide dimensions for revised cost estimates needed to establish funding requirements. These requirements will include estimates of non-recurring implementation costs and recurring operations costs. The following elements of costs will be identified:

- Implementation Costs
  - Planning Activities
  - Professional Services
  - Hardware/Software
  - Facilities
  - Installation/Test/Acceptance
  - Personnel Staffing and Training
- Operating Costs
  - Personnel Salary and Overhead
  - Supplies
  - Maintenance of Hardware/Software
  - Equipment Replacement
  - Continued Training

The distribution of these costs among the funding sources will be decided and firm commitments and/or agreements acquired. These funding sources will include:

- Federal and State grants funds
- Local municipal funds
- In-kind services, equipment, or facilities

- User agency cost sharing assessments
- Grants from private foundations
- Gifts from private sources.

The funding agencies must approve and be committed to the funding plan before final and binding commitments will be south from the State of Utah, county governments, and municipalities.

(3) Municipal Government Approvals

Based on the agency agreements and funding agreements achieved, firm commitments will be required from State, County and municipal governments to assure continued project support and to respond to Federal and State grants requests. These approvals will be required in the form of resolutions or other legally binding documents.

2. PRELIMINARY LICENSING CONSIDERATIONS

The licensing of multiple base station wide-area trunked radio systems in state and local government service and public-safety service is not clearly defined by present FCC Rules and Regulations. Waivers to the present FCC Rules and Regulations may be required, particularly Section 90.375 which defines time limits for phased implementation. It is probable that waivers to Section 90.739 which limits power and antenna height wll also be needed.

Before hardware and software commitments are made, preliminary discussions will be held with the FCC. An expression of assurance will be sought indicating that the trunked system, as planned and approved by the user agencies and governmental authorities, will receive favorable licensing consideration from the FCC when formal applications for licenses are submitted.

3. IMPLEMENTATION SCHEDULE

The detailed implementation schedule will be developed following assurances from FCC that the trunked radio concept will be licensable under FCC Rules and Regulations and that any revisions to the concept required by FCC evaluation of the system design has met the approval of the user agencies and the participating municipal governments. The implementation schedule will consist of two key interrelated parts; a system implementation schedule and a corresponding financial schedule.

(1) System Implementation Schedule

The system implementation schedule will be a time-dependent schedule. The project will be defined in terms of separate tasks with clearly defined milestones indicating the completion of each task and definitive measureable milestones leading to the completion of each task or project element. Major tasks include:

- Project Planning and Reporting
- Engineering Services
- Preparation of Specifications
- Preparation and Approval of Statement of Work
- Solicitation of Bids
- Contract Award
- Facility Preparation
- System Licensing
- Equipment Delivery/Installation
- Test and Acceptance
- Personnel Training
- System Cut-over
- System Evaluation.

Each major task will be supported by task breakdown schedules which define the subtasks needed to achieve the completion of each major task.

(2) Financial Schedule

The financial schedule will be coordinated with the system implementation schedule. This schedule will be based upon the funding agreements and will include the following major elements:

- Milestones showing each major commitment of funds
- The date and amount funds will be made available to the project from all sources
- The schedule dates for the submission of financial reports.

The submission and distribution of financial reports will be elements of the financial agreements and governmental approvals.

4. SYSTEM MANAGEMENT AND OPERATION

The management and direction of the implementation program will be the responsibility of the Program Director. The Program Director will be supported by a full-time and part-time staff representing each key function of the implementation program. These functions include:

- System Engineering - this staff function will be assisted by consulting engineers and the engineering staff of the successful system contractor
- Procurement - This staff function will be assisted by the purchasing and procurement personnel of Salt Lake County
- Finance - this staff function will be a part-time service provided by Salt Lake County
- Facilities - this staff function related to the acquisition and preparation of special facilities for the equipment and personnel of the project will be provided part-time by the State of Utah and Salt Lake County
- Personnel - the project staff personnel are under the direct supervision of the Program Director; personnel activities such as job descriptions, salary determination, and benefits administration will be under the direction of Salt Lake County unless the person is on loan from another municipal jurisdiction.

In addition to the project staff reporting to the Program Director, two advisory groups will be responsible for overall project policy with the Project Director serving as chairperson for each advisory group. These groups consist of:

- User Representatives - this group is composed of appointed representatives of each user agency; they provide direct liason between the project organization and their respective agencies
- Government Representatives - this group is composed of appointed representatives of each municipality and state or county government sections which have an operational or financial interest in the program.

It is the intention that this management group be carried over in form and function to the operation of the trunked radio system after it has been installed, tested, and accepted. Additional personnel needed to operate the system from a central location will be added to the Facility function of the project staff. At that time the Facility function will become a full-time staff position under the Program Director.

5. PROCUREMENT

The procurement of the trunked system will proceed in two sequential activities; system engineering and purchasing.

(1) System Engineering

Technical assistance will be required to develop the engineering design of the trunked radio system based on the system concept. Key questions to be resolved before procurement specifications are prepared include:

- Radio Propagation Analysis - engineering analysis of 800 MHz radio propagation from candidate base station sites will be conducted to determine radio coverage of the Salt Lake County area and to establish antenna pattern characteristics. FCC Rules and Regulations (Section 90.379) clearly limit the effective radiated power and antenna elevation at each proposed site and engineering analysis will be required if waivers from these FCC Rules and Regulations are needed

- Switching Logic - the switching logic for the master controller, site controller, mobile stations, and control stations will be engineered to be compatible with expected vendor hardware offerings

- Software - the system software for the master controller and site controller will be engineered to enable efficient software management from a master terminal

Based upon the results of these technical activities, systems engineering will prepare detailed system specifications and equipment specifications for competitive procurement.

(2) Purchasing

The purchasing function will consist of three key activities; developing a Statement of Work (SOW), soliciting competitive bids, and awarding a system contract.

- Statement of Work (SOW) - the SOW is a precise description of the materials and services required of the contractor and the time domain in which delivery is to be made. The key elements of the SOW will be:

  - Background and Objectives of the project
  - Required qualifications of successful bidders
  - Services and Support to be provided
  - Quantities of each equipment to be provided
  - Schedule for all deliverable items - hardware, software, serivces, and support items

- Soliciting Competitive Bids - competitive bids from all qualified vendors will be solicited by means of a procurement package which will include:

  - State and County legal requirements
  - Statement of Work
  - System Specification
  - Equipment Specifications.

A one-step solicitation is anticipated in which each bidder will provide a technical proposal and a firm fixed price cost proposal for the complete installation of an operating digitally addressed trunked radio system

- Award the System Contract - the combined technical proposal and cost proposal most advantageous to Salt Lake County and associated municipalities will identify the successful bidder. A firm fixed price contract without cost escalation is anticipated.

6. LICENSING

The signed contract defining the equipment to be purchased and the quantity of that equipment will provide sufficient information to file application with the FCC for system licenses. Present FCC practice for licensing 800 MHz trunked system requires the following minimum submission:

- Form 400 for each license requested (Section 90.357)
- Agreements with each user agency relative to control of the system (Section 90.179)

- Agreements with each user agency relative to cost-sharing of installation and operation (Section 90.179)
- Financial plan showing the service will be provided to user agencies at cost (Section 90.359)
- System description and specification (Section 90.359, Section 90.371, Section 90.375, and Section 90.379)
- Eligibility statement for each user (Section 90.359)
- Evidence of purchase orders placed for the equipment.

It is probable that FCC waivers will have to be asked to extend the number of years for phased implementation of the system (Section 90.375) and for the limits on power and antenna height (Section 90.379).

Technical support for negotiating system licenses with the FCC will be requested of the engineering consultant and from the system contractor.

7. FACILITIES ACQUISTION AND PREPARATION

It is the responsibility of the Program Director to provide adequate facilities for the equipment and staff of the trunked radio system. Subject to revision by the engineering study, the following facilities will be required:

- Mt. Vision - equipment shelter for fifteen 800 MHz repeaters, a site controller, ancillary equipment for the antenna subsystem, antenna support structure for four antennas, and appropriate power/climatic control equipment
- Lake Mountain - equipment shelter similar to Mt. Vision
- Hidden Peak - equipment shelter similar to Mt. Vision
- Control Operations - equipment shelter for the master controller/terminal, alarm equipment, recorders, printers, microwave terminations and other items of equipment associated with the central control function. Staff facilities for a Program Director, Facilities Manager, Engineering, Software/Hardware Manager, and Programmer/Operators will also be required.

Centralized maintenance will also require special facilities which must be provided by the State of Utah or Salt Lake County.

It will be the responsibility of the Facilities Manager on the staff of the Program Director to obtain these above facilities and prepare them in a timely manner.

8. PERSONNEL AND TRAINING

Personnel for the management and operation of the trunked radio system will be identified and prepared for their assignments in coordination with equipment installation and test. It is intended that the Project Director and staff will continue in their positions after the trunked radio system has been installed and accepted. The additional people required to operate the system will be recruited and trained during the system installation test so that their services can be used as much needed test personnel and the experience gained by them can serve as on-the-job training before the system becomes operational. It is anticipated that the following additional personnel will be required:

- Maintenance Technicians — Quantity 4
- Control Operators — Quantity 4
- System Programmer/Analyst — Quantity 1
- Facilities Administrator — Quantity 1

Job descriptions for these positions will be developed by the Program Director and the personnel offices of Salt Lake County. Recruiting will be by public announcement of available job openings. It is anticipated that the positions will be filled by transfer of presently employed and skilled personnel of Salt Lake County and Salt Lake City.

The training and certification of all operating personnel, maintenance technicians, and management personnel will be a contractual obligation of the system contractor.

9. POST IMPLEMENTATION SUPPORT

The post implementation support program will address the funding and staffing needed for sustained operation of the trunked radio system.

(1) Post Implementation Funding

The recurring costs of continued operation include the following major items:

- Personnel - salary and benefits
- Maintenance - maintenance of the facilities and system hardware/software after the warranty and first-year maintenance contract
- Supplies - all expendable materials used in operating and managing the system

- Training - refresher training and replacement training

- Utilities - power, telephone, and other services provided by an outside agency

- Equipment Replacement - periodic replacement of worn or obsolete equipment; equipment that can no longer be repaired economically.

These costs will have been identified and submitted to the FCC as part of the licensing requirements. They will be reviewed periodically. These will be filled to the user agencies in accordance with a formula developed and reported in each agency agreement.

(2) Personnel Replacement and Training

The replacement of personnel and the up-dating of staff personnel will be a recurring problem. There will be labor turnover. Recruiting of personnel will be by suitable public announcement of job openings and the testing of applicants. Probationary employees will be trained by the technical staff.

(3) Support Staff

The system will have the full time services of equipment maintenance personnel and software system personnel. At least one senior system programmer/ analyst will be required. It is anticipated that a full time staff of four specially trained maintenance technicians will be required and four qualified control operators will also be required to provide 24 hour service to the user agencies.

APPENDIX A

SUGGESTED AGENCY AGREEMENTS

FORWORD

Legally binding agency agreements are needed to support FCC license applications for 800 MHz Multi-agency trunked systems and to define correctly the role each agency will plan in the administration and use of the cooperative system. This Appendix will offer suggestions as to the scope and content of each set of agreements. Furthur discussion will be found in the System Implementation Planning Guidelines, a National APCO publication prepared by Booz Allen and Hamilton, dated November 15, 1980.

APPENDIX A

SUGGESTED AGENCY AGREEMENTS

I. INTRODUCTION

The agreement by two or more local government public safety agencies to enter into a joint enterprise which provides a mutual service of value to the participants is best documented by written agreements between the parties. By their nature, these agreements are highly individual; tailored to specific requirements of each program in each locality. This appendix to the System Implementation Planning Guide (SIP) is intended to suggest only a general outline of such agreements. The details, and the order of presentation, will depend upon each kind of enterprise contemplated, its complexity, and the immediate cooperative environment. Legal counsel should be consulted.

1. Purposes of the Agreement

The purpose of a written agreement is to describe the reason for the cooperative effort and the results that are expected to be achieved through mutual participation. By reducing this to a clear and unambiguous written statement, the involved parties will fully understand their mutual participation. Equally important, the governing bodies, of which the participants are a part, will be able to determine the true nature of the program and the expected results; thereby provide their support.

2. Scope of the Agreement

The agreement should define the dimensions within which the terms of the agreement apply. The responsibilities and liabilities of each of the participants should be clearly documented. There should be no unwritten understandings between the parties.

The following model outline of an agreement form provides a series of topical considerations to be evaluated during the development of an interagency agreement. The precise form of a specific agreement, and the language to be used in each case, should be provided by legal counsel. In many cases, standard legal form and substance is required by state or Federal regulation.

II. SUGGESTED MODEL OUTLINE

The following topics and items are intended to delineate key considerations in the preparation of an interagency agreement.

1. General Terms and Legal Base

The general terms will include the following as a minimum:

- The dentification of each participating agency
- The requirements to be imposed on those agencies who may wish to participate at a later date
- The concise purpose of the joint enterprise and the mutually advantageous results that are expected to be achieved
- A statement of the legal authority under which the public agencies are able to contract with each other for the stated purpose; this may be a state law, a local government act, a series of resolutions passed by the local governmental authorities, or similar authorization.

2. Services to be Provided

The services provided by each agency and to each agency will be defined. These include the following considerations:

- Definition of the services to be provided by each agency to the mutual system; these services could include, for example, equipment maintenance, equipment, facilities, operating manpower, support services, and similar items of value to the system
- Definition of services the system will provide to each participating agency; such services could include the dispatching of field forces, management reports, statistical data, and similar items of value to the agency
- The definition of the quantity or extent of each service to be provided
- The responsibility each agency has for delivering its service and the responsibility the mutual operation has for delivering its services to each agency
- The extent of any back-up or redundancy to assure that services are delivered in a timely manner throughout the life of the agreement.

3. Liability

A key element of the agreement between two or more public agencies is a clear definition of the liability each of the agencies has for the actions of other parties to the agreement. This is particularly true if one or more of the agencies provides public services on behalf of the other agencies. Agreements to limit the liability exposure of participating agencies would include the following considerations.

- Responsibility for defending the provider agency in potential lawsuits
- Indemnification of the providing agency against liability judgements against a participating agency
- Indemnification of the participating agency against legal actions or liability judgements against the provider agency arising from the normal provision of agreed-to services.

4. Amount and Manner of Payment

The providing agency must be reimbursed for the expenses of the service it provides to the participating agencies. A portion of this obligation will fall to the individual participating agencies. The agreement between the agencies must be specific regarding this individual responsibility and will be definitive of the following considerations:

- The specific services to be provided and the cost of each service
- The method by which the cost and value of each service is calculated
- The means of payment; for example, cash, in-kind services, cash equivalent in material or equipment, and any other valuable consideration agreeable to the parties to the agreement
- Time and manner payments are to be made.
- Use of outside funding sources such as grants or gifts.

5. Fiscal Procedures

Sound fiscal planning is key to the successful implementation of public agency cooperative programs. The responsibility of the provider agency for financial integrity must be defined in the agency agreements. The agreement will specify the following elements:

- The type of financial records and how they are maintained
- The contents of the periodic financial reports and the schedule for submitting these reports to higher authority and to participating agencies
- Access to the financial records by each participating agency
- Certification and/or audit of the records and financial reports
- Terms and conditions relative to the periodic reassessment of rates charged for each service provided.

6. Administration

The administrative structure of the cooperative program should be defined in the agency agreements. The authority and responsibility of each agency for participation in policy administration and the authority and responsibility for day-to-day operation should be included. Some of the key elements in the agreement are:

- The identification of the person(s) authorized to sign the agreement on behalf of each party to the agreement
- The identity of the person(s) who will represent the participating agency and providing agency in policy matters
- The responsibility and authority of the providing agency to supervise project personnel and establish personnel policy
- The responsibility and authority of the providing agency over joint-use facilities and equipment
- The retention by participating agencies of control, responsibility, and authority over their personnel, facilities and equipment that may be used in the cooperative project

- Identity and authority of persons responsible for the review of the agreements and for the determination of compliance

These and other administrative elements suitable to the unique environment and nature of the proposed project should be negotiated between the parties and made part of the written agreement to participate.

7. Real Property and Equipment

The cost-effective implementation of a multi-agency cooperative program should make maximum use of facilities, property and equipment available from the participating agencies. The agreement should identify these properties and materials; it should establish the rules under which the properties and materials are to be used. Some key considerations are:

- Identify each item of property and equipment that is to be transferred to the use of the cooperative system
  - Establish the value of the property and/or equipment and show the method used to establish the value
  - Provide for the return of the property and equipment during the term of the agreement and upon termination or cancellation of the agreement
  - Define the method to be used to establish the value of property and material to be returned to the original supplier upon the termination, modification, or cancellation of the agreement.

8. Duration, Termination, and Amendments

The agency agreement must provide for modification to the agreement during its term. It must also define the duration of the agreement, make provisions for cancellation of the agreement, and disclose how the agreement is to be terminated. The following items should be included:

- The term of the agreement.
- The circumstances under which the agreement can be terminated during its intended duration
- The terms under which the agency can withdraw from the agreement
- The circumstances under which either party can cancel the agreement

. Procedures for amending the agreement during its intended term

. Disposition of property and equipment upon termination or cancellation

9. Other Provisions

The agency agreement is a custom document generated to reflect the unique needs of the specific circumstance and the environment in which the mutual agreement is being generated. Each agreement will include terms and conditions of an individual nature. Key among these are the following suggestions:

. Method of resolving disputes; for example, arbitration, application of appropriate state or Federal law, etc.

. Identity of the court of jurisdiction for adjudicating disputes

. Definition of terms used in the agreement

. Statutory status and filing of the agreement

. Interrelationship of agreements.

* * * * *

The drawing of interlocal contracts and agreements to provide public services or hold public property for the mutual advantage of multiple governmental organizations may be subject to local, state, or Federal regulations and/or laws. These documents should be drawn up under the advice of legal counsel to insure their status as legal instruments.

APPENDIX B

SYSTEM REQUIREMENTS

FOREWORD

These system requirements for a digitally addressed trunked communication system (DATCS) for Salt Lake County, Utah evolved from the report "Analysis of Problesm and Requirements" prepared by Booz, Allen and Hamilton, June 18, 1980. This summation of DATCS system requirements is also included in the Project 16B Task 7 report "DATCS Design Concept-Salt Lake County/Utah County" prepared by Booz, Allen and Hamilton on September 19, 1980.

APPENDIX B

SYTEM REQUIREMENTS

The system requirements have been developed from a review of the Task 6 report "Analysis of Problems and Requirements" (June 18, 1980). The summation of this review was the subject of a meeting in Salt Lake City on July 22, 1980 and is reflected in the following subsections.

1. WIDE AREA COVERAGE

Radio coverage experience at UHF and the results of limited testing at 800 MHz in the Salt Lake County/Utah County area precludes any reasonable expectation that a single 800 MHz base station site will provide adequate coverage. Engineering studies of radio propagation and antenna pattern characteristics at 800 MHx must be conducted before the location of the base stations and other fixed sites can be established. The following suggestions are based on previously reported 800 MHz coverage tests and from known coverage patterns at VHF frequencies.

1) Salt Lake County

The Traverse Mountains south of Salt Lake City tend to partially separate Salt Lake County and Salt Lake City from Utah County and Provo/Orem areas. It is likely that north/south shadow effects will require a base station in Salt Lake County.

Preliminary indications are that Mt. Vision will provide the required coverage north of the Traverse Mountain ridge.

2) Utah County

Lake Mountain is the primary choice of a base station site to cover Utah County and the population concentration of Provo and Orem.

3) Canyons East of Salt Lake/Utah Counties

The east canyons of Salt Lake County and Utah County suggest a talk-back base station at Snowbird (Hidden Peak).

2. STATEWIDE DATCS CONSIDERATIONS

Wide area coverage is defined in the agreement of January 10, 1980, does not extend beyond Salt Lake County and Utah County. However, it is recognized that a statewide DATCS is desired and the Salt Lake County/Utah County system described in this system concept is the initial implementation of a statewide system. The following addresses statewide configurations with the understanding that it is advisory information only and no engineering support data was possible under the existing agreement.

1) Suggested Configuration

The configuration suggested is a four cell DATCS system will the major cell in the Wasatch Front from Ogden south through Salt Lake City to Provo. A second cell in the soutwest includes Cedar City/St. George area. A third cell in the northeast covers Vernal and the fourth cell in the southeast includes the Moab/Monticello area. These four DATCS cells are independent of each other and their Coverage areas do not overlap.

2) System Engineering

The system of DATCS cells must be engineered to preserve the trunked radio insolation between cells. Antenna elevations, antenna patterns, and limitation of effective radiated power from each site must control this isolation. This engineering effort will be part of a later DATCS implementation program.

3) Base Station Sites

The following candidate base station sites in areas other than Wasatch Front are suggested based on reported radio coverage experience from existing VHF radio installations. The sites which are also terminal points for the existing 2GHz statewide microwave system are preferred:

- Ogden Area - much of the Ogden area should be accessable to the DATCS base station at Mt. Vision but talk-back support (voted with Mt. Vision) might be needed from Little Mountain
- Brigham/Logan Area - a DATCS base station at Mt. Logan would appear to offer adequate coverage and also protect the north Ogden area
- St. George/Cedar City - A DATCS base station at Frisco Peak voted with a talk-back support station at Utah Hill would be primary candidates for southwest Utah DATCS; antenna pattern shaping will be required to restrict coverage north and northeast of Frisco Peak
- Vernal - a DATCS base station at Asphalt Ridge is the primary candidate for northwest Utah DATCS
- Moab - a DATCS base station at Bald Mesa is the primary candidate for southeast Utah DATCS; a talk-back support station at Abajo Peak voting with Bald Mesa may also be required.

4) Intermediate Sites

Bridging between DATCS cells can be accomplished by intermediate repeater sites strategically located between the DATCS cells. These sites are conceived as being one or more 800MHz channel repeaters which are accessed by the "fail soft" capability of a mobile which has gone beyond range of a DATCS control channel signal. Command and Control can be exercised by connecting these repeater sites to a control point through the existing 2GHz microwave system. Suggested candidates for these intermediate sites include:

- Tabby Mountain
- Ford Ridge
- Cedar Mountain
- Dutch John Gap
- Red Spur
- Black Mountain (Delle)
- Moccasin Peak
- Monroe Peak
- Leran Peak

The decision to use any of these locations or any other locations as intermediate sites will require engineering study and field tests at 800 MHz to determine the antenna elevations, antenna patterns and effective radiated power needed for system integrity.

Although statewide coverage with DATCS appears feasible, the configuration of a statewide system must remain flexible in response to engineering evaluation and expanding DATCS technology. In all probability the existing 2GHz backbone microwave system will not provide the channel capacity needed to support a statewide DATCS. The microwave will require revision to a higher level of channel capacity or replacement of some microwave legs with new microwave equipment. Again a thorough engineering study will be required beyond the scope of this program.

3. MULTIPLE DISPATCH POINTS

The existing public-safety, state government, and local government radio services in Salt Lake County/Utah County consist largely of independent radio channels; each gency having its own command and control requirements over its own fleet of mobiles.* In its operation DATCS will be a replica of this configuration. Therefore the DATCS concept will not only provide for a multiple of fleet and/or subfleet addresses but will also be programmed to direct these subfleets to their individual dispatch points by means of their address identity.

* Task Report, Salt Lake and Utah Counties - Mobile Radio Systems Description and Requirements, "Booz Allen, revised July 15, 1980.

The number of individual dispatch points for Salt Lake County and Utah County could include:

- Salt Lake County Sheriff
- Sheriff's Central Dispatch
- Pleasant Grove Police
- Utah Highway Patrol
- Salt Lake City Fire Department
- Salt Lake County Fire Department
- Salt Lake City and County Health Departments
- Salt Lake County Public Works
- Salt Lake County Attorney
- Salt Lake County Surveyor
- Salt Lake County Building Inspection
- Salt Lake County Security
- Utah Department of Transportation
- Salt Lake County Fleet Management Division
- Brigham Young University Police
- Utah University Police

This list assumes that Salt Lake City Police, the City of Provo municipal agencies, and City of Orem Municipal agencies will not participate in DATCS implementation according to the Task 4 participation.

In the final configuration each dispatch point must be independent of any other dispatch point without incidental interaction between them except on command and the master controller. The mobile units will not have the capability to modify address codes or change the dispatch point/

To respond to an incident which calls for a mobile command post and a mix of public safety/public service agencies responsible to the command post, the system controller can create a phantom group and the mobile units can be attached to that group control point by software instructions based on the mobile address codes. There would be no change needed in the mobile logic to create the phantom group or to return the units to their original group and control point assignment.

4. INTERAGENCY COORDINATION

The survey of Salt Lake County/Utah County area agencies* resulted in a pattern of interagency coordination connectivity though by the agencies to be appropriate to their operating needs. This pattern of permissible connectivity between the agencies must be programmed into the controller software and provisions made for it to be modified by program instructions as needed.

It is expected that regional public safety and public service interagency coordination plans will include the regional disaster assistance plan developed in accordance with Federal Act PL93-288 (Disaster Relief Act of 1979) as amended.

5. CONVENTIONAL RADIO SYSTEM INTERFACE

In accordance with the system philosophy adopted for DATCS, public safety communications systems, as now configured in the Salt Lake and Utah Counties area, some public-safety agencies would not fully participate in the DATCS concept. Public safety radio system tend to be portable radio intensive. This represents a significant investment in relatively new VHF high band equipment which must be protected. Together with the questionable availability and cost of trunked radio portables, a judgement has been made to continue the operation of police and fire portable radios on conventional radio system channels where they now operate and provide any required coordination with DATCS by cross patching at the appropriate dispatch console. The Salt Lake City Fire Department Mobile Data Terminals will also remain outside DATCS until technical uncertainties related to data error rate degradation due to the DATCS/MDT multipath characteristics at 800 MHz can be resolved by engineering field tests and theoretic calculations that are not within the scope of this assistance program.

With the Salt Lake City Police radio system remaining outside of the DATCS concept, there is no requirement for CAD interface. However, the provisions for interagency coordination will probably include the Salt Lake City Police dispatch Center; the interconnection being made by a control station. The interface with the Salt Lake City Fire CAD will include only status reporting to the status display of the CAD.

6. EMERGENCY ACCESS PRIORITY

The capability for prompt access to the DATCS under conditions which justify the exercise of channel access priority when the DATCS system is fully occupied would be limited to public safety mobiles and certain selected public officials. The exercise of a priority access function when the DATCS is fully occupied requires a system frequency plan which designates at least one DATCS radio channel for control information.

* Task 4 Report "Salt Lake and Utah Counties - Mobile Radio Systems Description and Requirements," Booz, Allen, revised July 15, 1980.

The waiting queue priority method has been selected as the means of emergency access to the fu" y occupied DATCS. When denied access to DATCS, those mobiles with emergency access priority capability can activate this function manually and thereby move their request for channel access to the top of the appropriate queue. The public service/public safety agencies have indicated the desire for a 5 level priority structure. The activation of the emergency priority request would move the request to the top of waiting queue but not ahead of any other request for emergency priority from an agency mobile with an equal or higher priority classification.

The activation of this emergency function will also be recorded by the central controller and display at the control station along with the identity of the mobile unit making the request. The central controller will cause the first available DATCS channel to be assigned to the priority request.

7. MOBILE-TO-MOBILE COMMUNICATION

Mobile-to-mobile communication is inherent in the trunked radio system. Each mobile is assigned an individual address and a group address. The controller software determines what group code or codes will be accessed by each mobile on an initial call-up.

A mobile is programmed to communicate with any other mobile in the group through the repeater. By means of the individual address assigned to each mobile, the controller can also be instructed to activate individual units within the group and exclude all other units even those with the same group address.

If intergroup or interagency flexibility is needed, the dispatcher or terminal operator can, through software instruction to the controller, enable the mobile unit to call up any individual address, group address, or subgroup address within the capability of the trunked system.

8. SYSTEM FAILURE MODES

A DATCS must inherently protect itself against common failure modes. The following paragraphs address system features required for system failure protection. The discussion in the following paragraphs relates to the three base station configuration described for the Salt Lake County/Utah County area in which two of the base stations, Mt. Vision and Lake Mountain, have their own control channel and the base station at Snowbird (Hidden Peak) has no control channel transmitter. Radio frequency propagation tests may later prove that the roles of Mt. Vision and Snowbird should be reversed.

1) Central Control Failure

The total failure of the master controller at the central location, or any of its terminals, should not be apparent to field operations. The switching and control logic is resident in the site controllers. The central controller monitors the site controllers and initiates any

changes or corrections. The journal recorder should be switched to the output of the site controllers when the master controller fails, and the voter selector interface with the master controller should be neutralized. The only functions that can not be initiated are manual program changes.

2) Site Controller Failure

The failure of a site controller should permit full DATCS operations in a degraded mode using the remaining two base station sites. There should be no need to switch the DATCS to conventional radio channel operation or "fail soft" operation. A failure of the site controller at Lake Mountain and Mt. Vision will be evident to the users as a temporary reduction in coverage due to shadow effect; the failure of the site controller at Snowbird (Hidden Peak) will probably create talk-back problems in the canyons. The failed base station site should also be muted to prevent interference on the voice channels.

3) Voting Selector Failures

The failure of a voting selector should not be apparent to the field operations; one voice channel will be disabled and its traffic will be distributed among the remaining DATCS voice channels (control channels are not voted). A total failure of the voter selector system effecting all voice channels should enable DATCS to function in a degraded mode using one base station site; Lake Mountian or Mt. Vision whichever proves to have the greater area coverage. The remaining two sites should be muted.

4) Base Site Repeater Failure

The failure of a repeater at any base site should be transparent to field operations. The failed repeater will not be voted in the DATCS sequence of operation until it is repaired and returned to service. It should not be necessary to take any DATCS voice channel out of service due to the failure of any one of its three repeaters.

5) Antenna Subsystem Failure

The antenna subsystem at each base station site shall be configured so that a catastrophic failure of any one antenna, combiner, filter, or multicoupler will have a minimum effect on DATCS operations. To the degree possible these antenna subsystem elements will be standardized so that repairs can be made by replacement or interchanging elements.

6) Control Channel Failure

The DATCS concept includes two separate control channels, one on Lake Mountain and one on Mt. Vision. The failure of either channel will cause the site controller to assign a back-up voice channel at that site as a substitute control channel. The mobiles or control stations will not require

programming modification to accept this substitution. If the loss of a voice channel is not desired due to traffic loads, a degraded mode of operation can be tolerated using a single control channel from either Lake Mountain or Mt. Vision.

Failure or degradation of individual control stations or mobile stations will not degrade DATCS system performance.

9. SYSTEM TESTING AND ALARMS

An alarm panel will be installed at the master control terminal location. This alarm panel shall provide failure alarms (performance below acceptable thresholds) for at least the following:

- Excessive VSWR in any antenna subsystem transmission line
- Loss or reduction in output power of any transmitter
- Reduction in receiver channel signal-to-noise ratio below threshold
- Unauthorized carrier on any channel
- Loss of site controller integrity
- Degradation in repeater receiver interface
- Degradation in repeater transmitter interface
- Failure or degradation of a voting selector.

The alarm system that alerts to any element of degraded performance should also provide preliminary diagnostic information. This level of diagnosis may be limited to the identity of the offending unit of equipment and the kind of offense being observed.

10. SYSTEM MANAGEMENT AND CONTROL

The high technology features of DATCS are centralized and require an integrated control. This implies central management and control for sustaining operation on behalf of the user organization. Key management requirements are discussed in the following subsections.

1) Journal Recorder/Printer

System operations, as reported by the site controllers and the voting selector, are recorded on a magnetic tape transport. This information will include:

- System activity by each user agency control station
- System activity by each mobile stations
- Total channel activity time
- Channel use profile by hour, day, week, month
- Use of special features such as emergency priority
- System queue population and holding time in the queue by hour, day, week, month
- All alarms by hour, day, week, month

Additional information entered manually by the master control terminal can include:

- User complaint reports
- Channel down time for routine maintenance
- Channel down time due to failure
- Maintenance reports - time/cost

Selected reports from the journal file can be programmed by the master controller and printed out periodically on the system printer. Other reports can be programmed and printed out off-line by batch process EDP operations.

(2) Centralized System Control

Overall DATCS operation on behalf of the multiple users will be controlled from a master control terminals at a central location. This control point will be responsible for sustaining the quality of system operation, providing limited access to the address code structure from user agency terminals, making programming changes, and implementing temporary program modifications such as interagency coordination and setting up phantom address groups.

3) Centralized Maintenance

The maintenance of the DATCS must be uniform and standardized. The performance quality of each voice channel should be uniform with every other voice channel regardless of which of the three base station sites is used for each transaction. The skill and training required to achieve this maintenance requirement calls for a highly skilled, centrally managed maintenance staff.

4) Management

The recurring costs of operating, maintaining and expanding DATCS over a phased implementation program, and the high level of performance required of the system requires a dedicated and centralized management organization. This management should be at the level of a Division or Department of the State or local government in order to exercise the needed authority.

APPENDIX C

CURRENT SYSTEM INVENTROY

FOREWORD

This Appendix has been derived from the report "SALT LAKE AND UTAH COUNTIES - MOBILE RADIO SYSTEMS DESCRIPTION AND REQUIREMENTS" submitted by Booz Allen and Hamilton on March 31, 1980 and revised on July 15, 1980. These data represent the radio systems as configured at that time according to the reports of personnel responsible for each system.

INTRODUCTION

Salt Lake County, Utah was selected along with four other areas within the United States to participate in a model project. The overall objective of this project is to demonstrate the feasibility of replacing several independent mobile radio systems with a single, integrated communications system that satisfied an entire region's local government mobile radio needs. Recent Federal regulatory changes and advancing technology in mobile radio, when coupled with special planning, will permit an entirely new approach to local government radio communications.

Because of its unique inherent capability, a digitally addressed trunked communication system (DATCS) offers the potential to revolutionize local government communications by providing local government users with:

- A greater number of operating channels on demand
- The ability to directly communicate with dispatch points, mobiles, and portables of all agencies, without regard to equipment compatibility
- The opportunity to manage resources through communications in ways that were previously impractical.

The first step of an implementation planning process includes interviewing users of the various communications systems currently serving the counties of Salt Lake and Utah to determine their present and future requirements. This Appendix presents the findings of the interviews conducted by Booz, Allen and Hamilton and develops a set of requirements to be met by any DATCS system implemented in the Counties of Salt Lake and Utah. The requirements are designed to meet the needs of all public agencies in these two counties and will eventually apply statewide.

1. PRESENT SYSTEMS - SEVENTEEN INDEPENDENT MOBILE RADIO SYSTEMS IN SALT LAKE AND UTAH COUNTIES USING EXTENSIVE EQUIPMENT AND FREQUENCY SPECTRUM RESOURCES PROVIDE BASIC RADIO COMMUNICATIONS CAPABILITIES TO MOST PUBLIC AGENCIES

(1) Each Public Agency Operates Its Own Independent Mobile System With Individual Dispatch Centers and Base Stations - About 17 Dispatch Centers and 38 Base Stations Provide Coverage to Salt Lake and Utah Counties.

- Sixty-six base stations and repeater stations strategically placed in 46 locations throughout the counties of Salt Lake and Utah provide mobile radio communications to the 17 agencies surveyed in these counties (See Exhibit I)
  - The four Law enforcement agencies, two fire departments and Utah DOT own and operate about 65% of all base stations and repeaters
  - Eight agencies use only one base station
  - The remaining use two or three base stations to achieve coverage in their operating areas.
- Each agency, excepting Fleet management, owns and operates its own base stations and dispatch centers
- Twenty-one Dispatch Centers manned by 104 full-time dispatchers coordinate the radio communications of the individual agencies - the public-safety agencies including Fire and the Utah DOT employ about 75% of all dispatchers.

(2) The Agencies Surveyed Have a Total Inventory of About 1100 Mobile Radios and 325 Portable Radios - Their Channel Capabilities Range From 1 to 8 Channels (See Exhibit II)

- The 17 agencies surveyed use about 1100 mobile radio with channel capabilities ranging from one to eight channels to provide communications among vehicles and the dispatch center - the law enforcement agencies, the fire departments and the Utah DOT own about 75% of all mobile radios most of which are four channels
- The law enforcement agencies, fire departments, and the Utah DOT also own over 65% of the approximately 325 portables used by the 17 agencies.

(3) Thirty-three Channels Are Assigned to the 17 Agencies Surveyed - In Addition, the Agencies Share or Monitor About 40 Channels Belonging to Other Agencies (See Exhibit III)

- Thirty-three channels are assigned to the seventeen agencies surveyed

EXHIBIT I
BASE STATION & DISPATCH CENTERS

Legend
* Voting Comparator
** One base station plus one satellite receiver

AGENCIES	DISPATCH CENTERS: No. of Dispatch Centers	DISPATCH CENTERS: No. of Dispatchers	BASE STATION LOCATIONS: 50 N. State	3500 S. 7 W.	2000 S. 300E.	Magna	Midvale	1.5 Miles S. of Lark	2100 South State	44 W. 545	Asphalt Ridge	87 E. 100 S.	4600 S. 2300E	Univ. of Utah	3460 S. Redwood	1.5 Miles N.-Salt Lake	450 S. 300E	3951 W. 5400S.	5300 S.-Salt Lake	Lake Mountain	Tabby Mountain	Ensign Peak	Hidden Peak	Ford Ridge	Delle	Oren H.P. Office	2080 S. 100W	State Office Bldg.	Dutch John Gap	1750 So. Dakota Lane	Bringham Young Univ.	U DOT District Bldg.	100 S. 200E	100 S. 159E
.Law Enforcement																																	
-Pleasant Grove P.D.	1	4											2																				
-Sheriff's Central Dispatch	1	8																												1			
-SLC Sheriff's Off.	1	22						3								1	2	1				3											
-Utah Highway Patrol	-	20									1								1	2	1	1	1	2	1	1		1	1	1			
.Fire																																	
-SL City Fire Dept.	1	10	2	1												1																1	
-SL County Fire Dep.	1	9								2*	2*																				1*		
.Public Services																																	
-SL City & County Health	1	1									1																						
-SL Public Works	2	5			1	2																											
-SLC Attorney	1	2									1																						
-SLC Surveyor	2	1									1																						
-SLC Blg.Inspection	1	2									1																						
-SLC Security	1	4																								1							
-SLC Aging Transp-ortation	1	1			1																												
.Universities																																	
-Bringham Young Univ.	2	5																												1			
-Utah University	1	7												2																			
.Other																																	
-Utah DOT	2	2									1									1	1	1	2	1	1	1	1					1	
-Fleet Management	0	0																															
TOTAL	15	103																															

EXHIBIT II
INVENTORY OF MOBILE AND PORTABLE RADIOS

AGENCIES	MOBILE RADIOS						PORTABLE RADIOS					
	Number of Channels						Number of Channels					
	1	2	3	4	8	Total	1	2	3	4	8	Total
. Law Enforcement												
- Pleasant Grove P.D.				17	2	19		3		10		13
- Sheriff's Central Disp.				73		73				24		24
- SLC Sheriff's Office				250		250				63		63
- Utah Highway Patrol				170	22	192				25		25
. Fire												
- SL City Fire Dept.		75				75	22					22
- SL County Fire Dept.	75					75	50					50
. Public Services												
- SL City & County Health	21					21	1					1
- SLC Public Works				110	30	140		3				3
- SLC Attorney				6		6						0
- SLC Surveyor		25				25		11				11
- SLC Building Inspection	20					20	1					1
- SLC Security	1					1	40					40
- SLC Aging Transportation	14					14	1					. 1
. Universities												
- Brigham Young Univ.	5			8		13	4			19	3	26
- Utah University			23			23			25			25
. Other												
- Utah DOT		50		150		200		5		10		15
- Fleet Management						2						0
TOTAL	136	150	23	711	32	1082	119	22	25	151	3	320

EXHIBIT III
CHANNEL ASSIGNMENTS

AGENCY	ASSIGNED		SHARED		MONITORED	
	Activity	Frequency (MHz)	Assigned To	Frequency (MHz)	Assigned To	Frequency (MHz)
. Law Enforcement						
- Pleasant Grove P.D.	Operations	46.520	Central Dispatch	154.860*	Central Dispatch	154.710xx
	Operations	465.475	Civil Defense	460.475	Orem P.D.	155.430
			Highway Patrol	155.505*		
			Highway Patrol	155.745*		
- Sheriff's Central Dispatch	Operations	154.860	Jeep Possee	47.500	Highway Patrol	155.625 **
	Car-to-car	154.710	Mos.Control	453.900	Provo P.D.	155.430
			County Roads	155.760	BYU	154.965 **
			County Fire	153.950		
			Like	154.040		
			Sp. Fork	155.625		
			Sp. Fork	155.820		
			Highway Patrol	155.505		
- SLC Sheriff's Office	Uniformed Officers	154.650	Search & Rescue	45.500		
	Adm.& Plain Clothes	154.785	Search & Rescue	45,660		
	Inquiry	155.370	Highway Patrol	155.505*		
- Utah Highway Patrol	SLC	155.580			Local law	46.520 **
	Tooele Co.	155.910			enforcement	465.475 **
	Utah Co.	155.625			agencies	154.710 **
	All counties	155.505				154.650 **
	Motor Vehicles	155.785				154.785 **
	Car-to-Car	155.745				155.370 **
. Fire						
- SL City Fire Dept.	Dispatch	154.430				
	Command	154.310				
	Paramedics	154.340				
	Radio Box	72.320				
	Mobile Printers	453.200				
	Mobile Printers	458.200				
	Car-to-Car	155.505				
- SLC Fire Dept.	Dispatch	46.060			Sheriff Dispatch	454.600
	Command	46.100			Medical Network	154.340
. Public Services						
- SL City & County Health	Operations	45.490				
- SLC Public Works	Sanitation	45.160			Search & Rescue	45.500
	Public Works	45.600				

EXHIBIT III(2)

AGENCY	ASSIGNED Activity	ASSIGNED Frequency (MHz)	SHARED Assigned To	SHARED Frequency (MHz)	MONITORED Assigned To	MONITORED Frequency (MHz)
. Public Services (cont.)						
- SLC Attorney	Operations	158.550			SLC Sheriff	154.650**
					Highway Patrol	155.505**
					Sandy City	155.310
- SLC Surveyor	Dispatch	158.955				
	Field Work	158.865				
- SLC Building Inspection			SLC Security	158.820*		
- SLC Security	Operations	158.820				
- SLC Aging Transportation	Dispatch	45.280				
. Universities						
- Bringham Young Univ.	Operations	154.965	Universities Statewide	154.815	Highway Patrol	155.505**
					Provo P.D.	155.190
					Utah Co.Sheriff	154.860
					Provo Fire Dept.	154.190
- Utah University	Operations	154.725	Universities Statewide	154.815		
. Other	Operations	47.040			Utah Highway Patrol	155.625
- DOT	Operations	47.180				
- Fleet Management	SLC Paging	156.120				

Frequency Band	Assigned	Shared*	Monitored
Low Band	10	3	2
VHF	20	10	19
UHF	3	2	2
TOTAL	33	15	23

* It should be noted that only 5 of the shared frequencies are assigned to the agencies surveyed. The remaining of shared frequencies belong to other agencies in the State.

xx Again it should be noted that only 12 of the monitored frequencies are assigned to the agencies surveyed. The remaining of the monitored frequencies belong to other agencies in the State.

. The four law enforcement agencies, the two fire departments, and the Utah DOT are the greatest users of the frequency spectrum

- These agencies have about 70% of the frequencies assigned to the agencies surveyed
- They share and use another 13 frequencies assigned to other agencies or about 90% of those frequencies found in our survey to be shared
- They monitor 12 frequencies from other agencies or about 50% of all monitored frequencies in our survey

The VHF band is predominantly used by the agencies surveyed as shown below:

Band	No. of Channels	% of Total
Low Band	15	22
VHF	48	68
UHF	7	10
Total	70	100

(4) The Total Annual Operating Costs - Mainly Salaries for the 104 Dispatchers Employed by the Agencies Surveyed - and Maintenance Costs Exceed $1.8 Million (See Exhibit IV)

. The total operating costs in 1979 was about $1.7 million with about 60% paid by the public-safety agencies and 20% by the two fire departments and the Salt Lake City Department of Public Service

. Maintenance costs for all agencies were about $175,000 with the public service agencies responsible for about 80% of this amount. The Utah Highway Patrol alone spent about $46,000 or about 35 percent of the total.

* * * * * *

The seven largest agencies from the seventeen agencies surveyed were the four law enforcement agencies, the two fire departments and the Utah DOT. These agencies:

. Own 65% of all base and repeater stations

. Own about 75% of all mobile radios

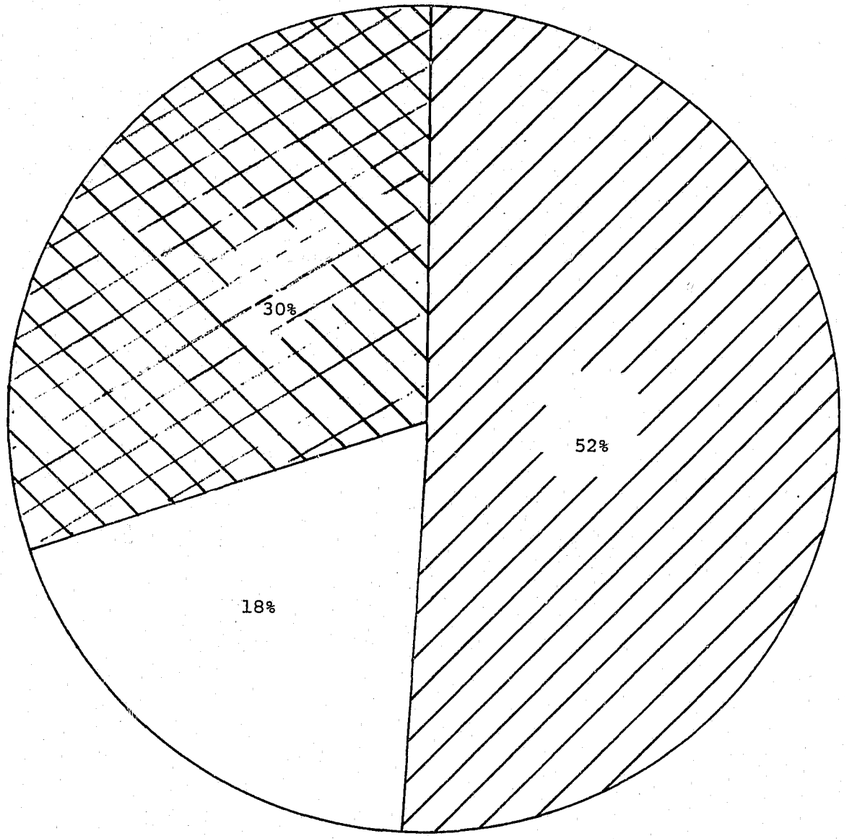
. Use 70% of all assigned frequencies.

EXHIBIT IV
Maintenance & Operating Costs

AGENCY	MAINTENANCE COSTS	OPERATING COSTS			TOTAL COSTS
		No. of Dispatchers	Operating Hours	Cost	
. Law Enforcement					
- Pleasant Grove P.D.	$ 3,000	4	24	$308,235	$311,235
- Sheriff's Central Dispatch	2,088	8	24	118,945	121,033
- SLC Sheriff's Office	12,250	22	24	410,000	422,250
- Utah Highway Patrol	45,657	20	24	269,360	358,140
. Fire					
- SL City Fire Dept.	6,000	10	24	120,000	126,000
- SL County Fire Dept.	10,000	9	24	140,000	150,000
. Public Services					
- SL City & County Health	2,100	1	7-5	5,000	7,100
- SLC Public Works	12,000	5	24	70,000	82,000
- SLC Attorney	700	2		25,000	25,700
- SLC Surveyor	3,900	1	7-4	10,000	13,900
- SLC Building Inspection	1,300	2	8-5	22,000	23,300
- SLC Security	1,100	4	24	40,000	41,100
- SLC Aging Transportation	1,250	1	8-5	10,000	11,250
. Universities					
- Brigham Young University	5,000	6	24	55,000	60,000
- Utah University	8,000	7	24	63,000	71,000
. Other					
- Utah DOT	19,000	2	8-5*	33,333	52,333
- Fleet Management	750	0	-	-	750
TOTAL	$134,095	104		$1,699,873	$1,877,091

Legend
* Dispatched by the Utah Highway patrol except in Utah County from 8AM to 5PM when DOT does its own dispatching

EXHIBIT V
Profile of Equipment Suppliers
to Individual Agencies



Legend:

- Agencies with equipment from three suppliers
- Agencies with two equipment types
- Agencies with one equipment type

2. MANAGEMENT AND MAINTENANCE OF PRESENT SYSTEMS - THE MOBILE RADIO SYSTEMS ARE INDEPENDENTLY MANAGED BY THE INDIVIDUAL AGENCIES: RECENT CENTRALIZATION OF EQUIPMENT MAINTENANCE AND REVIEW OF CAPITAL PROCUREMENTS CONTRIBUTES TO REDUCING COSTS

(1) The Mobile Radio Systems are Independently Managed by the Individual Agencies

- Each agency configures its system, installs its base stations and procures equipment to satisfy its communications needs
- Equipment types are procured on a need basis by each agency
- Each agency selects its equipment supplier and often purchases equipment from multiple suppliers or through State of Utah state contracts
- Frequency coordination is done through the Utah Chapter of APCO's Frequency Coordination Committee consisting of AASHTO, APCO, and ISMA Coordinators plus a local government coordinator.

(2) The Fleet Management Group in Salt County by Centralizing Maintenance and Computer Records of Repairs Helps the Salt Lake County Agencies Reduce Cost Through Lower Repair Costs and Identification of Opportunities to lower Costs by Replacing Equipment

- The Fleet Management Group was established by Salt Lake County in order to provide equipment maintenance services on mobile radios for all the public agencies in the county
- A few county agencies in Salt Lake County continue to provide their own maintenance, for example Salt Lake County Public Works through a private contract
- In 1978 and 1979 the Fleet Management Group billed the county agencies in Salt Lake County approximately $65,000 and $80,000 respectively for maintenance services rendered. This is estimated to be about 20-25% lower than otherwise would have been spent
- The Fleet Management Group keeps records on each piece of equipment sent by the county agencies for maintenance. Maintenance cost profiles are then developed for each equipment and used to determine replacement timing for the equipment

(3) Many Agencies Elect to Employ Independent Radio Maintenance and Repair Facilities

- The two universities, the Utah Highway Patrol, Utah DOT, Pleasant Grove Police Department and Sheriff's Central Dispatch continue to provide their own maintenance on all radio equipment

- The county agencies continue to service their consoles and base stations primarily through contracts with the supplier on local private firms

(4) Generally, Telecommunications Take Low Priority in Government Budgets and as a Result the Agencies are Unable to Replace Older Equipment or to Expand Their Systems

- Most agencies interviewed indicate that in recent years because of budgetary restraint in the state their communications capital procurement plans are severaly curtailed
- As a result the agencies have been unable to replace aging equipment, or to add needed mobile and portable radios.

3. PROBLEMS AND LIMITATIONS OF PRESENT SYSTEMS - THE INDIVIDUAL AGENCY SYSTEMS PROVIDE BASIC COMMUNICATIONS BUT BECAUSE OF TECHNICAL LIMITATIONS THEY ARE UNABLE TO MEET CERTAIN OPERATIONAL NEEDS SUCH AS PROVIDING INTER-AGENCY COMMUNICATIONS AND COMPLETE AREA COVERAGE

(1) The Individual Agency Systems Provide Adequate Internal Communications Among Vehicles and Their Dispatch Center

- Transmission quality was indicated by the surveyed agencies to be acceptable within the coverage area
- Channel access delay was not indicated to be a problem in most instances, except for some agencies during emergencies or special events. The agencies which expressed difficulties were:
  - Brigham Young and Utah Universities during special campus events (e.g., sports)
  - The Salt Lake City and County Fire Departments during major fires
  - The Utah Highway Patrol
- Most agencies operate on two or more frequencies depending on size and have assigned individual frequencies to different operating units to facilitate operations and improve channel access delay
  - Sheriff's Central Dispatch has assigned its two channels, one for general operations and the second for car-to-car communications
  - Salt Lake City Sheriff's Office has its three channels assigned one each for "uniformed officers", "administration and plain clothes" and "inquiry"

- The Utah Highway Patrol has assigned four of its six channels to geographic zones - one each for Salt Lake City, Tooele County, and two for Utah County, while the remaining two are functionally assigned for "All Counties" and for the Motor Vehicle Business Administration.

(2) Inter-agency Communications, System Adaptability and Coverage Difficulties in the Canyons Were Identified as Serious Limitations of the Current Systems

. All the agencies expressed problems of fading or total lack of communications in most canyons

. The lack of a capability to communicate with other agencies was indicated to be a serious operations handicap. Some inter-agency communication are achieved through frequency sharing and monitoring (See Exhibit VI)

- BYU monitors the frequencies of the Provo Police and Fire Departments, Utah County Sheriff's Office, the Utah Highway Patrol, and can communicate by mobile radio with these agencies

- Some inter-communications are possible among some agencies for example

.. Salt Lake City Public Works and Salt Lake City Sheriff

.. The Universities of Brigham Young and Utah

.. Pleasant Grove Police Department, Utah Sheriff Central Dispatch, Salt Lake City Sheriff and the Utah Highway Patrol

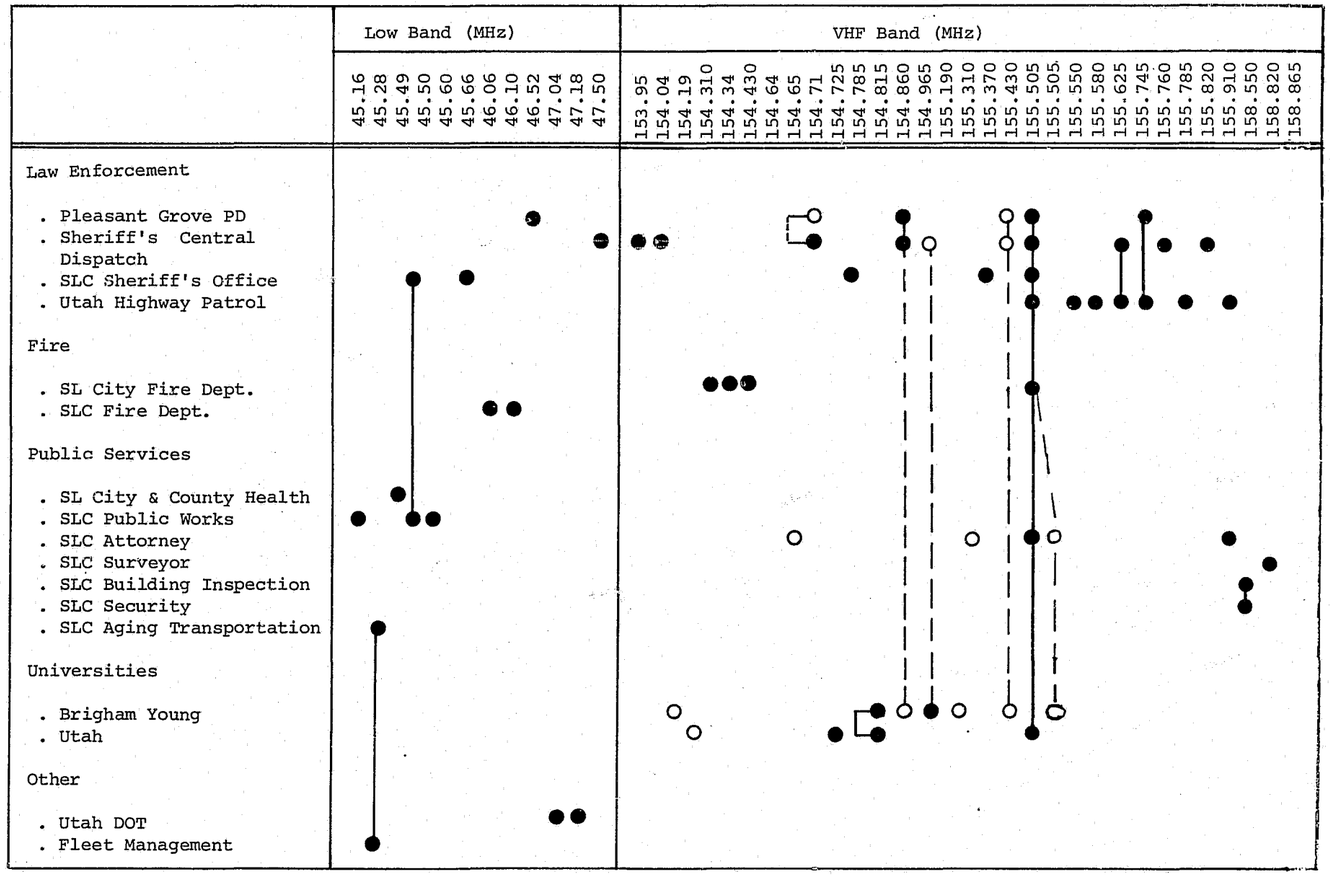
. System operational adaptability to organize field units of each agency by task or by geographic zone are deemed useful by most agencies interviewed as a means to improve operations.

(3) The Inherent Technical Limitations of the Present Systems Preclude Operational Needs From Being Met Economically

. A conventional means to achieve improved inter-agency communications would be to permit other agencies to procure radios with increased channel capacity which are compatible with the other systems

. This approach would translate into more expensive radios for these agencies and uncontrolled loss of privacy by the agencies. The loss of privacy would be unacceptable to public safety agencies

EXHIBIT VI
INTER-AGENCY COMMUNICATIONS



- To improve coverage in the canyons <u>each</u> agency would need to obtain and install additional base stations at considerable cost

- Improved system adaptability to permit greater flexibility in grouping mobile units on an assignment or geographic basis could only be achieved through acquisition of additional channels which are scarce

- Additionally, for each frequency assigned, new base stations would need to be established and the existing mobile radios would need to be modified or new ones procured.

4. <u>TRENDS AND FUTURE PLANS - THE CURRENT AND PROJECTED REQUIREMENTS OF THE INDIVIDUAL AGENCIES IF MET BY SIMPLE EXPANSION OF THE CURRENT OPERATING SYSTEMS WOULD TAX THE AVAILABLE FREQUENCY SPECTRUM, CAUSE DUPLICATION OF INVESTMENT AND NOT YIELD THE NEEDED OPERATIONAL IMPROVEMENTS</u>

(1) <u>The Projected 20% Growth in the Population of Salt Lake and Utah Counties Expected by 1985 Will Pressure Agencies to Expand Services (See Exhibit VII)</u>

- The populations of the two counties has increased by about 30% in the last ten years

- Utah state and federal government statistics forecast continued population growth of about 20% by 1985

- This population growth invariably will result in greater demand for services provided by the public agencies and corresponding increases in the use of telecommunications to provide these services.

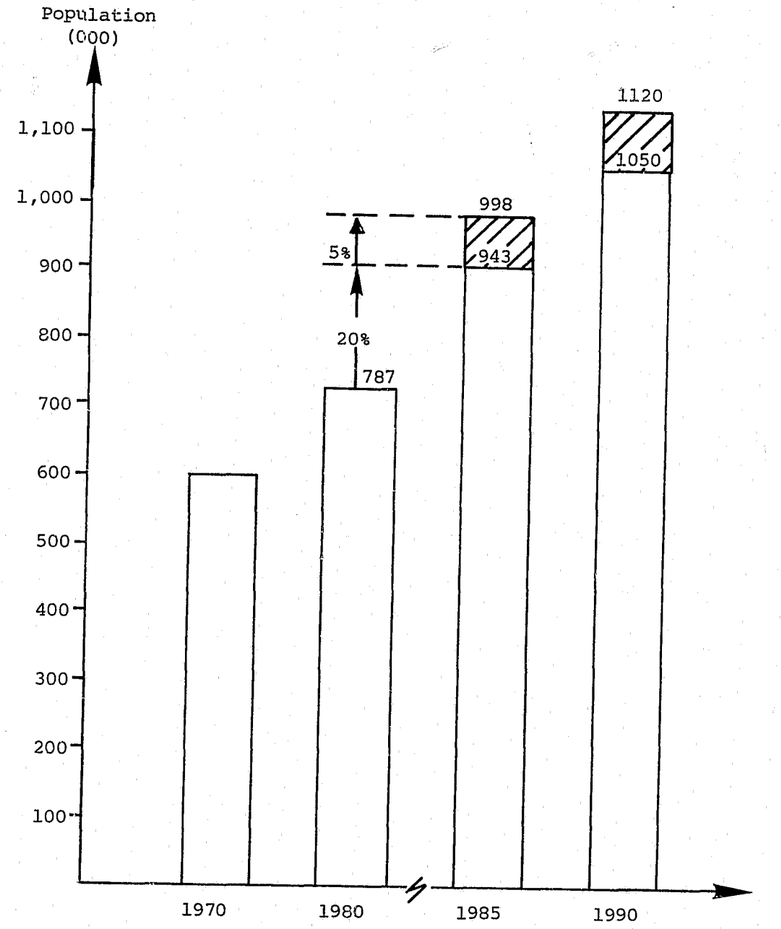
(2) <u>By 1985, the Radio Channel Requirements the Agencies in the Two Counties are Expected to Double and the Number of Mobile Radios and Portables are Projected to Increase by About 40% (See Exhibit VIII)</u>

- The agencies surveyed estimated an immediate need for 11 additional frequencies, an increase of over 30% to improve operations

- By 1985, an additional 42 frequencies, an increase of 130%, are projected which would increase the total channels in use to 75

- The requirement for 75 frequencies by 1985 would severely tax the available frequencies allocated for public mobile radio use and provide limited opportunities for further expansion

EXHIBIT VII
Census Projection for Salt Lake and Utah Counties



Source "Utah State Planning Coordinators Office, "Utah,2000, a High Development," March 1980

CONTINUED

4 OF 5

EXHIBIT VIII
Requirements for Channels
and Mobile Radios

Agencies	Channels			Mobile Radios		Portable Radios	
	Present	Presently Needed	Required in 1985	Present	Required in 1985	Present	Required in 1985
Law Enforcement							
. Pleasant Grove PD	2	2	3	19	19	10	15
. Sheriff's Central Dispatch	2	2	5	73	103	24	36
. SLC Sheriff's Office	3	5	8	250	375	63	95
. Utah Highway Patrol	8	8	10				
Fire							
. SL City Fire Dept.	2	3	5	75	75	22	22
. SL County Fire Dept.	2	3	5	75	75	50	50
Public Services							
. SL City & County Health	1	2	2	21	21	1	1
. SLC Public Works	2	2	3	141	180	3	12
. SLC Attorney	1			6	9		
. SLC Surveyor	2	2	2	25	30	11	13
. SLC Building Inspection	1	2	3	20	20	1	4
. SLC Security	1	2	2	1	2	40	50
. SLC Aging Transportation	1	1	2	14	40	1	6
Universities							
. Brigham Young	2	3	3	13	15	26	32
. Utah University	2	2	3	23	30	25	33
Other							
. Utah DOT	3	5	5	200	260	15	24
. Fleet Management				2	2		
TOTAL	33	44	61	1082	1481	317	448

- The VHF band is almost fully utilized
- The UHF band is about 50% used from the public safety standpoint

. The number of mobiles needed by 1985 are projected to increase by about 400 units or 37%

. The number of portables required in 1985 are about 500 units, an increase of 40%.

(3) Improved Coverage, Increased Inter-agency Communications, Improved Security and Other Capabilities are seen as Important Requirements to Improve Operations and Services to the Public (See Exhibit IX)

. Coverage of canyons is a particular difficulty at present with all public agencies

. Increased Inter-agency Communications was identified as an important requirement and one which would enhance operation efficiency

. Improved communications security is of particular interest to public safety agencies

. The ability to assign teams to a particular channel on a need basis is a strong need of all public safety agencies, including fire departments, to improve and facilitate operations

. Improved channel availability, especially during emergency situations is a strong need of all the agencies surveyed

. Greater system reliability and management information on system usage is attractive to some agencies and necessary for others.

(4) The Current Systems Are Severely Limited in Their Capabilities to be Expanded to Meet the Present and Projected Requirements Because of Technical and Economic Constraints

. To provide the 75 channels needed by 1985 to present systems would have to secure 37 additional frequencies within the two counties

. The number of base stations would need to proliferate at a rate proportional to the channel requirements to provide the current coverage. The additional base stations are estimated to cost about $3000 each

EXHIBIT IX
Operational & Features Requirements

	Operational							Management	
	Improved Reliability	Operational Reliability	Increased Channel Availability	Automatic Priority Capability	Improved Security	Intra-Agency Coordination	Other Functions (e.g., Radio-in service)	Management Information Recording	Common Equipment & Central Control
Law Enforcement									
. Pleasant Grove PD	○	●	●	●	●	●	○	●	○
. Sheriff's Central Dispatch	○	●	●	○	○	●	○	○	○
. SLC Sheriff's Office	●	●	●	●	●	●	●	●	○
. Utah Highway Patrol	●	●	●	●	○	●	○	●	○
Fire									
. SL City Fire Dept.	●	●	●	●	○	●	○	●	○
. SL County Fire Dept.	●	●	●	●	○	●	○	●	○
Public Services									
. SL City & County Health	○	○	●	○	○	●	○	○	○
. SLC Public Works	○	○	●	●	○	●	●	●	○
. SLC Attorney	○	○	○	○	●	○	○	○	○
. SLC Surveyer	○	○	○	○	●	●	○	●	○
. SLC Building Inspection	○	○	●	○	○	○	○	●	○
. SLC Security	○	○	●	○	○	●	○	○	○
. SLC Aging Transportation	○	○	○	○	○	○	○	○	○
Universities									
. Brigham Young	○	○	●	●	●	●	○	○	
. Utah	●		●	●	●	●	●	●	
Other									
. Utah DOT	○	●	●	○	○	●	○	●	○
. Fleet Management	○	○	○	○	○	○	○	○	○

Legend:

● Necessary

○ Desirable

- Expansion of the present systems would also not provide for many of the operational requirements of the individual agencies, for example:

  - Improve security
  - Greater interagency communications
  - Operation adaptability
  - Improved channel availability during emergencies.

5. DATCS REQUIREMENTS - THE SYSTEM AND MANAGEMENT REQUIREMENTS HAVE BEEN DERIVED TO MEET THE PRESENT AND FUTURE RADIO COMMUNICATIONS NEEDS OF THE AGENCIES SURVEYED AND TO PROVIDE FOR SYSTEM EXPANSION TO SERVE OTHER AGENCIES STATEWIDE (See Exhibit X)

(1) The System Requirements Which Must be Met By A DATCS System Have Been Derived From the Trends In Radio Communications and Future Plans of the Agencies Surveyed

- The system requirements for DATCS proposed are intended to meet the growing radio communications needs as expressed by the individual needs and as implied by demographic trends
- Other system requirements have been imposed because it is understood to be inherent capabilities of DATCS and can be of value to public agencies in improving operational efficiency
- The system requirements have been expressed in terms consistent with the DATCS architecture.

(2) The DATCS System Being Considered for Development has the Capability to Meet all the Requirements and Eliminate Duplication of Investment by the Individual Agencies

- Under DATCS System common base stations will be used by all the agencies transmitting and receiving at all frequencies. It is estimated that three of four sites could provide complete coverage in the two counties as opposed to those which would be required by 1985 with the present system configuration
- The number of frequencies needed would be reduced with DATCS from the projected 75 under the present configuration to approximately 40 because of the improved channel utilization efficiency of DATCS
- The DATCS system as presently conceived has the inherent capability to provide all the requirements needed or found desirable by the individual agencies to improve operations.

EXHIBIT X
BASIC DATCS REQUIREMENTS

ARCHITECTURAL

- The system initially must provide for at least 20 dispatch centers, geographically distributed, with several dispatch positions

- The system must be expandable to include other geographically distributed dispatch centers from user agencies

- The system must be expandable to include new user agencies.

COVERAGE

- The system must provide radio coverage throughout the counties of Salt Lake and Utah including all canyons

- The system must be expandable geographically to provide regional coverage statewide coverage

- Mobile radios beyond the range of the signaling system will be notified automatically.

ADDRESSING

-The system must be software adaptable to include or exclude specialized groups or discrete units or to recognize the group addresses

-The system must permit at least 5 levels of priorities

- The system should permit priorities and addresses to be reassigned by keyboard entry on the controller.

SYSTEM PERFORMANCE

- The system access time by any user must not exceed 0.5 seconds under normal busy hour traffic conditions

- The system must permit any group of mobile units to be transferred to any dispatch position within the system

- Privacy will be provided by discrete unit addresses and group addresses.

INTERCONNECTIVITY

- The system must be able to interface with the state, local or national data information systems such as NCIC.

- The system should be able to interconnect with the public telephone network

- The system should permit the use of conventional portable radios.

RELIABILITY

- Channel failure will be automatically detected and isolated from the system until restored

- Failure of the system controller will revert the system to a preplanned conventional mode of operation

- Failure of the signaling control channel will result in the automatic transfer of the signaling function to a usable voice channel.

EXHIBIT X (3)

MANAGEMENT

- Overall system responsibility must be centralized
- System management guidelines, controls and operational policies should be established
- System maintenance including individual units, control units, base stations and consoles should be pre-determined and centralized
- Each user agency's present and future responsibilities must be defined
- Common training standards for dispatch, field personnel and users must be established
- The system controller must monitor and record all message traffic including signaling by type user agency

APPENDIX D

STATEMENT OF WORK

FOREWORD

This Appendix is intended as a topical outline of a typical Statement of Work (SOW) for quick reference by the planner or system procurement manager. The SIP Guide (APCO Project 16B) provides supporting material for this topical outline.

The following outline adheres to the recommended order of topics for a high technology system SOW. The planner or system procurement manager is cautioned to employ only those elements of the outline which relate to the specific procurement and which can be accurately evaluated or measured.

APPENDIX D

STATEMENT OF WORK

I. INTRODUCTION

The introduction to the Statement of Work (SOW) should provide a general overview of the project to enable a better understanding by the responders. Key elements of this section are outlined in the following subsections of the Introduction.

1. Background of the Project

A brief historic description of the origin of the procurement and the constraints imposed on the design.

2. Objective of the Procurement

A brief discussion of the main system objectives to be achieved by the procurement.

3. Scope of the Procurement

A basic and brief outline of the hardware, software, and services that are being purchased. These may include for example:

- Hardware
- Software
- System Design
- Installation
- Testing
- Training
- Maintenance.

II. INSTRUCTIONS TO BIDDERS

This section of the SOW will provide the bidders with all the information needed to respond correctly to the bid request.

1. Procurement Schedule

The schedule time and dates for responding to the bid request will include:

- Time and place of the pre-bid conference
- Time and place bids and proposals are due

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- Time and place of the pre-bid conference
- Time and place bids and proposals are due

- Bid and proposal opening time, date, and place
- Proposed contract award date
- Expected date of contract completion.

2. Authorized Contracts

The persons will be identified who are authorized to respond to bidders requests prior to bid opening. These may be restricted to the:

- Procuring officer
- Technical consultant.

The statement should be made regarding how the issues raised by these contacts will be reported to the other bidders.

3. Bid and Proposal Requirements

Each of the items to be submitted as part of a responsive bid will be defined. Any limitations should be included in the description. These items would include for example:

- Itemized cost proposal
- Technical proposal
- Management proposal
- Provisions for alternate proposals
- Proposal limitation such as page count, standardized forms (cost proposal), proposal size, unnecessary artwork, and number of copies to be submitted.

4. Bidders Qualifications

The contractor for a high technology system must be qualified, technically and financially, to complete the required work. These qualifications should be expressed in the SOW by requiring reasonable responses to limits imposed on:

- Bidders facilities and financial resources
- Performance history in terms of references and a list of similar and recent contract work
- Support facilites such as field maintenance shops, training facilities, and spare parts replacement depots

- Bid and proposal opening time, date, and place
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- Performance history in terms of references and a list of similar and recent contract work
- Support facilites such as field maintenance shops, training facilities, and spare parts replacement depots

- The quality and availability of personnel for management, supervision, and technical staff.

5. Proposal Evaluation Criteria

Criteria should be established for the comparative evaluation of:

- Technical proposals
- Cost proposals
- Management proposals.

These criteria should be clearly defined in the SOW so that each bidder will understand the emphasis placed on the requirements of the RFP.

6. Contract Award

The SOW will identify the type of contract to be awarded the successful bidder whether or not this contract will be awarded without pre-contract discussions.

7. Indemnification

The purchaser should require indemnification against damages imposed through intentional or unintentional acts of the contractor. High technology system procurements will need indemnification against the improper use of patented items or processes. All procurements which include services such as installation and test will be well advised to require indemnification from damages resulting from the actions of contractors' employees or agents.

8. Titles and Rights

Rights of the purchaser and ownership of titles will be clearly defined by the SOW. These items include statements related to:

- The transfer of title to equipment and software
- Rights to data and software developed or provided as part of the contract
- Rights and title to the submitted proposals
- The right to reject proposals
- The right to negotiate with any bidder
- The right to cancel negotiations or the contract.

Legal counsel should be consulted for the scope, content, and wording of this subsection of the SOW.

9. Bonds, Insurance, and Warranty

Each governmental entity will have its own limits for, and description of, the bonds, insurance and warranty provisions for contractor provided material and services. Frequently there will be state regulations which also must be adhered to. These requirements will provide for:

- Performance bonds
- Workman's compensation
- Comprehensive liability insurance
- Warranty on workmanship and materials.

The purchasing department of the major governmental agency included in the program will provide counsel as to how these requirements are to be included in the SOW.

10. Costs of Proposal Preparation

The SOW should state clearly that any costs related to the preparation of bids or proposals can not be included in the proposed cost of the project or billed back to the purchaser in any manner.

11. Contract Disputes

At the option of legal counsel, the SOW may indicate the means by which the governmental agency resolves contract disputes. This will be a function of the governmental body and will not be an option of project management. These provisions may include:

- The procedure and method of resolving contract disputes
- Termination of contracts for cause
- The assessment of liquidating damages
- The identity of the court of jurisdiction.

12. Applicable Federal/State Laws and Regulation

When state or Federal laws/regulations affect the system design, its operation, or allowable use, these laws or regulations should be identified in the SOW.

III. SCOPE OF WORK

This section of the SOW defines the items of work expected of the contractor; the specific tasks required by the contractor are described in detail.

1. Services to be Provided

High technology systems will require professional services to be performed by the system contractor in addition to the delivery of hardware and software items. Typical services to be provided are:

- System design which can include system engineering, radio propagation engineering software development, and hardware development
- Installation and debugging of hardware and software
- Assistance in procuring required licenses and permits
- Developing and conducting performance tests and acceptance tests
- The preparation of sites and facilities which can include construction, HVAC, emergency power, lighting, installation of utility services, etc.

2. Deliverable Items

Each deliverable item should be identified in the SOW. Deliverable items include hardware, software, and services. The list will be unique to the complexity of the system to be procured. However, some common items on all lists will include the following:

- Each item of electronic or radio hardware
- Each item of computer software
- Maintenance support
- Spare parts and spare module provisions
- Towers, buildings and other structures
- Manuals and documentation such as test plans, test procedures, maintenance manuals, operators manuals, user manuals, training aids, installation drawings, and test reports
- Progress reports and deficiency reports.

3. Delivery Schedules

Each deliverable item should be supported by a delivery schedule. The SOW will require a formal and contractually obligated schedule for:

- Each item of electronic or radio hardware
- Each item of computer software
- Each tower or building
- The completion of all facility preparations
- Delivery of all manuals and documents
- The time and place of technical progress reviews
- The delivery of reports including progress reports, test reports, discrepancy reports, and the final report or acceptance test report.

IV. SYSTEM SPECIFICATION

The system specification is a complete technical system description which includes the system performance, system interfaces, and system configuration. It places technical limits on these parameters and adds reliability and/or maintainability requirements where appropriate.

1. Hierarchy of Specification and Standards

Industry or regulatory specifications or standards frequently apply to the specification of a system. These should be identified. The hierarchy of these documents, as they apply to the system specification, should be defined so that conflicts between them can be resolved.

2. System Description

The system description includes the configuration of the system elements and their interconnection with each other. It is recommended that this be done graphically with supporting written clarification. The system description is derived from the system concept design.

3. System Interfaces and Supporting Services

The means by which the system interconnects with the world outside of the system should be fully described. These interfaces are relatively unique to each individual system but some key interfaces will include:

- External communication systems such as mobile radios, private telephone systems, data processing, digital data systems, alarms, microwave transmission systems, and similar facilities
- Utility systems such as public access telephone systems commercial power systems, and water supplies
- Emergency operations such as emergency power services, fire protection, emergency medical services, and civil disaster prevention operations.

4. System Software

The system specification will include a complete description of the operations software and the applications software required to provide the needed system performance.

5. System Operation and Performance

The specification of system operation and performance is tailored to meet individual system requirements as developed in the system concept. Typically these specifications will include a complete description of:

- The functional modes of system operation for routine system performance, emergency system performance and allowable fail-soft or degraded levels of performance
- The calculated levels of personnel staffing for the operating staff, maintenance staff, and system management.

6. Expansion Requirements

Frequently limitations on funding or other resources will prevent the initial implementation of a sophisticated system from realizing the full potential of system operation, scope, and performance. When these expansion requirements are part of the initial system procurement, they must be fully described in the system specification.

7. System Licenses and Approvals

High technology systems may exceed the apparent limits of Federal or state licensing regulations and extraordinary procedures may be needed to acquire the necessary permits or licenses. These requirements should be clearly defined in the system specification. They will be unique to each specific system configuration and intended operation.

V. EQUIPMENT SPECIFICATIONS

The equipment specifications define the quality and performance characteristics of each item of hardware and software needed to meet the system specifications. The identity of each hardware and software item is derived from the system configuration diagram which was developed as part of the system concept.

1. General

This subsection of the equipment specifications accumulates all items of the individual equipment specifications requirements that are common among all items of equipment or software. It also defines the quality and quantity of each item of hardware and software that is required to meet the system configuration. Typical items that would appear under the general heading are:

- Applicable industry standards or publications and their hierarchy for this program
- Standard environmental conditions such as temperature, humidity, primary power, vibration, shock, dust, and dirt
- Deliverable equipment lists showing the quantity required of each item including spares
- The required level of quality and workmanship for each hardware item.

2. Individual Item Specifications

Each equipment item will have an individual technical specification which reflects its construction and performance as required to meet the system specification. These are derived individually from the system performance requirements and should be no more severe than that needed to meet the system performance specifications. Software specifications are typically combined with the equipment specification for the computer subsystem or the switching subsystem in which they are resident.

APPENDIX A

EXAMPLE PROBLEM ANALYSIS REPORT

DRAFT REPORT

Submitted to:

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Task 6

ANALYSIS OF PROBLEMS AND REQUIREMENTS

June 15, 1980

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I. INTRODUCTION

This document responds to Task 6 of the Support Agreement and Work Plan for Phoenix, Arizona under APCO Project 16B which was approved on January 10, 1980.

1.1 PURPOSE OF THE REQUIREMENTS ANALYSIS

The purpose of this requirement analysis is to define the functions and processes that should be satisfied by a trunked radio system for Phoenix and adjacent communities. To this end the discussion of the system requirements accepts the data output from Task 4 "Documentation of Existing Radio Systems and Reported System Requirements" and from this data develops the dimensions of those system requirements and planned solutions to the reported problem areas which impinge on the system concept.

1.2 SCOPE OF THE REQUIREMENTS ANALYSIS

This requirements analysis is limited in scope to those items that bear directly upon the development of a system concept. The system concept will be a baseline document intended to resolve the question of the feasibility of trunked radio techniques in solving public safety and public service land mobile radio problems in the Phoenix area. Areas of radio equipment design and the deveopment of a system procurement document are beyond the scope of this requirements analysis. These are to be addressed in later documentation.

The following paragraphs divide the requirements into three categories:

- System requirements
- Operating requirements
- Future considerations.

The discussion of system requirements is further divided into those classified as major problem areas critical to the basic functional integrity of the communications service and those system considerations which can be satisfied by trunked radio system basic capabilities.

II. SYSTEM REQUIREMENTS

The system requirements (as reported through the system survey data) present some major system problems which must be resolved if a trunked system is to be considered feasible. There are other system considerations which, although of serious concern, can be accommodated more routinely. These are addressed individually in the following subsections.

2.1 MAJOR SYSTEM PROBLEMS

The following problem areas and their proposed solutions are presented as being critical to the successful implementation of a trunked radio system in the Phoenix area. The potential solutions offered reflect state-of-the-art system technology and hopefully do not seriously violate the state-of-the-art hardware and software offerings that can be made available in the near future when competitive procurement documentation has been developed.

2.1.1 Multiple Base Stations

Radio coverage experience at UHF in the Phoenix area precludes any reasonable expectation that a single 800 MHz base station site will provide adequate coverage. At a minimum, base stations will be needed at North Mountain and South Mountain. Coverage of Paradise Valley, Tempe and Mesa will probably require a third base station site east or southeast of the Salt River. At this time Bell Butte or Tempe Butte are likely candidates but a location further east, such as the Mesa Water Tower may be preferred.

The technique of simulcasting from multiple locations could offer a solution. However, simulcasting requires the precise equalization of frequency, phase and FM deviation among all transmitters at each frequencey (there could be a total of 60 transmitters at 3 sites). Although simulcasting under these conditions is technically feasible, in practice it is extremely expensive to accomplish and requires an unacceptably high cost of maintenance to retain specified system performance.

The alternate solution for a dedicated control channel type of trunked system is to vote the received signal from the multiple locations and, by means of the voter comparator, also select the transmitter at the base station site which has the better received signal. Conventional hardware is available for accomplishing this and cost can be minimized if the backbone microwave system can be used for most of the interconnect transmission requirements.

The control channel, which is transmitting data continuously to all mobile units, can not be adapted to voter comparator steering of selected transmitter sites. A possible solution is to simulcast only the control channel from the multiple transmitter sites. An alternate solution is to transmit control information only from one site which can be reasonably expected to put a realiable data signal into all parts of the greater Phoenix area. The North Mountain site appears to be a possible candidate to meet this requirement.

If simulcasting the control channel is not an acceptable solution, and North Mountain will not provide adequate data coverage for the Greater Phoenix area, two or more separate control channels will be required to cover the service area. The mobiles will have to home on a different control channel depending upon what part of Phoenix they happen to be in. Control channel selection can be automated within the mobile logic but could create a problem for mobile-to-mobile communications across Phoenix.

A preliminary observation of the 3 candidate base station site configuration suggests the possibility of a two cell trunked configuration. The primary cell consists of North Mountain and South Mountain with North Mountain transmitting the dedicated control channel signal. The secondary cell consists of the southeastern base station site that covers Mesa, Tempe and Paradise Valley; this site would transmit its own dedicated control channel which would differ in frequency from that of the primary cell. The cost in "overhead" control channels would be 10 percent of a 20 channel system.

If a distributed logic type of trunked system is selected in which control information is transmitted on the "idle" channel, the frequency assignments for each base station site may be different (all three candidate sites are within propagation range of each other and could mutually interfere with each other). This would divide the available channels of the trunked systems (probably 20 channels) into three separate groups with the possibility that no one group would have enough channels to handle its peak traffic load. An alternate frequency control system which would provide better frequency utilization permits frequencies to be duplicated among the three base station sites and the central controller can be programmed to inhibit the use of a frequency at any site other than the site where it is first assigned as result of a mobile request.

The technical proposal of the potential system contractors will have to explore the feasibility and cost effectiveness of these system alternatives within the confines of each supplier's hardware and software offerings.

2.1.2 Operation with Portable Radios

The availability of trunked portable radios will depend upon the successful development of a technically acceptable frequency synthesizer and associated control system switching logic each of small size and with small power requirements. These circuits together with the usual 800 MHz portable radio subassemblies, and a battery pack with sufficient capacity to permit at least 8 hours of high performance service, must be made available in a small handheld portable radio case. Estimates by industry sources place the earliest availability of such a unit in the 1983-85 time frame. Until such portable radios are available, trunked radio system equipment configurations will include only base stations, control stations and mobile stations.

Public safety radio systems in Phoenix are portable radio intensive. This is also true of Glendale, Mesa, and Tempe public safety agencies. Scottsdale Police Department is also heavily dependent upon handheld portable radios. The significant investment in this mix of VHF high band/UHF portable radio equipment must be protected. These existing equipments must be permitted to operate with the trunked radio system with no modification or, at the most, a very minimum of modification.

Conventional portables can interface with the trunked radio system through a cross-band repeater. This repeater would have a two frequency half-duplex VHF or UHF channel on one side and a frequency synthesized trunked radio control station on the other side. In the trunked system logic the cross-band repeater will have a single unit address for a cluster of portable radios all having the same VHF or UHF channel. Each such cluster will have its own cross-band repeater.

Trunked systems can not pass the system control information through to a cross-banded portable. Therefore, the portable will not be able to detect an "all channels busy" signal and will not know why a channel request has been denied. To correct this the trunked control station side of the cross-band repeater can cause an audible tone to be sent on the receive channel of the cluster of portables when trunked channel access has been denied. The denied request for channel access from a portable radio should not be placed in the queue for the control channel type of trunked system even if a "channel available" signal is also transmitted to the cluster of portables. Because the cross band repeater can not individually address each portable in the cluster, the portable radio queue will have to be a contention queue. With all portables in a contention queue for trunked channel access, the portable radio will have to manually repeat the request for a channel whether or not a "channel available" signal is provided.

The users of portable radios cross-banding into a trunked system will also have to learn to "quick call" the system for a channel request and wait for the request to be acknowledged before they start to speak. This technique has proven difficult in the past. Also, the "hold time" of the repeater/base station combination will require special adjustment to prevent dropping the trunked channel during normal press-to-talk switching through the repeater. These techniques have proved troublesome for field personnel to master.

The preferred solution to UHF/VHF portable operation is to continue using the portable radios on conventional VHF/UHF radio channels and manually cross patch these channels into the trunked system at the dispatcher's console when crossband coordination is required. Until trunked portable radios become available and have been field tested, the recommended solution for the Phoenix area is to keep the conventional VHF/UHF frequencies for portable radio operation and use the trunked system for the mobile radios.

2.1.3 Satellite Voting Receivers

Radio propagation experience with 800 MHz trunked systems indicates that base-to-mobile and mobile-to-base coverage has been similar. The effective radiated power of the two types of stations is very much the same when the installation of both has been well engineered. Therefore, a base station/control station/mobile trunked system without trunked portables would need no satellite receivers or possibly need only one or two remote satellite receiver sites to correct unique trouble spot and to vote with the base station receivers in a transmiter steering configuration. It will be the obligation of the system contractor to conduct radio propagation tests to minimize the need for any satellite voting receivers.

If trunked portable radios are eventually added to the system, the need for satellite receiver installations throughout the Greater Phoenix area will have to be re-examined at that time.

2.1.4 Multiple Dispatch Points

The Phoenix land mobile radio system, including participation by all appropriate governmental agencies of Phoenix, Glendale, Mesa, Scottsdale, and Tempe, will require a number of dispatch points to maintain the existing level of command over the field units. The survey data shows a total of 46 dispatch positions in 14 dispatch centers throughout the Greater Phoenix area. In addition there are a total of 154 remote control positions at 43 locations throughout the total area. While this number of dynamic dispatch points can be reduced by system planning, the remaining number is going to be large and will remain dynamic. The assignment of an individual mobile unit to a specific dispatch point will be information that resides only in the system control equipment and can not be changed or initiated from the mobile unit.

In concept, the mobile unit, in transmitting a request to access the trunked system, would only transmit its own identity and possibly its assigned group address. From this address code, the controller can determine from its data file which agency the mobile belongs to, the dispatch point the mobile reports to at that particular time, and the group (or subgroup) the mobile will be permitted to include in its call-up. It is also conceived that some mobiles will also have the limited capability of modifying the group request; this feature should be permitted for the singular purpose of reducing the dispatcher work load.

To respond to an incident which calls for a mobile command post and a mix of public safety/public service agencies responsible to the command post, the system controller can create a phantom group and the mobile units can be attached to that group by software instructions based on the mobile address codes. There would be no change needed in the mobile logic to create the phantom group or to return the units to their original group assignment.

2.1.5 Failure Mode Operation

The trunked system must inherently protect itself against common failure modes. The following paragraphs address system features recommended for system failure protection.

2.1.5.1 System Control Failure

An individual base station repeater is installed for each channel licensed to the trunked system. Radio coverage problems and the system configuration may require the installation of repeaters for all channels at all base station sites. These individual repeaters are interconnected and controlled by a controller. If the controller fails completely, the repeaters can operate independently as conventional repeaters. They can be accessed by mobile stations and control stations that are operating on the assigned frequency for

each channel of the trunked system. The mobile stations can be preprogrammed to home on an assigned channel if there is a loss of control signal or idle tone (depending upon the selected trunked system); the available 800 MHz conventional channels will be distributed among the mobile fleet units according to need and coordination requirements. Access to the repeater from the dispatch point can be achieved by control station, wireline, or microwave.

Conversion to conventional mode of operation from a trunked operation can also result in a severe shortage of frequency resources needed to conduct routine operations. To avoid this inconvenience, it is recommended that redundant controllers be installed in a hot standby configuration to improve system reliability.

Failure of the control system in any mode other than a total catastrophic failure should result in a graceful degradation of the system capability. The failure should be limited to the loss of control over individual channels. This limited failure mode should be transparent to the system users. The loss of one or more channels should not effect the operation of the remaining channels.

2.1.5.2 Time-out Timers

A repeater configured land mobile radio system such as a trunked system can be paralyzed by accidental or intentional prolonged mobile or control stations transmissions. To protect the trunked system from this failure mode, all transmiters of the base stations, control stations, crossband repeaters, and mobile stations will be equipped with time-out times similar to the timers used in conventional repeater type systems. Two categories of timing circuits should be specified; the first permitting an absolute maximum time to hold the channel with or without modulation, the second should provide a limited channel hold time without modulation.

2.1.5.3 Distributed Logic Failure

The inboard logic functions assigned to control stations and mobile stations should be minimized; critical system logic and data files must be concentrated at the central control point location. Failure of the logic functions or RF functions at the mobile or control station should effect only that individual unit; such failures need not be alarmed back to the central control point.

2.1.6 System Testing and Alarming

The complexity of a trunked radio system that will provide adequate communication services for Phoenix will require a built-in capability to evaluate the individual channel quality and alarm back to the central control point any degradation in channel quality below established threshold limits or other significant system degradations. This requirement is not unlike the remote testing and alarm capability used routinely in private microwave systems.

2.1.6.1 Channel Quality Evaluation

To minimize catastrophe channel failures, individual channel quality should be continuously monitored by one of the following methods:

- Idle channel noise threshold (no signal)
- Busy channel $\frac{S+N}{N}$ threshold (signal or idle tone).

Departure from a predetermined threshold limit will be alarmed to the central control point.

2.1.6.2 System Test

The ability of the trunked system to respond to mobiles/control stations and to process their message content should be tested periodically. It is recommended that a programmable frequency synthesized test transmitter with known radiation characteristics and test message content (multi-frequency tone and/or digital message) be centrally located in Phoenix at a location that provides nominal 800 MHz converage of the Phoenix area. This test transmitter can be programmed to transmit its test signal on each trunked radio channel sequentially and the received test signal at each fixed receiver location in the Phoenix area can be compared by quality and message content with a standard. The standard can be established at the time the test transmitter system is installed. Any degradation below established limits will be alarmed to the central control point. It is preferable that this test system be peripheral to the trunked radio system.

2.1.6.3 Test Alarms

The alarm systems that alerts to any element of degraded performance should also provide preliminary diagnostic information. This level of diagnosis may be limited to the identity of the offending unit of equipment and the kind of offense being observed.

2.1.7 Emergency Priority

The trunked radio system operating in a public safety environment should have the capability of providing prompt channel access to mobile units exposed to life threatening situations or other incidents which require the immediate response of emergency services. The general approaches to emergency priority capability for a trunked radio system are discussed in the following paragraphs. The conditions under which initiation of any of these priority functions would be authorized include all of the following:

- A routine request for channel has been denied by the trunked system because all channels are in use and
- There has been a waiting queue established for the next available channel and
- The activation of the priority function has been conscionable decision; i.e., there has been a manual switch closure

These conditions presume the implementation of a dedicated control channel type of trunked radio system. If all channels are in use in a distributed logic system, the mobile will be in a frequency search mode and will have no capability of requesting emergency priority considerations and there will be no capability of developing a waiting queue with or without priority. Therefore the following three basic alternatives of Ruthless Preemption, Dispatcher Alert, and Waiting Queue Priority refer only to a dedicated control channel trunked system.

2.1.7.1 Ruthless Preemption

Ruthless Preemption will result in the seizure of any radio channel (except the Control Channel) from its current user. For a reasonable and automated decision to be made, the assumptions must be that:

- The controller has a positive indication that the seized channel was not carrying equally urgent emergency traffic at the time it was seized
- The controller is able to select a channel carrying non-critical traffic.

There is no assurance that these assumptions can be realized. The normal mobile/control station identifier or preamble will contain only the unit address. There is no information in the identifier that would signify the urgency of a given communication even among those mobile units who, by their identifier, are known by the controller to have preemption capability.

To permit the ruthless preemption of an in-use channel appears to be a very difficult equipment problem, programming problem, and operational problem. This approach to emergency priority is not recommended.

2.1.7.2 Dispatcher Alert

The activation of a unique and manually initiated emergency priority request through the control channel can be recognized by the Controller. An alert alarm message will be directed to the dispatch point assigned to the mobile unit; this message will also contain the identity of the mobile unit making the request. If the emergency priority capability is restricted to public safety mobiles, it is conceivable that this dispatch point will have one or more of the system channels in use at that time the priority alert is received and can release on of these channels to the mobile that requested the priority. This assumes that:

- The dispatcher has information relative to the identity of the trunked radio channel being used by his agency and can identify this channel to the Controller so that the mobile can be instructed to move to that specific radio channel and
- The dispatcher can "freeze" the channel long enough so that the mobile can be switched into it before the system drops the channel (otherwise the next mobile in the waiting queue will capture the idle channel).

It is possible to meet those requirements through hardware and software development. The complexity and estimated cost of the development constrains the recommendation of this method of enabling an emergency priority.

2.1.7.3 Waiting Queue Priority

A more easily implemented approach to emergency priority is to move the priority request for channel access to the top position in the waiting queue without attempting to seize a channel. The success of this method depends upon the following assumptions:

- The trunked system is properly engineered and, in complying with FCC liecensing criteria, the probablity of blockage at peak busy hours is minimal and
- Channel discipline is such that channel hold time for the average communication transaction is no greater than a few seconds (hopefully less than 5 seconds).

This type of emergency priority is inexpensive to implement in a dedicated control channel trunked system when compared to the other alternatives. Channel access to a well managed trunked system will normally be made within a few seconds even when the first call has been blocked. The Waiting Queue Priority system will insure that additional lost time is not incurred due to the size of the waiting queue. This method of emergency priority is recommended for the Phoenix trunked system.

2.1.8 Intersystem Operations

A mobile unit equipped with a trunked radio system configured for operation in the Greater Phoenix area can have difficulty communicating in other Arizona jurisdictions outside the Phoenix area each of which would have its own unique trunked system. Two of the more probable situations will be discussed briefly in the following paragraphs, one in which the adjacent trunked systems are provided by the same supplier, and the other in which the adjacent systems are provided by different suppliers. It is assumed that all mobile trunked radios have 800 MHz frequency synthesizers.

2.1.8.1 Vendor Compatible Equipment

When adjacent jurisdictions have procured trunked radio systems from the same vendor, the signaling methodology and protocols are assumed to be compatible. It is possible with coordinated planning between the cooperative jurisdictions for a mobile from one jurisdiction to be able to communicate within the trunked system of the other jurisdiction. However, the following must also be addressed:

- It must be assured that the visiting mobile be able to identify and access the host control channel frequency
- The host trunked system controller will have to recognize and accommodate any limitation in the visiting moble radio channel configuration. For example, a mobile from a 10 channel trunked system can not fully accept channel instructions from the controller of a 20 channel system

- The problem of a visiting mobile communicating directly with its own dispatcher in its owned trunked system through the facilities of a host trunked system also involves long haul transmission media. To automate such an interconnection will involve additional compatible switching logic at the controllers of both trunked systems and may also require the use of private backbone microwave systems or, alternatively, the use of the public access telephone system. This may require special waivers of the FCC Rules and Regulations regarding interconnect services.

The difficulties presented by the casual unplanned intrusion of a visiting trunked mobile unit into a host trunked system are formidable and go unresolved by vendor offerings at this time. In the Greater Phoenix area it is recommended that all trunked radio facilities of the several candidate jurisidictions be planned as part of the same radio system supplied by the same contractor.

2.1.8.2. Multiple Vendor Incompatibility

At this time the hardware and software offerings of the key vendors of trunked radio systems are incompatible with each other. Although the radio frequencies, as assigned by the FCC for trunked systems, can be accessed by the mobile frequency synthesizers of competitive suppliers, the channel control methodology and protocols are incomprehensible between the competitor's equipment. Visiting mobiles intruding upon a host trunked radio system supplied by another vendor will remain completely out of communication with the host system.

2.2 SYSTEMS CONSIDERATIONS

The following system considerations will be addressed during the system concept development of the Phoenix trunked radio system.

2.2.1 CAD/MDT Interfaces

The public safety agencies in Phoenix plan a continuing expansion of land-mobile data transmission by means of mobile data terminals. These terminals will be interfaced with the public safety data files that serve the police and fire departments CAD systems. Mesa plans to expand Public Works MDT installations. Therefore, the engineering design of the trunked radio system, as proposed by the system contractor, must be based upon the bit error rate limitations of the digital system rather than analog voice intelligibility. This manifests itself in these areas:

- Data rate error limitations will reduce the expected radio coverage range by approximately 6dB from that calculated for analog voice traffic according to past experience

- The error detection, error correction, and message retransmission coding of the digital MDT system must be compatible with the multipath deep fade characteristics of the digital trunked radio communication system at 800 MHz (MDT data rates could be advisely affected)

- The mobile terminal call-up and address protocols will have to be compatible with the switching delays introduced by the call-up and address protocols of the trunked system

- If automatic status updating is included in the trunked system, the CAD system must be programmed to recognize the unit address and relate that address to a specific incident report in the journal file.

The system contractor for the trunked radio system must be required to conduct sufficient tests to insure compatiblity between the existing CAD/MDT systems and the trunked radio system being offered.

2.2.2 Mobile-to-Mobile Communication

Mobile-to-mobile communication is inherent in the trunked radio system. Each mobile is assigned a group address and this group address is accessed by the controller using the address code of the mobile unit; the controller software determines what group code will be accessed by each mobile on an initial call-up. A single mobile unit can also be considered as a special subgroup within the assigned group. A mobile can be programmed to communicate with any other mobile in the group through the repeater.

If intergroup or interagency flexibility is needed the mobile unit can also be programmed to access the trunked system controller through the dispatcher or controller terminal operator. The dispatcher or terminal operator can, through software instruction to the controller, enable the mobile unit to call up any individual address, group address, or subgroup address within the capability of the trunked system.

This arrangement keeps the mobile logic as simple as possible and provides a higher level decision filter for permissible mobile-to-mobile communications. It is recommended for the Phoenix trunked system.

2.2.3 Management Information

All of the switching process for the trunked radio system is accomplished at the central control location; the mobile unit or control unit input consists only of its identity code and group address. Statistical information relative to system operation and performance can be made available from this central control point. This system management information should consist of at least the following:

- System activity by each user agency

- System activity by each mobile or control station

- Channel use profiles by hour, day, week, month

- Use of any special features such as emergency priorityor cross agency coordination

- Total activity time for each channel
- System queue status
  - Profile by hour, day, weeks, and month
  - Average channel excess time from the queue.

Additional management data can be entered by the terminal keyboard. This data can include:

- User complaint reports
- Channel down time
  - Due to catastrophic failure
  - Due to maintenance activity
- Automatic test system performance deficiency alarms
- Maintenance reports
  - Time and material expended
  - Installation and test man power costs.

III. OPERATING REQUIREMENTS

The basic operating requirements for the trunked radio system have been gleened from the individual survey reports of the potential user agencies and from documentation reported from APCO Project 16A. The basic operating requirements are discussed in the following sections.

3.1 UNIT AND GROUP ADDRESS

For considerations of cost, system complexity, and system flexibility it is evident that control and switching logic should be held to the absolute minimum in mobile equipment and control station equipment. This will also enhance the ongoing and future development of hand held trunked portable equipment in which size, weight, and power drain become critical design limitations.

It is conceived that the only information needed from a mobile or control station for the controller to identify the unit, identify the dispatch point for the unit, and identify the other members of the group to be included in the communication, is the two part address code of the calling mobile or control station. This address will consist of the unit identity and the group identity. All of the routing and control information can be programmed into the Controller data memory and activated upon recognition of the unit address. Routing codes and group access codes can be changed at any time by keyboard entry.

To provide a level of flexibility and thereby reduce the dispatcher work load, selected mobile units may also be provided with the capability for manual modification of the programmed group address. These are conceived as only permitting subgroup level changes in the performance of routine assignments. An address modifier can also be used by the mobile to request an interconnection with another agency or another group within the mobile's own agency. The dispatcher or terminal operator can permit this variance from routine operation by keyboard or function key instruction to the Controller.

In response to situations that require a multiagency emergency coordination with possibly a mobile command post as a dispatch point, the central control point can create a phanton group address by keyboard entry. Any number or type of mobile units within the trunked radio system can be assigned to this phantom group by keyboard entry without any change being required of the mobile address or mobile identity code.

To accommodate this level of operational flexibility, it is recommended that the Phoenix trunked system require all routing and dispatch point logic be located at the central control point and that the minimum of switching and address logic be located in the trunked mobile/control stations.

3.2 INTERAGENCY COORDINATION

The survey of Phoenix area agencies resulted in the development of particular pattern of interagency coordination connectivity thought by the agencies to be appropriate to their operating needs. This pattern of permissible connectivity between the agencies must be programmed into the controller software and provisions made for it to be modified by program instruction as needed. This capability of the trunked system must be required of the system contractor by procurement specification.

3.3 DISPATCHER WORK LOAD

The recommended group address configuration for mobiles and their dispatcher is that all mobiles and/or control stations that are assigned to a dispatch point be also assigned the same group address. All mobiles in the group will routinely monitor all the traffic between the dispatcher and the fleet and between mobiles within the fleet.

This group configuration is similar to the conventional repeater radio channel operation now used except that non-group co-channel users will not be heard by the group on the trunked system. If all members of the group are not simultaneously aware of the traffic between group mobiles and the dispatcher it is probable that the dispatcher will receive simultaneous multiple requests for service, to which a single dispatcher can not respond. Communication blockage will occur because of dispatcher overload even though each requestor is able to access a separate radio channel to the dispatcher. The less cost effective alternative is to add multiple dispatchers to each active dispatch point.

3.4 FIELD UNIT STATUS

It is desirable that the status of the mobile field units be reported in coded form rather than by analog voice. The present methods of status indications take two general forms; one a status interrogation by the group dispatch point and the other a volunteer status report by the mobile unit.

3.4.1 Volunteer Status Report by the Mobile

A device to encode preestablished mobile status codes and transmit these to the dispatch point need not, and probably should not, be integral to the mobile trunked radio system. An external encoder when activated can key the mobile trunked radio and, when channel access to the dispatcher has been achieved, will cause the appropriate status code to be transmitted. The trunked mobile radio will automatically provide the vehicle identity.

A companion decoder at the dispatch point will provide status information associated with the vehicle identity. This decoder output can be interfaced with a display board or with existing CAD systems to provide automatic logging of the information and to possibly update the CAD incident report.

3.4.2 Status Interrogation

An automatic device that could interrogate the group mobiles as to their last reported status need not, and probably should not, be an integral part of the trunked radio system. The device need only to key up the control channel or idle channel with the group address and, having accessed the radio channel, transmit the encoded polling sequence to the mobile units within the group. Decoding the mobile response can also be outboard to the trunked system.

The mobile units in the group will require additional logic capability in order to respond to automatic status polling. Each mobile must recognize the initiation of the unique polling sequence and respond individually and uniquely with previously recorded encoded status when it recognizes its own individual unit address code. This will increase the cost of the logic in each mobile which is expected to respond to an automatic status interrogation.

A mobile responding to an automatic status interrogation can only respond with a retransmission of the status previously transmitted manually. This is not fresh information and adds little to what the system knows to be the status of the mobile unit. Therefore, automatic status interrogation is not recommended for Phoenix on the basis of it being not cost effiective.

3.5 RESTRICTED ACCESS

Under the stipulation that all group assignments, routing, and switching is done by controller software in response to the mobile unit address, it follows that any mobile unit can be programmed out of the system by keyboard instruction. A mobile unit address that has been locked out of the trunked system will receive no communications other than the mute control channel or idle tone and will be unable to capture a communications channel.

3.6 DISPATCH POINT DISPLAYS

Each dispatch point in the trunked radio system will receive only those mobile unit calls that are assigned specifically to that dispatch point by the controller software. The Phoenix survey shows that the identity of dispatch points and the location of active dispatch points change significantly with the change of work shifts and, in some cases, with the time of day. When dispatch positions are shared with other dispatch positions or dispatch points, the traffic can be merged with these other dispatch operations by software instruction. The dispatch position will display the following information for the mobile units assigned:

- Code identity of the mobile unit in communication with the dispatcher
- Code identity of the mobile unit exercising an emergency priority option.

3.7 MOBILE UNIT DISPLAYS

For operational integrity the trunked mobile unit should have the following displays:

- A handshake indicating a request for channel has been received by the system
- An indication that the request for a channel has been accepted and a channel has been made available
- An indication that the request for a channel has been denied and the request has been placed in a waiting queue (not applicable to distributed logic systems)
- An indication that the mobile unit is beyond the range of the system base stations.

These displays can be visual, audible, or a combination of both.

3.8 MOBILE-TO-MOBILE TALK AROUND

When outside the range of the system base stations the mobile units should have the ability for the half-duplex talk-around between mobile units. The factors that should be specified in procuring the system include the following:

- One specific channel frequency must be selected for this operation
- The initiation of talk-around should require a manual switch selection in the mobile to prevent the mobile from automatic selection of the talk-around mode when experiencing deep fade multipath conditions within the range of the base stations
- The talk-around mode will be inhibited when the mobile is within the useful range of the base station signal.

3.9 PUBLIC TELEPHONE SYSTEM INTERCONNECT

The need for interconnection with the public telephone system was not expressed by the potential user agencies during the survey but has been included in the published requirements of APCO Project 16A. It is advisable that the trunked radio system not be configured for mobile access to the public telephone system without dispatcher or control operator intervention. The system specifications must conform to the FCC Rules and Regulations in effect at the time apllication is made for the system license.

3.10 MANAGEMENT CONSIDERATIONS

The management of a trunked radio system will require the adherence to standards of quality, performance, maintenance, and administration not previously required of conventional radio systems. The delivery of acceptable communications services to a group of user organizations having diverse operational needs implies centalized management and operation of the trunked radio system.

3.10.1 Operation Management

The trunked radio system is a centralized radio system with unified control that requires centralized management for its efficient operation. Some of the centralized functions include:

. Financial Considerations

- Acquisition of implementation and expansion funds
- Procurement of joint-use hardware and software
- Preparation of recurring operating budgets
- Distribution of system costs to user agencies

Technical Considerations

- Development of interagency compatible software
- Hardware installation and test
- Unified vendor/supplier relationships
- Regulatory agency procedures
- Uniform system performance standards
- Uniform maintenance standards

. Personnel Considerations

- Acquisition and training of control operators
- Acquisition and training of software staff
- Training of system maintenance personnel
- Training of agency dispatchers and mobile operators

It is recommended that a centralized management be governed by a body which represents the user agencies in proportion to their participation in the trunked system.

3.10.2 Maintenance

The quality of the maintenance of all base station, control stations, mobile stations and/or cross band repeater equipment used in the trunked radio system must be standardized and should be accomplished by one highly trained and well equipped centralized maintenance organization preferably administered by the City of Phoenix.

IV. FUTURE FUNCTIONAL STANDARDIZATION

The expansion of the trunked radio system concept beyond independent local systems into interjurisdictional and interregional coordinated systems will depend in part upon basic standardization of methodology, procedures, control functions and control protocols that is not now evident in the vendors offerings. The lack of such standards will also prevent competitive modular procurement, post implementation modular expansion, and interjurisdictional expansion of even the presently conceived independent local systems.

There is concern that implementation and expansion of wide area trunked radio systems without the opportunity for competition modular expansion offered by national standardization will not be in the best interest of the public safety community.

APPENDIX B

BUCKS COUNTY, PA - FINAL LETTER REPORT

FOREWORD

This Appendix to the Draft System Implementation Plans for Participating Communities contains the complete final report to Bucks County, Pennsylvania pertaining to their planning for a DATCS implementation. Following their review of the system problems and requirements, it was their decision to pursue the upgrading of their conventional radio system and to defer the digitally addressed trunked communications system planning until a later time.

BOOZ · ALLEN & HAMILTON Inc.

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747-9303
AREA CODE 201

November 14, 1980

06992-005-001

Mr. Charles McGill
Director of Emergency Services
Bucks County Administration Bldg.
Room 107
Doylestown, Pennsylvania 18901

Dear Mr. McGill:

Since the APCO Project 16B support contract with Booz, Allen ends officially on November 15, 1980, it is appropriate at this time for Booz, Allen to provide to Bucks County a final letter report on the completed activities and accomplishments of this project. Although DATCS planning was conducted only through the problem analysis stage, we feel that positive results were achieved and that the project in Bucks County was as successful as in other communities. In this letter report we would like to summarize the accomplishments under our support agreement and identify some of the major benefits to the county as a result of participation in the APCO 16B Project.

1. ACCOMPLISHMENTS

The Support Agreement and Work Plan for Bucks County under APCO Project 16B outlined ten activities to be accomplished during the Booz, Allen support effort. With the combined efforts of Booz, Allen and Bucks County project personnel, six of these activities were completed. The more significant activities were as follows:

- Conduct necessary interviews and review available documents
- Document current radio communications systems and requirements
- Analyze problems related to DATCS and conflicting requirements.

The first activity was a data gathering effort to form the basis for documenting current systems and requirements. Prior to the interviews, a data collection guide (another of the six activities completed) was developed for use in the data gathering process. Approximately 20 organizations including police, fire, and rescue services were interviewed throughout the county to collect current and future requirements and to obtain information on current radio systems.

Following the data collection effort, a report was prepared that documented current mobile radio systems and requirements. This report provided a baseline description of the police, fire, and rescue mobile radio systems now in use, presented a list of current and future mobile radio requirements, and presented functional requirements for a new DATCS. This report provided the foundation for the DATCS problem analysis and for developing various alternative system design concepts.

The analysis of problems and conflicting requirements was performed and documented in a problem analysis report. This report identified a number of potential problems, developed three alternative mobile radio system concepts, and provided an analysis of the technical and operational impacts of each alternative, including budgetary cost estimates for system procurement. The three alternatives included a new UHF conventional mobile radio system, a partial DATCS (Lower Bucks with DATCS, Upper Bucks with existing conventional), and a county-wide DATCS. The outcome of our analysis indicated that some serious technical and operational deficiencies would exist with any form of DATCS implemented in the near future.

Our report advised the county that if UHF frequencies could be obtained to operate a new conventional UHF system (the county had a draft plan to license 21 UHF frequency pairs in the commercial UHF TV channel spectrum for a new public safety repeatered mobile radio system), then this solution would be certainly more desirable than any near-term DATCS solution for the county.

Upon consideration of this recommendation, the county decided to pursue the UHF conventional radio system solution. Upon receiving the necessary licenses and waivers to begin implementation of a conventional UHF system, DATCS planning under APCO 16B was terminated.

2. BENEFITS FROM COUNTY PARTICIPATION IN APCO 16B

Although the original objective to produce DATCS implementation planning documentation was not attained, Bucks County did, however, derive a number of benefits from participation in the APCO 16B project. Some of the more significant benefits realized are:

- The county had the opportunity to explore the trunked radio system concept as it compared to a new UHF conventional system.

- The results presented in the problem analysis report were instrumental in obtaining the necessary licenses and waivers from the FCC for the new UHF conventional system.

- The documents prepared for Bucks County (requirements report and problem analysis report) and for the entire APCO 16B project (the SIP Guideline manual) provided Bucks County communications planners with insights into the proper planning and implementation of new public safety radio systems, both trunked and conventional.

- Basic problems and requirements have been identified and established for a trunked radio system, should the county decide to implement a DATCS in the far term when trunked systems may be sufficiently advanced to satisfy the problems and requirements identified within the County.

* * * * *

In light of the accomplishments and benefits resulting from participation in the APCO 16B Project, we feel that the Bucks County portion of the project should be viewed as a successful endeavor. Although DATCS will not immediately be implemented in Bucks County, the concept was successfully investigated and the investigation led to a viable solution to provide better public safety mobile radio communications.

It has been a pleasure working with you during the APCO project, and we wish you every success in the planning and implementation of your new UHF radio system. Please feel free to call upon us should you require further assistance in any aspects of telecommunications planning and implementation.

Very truly yours,

BOOZ·ALLEN & HAMILTON Inc.

Gerald W. Bernas
Principal

Approved by:

William F. Stasior

William F. Stasior
Senior Vice President

cc: Bruce Fisher
Martin Ficke
Frank Grausso

END