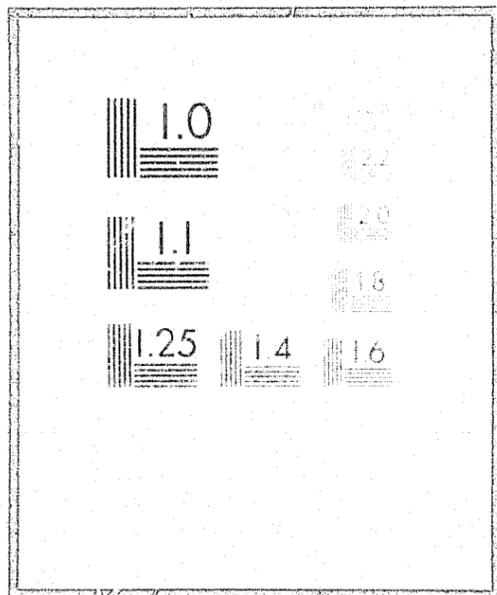


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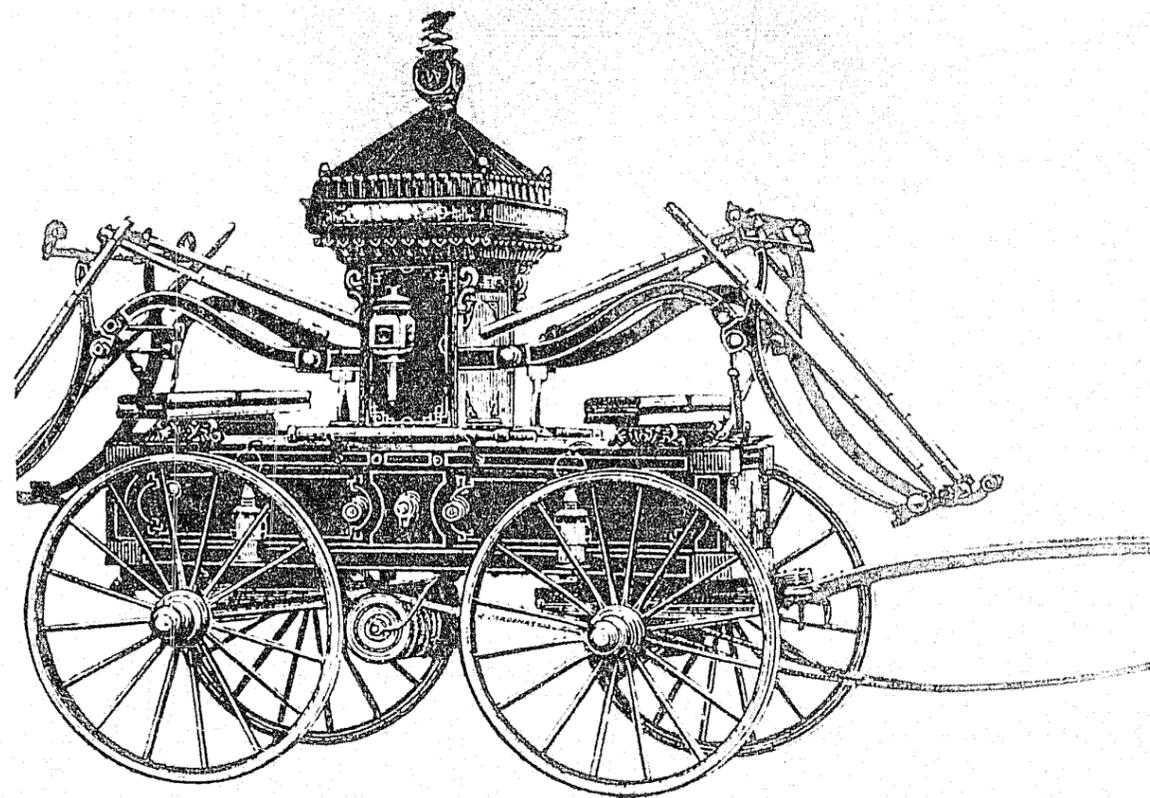
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Final Report: Volume I

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911 CONCEPTUAL DESIGN FOR THE CRAG AREA

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SUMMARY OF FINDINGS AND RECOMMENDATIONS

This report presents an analysis and recommendations for a conceptual design of a universal emergency telephone number (911) system for the five counties and associated cities of the Columbia Region Association of Governments (CRAG) area. Eight alternative system configurations are postulated, analyzed, and compared. For each of the eight alternatives, the personnel, telephone, facility, and major capital equipment required are given. For the recommended system alternatives, the methods of management, funding, and implementation that are best suited are described.

Specific findings and recommendations of the study are as follows:

Feasibility of 911 for CRAG

If the objective of CRAG is to maximize the ease and minimize the response time for citizens to the proper emergency services, then technical, operational, political, and financial analyses presented in this report would indicate that 911 is feasible for the CRAG area. In meeting this objective, however, the self-defined roles and operational procedures of law enforcement, fire protection, and emergency medical organizations must be changed to promote interagency and intergovernmental coordination. (Chapter I.)

Problems of Implementation

The CRAG area, with its 13 telephone companies, 120 public safety agencies, five counties and two states is far from an ideal region for the implementation of 911. The attitudes of cooperation expressed by many elected and appointed officials toward consolidation of public safety communications facilities and improved service to the public offset in large measure the problems posed by this unique political and institutional geography. (Chapter II.)

Philosophy of 911 Implementation

To solve the problem of the mismatch of telephone exchanges with county line and fire district jurisdictional boundaries by modification of the telephone plant would cost about

4 million dollars. This would greatly disrupt normal telephone service to the public and is, in our opinion, an unjustified solution. We conclude, instead, that it is only through intergovernmental cooperation to allow coordinated 911 answering among jurisdictions, rather than the preservation of existing fragmented public safety communications, that 911 can be made feasible in the CRAG area. (Chapter II.)

Operational Concept

To implement cooperative 911 telephone answering, a two-stage system in which 911 call answering from the public is separated functionally* from the radio dispatch of public safety resources is recommended. This system would utilize keyboard entry by 911 answering personnel together with computer indexing of telephone numbers, addresses, and agency jurisdictions to provide simultaneously rapid transfer of citizen information with a minimum of call transfers. (Chapter IV and Appendix C.)

Present Recoverable Costs

In computing the cost of 911 for the CRAG area, the present cost of facilities, telephone, and personnel must be considered to the extent that present costs are recoverable; that is, to the extent that the implementation and operating costs of any of the new systems proposed would be reduced. For the 52 small communications centers presently serving law enforcement and fire protection agencies in the CRAG area, the present value of space--measured by the cost to build additional space in the same facilities is about 1.2 million dollars. The telephone and personnel costs that are recoverable are about 2.02 million dollars annually. (Chapter V.)

System Alternatives for 911 and Radio Dispatch

The eight 911 telephone answering and radio dispatch options considered were formulated

*And possibly geographically and organizationally, as well.

by combining two 911 answering alternatives, regional 911 and county 911, and five radio dispatch alternatives: current facilities, one law enforcement and one fire center in each county, one combined law enforcement and fire center in each county, one law enforce-

ment and one fire center for the region, and one combined law enforcement and fire regional center.

On the basis of ten-year costs--initial and ten-year recurring--the following ranking of the systems* applies:

<u>911 Alternative</u>	<u>Radio Dispatch Alternative</u>	<u>Ten-Year Total (millions of dollars)</u>
Regional 911	One combined law enforcement and fire regional center	\$15.1
Regional 911	One law enforcement and one fire, two dispatch centers total	15.7
Regional 911	One combined law enforcement and fire center per county, five dispatch centers total	19.5
Regional 911	One each law enforcement and fire dispatch center per county, ten centers total	21.3
County 911	One combined law enforcement and fire center per county, five dispatch centers total	22.7
County 911	One each law enforcement and fire dispatch center per county, ten centers total	25.2
Regional 911	All current dispatch facilities, 52 total	32.0
County 911	All current dispatch facilities, 52 total	34.6

From the above it can be seen that with the exception of the alternatives that use current dispatch facilities for 911, all regional alternatives are lower in cost than all county alternatives. Furthermore, considering the 20.2 million dollars of recoverable dispatch costs over ten years, three of the regional alternatives would actually reduce costs when considered on a ten-year basis over what is currently being spent on communications including the costs of system implementation. (Chapter V.) In addition, the system design we have provided will be 50 percent more capable (i.e., can handle 1.5 times as many calls) than the existing system.

911 Recommendation

For the regional alternatives, about 10,000 main telephone stations (equivalent to about 20,000 people) would require the citizen's call to be transferred. For the county alternatives, about 270,000 main stations (or about 540,000 people) would require call transfer. On the basis of the vast difference in call transfer requirements and the significantly lower cost,

we unequivocally recommend regional 911 over county-by-county 911. (Chapter V.)

Radio Dispatch Recommendations

On the basis of operational factors, we recommend any of the first three alternatives listed above:

Regional 911 with

- (1) One dispatch center for the region.
- (2) Two regional dispatch centers (one each for law enforcement and fire).
- (3) One dispatch center per county.

Regional dispatch would offer the lowest cost and greatest operational benefit; its benefits would only be obtained, however, through cooperation on the part of local elected officials as well as law enforcement and fire agency heads. While we have seen significant evidence of a desire to consolidate on the part of various officials, at the present time our evidence indicates that the cooperation needed for regional dispatch is not manifest. For this

*Alternatives are illustrated on the last page of the Summary (Fig. S-1).

cooperation to become manifest, strong support from the public will be necessary. Such public support must in turn be created by strong public education from local elected officials on the costs and benefits of the alternative courses of action that are available.

Without this extensive public support, county-by-county radio dispatch, with regional 911 answering would be the best alternative. (Chapter V.)

Microwave Recommendations

Preliminary analysis of the cost of a microwave system to link the various central offices with a regional 911 center shows that, without considering the costs of interconnection to the telephone system and the costs of terminal equipment, a regional microwave system for 911 incoming lines could be paid for in about three and one-half years, when compared with the yearly telephone charges. We recommend, however, that a regional microwave system not be implemented until further analysis is made of the requirements for other local government communications that would use the same backbone facilities. (Chapter V.)

Emergency Medical Recommendations

For emergency medical communications we recommend the following features: (Chapter V.)

- A policy setting board that would include ambulance organizations, fire departments providing rescue and medical assistance, hospitals, and communications organizations.
- Each dispatch center implemented be provided a publicly funded dispatch capability for emergency medical care.
- Training courses for emergency medical communications procedures.
- A zoned system for improvement of emergency medical response.
- All "Code 3" ambulance requests be originated or be approved by the appropriate radio dispatch center.
- Ambulance companies be reimbursed for all "no loads" or "standbys" that are originated by dispatch center action.

Management Recommendations

On the basis of data acquired on the beliefs and perceptions of the political leaders of the region, we considered four alternatives for management of a regional system: management by a new entity; management by CRAG; management by Portland/Multnomah County in the CRISS format; and management by the Metropolitan Service District (MSD). Our recommendation is for management by MSD, when appropriate changes to the Metropolitan Service District Act are made by the state legislature of Oregon. An alternative would be management in a CRISS format, provided structural safeguards are built in to insure complete fairness and objectivity in management. In both alternatives, the use of an advisory or user board to set operational policies is strongly recommended. (Chapter VI.)

Recommended Financing

Five sources of funding for the regional alternatives were considered: federal grants, revenue sharing, an ad valorem property tax, a state-collected telephone excise tax, and private grants. For both implementation and operation of the system, our primary recommendation is a telephone excise tax. If such a tax cannot be obtained from the Oregon and Washington state legislatures, we would recommend implementation funding by federal grants in highway safety, emergency health, law enforcement, civil preparedness, and by the Robert Wood Johnson Foundation (emergency medical) and Ford Police Foundation private sources. Funding for operation, should the telephone excise be unavailable, should be by the ad valorem property tax levied for the MSD. (Chapter VI.)

Implementation

An implementation plan developed in this study provides for the system to become operational within two years after decision by CRAG. (Chapter VI.)

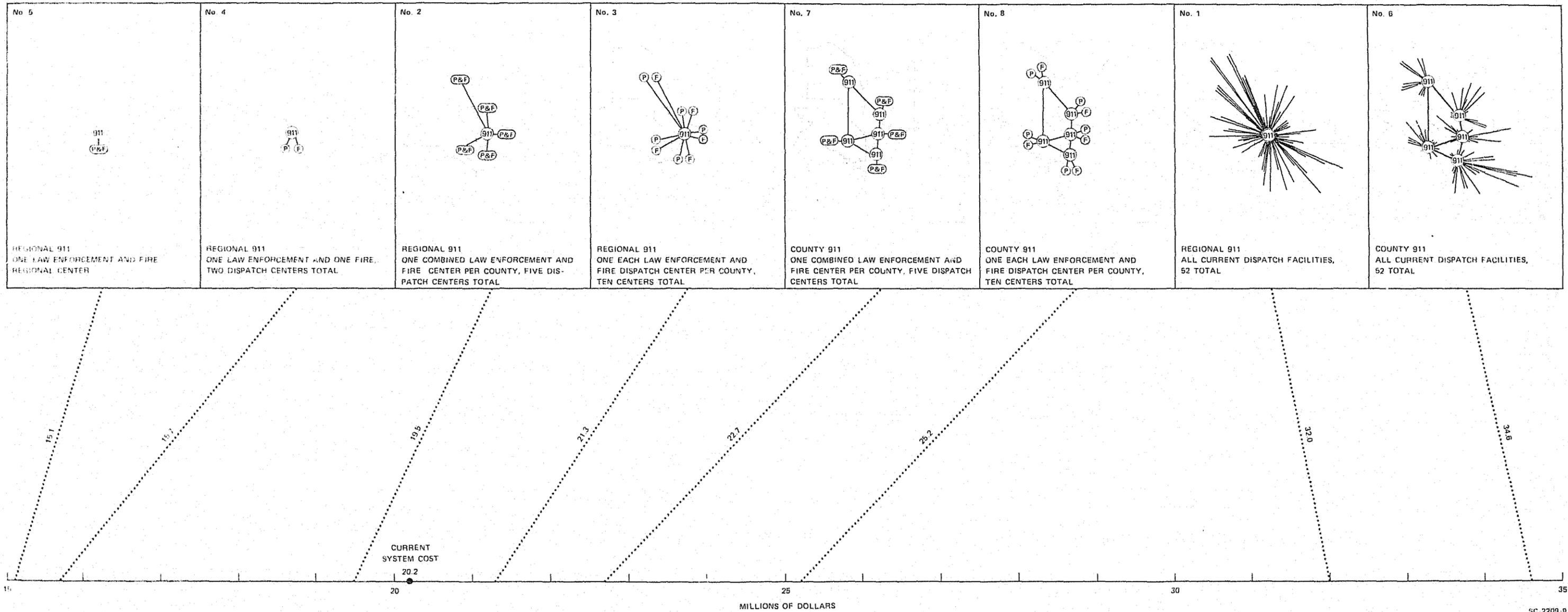


FIGURE S-1 TEN YEAR COSTS FOR SYSTEM ALTERNATIVES

I INTRODUCTION

A. BACKGROUND

On October 1, 1972, the Columbia Region Association of Governments (CRAG) selected SRI to develop a conceptual design for the implementation of a coordinated 911 emergency communications reporting and dispatching system. As initially planned, the study covered Columbia, Clackamas, and Washington counties in Oregon, and was to be completed by February 1, 1973. Subsequently, on January 15, 1973, the city of Vancouver and Clark county, Washington, jointly contracted with SRI for participation in the study, and on March 12, 1973, the city of Portland and Multnomah county, Oregon, were added to the study. To allow for the inclusion of these added cities and counties in the conceptual design, the completion date was extended to May 15, 1973.

The award of the contract was made under a federal action grant under the provisions of Part C of Title I of the Omnibus Crime Control and Safe Streets Act of 1968, as amended. CRAG, through her member agencies, contributed a local matching share in the form of contributed services of the Project Director, Mr. John Ryan of Washington county, and other police, fire, and communications officials from the city and county governments within the region.

B. OBJECTIVES

The overall goal of the effort described in this report was to improve the coordination among public safety organizations within the CRAG area and to facilitate citizen access to better coordinated emergency services.

Specific objectives, as stated in the contract, were the following:

- (1) A conceptual design (as opposed to a detailed engineering design) for the implementation of a coordinated emergency communications reporting and dispatching system.
- (2) Several system implementation alternatives, which may include, but will not be

limited to, a regional, local entity, and/or other desirable system.

- (3) A recommended implementation plan whereby the responsible governmental agencies may provide for a 911 emergency communication system(s) and associated dispatch facilities. The plan shall include a recommended configuration of the proposed system, the capital and operating costs, major equipment and facilities, and space and personnel requirements.
- (4) The alternative system configurations and implementation plans shall also include capital and operating costs, major equipment and facilities, and space and personnel requirements.
- (5) The alternative systems and the recommended implementation plan shall document major differences in terms of their expected impact on governmental and other entities affected. Economic and operational comparisons shall be presented in sufficient detail and language as to be readily understood by citizens and local officials.
In producing the above results, SRI shall specifically consider:
 - (a) The technical resources and expertise of the public safety and local governmental agencies participating in the program.
 - (b) The existing and already planned physical and transmission facilities and switching of the local and county governments as well as the telephone companies and other affected agencies.
 - (c) The capabilities of the various telephone companies to provide service commensurate with the past and expected rulings of the Oregon State Public Utilities Commission. In particular, to assure participating governments of the basis of the recommendations made by the contractor, written verification and documentation of telephone company intent shall be included.

- (d) The social, economic, legal requirements, and political processes and structures unique to each participating local and county government.
- (6) SRI shall investigate the availability of private, state, and federal funding programs to carry out the implementation plan and make such recommendations for outside funding.

C. PROCESS OF THE STUDY

It was recognized from the outset of this study that the success of this program--as measured by its resulting in an implemented 911 system as opposed merely to a report--depended heavily on strong collaboration, under the auspices of CRAG, between SRI and members of the local and county governments affected by the effort. It was anticipated that the successful implementation of 911 required some functional consolidation of many fragmented communication facilities. Such functional consolidation would require the active support of both elected officials and police, fire, and technical people employed in the various governments. Accordingly, our methodology was designed to insure that the recommended system concepts would have as wide a basis of consensus as possible.

Such consensus does not mean that the recommendations were to be unanimous or were arrived at through a process of majority vote. Each individual was accorded every opportunity to express his views throughout the course of the project in private and in meetings, and his views were considered in the light of rational argument. Some disagreement with our recommendations on the part of various individuals is expected, but we would not expect that those officials involved in the study would feel that their views were not considered fully. Hopefully, all individuals who have contributed to the study will feel a sense of responsibility in bringing a 911 system to fruition, even if some do not fully agree that the plan presented in this report is the best way to accomplish the task.

To implement the study process, CRAG, at SRI's request formed two task forces. One task force was made up of representatives of the various telephone companies operating within the region. The other was made up of law enforcement, fire protection, communications, and emergency medical officials representing both governmental and commercial

ambulance companies. Task force meetings were held every few weeks throughout the study. At each meeting, usually attended by 20 to 25 task force members, SRI provided written material on the progress of the study, gave a brief presentation, and received comments on the desirability of alternative courses of action. In addition, task force members performed the bulk of the data collection activities. By performing this task, the familiarity of the various members with their own activities was exploited to provide both more effective data collection and to enhance the feeling on the part of task force members for the orientation of the effort. Much spirited discussion took place, especially in the area of operational requirements for 911. After each meeting, the CRAG staff prepared minutes and an agenda for the next meeting.

Considerable help was also received from the CRAG Executive Board, as a body during briefings on the progress of the study and as individuals during the course of the study. Individual interviews were conducted with about 15 local elected and appointed officials in the five counties to determine the most effective management alternatives for a regional 911 system.

D. HISTORY AND PROGRESS OF 911

With the strong urging of the Federal Communications Commission (FCC), the availability of 911 as a universal emergency number was announced by the Bell System on January 12, 1968. According to statistics published by American Telephone and Telegraph (AT&T), as of June 1972 there were 222 systems in service and 56 systems scheduled to serve a total population of over 22 million. The basic idea of 911 is to provide a single, easily-remembered telephone number for all citizens to call for all emergencies. Such a number would reduce the total response time for emergency services--that is, the response time measured from inception of the citizen's need to delivery of such services to him. This is in contrast to the usual methods employed by public safety agencies for the measurement of response time--from receipt of call to delivery of service. The improvement in response time directly attributable to 911 is in the portion of time eliminated between the onset of need and the receipt of call by the public safety agency. Without 911, this time is often lengthy, since the citizen must look in

his telephone directory to find the proper number (in most metropolitan areas, there are usually tens of police, fire, and ambulance numbers in the directory), call the operator for assistance, or be transferred, sometimes haphazardly, from one agency to another.

The main advantage of 911 is the ease it provides the citizen in obtaining the help he needs. The main difficulty is that ease for the citizen comes only by close coordination between the public safety agencies, since all agencies involved must work together closely to plan and operate a 911 system. The narrow functional responsibilities preferred by many agencies at the expense of large public benefits are not possible with 911. In particular, 911 raises important and timely issues on the proper resource allocation policies of police; these issues transcend the technical problems of 911.

Costs of 911 vary in different areas of the country. Such costs are difficult to determine, since many 911 systems--in particular those implemented in larger cities--were coupled with other improvements to the communication systems of law enforcement and fire protection agencies. In many areas (and also for the CRAG area, as shown by this study), the largest costs are associated with additional personnel required to operate the system. These costs are offset considerably by the savings obtained from consolidation of communications facilities.

The major problem of 911 planning is to unify all agencies involved to work toward the common goal of implementing 911. By its very nature, a single emergency number requires consolidation of either telephone answering or radio dispatch facilities. Two types of general systems are in use through the United States. One, often called the "transfer method," requires that the 911 operators screen all calls and transfer the citizen to the appropriate agency without the citizen having to dial another number. The other, called the "relay method," requires the 911 operator to transfer the information given by the citizen to the agency. The relay method is superior to the transfer method in terms of reducing response time, but it requires greater cooperation among agencies at an operational level. It is the relay system that has been recommended for all alternatives in this study.

At the federal level, the Executive Office of the President supports 911 and encourages "local authorities to adopt and establish 911

emergency telephone service in all metropolitan areas, and throughout the United States. Whenever practicable, efforts should be initiated in both urban and rural areas at the same time."* Federal policy by the Executive branch, however, at the present time is that "responsibility for the establishment of 911 service should reside with local government." States are encouraged to assist local governments in providing for this service.

Considerable congressional interest, however, has been shown in 911 in recent years, and the momentum for requiring 911 (and for providing direct federal subvention for the additional costs) has been growing. In the 92nd Congress, bills for federal funding of 911 sponsored by Congressmen Roush of Indiana and Young of Florida attracted over 50 sponsors. In 1972, the state of California passed a bill sponsored by Assemblymen Warren and Russell, making 911 mandatory in the state by 1982, and providing for a plan to be worked out for state subvention to local government. We believe that many other states will probably pass similar statutes, and that within five to ten years 911 will be required by either federal or state law throughout the nation.

E. REPORT PLAN

Chapter II describes what we believe to be the nature of the problem of implementing 911 in the CRAG area. We contrast the political and institutional problems of the CRAG area with a jurisdictional ideal for implementing 911. This leads directly to the key assumptions we have made, and upon which our concept for 911 for CRAG is grounded. We then explore the problem of mismatch between public safety agencies and telephone exchanges and place some quantitative dimensions on the extent of such mismatch and the costs to the telephone companies to correct it. It is important to state that we do not endorse the extensive and costly changes described. On the contrary, we present them merely to provide objective explanation of the difficulties that would arise if local officials abrogate their responsibility for intergovernmental cooperation in favor of a posture of "let the phone company do it."

*"National Policy for Emergency Telephone Number 911," Executive Office of the President, Office of Telecommunication Policy, Bulletin No. 73-1, March 21, 1973. (Reprinted as Appendix G in this report.)

Chapter III presents the traffic analysis for the present expected traffic and that expected for 1990, for both 911 and radio dispatch.

Chapter IV contains (1) the operational requirements for exchange of information between telephone answering and radio dispatch; (2) a description of two classes of alternative 911 answering systems, regional and county-oriented, each with various radio dispatch options; and (3) the personnel, space, telephone line, and equipment requirements for the regional and county-by-county 911 systems.

Chapter V provides cost comparison for the alternatives on the basis of initial capital and recurring costs. A ranking (in terms of cost) of the various alternatives, over a ten-year period, is given.

Chapter VI provides recommendations for a proposed system with various alternatives. A plan for the management, implementation, operation and funding of the system is also given in this chapter.

Supplementary material used as a basis for many of the recommendations in this report is provided in a separately bound set of appendices. This material includes information on the public safety and telephone companies serving the five-county area, a discussion on the management of emergency medical resources, description of information processing and retrieval equipment, information on answering center force sizing requirements, facility costing information, answering center telephone line considerations and requirements, telephone costs, and the position of the Executive Office of the President on 911.

II THE NATURE OF THE PROBLEM

A. AN IDEAL 911 JURISDICTION

To aid in the understanding of the particular difficulties--or perhaps opportunities--that will be present in the implementation of 911 in the CRAG area, we describe an ideal 911 jurisdiction--a jurisdiction of arbitrary population, geographic area, and governmental level. Such a jurisdiction has but one important attribute: All physical, structural, and political conditions are tailored for complete ease in implementing 911. For other reasons, it might not be an especially desirable place to live and work.

First, we can describe the telephone system of such a jurisdiction. It should have but one telephone company throughout, with complete congruence of telephone exchanges with both the exterior boundaries of the jurisdiction and the interior boundaries between any sub-jurisdictions. The telephone equipment should be of the most modern variety, preferably with electronic switching equipment throughout. All pay telephones in this jurisdiction would of course be of the dial-tone-first variety; that is, they would require no money to dial 911. Most important, the costs of 911 telephone installation and operation would be absorbed completely by a public-service-minded telephone company, with benevolent investors.

The governmental structure of such a jurisdiction would be one in which there was both a high degree of central political authority and total obedience to this authority from police, fire, and communications agency heads. Central political authorities would dictate that 911 be implemented; law enforcement, fire protection, and communications agencies who are concerned with political ends or means would regard this decision as completely binding on their departmental policies without question. Law enforcement officials would view all citizens' requests for service as valid and would have sufficient resources to respond to all citizens' requests.

The jurisdiction would have one communication center that performed dispatch for all

public safety activities within its boundaries; if there were any other communications centers run by sub-jurisdictions, they would service areas that were in distinctly separate telephone exchanges.

Lastly, there would be no competition among law enforcement, fire protection, emergency medical service, or communications agencies for absorbing each other's communications facilities. Heads of such agencies would meet and decide that there should be one communications center to answer 911 calls from the public, dispatch emergency vehicles of all kinds, consolidate their activities physically, and in the process save their taxpayers a great deal of money in addition to providing them with 911. This ideal jurisdiction lacks the pluralism that characterizes most metropolitan areas in the United States where, ironically, 911 is needed most.

B. THE CRAG AREA COMPARED TO THE IDEAL

Instead of the ideal region's one telephone company, the CRAG area has thirteen, with almost every type of central office equipment from step to electronic switching. Over half of the telephone main stations are involved in some boundary mismatch problem; there are few pay telephones that are of the dial-tone-first type, and, needless to say, the investors in the thirteen telephone companies, if not excessive in their demands for return on invested capital are not totally benevolent either.

The five counties comprising the CRAG area contain 120 law enforcement, fire protection, and emergency medical service agencies. Officials of many of these agencies are active in the political life of their communities. Interaction with these officials individually and collectively during the project has given the distinct impression that they do not hesitate to both express and act upon their views on the desirability of 911. In particular, officials of many municipal fire departments and rural fire districts, who play important roles in the political life of their communities, view 911 as a distinct threat to the institutional forms of fire protection that have

existed for many years. For different reasons, some municipal police officials fear that 911 will create too much demand for service by the public, breaking apart the encapsulation of police from the community that presently keeps public demand for service within the limited budgets of the police departments. This in turn creates distrust on the part of officials of more service-oriented law enforcement agencies that the consolidation of 911 or dispatch facilities will cause their own citizens to complain about the quality of service.

The material and human resources allocated to public safety communications in the CRAG area are generally poor compared to those of more economically developed areas of the nation. There are only three communication directors employed by any of the jurisdictions in the region--Clackamas and Washington counties and the city of Portland. Public safety communications facilities are fragmented at present, with many one- and two-position single-stage communications centers that are frequently engineered, maintained, and operated at substandard levels of performance.

Yet on the part of the local governments involved, as well as the regional association of governments, there is clear recognition of these problems and a high degree of intentionality and enthusiasm has been mobilized to solve them. On the part of the county governments--Clackamas, Clark, Columbia, Multnomah, and Washington--there are definite programs underway aimed toward consolidating public safety dispatch. City governments within these counties are actively cooperating with the county governments by seriously considering joining these county dispatch centers by contract service or inter-governmental agreements. The city of Portland and Multnomah county are cooperating in the development of a modern police dispatch center to serve both the Portland Police Bureau (PPB) and the Multnomah County Department of Public Safety (MCDPS). CRAG has for several years sponsored and actively supported an enthusiastic communications subcommittee which both gave the initial impetus to the study described here and formed the nucleus of the task forces that have aided SRI substantially in the performance of the study.

To summarize, the CRAG area is beset with many technical, personnel, and political problems and deficiencies that will make im-

plementation of 911 difficult and perhaps costly; yet there is an active movement at all levels of government throughout the region to solve these problems and to create institutional forms that would make the implementation of 911 feasible.

C. 911 CONCEPTS FOR CRAG--BASIC ASSUMPTIONS

Considering both the ideal setting for 911 and the very real problems and presently ongoing solutions to some of these problems in the CRAG area, any concept for 911 in the CRAG area must be based on the following assumptions:

- There exists no presently operating facility that would be suitable for a complete 911 system--that is, a facility suitable for both 911 answering and radio dispatch of all public safety activities within the region.
- Modern communications and information systems technology makes technically and economically feasible the physical and functional separation of 911 telephone answering from radio dispatch, without deterioration of response time. This separation could be effected within the same facility or between different facilities. Specifically, this could be accomplished by digital transfer of the information received from the caller, rather than transfer of the caller.
- The momentum for consolidation of radio dispatch (which is believed to be highly desirable in addition to, but apart from, its advantages for implementing 911), would be either at the county level (or combined city/county in the case of Portland/Multnomah), or at a regional level.
- Our most critical assumption is that it is operationally, technically and organizationally feasible to consolidate further both 911 answering and radio dispatch operations of the various law enforcement and fire agencies within the region. The validity of this assumption rests on the following foundation:
 - That with the possible exception of the city of Portland, all of the law enforcement agencies within the region have more or less the same normalized telephone call volume; that is, the same number of calls per capita population.

This finding has been empirically confirmed in Chapter III.

- That any differences in policies of call answering; that is, the particular citizen requests that require dispatch action can be made effectively explicit to 911 answering personnel. Therefore radio dispatchers will not be burdened with direct conversations with citizens more than a small fraction of the time. This rests on sufficient information system capability for 911 operators, which we feel we have provided.
- That 911 answering personnel, who are not uniformed police or firemen, can be effectively trained to be responsive to the policies of different departments. This assumption has been confirmed in various dispatch centers throughout the nation.
- That radio dispatchers can likewise be trained to be responsive to the needs of various police and fire agencies if given the proper training and information system backup. If radio dispatch is consolidated on either a county or regional basis, the precise assignment of positions to different law enforcement, fire, and emergency medical agencies can be structured to assure responsiveness.
- Most important, the various senior officials of the law enforcement and fire agencies have both the will and flexibility to assure effective service to citizens with 911. This assumption rests partially on our knowledge of their attitudes acquired over the last six months and to a significant extent on our proposed structure for management and control which we have described in Chapter VI.
- Telephone system modification by either (1) sufficient new telephone switching equipment to implement automatic location identification or automatic call routing; or (2) modification of the existing telephone central offices in order to normalize the telephone exchange/public safety boundary mismatch problem would be prohibitively costly and therefore unlikely to occur given the present regulatory environment. This means that the resolution of the mismatch problem lies in the public safety agencies having as few 911 answering centers as possible

rather than the telephone companies allowing the present pattern of fragmentation of telephone answering to be perpetuated by technological rather than organizational change.

- The design of any 911 answering or radio dispatch facility must allow for incremental addition of public safety agencies served.*

On the basis of these assumptions, it is possible to postulate a set of alternative system concepts and a set of operational, technical, and administrative requirements that must be met by all alternative system concepts. Comparison of alternative systems and selection of recommended systems will then be possible. To demonstrate the magnitude of the need for consolidation of 911 answering facilities, the quantitative extent of the emergency service/telephone exchange mismatch problem will be presented.

D. EXTENT OF THE TELEPHONE AND EMERGENCY SERVICES BOUNDARY MISMATCH

1. Types of Mismatch

In Appendix A, Figures A-1 through A-15 illustrate the boundary mismatches among telephone, public safety, and political service areas. A mismatch can occur in any one of the following four situations:

- A citizen requiring emergency services calls from an exchange that is connected to a 911 center in another county.
- A citizen is in a fire district whose dispatch center is connected to a 911 center that is different from the 911 center to which the caller's exchange is connected.
- A citizen requiring emergency services calls from an exchange that is connected to a 911 center in an adjacent county but the citizen is in a county that does not have 911 service.

*For example, Clackamas county is presently planning a law enforcement dispatch facility that will not include fire at present. Both the Clackamas county dispatch facility as well as any 911 answering facility that serves it should be designed to allow either (1) consolidation of fire dispatch into the present law enforcement dispatch facility, or (2) consolidation of all fire dispatch in a separate facility. This is not to say that these alternatives are of equal benefit, but rather that they all must be considered as possible courses of action and therefore must be allowed for in the conceptual design.

- A citizen requiring emergency services in a county that does have 911 service calls from an exchange that is located in a county that does not have 911 service.

The first case is illustrated in Figure 1(a). The citizen is located in a telephone exchange that overlaps a county line. The exchange's central office is located in another county and is connected to the 911 center in that county. If the citizen requires assistance from his county sheriff, his call for the sheriff will be answered by the 911 center in the next county. Procedures would require that the 911 center receiving the call identify the calling location and pass the required information to the sheriff's dispatch center for the citizen's location, or transfer the citizen to the proper dispatch center.

The second boundary mismatch case is illustrated in Figure 1(b). In this case a citizen requests fire assistance from a fire district that overlaps county lines and is further split by two telephone exchanges or central offices. The call [Call Service point in Figure 1(b)] is first routed by Central Office (CO) No. 1 to the 911 center in which the CO is located. That 911 center recognizes that the correct fire dispatch facility is in another county and routes either the information or the citizen's call to the 911 center in the correct county. The second 911 center then contacts the correct fire district dispatch through its serving CO [shown as Central Office No. 2 in Figure 1(b)]. The correct equipment to aid the citizen is then dispatched by the fire district dispatchers.

Figures 1(c) and 1(d) illustrate the third and fourth boundary mismatch situations. These cases will occur along the exterior boundaries of the five-county region--Columbia/Clatsop, Washington/Yamhill, Washington/Marion, Clackamas/Marion, Clark/Skamania, and Clark/Cowlitz.

In Figure 1(c) the citizen is shown in an exchange that is connected to a 911 center but the citizen lives in a county not serviced by a 911 center. For that case, it is probable that the 911 operator would provide the citizen with a referral number for the county in which he lives. Alternatively, the 911 operator could simply tell the citizen that 911 was not active in the citizen's county and the citizen should use his telephone directory. This latter case

might occur if the 911 operator could not easily determine the correct number for the citizen's county.

Figure 1(d) illustrates a more serious situation in which the citizen lives in a county served by 911 but his exchange central office is in a county not served by 911. This situation could occur if most of the main stations in an exchange were in a county not served by 911 and it is economically and/or operationally not feasible to connect the exchange to the 911 center. In this case, the citizen will receive no response upon dialing 911 because the telephone equipment in the exchange will only recognize it as an incomplete number. It would be possible for the CO to recognize the 911 number and use a recorded message that would tell the citizen that 911 was not available in that exchange. This option would also have to be economically and/or operationally justified.

2. Magnitude of Mismatch

Information obtained from the telephone companies (see Appendix A) was used to quantify the extent of the mismatch due to telephone boundaries overlapping county lines of the types shown in Figures 1(a), (c), and (d). Table 1 lists the counties, exchanges, and telephone main stations affected by mismatch.

The number of main stations affected by mismatch in each county is given at the bottom of Table 1; the total for all counties in the study is 269,683. Some of these main stations are tied to central offices that are outside the five-county region. These central offices are: Jewell, Newberg, Aurora, Monitor, Silverton, Washougal River, and Woodland. These exchanges represent mismatch at the exterior boundaries as shown in Figure 1(d). Approximately 1,100 main stations (representing about 2,200 people, assuming 2 people per main station) in Clark, Washington, Clackamas, and Columbia counties would be affected by mismatch of Figure 1(d) if no provisions were made to connect these exchanges to the 911 center(s).

The other side of the problem, as illustrated by Figure 1(c), has about 10,700 main stations (about 21,400 population) which would receive a referral number from the 911 center(s). The proportion of the 11,800 main stations [Figures 1(c) and 1(d)] actually connected to the 911 center(s) will be a function

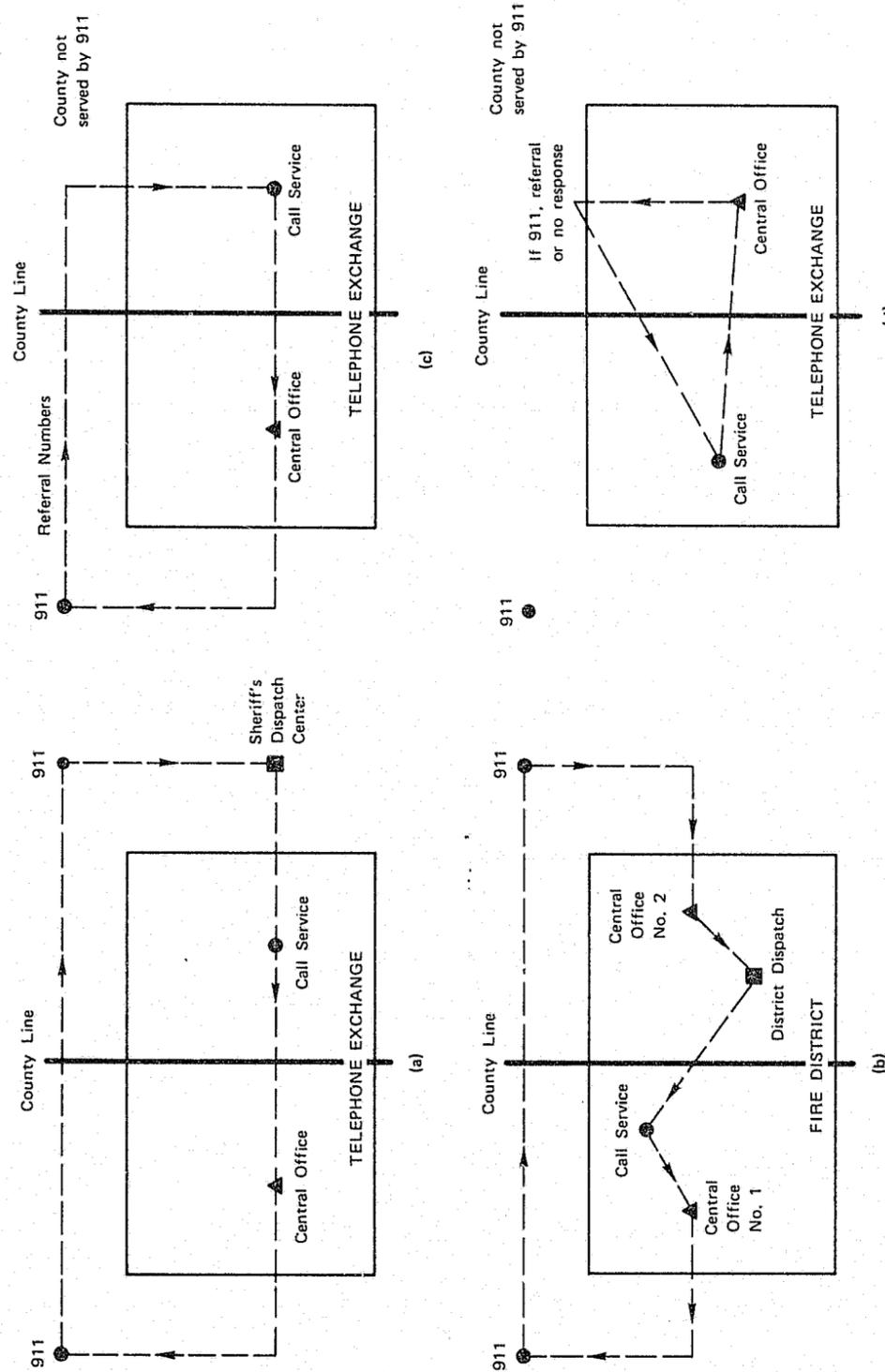


FIGURE 1

- (a) Case No. 1: County-by-county 911 Systems with Sheriff Service Required
 (b) Case No. 2: County-by-county 911 Fire Protection District Overlapping County Line and Cut into Two Telephone Exchanges
 (c) Case No. 3: Caller in Area Not Served by 911 is Referred to Local Public Safety Telephone Number
 (d) Case No. 4: Caller in Exchange Not Connected to 911 is Either Referred or Given Wrong Number Response

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Table 1

TELEPHONE BOUNDARY OVERLAP AND NUMBER OF MAIN STATIONS

Counties Overlapped	Central Office	Total Main Stations	Main Stations by County			
			Co	Cl	W	Mult
Columbia-Clatsop	Jewell	271	Co — 78	Clat — 193		
Columbia-Multnomah	Scappoose	1,838	Co — 1,798	Mult — 40		
Columbia-Washington	Vernonia	798	Co — 775	W — 21		
Washington-Multnomah	Somerset	2,566	W — 2,314	Mult — 252		
Washington-Multnomah	Cherry	18,180	W — 6,032	Mult — 12,148		
Washington-Multnomah	Cypress	9,045	W — 7,897	Mult — 1,148		
Washington-Clackamas	Stafford	2,472	W — 733	Clak — 1,739		
Washington-Clackamas	Tigard	8,823	W — 7,981	Clak — 842		
Wash-Clack-Yamhill	Sherwood	1,458	W — 729	Clak — 656		
				Y — 73		
Washington-Yamhill	Gaston	587	W — 555	Y — 32		
Washington-Yamhill	Scholls	982	W — 954	Y — 28		
Wash-Yam-Marion	Newberg	4,126	W — 227	Y — 3,706		
				Mar — 193		
Clackamas-Marion	Aurora	1,165	Cl — 215	Mar — 950		
Clackamas-Marion	Monitor	375	Cl — 210	Mar — 165		
Clackamas-Marion	Silverton	3,384	Cl — 40	Mar — 3,344		
Clackamas-Multnomah	Corbett/Aims	947	Cl — 35	Mult — 912		
Clackamas-Multnomah	Gresham	13,133	Cl — 3,068	Mult — 10,065		
Clackamas-Multnomah	Orient	2,092	Cl — 35	Mult — 2,057		
Clackamas-Multnomah	Harold					
	Street	11,607	Cl — 270	Mult — 11,337		
Clackamas-Multnomah	Lake Oswego	8,943	Cl — 8,076	Mult — 867		
Clackamas-Multnomah	Oak Grove/Mil	18,604	Cl — 18,519	Mult — 85		
Clackamas-Multnomah	Prospect	29,045	Cl — 1,405	Mult — 27,640		
Clark-Skamania	Washougal	2,333	Cl — 2,233	Ska — 100		
Clark-Skamania	Washougal	241	Cl — 111	Ska — 130		
Clark-Cowlitz	Woodland	1,390	Cl — 222	Cowl — 1,168		
Clark-Cowlitz	Amboy	294	Cl — 282	Cowl — 12		
<u>Total main stations, all counties:</u>		269,683				
<u>Total main stations, each county:</u>						
	Clackamas:	71,560	Multnomah:	67,099		
	Columbia:	9,746	Clatsop:	193		
	Washington:	64,044	Marion:	4,652		
	Clark:	4,258	Yamhill:	3,839		
			Cowlitz:	1,180		
			Skamania:	230		

of the economics/operations of the system and will be discussed later.

The internal boundaries between the four Oregon counties (Clark county boundaries with Oregon are all continuous with telephone exchange boundaries) cause mismatch of the Figure 1(a) type if there are 911 centers in each county rather than a single regional 911 center. Approximately 260,000 main stations (approximately 520,000 population) would be affected by this problem of call transfers from county to county.

The fire district boundary problem illustrated in Figure 1(b) is more difficult to quantify because it cannot be separated from the telephone boundary/political boundary mismatch problem. To illustrate the extent of the difficulty, however, population estimates were made for those fire districts that straddle county lines. Table 2 shows the results of that analysis, with county lines, fire districts, and populations shown for all such fire districts. Interior boundary problems—Washington county FPD No. 1,* Multnomah RFPD No. 11,* Lake Oswego, and Tualatin RFPD—are similar to that illustrated in Figure 1(a) and are amenable to solution through some form of call transfer. All other boundary problems listed in Table 2 also contain elements of the telephone boundary problems illustrated in Figures 1(c) and 1(d).

The boundary problems described in this section must be resolved by the 911 system selected for the CRAG area. Technical and management techniques for accomplishing this resolution are discussed in the remainder of the report.

3. Costs for Solution of Boundary Mismatch†

There are two primary ways to solve boundary mismatch in the CRAG region: (1) by intergovernmental cooperation and (2) by technical modification of the telephone plant. Intergovernmental cooperation is preferred; technical modification represents an expensive alternative. Objective estimates of the costs to the telephone companies for plant modification were developed on the basis of current materials, equipment, and

* FPD = Fire protection district.

RFPD = Rural fire protection district.

† Portions of this section were contributed by Mr. W. Curtiss Knoll of Berkeley, California.

labor costs and are presented below. In addition to the cost factor as a consideration is the disruption of normal telephone service that would result from plant modification. This disruption may be so severe that approval of a modification project would be denied by the state utilities commission.

Telephone companies provide their service on the basis of geographical (exchange*) boundaries, and their plant and central office facilities are situated on this basis. Any use of the telephone system must, therefore, consider this serving arrangement.

Of the 64 central offices serving the five-county region, there are 23 telephone central office boundaries that overlap county boundaries. Extensive central office installations and outside cabling have been built and laid out to coincide with these boundaries. Telephone rates and tariffs are based on these exchanges and their serving arrangements. To attempt to alter them would require a project of major proportions. Expensive central office equipment additions and trunking rearrangements would be required to enable the central office equipment to automatically route 911 calls to take into consideration the county boundaries.

Table 3 shows rough cost estimates of the expense to the telephone companies to solve boundary mismatch. The costs shown in Table 3 would be applicable if the alternative of a 911 center for each county were adopted (26 central offices involved) and interagency call transfer were not desired. The column headed "Line and Trunk Rearrangements" refers mainly to labor costs but also contemplates the adaption of some existing equipment.

The estimate of \$544,000-plus shown in Table 3 does not include the recurring costs of administration which multiply with the various subdivisions of a central office, nor does it include the cost of building additions if required. Not included also are all of the costs of the study, planning, and engineering that would be required before implementation.

To arrange the equipment in the central offices to handle the overlap problem with the fire districts would again require subdividing the central offices and furnishing extra service equipment and trunking. It is

*An exchange may contain one or more central office serving areas.

Table 2

COUNTY LINE—FIRE DISTRICT BOUNDARY MISMATCH

Counties	Fire Districts	Total	Population by County	
			Wash	Yam
Washington-Yamhill	Gaston RFPD	4,000	—	3,000
Washington-Multnomah	Wash. Co. FPD No. 1	91,000	—	88,000
Washington-Clackamas	Tualatin RFPD	26,000	—	22,000
Clackamas-Marion	Aurora RFPD	5,000	—	1,000
Clackamas-Marion	Monitor RFPD	2,500	—	2,000
Clackamas-Multnomah	Lake Oswego	21,000	—	20,000
Clackamas-Multnomah	Multnomah RFPD No. 11	7,000	—	2,000
Clackamas-Marion	Scotts Mills RFPD	1,000	—	500
Clark-Cowlitz	FPD No. 2	2,500	—	2,100

Totals:	All Population	=	157,500
	Washington Co.	=	113,000
	Clackamas Co.	=	29,500
	Multnomah	=	9,000
	Marion Co.	=	5,000
	Yamhill Co.	=	1,000
	Clark Co.	=	2,100
	Cowlitz Co.	=	400

Table 3

TELEPHONE COMPANY COSTS FOR SOLUTION OF BOUNDARY MISMATCH--911 SYSTEM IN EACH COUNTY

Telephone Company: Central Office Name	Cost (\$1,000)		
	Line Finder and Selector Equipment	Line and Trunk Rearrangements	Total
PNB*			
Cherry	49	30	79
Cypress	42 [‡]	6	48
Harold Street		2	2 ⁺
Jewell	14	1	15
Lake Oswego	42	5	47
Oak Grove/Milwaukie (Has both SXS and #5XB equipment)	21 [‡]	1	22 ⁺
Prospect	49	7	56
Subtotal	217 ⁺	52	269 ⁺
GTNW†			
Gaston	7	1	8
Gresham	42	15	57
Newberg	21 [‡]	2	23
Orient		1	1 ⁺
Scholls	7	1	8
Sherwood	28	1	29
Somerset	14	2	16
Stafford	28 [‡]	4	32
Tigard		5	5 ⁺
Vernonia	7	1	8
Washougal	14 [‡]	1	15
Washougal River		1	1 ⁺
Woodland	14	2	16
Subtotal	182 ⁺	37	219 ⁺
Other Independents			
Aurora	14	2	16
Cascade Utilities			
Corbett/Aims	7	1	8
Monitor Cooperative	7	1	8
Rose Valley			
Scappoose	7	1	8
Valley			
Silverton	7	1	8
Lewis River			
Amboy	7	1	8
Subtotal	49	7	56
Grand Total	448 ⁺	96	544 ⁺

*PNB = Pacific Northwest Bell Telephone Company.

†GTNW = General Telephone Company of the Northwest.

‡ These offices would need additional class of service serving equipment. The cost of this equipment is unknown at this time.

estimated that this would cost approximately \$400,000 for central office equipment, and \$20 per main station for cable and trunk re-arrangements in each central office involved. From Table 2, for 157,500 main stations the cost would be \$400,000 plus \$20 x 157,500 or \$3,550,000. Again, this does not include all the costs of planning and engineering.

The minimum total cost is then \$544,000 plus \$3,550,000 or \$4,094,000.

As an alternative to costly equipment arrangements or exclusion of some citizens from 911 service because most of the stations in their telephone exchange are in a county not served by 911, foreign exchange (FEX) lines could be connected from the 911 center to those exchanges in which the minority of the telephones are not served by 911. This means that, instead of dialing 911, these people would dial a special seven-digit number to reach the 911 center.

For example, in Valley Telephone Company's Silverton exchange, 40 of the stations are in Clackamas county and 3,344 of the stations are in Marion county. It is probably not feasible for the 911 center to serve all of the 3,384 stations. Therefore, rather than deny 911 service to the citizens being served by the 40 stations in Clackamas county, these subscribers could be individually informed that their existing seven-digit emergency numbers were being replaced by one seven-digit emergency number that would connect them with the 911 center.

The cost of this alternative has not been estimated, and it is presented here solely to provide another means of solving the boundary problem. The feasibility of this alternative would require further study because in some cases not only does the telephone exchange boundary overlap a county boundary but a fire district boundary also overlaps the county line within the telephone exchange. When the final engineering design is performed, this alternative could be studied in detail.

E. EMERGENCY MEDICAL SERVICES

Two forms of emergency medical services must be incorporated into the 911 system. These are (1) the dispatched services which include ambulances, rescue vehicles, and first aid vehicles, and (2) the advisory services such as poison control centers and suicide prevention centers. The existing advisory services can be connected by direct telephone lines to the

911 answering center or centers but the operations of the dispatched services require further study so that they can be connected to the center in a way that will provide the citizens of the CRAG area with efficient utilization of their services.

Emergency medical transportation, rescue, and first aid services are provided in the CRAG area by publicly-funded and voluntary fire departments, volunteer ambulance companies, and commercial ambulance companies (Appendix A). Some of the rural areas are served by an ambulance company which must provide service to a large geographical area with a relatively small population while the more urbanized areas are served by competing commercial companies. Commercial ambulances are not restricted by county boundaries (nor should they be) and companies based in the CRAG area serve counties outside the CRAG area (e.g., ambulances based in Forest Grove serve Tillamook and Yamhill counties) and northern Columbia county and northern Clark county are served by a company based in Cowlitz county.

Although no formal management of emergency medical resources presently exists for the region, there are informal agreements among the commercial ambulance companies and between ambulance companies and public safety agencies. These agreements vary from one county to another but their intent is to improve the efficiency of the ambulance service. There are some policies established between public safety agencies and ambulance companies that prevent the citizen receiving the full benefit of emergency medical services.*

In addition to considering the variations in ambulance availability and dispatching policies throughout the region, it is also necessary to consider the emergency medical services the various ambulance companies can provide. Although an ambulance has been traditionally considered as an emergency transportation vehicle staffed with an attendant capable of providing first aid to an injured citizen, this traditional concept falls short of the capability of many modern ambulances. In addition to first aid supplies, modern ambulances are

*In particular unnecessary delays can be caused by such agreements as the "12-9" policy in Multnomah county, whereby a police officer must report to the scene of an emergency to verify the need for dispatching an ambulance when one has been requested through the police department or a telephone company operator.

equipped with oxygen and resuscitation equipment, and, in some cases, equipment to monitor and transmit the vital signs of an individual. Besides the various types of equipment carried within the ambulances, there are variations in the training which the attendants have received. Since this study is concerned primarily with the communications aspects and their effects on the operation and feasibility of the 911 system, it is beyond the scope of this program to make a detailed analysis

and evaluation of the medical services provided by each entity serving the CRAG area, but it is important to note that these variations exist and they must be considered in the ultimate implementation of the 911 system.

The coordination of emergency medical services was discussed with the owners of commercial and volunteer ambulance companies. A technique to assist in the management of these resources, which grew out of these discussions, is described in Appendix B.

III TRAFFIC ANALYSIS

A. PUBLIC SAFETY AGENCY INFORMATION

The first step in traffic analysis was to identify and locate all public safety agencies--fire, police and emergency medical--in the five-county region. In Appendix A the locations, dispatch functions, and interconnections for each of the three services are shown.

Because the 911 center(s) must actually be connected to only the dispatch locations, a determination was made of those facilities that provide dispatch services for other agencies. Appendix A lists law enforcement and fire protection agencies on a county-by-county basis with their addresses and dispatch configurations. Other tables in Appendix A list ambulance and rescue facilities in the five-county area and whether these facilities are operated by private, fire, or volunteer agencies. These data, provided by the agencies, served as the basic data base for the study.

The tables in Appendix A show that 65 fire agencies, 38 police agencies, and 17 private and volunteer ambulance agencies are contained in the five-county region. A total of 21 fire agencies provide ambulance and/or rescue services, so only 17 private ambulance companies must be independently linked to the 911 center(s). Of these 120 agencies, only 69 must be linked to the 911 center(s) because of the existing dispatch combinations illustrated in Appendix A. An additional small group of agencies that serve the regional area should also be connected to the 911 centers. Examples of such agencies are the Federal Bureau of Investigation, U.S. Forest Service, Suicide Prevention Service, Poison Control Center, and so on as listed in Appendix A.

B. TELEPHONE COMPANY INFORMATION

The five-county area is served by Pacific Northwest Bell Telephone Company (PNB); a large independent, General Telephone Company of the Northwest (GTNW); and eleven other independent companies. Details on these companies are provided in Section G of Appendix A which contains information on: types of central office equipment, number of

main stations by type--residence, business and coin--and a breakdown of main stations by county.

Within the five-county area are 64 central offices including those which lie outside the CRAG region but which have main stations in the CRAG region. The locations of these central offices and their service areas are shown superimposed on a map of the CRAG region in Figure 2. Figure 2 clearly shows that many of the areas served by these central offices bear no resemblance to the political jurisdictions in the counties. Similarly, it can be seen by comparing these telephone boundaries with boundaries shown in Appendix A that there is little coincidence between the telephone, public safety agency, and political service areas.

Table 4 summarizes the number of companies, central offices (COs), and main stations in the five-county area. If all citizens of the five counties are to receive 911 service, each of the 64 central offices must be connected to the 911 center(s) configured for the CRAG region. Note, however, that 911 connection will require that procedures and/or equipment be developed to handle calls from citizens of five other counties because they use telephone service common with those in the CRAG counties.

C. TELEPHONE TRAFFIC ESTIMATION

Each public safety agency was asked to determine its peak hour telephone traffic. Appendix A shows that about 25 of the 120 agencies responded,* with law enforcement agencies giving the largest response. In general, the ambulance companies have a small total traffic volume so that peak hour traffic is not as meaningful as a measure of their communication requirements. Fire protection agencies are characterized by sporadic peaks of activity and normally do not have long-term records from which peak traffic data can be derived. The data that was obtained from the agencies

*Traffic data for Portland and Multnomah county were obtained from a separate study performed by Public Safety Systems Inc. (PSSI) for that city and county.

Table 4

SUMMARY OF TELEPHONE STATISTICS

Telephone Company	No. of COs	No. of Prefixes	No. of Main Stations
PNB	25	65	339,253
GTNW	21	26	82,855
11 Independents	18	19	28,949
Total	64	110	451,057*

Telephone Number Prefixes

PNB					GTNW		Eleven Independents	
221	236	281	556	774	324	646	266	658
222	243	282	621	775	357	648	375	678
223	244	283	635	777	429	649	548	824
224	246	284	636	256†	538	663	622	829
225	248	285	647	686	620	665	630	834
226	252	286	654	687	625	666	631	873
227	253	287	655	693	628	668	632	247†
228	254	288	656	694	638	728	634	263
229	255	289	659	695	639	985	637	269
232	256	292	755	696	640	225†	651	
233	257	297	760	699	643	834		
234	272	374	761	887	644	835		
235	280	397	771	892	645	837		

*Because of the telephone exchange boundary overlap problem, this total includes subscribers in Clatsop, Marion, Cowlitz, Skamania, and Yamhill counties. There is also overlap into Hood River, Jefferson, and Wasco counties, but at the present time there are no subscribers in these overlapped areas.

†The remainder of the prefixes are in Clark county, Washington, which is in another area code.

was used to extrapolate and interpolate traffic volume data for all nonresponding agencies in order to correctly size the alternative 911 systems. In this section, the traffic volume sizing analysis will be described.

1. Incoming Traffic

All available peak hour telephone traffic data was first used to establish traffic as a function of population in the CRAG region.

Population per public safety agency jurisdiction was obtained from 1970 census data. Using these data, curve-fitting for minimum least squares error was performed for both law enforcement and fire protection agencies.

Figure 3 shows the data supplied to us from various law enforcement agencies, not including Portland Police Bureau (PPB) or Multnomah County Department of Public Safety (MCDPS). These data were obtained

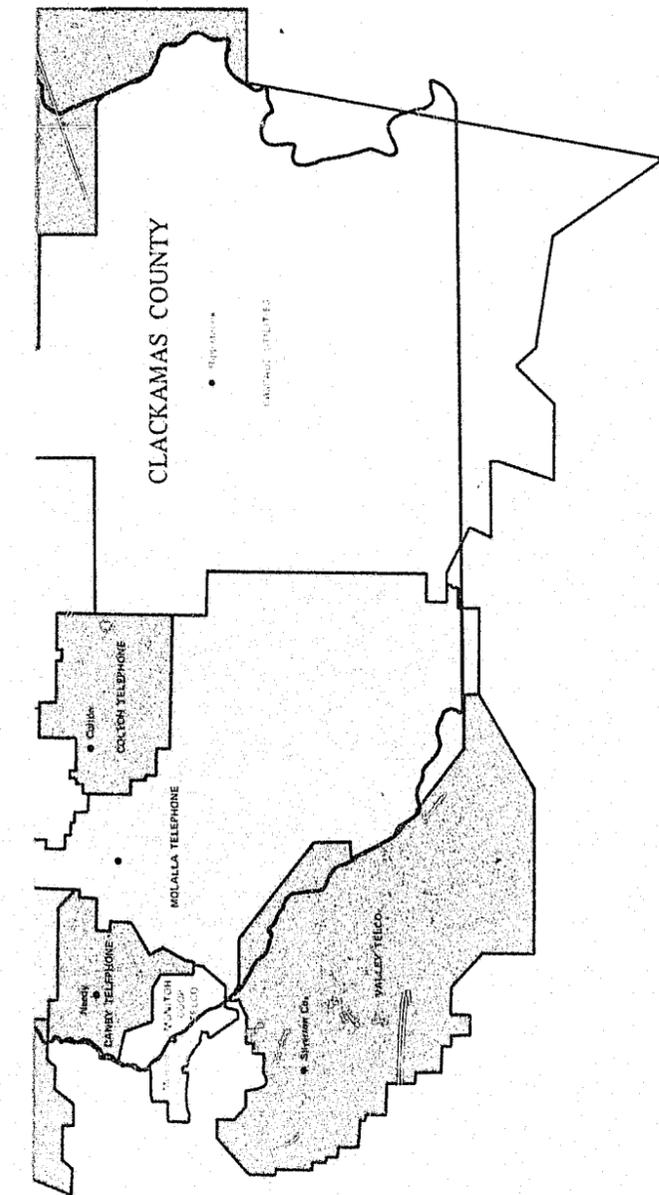


FIGURE 2 CRAG AREA TELEPHONE MAP

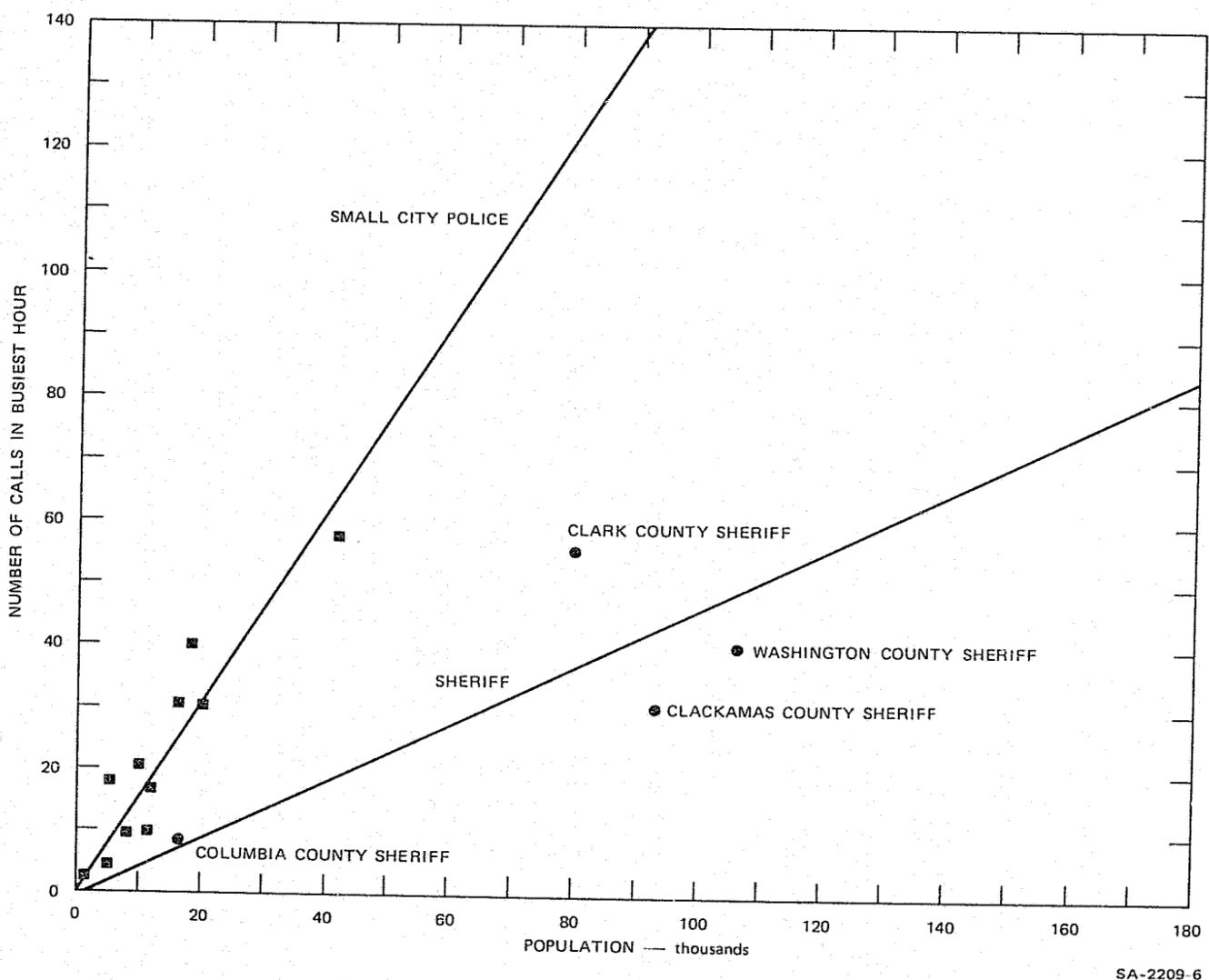


FIGURE 3 LAW ENFORCEMENT INCOMING EMERGENCY TELEPHONE CALLS—1972 ESTIMATES

SA-2209-6

prior to the entry of Portland and Multnomah into the study and represent estimates for the period October to December 1972. All agencies were supplied data forms and tally sheets in order to collect the data on incoming emergency (that is, excluding administrative) telephone calls. Respondents were instructed to count all emergency calls, including those calls, for whatever reason, in which no radio dispatch resulted.

The data fell more or less neatly into two categories for law enforcement--what we have called small city police (of which Vancouver was the largest) and sheriff. Excellent correlation of 0.68 was obtained between the measured data and the least squares line shown for small city police. Poorer correlation--0.4--was obtained for the various county sheriffs. We do not believe these results are surprising since the smaller cities are more uniform with respect to each other than the four counties. The Clark county sheriff, for example, patrols areas such as the city of Washougal (an urbanized area near Vancouver) which make his operation closer to a small city than are the other sheriffs' jurisdictions. The Clark county sheriff, therefore, has a higher call volume which reflects the more urban nature of the area patrolled. The urban data versus sheriff data clearly indicate a larger number of requests for the urban law enforcement agencies. Consistent with this pattern, the Washington county sheriff patrols an area of larger population that is slightly more urbanized than the area patrolled by the Clackamas county sheriff, even though Clackamas county has a slightly higher overall population.

When these data were compared with the Portland/Multnomah data for law enforcement obtained by PSSI, the results were surprising. In Figure 4 the small city police and sheriff least squares lines are shown extended to a larger scale. If it is assumed that 1972 data for Portland/Multnomah should lie in between the measured 1970 and the estimated 1975 data points, then Portland/Multnomah law enforcement agencies are receiving less than one-fourth their expected incoming call volume--given the probably poor assumption that Portland/Multnomah have the police assistance characteristics of a small city.

Assuming the data collected by both PSSI and SRI are correct, there appear to be three explanations for the telephone call differences (which are not mutually exclusive):

- (1) Portland/Multnomah citizens have less perceived need to request assistance by telephone from law enforcement agencies than do other citizens in the CRAG area.
- (2) The Portland/Multnomah law enforcement agencies, either intentionally or unintentionally, discourage requests for assistance by telephone, thereby reducing their volume of incoming emergency calls from citizens.
- (3) Certain service functions, that are handled by law enforcement agencies outside of Portland/Multnomah, are handled by non-law enforcement agencies within Portland/Multnomah.

Without a thorough understanding of the operations of the Portland/Multnomah law enforcement agency internal organization, it is difficult for us to explain which of the above reasons applies. Brief observations of both the Portland Police Bureau and the Multnomah County Department of Public Safety appear to us to indicate, however, that the Portland police, who service the majority of citizens in Multnomah county, and the present Portland Police Communications Center operation do, either intentionally or inadvertently, make it somewhat cumbersome for a citizen to obtain police help by telephone. The system presently requires that a request go through three stages before it reaches the radio dispatcher. The replacement of this outmoded and inadequate facility by a more modern and larger facility should encourage citizens to call the Portland police more often by telephone.

Brief discussion with various members of the Portland Police Bureau have indicated that the Portland police at present would prefer to commit resources only to more serious problems. This finding is consistent with that given by PSSI: "Although the departments (PPB and MCDPS) currently respond to a minimum of service calls (such as lockouts or treed animals), it is conceivable that these or other services might be required in the future."*

Ironically, perhaps, the estimates given by PSSI for the number of complaint positions

*Public Safety Systems Inc., "Development of a Law Enforcement and Fire Service Communications/Dispatch System--System Requirements," Report No. 14000-001 Revision, 3 November 1972, pages 3-4.

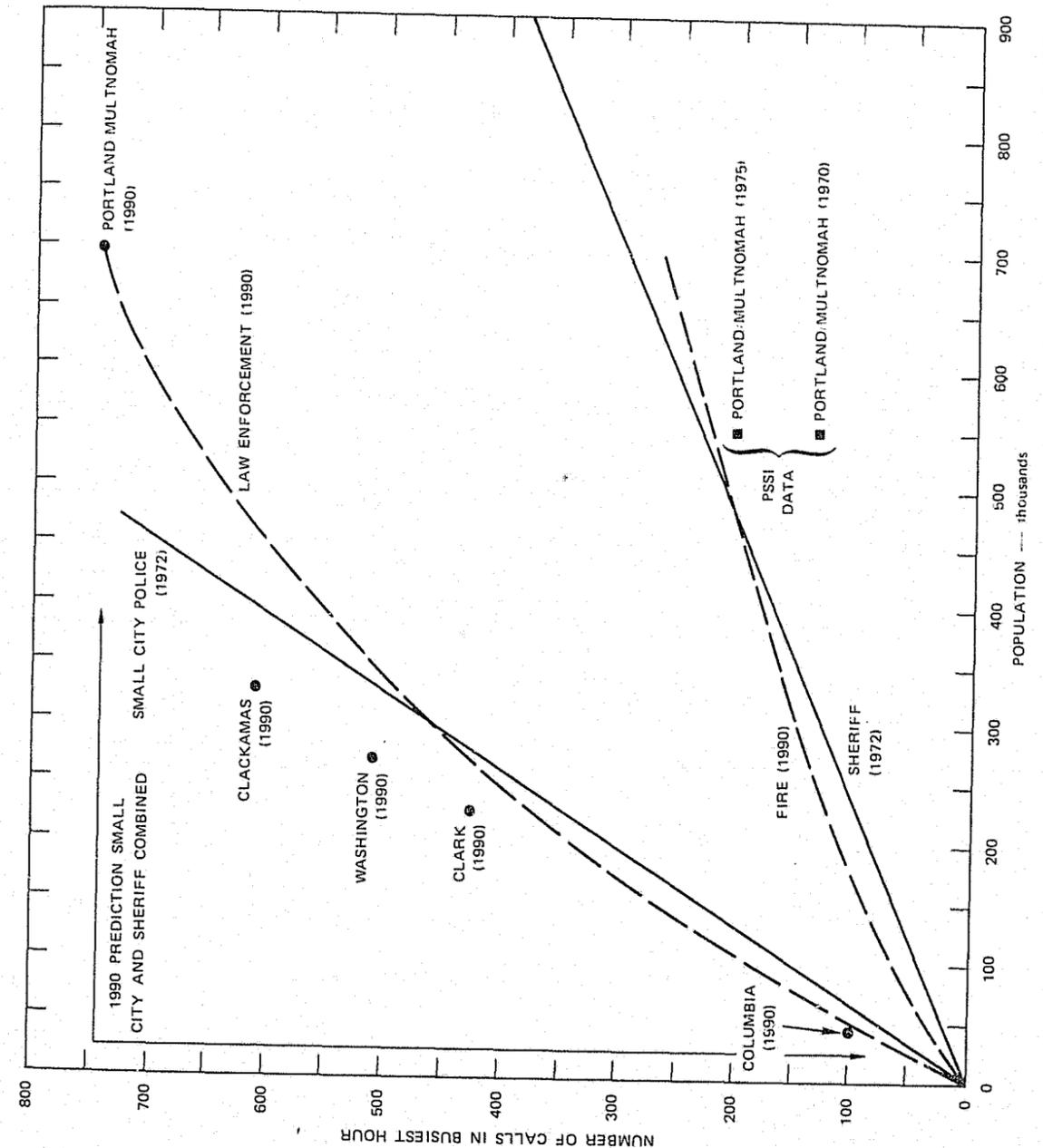


FIGURE 4 LAW ENFORCEMENT INCOMING TELEPHONE CALLS—COMPARISONS AND PROJECTIONS

if 911 is implemented in Portland/Multnomah are 18 positions for 1975 and 29 positions for 1990. Our own previously derived estimates for the total of the other CRAG area (excluding Portland/Multnomah) were 18 positions for 1973 and 23 positions for 1990.*

Presently Portland/Multnomah has almost exactly half the population of the CRAG area. We therefore draw the preliminary conclusion that although the methodology and data used to derive estimates of operator positions required were different, the results for the present number of 911 complaint operator positions are quite close for the two areas of comparable population (Multnomah and the other four counties.) For estimating the 1990 requirements for 911 complaint operators, we have assumed the same number of 911 calls per capita population, i.e., the increase in the required number of complaint operators between 1975 and 1990 would be due only to increasing population. The PSSI estimates, on the other hand, evidently assume a more rapid increase in 911 calls per capita for Portland/Multnomah than we have for the surrounding area. In other words, the PSSI estimates assume that 911 calls will increase in Portland/Multnomah at a much more rapid rate than will population between 1975 and 1990, while we have assumed the surrounding area to increase its 911 incoming calls at the same rate as population increase.

PSSI states that their normal procedure to project traffic loading could not be used for Portland/Multnomah. "This (normal) procedure usually calls for the establishment of the underlying driving factors that influence the demand for law enforcement and fire service communications through the use of historical, demographic, and communications data. Often planning departments can provide accurate projections of these factors into the future. It is then merely necessary to correlate these factors to current communications data to obtain a projection of future communications levels. However, in the City of Portland and County of Multnomah, unique growth characteristics precluded the development of sufficiently detailed and consistent projections of these underlying driving factors."

PSSI further states that "A correlation analysis, performed to determine the extent

*Ibid., page A-33.

to which values of suspected driving factors have corresponded to previous levels of communication's traffic loading, failed to produce any reliable projections." PSSI found that "... it was therefore necessary to utilize law enforcement and fire service historical transaction data to obtain the required projections."*

Evidently then, PSSI's estimates of traffic were based not on data external to the law enforcement and fire protection agencies but rather on the assumption that the increase in traffic loading existing at some time in the past will continue into the future. Since the detailed projections and correlation analyses referred to were not available to us, we cannot comment on the validity of the predicted traffic increase to 1990.

In any case, however, the 1990 estimates made by PSSI for Portland/Multnomah are more consistent with our own 1990 estimates for the other counties, based on our assumption of 911 calls being related to population increase. For our sizing of the number of 911 positions required for a regional system that includes Portland/Multnomah, we have therefore used PSSI's 1990 estimates, together with our own 1990 estimates for the other counties, in a second order curve fit. The implication of this fitting procedure is that with a regional 911 system, we would expect that a more uniform number of emergency requests per unit population would prevail between entities within the CRAG area; specifically this implies that Portland/Multnomah will receive a larger number of emergency incoming telephone requests from citizens. Correspondingly, as the population density of the surrounding area increases in the future, they will experience slightly fewer calls per capita, since some service calls will be discouraged. The surrounding areas will, however, still receive many more service calls per capita than does Portland/Multnomah now, according to the PSSI data.

We have used, then, the dashed curves shown in Figure 4 for both 1973 and 1990 estimates. The call volumes for the sheriff's areas were assumed to be the same as the urban areas for the purposes of sizing the system. The decision to do this was based on the rapid urbanization of the CRAG region and a consequent need not to undersize the alternative systems.

*Op cit., pages A-5 to A-9.

2. Outgoing Traffic

The outgoing traffic from the 911 centers to the public safety agencies was determined next. The telephone central offices serving each of the agencies are listed in Table 6.

For the purpose of a conservative 911 design, it was assumed that each incoming call would result in one call from the 911 center to the dispatch facilities. Table 7 shows the number of calls in the busy hour to each dispatch function in the five-county area. Call volumes for 1973, 1990, and 1.5×1973 were estimated on a county-by-county basis. By combining the data in Tables 6 and 7, and by making some assumptions about the characteristics of the traffic (as presented in Appendix F), the outgoing traffic to each exchange was desired.

3. Diurnal Variation

The data obtained from the public safety agencies was next evaluated to determine the diurnal dependence of the peak traffic periods. The data provided by the agencies indicated that their peak call volume periods occurred between 1600 and 1800. As discussed earlier, a considerable amount of estimation was required for fire protection agencies and a lesser amount for law enforcement agencies.

The occurrence of the peak call volumes over a relatively short period led to a sizing of the network to handle peak hour call volume using the assumption that all peaks for all agencies occurred in the same hour. Thus, all peak hour emergency incoming calls to the 911 center(s) and all calls from the 911 center(s) to the dispatch facilities were assumed to occur in a single one-hour period for the purposes of determining telephone line requirements, space requirements, operator force requirements, and so on for alternative 911 systems. It is recognized that peak volumes can come at any hour as a result of a catastrophe but that these peak side hours would not have to be considered separately from the peak hour.

Data from all agencies indicated that the ratio of police to fire calls was about 2 to 1. This ratio is consistent with similar data obtained in traffic studies throughout the country and was therefore the ratio we used in sizing the various alternatives.

Data on emergency calls received by operators were also obtained from PNB. This call volume showed that about two emergency phone calls per 10,000 population were being received during the busiest hours by PNB operators. This call rate was used to modify the law enforcement (police) and fire protection curves that are shown in Figure 4.

The next step in the analysis was to estimate busy hour call volumes for all law enforcement and fire protection agencies in the five-county area. This was accomplished by determining the populations of each service area and then reading the appropriate police or fire call volume from Figure 4. In this manner, each agency was assigned an expected peak hour call volume.

To estimate growth requirements for the system, the next analysis step was to utilize CRAG 1990 population projections for the Portland-Vancouver metropolitan area. These population estimates (by census tracts) were then compared with public safety agency service areas to estimate 1990 peak hour telephone traffic for each agency again using Figure 4.

Each exchange in the five counties was next compared to the census tract data to estimate the number of busy hour calls that would originate from each exchange. Table 5 lists the 1973, 1990, and 1.5×1973 figure for each central office in each of the counties. The latter figure (1.5×1973) was developed to account for ambulance calls (about 10 percent of total calls), other public safety agencies, and the so-called "turnpike" effect that has been observed when 911 systems are implemented in other areas of the U.S. In almost all other areas, the advent of 911 has increased the call volumes into public safety agencies because 911 has provided the general public with easier access to the agencies.

Table 5

INCOMING TELEPHONE EXCHANGE BUSY HOUR CALL VOLUMES

County	Central Office	No. of 1973 Calls	No. of 1990 Calls	1.5 X 1973 Calls
Clackamas	Aurora	2	3	3.0
	Beaver Creek	1	2	1.5
	Canby	19	21	28.5
	Needy	1	2	1.5
	Estacada/Eagle Creek	16	22	24.0
	Ripplebrook	1	1	1.5
	Redland	2	3	3.0
	Colton	1	2	1.5
	Sandy	15	18	22.5
	Stafford	27	48	40.5
	Molalla	7	9	10.5
	Monitor	1	2	1.5
	Government Camp	1	1	1.5
	Lake Oswego	54	126	81.0
	Oak Grove/Milwaukie	102	202	153.0
	Oregon City	87	175	130.5
	Hoodland	1	2	1.5
	Silverton	1	1	1.5
	Sunnyside	15	40	22.5
Washington	Aloha	10	15	15.0
	Banks	1	2	1.5
	Beaverton	107	187	160.5
	Forest Grove	38	47	57.0
	Gaston	10	10	15.0
	Hillsboro	40	70	60.0
	Newberg	1	1	1.5
	Scholls	10	15	15.0
	Sherwood	11	11	16.5
	Somerset	10	20	15.0
	Tigard	17	50	25.5
	Cypress	5	10	7.5
	North Plains	15	21	22.5

Table 5 (Concluded)

County	Central Office	No. of 1973 Calls	No. of 1990 Calls	1.5 X 1973 Calls
Columbia	Clatskanie	5	8	7.5
	Vernonia	7	9	10.5
	Jewell	1	1	1.5
	Ranier	7	10	10.5
	St. Helens	40	61	60.0
	Scappoose	8	12	12.0
	Clark	Camas	13	25
Washougal		7	15	10.5
Washougal River		1	2	1.5
Woodland		1	2	1.5
Amboy		1	3	1.5
La Center		3	7	4.5
View		1	2	1.5
Battleground		6	14	9.0
Orchards		40	109	60.0
Oxford		122	218	183.0
Ridgefield		12	24	18.0
Yacolt		3	7	4.5
Multnomah		Corbett/Aims	7	8
	Gresham	52	60	78
	Orient	11	13	16
	Alpine	101	116	151
	Atlantic	108	124	162
	Avenue	21	24	31
	Belmont	85	98	127
	Burlington	2	2	3
	Butler	52	60	78
	Capitol	53	60	80
	Cascade Locks	3	3	5
	Cherry	52	60	78
	Harold Street	31	36	46
	Prospect	89	102	133

Table 6

EXCHANGES AND DISPATCH SERVICES

Central Office	Dispatch Services
Aurora	Aurora RFPD
Beaver Creek	Beaver Creek RFPD, Clarkes Fire
Canby	Canby RFPD
Estacada/Eagle Creek	Estacada RFD
Colton	Colton Fire
Beaverton	Beaverton PD, Wash. FPD No. 1
Clatskanie	Clatskanie PD, Clatskanie RFPD
Forest Grove	Forest Grove PD, Forest Grove RFPD, Cornelius PD
Hillsboro	Hillsboro PD, Wash. FPD No. 2, Washington County Sheriff
Sandy	Sandy RFPD
Stafford	Tualatin RFPD
Tigard	Tigard PD
Vernonia	Vernonia PD, Vernonia RFPD
Molalla	Molalla PD
Monitor	Monitor RFPD
Lake Oswego	Lake Oswego PD, Lake Oswego FD
Oak Grove-Milwaukie	Milwaukie PD, Milwaukie RFPD No. 56
Oregon City	West Linn PD, Gladstone PD, Clackamas County Sheriff, Oregon City FD
Rainier	Rainier PD, Rainier RFPD
St. Helens	St. Helens PD, St. Helens RFPD, Columbia County Sheriff
Scappoose	Scappoose PD, Scappoose RFPD
Hoodland	Hoodland RFPD
Silverton	Scotts Mills RFPD
Sunnyside	Boring FD
Camas	Camas PD, Camas FD
Oxford	Vancouver PD, Vancouver FD, Clark County Sheriff
Washougal	Washougal FD
Capitol	Portland Police Bureau, Multnomah County Department of Public Safety
Belmont	Portland Fire Bureau
Harold Street	Multnomah County RFPD No. 10

Table 7

COUNTY-BY-COUNTY 911 CALL VOLUME TO DISPATCH CENTERS

County	Department	County Centers to all Current Dispatch Centers		
		1973 No. Calls	1990 No. Calls	1.5 × 1973 Calls
Clackamas	Lake Oswego PD	31	92	46.5
	West Linn	20	36	30.0
	Gladstone	19	22	28.5
	Milwaukie	34	83	51.0
	Oregon City	15	25	22.5
	Molalla	12	14	18.0
	Sheriff	98	174	147.0
	Lake Oswego FD	20	30	30.0
	Oregon City	25	49	37.5
	Canby	4	6	6.0
	Sandy	4	6	6.0
	Estacada	6	7	9.0
	Multnomah No. 11	7	8	10.5
	Boring	2	3	3.0
	Hoodland	1	2	1.5
	Beavercreek	2	4	3.0
	Aurora	2	3	3.0
	Clarkes	1	2	1.5
	Monitor	1	2	1.5
	Washington	Colton	1	2
Scotts Mills		1	2	1.5
Milwaukie		57	100	85.5
Forest Grove PD		19	22	28.5
Beaverton		37	57	55.5
Cornelius		12	15	18.0
Hillsboro		32	41	48.0
Tigard		17	50	25.5
Sheriff		75	103	112.5
Forest Grove FD		7	10	10.5
Fire District No. 2		20	30	30.0
Fire District No. 1		70	130	105.0
Tualatin	17	36	25.5	

Table 7 (Concluded)

County	Department	1973 No. Calls	1990 No. Calls	1.5 X 1973 Calls
Columbia	Clatskanie PD	3	5	4.5
	Rainier	5	7	7.5
	St. Helens	7	13	10.5
	Scappoose	6	9	9.0
	Vernonia	5	6	7.5
	Sheriff	26	41	39.0
	Clatskanie FD	2	3	3.0
	Rainier	2	3	3.0
	St. Helens	4	6	6.0
	Scappoose	2	3	3.0
Clark	Vernonia	2	3	3.0
	Sheriff-Police	52	96	78.0
	Vancouver PD	66	150	99.0
	Camas PD	8	25	12.0
	Sheriff-FD	15-45	17-48	22.5-67.5
	Vancouver FD	10-32	35-90	15.0-48.0
	Camas FD	5	11	7.5
Multnomah	Washougal FD	2	7	3.0
	Portland Police Bureau	240	276	360.0
	Multnomah County Department of Public Safety	207	238	310.0
	Portland Fire Bureau	118	137	177.0
	Multnomah FD No. 10	102	119	152.0

IV ALTERNATIVE 911 SYSTEMS

Two basic premises are to be noted in the consideration of system alternatives. One is that to achieve the advantages of enhanced operational effectiveness and decreased cost, 911 answering centers should provide service to the widest possible geographic area. From the point of view of the public this leads directly to improved service in terms of quick response time and the absence of call transfers. The other premise is that operational difficulties due to mismatch will be minimized if the boundaries of a 911 answering center are terminated in areas with the least population.

A. GENERAL OPERATIONAL REQUIREMENTS

The general operational requirements to provide a functional 911 answering center and a coordinated dispatch system for emergency services described here apply to each of the alternative systems detailed later in Sections C, D, and E of this chapter.

1. Overall Capabilities

One of the most important features of any 911 system is that it be readily accessible to the citizen in an emergency. This means that there must be sufficient incoming telephone lines and answering personnel so that citizens will rarely encounter busy signals or be required to hold unnecessarily. To establish design criteria, it is necessary to translate these relative measurements into quantitative form which can then be converted into the number of incoming telephone lines and the number of manned telephone answering positions required during the busiest operating period. It is not realistic to assume that a busy signal or lengthy hold period will never be encountered; thus, to establish reasonable criteria for these factors, the following two ground rules were agreed upon with the advice of the members of the CRAG 911 task force:

- A grade of service will be provided such that a busy signal is encountered not more than one percent of the time during the busiest hour.
- Sufficient operators will be provided at each 911 answering location so that

99 percent of the time a citizen will not have to hold before his call is answered for more than ten seconds during the busiest hour. (See Appendix D for comments on the effects of this requirement on personnel sizing.)

One of the problems currently encountered in many areas when a citizen calls an emergency telephone number is that he finds he has dialed an incorrect agency and must dial again (e.g., he calls the city police department when he should have contacted the county sheriff's office) or he must wait for his call to be transferred to another department within the agency. Thus, to expedite the citizen's call, all information related to the emergency will be obtained by the 911 answering personnel whenever possible. If necessary, a maximum of one call-transfer will be made for an emergency call placed anywhere within the region served by the 911 answering center(s).

It is recommended that cathode ray tube (CRT) displays and electronic keyboards be used in the answering center(s) to assist the answering personnel in recording and routing information obtained from citizens reporting emergencies. If the answering center(s) and dispatch center(s) are collocated, the information obtained from the citizen can be routed electronically from the answering area to the dispatch area. If the centers are not collocated, it will be necessary to provide dedicated telephone lines between the answering center(s) and dispatching center(s) to expedite the routing of emergency information. If a county-by-county system is employed instead of a regional center, it will be necessary to provide dedicated lines between adjacent county answering centers.

Incoming telephone calls to the regional answering center will be routed through an automatic call distributor to equalize the call volume to the answering personnel. Additionally, the supervisor position will have access to all of the incoming lines and outgoing dedicated lines to allow monitoring, emergency call assistance, and call coordination by the answering center supervisor.

In some instances, even after a 911 system is implemented there is still a tendency for citizens to use previously-learned seven-digit numbers. Ultimately, the seven-digit numbers should be discontinued from service, but in the intermediate period consideration must be given to either connecting some of these numbers to 911 answering centers or requesting telephone company operators to intercept these calls and refer the citizen to 911. Similarly, since people will dial the telephone company operator in an emergency, it will be necessary to provide all telephone company operators with direct connections to the 911 answering center.

The opposite of the problem just described is that people may dial 911 for assistance from the police, fire department, or an ambulance company, when their need is not of an emergency nature or when they need assistance from an agency not directly connected with the 911 answering center (e.g., utilities companies, state highway department, etc.). In these instances, it will be necessary to provide the answering personnel with a list of referral numbers to provide to the calling party.

Since automatic number identification and/or automatic location identification cannot be provided by the serving telephone companies, it will be necessary for the answering center to implement a manual or computer-assisted address verification system and a telephone-to-address directory system. More details are provided in Appendix C on the operations of these two features and how they could interact with other operations of the answering center.

In both the answering and dispatch centers there must be a record such that previous calls may be referenced and recalled. This system will be employed on a short-term basis to avoid unnecessary dispatching of multiple units to an emergency and, on a long-term basis, to provide information for legal and statistical purposes.

Although it will not be a practice to transfer the citizen to the dispatch center(s), the capability must exist for those instances where it may be advantageous to transfer. A list of agencies for which the CRAG task force recommended call transfer or referral is provided in Table 8.

The design philosophy for the answering center will be to automate as many of the

operations as possible, but it will be necessary that manually-operated systems be provided as backup for all automatic functions so that the center does not become inoperative in the event of a power failure or the failure of any of the automatic control devices.

A summary of the operational requirements described in this section is presented in Table 9.

2. Information Handling Capabilities

To service an incoming emergency call properly, the answering center must be capable of obtaining and processing the information necessary to define the emergency as rapidly and accurately as possible. It is, therefore, recommended that automatic storage (e.g., digital computers) be employed to assist in obtaining, verifying, and processing this information. A simplified block diagram of a computer system for a typical answering center is shown in Figure 5.

The digital information storage and transfer functions in the center will be based around small digital computers. Since this system is the principal control of the center operations, and even though manual back-up systems will be available in the event of a computer failure, it is recommended that this computational system employ a duplex front-end processor. The concept of the duplex front-end processor is basically that two computers are used to share the responsibility of controlling a critical operation so that there is a stand-by computer available to assume control in event of a failure of one unit. The duplex front-end also allows for one computer to perform functions directly related to emergency answering, while the alternate computer can be employed calculating growth statistics from previous emergency call data, etc.

There are several means of storing the addresses and locations in the computer system. These include core memories, magnetic tapes, and magnetic disks. Of these units, one or more movable-head magnetic disk memories would probably be the best choice of storage media, considering the quantity of information to be stored and the required speed to search the data. In this case, it would be advisable to use two disk memories, not only for reliability, but so that one could be used while the other is being updated.

Each answering position should be equipped with a console consisting of a CRT display and an electronic keyboard to record

Table 8

AGENCIES REQUIRING DIRECT CALL TRANSFER AND REFERRAL

Agency	Transfer	Referral
Police Departments, City and State	x	
Fire Departments	x	
Medical	x	
Coast Guard		x
FBI	x	
State Forestry Department	x*	
Poison Control		x
Suicide Prevention	x	
State Highway Department		x
County Roads Department		x
Utilities		x
U.S. Forest Service	x*	
Civil Defense	x*	

*Dependent on county.

information for display on the CRT and as an input source to the computer. The CRT is recommended because of its speed, and the electronic keyboard is recommended because it is much quieter than a conventional teletype. When an emergency call is received by the answering center, the first information that the operator will obtain is the address or location of the emergency and the nature of the emergency. These two pieces of information will be "typed" into the CRT display and the computer, while the address is being verified. The operator will obtain other details, as necessary, including the citizen's telephone number and any further details concerning the emergency.

In addition to its functions of verifying the address provided by the citizen, the computer could be used for all routing and determining the status of emergency calls. The computer could be programmed to automatically select the dispatch center for the required emergency agency. The degree of automation is variable in this case. In its simplest form, the computer could list those agencies providing emergency services in the area from which the call originated and list the dedicated lines going to their dispatch centers, and the

operator would manually select the appropriate direct line. A more complex system could be used to automatically determine and contact the proper dispatch center, using the address and information provided by the operator and the nature of the emergency.

Another display device which could be employed in the answering center is a status board showing all emergencies in progress so the operator would be aware of redundant calls (e.g., more than one call for a large fire). This could be in the form of a large display readily visible from all answering positions in the answering center, or the information could be displayed on the operator's console automatically or upon request. In the latter case, when the operator types the citizen's address, the computer could respond by listing all emergencies in the vicinity of the address, so that the operator would be aware of them and could provide this information to the dispatch center. Public safety officials have indicated that they desire the answering personnel to record all incoming calls and transfer the information to the dispatch centers so that the dispatchers can make the final decision on these calls and determine if additional units must be dispatched, if further details on the

Table 9

OPERATIONAL REQUIREMENTS

Requirement	Necessary	Desirable	Optional
Grade of service such that a busy signal is encountered only one percent of the time during busiest hour.	x		
Sufficient answering personnel at each 911 answering center that 99 percent of citizens will have to hold no more than 10 seconds.	x		
Maximum of one call-transfer for an emergency call placed anywhere in region.	x		
Dedicated hot lines between contiguous 911 answering centers.	x		
911 answering and radio dispatch centers either:			
— Physically collocated with electronic routing	x		
— Keyboard/CRT transfer if not physically collocated.	x		
Automatic call distributor to equalize loading to 911 answering positions.	x		
Supervisory console position with monitoring and communications coordination capability.	x		
Direct telco operator connections to 911 answering center(s).	x		
Referral of citizens if they need an agency not connected to the answering center(s) by dedicated lines.	x		
Called-party disconnect.	x		
Called-party hold.		x	
Automatic number identification.		x	
Automatic location identification.			x
Dial tone first on pay telephones.		x	
Ring-back while calling party is holding.			x
Call counters for aid in growth planning.	x		
Address verification system.	x		
Manual or computer assisted telephone-to-address directory.	x		
Record system to permit recall of earlier emergency calls.	x		
Call transfer to selected agencies.	x		

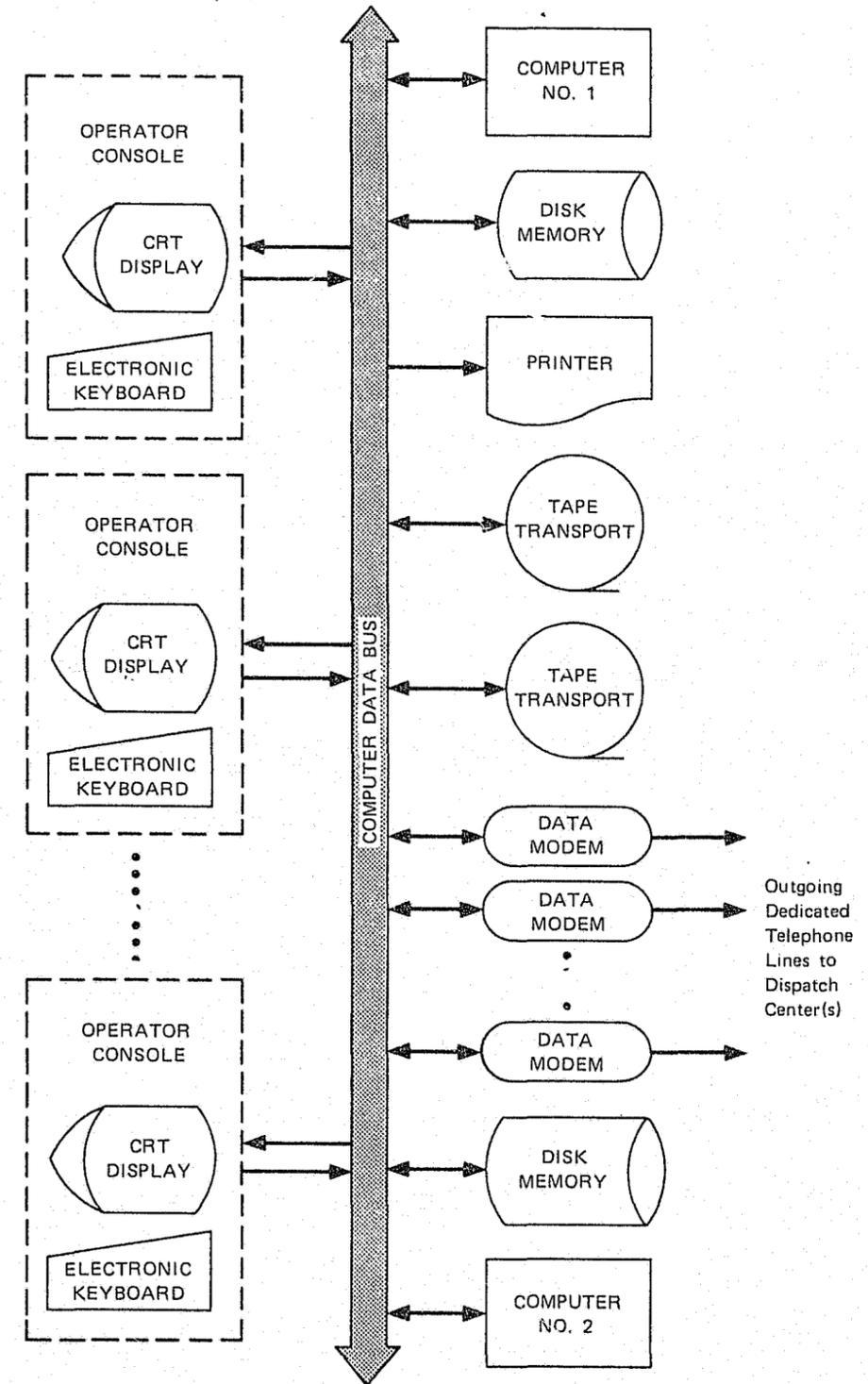


FIGURE 5 BLOCK DIAGRAM OF COMPUTER SYSTEM WITHIN A TYPICAL 911 ANSWERING CENTER

emergency must be obtained, or if the status of the emergency has changed.

Once the data have been obtained and verified by the answering personnel, they must be routed to the appropriate dispatch center. Since the information is available in digital form and digital information can be transmitted more rapidly than voice communication (the information describing a typical emergency could be sent digitally over standard telephone lines in less than 3 seconds), digital communication is the most practical means of information transfer. Thus at the completion of the information recording, the dispatch center would be either automatically selected or selected by the operator, contact would be made, and the digital information sent to the dispatch center. The dispatcher could review the information and decide if additional information were required from the answering center or citizen, and then either indicate a need for further information or acknowledge the correct receipt of the message to the operator using digital communications. If the dispatcher desired to talk to the citizen and the citizen were still available, the answering center operator would transfer the call at that time. Additional details and an example of an address verification routine can be found in Appendix C.

As a form of legal documentation and a documentation of answering center operations, all digital data sent from the answering center to the dispatch center will be stored on a digital magnetic tape at the time that the information is transferred or when the dispatch center replies that the emergency has been serviced.

In addition to the "file" of addresses on the disk memory system for the computer system, it is necessary to provide the center with a written copy of the address and location listings which would be used in event of computer failure. This unit should be designed so that it could produce and update information by printing directly from the computer. The information should be partitioned so that the answering personnel can locate information rapidly and the listings file must be located so that it is easily accessible by the answering personnel. If future access to any of the information recorded on an emergency call is required, the data will be available on the magnetic tape and could be listed on a printer

located either within the answering center or remotely.

It will also be necessary to have voice recordings of all emergency telephone calls in and out of the center. There should be one master recording which will continuously monitor each emergency line. This unit will provide the primary legal documentation of the center. In addition to the master recording, each answering position should be provided with a recorder with a capability of recording approximately five minutes of conversation. This will allow the operator to play back a previous conversation in the event that some of the digital information is questioned and/or the operator has lost contact with the caller.

3. Maintenance and System Reliability

To ensure reliable operation of the 911 answering center(s) and dispatch center(s), it is necessary to establish a routine preventive maintenance program and procedures to routinely verify the system operation in addition to providing redundant automatic equipment and manual secondary systems.

The operation of address verification and similar functions of the computer will be apparent because of the essentially constant usage of these programs, but allowances must be made for maintenance of the computer hardware on these systems. It is recommended that each answering center be equipped with duplex computers. The duplex arrangement provides for two front-end processors which will normally share the computational load; but in the event of failure or scheduled maintenance of one of the units the second unit has the capability of assuming the full responsibility for the center. Switching of the processor units can be by manual or fully automatic means. The duplex arrangement also would allow one of the units to be taken off-line and used for software checks or statistical and documentation routines while the alternate processor will continue to function as the answering center data and switching control unit.

Another critical area will be that of ensuring that all direct telephone lines are operational. A procedure must be established whereby each line will be tested once per shift or at some other convenient increment. Of particular concern will be the direct telephone lines to rural dispatch centers (if dispatching is

not consolidated) which may not be used more than once every two days.

B. CLASSES OF ALTERNATIVES

Because the operational and cost advantages of 911 answering on a large scale are so clear, only two alternative 911 answering systems were considered:

- Regional
- County-by-county.

Dispatch alternatives affect the costs and performance of a 911 system. The 911 answering centers must be connected to all dispatch centers in the areas they serve. Consolidation of dispatch facilities reduces the number of telephone lines that must be run from the 911 center(s) to the dispatch centers, reduces the complexity of locating the correct emergency service(s) for any given emergency, improves the operational efficiency and physical resources of the dispatch facilities, improves the utilization of the radio frequency spectrum through centralized control of the available channels, and decreases the number of facilities and personnel required for dispatching.

Because the configuration of the 911 answering center(s) and the various dispatch alternatives can be treated somewhat separately and because the existing dispatch facilities are in various stages of planned consolidation, a number of alternatives for 911 in the CRAG region are practical. Table 10 lists eight alternatives that have been proposed for consideration in the CRAG area. Both of the answering alternatives, regional and county-by-county, have been considered in conjunction with a number of dispatch alternatives.

Figure 6 illustrates the connections that would be required for Alternative 1 of Table 10. In this alternative a single 911 regional center is connected to all telephone exchanges (including those in adjacent counties which have main stations in the five-county area) and to all law enforcement and fire protection dispatch locations in the counties. Private ambulance companies are not shown connected to the center because they currently would be connected to the 911 center by dedicated lines and because they have a comparatively low traffic density.* Telephone lines from the

*SRI believes that a detailed study of emergency medical communications and their integration into a 911 system is required. Such a study was beyond the scope of this analysis.

exchanges to the 911 center and dedicated lines from the 911 center to the dispatch centers are shown by different colors for clarity.

Figure 7 illustrates county-by-county 911 centers with telephone exchanges and current dispatch centers in each county linked to their respective centers (Alternative 6). Telephone exchanges on the exterior boundaries are also shown as connected to the 911 centers although the costs and operational problems attendant to such connection may ultimately preclude their incorporation.

C. REGIONAL 911 REQUIREMENTS

This section describes the personnel, facility, telephone, and information system costs for a regional 911 center. The 911 alternatives covered in this section are numbers 1 through 5 of Table 10.

1. Personnel

Using the call volumes derived in Chapter III, and making certain assumptions about the work load for each operator (as given in Appendix D), we derived the number of operators and supervisors required for the regional 911 alternatives as shown in Table 11. The number of operators and supervisors for both 1973 and 1990 have been computed with and without Clark county. The reason for considering Clark separately was that an SRI study for Clark county* showed that it could have county 911 at a cost nearly equal that of regional 911 if it consolidated dispatch functions at the same time. Furthermore, the boundary with Oregon terminates all Clark telephone exchanges so that the overwhelming argument for regional 911 to minimize boundary mismatch does not apply to Clark county.

The operator force specified in Table 11 is based on an acceptable (10-second maximum) waiting time, since this waiting time is consistent with current public safety system sizing. An additional seven to nine operators would be required to provide five-second waiting time. The operator force would be highly trained in the police, fire, and emergency medical fields and would be responsible for service on a complete regional basis.

*K. D. Felperin et al., "Clark County/City of Vancouver Public Safety Communications Conceptual Design," Final Report, SRI Project 2387, Stanford Research Institute, Menlo Park, California (April, 1973).

Table 10

911 ANSWERING AND DISPATCH ALTERNATIVES

Alternative No.	Answering	Dispatch
1	Single regional center	All current dispatch facilities
2	Single regional center	One combined law enforcement and fire center per county, five dispatch centers total
3	Single regional center	One law enforcement and one fire center for each county, ten centers total
4	Single regional center	One regional law enforcement and one regional fire center, two centers total
5	Single regional center	One regional law enforcement and fire regional center
6	County centers	All current dispatch facilities
7	County centers	One center per county, five dispatch centers total
8	County centers	One law enforcement and one fire center for each county, ten centers total

Each shift would have a supervisor or chief operator. This individual's primary duties would be to supervise the 911 operators on duty, handle special problems that occur, and act as a 911 operator in the event of an unexpectedly large volume of calls. The supervisor's station will have the same equipment as a regular operator's, with the addition of certain extra facilities required to monitor overall system performance.

The center will require a full-time manager. This manager's primary responsibilities will be: (1) the administrative management of the center, (2) the compilation of statistical reports detailing the number and type of calls to and through the 911 center, (3) the determination of whether more telephone and answering capacity is needed, and (4) the translation of the controlling board's policy decisions into center operations.

The center will also require a secretary to assist the center manager in the performance of his duties. One full-time computer operator will also be needed to update the computer and manual backup data files and to handle miscellaneous clerical and data processing tasks.

2. Facilities and Space

Table 12 shows the space requirements for regional 911 centers both with and without Clark county. The square footage listed is an approximation. A more accurate determination of the space required can be made when the alternative to be implemented has been selected and the actual physical layout of the center has been determined.

The types of facility space listed in Table 12 are self-explanatory. There are, however, certain special requirements that should be noted: (1) the center should not be in the basement of the building; (2) the center should not be on the ground floor of a multistory building; (3) the center should have its own separate airconditioning system--possibly incorporating a dehumidifier and dust control; (4) space for the emergency power generators must be soundproofed and constructed to withstand heavy vibration; (5) fire extinguishers of a chemical type should be installed; (6) computer flooring, 18 inches above the room floor, will be required in all spaces having telephone and other electronic equipment;

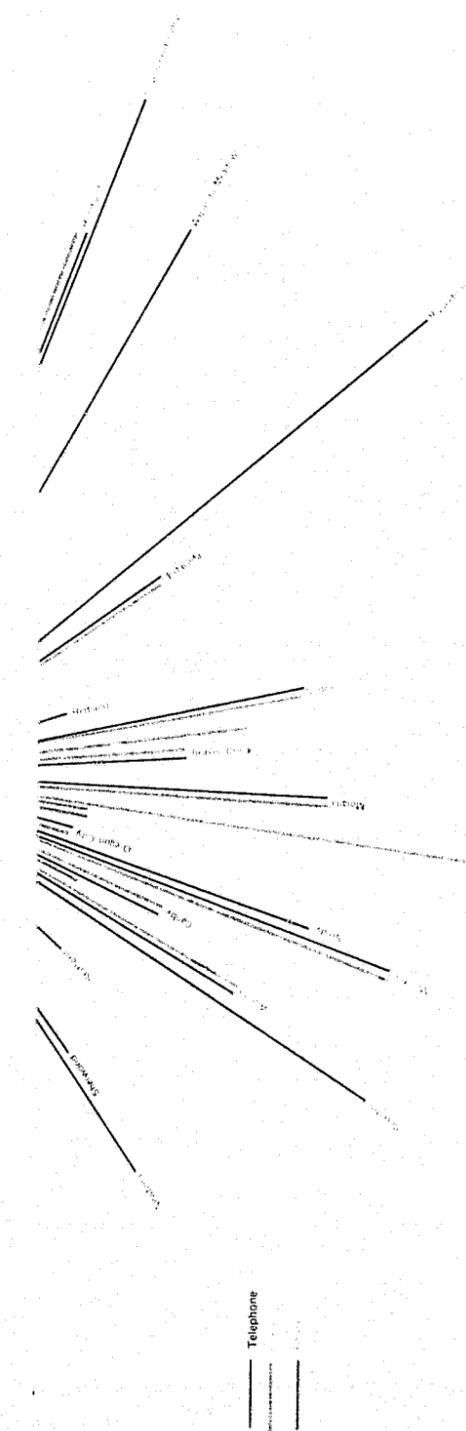


FIGURE 6 REGIONAL 911 CONNECTED TO EXISTING PUBLIC SAFETY AND TELEPHONE FACILITIES

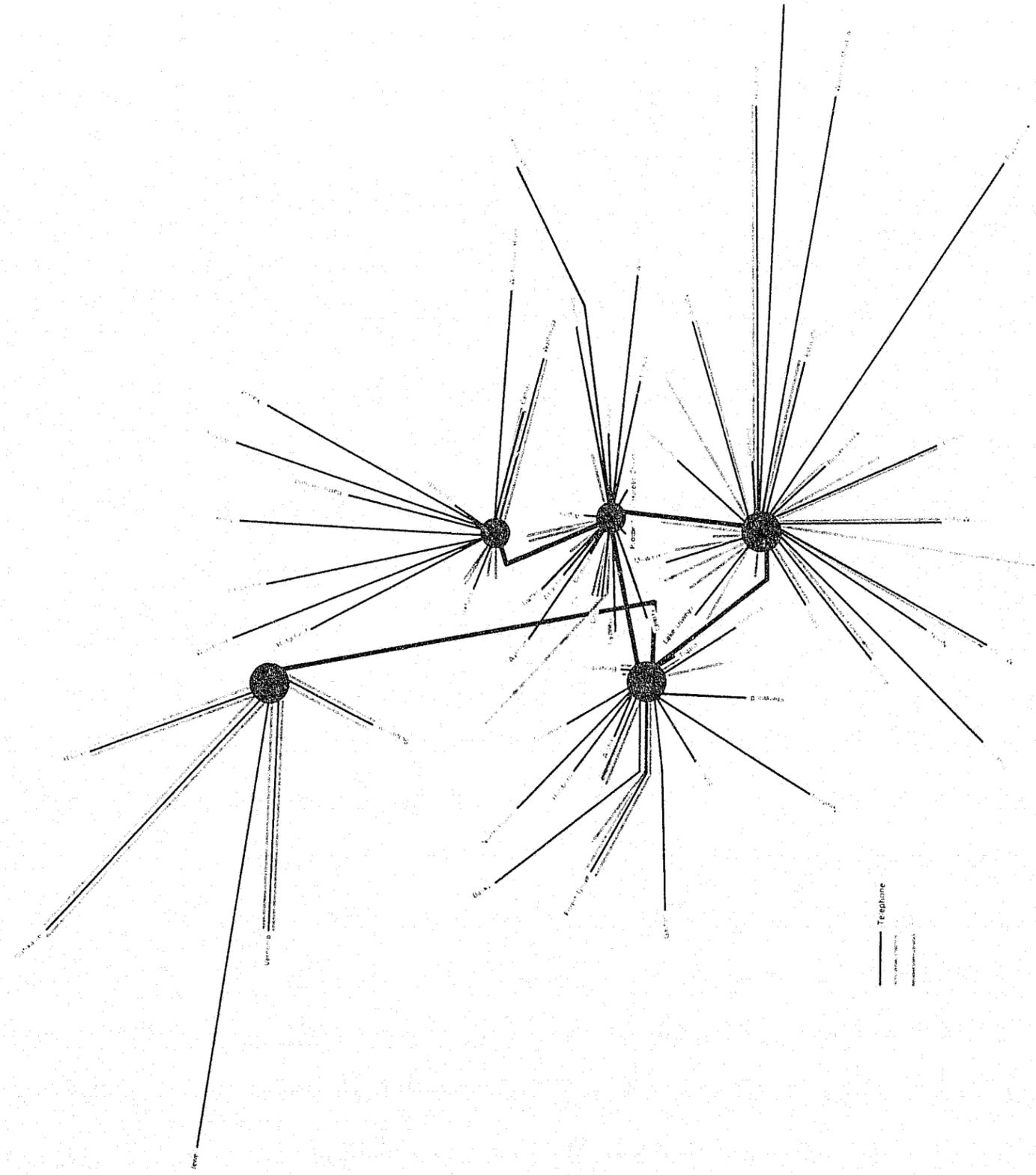


FIGURE 7 COUNTY 911 CONNECTED TO EXISTING PUBLIC SAFETY AND TELEPHONE FACILITIES

Table 11

REGIONAL 911 CENTER OPERATOR FORCE REQUIREMENTS

911 Center	Year 1973			
	No. of Operators		No. of Supervisory Operators	
	Busy-Hour	Total Force	Busy-Hour	Total Force
Regional (Incl. Clark Co.)	26	57	1	5
Regional (Excl. Clark Co.)	21	46	1	5
	Year 1990			
Regional (Incl. Clark Co.)	31	68	1	5
Regional (Excl. Clark Co.)	25	55	1	5

and (7) the facility must be as secure as possible from forcible entry. Detailed estimates of new building costs and the estimated costs of renovation are given in Appendix E.

3. Incoming Telephone Lines

Table 13 shows the number of incoming telephone lines from each central office to the regional center. For each central office, the number of busy-hour emergency calls and the traffic volume in hundred call-seconds (CCS) are given, assuming a calling time of 40 seconds and a maximum of five seconds ring-down time as specified in the operational re-

quirements.* The number of lines was then computed from standard telephone traffic tables, assuming a blocking probability of one percent (P01 grade of service) as specified in the operational requirements.

Where calculations indicate only one line was needed, we have specified two lines to ensure service in case of a malfunction of one line. The total number of lines--197--could be reduced by means of line concentration by

*Only 14 additional lines would be required if the ring-down time is increased to ten seconds.

Table 12

REGIONAL 911 CENTER SPACE REQUIREMENTS

Type of Space	Includes Clark County, Wash.		Excludes Clark County, Wash.	
	Year 1973 (ft ²)	Year 1990 (ft ²)	Year 1973 (ft ²)	Year 1990 (ft ²)
911 operator positions	1,120	1,300	940	1,080
Supervisory operator position	100	100	100	100
Administrative office (center manager, secretary, and their files)	400	400	400	400
Storage space for new supplies (magnetic tape, computer tape, log books, forms, paper, pencils, etc.) and for completed tapes, logs, forms, etc.	450	500	400	450
Two rest rooms, each containing a locker area for storing personal belongings of the staff on duty	800	800	700	800
Small kitchen and emergency food-stuffs supply storage area	500	500	500	500
Telephone trunk recorder and playback equipment	40	40	30	40
Minicomputer and its associated processing and switching equipment	100	100	100	100
Repair and maintenance shop space	100	100	100	100
Two automatic starting emergency power generators and heat dissipation equipment to supply power to the 911 center equipment, lights, and air-conditioning plant	200	200	200	200
Air-conditioning and heating equipment	300	300	300	300
Telephone company equipment room	300	300	300	300
Misc. space for walkways, manual backup system materials, etc. (approx. 20% of the above working space)	890	930	810	880
Total Space Required	5,300	5,570	4,880	5,250

Table 13

INCOMING 911 LINES TO REGIONAL 911 CENTER

Telephone Company	Central Office	Busy-Hour		No. of Lines Required
		Calls	CCS*	
Aurora	Aurora	3	1.35	2
Beaver Creek	Beaver Creek	1	0.45	2
Canby	Canby	21	9.45	3
	Needy	1	0.45	2
Cascade Utilities	Corbett/Aims	8	3.60	2
	Estacada/Eagle Creek	22	9.90	3
	Ripplebrook	1	0.45	2
Clear Creek Mutual	Redland	3	1.35	2
Colton	Colton	1	0.45	2
GTNW	Aloha	15	6.75	3
	Banks	1	0.45	2
	Beaverton	160	72.00	7
	Clatskanie	8	3.60	2
	Forest Grove	47	21.15	4
	Gaston	10	4.50	2
	Gresham	60	27.00	4
	Hillsboro	60	27.00	4
	Newberg	1	0.45	2
	Orient	13	5.85	3
	Sandy	18	8.10	3
	Scholls	15	6.75	3
	Sherwood	11	4.95	2
	Somerset	15	6.75	3
	Stafford	39	17.55	4
Tigard	25	11.25	3	
Vernonia	9	4.05	2	
Molalla	Molalla	9	4.05	2
Monitor Coop.	Monitor	1	0.45	2
Rose Valley	Scappoose	12	5.40	2
Valley	Hoodland	1	0.45	2
	Silverton	1	0.45	2
	Sunnyside	22	9.90	3

*CCS = hundred call-seconds

Table 13 (Concluded)

Telephone Company	Central Office	Busy-Hour		No. of Lines Required
		Calls	CCS*	
PNB	Alpine	116	52.20	6
	Atlantic	124	55.80	6
	Avenue	24	10.80	3
	Belmont	98	44.10	5
	Burlington	2	0.90	2
	Butler	60	27.00	4
	Capitol	60	27.00	4
	Cascade Locks	3	1.35	2
	Cherry	60	27.00	4
	Cypress	7	3.15	2
	Government Camp	1	0.45	2
	Harold Street	36	16.70	4
	Jewell	1	0.45	2
	Lake Oswego	79	35.55	5
	North Plains	21	9.45	3
	Oak Grove/Milwaukee	153	68.85	7
	Oregon City	129	58.05	6
	Prospect	102	45.00	5
Rainier	10	4.50	2	
St. Helens	60	27.00	4	
Subtotal for Oregon		1,760	--	164
GTNW	Camas	20	9.00	3
	Washougal	11	4.95	2
	Washougal River	2	0.90	2
	Woodland	2	0.90	2
Lewis River	Amboy	2	0.90	2
	La Center	5	2.25	2
	View	2	0.90	2
PNB	Battleground	9	4.05	2
	Orchards	60	27.00	4
	Oxford	183	82.35	7
	Ridgefield	18	8.10	3
	Yacolt	5	2.25	2
Subtotal for Washington		319	--	33
Grand Total		2,079	--	197

various telephone companies. Concentration could result in considerable cost savings (see Appendix F), but it would eliminate the called-party-hold feature that has been determined as desirable. In any case, cost estimates based on Table 13 are conservative in that they might be reduced at some sacrifice in performance.

4. Outgoing Telephone Lines

The outgoing lines will be used to transfer information between the regional 911 center and the various dispatch centers. It is part of our operational plan that the largest fraction of traffic will be by digital transmission, as discussed previously. It is anticipated, however, that some callers will have to be transferred from the 911 center to the dispatchers. SRI has assumed that a maximum of 10 percent of the callers may require such transfer and has allowed voice lines to provide this capacity. Where the traffic load is very low, alternate voice/data lines are provided so that both the voice and data systems have backup.

Detailed considerations used in determining the number and type of outgoing lines are provided in Appendix F. Also given in Appendix F are the number and type of lines required for the various regional 911 alternatives; Table 14 summarizes these outgoing line requirements for the various dispatch options. Note the progressive and significant reductions in line requirements as the dispatch functions are consolidated.

Table 14 does not provide line requirements from the regional 911 center to a combined regional dispatch facility, since it is assumed that such facilities would be collocated. The line requirements for a regional law enforcement and a regional fire facility are based on the premise that the regional 911 facility and the regional law enforcement facility will be collocated and that lines would be run to the regional fire facility. Sixteen of the lines shown in Table 14 as "Other" are to ambulance companies; consolidation of emergency ambulance dispatch into the dispatch centers would reduce line requirements to fourteen.

5. Costs of Information Storage and Transfer Equipment

The estimated acquisition costs of the information storage and transfer equipment, as described in Appendix C, are summarized for the two regional center concepts--with and

without Clark county--in Table 15. The information in the table is based on 27 console positions (26 answering personnel and one supervisor) for the regional center with Clark county included and 22 console positions (21 answering personnel and one supervisor) for the regional center without Clark county. The cost data provided were derived from manufacturer's literature and are not representative of any one manufacturer. It must also be remembered that cost reductions could be obtained by purchasing a complete system (if available) rather than purchasing separate modules to combine in a system. Since most computer equipment can be leased rather than purchased, this alternative should be investigated before equipment is purchased.

The data modems listed in Table 15 will permit the answering center to communicate digital traffic over dedicated telephone lines to the dispatch centers. The cost shown in the table is an average cost since the actual cost can vary from approximately \$5,000 to \$40,000 depending on the degree of dispatch consolidation.

D. COUNTY-BY-COUNTY 911 REQUIREMENTS

Alternative 911 systems 6 through 8 in Table 10 are discussed in this section.

1. Differences in Requirements: County-by-County and Regional

County-by-county 911 differs from regional 911 primarily in the following ways:

- Operational procedures are required to handle calls terminated at the wrong 911 center because of the boundary mismatch problems.
- Personnel are required to man five centers instead of one, so that the economies of scale in personnel are not realized.
- Five facilities instead of one are required.
- Incoming and outgoing lines are shorter, and hence less costly.
- Information storage and transfer equipment costs are higher because of the need to provide equipment for five rather than one facility.

These differences are explained in detail in the remainder of this section.

Table 14

TOTAL NUMBER OF OUTGOING LINES (VOICE, DATA, AND COMBINED VOICE/DATA) FROM REGIONAL 911 CENTER

Alternative	Clackamas*	Clark*	Columbia*	Washington*	Multnomah*	Other†	Total
Regional Center to: -							
1. All current dispatch facilities	57	20	17	36	23	30	183
2. One law enforcement and one fire dispatch center per county	13	12	4	12	6‡	30	77
3. One combined law enforcement and fire dispatch center per county	8	6	4	8	0	30	56
4. Regional law enforcement and fire dispatch centers	0	0	0	0	0	30	40§
5. One combined law enforcement and fire dispatch center for the region	0	0	0	0	0	30	30**

*Law enforcement and fire protection.

†All public safety agencies other than police and fire.

‡Multnomah law enforcement and regional 911 collocated.

§ Lines from 911 law enforcement center to a fire center.

**Collocated 911 law enforcement fire center.

Table 15
 INFORMATION STORAGE AND TRANSFER EQUIPMENT
 ACQUISITION COSTS--REGIONAL CENTERS

Item	Including Clark County (26 operator positions)	Excluding Clark County (21 operator positions)
Voice recording equipment		
Individual answering position recorders	\$28,360	\$ 22,970
Logging recorders	<u>35,440</u>	<u>28,870</u>
Total voice recording equipment	\$ 63,800	\$ 51,840
Digital equipment		
Duplex computers	35,440	36,900
Disk memory	94,750	104,000
Tape transports	21,320	23,400
Printer	7,110	7,800
CRT's/keyboards	91,200	12,800
Data modems*	<u>52,700</u>	<u>48,100</u>
Total digital equipment	302,620	295,100
Programming costs	<u>100,000</u>	<u>100,000</u>
Total costs	\$466,420	\$395,100

*Average cost--see text.

2. Operational Considerations

The principal difference between county and regional 911 centers is that county centers need a method to handle calls received from telephone prefixes extending across the boundaries of two counties served by 911. All incoming calls from an exchange would be routed to one answering center, where a decision would be made to establish which county center should process the emergency calls. A procedure to accomplish such processing would be established for the answering and dispatching of calls originating in a county served by 911 but whose calls are answered in an adjacent county (see Appendix C).

Essentially, three approaches could be employed when an answering center receives a call from a citizen located in an adjoining county served by 911:

- If the operator can immediately determine that the call is from the adjoining county, the call could be transferred to the county in which the citizen is located, and details of the emergency could be obtained by the second answering center.
- The operator could obtain the citizen's address and let the computer determine in which county the citizen is located. The operator would then continue obtaining details of the emergency during the computer's verification of the address. If the citizen's location was found to be outside the county, the information obtained from the citizen would be transferred digitally to the adjoining county answering center. The citizen's call would also be transferred to the adjoining county center if required by the adjoining county.
- The operator can acquire all the information describing the emergency and contact the adjoining county's dispatch center(s).

A combination of the first two methods has been assumed for this study, although it is realized that additional call transfers will be required. It is recommended that whenever a telephone prefix overlaps a county boundary, the prefix should be served by the county answering center of the county containing the largest number of telephone stations in the prefix. The third method outlined would minimize the number of call transfers but

would require establishing complex multi-county operational and funding procedures. Services could be dispatched for areas outside of the counties served by 911 or the 911 operators could provide the citizen with the seven-digit telephone numbers of their serving agency, depending on the policy established by the county center.

3. Personnel

Table 16 shows the operator force requirements for the various county 911 centers.

The method of computing the required number of operators to handle the busy hour traffic and the total force requirement is described in Appendix D. The number of busy-hour calls predicted for each county center were provided in Table 5.

The Columbia county 911 center probably does not have a requirement for a supervisory operator work station because of the small number of operators involved. When there are two operators on duty, one of them can be appointed as the senior operator and have responsibility for the center.

Clackamas, Clark, Multnomah, and Washington counties do require a supervisory operator's work station. This position for Clackamas, Clark, and Washington counties need be occupied, however, only during the shift that has the busy hour. During the other shifts when there will be only a few operators on duty, one operator would be classified as the senior operator. The supervisor's position for Multnomah county would probably have to be manned at all times.

Each of the county centers will require a center manager, a secretary, and a data clerk. Their duties are similar to those at the regional center. The Columbia county center may not require a full-time manager and secretary. This requirement will have to be determined when the system engineering design is performed.

The total operator force for the five county centers would be seven more than for the single regional center and the number of supervisors would be increased by 12. The reduced operator force in the regional 911 center is due to a more efficient use of operator personnel while the higher number of supervisors in the county centers is due to a need for supervision in multiple facilities.

Table 16

COUNTY 911 CENTER OPERATOR FORCE REQUIREMENTS

911 Center	Year 1973			
	No. of Operators		No. of Supervisory Operators	
	Busy-Hour	Total Force	Busy-Hour	Total Force
Clackamas Co.	6	13	1	4
Clark Co.	5	11	1	4
Columbia Co.	2	5	0	0
Multnomah Co.	10	22	1	5
Washington Co.	6	13	1	4
Total Force	29	64	4	17

911 Center	Year 1990			
	No. of Operators		No. of Supervisory Operators	
	Busy-Hour	Total Force	Busy-Hour	Total Force
Clackamas Co.	9	20	1	4
Clark Co.	6	13	1	4
Columbia Co.	2	5	0	0
Multnomah Co.	10	22	1	5
Washington Co.	7	15	1	4
Total Force	34	75	4	17

4. Facilities and Space

Table 17 shows the space requirements for county 911 centers. The same space elements that were described for the regional center (Appendix E) have been used. The required 1973 facility sizes vary from a minimum of 1850 square feet for Columbia county to a maximum of 3600 square feet for a Multnomah county 911 facility. The total space needed for these five facilities is 15,200 square feet in 1990. This combined space requirement is about two and three quarters times as large as a single regional facility and would probably cost \$532,000 (at \$35 per square foot) compared to \$194,950 for the regional facility--a difference of \$337,050.

To the space required for the 911 centers will be added space for dispatch services for certain alternatives. For combined county law enforcement and fire protection dispatch centers, the space required for these centers should be added to the 911 space requirements. For separate law enforcement and fire protection centers in each county, the space required for the law enforcement center should be added to 911 space requirements. The actual size of the space to be added will be discussed in the next section of this chapter.

5. Incoming Telephone Lines

Tables 18 through 22 contain the number of incoming 911 lines required to service the busy-hour emergency calling volume. These line requirements were sized using a P01 grade of service, a five-second ringdown time, and an average 40-second call length. The method used in these calculations is detailed in Appendix F. Appendix F also discusses the additional lines that are required for a ten-second ring-down time.

The selection of exchanges to be connected to each center was made on the basis of the distribution of population in the exchanges. The county with the largest population in an exchange had its 911 center connected to that exchange. Reference to Table 1 in Chapter II shows the main station distribution of the exchanges with service in more than one county. For example, the Gresham exchange, with 3,068 main stations in Clackamas and 10,065 main stations in Multnomah, would be connected to the Multnomah 911 center. Calls from the Clackamas stations through this exchange would then be routed

through the Multnomah 911 center to the Clackamas 911 center and then to the correct Clackamas dispatch facility. This operation was described earlier and is detailed in Appendix C.

6. Outgoing Telephone Lines

In Appendix F, the techniques used to determine the number of voice, data, and alternate voice/data lines required to connect the county 911 centers to the dispatch facilities are described. Alternatives 6 through 8 of Table 10 are the dispatch alternatives that are considered with county 911 centers--these are existing dispatch facilities, separate law enforcement and fire protection dispatch centers in each county, and combined law enforcement and fire protection dispatch facilities in each county.

Table 23 contains the line requirements for each of the alternatives. The number of lines for connection of all existing dispatch facilities to county 911 centers assumes that no existing dispatch facilities would be collocated with the 911 centers. With one law enforcement and one fire protection radio dispatch center per county, the line sizing is based on collocated county 911 and law enforcement dispatch with lines connecting that facility to the fire dispatch center. Finally, combined county law enforcement and fire protection dispatch centers are assumed to be collocated within the county 911 centers. Table 23 reflects these consolidations by requiring a total of 152 lines to existing law enforcement and fire protection dispatch centers, 40 lines to fire protection centers for separate law enforcement and fire protection centers and no lines for completely combined facilities.

Additional line requirements (listed as "Other" in Table 23) over those required for a regional 911 center result from two requirements: (1) each center must be connected to the regional emergency facilities--such as the U.S. Forest Service and the FBI, and (2) calls must be transferred between the 911 centers because of the telephone boundary and fire district mismatch problems and because of possible emergencies affecting more than one of the counties. The line requirements due to multiple connections from each 911 center to the other emergency facilities will be about 54 lines compared to about 30 lines for a regional center. Line requirements for connecting the

Table 17

COUNTY 911 CENTER SPACE REQUIREMENTS

Type of Space	Clackamas County		Clark County		Columbia County		Washington County		Multnomah County	
	Year 1973 (ft ²)	Year 1990 (ft ²)	Year 1973 (ft ²)	Year 1990 (ft ²)	Year 1973 (ft ²)	Year 1990 (ft ²)	Year 1973 (ft ²)	Year 1990 (ft ²)	Year 1973 (ft ²)	Year 1990 (ft ²)
911 Operator positions	300	400	220	300	70	70	250	330	470	470
Supervisory operator position	100	100	100	100	-	-	100	100	100	100
Administrative office (center manager, secretary, and their files)	400	400	400	400	300	300	400	400	400	400
Storage space for new supplies (magnetic tape, computer tape, log books, forms, pencils, etc.) and for completed tapes, logs, forms, etc.	300	300	300	300	300	300	300	300	350	350
Two rest rooms, each containing a locker area for storing personal belongings of the staff on duty	400	500	400	400	200	200	400	400	500	500
Small kitchen and emergency foodstuffs supply storage area	400	400	400	400	100	100	400	400	400	400
Telephone trunk recorder and playback equipment	20	20	20	20	20	20	20	20	20	20
Minicomputer and its associated processing and switching equipment	100	100	100	100	100	100	100	100	100	100
Repair and maintenance shop space	100	100	100	100	100	100	100	100	100	100
Automatic starting emergency power generator and heat dissipation equipment to supply power to the 911 center equipment, lights, and air conditioning plant	100	100	100	100	100	100	100	100	100	100
Air conditioning and heating equipment	200	200	200	200	100	100	200	200	200	200
Telephone company equipment room	200	200	200	200	150	150	200	200	250	250
Misc. space for walkways, manual backup system materials, etc. (approx. 20% of the above working space)	580	580	510	530	310	310	530	550	610	610
Total Space Required	3,150	3,400	3,050	3,150	1,850	1,850	3,100	3,200	3,600	3,600

Table 18

INCOMING 911 LINES TO THE CLACKAMAS COUNTY 911 CENTER

Telephone Company	Central Office	Busy-Hour		No. of Lines Required
		Traffic	CCS	
Aurora	Aurora	3	1.35	2
Beaver Creek	Beaver Creek	1	0.45	2
Canby	Canby	21	9.45	3
	Needy	1	0.45	2
Cascade Utilities	Estacada/Eagle Creek	22	9.90	3
	Ripplebrook	1	0.45	2
Clear Creek Mutual	Redland	3	1.35	2
Colton	Colton	1	0.45	2
GTNW	Sandy	18	8.10	3
	Stafford	39	17.55	4
Molalla	Molalla	9	4.05	2
Monitor Coop	Monitor	1	0.45	2
PNB	Government Camp	1	0.45	2
	Lake Oswego	79	35.55	5
	Oak Grove/Milwaukie	153	68.85	7
	Oregon City	129	58.05	6
Valley	Hoodland	1	0.45	2
	Silverton	1	0.45	2
	Sunnyside	22	9.90	3
Total		506	--	56

Table 19

INCOMING 911 LINES TO CLARK COUNTY 911 CENTER

Telephone Company	Central Office	Busy-Hour		No. of Lines Required
		Traffic	CCS	
GTNW	Camas	20	9.00	3
	Washougal	11	4.95	2
	Washougal River	2	0.90	2
	Woodland	2	0.90	2
Lewis River	Amboy	2	0.90	2
	La Center	5	2.25	2
	View	2	0.90	2
PNB	Battleground	9	4.05	2
	Orchards	60	27.00	4
	Oxford	183	82.35	7
	Ridgefield	18	8.10	3
	Yacolt	5	2.25	2
Total		319	--	33

Table 20

INCOMING 911 LINES TO THE COLUMBIA COUNTY 911 CENTER

Telephone Company	Central Office	Busy-Hour		No. of Lines Required
		Traffic	CCS	
GTNW	Clatskanie	8	3.60	2
	Vernonia	9	4.05	2
PNB	Jewell	1	0.45	2
	Rainier	10	4.50	2
	St. Helens	60	27.00	4
Rose Valley	Scappoose	12	5.40	2
Total		100	--	14

Table 21

INCOMING 911 LINES TO THE MULTNOMAH COUNTY 911 CENTER

Telephone Company	Central Office	Busy-Hour		No. of Lines Required	
		Traffic	CCS		
PNB	Alpine	116	52.20	6	
	Atlantic	124	55.80	6	
	Avenue	24	10.80	3	
	Belmont	98	44.10	5	
	Burlington	2	0.90	2	
	Butler	60	27.00	4	
	Capitol	60	27.00	4	
	Cascade Locks	3	1.35	2	
	Cherry	60	27.00	4	
	Harold Street	36	16.20	4	
	Prospect	102	45.90	5	
	Cascade Utilities	Corbett/Aims	8	3.60	2
	GTNW	Gresham	60	27.00	4
Orient		13	5.85	3	
Total		766	--	54	

Table 22

INCOMING 911 LINES TO THE WASHINGTON COUNTY 911 CENTER

Telephone Company	Central Office	Busy-Hour		No. of Lines Required	
		Traffic	CCS		
GTNW	Aloha	15	6.75	3	
	Banks	1	0.45	2	
	Beaverton	160	72.00	7	
	Forest Grove	47	21.15	4	
	Gaston	10	4.50	2	
	Hillsboro	60	27.00	4	
	Newberg	1	0.45	2	
	Scholls	15	6.75	3	
	Sherwood	11	4.95	2	
	Somerset	15	6.75	3	
	Tigard	25	11.25	3	
	PNB	Cypress	7	3.15	2
		North Plains	21	9.45	3
Total		358	--	40	

Table 23

TOTAL NUMBER OF OUTGOING LINES (VOICE, DATA, AND COMBINED VOICE/DATA) FROM EACH COUNTY 911 CENTER

Alternative	Clackamas		Clark		Columbia	
	Law Enforcement & Fire	Other	Law Enforcement & Fire	Other	Law Enforcement & Fire	Other
County 911 Centers to:						
1. All current dispatch facilities	57	12	20	12	16	9
2. One law enforcement and one fire dispatch center per county	8	12	8	12	5	9
3. One combined law enforcement and fire dispatch center per county	--	12	--	12	--	9
Alternative	Multnomah		Washington		Total	
	Law Enforcement & Fire	Other	Law Enforcement & Fire	Other	Law Enforcement & Fire	Other
County 911 Centers to:						
1. All current dispatch facilities	23	9	36	12	152	54
2. One law enforcement and one fire dispatch center per county	11	9	8	12	40	54
3. One combined law enforcement and fire dispatch center per county	--	9	--	12	0	54

911 centers were developed based on telephone and fire protection boundary overlap problems as specified in Tables 1 and 2.

On the basis of the data provided in those tables, SRI developed the following line requirements for interconnecting the county 911 centers:

- Three data and three voice lines between the Multnomah and Clackamas centers.
- Three data and three voice lines between the Multnomah and Washington centers.
- Two alternate voice/data lines between the Multnomah and Clark centers.
- Three data and three voice lines between Clackamas and Washington centers.
- Two alternate voice/data lines between Columbia and Washington centers.

Thus, a total of 22 lines will be required for interconnecting the centers to accomplish call transfer. Other lines between the centers would also be required for normal business and coordination purposes.

Multiple connections to regional emergency facilities will require a total of 15 lines. The remaining 17 lines (of the total of 54) will be needed to connect to the various ambulance dispatch centers. If the ambulance dispatch function is consolidated on a county-by-county basis, then 17 lines will not be required for either the consolidated or separate law enforcement and fire facilities assuming that the law enforcement and ambulance dispatch centers were collocated.

In summary, it is evident that the distances between county 911 centers and county dispatch facilities will be shorter but that the line cost savings of these shorter distances is partially balanced out by a need to provide 34 additional lines (22 plus 12) in the county center options in order to provide for boundary mismatch call transfers and redundant connections to regional emergency facilities.

7. Costs of Information Storage and Transfer Equipment

The estimated acquisition costs of information storage and transfer equipment for the county centers are provided in Table 24. Two types of equipment, voice and digital, are priced in the table. The equipment elements are identical to those shown in Table 15 for the regional center. A total of 29 positions

are required instead of the 26 required for the regional center. Since each center would have its own information storage and transfer system, the digital equipment costs would be much higher than they would be for the regional center.

The total cost of the five individual county systems would be \$771,970 instead of \$398,910 for the regional system--nearly twice as expensive. The costs shown for the data modems in Table 24 are average costs; the actual costs of modems will be determined by the number of lines connecting the 911 centers to the dispatch facilities. Referring to Table 24, it can be seen that the number of modems required can vary from a low of zero to a maximum of 57 (Clackamas with no consolidation) depending on the degree of consolidation.

The costs shown in Table 24 are purchase costs for the equipment; it would also be possible to lease many of these equipments. The decision of whether to purchase or lease should be based on the type of funding available to the counties and the cost depreciation value of purchasing.

E. RADIO DISPATCH CONSIDERATIONS

The radio dispatch alternatives described in Table 10 will result in modification of the frequency requirements and operating costs in the five-county area. In this section, the general advantages and disadvantages of dispatch consolidation are described as are the frequency, frequency utilization, facility, and personnel considerations for the dispatch alternatives.

1. Advantages and Disadvantages of Dispatch Consolidations

The benefits that derive from consolidating dispatch facilities occur in many areas. Primary among these are:

- The number of physical plants required is minimized.
- The number of dispatchers needed to handle the dispatch traffic is minimized.
- The efficiency of channel usage is greatly increased.
- A greater revenue base can be applied to system engineering and equipment.
- Coordination among a few large consolidation dispatch centers is more efficient than coordination among a

Table 24

INFORMATION STORAGE AND TRANSFER EQUIPMENT ACQUISITION COSTS—COUNTY CENTERS

Item	Clackamas (6 Positions)	Clark (5 Positions)	Columbia (2 Positions)	Multnomah (10 Positions)	Washington (6 Positions)	All Counties (29 Positions)
<u>Voice Equipment</u>						
Operator recorders	\$ 6,400	\$ 5,330	\$ 2,110	\$ 10,660	\$ 6,400	\$ 30,900
Logging recorders	10,000	8,330	3,330	16,660	10,000	48,320
Total voice equipment	16,400	13,660	5,440	27,320	16,400	79,220
<u>Digital Equipment</u>						
Duplex computer	20,000	16,600	6,600	33,200	20,000	96,400
Disk memory	53,300	44,450	17,590	88,500	53,300	257,540
Tape transports	12,000	10,000	4,000	20,000	12,000	58,000
Printer	4,700	3,330	1,550	6,660	4,700	20,940
CRT's/keyboards	21,000	17,500	7,000	35,000	21,000	101,500
Data modems	12,000	10,000	4,000	20,000	12,000	58,000
Total digital equipment	123,000	101,900	40,690	203,800	123,000	592,390
Programming	20,690	17,240	6,900	34,480	20,690	100,000
Total costs	\$160,100	\$132,800	\$53,370	\$265,600	\$160,100	\$771,970

large number of small, minimally-equipped dispatch centers.

The chief disadvantages of dispatch consolidation derive from the fact that existing dispatch systems must be preempted or modified for their functions to be handled at the consolidated dispatch facilities. Generally, this means that start-up costs for consolidation are fairly high and a new operational doctrine must be developed for the consolidated system.

In general, the multiple long-term advantages of dispatch consolidation have led local governments and public safety agencies--frequently supported by federal funds--to implement consolidation. The county-by-county consolidation alternatives described in the previous section are typical of consolidation efforts that have been implemented (and are being currently considered for implementation in the CRAG counties) in many areas. Regional dispatch consolidation alternatives are not common and require additional operational considerations beyond county consolidations. However, the economies of scale that result from consolidation on a regional basis are significant and have, therefore, been included in our evaluations.

2. Consolidation Alternatives

One-hundred three law enforcement and fire protection agencies are currently using 74 frequencies to dispatch emergency service vehicles in the five-county area. In addition, 11 frequencies are in use by ambulance companies. For Alternative 1, the radio dispatch performed on these frequencies would not change. For the other alternatives, consolidation will increase the number of frequencies being used by the consolidated dispatch centers. Consolidation of dispatch alternatives will permit the use of fewer frequencies because of more efficient procedures. The total number of frequencies needed for each alternative will depend upon operational procedures adopted by the individual dispatch centers, thus a determination of the actual number of frequencies required for each alternative is beyond the scope of this study.

3. Dispatcher and Facility Requirements

Each increased consolidation increment decreases the required number of dispatchers in the same manner that combining telephone answering facilities reduces the number of telephone operators required. For example,

the operator force required for a regional 911 system was shown to be 18 less than the operator force required to handle the same number of calls in a county-by-county system.

The introduction of 911 answering will greatly reduce the load on the dispatch personnel. Currently, the dispatcher and phone answerer are usually the same person (single-stage systems), whereas, with 911, the telephone will be answered by the 911 operators and dispatch will be performed by dispatch personnel (two-stage systems). This will remove a large time load from the dispatch force so that it can be considerably smaller than the current force.

To estimate the number of dispatch positions required, SRI used an estimate of 10 seconds per transmission and a requirement for a total of 20 seconds for a transaction (base transmission and mobile response). SRI used PSSI data for Multnomah county; PSSI also used an average of about 10 seconds for all radio messages for that county. In addition to the actual number of dispatch positions required, personnel are also required to support the dispatcher. PSSI covered this aspect of operations by using the "Complaint" or "Backup" position in the dispatch center. SRI has added similar weighting to its estimates to provide adequate support and supervision for dispatch personnel. Such personnel additions are particularly important in fire operations where each event may create a considerable workload because of alerting, operating, and command control procedures.

SRI believes that public safety operations in the CRAG area would greatly benefit from computer-aided dispatch and command/control techniques. Such techniques would tend to reduce the number of support personnel specified in Table 25; however, because the CRAG counties are in various planning stages for dispatch consolidation, SRI has used a conservative manpower support level. We have used these manpower levels in our cost comparisons to provide a consistent evaluation tool. Refined personnel allocations should be made during detailed engineering design of the selected alternative. On the basis of these assumptions then, the numbers of dispatch positions in the busy hour for each alternative are shown in Table 25.

The values used for total dispatcher force shown in Table 25 were derived using diurnal radio traffic loading which showed a need for

Table 25

FACILITY AND PERSONNEL REQUIREMENTS FOR DISPATCH ALTERNATIVES

Agencies	No. of Facilities	No. of Dispatch Positions	No. of Dispatchers and Support Personnel
All current dispatch	52		162
County centers:			
Clark	1	3	12
Columbia	1	1	7
Clackamas	1	5	20
Multnomah	1	6	24
Washington	1	5	20
Total	5	20	83
Clark law enforcement	1	2	11
Clark fire	1	1	7
Columbia law enforcement	1	1	7
Columbia fire	1	1	7
Clackamas law enforcement	1	2	11
Clackamas fire	1	2	11
Multnomah law enforcement	1	4	16
Multnomah fire	1	2	11
Washington law enforcement	1	2	11
Washington fire	1	2	11
Total	8	19	95
Regional law enforcement	1	8	32
Regional fire	1	6	24
Total	2	14	56
Single dispatch center	1	13	52

full manning only during a single eight-hour shift.

- If only one position is to be manned, then a full force of five dispatchers is required.
- If two positions in a single service are to be manned, then a force of four dispatchers per position is required.
- If three or more positions in a single service are to be provided, then a force of three dispatchers per position is required.

All of these multipliers are more than that used for the 911 operator force (2.2) because the operator force can more easily provide backup for itself, i.e., all operators will be trained to man any position. For law enforcement and fire protection dispatch operations, however, we have assumed that the dispatchers

for law enforcement and those for fire protection will not man each others' consoles. Additional personnel have been added at a rate of one for three to provide backup and support services. The single exception we have made to this rule is for a combined Columbia county dispatch center where traffic requirements dictate the need for only one console and we have allocated only seven personnel. The final consideration we used in sizing the dispatcher force requirement was the need to man all positions only during the peak hour periods as we did for the telephone 911 operator force.

For the regional dispatch operations, SRI believes that a supervisory dispatch position should also be included in the center design. This position would be capable of monitoring and transmitting on all channels. This addition will mean a requirement of nine consoles for

regional law enforcement, six consoles for regional fire protection, and twelve consoles for combined regional law enforcement and fire protection. An additional four supervisors would also have to be added to the staffs of each of these centers.

4. Costs

Estimates of facilities and dispatchers required for the various dispatch alternatives, plus estimates for the digital terminals at the dispatch centers were used to price the dispatch alternatives. The resulting cost estimates, while obviously not the complete costs for the dispatch facilities, are adequate for comparing dispatch alternatives. Table 26 lists the costs for various dispatch consolidations, including facility, personnel, and position costs for each of the alternatives.

As discussed earlier, facility requirements are based on the following general assumptions: (1) all county 911 centers will be collocated with either a combined county dispatch facility or a law enforcement dispatch facility--in the event of separate law enforcement and fire dispatch centers in each county, and (2) a regional 911 center will be collocated with the Multnomah combined law enforcement and fire dispatch facility or with a Multnomah law enforcement facility.

The first assumption is based on the fact that none of the existing law enforcement and fire dispatch facilities in the counties is large enough to house consolidated facilities so that a new facility will be required. On that basis, the consolidation of dispatch and 911 in a single new facility will be much less costly than the provision of separate facilities for each system. The second assumption is based on the fact that the centroid of emergency telephone traffic will fall in Multnomah county

and that the single largest volume of emergency traffic will go to the Multnomah county public safety agencies.

To accommodate the dispatch facilities in the 911 centers, we have allowed the following additional square footage for the various facility elements:

- 150 square feet average per dispatch, support or supervisory position
- 25 square feet of storage per personnel position
- 15 square feet for equipment repair per personnel position.

These numbers have been added to the values shown in Tables 12 and 17 to obtain total space requirements for combined 911 and dispatch facilities. For the separate dispatch facilities--county or regional fire facilities--the building sizes have been sized by comparing the number of dispatch positions required for comparable 911 centers as outlined in Appendix E. The costs shown in Table 26 for facilities are based on \$35 per square foot and include all possible 911 and dispatch facility cost combinations in 1990.

Personnel costs were computed using an \$11,000/year salary which was selected to include overhead support and an average of 6 percent salary increase per year. Position costs are based on \$5,000/position for a digital CRT terminal with MODEM. It should be noted that in its separate effort for Clark county, SRI determined the facility size for Clark county to be 5,800 square feet for combined 911, law enforcement, fire, emergency operation center, and radio repair facility but did not allow for support personnel space. In this report, SRI used estimates for Clark county that were consistent with the estimates made for the other counties for comparison purposes.

Table 26

DISPATCH FACILITY COSTS

Alternative	Agencies	No. of Facilities	Size of Facilities	Costs of Facilities	No. of Personnel	Costs of Personnel	No. of Positions	CRT Terminal Costs
1	All current dispatch	54		\$ 837,000	162	\$1,782,000/yr	59	\$295,000
County 911	County centers:							
	Clark	1	5,450	190,750	12	144,000	3	15,000
	Columbia	1	3,275	114,625	7	77,000	1	5,000
	Clackamas	1	6,850	239,750	20	220,000	5	25,000
	Multnomah	1	8,100	283,500	24	264,000	6	30,000
	Washington	1	6,950	239,750	20	220,000	5	25,000
	Total	5	30,525	1,068,375	83	927,000	20	100,000
County 911	Clark law enforcement	1	5,240	183,400	11	127,000	2	10,000
	Clark fire	1	2,730	95,550	7	77,000	1	5,000
	Columbia law enforcement	1	3,280	114,800	7	77,000	1	5,000
	Columbia fire	1	2,730	95,550	7	77,000	1	5,000
	Clackamas law enforcement	1	5,490	192,150	11	121,000	2	10,000
	Clackamas fire	1	3,490	122,150	11	121,000	2	10,000
	Multnomah law enforcement	1	6,640	232,400	16	176,000	4	20,000
	Multnomah fire	1	3,490	122,150	11	121,000	2	10,000
	Washington law enforcement	1	5,490	192,150	11	121,000	2	10,000
	Washington fire	1	3,490	122,150	11	121,000	2	10,000
	Total	10	41,470	1,451,450	95	1,133,000	19	95,000
Regional 911	Regional law enforcement	1	11,650	407,750	32	352,000	8	40,000
	Regional fire	1	5,960	208,600	24	264,000	6	30,000
	Total	2	17,610	616,350	56	616,000	14	70,000
Regional 911	Single dispatch center	1	15,450	540,750	52	572,000	13	65,000
Regional 911	County centers:							
	Clark	1	3,580	125,300	12	132,000	3	15,000
	Columbia	1	1,650	57,750	7	77,000	1	5,000
	Clackamas	1	5,100	178,500	20	220,000	5	25,000
	Multnomah	1	5,860	205,100	24	264,000	6	30,000
	Washington	1	5,100	178,500	20	220,000	5	25,000
	Total	5	21,290	745,150	83	925,000	20	100,000
Regional 911	Clark law enforcement	1	3,400	119,000	11	121,000	2	10,000
	Clark fire	1	2,730	95,550	7	77,000	1	5,000
	Columbia law enforcement	1	2,730	95,550	7	77,000	1	5,000
	Columbia fire	1	2,730	95,550	7	77,000	1	5,000
	Clackamas law enforcement	1	3,400	119,000	11	121,000	2	10,000
	Clackamas fire	1	2,730	95,550	7	77,000	2	10,000
	Multnomah law enforcement	1	4,440	155,400	16	176,000	4	20,000
	Multnomah fire	1	3,400	119,000	11	121,000	2	10,000
	Washington law enforcement	1	3,400	119,000	11	121,000	2	10,000
	Washington fire	1	2,730	95,550	7	77,000	2	10,000
	Total	10	31,630	1,109,150	95	1,045,000	19	95,000

V COMPARISON OF SYSTEM ALTERNATIVES

A. SYSTEM COST ELEMENTS

In previous chapters, the basic data needed to provide a basis for selection of a 911 system were developed. Specifically, the current operations and costs of law enforcement, fire protection, and ambulance operations were analyzed, the management and political considerations for 911 operations were described, the problems of telephone boundary and fire protection boundary mismatch were quantified, the operations of 911 systems in the context of the five-county area were described, and a group of viable 911 system alternatives were developed and costed. In this chapter, the advantages and disadvantages of these alternatives are compared in terms of costs, benefits, and operational desirability.

Table 27 contains the key cost data that were used to compare the various alternatives:

- Costs of incoming 911 telephone lines, costs of 911 facility space, costs of operators, supervisors and other personnel, and costs of telephone and information system equipments in the 911 centers
- Costs of outgoing lines to the dispatch alternatives, costs of dispatch facilities, and costs of dispatch digital terminals
- Sizing of facilities, line requirements (911 and outgoing lines), 911 operator and dispatch staffs, and operator and dispatch positions.

The costs of the alternatives have been divided into initial and recurring cost elements so that funding comparisons can be provided.

B. COSTS OF CURRENT SYSTEMS

To provide a basis for comparison of the 911 alternatives, the approximate costs of the current five-county public safety communications systems were developed to the extent possible. The current system differs in the following significant ways from the 911 alternatives analyzed in this study.

- Current facilities are mostly single stage with personnel performing both dispatch and answering functions as opposed to the 911 alternatives which have two-stage operations with answering and dispatch functions being performed separately

- Current answering/dispatch services are generally sharing facilities with other public safety functions so that their initial costs and recurring costs are not clearly separable from those of the other functions.

A survey of the field, combined with the use of estimation techniques, yielded the following approximate costs for existing facilities:

- Personnel: 162 employees and 12 supervisors at an annual salary of approximately \$1,914,000*
- Space: Space in 54 public safety facilities at an estimated cost of \$1,195,000†
- Telephone: Annual charges on lines to the 54 dispatch facilities of approximately \$109,500.

C. COST COMPARISON OF ALTERNATIVES

The alternatives listed in Table 27 have costs and benefits relative to one another. In this section, the alternatives will be compared in terms of their total costs, the elements that contribute to the total costs, and the operational value of each alternative.

1. Comparison of Total Costs

Table 28 contains estimates of initial and recurring costs for the alternatives, a cost estimate for 10-year operation, absolute and relative ranking of the alternatives on a cost basis, and a measure of the call transfer problem. In addition, equivalent estimates have been made for current facilities using the cost data provided in the previous section.

The least costly system is a single 911 regional answering center combined with a single regional dispatch facility. Increasing the number of dispatch facilities to two (regional law enforcement and regional fire dispatch) increases the 10-year cost by 4 percent while an

*Using \$11,000 average annual salary to permit simple comparison with the costs of the alternatives.

†Assuming an average of 500 square feet equivalent area per dispatch facility at \$35 per square foot.

Table 27

BASIC-COST DATA—REGIONAL AND COUNTY-BY-COUNTY CENTERS

911 Option	Dispatch Alternatives	Incoming Telephone Lines		Outgoing Telephone Lines			911 Facility	Dispatch Facility	Equipment Costs				Personnel Costs			
		No.	Initial	Recurring	No.	Initial			Recurring	Telco Initial	Telco Recurring	Info Systems	CRT Equipment	911 Operators	911 Supervisors	Dispatch
Center																
Regional	Current facilities	197	\$8,300	\$211,500	183	\$9,050	\$241,450	\$194,950	\$1,195,000	\$11,750	\$53,400	\$466,400	\$295,000	\$506,000	\$55,000	\$1,914,000
Regional	Center per county	197	8,300	211,500	58	3,000	61,050	--	745,150	11,750	53,400	466,400	100,000	506,000	55,000	925,000
Regional	Regional law enforcement and regional fire protection	197	8,300	211,500	10	450	13,350	--	616,350	11,750	53,400	466,400	70,000	506,000	55,000	616,000
Regional	One law enforcement and one fire protection per county	197	8,300	211,500	92	4,700	86,200	--	1,098,650	11,750	53,400	466,400	95,000	506,000	55,000	1,045,000
Regional	Regional center	197	8,300	211,500	--	--	--	--	540,750	11,750	53,400	466,400	65,000	506,000	55,000	572,000
County	Current facilities	197	5,700	144,000	202	7,400	114,000	532,000	1,195,000	39,500	79,400	772,000	295,000	704,000	187,000	1,914,000
County	Center per county	197	5,700	144,000	56	1,800	28,950	--	1,068,325	39,500	79,400	772,000	100,000	704,000	187,000	925,000
County	One law enforcement and one fire protection per county	197	5,700	144,000	93	3,200	37,100	--	1,451,450	39,500	79,400	772,000	95,000	704,000	187,000	1,133,000
County Centers*	All alternatives				22	1,100	26,200									

*Line costs for interconnecting county centers

Table 28

RANKING OF 911 ALTERNATIVES BY NET COSTS

Alternative No.	911 Alternative	Dispatch Alternatives	Initial Cost	Recurring Cost	10-Year Total	10-Year Ranking		Transfer or Referral
						Absolute	Relative	
1	Regional 911	Current facilities	\$2,200,450	\$2,981,350	\$31,993,950	7	2.12	10,094
2	Regional 911	One combined law enforcement and fire center per county	1,334,600	1,811,950	19,454,100	3	1.29	10,094
3	Regional 911	One law enforcement and one fire center per county	1,684,800	1,957,800	21,256,500	4	1.41	10,094
4	Regional 911	One law enforcement and one fire center for region	1,173,250	1,455,250	15,725,750	2	1.04	10,094
5	Regional 911	One combined law enforcement and fire center for region	1,092,200	1,397,900	15,071,200	1	1	10,094
6	County 911	Current facilities	2,846,600	3,172,400	34,570,600	8	2.29	269,683
7	County 911	One combined law enforcement and fire center per county	2,027,225	2,068,350	22,710,725	5	1.51	269,683
8	County 911	One law enforcement and one fire center per county	2,366,850	2,284,500	25,211,850	6	1.67	269,683
	Current system	current facilities	1,195,000*	2,023,500†	20,235,000†			

*Value of current space in dispatch facilities

†Annual telephone and personnel costs only

increase to five dispatch facilities (county-by-county combined dispatch facilities) increases the 10-year cost by 29 percent. Going to 10 dispatch facilities (one law enforcement and one fire per county) increases the cost by 41 percent over the lowest cost alternative. Thus, the four least expensive systems are those that have a regional 911 center connected to 1, 2, 5, or 10 dispatch centers. The cost of operating the current system (not including current building space) is 34 percent higher than the costs of the lowest priced alternative; the costs of the current operations can also be considered as nearly directly transferable to the costs of any of the alternatives. Thus, the three lowest cost alternatives would have lower costs than the current systems, would be sized to handle 50 percent more traffic, and would have facility space available to permit growth to 1990.

The first of the county-by-county alternatives is ranked fifth and consists of combined 911 and dispatch centers in each county. This particular alternative would cost 51 percent more than the lowest cost alternative and would involve the operation of five centers, as opposed to two centers for the least expensive alternative.

The next county alternative, ranked sixth, is for a county-by-county 911 center and separate fire protection and law enforcement dispatch centers in each county (with 911 and law enforcement collocated). This alternative would cost 67 percent more than the least expensive alternative.

The costliest alternatives are ranked seventh and eighth in Table 28 and are 2.12 and 2.29 times as costly as the least expensive alternative. These alternatives involve the linking of either a regional 911 center or county-by-county 911 centers to existing dispatch facilities.

Comparison of the regional 911 answering to county-by-county 911 answering shows that the least expensive county-by-county alternative, ranked fifth, is 51 percent more costly than the least expensive regional alternative. Comparison of the 911 alternatives linked to comparable dispatch alternatives shows that regional 911 alternatives average 23 percent less cost than comparable county-by-county 911 alternatives.

2. Comparison of Cost Elements

The net costs discussed in the previous section are composed of four basic elements: facility costs, equipment costs, personnel costs, and telephone line costs. In this section, the effects of each of these cost elements on the overall cost will be discussed, as will the sensitivity of the overall cost to different assumptions.

Table 28 contained the costs for each alternative while Table 29 shows the percentage of the total contributed by each cost element. It is immediately clear from these tables that personnel costs--for both answering and dispatch--are the major contributor to overall costs, yielding 75 percent to 81 percent of the total. Telephone costs for incoming and outgoing telephone lines are the next most costly element with from 7 percent to 14 percent of the total, depending on the alternative. Equipment costs--including telephone, information system, and dispatch CRT equipments--comprise 4 percent to 8 percent of the totals, while facility costs are the least costly, being from 4 percent to 6 percent of the totals.

Personnel costs are clearly the controlling element of the system costs. The fewer personnel needed to man the regional alternatives result in about 3 percent lower personnel contribution to the total costs than their comparable county alternatives. This difference can also be clearly seen by comparing 10-year costs which show the regional personnel costs to be about \$3.2 million lower (over 10 years) than comparable county personnel costs. This difference effectively overshadows the higher costs for the telephone system in the regional alternatives which have the regional center telephone systems costing about \$900,000 more over 10 years than their county counterparts.

Table 27 shows that facility costs are lower by about \$320,000 for the regional alternatives, but the small contribution to the overall costs of the alternatives made by these costs tends to make this difference relatively insignificant. Of more significance are the \$650,000 more costly equipment costs for the county alternatives which make the contribution to overall costs, about 2 percent higher for the county centers.

Summarizing these cost differences, it can be seen that the savings in telephone costs

Table 29
PERCENTAGE CONTRIBUTIONS OF COST ELEMENTS

911 Option	Dispatch Option	Total 10-Year Cost	Percent Telephone	Percent Facility	Percent Equipment	Percent Personnel	10-Year Ranking Cost Relative
Regional center	Current facilities	\$31,993,950	14%	4%	4%	78%	7 2.12
Regional center	Center/county	19,454,100	14	4	6	76	3 1.29
Regional center	Regional law enforcement and regional fire	15,725,750	14	4	7	75	2 1.04
Regional center	One law enforcement and one fire/county	21,256,500	14	5	5	76	4 1.41
Regional center	Regional center	15,071,200	14	4	7	75	1 1.00
County center	Current facilities	34,570,600	8	5	6	81	8 2.29
County center	Center/county	22,710,725	8	5	8	79	5 1.51
County center	Law enforcement and fire centers/county	25,211,850	7	6	7	80	6 1.67

in the county 911 alternatives are effectively cancelled by the savings in facility and equipment costs in the regional 911 alternatives. Thus, the savings in personnel costs in the regional alternatives can be considered to be the primary cost driving function.

The sensitivity to changes in requirements can clearly be seen from this analysis. Changes in personnel requirements would provide the most significant change in the overall cost and, depending on the nature of the change, could easily alter the relative rankings of the alternatives. Much more significant changes would have to be made in telephone line assumptions to affect the overall rankings, while changes in equipment and facility assumptions would have to be of the order of ten times to make any meaningful changes in the overall cost rankings. The different assumptions made to arrive at the above rankings are, we believe, sufficiently accurate that the overall cost rankings are valid and will not change.

In summary, it can be seen that the lower costs for personnel, equipment, and facilities in the regional alternatives clearly outweigh the higher telephone costs for those alternatives. This is clearly illustrated by the fact that the county alternatives are about 22 percent higher than comparable regional alternatives. It is also evident that complete dispatch consolidation on a regional level could save 29 percent in costs--or \$3,730,000 over the nearest competitor in county dispatch alternatives.

3. Special Cost Considerations

Two additional cost considerations were investigated by SRI, these were: (1) cost savings from combining ambulance dispatch in police dispatch facilities, and (2) costs of installing a microwave system to provide connections from the telephone central offices to a regional 911 answering center.

a. Ambulance Dispatch

The ambulance situation in the CRAG area is discussed in Appendix B and summarized in Section 5 of this chapter. SRI's evaluation of this situation leads us to the conclusion that ambulance districts for Code 3 emergencies should be set up in the CRAG region. The costs we have presented in the previous section are predicated on the following assumptions:

- Emergency calls for ambulance service would be handled by 911 operators

- Ambulance calls would be communicated to ambulance company dispatch points according to some zone/priority plan to be set up by the companies
- Ambulance company operational procedures for Code 3 responses would be established on a uniform regional basis.

These assumptions have led to certain costing decisions that would be modified if the ambulance companies elect to consolidate their dispatch facilities. Specifically, as one viable option, the ambulance companies could consolidate their dispatch facilities with either county or regional police dispatch centers. Such consolidations would have the following general effects on the overall 911/dispatch system costs:

- Line Costs. Combining with a regional police center would reduce line costs by \$1,500 for initial costs and \$18,000 for annual costs. Combining with county police centers would reduce line costs by \$800 for initial costs and \$14,100 for annual costs
- Personnel Costs. On a regional level, two additional dispatch positions could handle all ambulance calls while one dispatch position per county (except Columbia county which could absorb the traffic with current positions) would be required for the county dispatch options. Thus, two positions for regional and four positions for county options would handle all emergency dispatch for the 16 ambulance companies. These represent a savings of about \$115,000 and \$82,000 for regional and county ambulance dispatch, respectively
- Facility Costs. Additional space in the police dispatch centers would be inconsequential and hence would not be a factor in the decision of whether or not to consolidate dispatch functions.

The postulated personnel savings costs would only be realized by the system if the dispatchers save positions for the ambulance companies. A mechanism to actually effect such savings must be jointly worked out by the ambulance companies and the agency responsible for dispatch center operations.

In summary, consolidation of ambulance dispatch into the police dispatch facilities could save 30 percent of outgoing line costs and could effect a maximum personnel saving of about \$100,000 annually in ambulance dispatch personnel.

b. Microwave System*

SRI also developed preliminary costs for a microwave system that would link the telephone central offices to a regional 911 center located in the Harold Street exchange. Such a system could be used as either a complete replacement for a hard-wire (telephone line) system or as a communications backup system to the hard-wire system.

The costs for the system elements are detailed in Table 30. The various entries in the columns are keyed at the top of each column and are as follows:

- Column 1: Homing Exchanges. This is the number of exchanges that are expected to "home" on the particular radio site
- Column 2: Average Distance. The average distance of all exchanges homing on a given site from the site
- Column 3: Pole-Line Miles. The estimated number of pole-line miles that need to be constructed
- Column 4: Plant Extension. Estimated number of telephone outside plant miles that need to be constructed
- Column 5: Pole Line Dollars. Construction costs of pole-line extension estimated in Column 3. The first 1,500 feet are free and the balance costs \$1.40 per foot
- Column 6: Plant Dollars. Cost of outside plant extensions estimated in Column 4. Since it can be expected that this construction will be "joint," i.e., uses the same pole as the power lead, a figure of 40 cents per foot was used, again deducting the first 1,500 feet
- Column 7: Site Preparation. Costs developed on other SRI projects for similar systems

*This section was prepared by Mr. William Roberts of SRI.

Column 8: Shelters and Transportation. Shelters cost about \$4,000 each, and it costs about \$600 to transport the shelter and the other equipment to the site from some central depot

Column 9: Radio Equipment. Budget estimate supplied by a manufacturer for a 12-GHz terminal arranged in duplex configuration. Note that there are two additional transmitters and receivers which will offset the costs of the multiplex equipment required

Column 10: Antenna Dollars. Based on an average guyed tower of 100-foot height

Column 11: Purchase/Lease. Costs developed by SRI on another project for a similar system.

To these various cost items must be added about 10 percent for radio equipment spares and about 15 percent for detailed engineering. If the various cost elements are summed, a total installation cost is about \$600,000 with an annual operating cost of about \$50,000. Incoming line costs for a regional center are about \$211,500 (Table 27) with an installation cost of about \$8,300.

Comparison of telephone and microwave systems shows that the higher initial costs of the microwave system--\$600,000 vs \$8,300--are equalized in about three and one-half years by the lower operating costs of the microwave system--\$50,000 vs \$211,500. After this three and one-half year period, the costs of the microwave system are about \$161,500 per year cheaper than the telephone system. This does not include the costs of interconnection or the purchase of telephone equipment that would be necessary.

The long range cost benefits of a microwave system could also be realized for linking dispatch centers to one another. If CRAG elects to implement a microwave system, the cost-effectiveness of adding cable television (CATV) and educational TV to the original network should be investigated. Such additions would undoubtedly be more easily and economically implemented during the initial implementation of an emergency call microwave network.

CONTINUED

1 OF 2

Table 30

MICROWAVE SYSTEM COSTS

Microwave Location	Homing Exchange	Average Distance (miles)	Pole Line (miles)	Plant Extension (miles)	Pole Line (dollars)	Plant (dollars)	Site Preparation (dollars)	Shelter and Transportation (dollars)	Radio Equipment (dollars)	Antennas (dollars)	Purchase/Lease (dollars)
Rainier	2	5	2	2.5	\$ 12,684	\$ 4,680	\$ 1,000	\$ 4,600	\$ 17,500	\$ 15,000	\$10,000
Vernonia	2	5	2	2.5	12,684	4,680	1,000	4,600	17,500	15,000	10,000
Tukes Mtn.	11	10.6	2	2.0	12,684	3,624	1,000	4,600	17,500	15,000	10,000
Holbrook Peak	5	9	5	5-8	34,860	9,960	1,000	4,600	17,500	15,000	10,000
Chalhalern Mtn.	7	8.4	2	5	12,684	9,960	1,000	4,600	17,500	15,000	10,000
Harold Street	20	6	--	--	--	--	5,000	600	17,500	15,000	--
Estacada	6	9.8	3	3	20,076	5,736	1,000	4,600	17,500	15,000	10,000
Needy	6	5.7	--	--	--	--	5,000	600	17,500	15,000	--
Totals					\$105,672	\$38,640	\$16,000	\$28,000	\$140,000	\$120,000	\$60,000

Installation Costs = \$600,660

Annual Operation = \$50,000

D. COMPARISON OF OPERATIONAL FACTORS

In this section, comparisons will be made between the operational factors that affect the selection of alternatives. Three general areas will be treated, with each area rated in terms of either difficulty of implementation or degree of operational benefit. These three areas are: the call transfer problem, the characteristics of the 911 answering force required, and the dispatch operations.

The call transfer problem is the most visible one that faces any 911 system, since it is directly noticed by the public. Call transfers are made necessary by the mismatch between telephone central offices and the jurisdictional boundaries of public safety agencies. As was explained in Chapter II, the call transfer problem will arise whenever either a telephone exchange or a fire district crosses a county boundary. To minimize the problem of call transfers, 911 answering should be as centralized as possible. Furthermore, in the CRAG area, the areas of mismatch should be as sparsely populated as possible, to affect the smallest number of citizens.

Although both types of mismatch (telephone exchange or fire district) are serious, telephone mismatch is somewhat more serious, both in number of citizens affected and in the impact on the citizen unfamiliar with the prevailing situation who would be referred or transferred because of the mismatch. Operational techniques, on the other hand, can be employed by the answering and dispatch centers to obviate the problems of public safety/county line mismatch. Table 31, therefore, shows a ranking of the alternatives with all regional 911 alternatives ranked ahead of all county-by-county 911 alternatives on the basis of boundary mismatch considerations. Within these two 911 families, the alternatives are ordered by increasing dispatch consolidation because of the advantages in the area of public safety/county line mismatch.

Another factor to be considered in comparing the alternatives is the 911 answering force requirements. As we discussed earlier, the number of answerers required is less for the regional than for the county-by-county 911 alternative. At the same time, however, the regional center is always manned by more answerers than any of the individual county centers which means that the diversity of the regional answering force can be greater than

that of the individual county centers. The regional centers could, therefore, have an answering force which would more economically have the following capabilities: be able to handle calls in foreign languages, provide specialists in certain problems (such as suicide or poison control), and be more easily supplemented in the event of a serious emergency. A regional answering force would have a capability to shift the major part of its efforts to a serious county emergency if one were to occur so that it offers greater flexibility of response to unusual emergency situations.

A counter effect to this advantage, however, is a large number of dispatch facilities. Fragmenting the dispatch facilities increases the burden on the 911 answering force by requiring more of their time in the determination of the correct dispatch facility to contact. By weighting these two factors, the ratings shown for 911 answering force in Table 31 were established.

The last consideration for ranking the systems was the relative value of consolidating the dispatch facilities. In this rating, it was recognized that the fire protection, law enforcement, and emergency medical services are essentially county-oriented in their operations and that furthermore the law enforcement and fire protection operations in each county are only beginning to be consolidated. Essentially, this means that consolidation of these operations requires modifications in current operational procedures. In Table 31, the dispatch alternatives were ranked according to this operational and procedural complexity. Thus, the highest ranked system from a dispatch standpoint would maintain the separation of dispatch functions into law enforcement and fire protection centers on a county-by-county basis while the lowest ranked system would combine these dispatch functions into a single regional dispatch center. Note from Table 31, that this ranking gives results that are at considerable variance from the other rankings, yet it is a valid and important consideration in system selection. Furthermore, our cost data for regional dispatch are based on minimization of the number of dispatchers. Externalities and discontinuities such as maintaining special dispatch positions for certain cities would decrease the cost advantage of regional radio dispatch to the point that its savings over county-by-county might be only

Table 31

RANKING OF 911 SYSTEMS ALTERNATIVES

Alternative No.	911 Option	Dispatch Option	Relative Rank			Cost	Average	Overall Rank
			Call Transfer	911 Answering Force	Dispatch Operations			
1	Regional	Current dispatch	5	7	8	7	6.70	7
2	Regional	One center per county	3	3	4	3	3.25	3
3	Regional	One law enforcement and one fire center per county	4	5	2	4	3.75	4
4	Regional	One law enforcement and one fire regional center	2	2	5	2	2.50	2
5	Regional	One combined law enforcement and fire regional center	1	1	6	1	2.25	1
6	County	Current dispatch	8	8	7	8	7.75	8
7	County	One center per county	6	4	3	5	4.50	5
8	County	One law enforcement and one fire center	7	6	1	6	5.00	6

in economies of scale in facilities and equipment.

Finally, in Table 31, we have averaged the four rankings, (giving equal weight to each) to arrive at an overall ranking of the alternatives. Note that the ranking of the alternatives is the same as that for the cost ranking.

E. SYSTEM SELECTION RECOMMENDATIONS

On the basis of the cost analysis and the analysis of operational considerations, the three best systems would be, in descending order,

- Regional 911 with combined law enforcement and fire regional radio dispatch
- Regional 911 with separate law enforcement and fire regional radio dispatch
- Regional 911 with combined law enforcement and fire county-by-county radio dispatch.

We believe that any of these three alternatives would provide the citizens of the CRAG area with a viable public safety communications system having the benefits of 911. In our opinion, selection by CRAG as one alternative among the three given must be based on political as well as technical considerations. The function of the analyses and recommendations reported here is to make available essential information that can form the basis for these considerations. Accordingly, for each of the three alternatives recommended above, the benefits as well as the difficulties likely to be encountered in their implementation and operation are given in the following paragraphs.

The first alternative, regional 911 with one regional radio dispatch, would clearly provide the lowest cost alternative, both in implementation and in operation. If the necessary cooperation among the various public safety agencies, county and local governments were achieved, this alternative would further provide the best system of managing the public safety resources of the region, since all resources would be controlled from a single location. Such centralized coordination capability would be of great benefit in improving the day-to-day law enforcement and fire protection activities that require the real-time cooperation and coordination of law enforcement, fire, and emergency medical agencies. Additionally, a single regional dispatch center would no doubt have the long-term effect of smoothing out differences in law enforcement

resources allocation policies between present law enforcement agencies.

A single regional dispatch center would, however, have problems associated with its operation, and particularly its implementation, that have as their root the opportunities presented above. Essentially, the opportunities or benefits of a single regional dispatch could only come about with an attitude of cooperation on the part of nearly all of the senior officials of the law enforcement and fire agencies in the region. On the basis of our understanding of the various agencies, we believe that the cooperation required to make a single regional dispatch center possible could come about in turn only by creating a climate of belief that regional dispatch from one location is the most desirable alternative. This desirability could be assured by any or all of the following:

- Strong and overwhelming support for regional radio dispatch on the part of local elected officials of stature
- Legislation, by the state of Oregon, mandating regional radio dispatch
- External funding, such as by federal or state grants, (or alternatively a state telephone excise tax) that specifies regional dispatch for the requirements of eligibility.

It is important to emphasize that the cooperation we have described as being necessary for the implementation of regional radio dispatch is not spontaneous (simply there); it is created by action outside the community of law enforcement and fire officials. We believe that the viability of regional dispatch is directly a function of the effort made to demonstrate its desirability. Without the exertion of strong creative effort to mobilize support from leading citizens and elected officials, legislative action by the state, or external funding, the climate of cooperation will not come into being.

Another difficulty that would present itself for regional dispatch from a single location is the security of the facility against natural disaster or possibly sabotage. A single facility would, of course, be more attractive to sabotage than would many facilities; additionally, without a backup facility or facilities, the consequences to the law enforcement and fire operations would be quite serious. A facility could be designed to make natural or

man-made damage much less likely; it is important that this be taken fully into account in the facility design.

Operation of a single dispatch facility for the region would require a great deal of cooperation between law enforcement and fire protection in the setting of policy. Again, the amount of meeting time required would be determined by the extent to which these officials felt that they had no alternative but to cooperate. It is difficult then to estimate the additional costs of the time spent by public safety agency officials attending meetings; the duration and frequency of such meetings might be considerable if the officials felt they could "get out of the regional dispatch arrangement" and therefore were more willing to be insistent that their policies be followed to the letter.

The second alternative, two regional dispatch centers, one for law enforcement and one for fire would have benefits and difficulties similar to those attendant on the single regional dispatch center. Central coordination would be less possible; our belief is that the difficulty in bringing about this coordination would be about the same as it would be for a single facility.

The third alternative, regional 911 with combined law enforcement and fire dispatch for each of the five counties, would cost significantly more than either the first or second but it would have two major advantages. First, it would require less secure facilities, since damage to one that would result in its inoperativity for some period of time could be taken care of by the other facilities. If space were provided 911 answering could even be taken over by the dispatch centers in the event of damage to a single regional 911 center.

The second advantage to county-by-county dispatch is that to some measure, a climate exists at present for its implementation. Law enforcement and fire officials regard regional 911 answering as feasible. Their belief, from our observation, is that there would be less variation in the policies of 911 answering between the agencies than there would be in the policies of radio dispatch. For fire, variations in dispatch policies come about for technical reasons. For law enforcement, radio dispatch seems to provide officials with a sense of command that they would lose if dispatch were regionalized. For reasons of tradition, they appear to believe that this sense of command

would be retained with county-by-county dispatch.

F. RECOMMENDED POLICIES FOR EMERGENCY MEDICAL SERVICES

For the emergency medical community to be effectively incorporated into a CRAG 911 system, SRI believes that the following operational guidelines must be followed by this community and CRAG:

- An emergency medical service board comprised of ambulance company owners and/or operators, representatives from fire departments providing medical assistance, representatives from hospitals providing emergency rooms, and communicators will be established to enact and review emergency medical service policies and establish local or regional standards for emergency medical services
- A publicly-funded emergency medical dispatch operation will be established for the region or each county (depending on the dispatch alternative selected for the 911 system) and the operation will be located within the public safety dispatch center
- Training courses will be developed, with assistance from the emergency medical service board, to educate the dispatcher and the 911 answering personnel in areas of emergency medical and communications procedures
- Geographical districts or zones will be established to assist the dispatcher in determining the most suitable ambulance, rescue, or first aid unit (based on availability, location, equipment, and training requirements for the emergency, etc.) to provide service for each emergency dispatch. (If more than one ambulance company with similar equipment is serving an area it may be necessary for the dispatcher to rotate the responsibility for service to assure sufficient revenues to the companies.)
- The dispatch center will contract ambulance companies to provide service to the districts and only those companies with contracts will be dispatched into the districts to provide emergency service
- All Code 3 dispatches will originate or be approved by the dispatch center
- At least one ambulance will be stationed in each zone to be responsible for emergency medical services

- The companies must inform the dispatch center when all of its ambulances are "out of service" so that the dispatch center will be aware that adjoining districts or alternate companies must support the district if additional ambulances are required
- Districts in areas of low emergency service volume will be either subsidized through the dispatch center, or through fire districts if ambulance districts and fire districts are coincident
- Ambulances provided by fire districts will operate under the same emergency zones regulations as the commercial ambulance companies
- Ambulances, rescue units, and first aid units provided by fire districts which can be served by commercial companies will be used to supplement the commercial equipment as necessary
- To permit more mobility of ambulances and allow ambulances in adjoining districts to support a district requiring disaster assistance, city licensing will not be required for ambulances serving emergencies. Licenses for nonemergency calls will be dependent upon city policy
- Any policies for dispatch of ambulances which result in a delay in providing emergency medical services, should be abolished. The dispatch center should immediately dispatch an ambulance when

the trained 911 operators determine that the ambulance is required.

- The dispatch center will provide direct telephone lines from the center to hospitals providing emergency rooms and to ambulance companies serving the emergency districts
- The dispatch center will provide, or assist in the acquisition and maintenance of, mobile radio equipment required to operate on the emergency medical dispatch network
- The dispatch center will reimburse the companies at a predetermined rate for "no loads," and "standbys" which result from a dispatch originating or approved by the dispatch center
- The dispatch center will provide a collection service for the ambulance companies to reduce their losses caused by uncollectable accounts
- Emergency medical service will be reviewed annually by the emergency medical service board to determine if suitable service is being provided and to determine means of improvement if needed

Specific procedures to implement each of these actions will take a more detailed analysis than was possible for SRI under the terms of this study.

VI MANAGEMENT, FUNDING, AND IMPLEMENTATION

A. OVERVIEW

In Chapter V on the basis of our analysis of the various alternatives for 911 and radio dispatch we concluded that a regional system would provide the least costly and most beneficial alternative for the CRAG area. Subject to the specific constraints given in Chapter V, we have recommended either (1) regional 911 answering with regional combined law enforcement and fire dispatch; (2) regional 911 with one radio dispatch center in each county; or (3) 911 answering with separate law enforcement and fire regional radio dispatch systems.

The implementation and operation of these alternatives require a management organization that does not now exist. It is therefore necessary to design such an organization based on either existing organizations that perform similar regional tasks or a new entity. We therefore describe and compare four alternatives:

- Management by a new entity
- Management by CRAG
- Management by a CRISS*-type organization
- Management by the Metropolitan Service District (MSD)

We find that the MSD is perhaps the best alternative, with a CRISS-type organization being acceptable provided certain stipulations are met.

For funding, we recommend two sources to cover the implementation and operation of a regional 911 and/or radio dispatch system. For implementation funding--that is, for the construction of the system--we recommend a combination of various federal grant programs that should be pooled. For operation of the system, we have suggested an innovative approach--a trust fund with revenues derived from a state of Oregon and Washington excise tax on telephone service that would replace the existing federal telephone excise as the latter is phased out over the next nine years. We believe such an approach would be attractive to the citizens of the CRAG area since their total tax burden would not be increased, and, furthermore, their property tax

burden--specifically that used to finance the recoverable portion of present public safety communications expenditures--would be reduced. Such a fund should be administered by the state of Oregon and funds subvented directly to the regional entity that manages the 911 and/or radio dispatch system.

For implementation of the regional alternatives, we believe that at the present time, CRAG should manage the implementation directly through either an outside systems contractor or a contract to one or more existing local or county entities in the region.

B. MANAGEMENT CONSIDERATIONS

1. Objectives

If our recommendations after a comparison of systems alternatives had been for county-oriented 911, there would be no need for investigation of the desirable entity for management. Each would have the necessary statutory authority to operate its own system, and a regional entity--such as the present CRAG communications subcommittee--could be used as a vehicle to set standards and resolve differences regarding procedures that affect more than one county, such as call transfers, etc. For a regional 911 entity, however, no organization presently exists that can either implement the system or operate it. Either a new entity must be created, or an existing entity given the authority and funds to implement and operate the system.

Our objective here is to determine the entity that should implement and manage the system. Two constraints are involved in this determination: (1) statutory, i.e., those under the laws of the state of Oregon that specify the functions that existing regional entities can perform and (2) political, i.e., the constraints that various political leaders of the five-county CRAG area define for themselves through their own perceptions of what is "workable." Examination of the desirability of various alternatives must consider both constraints. The first set of constraints is readily determined by written statute; the second requires a more involved methodology to determine.

*Columbia Region Information Sharing System.

2. Methodology

Our basic concept is that, aside from statutory constraints, the effectiveness of a management alternative is determined by its viability as perceived by various political leaders. These political leaders include elected county and city officials, as well as the heads of various public safety agencies in the CRAG area. The relative success of each alternative then is determined by the support it will receive from this political group.

This is not to say that our methodology to determine the best of the alternatives should be to simply submit them to a vote of the political leaders. Such a vote would be meaningless since most of the individuals involved do not fully appreciate the significance of each alternative. They have not related the advantages and disadvantages of each to their own organizationally "lived-world" or realized the impact of each alternative on their own organization's future. For us to ask political leaders to rate quantitatively each alternative would be the premature preempting of the legitimate political process. We also rejected the questionnaire approach because any instrument of that type we could have devised would have merely projected our own subjective opinions onto the political leaders and not drawn forth their own perspectives and intentions. Instead, we chose to conduct interviews of each political leader, with the conviction that the interview process could best explicate the reality of the organizational and interpersonal state of affairs in the five-county area. The interview process developed for this task was designed to search out and rationalize the perceptions, intentions, and motives of a large sample of appointed and elected officials throughout the study area. The analysis of the aggregate feelings, perceptions, and intentions expressed in the interviews is the foundation for our recommendations.

This particular phase of the study was initiated by researching the feasible alternatives of regional 911 management. Talks with officials of CRAG narrowed the choices of feasible alternatives to six (made up of combinations of essentially four management organizations [Table 32]). Each alternative was evaluated for its representation possibilities (felt to have major impact on the "workability" of any management choice) and its pros and cons.

To provide stimulus to the officials selected for the interviewing program, information packets were sent to each individual with a cover letter indicating our intentions. Each official was asked to carefully review the information, note additional issues and management alternatives, and set aside some time for the interview to follow. The "think papers" mailed were open-ended and were only intended to stimulate thought and reflection and not to be exhaustive statements of management possibilities.

Although not every official or political jurisdiction was interviewed, our sample accurately reflected the political, geographic, and functional structure of the emergency communication scene. Seventeen officials, and in some cases their assistants, were asked for their assessment of the management issue, and their reflections and notions concerning each of the management alternatives.

Each interview was taped to facilitate analysis of both the comments, and in some cases, the complaints. The interviews, lasting from 45 to 90 minutes, frequently saw the participants engaged in lengthy personal critiques or praises of certain management possibilities. Generally, we feel that these taped interviews, even as raw data, provided an exceptional data base for our later analysis.

3. Management by a New Entity

As one management possibility, we considered the formation of an entirely new organization, expressly for the management and operation of a 911 answering and/or dispatch facility. Our intention was to pose this alternative to those participating in the interview program as a possibility that could be considered as a fall-back or compromise should the other possibilities be seen as entirely unworkable. Essentially, the elected and appointed officials viewed this particular alternative much as we did, as a last resort.

With few exceptions, no official desired the formation of an entirely new governmental entity for the management or operation of regional 911. A strong desire exists to reduce the already fragmented local government scene. It was the area-wide consensus that the management issue can be resolved without resorting to the formation of a new entity, however, the "uncertain" exceptions to a perfect consensus must be mentioned.

SYNOPSIS OF REGIONAL 911 MANAGEMENT ALTERNATIVES

MANAGEMENT ALTERNATIVE 1

A regional 911 answering (and radio dispatch?) organization that is managed and operated by the Portland Police Bureau/Multnomah County Department of Public Safety on a contract basis. A program similar to the present CRISS (Columbia Region Information Sharing System) operation could be implemented.

REPRESENTATION POSSIBILITIES

- CRISS executive board with a 911 policy management committee (in addition to present policy committees for corrections, etc.)
- 911 executive board drawn from a user board representing all agencies (police, fire, emergency services) and geographical areas.

PERTINENT ISSUES

- CRISS precedent exists
- Heavy Portland/Multnomah county "orientation"
- Heavy police "orientation" (vs fire or emergency services)
- Further fragments area government (unless completely subsumed under present CRISS operation)
- Relatively short time-lag to operation
- Attractive for ease of federal funding application.

MANAGEMENT ALTERNATIVE 2

A regional 911 answering (and radio dispatch?) organization that is managed by the Metropolitan Service District (in addition to sewage treatment and solid waste disposal) and operated (by contract to) the Portland Police Bureau/Multnomah County Department of Public Safety.

REPRESENTATION POSSIBILITIES

- MSD executive committee made up of elected officials of each city and county represented. Advisory board of users could provide technical advice for policy considerations.

PERTINENT ISSUES

- MSD boundary currently includes Portland SMSA only; could require citizen petition and Washington-Oregon legislative action
- MSD not presently chartered to perform a 911 related function; may require legislative action
- Equitable representation
- Regional philosophy upheld
- Major time-lag to operation probable
- Taxing ability attractive
- MSD not fully operational
- Portland "orientation" for operation
- Police "orientation" for operation (vs fire or emergency services).

MANAGEMENT ALTERNATIVE 3

A regional 911 answering (and radio dispatch?) organization managed and operated entirely by the Metropolitan Service District.

REPRESENTATION POSSIBILITIES

- MSD executive committee made up of elected officials of each city and county represented. Advisory board of users would provide technical advice for policy considerations.

PERTINENT ISSUES

Same as Alternative 2 except:

- No "Portland orientation"
- No "Police orientation"
- Operation by professional staff.

MANAGEMENT ALTERNATIVE 4

A regional 911 answering (and radio dispatch?) organization managed by CRAG executive board and operated by contract to Portland Police Bureau/Multnomah County Department of Public Safety.

REPRESENTATION POSSIBILITIES

- CRAG general assembly and its executive committee.

PERTINENT ISSUES

- CRAG is regionally oriented
- CRAG is the only five-county body in existence
- Precedent exists in CRAG
- Would strengthen CRAG's management role
- Equitable representation
- Furthers the regional philosophy
- Attractiveness of application for federal funds
- CRAG to date has had planning rather than strictly management functions
- May be quite feasible as equitable compromise
- May further the disinterest in MSD
- May initiate CRAG "umbrella agency" concept
- No CRAG charter provision for user advisory board
- Relatively little time required to operationalize.

MANAGEMENT ALTERNATIVE 5

A regional 911 answering (and radio dispatch?) organization managed and operated by CRAG.

REPRESENTATION POSSIBILITIES

- CRAG general assembly and its executive committee.

PERTINENT ISSUES

Same as alternative 4 except:

- Would require legislative action changing CRAG's charter to allow for the "operating" functions
- No precedent presently exists
- No precedent for a CRAG technical or maintenance staff
- Significant time-lag to operationalize.

MANAGEMENT ALTERNATIVE 6

A regional 911 answering (and radio dispatch?) organization managed (and operated?) by a new entity—one charged with only the 911 function.

REPRESENTATION POSSIBILITIES

Numerous—many precedents to choose from.

PERTINENT ISSUES

- Further fragments local government scene
- Could be designed as best possible operational compromise
- Significant time-lag to operationalize
- Would require legislative action
- No specific organizational precedent
- May be an effective political compromise.

The 911 concept, as presented in this report, is either not well understood, or is felt to be unacceptable by certain top fire officials in the five-county area. These few officials, apparently fearful of something poorly suited to their present operation, would prefer that an entirely new organization be chartered to manage a regional 911 operation if such a system were to be implemented. We believe that the mere fact of these expressions deserves reporting.

One top fire official in the area feels that the only way the 911 concept will work is if 911 is utilized as a last resort emergency number, to be used when the proper number is unknown. He added, "perhaps the telephone company could manage such a limited operation, if not, a new entity should probably take over the function." This is an indication, first of unacceptance of the universal 911 concept, and, second of concern about the orientation of 911 management. This official expressed distress with the notion of "nonfire" (i.e., police) management of 911; "fire and

police operations are simply not functionally similar."

4. Management by CRAG

These expressions of concern over organizational dissimilarities were expected and may be deeply rooted. The orientation and style of regional 911 management must reflect the needs and desires of all participating jurisdictions and agencies to be entirely successful. Our intention in proposing the CRAG management alternative was to explore the extent to which CRAG, as an operating regional organization (given an expanded role), would be viewed as a fair and objective possibility to all agencies throughout the region. We had felt that the agencies and governments representing areas outside the urban core would perhaps view CRAG as an equitable representative of their interests. Essentially, this was not found to be true, proving the error of our own presuppositions.

Comments we heard included one official's observation, "CRAG management is a

possibility. . . yet the MSD is perhaps better suited. . . representation is not the only issue." This would indicate that CRAG's historical role is accepted but that expansion of that role would infringe on the philosophy of the MSD. The real issue is perhaps suitability of existing charters as well as objectivity and representation. Lending credence to this assertion is the comment by a fire district official, "CRAG has never given fire districts any representation and we've asked for such charter amendments."

Although a recent bill (SB 769) to alter CRAG's present role has made steady progress through the state's legislative process, the consensus of the area's top governmental officials is that CRAG is not now providing managerial or operating functions nor should it be expected to in the future. Even the recently proposed legislation to merge CRAG and the MSD, when mentioned as an indication of the kind of role possible for CRAG, did little to spur enthusiasm for these (CRAG-oriented) alternatives. Another official commented, "The chances of this proposal being accepted are slim, I just don't know if this would change my mind on the matter."

Our analysis of these responses indicates that CRAG is considered by those outside the urban core as their voice in regional affairs but that it should remain simply a "voice." Perhaps, for appointed officials, this results from an inability, or lack of desire, to see beyond the status quo; the elected officials would tend to prefer another alternative (MSD, to be discussed later). The elected and appointed officials within the urban core (Portland) generally perceive their representation on the CRAG Executive Committee as inequitable. For this reason, particularly, the CRAG alternatives are discounted by them in favor of other alternatives.

In summary, our analysis of the thoughts and emotions expressed by area officials indicates a general discounting of the CRAG management possibilities based principally on CRAG's past (and apparently accepted) role as a planning and review agency. No official expressed a strong desire for the CRAG management alternatives and the thought of considering major changes in CRAG's charter was generally unappealing to most. However, many officials seemed genuinely interested in the MSD-CRAG merger recently proposed

and this is reflected later in the discussion of the MSD management alternative.

5. Management in the CRISS Format

To follow the precedent set by CRISS seemed an attractive alternative from the outset. Briefly, CRISS was inaugurated with a contract between CRAG and Portland/Multnomah county for the development and implementation of a regional law enforcement information sharing system. The CRISS executive board consists of representatives from the city of Portland and Multnomah county, and the chairmen of the Policy Management committees (Law Enforcement, Courts, and Corrections). The members of this board are charged by the city and county with maintaining overall administrative control of the project and insuring that the objectives listed in the contract are achieved.

This organization is now in operation, is somewhat related functionally to 911 (i.e., to the extent that it is generally related to the public safety function), and we believed it would be well perceived throughout the region it served. To follow this particular format, a 911 management policy committee could easily be inaugurated, a 911 coordinator selected and, with operation by the Portland Police Bureau and Multnomah County Sheriff's Department, the 911 function could perhaps be successfully undertaken.

Our findings indicate, however, that this particular management style and method would prove unworkable unless major changes were made upon the present CRISS management practices. The CRISS policy-making and management methodology is not well perceived by many outside the city of Portland.

Generally speaking, non-law enforcement and non-Portland agencies equate CRISS management practices with those of the Portland Police Bureau. One official felt strongly that policy is made by the city and county and that the present project director was chosen with disregard of the inputs by agencies other than the city and county. Another official commented, "It's the old game--if it's Portland's way, that's fine, if it isn't Portland's way, we're going to do it Portland's way anyway." This expression indicates the feeling of powerlessness felt by those outside of Portland. These feelings run deep, deep enough to alter

the way people perceive their daily experiences. Perceptions such as the above must be dealt with openly and forthrightly if the 911 management issue is to be adequately resolved.

The issue appears to be one of equitable representation; the smaller agencies feel somewhat controlled by the desires of, as one official expressed it, "the politicians downtown." The concern was not so much with the visible activities of the CRISS management group as it was with the perceived control by other than the members of the executive board. These aggregate perceptions have apparently resulted in a certain policy-management apathy on the part of agencies outside the urban core (Portland).

The fire officials are generally concerned with having a 911 management organization that reflects strictly a police orientation, a law enforcement background, when the functions to be managed are not strictly law enforcement oriented. Fire officials continually reiterated the major differences between fire and law enforcement emergency telephone practices (i.e., the following comment was heard more than once, "All emergency telephone calls for fire department action require a Code 3 response. Police calls more often than not are 'cold' calls for service. Our operations are simply not the same and cannot be effectively managed as though they were").

It must be emphasized that these expressions of concern are not felt to be simply "sour grapes." The interviews and their analysis were designed to reach beyond surface emotions; these feelings are deeply rooted and must not be taken lightly. This is not to say that the CRISS approach is entirely unworkable. A later section of this chapter will explicate the kinds of changes that might make a CRISS-like management style consensually acceptable.

More on a basis of organizational philosophy, the CRISS approach should be explored for those among its objectives that might apply to management of a 911 center. CRISS exists to serve its participating agencies; 911 service, on the other hand, is "public oriented;" its management should reflect the primary objective of service to the public.

6. Management by the Metropolitan Service District

The Metropolitan Service District offers attractive possibilities for managing or operating a regional 911 center. Although the MSD has not yet begun operations as originally intended, its executive board remains active and recent proposals have indicated that officials are making an effort to revive interest in the district and its functional possibilities. As currently chartered, the MSD has neither a communications-related function nor a geographic boundary corresponding to the five-county area represented by CRAG. To make these changes would require legislative action as well as citizen petition with the probability of success in these endeavors remaining unknown.

The MSD, given the above changes in its by-laws, could perform the 911 management function, utilizing an advisory or user board equitably representing all member agencies and could also operate the 911 and/or radio dispatch center utilizing a professional and highly trained staff of operators and supervisors.

During the interview program, the MSD management alternative received a great deal of interest by all elected officials in the five-county area and by many appointed professionals outside the urban core. This is not to say that no negative perceptions exist. In the election that initiated the MSD, the measure carried throughout Portland, and thus carried Multnomah county. The measure did not carry in Washington or Clackamas counties yet these counties were overridden by the Portland vote. Again, the perceptions of those outside the city of Portland are that they have little control of their own destiny, on a regional basis. The MSD is not well liked by those that voted in a block against the measure but were defeated by a much larger block.

These are emotions expressed by people that understand the workings of democracy yet find it hard to see the justice. To them, it is difficult to overcome the feeling that no matter what they do, their regional destiny is dictated by the power of Portland. The end result can often be the kind of apathy expressed in comments about the CRISS operation.

As mentioned earlier, there is proposed legislation now being considered to amend the present MSD statute to accomplish the following five purposes:

- (1) Expand MSD boundaries to include all of Clackamas, Multnomah, and Washington counties.
- (2) Authorize weighted voting by the MSD executive board.
- (3) Authorize MSD to expand services by contract with cities and counties.
- (4) Permit Clark county to become part of the district.
- (5) Provide a way to take over the CRAG organization after MSD's powers have been expanded.

Given passage of this proposal (the probability of which is entirely uncertain at this time), the MSD management alternative would appear even more attractive, although it does not provide for easy (other than by a vote of the people) inclusion of additional functions such as management and operation of metropolitan public communication systems. Even so, the expanded role of MSD is felt to be a particularly viable 911 management alternative by a majority of public officials. There remains, however, the problem mentioned earlier of a general displeasure on the part of those citizens who voted against MSD only to have Portland override them.

There is only one way to overcome the impotence felt by law enforcement and fire protection professionals outside of Portland and it rests in the development of the best possible methods and style of management, organization, and, more than anything else, representation in a 911 system. Little can be more important to the ultimate success of a regional 911 center, should that be the alternative chosen, than a management reflecting the needs and concerns of all involved. Of course, no one management approach will be rigorously embraced by all, yet careful analysis of needs, motives, intentions, and emotions of the principals can go a long way toward developing the kind of organization that will best insure success.

7. Recommendations

Our analysis has indicated that the various officials in the CRAG area, both elected representatives and appointed professionals, tended to prefer either a CRISS-type of management organization with Portland Police

Bureau-Multnomah County Sheriff operation or MSD management and operation over the alternatives involving CRAG or a new governmental entity.

Essentially, most elected officials and the appointed professionals outside the city of Portland tended to prefer an MSD management effort if a regional 911 and/or radio dispatch system were shown to be the best alternative. The law enforcement professionals within Portland, however, felt that a CRISS-type of system was best suited for managing and operating a regional 911 and/or radio dispatch system if that alternative were chosen. However, neither CRISS nor MSD is seen as being acceptable unless certain steps are taken.

To follow the CRISS precedent would require a project director that was entirely acceptable to all participating agencies. The selection method must reflect the desire to retain an entirely objective and administratively competent person who would be quickly responsive to the policies dictated by the user board consisting of representatives from all user agencies. Perhaps the key to using the CRISS approach successfully lies in the makeup of the user board and the perceived autonomy of this board. This would require complete and visible freedom to set day-to-day policy without outside influence by political leaders.

Initiating these changes in the way the CRISS operation is presently managed would allay many of the real concerns explicated earlier. However, the fact that it would be necessary, in following the CRISS structure completely, to contract the regional 911 and/or radio dispatch operation to the Portland Police Bureau/Multnomah County Sheriff (although it is not known whether these organizations would indeed want such a contract) would probably engender resistance among other agencies regardless of their perceptions of equitable representation. This conclusion is based on an analysis of the depth of such feelings on the part of all fire protection district officials in the area and law enforcement officials outside Portland.

Management and operation by MSD, while by no means a panacea, appears to us to best meet both the objective needs for regional 911 and the subjective expectations of the majority of elected and appointed officials throughout the five-county area. With an equitable advisory board of participants, the

MSD could provide the professional objective management required to assure continued acceptance and participation by all concerned. The importance of a perceived inherent fairness and impartiality must be again emphasized. Given this perception, management problems resulting from questioned representation should be minimized, thus increasing the chances of successfully overcoming the problems posed by the regional 911 alternatives.

C. FUNDING

1. Sources

Four sources of funds are considered for the implementation and operation of our selected alternatives--Regional 911 Answering with One Radio Dispatch Center per County or Regional 911 Answering and Radio Dispatch. We further assume from the last section that the management of the system for implementation will be directed by CRAG, either directly or under contract to MSD. The operation of the system will be by MSD, either with its own professional staff, or by contract to an existing city or county organization.

Based on the above systems alternatives and management, the four sources of funding considered are:

- (1) Federal grants for implementation, and perhaps initial operation of the system.
- (2) Revenue sharing, from existing city or county governments, negotiated by intergovernmental agreement, or special revenue sharing. Such funds could pay for the capital costs of implementation, and perhaps the first several years of operation.
- (3) Ad valorem property taxes, for the operation of the system, as specified by the Metropolitan Service District Act of 1969, and Section 268 of the Oregon Revised Statutes.
- (4) An excise tax on intrastate telephone service to be collected by the states of Oregon and (if Clark county is included) Washington.

This tax should be placed in an interest-bearing trust fund and subvented to the MSD on a population basis for operating costs (as well as capital costs, if the legislation can

be passed within the time frame of implementation).

2. Federal Grants

Federal grants offer an attractive possibility for funding the implementation of the system, and perhaps the first year of operation. Two sources of federal grants should be considered: matching fund programs and fully financed federal funds for special demonstration projects.

Matching fund programs would supply up to 50 percent of the cost of implementation. The following sources should be pooled for a combined funding program:

- Health Services and Mental Health Administration, U.S. Department of Health, Education and Welfare, Program 13.249, Regional Medical Programs.
- Law Enforcement Assistance Administration, U.S. Department of Justice, Program 16.502, Law Enforcement Assistance through Oregon Law Enforcement Council.
- National Highway Traffic Safety Administration, U.S. Department of Transportation, Program 20.600, State and Community Highway Safety through Oregon State Highway Safety Program.

Additionally, the Defense Civil Preparedness Agency, through the various Oregon state and federal offices might make funds available if the regional facility is used as an emergency operating center.

Recently, the Robert Wood Johnson Foundation has announced their interest in funding regional emergency medical programs, for which the emergency medical communications discussed in this report would certainly qualify. This source of funds should be further investigated. As an alternative to categorical grant programs, CRAG should investigate obtaining 100 percent federal funding by a special demonstration grant from the National Institute for Law Enforcement, U.S. Department of Justice.

3. Revenue Sharing

Revenue sharing would provide a means of funding the implementation costs and operating costs for the first several years.

Under present federal revenue sharing laws, the funds would be available for the next four years. These funds could be used to finance initial operation of the regional system with a sliding apportionment whereby property or excise taxes assume over a period of several years the greater share of the financial burden of operation and revenue sharing is phased out as a means of financing recurring costs.

4. Ad Valorem Property Taxes

As authorized by the Metropolitan Service District Act of 1969, if authorized by the voters, an ad valorem tax of up to one-half percent on all taxable property within the district could be levied. This would be the only basis for permanent funding of operating costs if no excise tax were used.

5. Telephone Excise Tax

Perhaps the best source of funds for the recurring costs of 911 would be for the states of Oregon and Washington to pass legislation authorizing the collection of a statewide tax on intrastate telephone service in each state. This should be administered by the state in the form of an interest-bearing trust fund, to be subvented to local and regional governments to finance the implementation and operation of emergency communication systems that provide for 911.

At the present time, the federal government is taxing all telephone service--both inter- and intrastate at the rate of nine percent. This tax is scheduled at present to decrease in one-percent steps each year, and thus be eliminated as a source of federal revenue by 1982.

It would, of course, be desirable for the tax to be collected by the federal government and subvented to state governments on the basis of the yield in each state. Federal collection would allow collection of interstate revenue; states would be limited to intrastate revenue since interstate telephone revenue taxation by a state government is probably equivalent to a state tax on interstate commerce. We believe, however, that the present federal legislative climate should not be depended on for passage.

Nevertheless, state collection of a telephone excise would be significant and is therefore strongly recommended. For calendar year 1971, the total taxable intrastate revenue

would be about \$228 million in Oregon and \$280 million in Washington, according to data supplied by the public utility commissions of each state. At a rate of one percent, 2.28 million dollars could be collected in Oregon, 2.8 million dollars in Washington. Since the CRAG counties comprise 43.2 percent of the population of Oregon, about 984 thousand dollars could be obtained on a population basis in Oregon. In Washington, Clark county has a population of 3.77 percent of the state total; this would raise about 105 thousand dollars. For a regional system including Clark county, about 1.09 million dollars per year could be raised for each one percent of excise.

Over the next several years, as the federal excise tax is removed, the states could add between one and three percent. This sum would probably finance the operation and construction of 911 systems for the entire states of Washington and Oregon, at no noticeable increase in tax burden to its citizens. We believe that most citizens would feel that the taxing of normal telephone service to pay for emergency communications would be just and equitable. Furthermore, we believe that the excise should be used to pay for all public safety communications, provided such communications use 911. In this way there would be considerable enthusiasm on the part of previously recalcitrant officials (especially those of special districts) who would be able to use their property tax derived revenues for other purposes than communications. The public would experience a net reduction, although slight, in property taxes if the excise were used as indicated.

We believe it is beyond the scope of this study to recommend a specific funding mechanism between the state governments and the MSD, or for that matter what the state policy should be, which state agency should disburse the funds, criteria for disbursement, etc. We do believe, however, that subvention to the MSD should not be delayed by the adoption of uniform policies for other areas of the states.

The present incidence of the telephone excise shows about the same regressivity as a sales tax. To reduce this regressivity to low income persons and families, a higher excise tax with an exemption for "basic telephone service" would greatly improve the vertical equity of the tax and should therefore be seriously considered.

Table 33 shows the estimated yield of a one and two percent excise tax on intrastate telephone revenue, both for the states of Oregon and Washington, and for the CRAG area. The assumptions made were first that there would be a yearly increase in telephone revenue of 9 percent; second that the CRAG counties represent 43.2 percent of the population of Oregon and 3.77 percent of the population of Washington (1970 census figures); and third that telephone revenue is proportional to county population. These assumptions reflect the lack of any better data available; it would of course be desirable to apportion

telephone revenue on the basis of collection in each county rather than basing revenue on population. This could readily be done of course when the tax is collected.

Table 33 shows that, depending on the system alternative selected by CRAG, the excise tax should be set somewhere between one and two percent to finance the total recurring costs. This assumes in turn that the recurring costs for the rest of Oregon and Washington are similar on a per capita basis--an assumption that we have not tested. We would recommend then that a two percent excise be selected by the two state legislatures initially;

Table 33

ESTIMATED YIELD OF A TELEPHONE EXCISE TAX FOR OREGON AND WASHINGTON--1971-82

(All revenue in millions of dollars)

Year	Oregon Revenue	Washington Revenue	Total Revenue	CRAG Share of Revenue-- 1 Percent Tax	CRAG Share of Revenue-- 2 Percent Tax
1971	2.28	2.80	5.08	1.09	2.18
1972	2.49	3.05	5.54	1.19	2.38
1973	2.70	3.33	6.03	1.29	2.58
1974	2.95	3.63	6.58	1.41	2.82
1975	3.22	3.95	7.17	1.54	3.08
1976	3.51	4.31	7.82	1.68	3.36
1977	3.83	4.70	8.53	1.83	3.66
1978	4.17	5.12	9.29	1.99	3.98
1979	4.55	5.58	10.13	2.18	4.36
1980	4.95	6.08	11.03	2.37	4.74
1981	5.40	6.63	12.03	2.58	5.04
1982	5.89	7.22	13.11	2.84	5.68

- Assumptions: (1) Yearly increase in intrastate revenue of 9 percent in Washington and Oregon.
- (2) Oregon counties represent 43.2 percent of population of Oregon; Clark county represents 3.77 percent of population of Washington.
- (3) Telephone revenue is proportional to population for all counties.

as the rest of the two states are studied, the excise rate should be adjusted accordingly.

6. Recommendations

On the basis of consideration of the types of funding given in this section, we recommend that for implementation of a regional 911 answering and/or radio dispatch system, either a 100 percent federally financed grant from the National Institute for Law Enforcement or a state subvented telephone excise to the Metropolitan Service District be selected. The choice between these alternatives is in our view only one of ease of obtaining funds; in the short term we would recommend active and energetic promotion of both alternatives by CRAG to the National Institute for Law Enforcement and state legislatures of Oregon and Washington. If National Institute funding is not available, the excise could be used to finance the local match for the categorical grant programs discussed.

For the recurring costs of the system--that is operating funds--we would recommend the excise option over all others. Should the excise prove infeasible, revenue sharing in the short term and ad valorem tax on property in the long term are next best alternatives.

Should county dispatch rather than regional be chosen, our recommendations would

not be changed. We would still recommend the MSD as a conduit for funds and for supervision, with contracts to the various counties.

D. IMPLEMENTATION PLAN

Figure 8 shows a proposed implementation plan. Inasmuch as CRAG has to select from several alternatives presented in this report, it is not possible to present a detailed implementation plan at this time. We have attempted to provide more detail on suggested actions to be taken within the next several months, leaving the detailed implementation planning for the time when major alternative selection has been made.

We have divided implementation into three phases: preparation, engineering design, and construction. The preparation phase, during which the institutional decisions should be made, would commence upon delivery of this report, and end on November 15, 1973, a period of five months.

The engineering design phase begins with the award of an engineering design study by CRAG and ends in May 1974 with the selection of various contractors for the construction of equipment and facilities.

Construction and acceptance tests are scheduled for completion by December 1974, and final cutover of the 911 system would be completed by July of 1975.

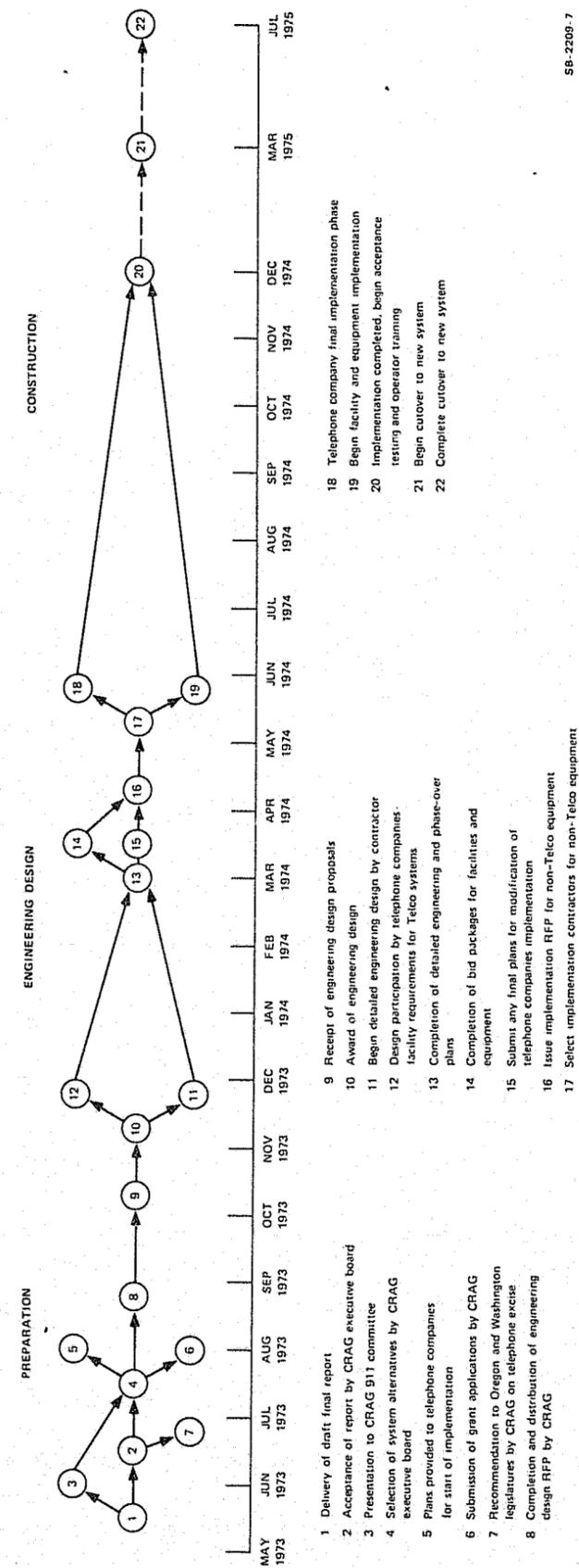


FIGURE 8 PROPOSED IMPLEMENTATION PLAN

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