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FINAL REPORT

PILOT PROGRAM FOR THE TESTING OF A DIGITAL FINGERPRINT TRANSMISSION SYSTEM

Grant #75-SS-99-6016

CALIFORNIA CRIME TECHNOLOGICAL RESEARCH FOUNDATION

CTRF

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AUTHORIZED BY

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ACQUISITIONS

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EXECUTIVE SUMMARY

I. INTRODUCTION

With the recent and significant advancements that have occurred in the electronics and facsimile industries, it has become feasible to study their adaptability to a problem area in the criminal justice field. The problem is the current slow methods of conveying fingerprints from a remote or distant location to another for identification purposes.

In view of this need and the available technology and knowledge of facsimile, a recent concept of digital facsimile appeared to have several desirable and practical advantages for the transmission of fingerprints. As a result, a project was conducted to fabricate equipment, using existing technology, and to demonstrate the equipment in an operational environment. The concluding aspect of the project was an evaluation of this digital facsimile technology.

II. GENERAL DISCUSSION

With the support of the Law Enforcement Assistance Administration, a project was established to: (1) fabricate and assemble equipment that would transmit a facsimile fingerprint utilizing digital technology; and (2), to demonstrate this equipment in an operational test environment. For the fabrication and assembly phase, a contract with DACOM, Inc. was implemented. The Los Angeles Police Department (LAPD) and the California Department of Justice, State Identification Bureau (SIB) participated in the two-phase operational tests to demonstrate volume operation and long distance transmission of fingerprints. Project management and coordination was conducted by the California Crime Technological Research Foundation (CCTRF).

After several months of engineering effort, a pre-prototype facsimile transmitter and receiver were assembled and acceptance tested prior to the commencement of operational tests. With equipment performance being accepted by CCTRF, the operational demonstration was implemented in the Phase 1 test sites of the Van Nuys Substation and Parker Center of the Los Angeles Police Department. The conclusion of these tests was a successful demonstration of continuous volume fingerprint transmission and the ability of digital facsimile fingerprints to be utilized in an operational environment.

The Phase 2 tests were conducted between Parker Center of the LAPD and SIB, Sacramento to demonstrate long distance transmission. Fingerprint images of these tests were found to be of equal quality to print images of the short distance Phase 1 tests.

An evaluation was conducted utilizing staff of both participating agencies to evaluate: (1) equipment performance and operation; and (2) the utility of digital facsimile fingerprints in an operational identification environment.

The evaluation concluded that digital facsimile fingerprint transmission is very satisfactory in terms of: (1) equipment operation; and (2) identification and confirmation of fingerprints using digital facsimile methods.

III. CONCLUSION AND RECOMMENDATION

This project demonstrated to a conclusive degree that digital facsimile is very workable in fingerprint identification systems. With the several advantages of digital facsimile transmission, great possibilities for local, regional, state, interstate and national transmission of fingerprints arises. This has never been done before, and as a result, the potential is tremendous. It is recommended that additional effort in this field be conducted.

Acknowledgements

The efforts of several people have been involved in this project. We would like to acknowledge those who have contributed much and actively participated in this project.

Initially, we would like to thank those directly responsible individuals within LEAA for their cooperation, financial assistance and continuous programmatic support provided to the project.

Secondly, we would like to thank the many members of the Los Angeles Police Department and the California Department of Justice for providing facilities for the conduct of the tests and evaluation of the results. There are many others in project operations and engineering that participated to help make the project a success, and to all those who have contributed we say a sincere thanks.

I INTRODUCTION

For many years the criminal justice community has relied on the U.S. mails for the conveyance of fingerprints, as this was one practical method. This was satisfactory until the time requirements for identification purposes were greatly reduced as a result of court rulings. With the significant increase in the volume of fingerprints and the reduced time allowed for identification, it became apparent that a speedy method of fingerprint transmission must be developed. In this regard, analog facsimile transmission technology has been applied and utilized very satisfactorily.

In furtherance of the facsimile transmission capability, a new technique of facsimile was developed in recent years for the business world. This technique was digital facsimile. The initial high cost of this technology has decreased significantly with the rapid technological developments in the electronics and communications industries, and as a result, the alternative of digital facsimile transmission for fingerprints became feasible. With the several advantages of digital facsimile over analog facsimile, it became prudent to investigate digital facsimile transmission.

A. PROJECT DESCRIPTION

Since significant research and development accomplishments have been made in the area of digital facsimile transmission for the general business world, certainly some of the achievements and knowledge from this effort appeared applicable to fingerprint transmission. The general concept of this project, therefore, was to avoid "re-inventing the wheel" by utilizing existing technology. In general terms, this project was not a "research and development" project but a project dealing with; (1) the fabrication and assembly of digital facsimile equipment utilizing existing knowledge and capability; and (2) the operational testing of pre-prototype equipment. The purpose of the project was to determine the applicability of digital facsimile transmission technology in the fingerprint identification field.

In regards to the fabrication and assembly of equipment, a contractor was utilized. The contractor was DACOM, Inc., of Santa Clara, a state-of-the-art company in the field of digital facsimile. In order to conduct a test in a real-life operational environment, staff and facilities of the Los Angeles Police Department and the California Department of Justice, Bureau of Identification, were offered and utilized.

B. SUBCONTRACTOR PROJECT REQUIREMENTS

With the technical work of the project being performed by the contractor, DACOM, Inc., certain project requirements

were established as contractual specifications with which the prototype facsimile equipment must conform. These requirements are identified and discussed in the following:

1. Resolution - for fingerprint quality transmission, the resolution mode was 400 lines per inch (lpi) horizontal by 200 lpi vertical. (The non-fingerprint low resolution mode was 400 lpi horizontal x 100 lpi vertical. The original low resolution was 400 x 133, however, this was an unachievable level, therefore, approval was received to lower the specification to 400 x 100.) For the 400 lpi horizontal x 200 lpi vertical mode, an interpolation algorithm was to expand the mode to a 400 lpi x 400 lpi level for quality fingerprint image regeneration. This was a requirement.

   As a feature provided by DACOM, the lower resolution mode was interpolated to expand the 400 lpi horizontal x 100 lpi vertical mode to a 400 x 200 level. It is noted this was not a requirement.

2. Image Regeneration - the regenerated image was to be a positive black on white permanent image on white dielectric paper.

3. Image Bias - an image bias threshold of 2 percent was allowed. In this regard the overall physical dimensions of the facsimile were to be within 2 percent of the original.

4. Transmission Time - a transmission time goal was set at 5 minutes or less.

5. Operation and Maintenance - to be simple and non-technical.

6. Equipment - one device would scan and transmit data; the other device would receive data and regenerate facsimile images utilizing a print head with styli measuring .0025 inches - .0030 inches (2½ to 3 mils).

7. Telecommunications Systems Interface - modems (line adapters) were to be utilized with a transmission rate of 4800 bits per second. The modems were to have automatic adaptive equalization capability and function on conditioned or non-conditioned telephone lines.

8. Automatic Document Feeders - an automatic batch feeder was to allow for unattended operation of 50 fingerprint cards.

9. Image Quality - the image quality was to be such that a facsimile copy of a standard fingerprint card could be

utilized in a typical fingerprint identification process. The process is inclusive of coding or classification by a standardized scheme, a file search and verification of identification.

In addition to the performance specifications previously outlined, DACOM was to provide for the shipment and installation of the equipment and to conduct training of operations staff at the Los Angeles Police Department and the California Department of Justice.

C. FACSIMILE TRANSMISSION

Facsimile transmission is not a common knowledge shared by many people, therefore, in order to provide a general understanding of what facsimile is and how it works, a very brief discussion on facsimile methods is provided in Appendix A.

II MAJOR MILESTONES

The original project objectives consisted of two major tasks; (1) the fabrication and assembly task and, (2) the operational test task. Within each of these divisions, major milestones were developed in order that project progress could be meaningfully categorized, monitored and controlled. Five major milestones are those shown below and each is briefly discussed in the paragraphs that follow:

Fabrication and Assembly;
Acceptance Test;
Equipment Installation;
Operational Test;
Evaluation.

A. FABRICATION AND ASSEMBLY

As stated earlier in this report, the project was not a research and development project. It was not difficult to conclude that existing digital facsimile equipment could be modified to fit the project rather than to design and build a new machine. The plan that resulted included the modification of a standard DACOM productline model 400 facsimile machine. The video processing, optics, interpolation, printing and other integral modules would be modified as needed to conform to performance specifications of the project as set forth above. Three management review meetings were conducted by CCTRF during this period. The purpose of each management review meeting was for CCTRF project management to closely monitor project progress and to approve or reject activities and plans prior to their implementation. These review meetings are briefly summarized as follows:

1. First Management Review - The design plans developed by DACOM dealt with the modification and enhancement to the optics, communications, stylus and other integral modules of the planned prototype facsimile equipment. The design plans for the components were approved by CCTRF.

2. Second Management Review - This meeting was conducted to review the development of sub-system components and to approve review plans for the general functioning of the equipment. With the approval of sub-systems specifications, modular component integration was started.

3. Third Management Review - This meeting was a systems review meeting in terms of a demonstration and review of the completed system. The highlight was a performance demonstration of the pre-prototype test equipment. In conjunction to this, an acceptance test was conducted.

B. ACCEPTANCE TEST

This project milestone was conducted during the week of November 3, 1975. The purpose of the test was to measure and evaluate performance of the equipment and to accept or reject the equipment in terms of compliance to contractual specifications of Section I B. The acceptance test was concluded satisfactorily; the equipment performed within acceptable tolerance of contract specifications and was accepted for the operational test phase. An evaluation plan guide that was utilized during the acceptance test is provided as Exhibit A.

The results of the various tests that were conducted during the course of the acceptance test are discussed in Section III B below.

C. EQUIPMENT INSTALLATION

The general plans of activity to occur subsequent to the acceptance test include the following: (1) Prepare the equipment for shipment and transport to the test sites; (2) install the equipment and "debug" as necessary; (3) train on-site operations personnel; and (4) turn over the equipment for operational testing when the "install and debug" phase was completed. Telephone network arrangements for communications needs were to be complete and ready to go at installation time.

The installation and debugging of Phase I was started on November 10, 1975 and completed on November 19, 1975. A detailed description of some of the debugging activity is provided in subsequent sections.

D. OPERATIONAL TEST

The operational test was conducted in two phases in different locations with different objectives. The operational test of Phase I was started after the completion of the install and debug phase on November 20, 1975.

The scope of the test was limited to transmission of fingerprints. The term fingerprint is meant to include the rolled and flat fingerprint impressions that are recorded on the standard 8" x 8" fingerprint card.

Even though booking and criminal history information were also transmitted during the course of the test, their transmission was considered outside the scope of the project. The test objective was: (1) Volume transmission of fingerprints to determine, in part, the durability and reliability aspects of the equipment's sophisticated and delicate electronic components; and (2) the ability of the equipment to regenerate fingerprint images of acceptable quality for identification purposes.

1. Phase I - The first phase test was conducted in cooperation with the Los Angeles Police Department (LAPD). The facilities utilized were the Van Nuys field division facility and the central records facility; Parker Center, in downtown Los Angeles - a distance of about 20 miles. The Van Nuys facility is a booking and temporary jail holding facility; hence fingerprints of persons booked at the facility were transmitted over the prototype test equipment and received in the central records office where the departments identification bureau is located.

2. Phase II - The second test phase was conducted in cooperation with the California Department of Justice, State Identification Bureau (SIB), and the Los Angeles Police Department. The SIB is the central repository of criminal records for the State of California and is located in Sacramento, a distance of about 400 miles from Los Angeles. For this phase of the test, fingerprints were transmitted from Los Angeles to Sacramento starting on January 5, 1976.

   The objective of this phase of the operational test was low volume transmission of fingerprints to measure the impact of long distance on the ability of the digital facsimile test equipment to transmit and regenerate fingerprint images of sufficient quality for utilization in an operational identification environment. The operational test was concluded and terminated on January 12, 1976.

E. EVALUATION

Evaluation activity in this project was probably the most significant activity conducted during the course of the project. In general terms, the scope of the evaluation conducted for this project included two categories; (1) the performance of the equipment in terms of its operational capability, and (2) the potential utilization of digital facsimile fingerprint images in an operational identification environment.

Evaluation activities were generally conducted twice during the course of the project: (1) At the time of the acceptance test; and (2) at given times during the operational test phases I and II. Identification personnel of the State Identification Bureau and operations and identification staff of the Los Angeles Police Department were utilized in the evaluation processes of the acceptance test and the operational test. The detail items subject to evaluation and the results of the various evaluation activities are identified and described in Section VI.

III FABRICATION AND ASSEMBLY

A. GENERAL DISCUSSION

The general phase of fabrication and assembly was organized into three basic areas: Planning design, sub-systems development, and sub-system integration (assembly). The planning design portion was implemented about February 1, 1975 and required about 12 weeks to complete. The sub-system development was the most involved task as in-depth engineering effort was undertaken to complete the fabrication and modification work on the various electronics modules. Assembly of the various sub-systems into the base unit was completed about mid October. Final systems checkout was then conducted to finalize equipment preparation for the demonstration and acceptance test.

The overall fabrication and assembly phase was not completely trouble free. There were problems of various nature that did cause schedule slippage, however, there were no significant problems. A summary overview of the problem areas are noted in the following:

1. High Resolution Stylus - Initial projections were low regarding development of the high resolution styus (print head). Some problems were experienced with the stylus in terms of optimizing proper wire size, voltage, toner concentration, and styli spacing uniformity.

2. Data Compression Modules - Difficulty in interfacing data compression modules to custom printer electronic circuits were experienced.

3. Stepper Motor - Dynamics problems caused improper image regeneration with irregularities in horizontal row spacing.

4. Interpolation Algorithm - One dimensional algorithm, in video processing, was inadequate and resulted in impure image regeneration. A second dimension was added to resolve the image impurity.

Each problem area was resolved satisfactorily. The final activity of the fabrication and assembly phase was the equipment demonstration and acceptance test.

B. ACCEPTANCE TEST

The performance of the equipment was reviewed, observed, measured and evaluated. The purpose of the acceptance test was to approve or disapprove the equipment for conduct of the operational test phase. The items subject to evaluation were previously identified and discussed above. The plan of Exhibit A was utilized during the course of acceptance test.

The acceptance test was conducted in the laboratory facility of the Santa Clara DACOM plant. The prototype facsimile equipment was connected via a private business telephone line. Even though the devices were in the same room, a physical distance was simulated by having the machines connected by telephone service on a standard dial-up voice grade, unconditioned telephone line.

1. Test Results - This part will deal with the measurement and evaluation of each applicable evaluation criterion of the acceptance test of Section I B. Each will be discussed in the following to identify the various measurements that were employed and the resultant findings:

   a. Resolution(I.B.1)- Measurements were made of each mode of resolution and the interpolation result for each mode. A 100 power microscope was utilized for this measurement. Facsimile copies representing all required modes were made during the acceptance test and observed under the microscope by CCTRF staff. The cell diameter of the styli mark on the paper and the styli wire were measured. Each measurement of resolution and styli cell diameter were found to be consistent with the specification requirements and, therefore, the resolution criterion was found acceptable.

   b. Image regeneration (I.B.2) - For acceptance to this requirement, DACOM certifies in a letter, provided in Exhibit B with attachments, that the facsimile copies produced are permanent in nature and are positive black on white utilizing white dielectric stock. With the facsimile copies shown in Exhibit B, dated November 14, 1973, acceptance was given to this evaluation criterion.

c. Image bias (I.B.3) - Several facsimile copies were measured; for horizontal and vertical bias. It was noted that bias did exist in both the vertical and horizontal plane. The bias was consistent with the several facsimile copies that were measured and the results are the following:

horizontal - a stretch of 2.8% was measured in this dimension.

vertical - a shrinkage of 3.5% was found in the vertical plane.

DACOM, Inc. indicated the bias was a correctable condition. The measuring tool utilized to measure the facsimile image bias was a 100 mark per inch drafting rule. Measurements of the same plane were made of the facsimile copy and the original copy, and the variance of the measurements was utilized to calculate the bias to a percentage figure. During the course of the management review discussion on this factor, it was mentioned that Sperry Rand Company is currently conducting prototype testing on an automated fingerprint search system, and that the bias threshold factor in their system is approximately 5%. Since the DACOM bias factor is well under that threshold, and since DACOM indicated their bias is a correctable condition, it became apparent the 2% bias threshold was an arbitrary limit and a minimal bias in excess of the 2% limit would be considered insignificant.

The performance of the equipment, although in excess of 2% image bias level, was conditionally accepted.

d. Transmission time (I.B.4) - After conducting several fingerprint transmissions, the transmission time experienced ranged from 6 minutes 45 seconds to 7 minutes 45 seconds; the average time was around 7 minutes 30 seconds. It should be noted that transmission time will vary from one fingerprint card to another because greater amount of detail on a given card will require a greater transmission time.

Transmission time of given analog facsimile transmission devices range upward to 14 minutes with an average of 9½ - 10 minutes. Although the 5 minute time goal was not achieved, the evaluation criterion was conditionally accepted with the digital timing performance being significantly superior to that of analog transmission.

e. Operation and Maintenance (I.B.5) (operation and maintenance to be simple and non-technical) - For this criterion, Los Angeles Police Department (LAPD) staff participating in the acceptance test indicated the operation and maintenance aspect of the DACOM prototype equipment was very satisfactory in comparison to the existing analog system presently in use by the LAPD. Operation and maintenance was significantly easier, faster and less bothersome in terms of loading paper and the complete absence of the chemicals for the photographic development process. Therefore, this condition was accepted.

f. Equipment (I.B.6) - During the course of the test, it was noted the two facsimile devices were concurrently operational, the machine was scanning and transmitting data while the other device was receiving data and regenerating facsimile images.

The components of the print head (styli) were measured by CCTRF staff. A 100 power microscope with a 1000 mark per inch internal grid was utilized for this measurement. It was found that the styli wire diameter measured .0025" - .003" in diameter. The finding was within contract specifications and, therefore, acceptable.

g. Telecommunications Systems Interface (I.B.7) - A letter from DACOM certifies the modems operate at a 4800 bit per second rate. This letter is provided in Exhibit C. With successful transmission occurring between the two terminals, it was very apparent the modems did have the automatic adaptive equalization capability. This evaluation criterion was accepted.

h. Automatic Document Feeder (I.B.8) - The automatic document feeder provided by DACOM, Inc. was a model ADF-14 Document Feeder specially adjusted to handle fingerprint cards. In the initial test, the feeder device would not handle 50 fingerprint cards; however, "fail-to-success" testing concluded that 30 fingerprint cards could satisfactorily be transmitted without operator attendance. This means that approximately 2½ hours of transmission could be conducted without operator assistance. In this regard, this evaluation criterion was accepted on a conditional basis.

i. Image Quality (I.B.9) - This is perhaps the most significant aspect of the acceptance test, the ability of DACOM facsimile fingerprints to be utilized in an identification process.

California Department of Justice, State Identification Bureau (SIB) staff participating in the acceptance test, conducted an evaluation of digital facsimile fingerprints that were generated during the acceptance test. The facsimile copy prints were classified, analyzed and evaluated by the SIB staff. One staff member classified the facsimile copy while the other classified the original print. The classifications and the prints were then compared and evaluated.

The fingerprint evaluation process concluded with SIB staff indicating, very positively, that DACOM facsimile fingerprints, in their professional opinion, could be utilized in an operational identification process. They indicated the clarity and general overall resolution was adequate for fingerprint classification, identification and verification of identification. They also indicated two additional items of significant information:

(1) they would be able to process the same volume of DACOM facsimile prints as original prints; and (2) they could maintain an identification rate with the DACOM facsimile prints equal to the rate currently experienced on the analog facsimile fingerprints received from LAPD.

In view of the positive conclusions made by the SIB fingerprint staff, the performance of the prototype equipment, in terms of image quality, was acceptable.

2. Conclusion - The overall findings and results of the acceptance test produced a conditional acceptance of the equipment. This does not mean the performance of the equipment was sub-standard. It may be an indication that certain evaluation criterion levels were perhaps inappropriate, unnecessary or not achievable.

IV EQUIPMENT INSTALLATION

The installation phase of the project, although a small portion in time, was not unimportant. With the operational test being conducted in two phases, the activities surrounding the equipment installation of Phase I (Van Nuys to Parker Center LAPD) and Phase II (Parker Center LAPD and Sacramento) are each identified and described separately in the following sections.

A. PHASE I

For the Phase I test, the facsimile transmitter device was installed in the Van Nuys substation of the LAPD; while the receiver was installed in Parker Center in downtown Los Angeles.

With the acceptance test at DACOM completed on November 7, 1975, the equipment was transported over the weekend and delivered to each test site on the following Monday morning, November 10, 1975. Engineering staff from the DACOM plant were on-site to install the equipment. The activities of installation included the following:

1. Unpacking (uncrating) the equipment and supplies;
2. Connecting the device to the "direct access arrangement"-(DAA);
3. Service the machine by placing proper supply of paper and toner into the machine;
4. Conducting various diagnostic check out tests utilizing electronic test equipment to monitor equipment performance;
5. Conduct several test transmissions with test equipment to verify the accuracy of sensitive electronic adjustment settings of scanner, video and printer electronics.

Approximately 3 hours was utilized for the complete installation process. The installation itself was smooth and troublefree.

In order to qualify certain aspects of the test and to place the equipment performance in proper perspective, it must be mentioned that the devices are strictly pre-prototype in nature and one of a kind. Some of the enhancements made to the equipment were previously untested and it is not unrealistic, from a development point of view, for a debugging process to take several days.

In the case of the facsimile equipment provided by DACOM, for this experimental test of digital facsimile transmission of fingerprints, the installation and debugging time period experienced was 10 days, from November 10 - 19, 1975. DACOM engineering staff indicated the 10-day period for installing and debugging prototype and previously untested equipment is reasonable in their view.

1. Equipment Debugging - During the 10-day phase of checking out performance of the prototype machines, several different and apparent non-related performance malfunctions occurred. These are briefly identified and discussed in the following:

a. Paper Jams - the transmitter device initially had a paper jam problem in the 5½ inch form mode. When advised of this, a field modification was made to eliminate any further reoccurrance;

b. Failure of Image Transmission - a serious problem was an intermittant failure of transmitting facsimile copy; the problem was monitored for several days before it was traced to a faulty connection on a phase lock module; once corrected, the problem did not reoccur; and

c. Non-clear Image Regeneration - this condition was traced to a dirty platen condition; this was caused by ink coming off of the fingerprint card as the card passed over the platen during transmission; the problem was resolved by cleaning the platen once a work shift. This one minute cleaning operation was easily done by operations staff.

2. Operator Training - Training the personnel to operate the machines was not a technical nor difficult process, however, the availability of staff was a problem in terms of the shift work schedule that was utilized by LAPD. Staff worked a rotational shift with days off during the week. Staff trained on a given day would be off the next and those in attendance would be untrained. As a result, CCTRF staff monitoring the project conducted several training sessions during the 3 shifts of the work day as needed. The training sessions would require approximately one hour to cover all aspects of equipment operation.

B. PHASE II

For the Phase II tests, equipment relocation occurred to place the transmitter device in Parker Center, Los Angeles and the receiver device in Sacramento. Equipment shipment was conducted over the holidays and delivery was made for installation on January 5, 1976. DACOM engineering and field service staff were on-site to conduct concurrent equipment installation. The transmitter was installed in the central records section in LAPD while the receiver was installed in the State Identification Bureau in Sacramento.

1. Equipment Debugging - The only trouble associated with the Phase II installation was a broken wire on a video processing circuit connection. There were no other installation problems.

2. Operator Training - At the State Identification Bureau equipment operation was limited to day shift only,

therefore, only day shift staff were trained. Problems associated with Phase I training were non-existent for Phase II.

C. TRANSMISSION CIRCUITRY

The telephone network facility for each phase utilized a different arrangement. The Phase I tests utilized a private business line with a foreign exchange telephone arrangement for calls from Parker Center to Van Nuys and vice versa. The arrangement for the Phase II test was a separate line in the leased telephone network ATSS (Automatic Telephone Switching System) for the State of California. In each case, the line specification was the same; a voice grade non-conditioned telephone line with a 4800 bit per second transmission rate volume. The line adapters or modems (a device to modulate and demodulate the transmission frequency) were a standard DACOM modem productline with a transmission rate setting of 4800 bits per second.

V OPERATIONAL TESTING

With the installation and debugging of Phase I complete, equipment operation was expanded to operational status on November 20, 1975. The operational test mode conducted in two phases since different scope and objectives existed in terms of, (1) "local-to-local" volume test and, (2) a "local-to-state" long distance test. The scope and objectives and the conduct of each test phase are described in the following test phases.

A. PHASE I

1. Limitations

With the operational flexibility of the DACOM test equipment and the multitude of data activity in Van Nuys and Los Angeles test sites, certain limitations were imposed to optimize control of the test. The limitations are the following: (a) Fingerprint and booking data only would be transmitted to Los Angeles; (b) criminal history or no-record responses only would be transmitted to Van Nuys; (c) high resolution transmission was limited to fingerprint transmission; and (d) low resolution transmission was limited to non-fingerprint booking and criminal history data.

The general operation of the equipment was performed by LAPD staff normally involved in facsimile equipment operation. At first, the operation involved those initially trained but as testing progressed, several staff were involved in each work shift.

Volume operation was a constant objective and the machines were subject to heavy utilization during the test. The actual number of transmissions is not precisely known as each test facsimile transmission was not recorded. However, the volume of transmissions is estimated to range from 2100 - 2300 standard print cards. This is based on utilization of paper supplies and an average of the booking activity that was experienced during the time of the test.

The location of the equipment at each test site is, of course, important to the success of the project. For this test phase, the equipment was located as follows: (a) Los Angeles - the records and identification section in the LAPD central headquarters includes a file unit, an operations unit, and identification unit; the test equipment for this project was placed, in close proximity to the existing analog facsimile equipment in use at LAPD, in the operations unit; and (b) Van Nuys - the facility in Van Nuys has temporary jail holding facilities with a control room established as the "nerve-center" for jail operations; the test equipment was located in this control room, next to the LAPD facsimile equipment.

2. Description of Operations

The general purpose of facsimile fingerprint transmission is primarily the identification of a person arrested in the shortest possible time. In this regard, the facsimile system in LAPD is utilized to transmit fingerprint and pertinent arrest data to the identification bureau. For this test, the existing system was expanded to accommodate the DACOM prototype test equipment. The DACOM equipment was actively utilized to transmit fingerprint and booking data to the identification bureau for processing.

In conclusion, the general conduct of this aspect of the operations test was very smooth. The equipment performed very satisfactorily with no downtime or operational failure. In several observations it became apparent that operational staff in both test locations strongly preferred the DACOM equipment over the existing LAPD facsimile equipment.

B. PHASE II

The second phase tests were implemented in a very smooth manner with a minimum amount of time. Once installed, the equipment performed very satisfactorily. The general purpose of the Phase II tests was a low volume, long distance test. The test was implemented on January 5, 1976 and terminated on January 12, 1976.

1. Limitations

The general limitations of Phase II are of two areas: (a) The limitations of Phase I apply to Phase II except that booking data is not transmitted; and (b) the limitations of the existing facsimile system between LAPD and SIB which are generally the following;

- non-drug felony
- John or Jane Doe (living, name unknown)
- deceased Jane or John Doe

2. Description of Operation

The Los Angeles Police Department has utilized the terminals located in the State Identification Bureau for some time in an operational setting. The general purpose of having the terminal in the SIB is transmission of fingerprints for the conduct of speedy identification of persons arrested for non-drug related felony crimes that the LAPD cannot identify.

Testing of Phase II was conducted on this same concept and the test equipment was utilized in an operational mode during the day shift. The LA terminal was operated by LAPD operations personnel and the Sacramento terminal was operated by specialty staff that work in the special LAPD facsimile terminal unit. The Los Angeles terminal was located the same as in Phase I; the Sacramento terminal was located next to the facsimile equipment in the State Identification Bureau.

VI EVALUATION

The evaluation aspect of many meaningful projects will normally determine the success or failure of the project. An evaluation is also critical and sensitive in terms of the evaluation data being objective and the opinions of people involved non-subjective insofar as is possible. For the evaluation of this project, data was collected at given times during the operational tests and analyzed with the end of operational testing.

For the equipment operation aspect, opinions and comments were drawn from the personnel involved with operation of the equipment. For evaluating the digital facsimile fingerprints, a test set of 20 original fingerprint cards were utilized from which 20 analog facsimile copies and 20 digital facsimile copies were made. This was accomplished by the use of the analog equipment of the current LAPD facsimile system and the DACOM digital facsimile test equipment.

The three sets of prints (the 20 originals, the 20 analog facsimile copies and the 20 digital facsimile copies) were evaluated by fingerprint identification personnel of the State Identification Bureau. Each test set of prints was classified separately such that one fingerprint examiner would classify only one set of prints. The resultant classification code for each facsimile copy of the original print was then analyzed. In addition, the facsimile copies were also compared with one another. This was performed for each of the 20 original test prints.

A. QUALIFICATION

During the course of conducting tests of prototype or previously untested equipment, it is prudent to establish guidelines and limitations for the conduct and evaluation of the test in order to optimize control of the test. In regard to this, certain limitations were established. They are identified and discussed in the following:

1. Evaluation Analysis - evaluation analysis included information gathered from LAPD operations and identification staff and the identification staff of the California State Identification Bureau;

2. Fingerprint Classification System - the coding system

utilized by the Los Angeles Police Department is a new system known as "NCF" (numerically coded fingerprint). This system was derived from a national numerically coded system, however, it was modified and tailored to fit the unique needs of the LAPD. The classification systems utilized by the California State Identification Bureau is the standard Henry system with extensions. The latter scheme is more of a standardized system and was considered to be the more appropriate classification scheme to utilize for classification, comparison analysis, and evaluation. Therefore, the classification system utilized for the evaluation phase was the Henry system with extensions;

3. Fingerprint Comparison - the conduct of the fingerprint evaluation was based on the test copies with (1) the 10 rolled fingerprint images and (2) the flat impressions that are normally contained on the standard 8" x 8" fingerprint card;

4. Exclusions - information regarding single fingerprint impressions, such as thumbprints on arrest booking forms, was excluded; information relating to facsimile test fingerprint images being utilized in "latent print" identification processes was excluded also. Comparison of facsimile fingerprint images on arrest booking forms or for "latent print identification" are beyond the scope of this project and, therefore, excluded from testing and evaluation;

5. Transmission Time Measurement - transmission time was measured using standard wall clock time in minutes and seconds. Continuous transmission time was measured only during the volume test mode. Initial measurement during the long distance Phase II test mode indicated the same transmission time requirement as Phase I and, as a result, transmission timings were not continued.

B. TEST RESULTS AND FINDINGS

The evaluation results and findings of data indicate very positively that digital facsimile will perform well in an operational identification process. The opinions of people in the operations area were unanimously in favor of the digital machines that were tested; however, the comments of the identification personnel that were consulted were not unanimously in favor of the digital facsimile fingerprints. There was one, and only one, staff member that was consulted who had expressed negative comments regarding the utility of digital facsimile test prints. The comments and opinions of staff that were consulted are discussed by equipment operations fingerprint identification categories.

1. Equipment Operations - The staff involved in operating the equipment rated the test equipment very high. Some of the following comments were expressed:

   (a) easier to operate;
   (b) faster for fingerprints and administrative documents;
   (c) requires less operator attendance as the automatic document feeder can be utilized for transmission of documents;
   (d) the number of resends is almost zero with digital. When transmission is completed, the sending operator knows if the receiving machine has received the copy;
   (e) supplies are significantly easier to replace. Only paper and toner have to be refilled whereas on existing analog machines, various chemicals have to be loaded and the loading process is "horrendous";
   (f) the machines have a voice communications mode for operator communications before and after transmission, if necessary;
   (g) the copy received is easier to work with in terms of being dry, and odor free. (The copies of the existing analog system are wet, sticky, and have a very unpleasant odor.)

2. Fingerprint Identification

   (a) General comments and opinions - Although staff of the Los Angeles Police Department were not utilized in the actual evaluation of the test prints, their comments and opinions were solicited and the response was good. Of all persons expressing an opinion regarding the digital facsimile fingerprints, only one person commented in a negative manner: He commented that the facsimiles were very clear at first glance but viewed closely under fingerprint magnifier, distortions of minutia are immediately apparent, rendering accurate fingerprint classification extremely hazardous. However, other fingerprint personnel staff mentioned that there was added a minutia data in some prints, but it did not interfere

with the ability to identify or verify identity of prints.

The general response indicated that the test facsimile prints were at least as good as the prints provided by the existing analog facsimile system.

C. EVALUATION FINDINGS

The evaluation of the test fingerprints indicated objectively and conclusively that digital facsimile fingerprints are of sufficient quality that they can be utilized in an operational identification process. Each test set of fingerprints were classified by separate, journeyman level, fingerprint identification staff of the State Identification Bureau (SIB). Comparison of the test prints was also conducted with an SIB staff member that is a recognized expert in the field of fingerprint identification. This member's expert opinion was favorable toward digital facsimile fingerprints, and consistent with those indicated earlier.

In comparing the analog facsimile fingerprints to the digital facsimile, the following opinions were given:

(1) The digital prints were superior to the analog prints in most cases; and

(2) A more accurate classification code was achieved from digital facsimile than analog (in comparing the digital to the analog to the original there was a lesser degree of "referencing" in the classifying of the digital prints in comparison to the analog prints).

A general summary of the evaluation conducted by SIB staff on the test print sets concludes that the quality of digital facsimile, in most cases, was superior to the quality of the analog facsimile and in all cases, at least as good as the quality of an analog facsimile.

VII. CONCLUSIONS AND RECOMMENDATIONS

This was a pilot project to assess digital facsimile technology. The project has clearly demonstrated the capability of this technology and its acceptance in professional identification establishments. With the vast potential of digital facsimile in terms of its advantages, flexibility, and demonstrated acceptance, additional effort should be conducted to expand the horizons of this technology. Local, regional, statewide, interstate, and national transmission of pertinent and

allowable criminal justice information should be the ultimate objective of further project activities. In addition to fingerprints, important documents such as for extradition proceedings and warrants for arrest could be speedily and securely transmitted from one point in the nation to another in a few seconds or minutes. This has never been conducted or established before. There is not now a need because technology was not available before. It is now available and its full potential should be explored and developed.

EXHIBIT A

"PILOT PROGRAM FOR THE TESTING OF A DIGITAL FINGERPRINT TRANSMISSION SYSTEM"

LEAA GRANT #75-SS-99-6016

CONTRACT C-5-124

EVALUATION PLAN

for the

THIRD MANAGEMENT REVIEW

An Acceptance Test

CALIFORNIA CRIME TECHNOLOGICAL RESEARCH FOUNDATION

November 4, 1975

INTRODUCTION

The California Crime Technological Research Foundation, on behalf of LEAA, has entered into a contractual agreement with DACOM, Inc. of Santa Clara, CA. for the fabrication and assembly of existing digital facsimile technology for high speed digital facsimile transmission of fingerprint and related textual data. The purpose of the third management review is a demonstration of equipment performance by DACOM, Inc. and an acceptance test by CCTRF. This evaluation plan is to assist in measuring the equipment performance in accordance with the terms and requirements as specified in contract C-5-124.

The remaining portion of the evaluation plan contains the contract requirements and specifications.

1. Resolution:

High resolution - 400 lines per inch (lpi) horizontal mode x 200 lpi vertical mode shall be transmitted.

Low resolution - 400 lpi horizontal x 133 lpi vertical shall be transmitted.

Interpolation: An algorithm shall be utilized to increase resolution from 400 lpi horizontal x 200 lpi vertical to a 400 lpi horizontal x 400 lpi vertical performance level.

Requirement: ☐ Accepted
☐ Rejected
☐ Conditional Acceptance

CONDITION: _____

_____

_____

GENERAL REMARKS: _____

_____

_____

2. Telecommunications Systems Interface

A 4800 bit per second MODEM with automatic adaptive equalization to function on non-conditioned or conditioned lines.

Requirement: ☐ Accepted

☐ Rejected

☐ Conditional Acceptance

CONDITION: _____

_____

_____

GENERAL REMARKS: _____

_____

_____

3. One-Way Operation

There shall be two terminals: a transmitter and a receiver. The transmitter shall contain an enhanced scanner; the receiver shall contain a 400 styli per inch recording head (an image regenerator apparatus) with associated electronics. Each styli shall have a cell diameter of 2 1/2- 3 mils. (.0025 - .003 inches).

Requirement: ☐ Accepted

☐ Rejected

☐ Conditional Acceptance

CONDITION: _____

_____

_____

GENERAL REMARKS: _____

_____

_____

4. Operation and Maintenance

A. Operation and maintenance (supply replenishment) shall be simple and non-technical in nature.

Requirement: ☐ Accepted

☐ Rejected

☐ Conditional Acceptance

CONDITION: _____

_____

_____

GENERAL REMARKS: _____

_____

_____

B. An automatic batch feeder device shall allow for automatic feeding of fingerprint cards. The loader shall hold 50 cards for automatic unattended operation.

Requirement: ☐ Accepted

☐ Rejected

☐ Conditional Acceptance

CONDITION: _____

_____

_____

GENERAL REMARKS: _____

_____

_____

5. Image Type and Performance

A. The regenerated image shall be a positive black on white permanent image on white dielectric paper.

Requirement: ☐ Accepted
☐ Rejected
☐ Conditional Acceptance

CONDITION: _____

_____

_____

GENERAL REMARKS _____

_____

_____

B. The regenerated fingerprint card image shall be within 2% of the physical dimensions of the original fingerprint card.

Requirement: ☐ Accepted
☐ Rejected
☐ Conditional Acceptance

CONDITION: _____

_____

_____

GENERAL REMARKS: _____

_____

_____

C. A transmission time design goal is under 5 minutes.

Requirement: ☐ Accepted
☐ Rejected
☐ Conditional Acceptance

CONDITION: _____

_____

_____

GENERAL REMARKS: _____

_____

_____

SUMMARY

The five major categories of contract requirements shall each be evaluated. They do not necessarily have to be evaluated in the order shown in the Evaluation Plan.

One additional characteristic of equipment performance is the ability of a given facsimile fingerprint copy to be utilized in a fingerprint identification process. This process generally includes a classification or coding function, a file search and an identification verification process. This general process is conducted by fingerprint examiner personnel. In this regard, two fingerprint examiner staff from the State Identification Bureau will participate in the acceptance test to assess the characteristic and quality of a facsimile fingerprint copy.

RESULT: ☐ Acceptance

☐ Rejection

☐ Conditional Acceptance

CONDITION: _____

_____

_____

GENERAL REMARKS: _____

_____

_____

CONCLUSION

The general overall rating of this acceptance test is provided in the appropriate box below. The DACOM equipment overall performance is:

☐ ACCEPTED

☐ REJECTED

☐ CONDITIONAL ACCEPTANCE

CONDITION: _____

_____

_____

GENERAL REMARKS: _____

_____

_____

CCTRF

_____

W.L. Winegar
Project Director

DACOM

_____

Don Weber
Senior Vice President, Engineering

EXHIBIT B

DACOM

November 11, 1975

California Crime Technological
Research Foundation
4433 Florin Road
Suite 690
Sacramento, CA 95823

Attention: Mr. David Anderson

Gentlemen:

Subject: Contract C-5-124, "Pilot Program for the Testing of the Digital Fingerprint Transmission System"

One of the subject contract requirements is the generation of a positive black on white permanent image on white dielectric paper.

Dacom is pleased to submit herewith evidence demonstrating its compliance with this requirement.

Enclosed you will find samples of facsimile copy printed on Dacom terminals as far back as 1973. There has been no perceptable change whatsoever in the quality of paper or print on these samples since they were reproduced. Thus, the samples demonstrate the archival nature of the dieletric paper and print used. This paper is similar to paper presently being employed in the fingerprint equipment presently offered to meet contractual specifications.

We trust this information satisfies your requirements.

Yours very truly,

Robert S. Meltzer
Vice President, Special
Projects Marketing
RSM/j

FAX (408) 984-2075 ■ 2972 STENDER WAY, SANTA CLARA, CALIFORNIA 95051 ■ PHONE (408) 249-7200

FINE DETAIL
(200 LPI)

70-CP-288-COM

DACOM® FACSIMILE DATA COMPRESSION TECHNIQUES

Daniel Hochman and Donald R. Weber
Dacom, Inc.
Sunnyvale, California

Summary

The inherent data redundancy obtained from scanning pictorial information and the resultant excessive communications time and bandwidth requirements have been a major obstacle in expanding the use of facsimile transmission systems.

With an objective of providing practical and economical data compression solutions, Dacom developed several novel techniques and has incorporated them in various equipments for facsimile communications. This paper presents these techniques as they apply to

- message facsimile and medium-resolution graphics transmission systems,
- high-resolution facsimile systems for remote printing of quality publications, and
- efficient digital transmission of continuous-tone pictures.

Introduction

The process of facsimile transmission is more than 125 years old, yet until recently its use has been limited to relatively few special applications. In a June 1969 presentation of the American Press Telecommunications Technical (APTT) Committee entitled "Facsimile Comes of Age", it was pointed out that facsimile cannot compete with data techniques in the high-speed category because of problems referred to as "R and R" — Redundancy and Resolution. As applied to facsimile, redundancy means too much electronic effort goes into reproducing areas of identical data (stretches of equal value picture elements) so that as the entire page is transmitted, up to 90% of the transmission is waste. Resolution, the second of the R's, is determined by how closely the facsimile scanner inspects the document to be transmitted. Resolution improves with repetition and repetition involves additional time (transmission time is proportional to the product of horizontal and vertical resolution).

Data compression provides a solution to both these problems and, consequently, greatly reduces facsimile communications costs. This paper presents the various data compression techniques developed by Dacom for digital transmission of documents, graphics and continuous-tone pictures.

Facsimile Data Compression

Message Facsimile and Medium-Resolution Graphics Transmission

In these applications, facsimile equipment is used to transmit copies of handwritten or typed documents, simple drawings, weather maps, etc. The scan resolution is in the range of three to four lines per millimeter and, without special signal processing, the transmission time over a conventional telephone line is between 4.5 and 6 minutes for an 8.5 x 11" page. Since the information of interest to the user is in the form of black and white graphics rather than continuous gray scale pictures, data compression approaches have most frequently employed the principle of run length encoding.

Various coding configurations and techniques have been used which are typically based upon the statistical probability of the scanned information remaining fixed for at least a finite period of time. In one such system, the approach is to simultaneously evaluate the compression efficiency of several different encoders and then identify the one that is able to represent the most recent portion of the scan with the smallest number of digits. This encoder is then selected and caused to transmit the compressed data. This techniques is able to selectively assign encoders in any combination, such that the encoder used at any given time is the best choice for that portion of the scan. Although this solution provides improved compression efficiencies for a certain class of data, its effectiveness is limited because the number of encoders which can be incorporated is finite and the cost of including more than three or four different encoders to accommodate different data statistics in a single system is significant.

In another system, transition indicia are produced by differentiating the scan signal. Since the spacing between indicia may typically be short or long, a coding technique is employed for using a long and a short binary code in any desired combination. To distinguish which code is being used, a prefix bit is added preceding the associated code. This technique has been found to work well if the long code appears quite frequently; however the system efficiency falls off rapidly if many short codes are required. This loss in efficiency is due to the fact that the required prefix bit occupies a

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1973

DACOM, INC.
1060 MORSE AVE.
SUNNYVALE, CA 94086

NOVEMBER 14, 1973

ATTENTION: MEMBERS
PROJECT SEARCH TECHNOLOGY COMMITTEE
PHOENIX, AZIZONA

GENTLEMEN:

THIS IS AN EXAMPLE OF PRINTING USING A TERMINAL SIMILAR TO THE DACOM EQUIPMENT NOW BEING USED FOR FINGERPRINT TRANSMISSION IN PHOENIX. THIS MESSAGE WAS ENTERED INTO A TELETYPE UNIT BY MEANS OF A PAPER TAPE. THE MESSAGE WAS THEN PRINTED ON THE DACOM PRINTERFAX TERMINAL, A MODEL SIMILAR TO THE FINGERPRINT FACSIMILE EQUIPMENT EXCEPT FOR THE ADDITION OF AN ELECTRONIC INTERFACE KIT. THE DACOM PRINTERFAX TERMINAL CAN RECEIVE OUTPUT FROM A TELETYPE UNIT, A DIGITAL COMPUTER, OR A STANDARD DACOM FACSIMILE TRANSCEIVER.

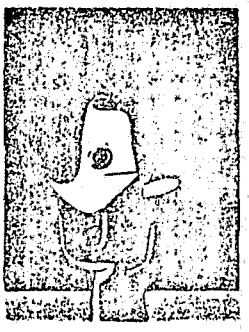
THIS MESSAGE WAS PRINTED IN 15 SECONDS.

IF I CAN ANSWER ANY ADDITIONAL QUESTIONS, PLEASE LET ME KNOW.

SINCERELY,

BOB MELTZER

JAN 1974



The eye of Texas seems firmly fixed upon the future in George Giusti's three-dimensional cover design.

TRAVEL & LEISURE

AUTUMN 1973 CONTENTS VOL. 3 NO. 4

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3. ALIAS(ES) AND ALL FORMER NAME(S)	4. SOCIAL SECURITY NUMBER
5. MONTH, DAY, YEAR OF BIRTH	6. PLACE OF BIRTH
	7. SERVICE NUMBER

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a. FATHER			
b. MOTHER *(Full Maiden Name)*			
c. SPOUSE *(Full Maiden Name)*			

9. RESIDENCES *(List all from 18th birthday or during past 15 years, whichever is short r If under 18, list present and most recent addresses.)*

a. FROM	b. TO	c. NUMBER AND STREET	d. CITY	e. STATE

10. EMPLOYMENT *(List all from 18th birthday or during past 15 years, whichever is shorter If under 18, list present and most recent employment)*

a. FROM	b. TO	c. EMPLOYER	d. PLACE

11. LAST CIVILIAN SCHOOL

a. FROM	b. TO	c. NAME	d. PLACE

PART II *(TO BE COMPLETED BY EMPLOYER)*

TO:

Defense Industrial Security Clearance Office
Defense Supply Agency
Box 2499
Columbus, Ohio 43216

NAME AND ADDRESS OF EMPLOYER *(If a subsidiary, include name of parent company)*

JOB TITLE AND DESCRIPTION OF EMPLOYEE'S DUTIES WHICH REQUIRE ACCESS TO CLASSIFIED INFORMATION

CONTRACT NUMBER, WHEN APPLICABLE

SECURITY CLASSIFICATION OF MATERIALS OR INFORMATION EMPLOYEE WILL HAVE ACCESS TO

I CERTIFY THAT THE ENTRIES MADE BY ME ABOVE ARE TRUE, COMPLETE, AND CORRECT TO THE BEST OF MY KNOWLEDGE AND BELIEF AND ARE MADE IN GOOD FAITH.

SIGNATURE OF EMPLOYER OR DESIGNATED REPRESENTATIVE

DACOM, INC.
1060 MORSE AVE.
SUNNYVALE, CA 94086

NOVEMBER 14, 1973

ATTENTION: MEMBERS
PROJECT SEARCH TECHNOLOGY COMMITTEE
PHOENIX, AZIZONA

GENTLEMEN:

THIS IS AN EXAMPLE OF PRINTING USING A TERMINAL SIMILAR TO THE DACOM EQUIPMENT NOW BEING USED FOR FINGERPRINT TRANSMISSION IN PHOENIX. THIS MESSAGE WAS ENTERED INTO A TELETYPE UNIT BY MEANS OF A PAPER TAPE. THE MESSAGE WAS THEN PRINTED ON THE DACOM PRINTERFAX TERMINAL, A MODEL SIMILAR TO THE FINGERPRINT FACSIMILE EQUIPMENT EXCEPT FOR THE ADDITION OF AN ELECTRONIC INTERFACE KIT. THE DACOM PRINTERFAX TERMINAL CAN RECEIVE OUTPUT FROM A TELETYPE UNIT, A DIGITAL COMPUTER, OR A STANDARD DACOM FACSIMILE TRANSCEIVER.

THIS MESSAGE WAS PRINTED IN 15 SECONDS.

IF I CAN ANSWER ANY ADDITIONAL QUESTIONS, PLEASE LET ME KNOW.

SINCERELY,

BOB MELTZER

EXHIBIT C #2

DACOM

November 7, 1975

California Crime Technological
Research Foundation
4433 Florin Road, Suite 690
Sacramento, CA 95823

Gentlemen:

Subject: Contract C-5-124

Dacom certifies that the modems used in both terminals in the tests under the subject contract operate at 4800 bits per second.

Yours very truly,

Paul L. Brobst
Senior Vice President, Marketing

PLB:di

FAX (408) 984-2075 ■ 2972 STENDER WAY, SANTA CLARA, CALIFORNIA 95051 ■ PHONE (408) 249-7200

APPENDIX A

A BRIEF DISCUSSION ON FACSIMILE TRANSMISSION

I GENERAL

The basic function of a facsimile transmission is to convey an image of an original document to a remote or distant location. Essentially, the facsimile operation is the following: (1) The machine reads or scans the document, converts the data to electronic impulses and transmits the data (impulses) to the receiving location by one of several communications medium; (2) the receiving equipment will "receive" the data sent to it and re-convert the elctronic impulse in such a way that a duplicate or a facsimile copy of the original document can be regenerated. Depending on the amount of data to be copied, the size of document, speed of transmission, and the transmission medium, the time of sending a facsimile copy can range from a few seconds to over 15 minutes.

II ANALOG METHOD

Analog facsimile is different from digital facsimile. In the analog method, scanning transmission and receiving of data occur in a constant and uninterrupted manner. (Transmission of data is in a constant and virtually uncontrolled mode of transmission.) The copy received may be a dry copy or a wet "photograph" type of copy. The transmission time of the analog method is typically slow. The equipment of this type, utilized by the Los Angeles Police Department, will transmit a fingerprint in 9 to 14 minutes. (The pre-prototype digital facsimile equipment transmitted the same print in approximately 7½ minutes.) One advantage of analog method is a lower unit cost. Some of the disadvantages are:

(a) Slower (longer) transmission time resulting in perhaps higher transmission costs.

(b) Slower (longer) machine operation resulting in a greater number of machines for transmitting a given volume of data.

III DIGITAL METHOD

Digital facsimile is similar to analog in terms that the document is also scanned or read, however, this process can be controlled via programming. Once the data is scanned and converted to electronic impulses, it is converted to digital data. The digital data may then be compressed and transmitted utilizing one of several digital transmission modes. Upon being received it is reconverted to "equivalent" analog data for image regeneration. Some of the significant advantages to digital over analog facsimile include:

(a) Speed - transmission speed is generally faster with digital. This is achieved by data compression and interpolation or expansion techniques on the receiving end. In other words,

as data is prepared for transmission, it is compressed and manipulated by removing redundant data. This results in a greatly reduced volume of data to be transmitted. As data is received, it is expanded by a mathematical algorithm to fill in the blanks of the data that was not transmitted. These two features almost cut in half the transmission time.

(b) Cost Savings - because transmission is faster, transmission costs are less.

(c) Communications Compatible - digital transmission is compatible to message switch communications such as the "store and forward" approach to telecommunications. This is a common communications technique in today's Law Enforcement Communications Systems.

(d) Less Equipment - since digital facsimile machines work faster, a fewer number of machines would be needed to transmit the same volume of data, resulting perhaps in savings.

The prime disadvantage to digital facsimile is equipment cost. Digital is new and as a result, quite costly in terms of unit cost per device in comparison to a per unit cost of an analog unit.

END

7 attachments