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Westinghouse Justice Institute

REVIEW OF PORTLAND, OREGON IMPACT PROGRAM POLICE COMMUNICATIONS PROJECT

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FOREWORD

The Portland, Oregon IMPACT Program requested technical assistance to review their Police Communications Project. In response to this request the Westinghouse Justice Institute, under U.S. Department of Justice Contract J-LEAA-016-72, provided Mr. M. Wayne Kincheloe. This report documents his brief but intensive review and gives recommendations.

CONTENTS

1. INTRODUCTION

This report summarizes findings concerning the Portland Police Communications Project. The report is based on a review of the visit, and subsequent discussions with representatives of the Portland Police Bureau, IMPACT Program Staff, Oregon Law Enforcement Council, Portland Communications Bureau, and LEAA. These activities were carried out during January and February 1973. Material which follows presents recommendations (Section 2), indicates supporting considerations (Section 3), and summarizes the supporting documentation (Section 4).

2. RECOMMENDATIONS

2.1 General

This proposed multi-year project for communications and computer-directed dispatch system, if properly designed and implemented, will greatly improve response time, and will reduce hazards to the officer and general public as well as provide for improved manpower allocation, management control, and cost/benefit ratio. Several components of the overall system started concurrently in both the engineering design phase and the construction phase: the facility, the power supply system, the computer-assisted C/D system, the telephone answering system, and the radio systems. Assuming competent management, the total system could be operational in about three years; partial operation is likely feasible in a year and a half. Sections 2.2 through 2.12 detail the specific recommendations.

2.2 Consulting Engineering Firm

2.2.1 Selection

The first and perhaps most important step is to select a consulting engineering firm for the City and County, to provide overall management for the entire project. This is essential to ensure that the proposed system meets the technical requirements of the City and County, and that it will be developed in an orderly, expeditious, and economical manner. Such project management must not be segmented; the Consultant would provide all of the following services:

(1) Construct a detailed PERT chart indicating the task milestones, inter-relationships, and time phasing.

(2) Carry the responsibility for hardware, software, and overall system planning,

design, and implementation; and will act as advisor to and coordinator for the City and County.

(3) Prepare plans, specifications and contract documents for facilities, equipment and related services.

(4) Assist the City and County in the advertising, taking, and evaluating of bids for facilities, equipment, and services.

(5) Coordinate procurement contracts and provide construction engineering services for the construction of facilities, including installation of equipment, programming services, and testing and start-up of the completed facilities.

The Consulting Engineering firm selected to provide these services should be free of commercial connections with manufacturers, suppliers, or contractors. It should have sufficient staff size and depth, including licensed professional engineers, to be able to assign sufficient personnel in all of the required disciplines to assure efficient and timely completion of the project. On a project of this magnitude, it may be necessary, during various stages of the work, to have 10, 15, or 20 people working at one time.

The Consulting Engineering firm should command seasoned expertise in the following general design areas:

(1) Real-time computer-directed control systems, including facilities and system design (should cover the application of computer equipment, operator's consoles, loggers, CRT's, keyboard and digital transmission, and all related interface equipment).

(2) Telecommunication systems, including mobile radio, microwave, digital telemetry, supervisory, and telephone.

(3) Real-time computer programming, including both system and application. Have in-house computer facilities for testing and debugging of application

programs; or have access to a shared-time computer facility for this purpose.

(4) System engineering, including reliability and redundancy design that is compatible with overall economics.

(5) Experience in developing and implementing public bidding procedures.

(6) Project administration, management, and scheduling, utilizing PERT and CPM techniques.

2.2.2 Funding

On the basis of the PSSI report, it appears that approximately $590,000 are attributable to the remaining consultant engineering function, as follows:

Project Management	$230,000
Detailed Design	300,000
System Integration (Total Amount Allotted - $200,000)	
Estimated Amount for Consultant Services	50,000
Installation Monitoring and Test Review (Total Amount Allotted - $90,000)	
Estimated Amount for Consultant Services	10,000
Total, Consultant Services	$590,000

From the FSSI report, total costs excluding consulting engineering services as well as costs associated with telephone system upgrading and facility design and procurement are:

Total cost indicated in PSSI Report	$5,350,602
Estimated Consultant Services	590,000
Net Total Excluding Consultant Services	$4,760,602

From "Consulting Engineering Services",* the median compensation for consulting services is about 7% of the net total. One hundred thousand dollars has already been spent on consulting services. However, it is recommended that a maximum of $350,000 be allocated for the remaining professional services, in contrast to the $590,000 indicated above.

2.3 Interim Radio System

It is recommended as soon as one or two radio systems are ready for operation that temporary control consoles be installed in the existing dispatch center and the cutover to the 450 MHz channels be initialized.

2.4 Radio Systems

It is recommended that the City and County move to the 450 MHz band from the 150 MHz, install conventional eight-channel mobile radios in the vehicles, and equip each field officer with a four- or six-channel personal portable radio. Further, it is recommended that the mobiles be able to operate in a simplex mode on all eight channels, and that the portables be able to operate in a simplex mode on at least two channels.

2.5 It is Recommended that all Base Station Radios, all Microwave Equipment and Voting Receivers be powered from Batteries and Battery Chargers

This requirement appears to have been overlooked in all system documentation. On loss of A-C power at a remoter station, an alarm should be sent to the C/D center indicating that a particular station has had a commercial power failure.

2.6 Telephone Sub-System

The telephone answering sub-system and related operating procedures in the computer-assisted dispatch (C/D) center will have the greatest effect on response time; therefore, this is a very important task. The Telephone-Company-provided "automatic call distributor" system seems to work well and probably could be installed in a short period of time. However, since this system is expensive and may not provide adequate backup in case of failure, other alternatives should be investigated.

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* American Society of Civil Engineers - Manuals and Reports on Engineering Practice - No. 45, dated 1972.

2.7 Computer-Assisted C/D Center

General. It is recommended that instead of building an interim C/D center that a permanent C/D be built or procured which has the capacity to house the City and County police and fire dispatching operations, with anticipated growth taken into consideration. The problem of cutover makes an interim facility almost an impossibility. With today's methods of data transmission, the location of this facility with respect to other related facilities is almost insignificant.

2.8 Power Supply

Similarly as for the radio and allied equipment (Section 2.5), all equipment in this facility should be D-C powered or inverter powered from a power plant consisting of a reliable commercial A-C feed augmented by automatic transfer (in event of commercial power failure), battery chargers, batteries, and inverters. The reliability requirements of the power system dictate redundancy engineering.

2.9 Computers

The computer-assisted dispatch system should be designed for a high degree of reliability. A dual computer configuration should be installed right from the start, including the necessary software, in order to maintain the required redundancy. The C/D center should never be operated in a mode where a failure of one piece of equipment would shut down the whole operation--not even in a temporary operating mode.

2.10 Status and Map Displays

It is recommended that the cost and benefits of using CRT's for status display be investigated as an alternative to employing wall mounted status and map displays.

2.11 Contracts

It is recommended that one contract be let for the control-related equipment for the C/D center. The following should be included:

(1) Computers and related hardware

(2) CRT/keyboard terminal units

(3) Status CRT terminals

(4) Digital-mobile terminals, including the central control and interface equipment.

(5) Radio consoles and necessary interface equipment

(6) All operational software packages

(7) Modems (for connecting to other systems) including the necessary computer interface equipment.

2.12 Mobile Terminals

Since the digital mobile terminal systems in existence today have an inherent problem, it is recommended that the consulting engineer design the digital system in his specification. As off-the-shelf digital radio systems exist today, they support only about 20-30 mobile units per channel. With proper design, one channel can support about 70-100 mobile units, thereby achieving maximum utilization of the channel.

The contractor who is awarded the contract for the system that includes the mobile terminal digital subsystem, should be required to supply his own equipment conforming to the specifications, or to buy the digital equipment from a supplier and modify it to meet the specifications, or to have the supplier modify his equipment to meet the specifications. In short:

(1) There is ample operational and management potential in mobile terminals to justify their inclusion in the communications system.

(2) At the present time, a definite technical risk attends the buying of such systems off-the-shelf.

(3) This technical risk can be greatly alleviated by having the consultant engineering firm specify the mobile digital system requirements. Mobile terminals should be purchased only on this basis.

(4) It is further recommended that (a) a dedicated channel be employed for the digital mobile system, with the capability for emergency voice communications, and (b) a separate radio be provided for the digital system.

3. DISCUSSION

The three main subsystems of the overall project are Telephone, Radio, and Control Center.

3.1 Telephone Subsystem

The conceptual design leaves out one of the most important subsystems in the design of the ultimate communication/dispatch system--the telephone subsystem. In Portland, this subsystem, like many others, needs to be upgraded. The telephone answering subsystem and related operating procedures have the greatest potential for shortening response time; therefore, this should be one of the first tasks to be implemented. The Telephone-Company-provided "automatic call distributor" system seems to work well and could probably be installed in a short period of time. However, since this system is expensive and may not provide adequate backup in case of failure, it should not be adopted without investigating other alternatives.

3.1.1 Cutover

One area that was not given much consideration in the report is the amount of work time, cost, and continuity-of-service considerations involved in cutting over to the new communication/dispatch center. Closer examination of this factor would have revealed the nonfeasibility of implementing an interim control center.

3.2 Radio Subsystem

3.2.1 Frequency (150 MHz vs 450 MHz)

A recommendation is made in the submitted reports to move to the 450 MHz band from the 150 MHz band. This recommendation appears sound. Propagation of 150 MHz frequencies is better in hilly and foliage-covered areas than is that of 450 MHz frequencies; however, this can be compensated for with a properly designed radio system. There are two main reasons for going to the 450 MHz band: (1) the required number of channels, not available in the 150 MHz band, are available in the 450 MHz band; and (2) since the 450 MHz frequencies do not propagate as extensively as the 150 MHz frequencies, the same 450 MHz frequency can be reused by other agencies in other areas, whereas if they were sharing a 150 MHz frequency, the intervening distance might not prevent an unbearable amount of interference.

3.2.2 Radio System Design

In most police departments today, when the officer leaves his vehicle, he leaves his contact with the dispatch center and other

officers behind--a very hazardous situation. Acceptable design of the radio system today requires that he be able to communicate with the dispatch center and other officers at all times, whether he is on foot or in his vehicle. There are in general four main alternatives for the design of the kind of radio system proposed.

Alternative #1

A conventional eight-channel mobile radio for the vehicle and a four- or six-channel portable for the officer. All vehicular mobiles are able to transmit in the simplex mode as well as in their normal full-duplex mode. Also, the portables are equipped with at least one simplex channel. This system includes a group of receivers connected to form a voting subsystem, a necessary provision to get good coverage from the portable.

Alternative #2

The vehicles are equipped with a "jerk and pull" type of radio. This alternative is similar to #1 except one radio serves as both the vehicle unit and the personnel portable.

Alternative #3

The vehicle is equipped with a conventional type of mobile interfaced to another radio (similar to a portable) to create a mobile repeater. The officer would be equipped with a portable which when keyed would repeat through the repeater-equipped vehicle. In this system, the base station transmitter also repeats through the mobile.

Alternative #4

This system is the same as #3 except the mobile repeats only the transmission from the portable. The transmission from the base station goes directly to the portable.

Some of the advantages of using a conventional mobile radio in the vehicle instead of one that could double as a portable (Alternative #1) are: an increase in reliability and service life, superior operating characteristics (i.e., intermodulation rejection, higher transmitter power), and more available options. Since the power output of the portables is low, a receiver voting scheme is necessary for communication between the portables and the dispatch center or via a repeater to another mobile or portable. In the event of a failure of part or all of the receiver voting system, even though communications might be lost with the portables, mobile units with high power transmitters would act as backup. At least the officer would still be able to communicate from his vehicle.

The only advantage that Alternative #2 has to offer over #1 is lower initial cost. However, this is probably not a wise saving since the "jerk and pull" radio does not have the operating characteristics, flexibility, and high power output possessed by the conventional mobile radio. Also, an officer leaving his car may not have time to pull his radio and take it with him.

The advantage of Alternative #3 is to minimize the receiver voting system; however, the complications of the mobile repeater and the required additional frequencies do not appear to make this a very good choice for Portland. If repeating through a mobile and in addition through the base station equipment is required, the complications get prohibitive.

Alternative #4 uses the mobile as a repeater only in one direction--toward the base station from the portable. The Base station would transmit directly to the portable. Repeating through base station equipment also requires a very complicated system.

3.3 Control Center

The computer-directed control center is a real-time computer application as opposed to other types of law-enforcement computer installations which are more oriented toward data processing. A real-time control computer is basically a general-purpose computer with capacity for high-speed processing. A small, medium, or large-scale computer or a mini-computer may be used in real-time control applications. A real-time control computer system must also include equipment for communications with other equipment. This includes CRT's for operator interface, digital inputs from alarm and control consoles, digital outputs to status and map displays and consoles, digital input and output from and to digital radio systems, as well as a real-time monitor system with routines for control of the internal communications.

A computer system for control must be designed for continuous 24-hour operation with a high degree of reliability. This probably means two computers (one primary and one for backup). Bulk memory systems must have minimum electromechanical components such as fixed head disk or drum, or duplicate equipment must be provided to permit periodic preventive and corrective maintenance of peripheral equipment without interference with the operation of the control system.

A real-time computer must be provided with a highly reliable power supply. Many data processing facilities as well as process control installations are provided with fail-safe power supplies. Two examples are:

(1) A dual power supply with power on and power off interrupt devices to permit automatic shutdown and restart of the computer during switching of power supplies.

(2) A battery charger and static inverter with battery system backup.

A computer applied to control a dispatch center will greatly improve the center's operation. With the aid of Cathode Ray Terminals (CRT's), the primary and secondary telephone answerers and radio dispatchers can intercommunicate with great speed and accuracy. As soon as the address of an incident is keyed into the CRT, the computer indicates the unit that should respond, since the computer continuously integrates the status of all units, and can correlate the address versus district information to spot the nearest available unit and any other nearby units on lesser details that might be dispatched.

The conceptual design proposes to use status and map displays. Instead, it might be better to utilize another alternative like dedicated CRT's for this purpose (see Recommendation 2.10).

4. SOURCE DOCUMENT SUMMARY

The evaluation in this report is based on a review of: (1) the PSSI report, (2) the draft grant application, and (3) supplementary material submitted by Portland on February 2, 1973. For those who are not intimately familiar with these documents, an over-view summary is as follows.

4.1 PSSI Report

This report presents an implementation plan for the design, acquisition, installation, testing, and operation of the law enforcement and fire services communication dispatch center. The plan presents a conceptual design and a general description of the basic steps required to develop and implement the design, and provides general estimates of the associated costs. The design and acquisition of facilities and telephone equipment, the assignment of personnel, and the procurement of vehicles are not included within this plan.

4.1.1 The PSSI conceptual design will provide the following:

(1) A computer-directed control center including CRT/keyboard, terminals, loggers, status

and map board displays, radio consoles, and telephone answering positions. The control computer system would also have data link connections to larger law and justice data processing centers.

(2) Eight full duplex radio channels and related receiver voting systems. All eight channels to operate in the 450 MHz band.

(3) Eight-channel mobile radio for each vehicle and four- or six-channel portable radios for each field officer.

(4) One full duplex digital radio channel and related mobile terminals in patrol and traffic vehicles. This channel is also to operate in the 450 MHz band.

(5) Microwave links connecting radio base stations and other major points.

4.1.2 This system is to be implemented in yearly phases over a span of five years.

Year 1

(1) Initiate detailed design for the entire communication/dispatch (C/D) system.

(2) Design, procure, and install necessary equipment to implement two of the proposed 450 MHz channels.

(3) Procure and install a first module of mobile radios and portables. Mock up and evaluate consoles.

(4) Design map coordinate system.

Year 2

(1) Design, procure, install, and test necessary equipment to implement the remaining seven 450 MHz channels.

(2) Procure, install, and test a second module of mobile radios and portables.

(3) Procure, install, and test dispatch center digital radio equipment along with 15 mobile terminals.

(4) Upon completion of items one and three above, procure a second module of digital equipment.

(5) Let contracts for consoles, wall status display, audio recording equipment, radio alarm decoding and display equipment, microfilm displays, and a communications/dispatch center intercom.

(6) Select computer equipment.

(7) Develop system software specifications.

(8) Procure, install, and test computer equipment.

(9) Initiate development of applications software.

Year 3

In this year the new C/D center facility is available.

(1) Install and test all equipment which has been purchased.

(2) Procure, install, and test second module of data processing equipment (additional CRT/keyboard terminals, core storage, and peripheral devices).

(3) Develop, install, and test status display and CRT/keyboard system.

(4) Develop, install, and test basic computer-assisted dispatching software module.

(5) Microfilm and install graphics display data base which was assembled in Year 2.

(6) Initiate phaseover of existing C/D operations to the new C/D center. At this point, all patrol and traffic units are equipped with digital mobile terminals.

(7) Develop, install, and test digital software package for interfacing mobile digital terminals with

C/D and the CRISS system. The digital file inquiry capability will be ready for operation by the end of the third year.

Year 4

(1) Train operating personnel to utilize the computer-assisted dispatch center.

(2) Install and test the second central processing unit which will achieve a duplex configuration.

(3) Install and test two additional CRT/key-board terminals.

(4) Develop, install, and test software for personnel status subsystem, introduce departmental communications network and the review and selected retransmission of messages received by LEDS.

Year 5

(1) Procure, install, and test the microwave network connecting the radio base stations and other major points.

(2) Develop, install, and test software required for duplex computer operations.

4.2 Draft Grant Application

4.2.1 The grant request proposes to do the following in two phases (Phase I and Phase II). Phase I is divided into three stages (Stages A, B, and C).

Phase I

Stage A

(1) Initiate fielding of the strike force.

(2) Prepare RFP for a consulting firm to do detail design and serve as prime contractor for systems completion. Thirty days from time of funding, 21 vehicles will be equipped with 150 MHz radios on the existing city band for use by the strike force.

These units will be utilized until the first 450 MHz channel is ready, about 60 days.

(3) One hundred days after funding, the first 450 MHz channel is to be operational with a control console in the existing communication/dispatch center.

(4) Equipment units (patrol, traffic, and strike force officers) with personal portables on this first 450 MHz channel.

Stage B

(1) Begin search for an interim facility. Find it and begin renovation.

(2) Bring three additional 450 MHz channels to operational level.

(3) Recall all vehicles (patrol, traffic, and strike force) for mobile changeover to the 450 MHz band. This work to be completed by the end of seven months from funding day.

(4) With the phaseout of the 150 MHz bands (seven months from funding date), move into an interim facility.

Stage C

(1) Upgrade radio alarm system.

(2) Award contract to consulting engineering firm for detail design, about seven months after funding date.

Phase II

During this phase, the consulting engineering firm will do the detail system design and prepare the necessary specifications for bidding.

4.2.2 Fund Request

Note under Phase I and II. The LEAA funds requested in the draft grant request are as follows:

Operation Support Program	
Personnel	$1,725,996
Equipment	289,222
Supplies and Operating Expense	122,950
Subtotal	$2,138,168
Communications	
Professional Services	$ 483,545
Travel	3,000
Equipment	973,797
Supplies and Operating Expense	19,977
Subtotal	$1,480,319
Total	$3,618,487

In addition to the above monies, the City and County are indicated as contributing matching funds in the amount of: $1,216,186. It should be noted that the grant application cost figures are not directly comparable to those indicated in the PSSI report. They differ in two major respects:

(1) With respect to communication, cost estimates in the grant application are for the initial phase only. They are primarily concerned with the purchase and installation of equipment necessary to implement four radio channels (see the last sentence in Section 4.2.1, under the heading, Phase II). This primarily includes approximately 220 mobile radios; 220 personal portables; base stations and voting receivers. Also included are costs associated with control system design specifications. Excluded are control center facility procurement; control center system implementation, including computer assisted dispatch and mobile terminals; and telephone system upgrading.

(2) The grant application includes monies for the strike force whereas the PSSI report is strictly in the area of communications. Of

the funds requested in the grant application, approximately $1.5 million dollars applies directly to the $5.5 million dollar multi-year cost estimates indicated in the PSSI report.

Supplemental Material Submitted by Portland (February 2, 1973)

The data contained in this submittal consists of the following:

(1) Material to support the move to the 450 MHz band from the 150 MHz band.

(2) Material to justify the number of proposed radio channels (nine in total).

(3) Material concerning the proposed location of the transmitting and receiving equipment.

(4) Material regarding the decision to use full-size mobile units and separate personal portables instead of the "jerk and pull" or "mobile repeat" types of equipment.

(5) An outline of the work for the detail design of the proposed communication/dispatch system to be accomplished by the selected consulting engineering firm.

END