WASHINGTON OPERATIONS

SAMPLE SURVEY OF POLICE DEPARTMENT RADIO CHANNEL NUMBER AND USE

JANUARY 1974

Equipment Systems Improvement Program Report
prepared for

NILE&CJ

U.S. DEPARTMENT OF JUSTICE
LAW ENFORCEMENT ASSISTANCE ADMINISTRATION
NATIONAL INSTITUTE OF LAW ENFORCEMENT
AND CRIMINAL JUSTICE

MITRE

THE EQUIPMENT SYSTEMS IMPROVEMENT PROGRAM

Following a Congressional mandate* to develop new and improved techniques and equipment to strengthen law enforcement and criminal justice, the National Institute of Law Enforcement and Criminal Justice under the Law Enforcement Assistance Administration of the Department of Justice established the Equipment Systems Improvement Program. The objectives of the Program are to determine the priority needs of the criminal justice community to help in its fight against crime, and to mobilize industry to satisfy these needs. A close working relationship is maintained with operating agencies of the criminal justice community by assigning systems analysts to work directly within the operational departments of police, courts and corrections to conduct studies related to their operational objectives.

This document is a research report from this analytical effort. It is a product of studies performed by systems analysts of the MITRE Corporation, a not-for-profit Federal Contract Research Center retained by the National Institute to assist in the definition of equipment priorities. It is one of a continuing series of reports to support the program decisions of the Institute relative to equipment development, equipment standardization and application guidelines. Comments and recommendations for revision are invited. Suggestions should be addressed to the Director, Advanced Technology Division, National Institute of Law Enforcement and Criminal Justice, Law Enforcement Assistance Administration, U. S. Department of Justice, Washington, D. C. 20530.

Gerald M. Caplan, Director
National Institute of Law
Enforcement and Criminal Justice

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* Section 402(b) of the Omnibus Crime Control and Safe Streets Act of 1968, as amended.

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8 January 1974

SUBJECT: SAMPLE SURVEY OF POLICE DEPARTMENT RADIO CHANNEL NUMBER AND USE

REFERENCE: D38-487
LEAA Directive A-73-045

BACKGROUND

In response to Directive A-73-045, a survey has been conducted of a representative sample of police departments 1.) to determine the number of radio channels being used and their purpose, and 2.) to analyze the factors affecting the number of channels in use.

The data collection and analysis for this was performed by several of our Field Site Representatives under technical direction from the Representative in Indianapolis.

FINDINGS

In response to LEAA Directive A-73-045, a study was made of police radio channel usage in order to assess whether the LEAA-supported portable provides sufficient channel capacity to meet user demands.

The study included examination of current channelization practices nationwide, future plans of selected larger cities, and buying practices and development trends.

As a result of this study the following conclusions and suggestions are made:

1. Larger cities (particularly those with populations 300,000 or greater) appear to constitute the most significant market for portables. However, it appears in general that the LEAA portable will not be competitive in this market with higher-capacity portables now commercially available from four major manufacturers.

2. Portables do not appear to be competitive with mobiles for state law enforcement operations; it does not appear that states should constitute a significant market for portables.

3. The LEAA portable appears to provide adequate capacity for most counties, townships and smaller cities. As an aggregate, the potential of this market appears to be significant.

4. There is considerable doubt that crossband capability for a portable is a significant, widespread need. No commercially available portable now provides crossband capability, and no respondent to the 1972 LEAA communications equipment survey cited the need for such a capability.

5. Effective and efficient utilization of available channel capacity is now limited by the universal reliance on voice-only portable communications and on the dedicated approach to channel allocation and use. However, commercial development interest appears low in voice/data portables and in common-user systems operating in VHF and UHF under priority control.

6. Consideration might be given to development action to increase the channel capacity of the LEAA portable. Such a decision should be based upon convincing evidence that something better or cheaper would be provided than would be commercially available. Commercial sources have indicated that the eight channel portable represents a practical design limit.

7. As an alternative to, or in addition to, increasing the channel capacity of the LEAA portable, consideration might be given to: (1) development action to provide portables with limited data I/O capability, and (2) development of shared-channel systems under priority control which provide for more effective and efficient channel utilization, thereby reducing channel capacity requirements for field radios. These areas appear to be attractive candidates for LEAA support, since commercial development in these areas is lagging.

PROBLEM STATEMENT

The channel handling capacity for the LEAA-supported portable transceiver was specified several years ago. Its capacity is four channels (four frequency pairs). A question has arisen as to whether this capacity is adequate in the light of current and projected user demands.

APPROACH

Three steps were taken to estimate the capacity demand for portable radios:

a review of communications questionnaire responses resulting from the 1972 LEAA Police Equipment Survey,

a review of current channelization practices and future plans of selected larger cities, and

consultation with major manufacturers to ascertain current buying practices and trends.

DISCUSSION

LEAA Police Communications Equipment Survey

Survey results were reviewed in order to get a national picture of current usage and expressed needs for personal portables, and to determine portable channelization and networking characteristics to the extent permitted by the questionnaire responses.

While the survey includes information on mobile and portable frequencies utilized by several hundred departments, examination of the questionnaire responses revealed errors and misinterpretation concerning simplex and two-frequency channelization. For example, 460 MHz frequencies with 5 MHz separation (for send and receive) sometimes were counted as two channels. In other words, the number of channels in an operational sense was overestimated. The survey did not explore how channels are utilized operationally, nor did it query concerning networking schemes to permit portables and mobiles to operate cooperatively. However, it was possible to infer some networking arrangements by examining the specific frequencies employed. Because of the promise of anonymity made to respondents, it was not possible to identify the departments for follow up to correct errors and to identify operational usage of channels. Instead, a separate survey was made of several larger cities to ascertain current practices and future plans.

The 1972 survey results indicate that new equipments, additional channels and personal transceivers for each officer are perceived as critical communications needs by about 44% of 428 respondents. Among the LEAA Regions, departments in Regions 5 and 9 reported the greatest need for portables (55 and 58%), while Regions 8 and 6 reported the smallest need (21 and 35%).

Notwithstanding the finding that the largest cities accounted for 72% of all portables owned by 348 departments, these cities noted a critical need for additional portables (74% of 46 responding), whereas states indicated the lowest need of all department types (21% of 47 responding). Nearly half the largest cities also cited the need for additional frequencies; more channels was the greatest need cited by the states (57%).

Almost full usage of authorized channels (86-95%) was reported for each department type. Only 21% of 310 departments reported using more than one frequency band. Seventy percent of these were low band and high band or low band and UHF combinations. This latter finding is significant in that the LEAA portable was designed to transceive in only high band and UHF combinations. For 247 cities, it was noted that there was a lower average number of channels used with portables (2.9) than with mobiles (3.2). According to the survey, transmitting and receiving frequencies were generally about the same (90% of the cases) except for the largest cities (43%) and cities with 50 or more officers (77%).

Findings concerning average numbers and ranges of high band and UHF channels used with portables are given in Table 1. From this table, it can be concluded that the LEAA portable on the average provides adequate capacity for all department types other than states and the largest cities.

In response to the open-ended question: "What are your most serious problems with communications equipment?", no jurisdiction cited channel capacity limitations for mobile or portable radios, or crossbanding, as problems. (Commercially available radios now provide up to 8 channels for portables and 12 channels for mobiles.) Overcrowding and congestion of channels, however, was the most frequently mentioned problem (20% of respondents).

Review of Current Practices and Future Plans

The demand for additional channels, as reflected in the results of the 1972 survey, can be explained in large measure by the fact that police communications channels are very inefficiently utilized. There are two principal reasons: (1) all police communications systems are dedicated; (2) two-frequency channels are utilized extensively in larger cities with transmit frequencies used to automatically relay all incoming traffic back to subscribers.

Typically, channels are dedicated for one or more of the purposes implied in the listing in Table 2. One result of this practice is to reduce the number of usable channels for a given radio assigned to a particular field unit operating in a particular area. On the other hand, such dedication increases the probability that one or more channels will be saturated during periods of peak demand, which leads to a requirement for additional dedicated channels. Moreover, departments prefer to

Table 1

HIGH BAND VHF AND UHF CHANNELS UTILIZED WITH PORTABLE RADIOS
(1972)

Department Type	Number Responding and Using Portables	Average No. of High Band and UHF Channels Used with Portables	Range of Values High Band	Range of Values UHF
Fifty Largest Cities	46	5.7	1-29	1-14
State	47	4.1	1-14	2-7
County	43	1.8	1-7	1-1
City (50 + officers)	78	2.1	1-5	1-4
City (10-49 officers)	77	1.4	1-4	1-2
City (1-9 officers)	41	1.7	1-4	2-2
Township	16	2.3	1-4	3-3
	348			

Table 2

Types of Channel Dedication

Jurisdiction (e.g., city, county)

Class of Use (e.g., police, fire, ambulance)

Load Distribution (e.g., Sector A, Sector B, city-wide)

Type of Function (e.g., traffic, patrol, investigation, emergency)

Type of Radio (e.g., mobile, portable, satellite receiver)

Operating Mode (e.g., voice, data, secure)

Duplexing

buy multichannel radios equipped to operate in as many modes and locations as possible with additional capacity for growth, in order to simplify radio handling, recharging and maintenance, and to insure a long period of useful service life for cost amortization.

Dedication increases the difficulty of timely coordination among units using different frequencies. The greater the need for coordination, the greater the need for additional channels just to maintain adequate communications continuity. Frequencies are sometimes dedicated specifically for total area broadcasts, or are used unnecessarily to relay communications.

Table 3 lists the types of police networks now in existence. There are two general types; use of the terms simplex and duplex in police systems is not rigorous in an engineering sense, but these terms are commonly used to denote types of operation, as the table indicates.

The alternatives cited in the table are listed in order of efficiency. The most efficient system is patently a single frequency system. However, such a system is uncontrolled and it saturates easily, making it a preferred candidate for only small departments in locations not susceptible to heavy message traffic or to interference from other users. Two frequency systems, wherein dispatchers and field units transmit on different frequencies, provide some control at some expense in efficiency.

All systems commonly used, excepting single frequency and wasteful duplexed systems, do not permit field units to receive each other's transmissions. Two problems arise from this: (1) users block each other's broadcasts because they do not know when their frequency is being used, and (2) broadcasts of general interest, e.g., a fleeing suspect, have to be rebroadcast, thereby increasing the dispatcher's frequency utilization and workload and introducing delays in the response of all field units.

As an alternative to dedicated systems, a recent study has pointed up the potential utility of a shared-channel system with selective addressing, which utilizes a data channel for channel allocation and use under priority control (Reference: MITRE Memo D38-M71-ID). Theoretically, with such a system, a four channel portable with a very limited data I/O capability could provide far more usable channel capacity than an eight channel portable operated in a dedicated network. The rationale and uses for two types of voice/data portables are explored further in MITRE Memo D38-M47-ID.

To sum up this section, dedicated systems are both inefficient and ineffective, but their usage is pervasive. While such systems result in a condition wherein only a small number of channels may be used for a particular purpose at a particular location, other factors mitigate to encourage users in the larger cities to select portables with a larger channel capacity. Given a choice between a four channel and an eight channel portable for a dedicated network, it appears that most larger cities would opt to buy the eight channel portable.

Table 3

Types of Police Networks

I. Single Frequency (Simplex)

any subscriber can seize and use on a first-come, first-served basis to broadcast to any other subscriber within range

II. Two Frequency -

dispatcher and field units transmit to each other on different frequencies:

a. Simplex Design - no field unit can transmit directly to another field unit

b. Simplex-Plus Design - field radios are equipped so that they can be switched to transmit to other field units within range, using the dispatcher's frequency (subject to dispatcher interference and override)

c. Half-duplex Design - every field unit hears every other field unit via base station relay (it is assumed that field-originated data would be relayed selectively)

d. Full-duplex Design - any subscriber can relay

Examples of Current and Planned Channelization

Results of the LEAA 1972 survey and the other studies cited indicate that the focus of concern about the channel handling capacity of the LEAA portable should be the larger city. For counties and smaller cities, a portable with a capacity of 1-4 channels appears generally adequate. While states typically operate with more than four channels, their demand for portables appears limited. Mobiles provide a better alternative since: (1) most of the state operations directly involve the use of a vehicle, (2) mobiles can provide more channel capacity than portables, and (3) mobiles have a much longer effective range.

Examples of operational utilization of frequencies at several large cities are given in Table 4. Examination of these data suggests additional factors bearing on required portable capacity. For example, Los Angeles (not included in the responses to the 1972 survey) is so large that it is decentralized and, in effect, operates as smaller cities. Their current portables are normally equipped to operate with up to four channels. Dallas, either by choice or because of propagation limitations, only uses portables as ancillary communications, whereas South Bend uses portables exclusively (in and out of the patrol car). Thus, South Bend employs three channel portables and Dallas two channel portables, notwithstanding that Dallas patrols over 13 times the area, and patrols over five times the population.

Discussions with Major Manufacturers

Sales and technical representatives of Motorola, RCA and General Electric were contacted to ascertain current buying practices of law enforcement agencies and projected trends.

The channel capacity of the various models of portables now commercially available is two, four, six or eight. An eight channel capacity is regarded to be a practical design limit, and RCA has recently joined General Electric in offering an eight channel model.

While the emphasis in the responses of the manufacturers differed (primarily attributable to differences in participation of each company in the total market), the consensus is that, with a continuation of current system design practices, the LEAA portable is not likely to be competitive in the larger city market (particularly in cities with populations greater than 300,000), but that the portable should provide adequate capacity for most smaller city applications.

None of the manufacturers produce a VHF/UHF portable; the representatives contacted expressed the opinion that there is not a significant need or market for such a capability.

Commercial interest at this time appears low in development of voice/data portables, and in development of common-user systems operating under priority control.

Table 4

Examples of Current and Projected Channel Utilization at Larger Cities

City	Population (1970)	Patrol Area(SqM)	Frequencies/Channels Now Utilized	Portable Channelization	Projected Frequency Plan
Los Angeles	2,816,061	464	High Band Patrol: 5 Xmt(duplexed) 18 receive 1 simplex 3 tactical simplex 1 investigation simplex 2 UHF investig.	same (normally equipped to operate up to four channels. no Division has >4)	UHF plan in process of development
Dallas	844,401	297	12 UHF: 5 sectors 1 traffic 1 data 1 city wide 1 administration 1 criminal investi-tation 1 intelligence 1 special ops.	same (normally buy for two ch. operation)	1-watt portable is range-limited with only 8 satellite receivers - Dallas trying mobile relay
San Francisco	715,674	49	4 Low Band 3 sectors 1 traffic 1 High Band 1 Investig.	6 UHF, 3 city-wide, 3 sectors	Current System Adequate
Indianapolis(city)	490,442	95	2 High Band 2 sectors 1 UHF 1 investigation	same	2 High Band: mobiles and direct da 6 UHF, portables: 3 sectors, 1 dat inquiry, 1 traffic, 1 invest.

Table 4 (cont.)

City	Population	Patrol Area	Frequencies/Channels Now Utilized	Portable Channelization	Projected Frequency Plan
Toledo	383,818	86	6 UHF 2 sectors 1 traffic 1 investi-gation 1 not used	same	Current System Adequate
Newark	381,930	23	2 High Band 2 sectors 2 UHF 1 tactical 1 investig.	same	2 High Band special events 6 UHF 4 sectors 1 city wide 1 data inquiry
Miami	334,859	34	4 UHF 3 sectors (half duplexed) 1 city wide	same	Adding 1 UHF channel for investigation
Fort Wayne	178,021	52	6 UHF 2 sectors 1 traffic 1 administration 1 investigation 1 not used	same (normally buy for four channel operation)	Current System Adequate
South Bend	125,580	22	3 UHF 1 area (shared with Mishawaka) 1 sector 1 traffic & investig.	same (use portables in and out of cars in lieu of mobiles)	Plan to dedicate an additional UHF channel for investigation

CONCLUSIONS

On the basis of the findings of this study, it is concluded that:

1. Larger cities (particularly those with populations 300,000 or greater) appear to constitute the most significant market for portables. However, it appears in general that the LEAA portable will not be competitive in this market with higher-capacity portables now commercially available from four major manufacturers.

2. Portables do not appear to be competitive with mobiles for state law enforcement operations; it does not appear that states should constitute a significant market for portables.

3. The LEAA portable appears to provide adequate capacity for most counties, townships and smaller cities. As an aggregate, the potential of this market appears to be significant.

4. There is considerable doubt that crossband capability for a portable is a significant, widespread need. No commercially available portable now provides crossband capability, and no respondent to the 1972 LEAA communications equipment survey cited the need for such a capability.

5. Effective and efficient utilization of available channel capacity is now limited by the universal reliance on voice-only portable communications and on the dedicated approach to channel allocation and use. However, commercial development interest appears low in voice/data portables and in common-user systems operating in VHF and UHF under priority control.

SUGGESTIONS:

It is suggested that:

1. Consideration might be given to development action to increase the channel capacity of the LEAA portable. Such a decision should be based upon convincing evidence that something better or cheaper would be provided than would be commercially available. Commercial sources have indicated that the eight channel portable represents a practical design limit.

2. As an alternative to, or in addition to, increasing the channel capacity of the LEAA portable, consideration might be given to: (1) development action to provide portables with limited data I/O capability, and (2) development of shared-channel systems under priority control which provide for more effective and efficient channel utilization, thereby reducing channel capacity requirements for field radios. These areas appear to be attractive candidates for LEAA support, since commercial development in these areas is lagging.

Serial No. A-73-045
(Group) (Year) (No.)

LEAA DIRECTIVE

Attachment II
D38-M73-ID
4 January 1974

SUBJECT:

Police Radio channel usage

REFERENCED DOCUMENTS AND ATTACHMENTS:

RECEIVED
OCT [illegible]
[illegible]

ACTION REQUIRED:

1 - Through the Analysis Group Field Site Representative Survey a representative sample of police departments to determine the number of radio frequency channels being used and their purpose. 2) Analyze and present survey data to show the factors affecting the number of channels in use.

SCHEDULE:

Report to LEAA: 11/16/73

FINANCE

BUDGET AUTHORIZED: -0-

CHARGE TO TASK: 816C

SIGNED: George Gallagher
LEAA Project Leader

10/9/73
Date

Ack:
MITRE Project Leader

Date

END