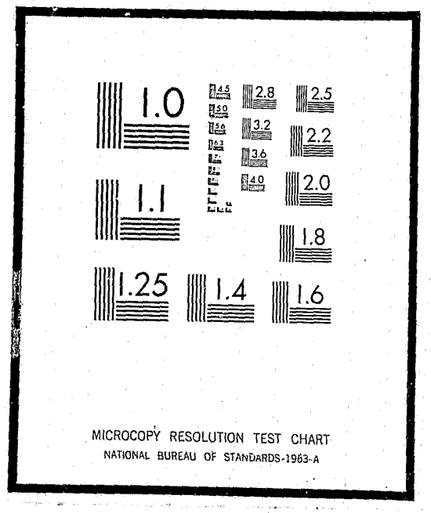

TELECOMMUNICATIONS FOR CONNECTICUT

COMMUNICATIONS CONCEPT FOR THE PUBLIC SAFETY AGENCIES

Extracted from Connecticut State Government Telecommunications Study

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Funded in Part by Connecticut Planning Committee
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1. BACKGROUND

The State of Connecticut contracted with Booz, Allen & Hamilton, Inc. on May 1, 1974 to perform a Statewide study of telecommunications. The study was designed to develop a long-range plan for implementing an effective telecommunications system capable of meeting the requirements anticipated for 1985. Guidance and direction were provided by the Connecticut Communications Coordinating Committee (CCCC), composed of representatives of State and local government agencies which are major telecommunications users.

During the course of the study, the following milestones have been accomplished:

- June 3, 1974 - study was initiated by a working session with the CCCC.
- July 2, 1974 - questionnaires on telecommunications usage were mailed to local law enforcement agencies.
- October 16, 1974 - initial wire communications information was obtained from the Southern New England Telephone Company (SNETCO)
- November 6, 1974 - initial access was provided to State wire communications billing records.
- January 30, 1975 - draft Report 1 was reviewed with the CCCC.
- March 17, 1975 - Report 1, Inventory and Usage of Existing Telecommunications Facilities, was completed.
- May 15, 1975 - Report 2, Projection of Connecticut State Government Telecommunications Requirements to 1985, was completed.

- May 22, 1975 - Report 3, Opportunities for Near-Term Improvements to Connecticut State Government Telecommunications Systems, was completed.

- May 29, 1975 - recommendations for 1985 telecommunications systems were presented to the CCCC.

- June 25, 1975 - draft Report 4 was reviewed with the CCCC.

2. OBJECTIVES

The principal objectives of the study were to:

- Determine present telecommunications needs and capabilities and define future telecommunications requirements for State government and interrelated systems.

- Identify near-term improvements.

- Define alternative telecommunications systems and recommend a system concept to meet future requirements.

- Recommend the steps required to effect an orderly transition from the present to the recommended system, including provisions for financing.

3. APPROACH

The overall approach to the study has followed these basic steps:

- Identify present capabilities and deficiencies in relation to current operational requirements for telecommunications.

- Determine functional capabilities needed.

- Project operational requirements for 1985.

- Identify alternative ways of meeting these requirements.

- Determine the effectiveness and cost of each alternative.

- Select the preferred alternative in terms of both effectiveness and cost.

Part of the study efforts included collecting data from CCCC members and other sources to establish the inventory of present capabilities and to form a base for future projections. Additional information sources included:

- Published material including reports, plans, maps, charts, and tables.

- Personal interviews - over 100 interviews were conducted with State and local government officials.

- Questionnaires - 89 police departments were sent questionnaires.

- Manuals, computer printouts, and other material - SNETCO supplied facility and billing information for State accounts.

- Comptroller's Office - the Communications Section furnished procedural and telephone billing information primarily for agencies in the Executive Branch.

Projections of future requirements for both wire and radio were based on an analysis which involved:

- Population - geographical distribution, migration, and discernible trends

- State agency employment - historical trends, growth rates peculiar to certain agencies, office decentralization

- Functional changes - possible changes in functions and responsibilities of State agencies

- Technological changes - possible impact of technological advances in telecommunications.

In identifying opportunities for near-term improvement in performance and/or cost, the collected data was analyzed and the following identified:

- Deficiencies - shortcoming in present capability, particularly in areas relating to public safety
- Controllable factors - those areas under control of using agency, e.g., antenna height/location versus significant change in operating frequency
- Achievable scope - areas of possible improvement where results could be achieved in a relatively short period.

Applying the constraints that present operations should not be disrupted, that changes should not be attempted which might conflict with recommendations for long-term application, and that existing State plans be observed, recommendations were proposed for specific telecommunications areas.

To define the region/zone system concept for Connecticut involved a review of current capabilities, deficiencies, and projected requirements; definition of feasible alternatives for each subsystem (wire and radio); and evaluation to determine the most promising alternative for development through 1985. Alternatives were developed based on the technology available in the next 10 years. Those meeting minimum effectiveness criteria were costed and compared. Advantages and disadvantages were identified for each, and the preferred alternatives were identified.

4. FINDINGS

The most important finding of the study for public safety agencies was the suggested application of the region/zone communications concept to Connecticut and the impacts this concept can have on existing and future systems. Implementation of this concept requires that Connecticut begin today to ensure that it can meet 1985 demands. Several courses of action need to be explored in detail, with the final result being to enhance communications in the State of Connecticut. System changes and improvements are needed; these will be effected in accordance with a plan that considers overall State communications needs.

Since the complete report covers five volumes, it is not practical to reproduce and distribute it to all potentially interested parties. A few sections that both describe the recommended system concept and are most relevant to individual agencies' needs have been attached: (1) Public Safety Communications (III-31 to 67); (2) Appendix H (H-1 to 3); (3) Appendix I (I-1 to 13); (4) Factors Affecting Future Requirements for Local Government (III-25 to 28); and (5) Future Radio Communications Requirements for Local Government (V-41 to 73). These sections detail the recommended region/zone concept. This concept represents a first total look at Connecticut communications requirements and is not necessarily the final arrangement that will be followed. Additional effort is needed to refine this concept and to properly reflect the requirements of the individual agencies. The system concept requires planning to establish the proper time sequencing for making improvements and to detail the exact changes that are needed.

The attached material has been reproduced directly from the study report. It should not be considered as a final decision, but only as a starting point for making system improvements. Zones and regions defined by this report are flexible and will not necessarily be applicable throughout the State. These considerations must be reviewed further by the individual agencies who have the potential to offer other operational approaches.

2. PUBLIC SAFETY COMMUNICATIONS

Public safety services generally include:

- Police protection
- Firefighting
- Emergency medical and rescue capabilities.

In the past, these areas have been treated separately for communications planning and operation. In many cases, this has resulted in duplication of effort and suboptimum system design.

Review of Connecticut's public safety communications requirements for local law enforcement, fire service, and EMS indicated that these requirements could be more effectively analyzed and responsive systems planned on an integrated, rather than individual, basis. A total public safety systems approach offers the benefits of coordination among departments as an integral component of the system design. It takes advantage of the full benefits of emergency public access systems (such as 911 and special emergency numbers), and contributes to increased operational efficiency and possible economic savings.

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This approach required that the study team review the general communications requirements for the three functional components, aggregate these on a statewide basis, develop a conceptual system framework that would fulfill the requirements, and prepare recommendations for local areas based upon this framework. In the remaining subsections, the results of this approach for improving Connecticut's public safety communications are discussed. A review of the common aspects of the operational communications requirements for public safety agencies is presented, followed by a discussion of the local nature of these requirements and the generalized Public Safety Communications System (PSCS) concept developed for a regional communications district. This section ends with a presentation of the recommended communications districts proposed for Connecticut and a summary of the recommendations. The PSCS design approach and an indication of the results achievable when the concept is applied to a sample communications district can be found in Appendix I.

(1) System Design Considerations

Radio communications system requirements for any agency are based on its operational objectives. For public safety agencies, the objectives generally include reducing the time interval between incident and service reaction or improving the efficiency of the service. For law enforcement, the two primary objectives are to enable an officer to respond to an incident while it is still in progress, and to provide him with the information he may need in confronting any situation. Fire service communications objectives are to reduce the time between the discovery of a fire and the arrival of fire apparatus at the scene, and to provide the coordination required to manage firefighting resources. For EMS, the primary objective of the communications system is to minimize the time between incident and the rendering of qualified medical service.

Communications systems serving public safety agencies have the following common functional features:

- Public access. Capability of citizen to reach a public service agency. This ranges from call boxes for fire reporting and highway assistance to the more prevalent telephone access.

- Dispatch. The process of mobilizing the appropriate resource as a result of a call. For law enforcement services, this communications link generally is provided by a radio channel between a dispatcher and a roving mobile. For EMS and fire, the methods range from telephone calls for ambulance drivers to direct radio dispatch of the fire apparatus.

- Service. For law enforcement, the service requirements are for separate tactical or surveillance channels, or for information channels accessing criminal justice data bases. For fire, the service requirement is for a working channel used at a fire scene so as not to overload the dispatch channel. For EMS, the service requirement is related to the communications between an ambulance and hospital concerning the diagnosis and medical care of victims or patients, and includes the use of radio telemetry.

- Coordination. Information exchanges that are not directly related to the provision of the normal service. For law enforcement and fire, a coordination requirement may involve a common regional frequency on which all departments have capability. EMS coordination involves hospital communications links with the other public safety agencies and other hospitals.

Public safety communications within Connecticut currently has the problems of spectrum congestion (causing crowded channels, frequency shortages, and interference) and insufficient coordination among nearby public safety agencies. The severity of these problems varies with the agencies and towns involved.

Of the 77 law enforcement agencies responding to the questionnaire survey, 51 (66 percent) reported interference on police frequencies. In addition, communications for these departments utilize 109 separate frequencies, an average of 1.4 frequencies per department, or approximately ten frequencies for every seven departments. This is unsatisfactory. Communications coordination with nearby public safety agencies is also unsatisfactory. Approximately half of the responding departments indicated the need for additional communications coordination. Sixty-three percent report coordination with surrounding local police departments; however, it is doubtful that total coordination (all surrounding departments) is achieved. Of the responding agencies, only seven percent reported hospital coordination capability, and 28 percent ambulance service coordination capability. Fewer than half of the local police departments have radio coordination capability with local fire departments.

The situation in the fire services is less severe as a result of the use of county and Statewide mutual aid channels and central dispatch centers. In many cases, mutual aid frequencies are used for dispatching, and coordination channels are not available through the State. Currently, 61

fire service frequencies are shared by over 300 departments; distribution of these frequencies is not uniform.

It is evident then, that to continue in the present course (i.e., fragmented growth on an "as needed" and "as available" basis) will cause even more congestion and interference. Therefore, a new concept is needed to provide for coordinated growth and more efficient operations Statewide.

For each functional area of public safety communications, a number of alternative concepts are available. These are presented in Exhibit III-7 and discussed in the following text.

Public access has traditionally been accomplished by telephone or call box using different numbers to access different agencies. Confusion during emergencies can cause costly time delays in service. Several alternatives are available to alleviate this confusion. One is use of a single, seven-digit number to reach all public service agencies in an area. Another concept, being implemented nationwide, and currently serving more than 22 percent of Connecticut's population, is use of the single emergency number "911." This number can be used to provide access to any or all of the public safety services in a given area. Many states have passed legislation making 911 implementation mandatory with a given time frame.

In analyzing dispatch alternatives, a tradeoff must be made between control over the dispatching operation and spectrum efficiency. The latter has become increasingly important as the use of land-mobile radio has grown, and interference levels have increased. With proper arrangements, channel sharing and other cooperative arrangements provide service benefits (especially spectrum efficiency and coordination) which more than overcome potential shortcomings.

Coordination between nearby agencies and between public safety services is a key to providing fast and efficient service. Coordination links should include as many participants as possible within the limits of normal and potential high-priority needs. Various approaches can be considered for providing the necessary coordination including the use of common communications channels, operation on the other service's frequencies, and the use of cross-band monitor receivers or repeaters.

In the following subsection, a system design approach which reflects these system considerations and which will lead to a coordinated, improved PSCS in Connecticut is presented.

EXHIBIT III-7
Alternative Concepts for Functions
of Public Safety Communications

Functional Area	Alternative	Advantages	Disadvantages
Public access	Separate fire, police, EMS numbers	Easy to implement, low cost	Difficult to remember
	Shared emergency number	Citizen need remember one number only, easy to implement	May be forgotten under stress
	911	Easy to remember in emergency	Implementation difficulties
	Call boxes	Direct line to service agency	Not universally available Subject to vandalism
Dispatch	Individual channels, separate dispatch centers	Local control	Interagency coordination hampered, interference, inefficient spectrum
	Shared channels, separate dispatch centers	Local control, improved regional coordination, improved spectrum efficiency	usage by adjacent agencies may cause interference
	Shared channels, cooperative dispatch center	Improved coordination, facilitates use of single emergency number of 911. Superior spectrum efficiency	Divided control requires cooperative agreements
Service	Individual agency service frequencies	Privacy, local control	Inefficient spectrum usage, hampers coordination
	Shared channel with adjacent agencies	Improved coordination, more efficient use of spectrum	Lack of privacy or local control
Coordination	Individual coordination channels or lines between agencies	Can be implemented piecemeal as needs and budget permit	Inefficient, hard to manage, expensive to implement
	Regional coordination channels	Efficient use of spectrum, common ability among agencies	Requires an agreed upon plan or concept

(2) Integrated Planning and Cooperative Dispatching

In view of the common functional features of public safety services, the common problems encountered, and the alternatives available in each area, it is clear that system planning for local law enforcement, fire, and EMS should be undertaken on an integrated, cooperative (rather than an individual) basis. Integrated planning should take maximum advantage of the benefits provided by 911 and cooperative dispatching operations.

Cooperative dispatching can encompass anything from informal mutual aid agreements to full integration of services on a regional basis. An approach is recommended whereby frequencies are apportioned according to regional concepts and cooperative dispatch centers are established to serve a number of public safety agencies within a region.

Although the term "central dispatching" is often used to describe a multi-agency dispatch facility, "cooperative dispatching" will be used throughout this report to emphasize that individual agency autonomy need not be compromised, and agencies cooperate to serve a common communications (and only communications) need in a more efficient manner.

Cooperative dispatching is defined as a single dispatching facility serving all agencies. A cooperative dispatch facility may use a number of radio channels for different purposes. An interim alternative is the use of shared base station equipment, with each agency operating a control unit and dispatching its own units via a common base station. Some of the operational and technical benefits which will be derived from the use of cooperative dispatching are discussed in the following text, along with the problems that can be encountered in establishing such a facility. Adoption of the recommendations for public safety communications can:

- Permit use of a single emergency number
- Aid rapid response to service calls
- Promote efficient use of frequency channels
- Facilitate implementation of advanced technology
- Improve coordination among nearby agencies
- Facilitate establishment of central automated records
- Result in overall cost savings.

Each potential benefit is discussed in the following text.

The establishment of a single emergency number (either 911 or a seven-digit number) over a wide geographic area facilitates citizen access to emergency assistance. Studies have demonstrated the significant reduction in response time using either 911 or some other single emergency number. It is recommended that Connecticut require all communities to have 911 capability by 1985. An immediate objective should at least be the use of separate lines for routine administrative public safety functions and emergency service.

A cooperative dispatching facility will provide improved response time for several reasons, including access to a larger qualified professional staff. The degree of professionalism and capability is generally greater than could be afforded by any single member agency; this staff, by controlling the entire resources in the area, can more efficiently meet the demands for service. If a particular jurisdiction at any given time has an excessive number of calls, the dispatcher can readily and rapidly dispatch units from adjacent jurisdictions or areas according to interagency agreements.

The increasing congestion of the frequency spectrum has necessitated frequency sharing. The guidelines for police networks are that 25-35 vehicles should be assigned to a given channel. Therefore, frequency sharing will be required. The most efficient mode of operation, given the necessity for channel sharing, is cooperative dispatching. Independent dispatching can result in lack of channel discipline wherein the dispatchers are constantly competing for air time. Cooperative dispatching resolves this problem since the channel is controlled by a single dispatcher.

Pooling available resources allows the use of more technically sophisticated and advanced systems which will improve the efficiency of operations. Multichannel equipment with tone-coded squelch is desirable to achieve flexibility. In addition, a cooperative dispatching facility should also consider the use of computer-aided dispatching, direct digital access to computer files (such as COLLECT) from the vehicle, automatic vehicle monitoring, and so forth. Such techniques have significant operational advantages, but can rarely be afforded by individual agencies.

Since cooperative dispatching provides control of all forces over a large geographic area, coordination in times of special emergencies, as well as during routine operations, is greatly facilitated. This does not, however, completely fulfill the intergency coordination requirements and,

depending upon the local conditions, special coordination channels or cross-band capabilities will still be needed.

Consolidating communications services greatly facilitates the establishment of uniform reporting systems and automation of record keeping, thereby relieving member agencies of manual clerical work and providing improved operational data banks at the local level and for input to the Uniform Crime Report.

Cost savings are often possible in a cooperative dispatching arrangement as a result of sharing of equipment, space, and personnel. The cost of providing communications services varies from agency to agency and, therefore, it is incorrect to assume that cooperative dispatching will always save money. However, it is believed that cooperative dispatching provides the most efficient professional operation at the minimum cost.

Many local considerations must be addressed in any decision to consolidate dispatching services; a variety of approaches may be considered. A difficulty encountered is that placing control in a single agency has the inherent risk that the dispatcher will give highest priority to his own agency's requirements, thereby providing less than desirable service to the other participating agencies. It is possible to reduce this risk, however, by proper contractual agreements among the involved municipalities prior to implementation.

A successful approach in many areas of the country has been the establishment of an independent communications agency. In this case, all member agencies would have representation in the organization and control the policies and operation of the dispatching center. A formal agreement is generally used for this purpose which defines the services to be performed, procedures to be used, management responsibilities, distribution of operating costs, personnel qualifications, as well as providing a legal basis for the establishment of the center.

There are many arguments against the establishment of cooperative dispatching arrangements. Such opposition should be carefully examined to establish its validity before any decisions are reached. Local requirements vary considerably depending upon factors such as geography, population density, and types of communities involved. Because of these differences, cooperative dispatching may not be appropriate universally, and therefore all agencies

must carefully consider the alternatives before making a final decision. Opposition to cooperative dispatching includes:

- Loss of autonomy
- Geographic restrictions
- Lack of trained dispatchers
- Different operating procedures
- Increased cost.

Each of these is discussed in the following text.

Local public safety agencies are concerned with maintaining the character of services they presently provide. They must be primarily motivated by their responsibilities to the citizens in their jurisdiction. Many agencies fear a loss of autonomy as a result of cooperative dispatching. It must be remembered, however, that cooperative dispatching involves coordination of communications services only. Each member agency would retain its autonomy and independent structure. Further, even with cooperative dispatching, all agencies would be provided access to the radio system allowing the personnel of any agency to access the radio system in event of emergency.

In some cases, cooperative dispatching may be inappropriate because of geographic characteristics. This is particularly true in large rural areas with natural obstacles (such as lakes and rivers) separating agencies. Such arguments, therefore, may well be valid reasons for not using cooperative dispatching.

Officials often express the fear that in a cooperative dispatching system, the dispatcher will be unfamiliar with his jurisdiction. Such fears, however, are usually unfounded. The dispatcher can be trained not only in dispatching procedures, but also in the detailed geographic area for which he is responsible.

Many agencies are hesitant to join a cooperative system because their operating procedures differ from those of the neighboring agencies. This is often valid, and constitutes an area for improvement in that uniform operating procedures are more desirable from an overall operating viewpoint. Cooperative dispatching ensures establishment of uniform operating procedures for all agencies within the area, thereby minimizing problems and confusion when larger-than-ordinary forces must be coordinated in extreme emergencies or public safety disasters.

In small villages or towns, a dispatcher often has many additional responsibilities including dispatching for other public safety services, prisoner booking, clerical, walk-in interviews, etc. In such a case, a cooperative dispatching arrangement for one service only (such as police) would not reduce the manpower requirements of the agency. The agency, therefore, would be faced with additional costs. In the case of local law enforcement, many police departments operate 24 hours per day. Therefore, a person must be on duty at all times even though service calls are handled by a central dispatching facility. Cooperative dispatching would involve additional expenditures for such a department. However, it is believed that the additional expense is justified in view of improved response time, improved safety of responding personnel, as well as the other advantages mentioned previously. Integration of not only police, but fire and ambulance communications services as well, should be the ultimate goal except in unusual situations.

This discussion has attempted to emphasize both the advantages and problems of establishing a cooperative dispatch system. While there are problems, the advantages to be gained are sufficient to recommend that cooperative dispatching for public safety services be implemented wherever possible. If, in conjunction with the previously mentioned recommendation for implementation of 911 access, and general upgrading of equipment capabilities (multi-channel operation, tone-coded squelch, etc.), the State adopts a policy encouraging the growth of cooperative dispatching organizations, public safety communications can be responsive to the 1985 requirements.

In consonance with these recommendations, individual concepts for the three major public safety communications systems have been developed which enable full advantage to be taken of cooperative dispatch. The following text presents these recommended concepts. The concepts center around communications districts within which coordinated cooperative networks and mobile radio zones (subdivisions or districts) form the basic elements of a cooperative dispatch system.

(3) Generalized Public Safety Communications System Design

Public safety operations are intrinsically local in nature. For this reason, it is impractical to design a single Statewide system that would have the same features for dissimilar demographic or geographic areas. Utilizing the concept of a communications district, a state may be

divided into areas within which local public safety operations share common characteristics; thus, communications planning can be responsive to local needs. This subsection presents a generalized public safety communications system design for such a communications district which provides a framework for local areas to meet their requirements while remaining responsive to State-level system considerations.

Within a communications district, radio networks should be designed to meet the communications needs of all local public safety agencies. One network may suffice for an entire district, or service requirements may dictate a number of networks in subregions (or zones) within a district. The following paragraphs describe system concepts for each of the three public safety services within a communications district. It should be noted that these concepts all depend to some extent on the cooperative sharing of individual radio channels by multiple users. This is necessary as a result of the severe limitation on available frequencies, which prevents agencies from having dedicated channels; it also provides for efficient spectrum use.

1. Local Law Enforcement Subsystem

Local law enforcement operations require several types of communications. The National Committee on Law Enforcement Standards and Goals recommends that, as a minimum, three channels be established within a zone:

- P_1 - zone dispatch (base and mobile)
- P_2 - zone tactical (mobile only)
- P_3 - district coordination (base and mobile).

For network hierarchy coordination between districts and within a state, the following frequencies are used:

- P_4 - district special-purpose (mobile-only)
- P_5 - statewide coordination (base and mobile)
- P_6 - statewide coordination (point-to-point.

The dispatch channel (P_1) would be used by all agencies within a zone and would serve from 20 to 30 mobile units.* It may be used by individual agencies

* This number is a result of a queueing analysis to limit to under 5 seconds the expected waiting time for a clear channel.

or as part of a shared base station or cooperative dispatch arrangement. It should be a two-frequency simplex or preferably a mobile relay channel to prevent interference to a mobile unit transmission by another base station. This also allows a greater degree of channel reuse by allowing co-channel zones to be spaced more closely than if single-frequency simplex operations were used.

For each dispatch zone there should also be a zone tactical channel, P_2. This would be a single-frequency simplex channel (or possibly a two-frequency mobile relay channel in UHF systems), which would be used for mobile-to-mobile communications to preclude tying up P_1 during extended local operations.

At the district level, a simplex coordination channel, P_3, should be provided to allow communications between mobile units and dispatch centers of adjacent zones. A district may contain several zones.

Another channel that should be available for local law enforcement communications is a district-wide special-purpose channel (P_4) for functions such as surveillance. It should be configured as a mobile-only channel.

Normally, one vehicle would use either P_2, the zone tactical channel, or P_4, but not both.

The selection of an approach for statewide coordination affects many agencies in a state and, therefore, involves compromises. The first and simplest approach to providing this capability would be to operate all local law enforcement communications on a single frequency band and establish a Statewide coordination channel. A second approach involves adding a second radio in every police vehicle. Such an approach (ISPERN) has been used successfully in Illinois. The advantage of this approach is that it is simply an overlay on the existing system and requires no modification. It has the disadvantage, however, of requiring a large investment and additional equipment in all vehicles. A third approach for providing coordination capability is through the use of cross-band repeaters. A cross-band repeater enables car-to-car communications for agencies operating on different frequency bands. Coordination channels in each frequency band would be required to provide a completely coordinated system.

Cross banding is an effective and economical approach to interagency coordination but has the disadvantage of requiring dispatcher intervention to properly control the repeaters. Still another approach for coordination is through the use of monitor receivers in both base stations and vehicles. It is recommended that a VHF high-band base and mobile channel, P_5, (one frequency) be adopted for Statewide coordination, resorting to cross-band repeaters with local coordination channels in areas not in high band. A second high-band channel, P_6, (one frequency) is recommended for point-to-point coordination.

This communications concept is illustrated in Exhibit III-8. It ensures coordinated communications both within each radio district and statewide, a capability that in many cases presently does not exist. In addition, it promotes efficient use of the frequency spectrum by equalizing the number of mobile units operating in each dispatching zone.

Frequency usage by local law enforcement agencies varies widely through the State. A large number of departments currently operate on VHF low band, with fewer on VHF high band and UHF. The use of UHF systems in urban areas is a growing trend in local law enforcement communications and is in evidence in Connecticut in the Regional Access Frequency System (RAFS) in the Hartford area, and the use of UHF by the New Haven Police Department. Such systems recognize the need to tailor radio coverage to the area to be served, avoiding "spillover" and promoting efficient use of the spectrum.

It is for these reasons that a band usage policy is desirable. Such a policy serves as a guideline for communications system planning and spectrum management by outlining which frequency bands should be used by various types of systems. A recommended band use plan for local law enforcement is:

- VHF low band - networks requiring wide area coverage (rural/regional systems)
- VHF high band - intermediate size networks (suburban areas)
- UHF - urban areas or small regional networks.

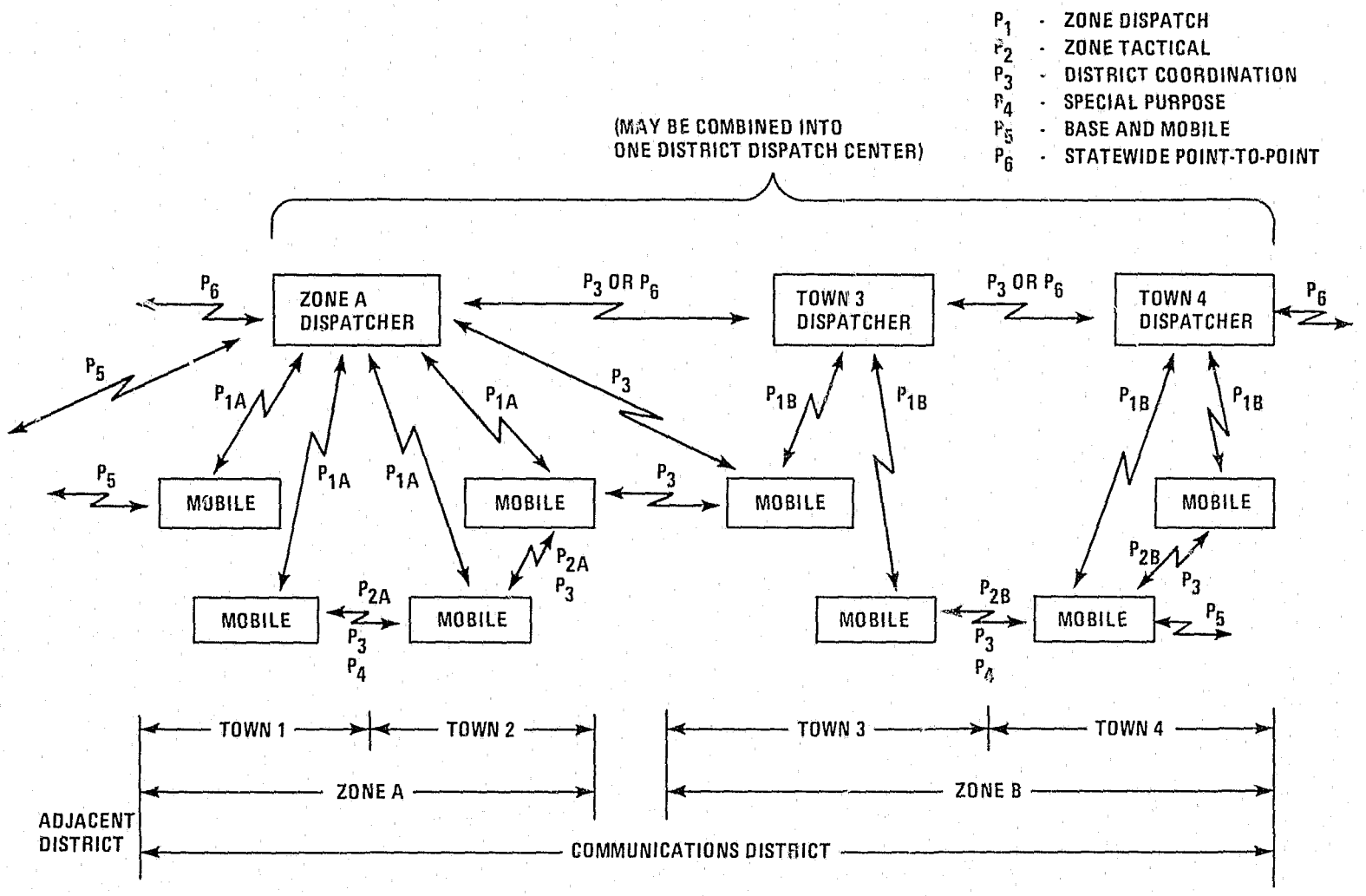


EXHIBIT III-8
Local Law Enforcement Concept

In addition, 900-MHz systems could be used in the same applications as UHF. This band is not formally addressed in the recommended usage plan since equipment is currently unavailable and certain regulatory questions must be resolved. It should, however, be considered for urban usage in the long term.

The growing number of mobile citizens band users constitutes a potential source of emergency reporting by the public. Monitoring CB channel 9 traffic, either at dispatch centers or in patrol vehicles, could provide an important input. Direct communications with the public, truckers, etc., on CB frequencies must be conducted in accordance with FCC rules.

It is recognized that for the most part, current operations are not in conformance with either the district and zone communications concept or the band usage plan outlined above. Before a Statewide concept can be implemented, a detailed frequency plan must be developed which considers not only the conceptual design and band usage guidelines, but current frequency usage (both in Connecticut and in adjacent states) and total equipment investment. As part of such a frequency plan, a time-phased transitional schedule must be determined which will enable an orderly and cost-effective allocation of frequencies.

Certain general equipment recommendations pertaining to local law enforcement systems should also be incorporated into any district's plan for communications reconfiguration, as they are intrinsic components of the recommended concept. These include the use of multichannel equipment, tone-coded squelch for interference reduction and portable units for use by officers away from their vehicle.

2. Fire Service Subsystem

Fire service radio communications requirements are similar to those of local law enforcement agencies. Each communications district should contain at least three district channels and two statewide channels:

- F_1 - district (or zone) dispatch
- F_2 - district (or zone) fire working

- F_3 - district coordination
- F_4 - statewide mobile-to-mobile coordination
- F_5 - statewide coordination (point-to-point and base-to-mobile).

A single dispatch channel should be sufficient for each district since, unlike law enforcement, there is no patrol function, and units only use the channel en route to the scene of the fire. The selection of either single- or two-frequency simplex channel mode must be evaluated for every district in light of potential base station interference with mobile transmissions. If traffic volume is such that more than one dispatch channel is required in a district, they should be assigned to subdistricts (or zones) similar to the case for local law enforcement. At least one simplex fire working channel, F_2, should be associated with each dispatch channel. This would be used at the scene of the fire to coordinate firefighting efforts, and at the same time would ensure that the dispatch channel remains free for its intended purpose. F_3, a regional simplex coordination channel for use by mobile units and base stations, allows all fire units in a district to communicate, and can also be used as a fire working channel between units from different zones.

Statewide, two simplex channels should be provided for mobile-to-mobile coordination (including large fires where units from different districts might respond) (F_4) and for point-to-point operation between dispatch centers and base-to-mobile operation (F_5). The latter channel would provide Statewide coordination. Exhibit III-9 illustrates this concept.

Current fire service radio systems operate almost exclusively in the VHF low band, with the exception of some high-band networks in the Stamford, Bridgeport, and Hartford areas. A structure similar to the concept outlined above presently exists within Connecticut and is centered around county and State coordination frequencies. Based on this existing situation, low-band frequencies appear desirable for the Statewide coordination channels and for many of the proposed district dispatching and working channels, particularly in the more rural areas. High-band frequencies should be utilized in the cities and smaller districts where the extended range of low band is not required. Although coordination benefits can be derived through Statewide

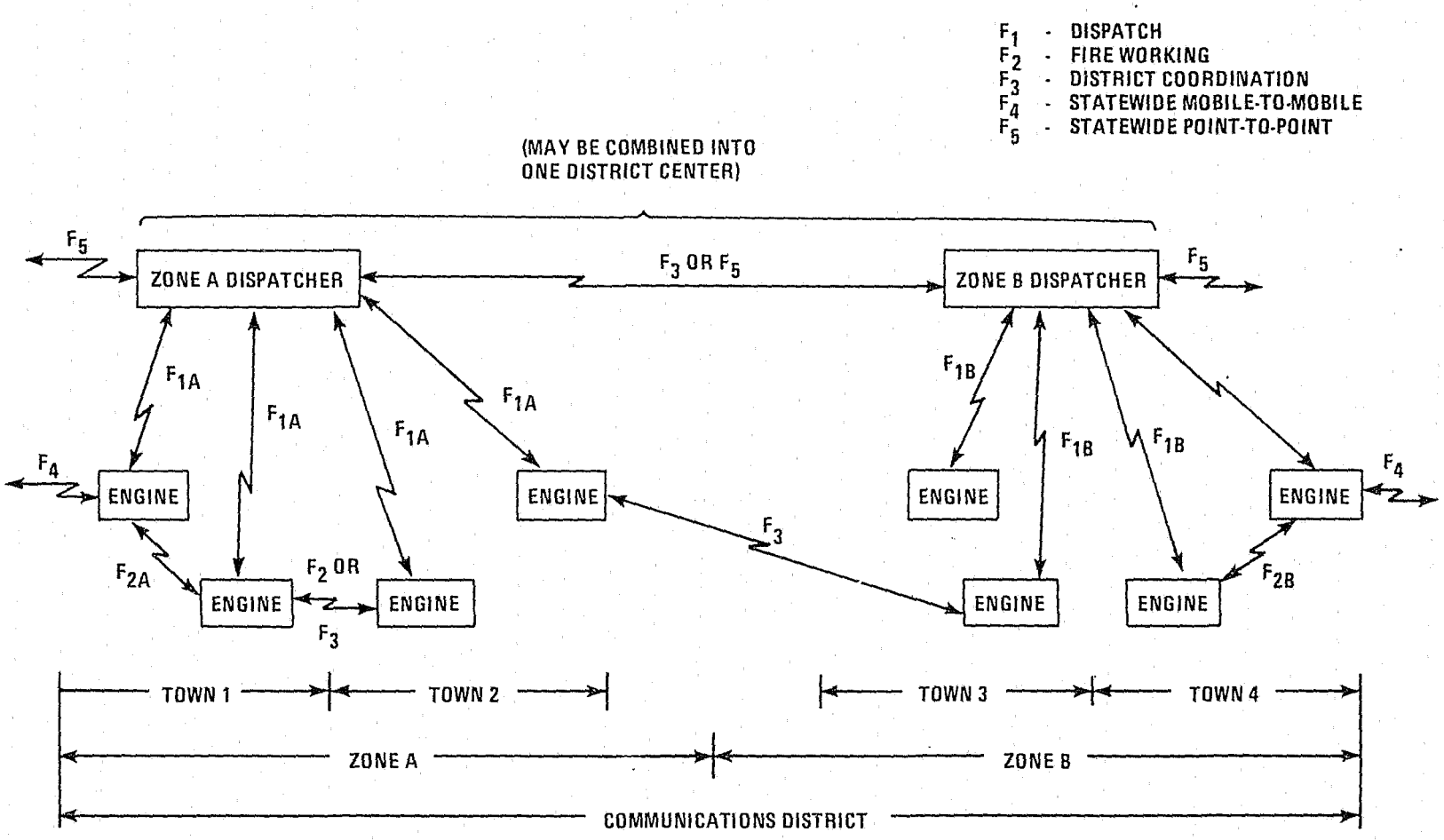


EXHIBIT III-9
Fire Concept

operation on a single band, low-band frequency resources are already heavily taxed and new growth will need to occur in the high band. The coordination channels, however, should remain in the low band with new systems to retain any present low-band equipment for interface capability.

3. Emergency Medical Services Subsystem

Emergency medical service operations require communications among dispatch centers, ambulances, and hospitals, as well as coordination links with public safety agencies. Requirements fall into roughly three categories:

- Operational dispatch
- Medical service
- Coordination.

The operational dispatch requirement encompasses a base-to-mobile channel (D) for alerting ambulance vehicles and directing them to the scene. In addition, it can be used to alert the appropriate hospital that a call is to be expected from an ambulance (selective calling would be advantageous here). There should be at least one dispatch channel in each district, however, smaller districts may desire to share a channel based on dispatch needs.

The medical service requirement encompasses links between ambulances and hospitals for communications regarding patient diagnosis and treatment. This could include telemetry data and related voice communications. Each district should have at least two medical service channels (M_1 and M_2; possibly shared with adjacent districts) so that traffic on one frequency would not preclude serving a second emergency case.

Coordination links must be provided between all fixed components of the EMS system to provide mutual assistance and to coordinate resources. Since this channel will not be used in vehicles, it need not be in UHF band if a frequency in another band is more appropriate, such as 155.340 MHz (which has been authorized by the FCC for this use). In addition, there should be coordination links with police and fire agencies in the area. Depending on the degree of consolidation by cooperative dispatch facilities, this may be accomplished through the use of either a common facility or radio channels designated for this purpose (such as

the district coordination channels for police and fire, P_3 and F_3). Exhibit III-10 illustrates the EMS communications concept.

The selection of frequencies for these channels is determined primarily by the FCC Rules and Regulations, Part 89. A complete set of eight, two-frequency channels in the UHF band is available for medical service use (including biomedical telemetry) and coordination. In addition, two UHF pairs have been set aside for dispatch purposes. Many existing systems currently use VHF high-band frequencies for medical communications as described above. However, biomedical telemetry is not authorized on these frequencies and the UHF channels should be used if this is a desired capability. Existing high-band channels can be retained for coordination purposes, especially for hospital-to-hospital links, and can also serve as the dispatch link (D) if the frequencies are not already too congested.

4. Integrated Public Safety System

The system concepts developed above are all designed for maximum operational flexibility and efficiency of spectrum utilization. They are functionally compatible and are designed to be implemented within individual communications districts and zones. A cooperative dispatch facility for all services within a district or zone is an objective. However, individual operations or an intermediate approach using shared base station equipment can also be easily accommodated and mixed within a district. Exhibit III-11 illustrates how the cooperative dispatch concept would be applied to integrated multi-service communications

A recap of the communications system concepts for the three public safety services is included in Exhibit III-12. It summarizes the integrated approach recommended for providing local public safety communications in Connecticut.

(4) Communications Districts

The preparation of a well conceived statewide communications system design requires consideration of the unique geographic and demographic characteristics of different local areas, while still remaining responsive to State-identified system requirements. This can be accomplished by dividing the State into local areas for design purposes. In the past, each

EXHIBIT III-10
EMS Concept

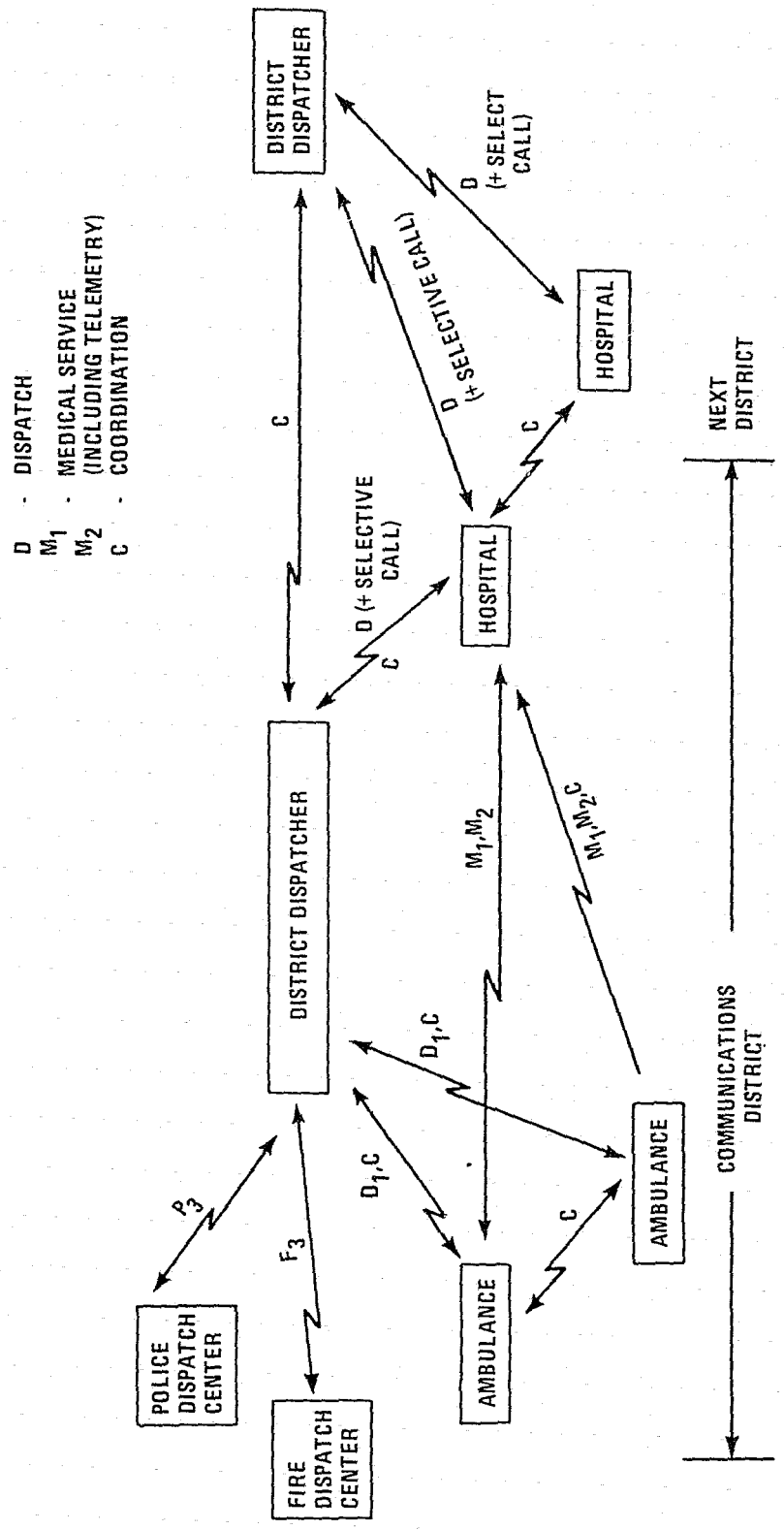


EXHIBIT III-11
Cooperative Dispatching Concept

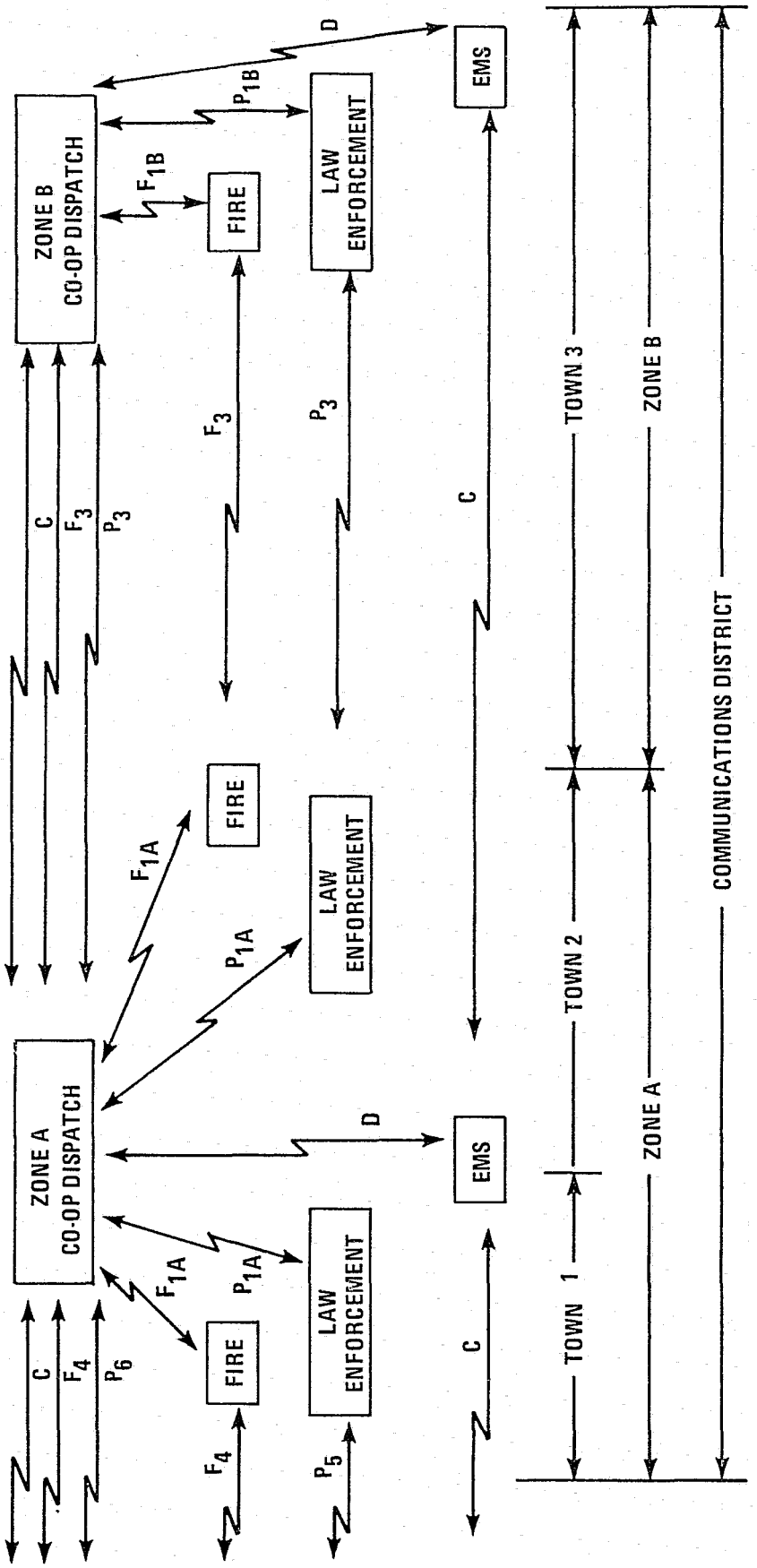


EXHIBIT III-12
Integrated Communications System
Concept Recap

Police	P_1	-	Zone dispatch
	P_2	-	Zone tactical
	P_3	-	District coordination
	P_4	-	District special purpose
	P_5	-	Statewide mobile-to-mobile
	P_6	-	Statewide point-to-point
Fire	F_1	-	District (or zone) dispatch
	F_2	-	District (or zone) fire ground
	F_3	-	District coordination
	F_4	-	Statewide mobile-to-mobile
	F_5	-	Statewide coordination (point-to-point and base-to-mobile)
EMS	D	-	District (or zone) dispatch
	M_1 M_2	-	District (or zone) medical service and telemetry
	C	-	District (or zone) coordination

agency or public safety service used different boundaries for their service areas. An integrated system design, however, requires a common set of districts for all local services which can be treated as building blocks in a statewide system design effort. This requirement was satisfied by establishing 11 communications districts within Connecticut.

A communications district is a group of towns within which public safety communications can operate in a coordinated and cooperative manner, and reflects the operational requirements of police, fire, and EMS described in the previous subsection. For the purpose of this study, Connecticut has been partitioned into 11 proposed districts shown in Exhibit III-13.

In developing these districts, a large number of interrelated factors were considered. It was believed that each district should:

- Accommodate current EMS planning regions
- Encompass existing mutual aid and cooperative dispatch operations
- Include current 911 service areas
- Accommodate State Police service areas
- Recognize population patterns and transportation corridors
- Consider geographic restrictions to providing service (lakes, mountains, rivers, etc.)
- Consider radio coverage capabilities
- Recognize town boundaries.

In the districts developed for Connecticut, these objectives were satisfied to the maximum extent possible. Adjustments to current regional boundaries used for public safety services were made only where necessary and where the impact on current operations would be minimal. Exhibit III-14 shows the current areas for cooperative fire services, EMS planning, 911 service, and State Police troops, and illustrates how these areas are accommodated in the 11 proposed communications districts.

EXHIBIT III-13
Proposed Communications Districts

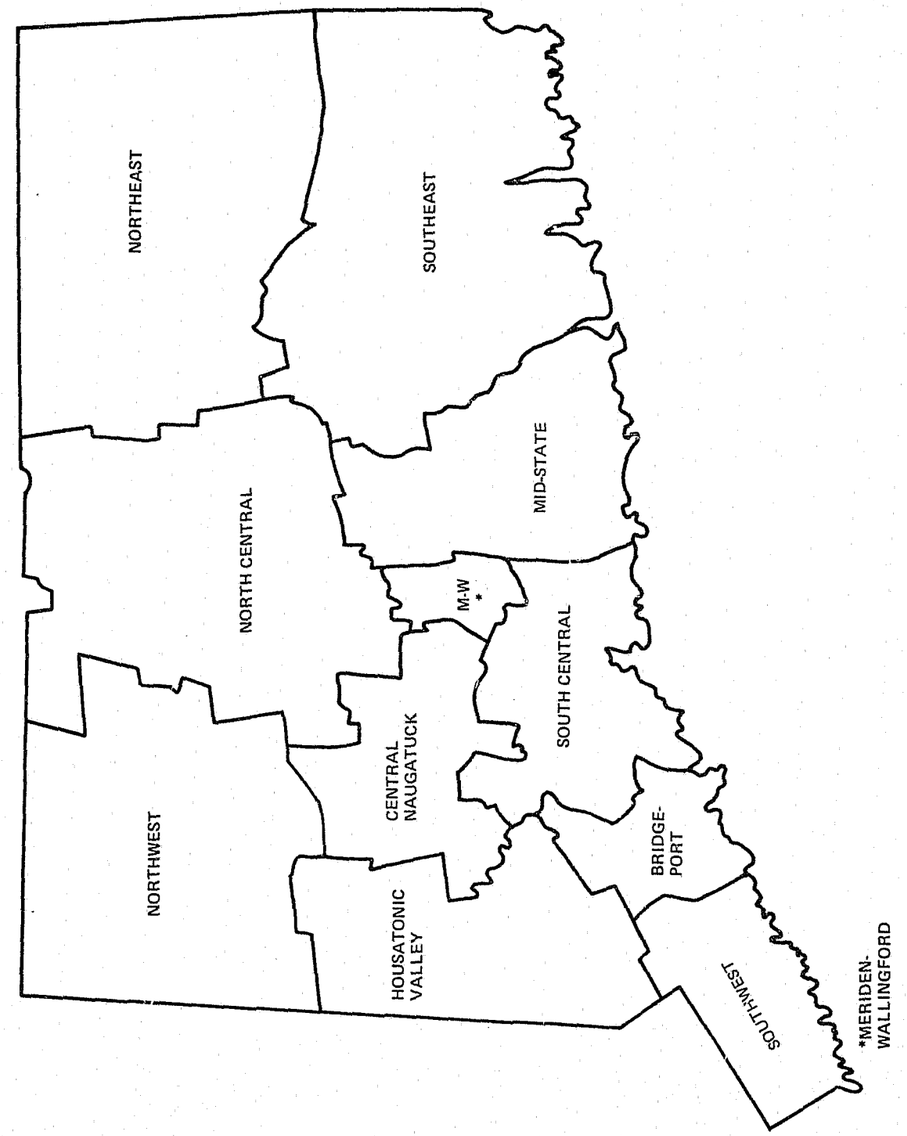
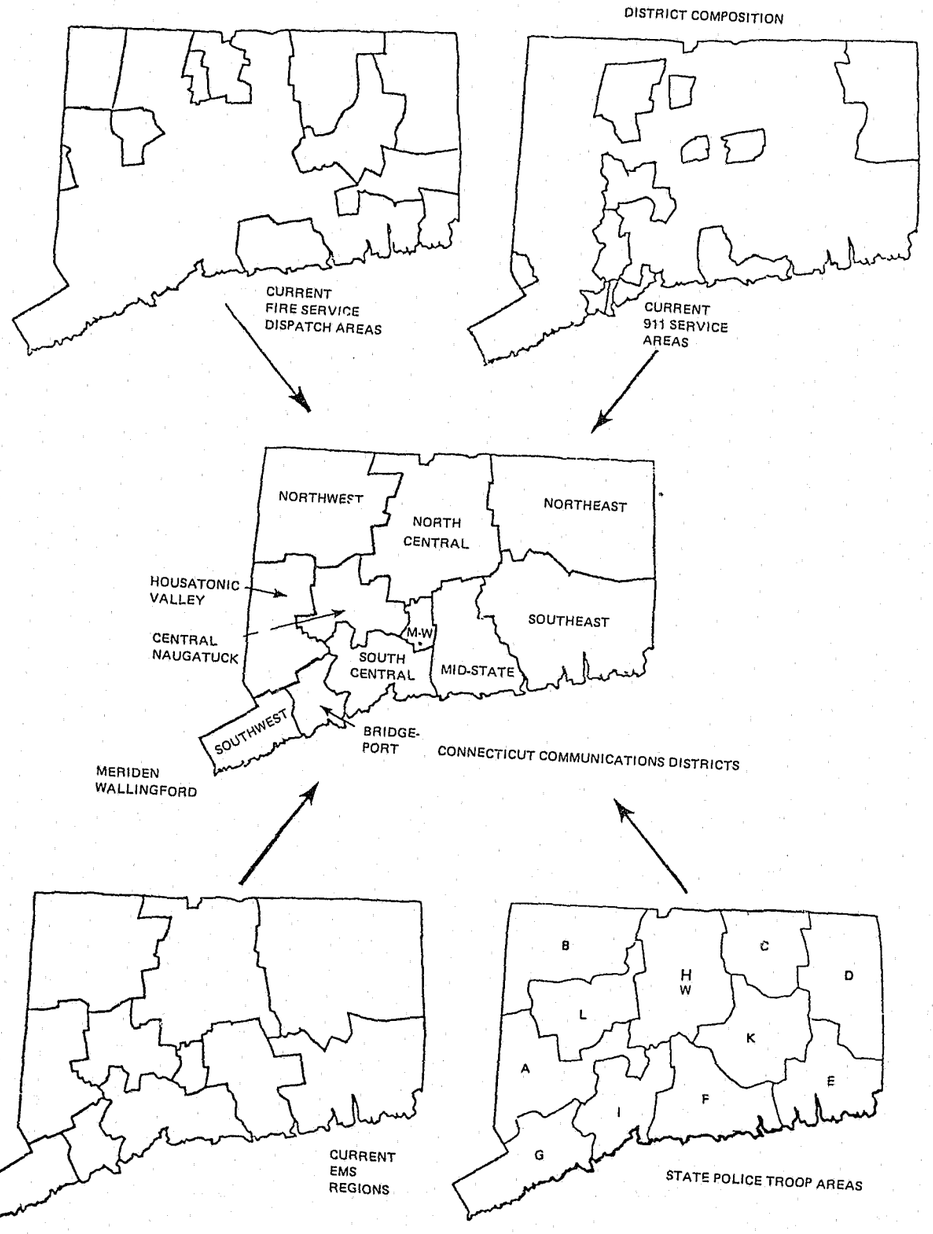


EXHIBIT III-14
Derivation of
Communications Districts



The Southwest District consists of eight towns on the extreme southwest corner of the former Fairfield County. It is contained within State Police Troop G area and is identical to the Southwest EMS planning district. It has no present consolidated public safety organizations or 911 systems. Each town operates relatively independently but agreement has been obtained to consider a common emergency number answering point.

The Bridgeport District includes five towns surrounding the urban center of Bridgeport. It occupies the remainder of the Troop G area, and is also contiguous with EMS planning district B. It already has an operational 911 service in Bridgeport covering over one-half of the district's population.

The Housatonic Valley District includes most of the remaining towns in what was formerly Fairfield County and three towns from the former Litchfield County. It covers a large portion of State Police Troop A area and one town each from the areas of Troops G and L. Although the Sherman Fire Department participates in a fire dispatching system operating out of the State Police barracks in Litchfield, other central dispatching facilities or 911 systems exist and the district boundaries were selected to correspond with the EMS planning district for Housatonic Valley.

The Northwest District includes 17 towns in what was formerly Litchfield County. It encompasses most of State Police Troop B and portions of Troop L. The region is essentially rural and the boundaries coincide with the Northwest EMS planning district. A regional dispatch center in Litchfield coordinates the fire activities of seven towns, and five more participate in a 911 system. Barkhamsted Reservoir presents a geographical obstacle for service to the eastern portion of the town of Barkhamsted, which may require additional district boundary definition.

The North Central District consists of a majority of the towns that formerly comprised Hartford County, with the deletion of Marlborough and the addition of Plymouth. It contains the areas of State Police Troops H and W, and a portion of the Troop L area. Two cooperative fire dispatch groups cover six northwest towns; five towns presently have 911 capability. Plymouth was included for consistency with the North Centeral EMS planning district; Marlborough was deleted and included in the central dispatching system planned for Colchester.

The South Central District includes 16 towns surrounding the New Haven urban area. The geography is characterized as a lowland valley with hills and forests in the areas outside

of New Haven. The area resembles the South Central EMS planning district; the towns of Gilford and Madison were excluded because their fire departments participate in an existing mutual aid agreement with the adjacent district. Since receipt of a Robert Wood Johnson Foundation grant, an EMS communications system is being implemented in ten of the district's towns. A 911 system exists in seven of the towns and is expanding. The district also contains portions of State Police Troop areas A, I, and L.

The Meriden-Wallingford District was chosen to correspond with the Meriden-Wallingford EMS district. Although it is the smallest in geographical area, the EMS plans were sufficiently developed for these towns that public safety communications improvements could be achieved in the near future. There were no mutual assistance agreements for fire services, 911 systems, or other centralized dispatching organizations that overlap the boundaries. The area is completely within the State Police Troop I area.

The Central Naugatuck District resembles the Central Naugatuck EMS planning district; a 911 system currently exists in five of the district's 11 towns. Although the town of Bethlehem participates in a mutual assistance agreement with fire services in the Northwest District, it was included here because of its advanced EMS planning. The boundary includes portions of State Police Troop areas A, I, and L.

The Mid-State Communications District is similar to the former Middlesex County area. Several factors, however, led to the addition of two towns in the Southeast, Guilford and Madison, and the deletion of two towns in the Northeast, East Haddam and East Hampton. The two Southeastern towns were included because of their previous participation in the district's mutual aid fire arrangement, their current 911 public safety access capability, and their local law enforcement requirements. While adding them to this region, consideration was given to certain of their affinities (particularly in EMS transportion to New Haven) for the South Central District, however, it was felt the overall public safety needs of these two towns could be best served by the proposed grouping. The primary reason for excluding the two Northeastern towns was their anticipated participation in the regional public safety dispatching system to be operated by the neighboring State Police barracks in Colchester. A secondary factor was the geographic isolation imposed by the Connecticut River, which splits these towns from the main district grouping.

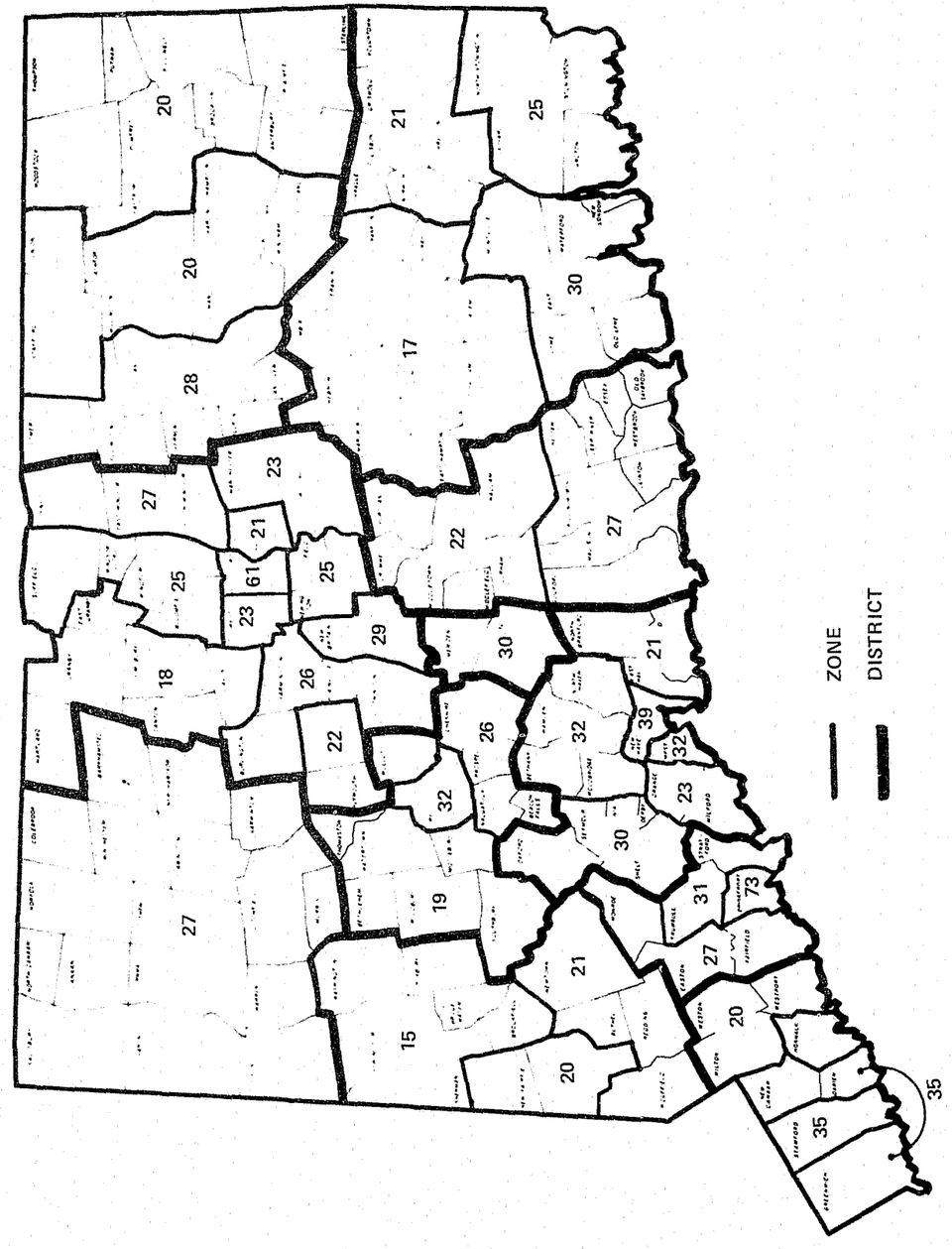
The Northeast District includes most of the towns within the former Windham and Tolland Counties. Several compromises were made to reach the recommended boundaries. The only current 911 central dispatching region, Quinebaug Valley, was included in its entirety. However, the Windham and Tolland fire dispatching districts were divided by placing the towns of Marlborough, Hebron, Columbia, Lebanon, and Franklin in the Southeast District because of their intended participation in the Colchester-based central dispatching organization. The recommended boundaries resemble the Northeast EMS planning district boundaries and include towns within State Police Troop areas C, K, and D.

The Southeast District consists of 25 towns in the southeastern portion of the State. The towns selected reflect compromises among the boundaries of the Northeast, North Central, and Mid-State Communications Districts. Two existing cooperative fire organizations were undisturbed in the northeast and extreme southeast; however, portions of the Windham Mutual Aid organization for fire services were divided because of the planned central dispatch facility at the State Police barracks in Colchester. Currently, there are no 911 systems. The district includes portions of State Police Troop areas F, D, K, and E.

The district boundaries proposed here are not to be construed as being inflexible. It is recognized that local conditions and desires may warrant the adjustment of district boundaries. It is therefore recommended that officials of local police, fire, and EMS services refine these boundaries to suit their needs, keeping in mind the overall criteria set forth above.

For some agencies, service requirements are such that communications districts must be further subdivided into radio zones. A zone is a group of towns which, when taken together, generate sufficient radio traffic to efficiently use a single dispatch channel. In the case of large cities requiring more than one dispatch channel, one radio zone for the entire city can be used, the subdivision of the city being a matter for local decision. Exhibit III-15 shows a zone concept for local law enforcement agencies in Connecticut which is responsive to the projected 1985 service requirements. It is based on a channel loading of between 25 and 35 deployed mobile units per channel. As is the case for district boundaries, zone boundaries should be adjusted on local preference. It should be noted that these zones were developed considering the loading presented by State Police units serving a local law enforcement role (resident troopers, etc.) in addition to local police departments.

EXHIBIT III-15
Local Law Enforcement
Zone Concept



This recognizes the potential for service being assumed by new local police departments which may be established between now and 1985. Should local conditions dictate, State Police units could be excluded from the analysis, and fewer zones would result.

Within each zone (and preferably within each district), a common frequency range should be used by all agencies of a given service to facilitate radio coordination. Establishing frequency band recommendations for each zone is the first step in developing a detailed Statewide frequency plan. Consideration in determining frequency bands must be given to a number of factors including:

- Zone size
- Geography
- Propagation characteristics.

In addition, current frequency usage and availability must also be considered.

The three frequency ranges available for public safety communications all have differing characteristics which determine their suitability to various applications. The VHF low band has the greatest range of the three (20 to 35 miles), but is most susceptible to man-made noise. This frequency range is therefore best suited to suburban or rural areas where noise is low and greater ranges are required. A major problem with low band is its susceptibility to ionospheric "skip" propagation, resulting in periodic interference from stations 600 to 1200 miles away.

The VHF high band is not suscpetible to skip interference (although stations up to 200 miles away may be heard under unusual circumstances), and is more immune to man-made noise. Its range is somewhat shorter (15 to 30 miles), and antennas are smaller than for low band, making the use of high-performance "gain" antennas on vehicles practical. High band is useful in suburban and urban areas, but in the latter, dead spots may be found inside or near large buildings resulting from signal blockage.

The UHF band provides excellent penetration into buildings, and because of its short wavelength signals, can be reflected into areas between buildings which would be shielded at VHF. Range in this band is the shortest of the three (10 to 20 miles), due in part to signal absorption by foliage. High-gain antennas are practical; man-made noise is almost nonexistent. For these reasons, the UHF band is most applicable to small areas and urban locations.

Based on these considerations, frequency band recommendations have been developed for the public safety services in Connecticut and are described in the following paragraphs.

EMS communications should utilize the UHF band Statewide. Specifically, medical service operations should utilize the eight frequency pairs provided in FCC regulations. Although dispatching could be accomplished on any band, use of the two UHF dispatching pairs designated in the FCC regulations is recommended to assure Statewide compatibility and to reduce the need for additional ambulance radios. Use of individual frequencies should be in accordance with the existing State EMS communications plan.

Fire service communications are currently confined to the VHF low band almost exclusively, with only a few assignments in high band and none in UHF. Since UHF frequencies are also licensable in the Police Radio Service, they are not recommended for fire use, since the spectrum shortage is more acute in the local law enforcement area. The desire to limit radio coverage to the area of operations therefore results in recommendations for the use of low- and high-band frequencies for fire department operations. The choice is dependent on the size of the district and current frequency usage. High band is recommended for the smaller districts and areas of high population density, while low band should be used in the large districts and rural areas and for continued Statewide coordination.

The local law enforcement situation is much more complex than for the other public safety services. Although the majority of departments use low band, there are enough licenses on high band and UHF to indicate a trend towards higher frequencies for local networks. The RAFS concept in the Hartford area is an an example of such a network in the UHF band. Accordingly, the VHF high-band and UHF frequencies should receive special emphasis in planning local law enforcement communications. Low band should be retained in large districts and rural areas, while high band should be used in mid-sized and suburban districts. UHF systems should be employed in small districts and urban areas to limit coverage "spillover" and to provide improved service around large buildings. Statewide coordination among local law enforcement agencies should be accomplished on high band for two major reasons. First, coordination is generally only required in a limited area, even if resources are drawn from a wider area; and second, the Associated Public Safety Communications Officers, Inc. (APCO) has petitioned the FCC to designate the frequency 155.745 MHz as a nationwide common police emergency channel. This proposal

was approved by both APCO and the International Association of Chiefs of Police at their annual conferences. Although nationwide implementation of this specific frequency as a common channel faces a number of obstacles, it is felt that sufficient justification exists for designating the UHF high band for Statewide coordination.

The problem of providing interagency coordination capability among districts whose primary dispatch bands are different will have to be addressed specifically for each area. Coordination within the district is provided by the common mutual aid frequency. The Statewide high-band coordination capability will also be available to those districts normally operating on the VHF high band. Other districts will require complete second radios operating on the high-band channel, monitor receviers for cross-band operation, or possibly cross-band mobile relay operation. Degraded mobile coordination (not direct mobile/mobile) can also be provided through communications among the adjacent district dispatchers.

Exhibit III-16 lists the frequency band recommendations for each communications district and for each public safety service. Certain exceptions to district band recommendations have been made in specific locations based on unique requirements. For instance, in the fire service, high band is recommended in the Hartford area because of current usage and small coverage area requirements, while the rest of the North Central district would operate on low band. Similarly, the South Central district would use UHF for local law enforcement communications, but two larger zones in the district would use high band. Exhibit III-17 shows individual zone frequency band recommendations for local law enforcement service.

These recommendations should serve as a guide to system planning, the first step of which should be a detailed frequency plan for all services. This plan must consider not only current usage within Connecticut, but in adjacent states as well. The results of this process may require individual exceptions similar to those identified above; however, the band recommendations presented should serve as a point of departure for more detailed efforts.

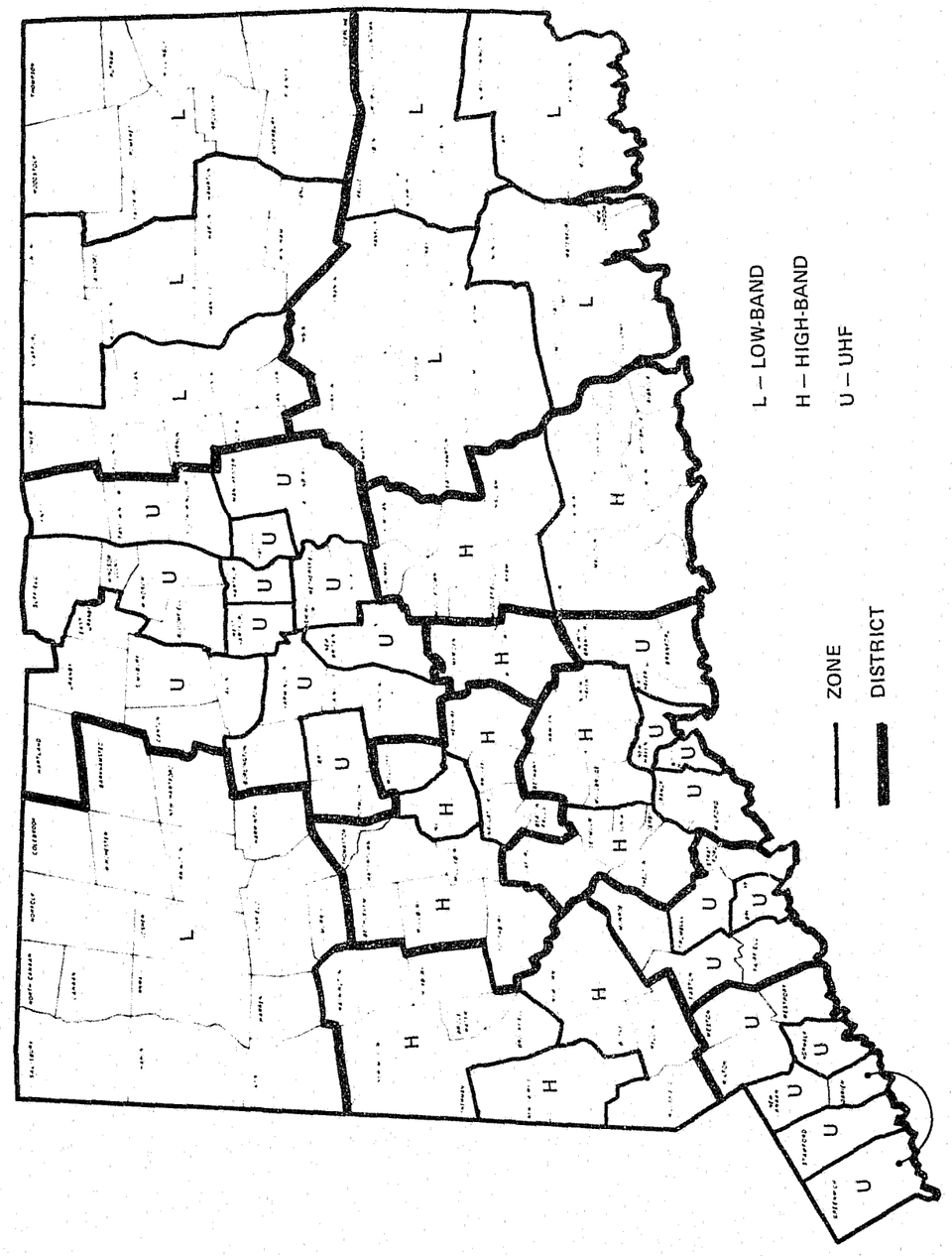
(5) Summary

Minor problem areas in individual local law enforcement, fire, and EMS communications systems are easy to deemphasize when considered on a local basis. When aggregated on a Statewide level, as has been done in this study, the magnitude

EXHIBIT III-16
Frequency Band Recommendations
for Communications Districts

District	Band Recommendation		
	Local Law Enforcement	Fire	EMS
Southwest	UHF	High band	UHF
Bridgeport	UHF	High band	UHF
Housatonic Valley	High band	Low band	UHF
Northwest	Low band	Low band	UHF
Central Naugatuck	High band	Low band	UHF
South Central	UHF (2 zones high band)	High band	UHF
Meriden-Wallingford	High band	High band	UHF
North Central	UHF	Low band (high band in Hartford, East Hartford, Newington and New Britain)	UHF
Mid-State	High band	Low band	UHF
Northeast	Low band	Low band	UHF
Southeast	Low band	Low band	UHF
Statewide Coordination	High band	Low band	UHF

EXHIBIT III-17
Zone Frequency Band Recommendations
for Local Law Enforcement



and complexity of the results clearly indicate the necessity of an overall "systems" approach to public safete communications. It is essential, therefore, that if the local problems are to be resolved and Connecticut's 1985 public safety communications posture is to be responsive to projected operational requirements, the conceptual system recommendations presented in this section must be adopted. If they are not, unstructured growth will continue and the attendent problems will expand.

Alternative methods of satisfying the operational requirements of the three components of public safety were analyzed. The optimum and recommended approach is based upon the concept of a communications district within which all public safety communications systems can operate in a coordinated, cooperative, and, in many cases, consolidated manner. District communications systems can be developed which fulfill local requirements yet remain responsive to the recommended Statewide system goals. These State-level goals include the implementation of 911 emergency assistance telephone numbers; law enforcement communications systems in line with the recommendations of National Committee on Law Enforcement Standards and Goals; fire service communications systems with full dispatch, operations, and coordination capabilities; and EMS communications systems in line with HEW and DOT guidelines.

In summary, Connecticut should:

- Adopt the total public safety system viewpoint for communications planning and design
- Define public safety communications district boundaries
- Prepare a detailed Statewide frequency plan for local law enforcement, fire, and EMS
- Implement 911 emergency access numbers or seven-digit emergency numbers
- Acquire new communications equipment per district plans in line with system concept (i.e., multichannel, tone-coded squelch, etc.)
- Expand use of consolidated communications facilities
- Consider citizens band channel 9 monitoring capability at dispatching centers.

At this stage of planning it is difficult to estimate meaningful total costs for implementing these recommendations. As an example, however, an analysis was conducted and a sample system design prepared as Appendix I for the 15 towns comprising the proposed Mid-State Communications District.

APPENDIX H

COST BASIS FOR LAND-MOBILE RADIO SYSTEMS

This appendix lists typical costs to indicate the basis for many of the cost estimates concerning land-mobile radio equipment. The actual cost for this equipment for a specific installation may vary as a result of optional equipment features and equipment quality. Costs shown generally reflect first-grade equipment. The actual costs may also vary as a result of competitive circumstances. In general, the costs listed provide conservative figures for budget estimating purposes.

Equipment Category	Typical Cost
VHF high-power, dual-channel base transmitter, two receivers, tone-coded squelch, remote control unit (tone) (single-channel: $600 less)	$ 5,600
VHF low-power, dual-channel base transmitter, two receivers, tone-coded squelch, remote control unit (tone) (single-channel: $600 less)	3,300
VHF gain antenna, 200 feet of transmission line, and isolation filters	1.700
UHF high-power, four-channel base transceiver, tone-coded squelch, remote control unit (tone)	6,000
UHF low-power, four-channel base transceiver, tone-coded squelch, remote control unit (tone)	3,800
Multichannel control console (five channels or more), cost subject to variation per functions implemented, cost per channel	1,000
100-foot guyed tower, emergency power supply and equipment shelter, exclusive of real estate and site preparation costs	6,000
900-MHz radio control link, two channels (transceiver at each end of link), (add $3000 for control of four channels)	13,300
Two microwave antennas, 400 feet of transmission line (one antenna at each end of link)	2,000
Four-channel, high-power mobile transceiver and antenna, UHF or VHF	1,500
Portable transceiver, UFH or VHF	750

Service Category	Typical Cost
Mobile service contract units >10 years	$ 11/month
Mobile service contract units <10 years	$ 7/month
Base station service contract	$ 22/month
Desk top control unit service contract	$ 11/month
Recrystal existing equipment with different frequency	$ 80/channel + $20 fixed charge
Expand capacity of single-channel equipment	$500/unit

APPENDIX I

MODEL PUBLIC SAFETY COMMUNICATIONS SYSTEM FOR THE MID-STATE COMMUNICATIONS DISTRICT

To illustrate the recommended Public Safety Communications System (PSCS) concept and to demonstrate the approach, an analysis was performed on a region in the middle of the State. For purposes of the sample analysis, this region was identified as the Mid-State Communications District. The existing fire, EMS, and local law enforcement resources were reviewed and system improvements consistent with the recommended PSCS concept were identified. Cooperative dispatching arrangements were proposed for a northern and southern communications zone. It must be emphasized here that the recommended communications district and associated system improvements provide a structure which can be both reviewed and modified by the local agencies concerned.

The results of this analysis are presented in five parts:

- Considerations in selecting the boundaries of the Mid-State District
- Local law enforcement system
- Fire services system
- EMS system
- Cooperative district-wide communications dispatching.

1. CONSIDERATIONS IN SELECTING THE BOUNDARIES OF THE MID-STATE COMMUNICATIONS DISTRICT

The Mid-State Communications District boundaries reflect geographic and operational compromises considering the several existing public safety planning areas, 911 system boundaries, and existing or proposed central dispatching organizations. These include cooperative arrangement of the fire departments within the nine southern towns, proposed facilities in Middletown, and organizations in adjacent districts such as

those in the Colchester and New Haven areas. Other considerations include the 1985 service requirements for local law enforcement and geographical factors.

As illustrated in Exhibit I-1, the Mid-State Communications District is similar to the former Middlesex County area. Several factors, however, led to the addition of two towns in the southeast, Guilford and Madison, and the deletion of two towns in the northeast, East Haddam and East Hampton. The two southeastern towns were included because of their previous participation in the District's mutual aid fire arrangement, their current 911 public safety access capability, and their use of a shared local law enforcement dispatch channel with Clinton. In adding these towns to the region, consideration was given to certain items of common interest (particularly in EMS transportation to New Haven) with the South Central District. However, it was believed the overall public safety needs of these two towns could be best served by the proposed grouping. The primary reason for excluding the two Northeastern towns was their anticipated participation in the regional Public Safety Dispatching System to be operated by the Troop K State Police barracks in Colchester. A secondary factor was the geographic isolation imposed by the Connecticut River splitting these towns from the main district grouping.

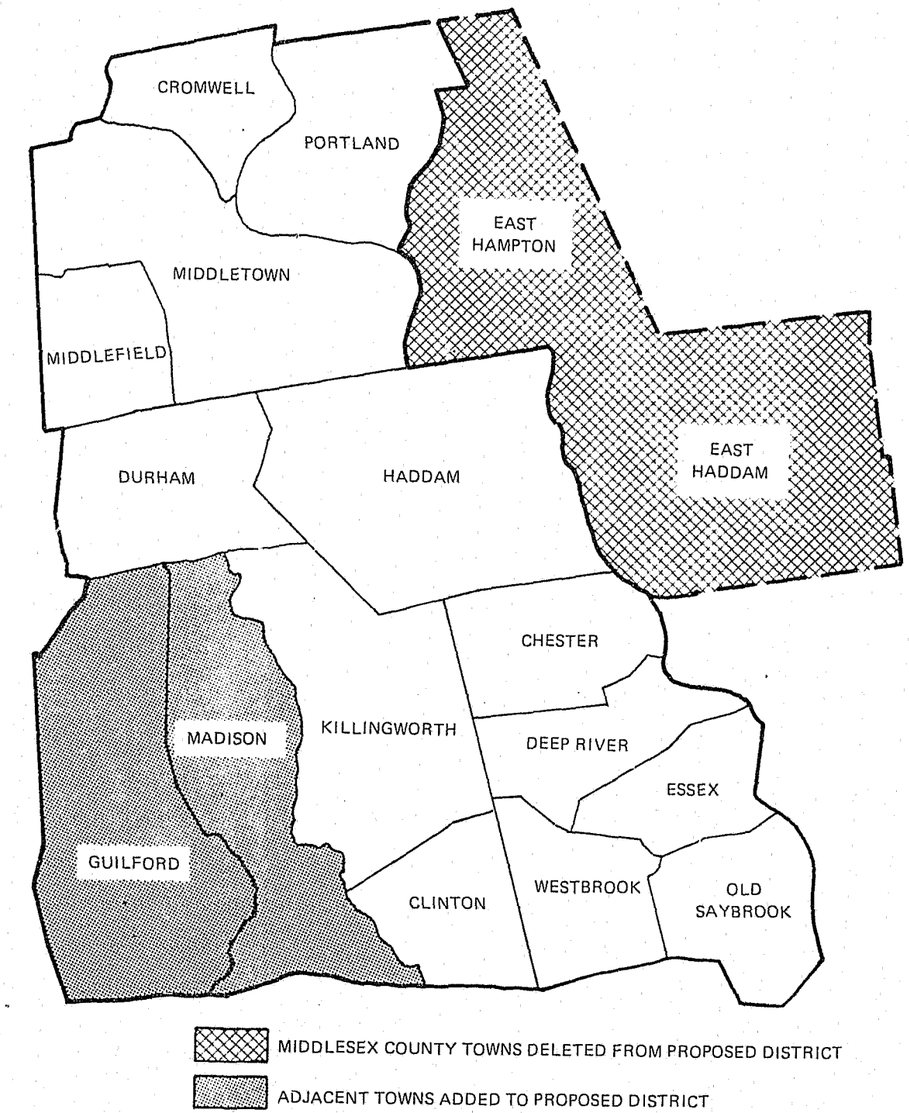
As currently configured, the district represents a good cross section of the public safety problems likely to be encountered in other regions. From a local law enforcement service viewpoint, the district divides itself into a southern and northern zone which correspond well with existing fire and proposed EMS systems. The southern portion is a sandy coastal strip on Long Island Sound which becomes more hilly to the north. There are no urban centers and it is representative of a rural sparsely settled area. The northern portion is more urban. It has a forest-covered plateau with rolling hills and contains the District's concentration of population in Middletown and Portland.

2. MID-STATE LOCAL LAW SYSTEM AND RECOMMENDED PLAN

Local law enforcement services within the Mid-State District are presently provided by both State Police and local agencies. The following towns have their own police departments and use the dispatch frequencies indicated:

- Middletown - 155.37 MHz
- Old Saybrook - 159.21 MHz
- Guilford, Madison, Clinton - 39.42 MHz

EXHIBIT I-1
The Mid-State Communications District



The last three towns are adjacent to one another and share a common frequency, although separate dispatch facilities are used. All five towns presently experience outside interference, with Middletown experiencing co-channel interference from a community in Rhode Island using the same tone squelch frequency.

In establishing an integrated communications approach for local law enforcement in the district, mobile radio zones must first be established. Mobile radio zones are groups of towns in which the total number of mobile or portable units in service during the busy period is such that efficient use of the channel is achieved consistent with response time requirements (application of queueing theory results in a loading of between 25 and 35 radio units per channel for a 5-second delay).

Two approaches may be taken in determining mobile radio zones. First, only existing police departments may be considered, the implicit assumption being that towns currently served by State Police will continue to be served in this manner. In this instance, the projected total number of deployed radio units in the Mid-State District in 1985 would be 29. This would mean the entire district would comprise a single zone.

A second approach is to consider the service requirements of all towns, regardless of how service is presently being provided. This implies that eventually all local law enforcement units in the district would operate on the district system. This allows for the formation of town police departments as individual towns grow and need to provide their own police services. Under this approach, a total of 49 mobile units would be expected in 1985. Two zones would be sufficient for this purpose; a northern zone containing six towns and 22 radio units, and a southern zone of nine towns and 27 radio units. Of the two, the two-zone approach is the more conservative, providing significant flexibility to accommodate new departments and growth.

According to the conceptual design for local law enforcement communications described earlier, a two-zone district would require two dispatch channels, two tactical channels, two special-purpose channels, and one district coordination channel for a total of nine frequencies.* The single-zone approach would need only one dispatch channel, one tactical channel, and one special-purpose channel (a district coordination channel would not be required since this function is inherently provided within a single zone)

* Assumes two frequencies per dispatch channel.

for a total of five frequencies. In either case, sufficient frequency resources do not presently exist within the district and would presumably be made available as part of a Statewide frequency plan, which would address all police frequencies within the State in addition to others which may be available but are presently unlicensed.

The typical channel usage for a four-channel mobile radio in a law enforcement vehicle would then be as follows for a two-zone district:

- Statewide coordination channel
- District coordination channel
- Zone dispatch channel
- Tactical (or special-purpose) channel, a mobile-only channel.

After selecting mobile radio zones, the district frequency band should be selected. The proposed band use policy would indicate a low-band system if one zone were used. This is because the Mid-State District covers a relatively large area. On the other hand, the two-zone concept would yield smaller coverage areas which could be served by high-band systems. Normally, if equipment replacements are required to implement a band selection, the choice of band should minimize the required investment in equipment and maintenance over the entire district. In any case, all departments within the district should, as an objective, operate on the same band to facilitate coordination.

Current equipment assets in the Mid-State District are shown in Exhibit I-2. Although more departments operate on low band, the equipment count slightly favors high band because of the relatively large number of radios in use by Middletown. This approach, however, might not be able to provide district-wide service from a single location (such as might be required if central dispatch were adopted in a one-zone district). In the two-zone approach, high band would be favored because of current equipment investment and zone coverage.

EXHIBIT I-2
Equipment Breakdown, Mid-State District

	Mobiles	Portables	Base Stations	Total
High Band				
Old Saybrook	7	6	1	
Middletown*	17	17	2	
	24	23	3	50
Low Band				
Guilford	8	6	2	
Madison	6	8	1	
Clinton	5	4	1	
	19	18	4	41

A compromise approach for the two-zone configuration would be to place the northern zone on high band, building around the operation in Middletown (currently the only department in the zone), while the southern zone would build around the low-band system in use by Guilford, Madison, and Clinton. The disadvantage of this approach would be the cost of providing all units in the district with a district coordination channel, necessitating a second radio in some vehicles.

The alternatives described above and some of their implications are summarized in Exhibit I-3. A two-zone approach is recommended because of flexibility in accommodating future growth and the characteristics of the region (i.e., a coastal area and an urban area around Middletown). The use of high band is also recommended because of the coverage area requirements and the desire to avoid spillover. Additionally, the current equipment investment favors the high-band approach. The cost of implementing this approach is summarized in Exhibit I-4.

Before these recommendations can be implemented, an assessment of frequency usage in Connecticut and surrounding states must be made and a detailed frequency plan developed. The plan must specify whether current fequencies are to be retained or whether a total reallocation is in the best interests of law enforcement agencies in the State. A time-phased transition must also be considered. Since the objective period is 1985, most current equipment will be scheduled for replacement in any case, and a gradual town-by-town conversion schedule should be determined as part of any frequency plan to enable the local law enforcement communications concept to be gracefully implemented.

* Replacement of all equipment is scheduled by 1980.

EXHIBIT I-3
Mid-State District Configuration
Options and Implications

Number of Zones		
Frequency Band Plan	Single Zone	Two Zones
High Band: New equipment required in three towns	Minimum spectrum requirements	More flexible in meeting needs of new departments
High Band: More high-band equipment currently in use in district (50 units)	Requires large coverage areas from dispatch center	Recognizes different types of service required within the district (rural coastal area, settled northern area)
High Band: District-wide coverage from one site may be a problem		
Low Band: New equipment required in two towns	Minimum amount of new equipment required	
Low Band: Less equipment currently in use (41 units)	Takes advantage of shared system in south	
Low Band: Takes advantage of existing shared system in south	Needs added radio in 41 vehicles	
Low Band: May result in coverage over-spill in two-zone concept	Coordination difficulties in two-zone configuration	
Mixed (HB-north) (LB-south)		

EXHIBIT I-4
Mid-State Local Law
Enforcement Conversion Costs*

North Zone	
Middletown	
Replace current inventory with new four-channel equipment	
17 mobiles @ $1,500	$ 25,500
17 portables @ $750	12,750
2 bases @ $3,800	7,600
2 antennas, cabling, etc. @ $850	1,700
	47,550
South Zone	
Old Saybrook	
Modify and recrystal inventory for four channels	
2, single-channel mobiles @ $500	$ 1,000
5, 2-channel mobiles @ $500	2,500
3, 4-channel portables @ $100	300
3, single-channel portables (replace) @ $750	2,250
Replace two base stations with four-channel units @ $3,800	7,600
	$ 13,650
Guilford, Madison, Clinton	
Replace low-band system with four-channel high band	
19 mobiles @ $1,500	$ 28,500
18 portables @ $750	13,500
4 bases @ $3,800	15,200
4 antennas, cabling, etc. @ $850	3,400
	$ 60,400
Mid-State District Total	$121,600

* Assumes two zone, high-band, two dispatch centers, no new departments.

3. MID-STATE FIRE SYSTEM AND RECOMMENDED PLAN

Six low-band fire frequencies are used in the Mid-State District. These include one county mutual aid, one Statewide coordination, and four local operational channels. Nine southern towns participate in mutual dispatching on the Middlesex County coordination frequency.

By comparison with the recommended communications concept developed earlier, modifications to the existing system can be recommended which will result in improved fire service operations. First, Statewide coordination capability is only partially available since only the point-to-point frequency of 46.16 MHz is licensed within the district. If several mobiles were equipped with the mobile-to-mobile coordination frequency of 33.78 MHz, inter-mobile communications with units external to the district would be made possible. District coordination is presently well established since all departments are equipped with the county mutual aid frequency of 46.18 MHz. If a similar frequency for district-wide dispatching were designated, two operational improvements would result. First, since the frequency would be in low band, a single centralized facility could dispatch all district departments with one base station; second, the present practice of using the mutual aid freqency for dispatching would be eliminated and this frequency would be freed for its intended use. This dispatch frequency should be selected from one of the district's four present operational channels. Three channels could then be allocated among the 15 towns, for their operational use. Each department would then be equipped with capability for district mutual aid, district dispatch, and local operation. The recommended channel allocation is depicted in Exhibit I-5.

EXHIBIT I-5
Recommended Channel Allocation

Channel Type	Existing (MHz)	Recommended Design (MHz)
Statewide Coordination	46.16	46.16, 33.78
District Coordination	46.18	46.18
District Dispatch	-	46.06
Working Channels	46.06, 46.08 46.12, 46.54	46.08, 46.12*

* A third frequency would need to be selected as part of a Statewide frequency plan. 46.54 MHz is a local government frequency and would not normally be designated as a district working channel.

The fiscal implications of this design derive from providing existing equipment with expanded channel capacity. Significant acquisition of new radio gear is not required. The seven towns with present capability only on the mutual aid frequency would be reconfigured for three-channel base and mobile operation. The remaining departments would rechannel their communications gear with the appropriate district and local operations frequency. To operate on the Statewide mobile-to-mobile coordination frequency, 33.78 MHz, a second radio in each vehicle would be required since existing equipment could not accommodate the frequency spread. Improved central dispatch equipment would also be required. Exhibit I-6 presents budget estimates for reconfiguring the existing equipment.

EXHIBIT I-6
Budget Estimates for Reconfiguration of Existing Equipment

Retrofit base stations with three channels @ $500	Seven departments with present single-channel capability	$ 3,500
Retrofit mobiles with three channels @ $500	21 mobiles associated with departments above	10,500
Mobile radios on Statewide mobile coordination frequency @ $1,500	Four vehicles	6,000
Recrystal base stations for new frequencies @ $260	Eight departments in remainder of district	2,080
Recrystal mobiles @ $260	24 vehicles associated with departments above	6,240
Dispatch center equipment @ $2,000	One console for each of two zones	4,000
Total		34,320

4. MID-STATE EMS SYSTEM AND RECOMMENDED PLAN

The Mid-State District closely resembles the Mid-State EMS planning region. Guilford and Madison were added to this district because of their participation in the 911 system currently operating in the coastal towns. East Hampton and

East Haddam were omitted because of their anticipated participation in the Colchester-based central dispatching organization. Within the district approximately 17 ambulance vehicles are associated with volunteer fire and rescue squads. Although these vehicles are radio-equipped to communicate with their dispatcher, none has capability to call the Middlesex Memorial Hospital (the primary emergency care facility in the district) or other hospitals outside of the region. Coordination capability presently exists for those ambulances sharing the common fire mutual aid channel. The hospital is not radio-equipped; therefore, dispatch center/hospital radio communications is impossible.

The former EMS district I has prepared an EMS communications system plan which generally conforms to the EMS communications system concept described earlier. The plan proposes both a dispatch and medical service UHF mobile radio for each ambulance; portable units for use by attendants away from the vehicle; a single UHF base station accessible through remote control by every dispatch center and the two emergency care facilities; and several additional mobiles on the fire mutual frequency for improved coordination.

In comparison with the recommended system concept, the plan provides D1, the dispatch link; M1 and M2, the medical service links between the ambulances and local hospital; and C, the coordination link with the local fire services. Some modifications to the current plans are recommended. The coordination link should provide coordination with other dispatch centers (such as one in New Haven and with hospitals) using a point-to-point channel. The dispatch channel permits coordination between ambulances. Usually, no requirement is considered for coordination between ambulances and fire vehicles. One of the VHF high-band frequencies, such as 155.340 MHz, is very useful for this purpose. Dispatching efficiency can be improved by consolidating the proposed 15 dispatch points at one or two locations corresponding to the northern and southern communications zones. Additionally, since Guilford and Madison ambulances often transport patients to hospitals in the New Haven area, coordination channels as well as medical service channels should be compatible with frequencies in use in the South Central district and should be developed as an integrated plan for the whole State. Exhibits I-7 and I-8 present the channel allocation and equipment cost, respectively.

EXHIBIT I-7
Channel Allocation

Type Channel	Present (MHz)	Recommended Design (MHz)
Dispatch	46.18 (primarily)	460.525/465.525
Medical Service	-	463.000/468.000 463.100/468.100 463.125/468.235
Coordination (inter-system)	-	155.340
Coordination (other agencies)	-	46.18 (fire)

EXHIBIT I-8
Equipment Cost

17 UHF disptach mobiles @ $1,000	$ 17,000
17 UHF medical service mobiles @ $2,000	34,000
17 UHF portables @ $750	12,750
Six portable telemetry packages @ $6,000	36,000
One UHF central dispatch base @ $5,500	5,500
One UHF central medical service base @ $7,000	7,000
Two remote control links @ $20,000	40,000
	$ 152,250

The system costs for EMS are substantially greater than for fire since a significant investment in new equipment is required.

5. COOPERATIVE COMMUNICATIONS DISPATCHING

The recommendations developed for the Mid-State fire, EMS, and local law enforcement services will improve the existing communications systems and make them more responsive. The communications system can be further optimized through the implementation of cooperative or consolidated dispatching centers. Response times will improve if a single emergency number terminates at a facility which can directly dispatch the required service. Coordination improvements will result from the collocation of personnel from several services and the cross-banding and dispatching capabilities that can be incorporated in multiservice dispatch centers.

Since the Mid-State District contains two communications zones, two dispatching centers are recommended. The northern center would be located in Middletown and could initially be housed at an existing fire or police facility. Eventually, if a single center became feasible for the entire district, a new facility might be required. The dispatch center for the southern zone would most likely be located at an existing public safety facility in one of the nine towns. A 911 system or single seven-digit emergency numbers would terminate at these new locations. An interim system would involve central emergency answering and switch-off to local fire, EMS, and police dispatchers. The final system should accommodate centralized dispatching of the district's 15 fire departments, 17 ambulances, and all projected police units. In addition to the previously documented costs for improving the individual public safety communications systems, approximately $50,000 would be required to implement the two consolidated dispatching centers in an existing building. This would include such expenses as equipment relocation, telephone interconnections, and installation of new dispatch consoles. Exhibit I-9 summarizes the investments required to achieve the total recommended system improvements for public safety services in the Mid-State District.

EXHIBIT I-9
Summary of Investment to Implement
Mid-State PSCS

Fire Communications Improvements	$ 34,320
Emergency Medical Service Improvements	152,250
Local Law Enforcement System	121,600
Two Central Dispatch Facilities	50,000
Total	$ 358,170

V Factors Affecting Future
Requirements for Local Government

2. FUTURE REQUIREMENTS OF LOCAL GOVERNMENTS

Local government functions are expected to change during the next 10 years; these changes will probably affect telecommunications demand. Some influences and the operational requirements for communications which they generate are identified and discussed in this subsection.

(1) Local Law Enforcement

In recent years, there has been considerable study of local police procedures and their impact on crime. The results of one study in Kansas City, sponsored by the Police Foundation, indicate that changes in the level of preventive patrol produced no substantial differences in criminal activity, the amount of reported crime, the rate of victimization, the level of citizen fear, or the degree of citizen satisfaction with the police. If these findings can be extended to other communities, there is no reason to keep large numbers of officers on patrol. By reducing preventive patrol, additional manpower could be utilized for investigation, surveillance, or community service.

Other studies have devised patrol strategies replacing preventive patrol. One of these, the "community service" approach, assumes that police will win citizen confidence and cooperation in solving and preventing crimes through familiarization with the neighborhoods in which they work and by assuming larger responsibilities for following through on requests for assistance. A variation of this approach is used in Hartford.

Another approach, the "crime attack" model, involves placing patrolmen as close as possible to the scenes of potential crimes to apprehend criminals in the act.

To what extent these or other patrol strategies will be adopted in Connecticut is unknown. Substantial changes in the number of police on patrol will affect the number of mobile and portable radios that will be required. Other factors, such as radio traffic density and areas patrolled will, in turn, affect the number of channels required.

James Q. Wilson, Professor of Government at Harvard, offers these observations:*

- A great increase in police presence on foot in densely settled areas probably will lead to a reduction in public crimes, such as muggings and auto theft.

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* "Are the Police Used Effectively to Fight Crime?" Chicago Sunday Sun-Times, October 20, 1974.

- Substantial increases in random preventive patrol by police in marked cars do not appear to have any effect on the crime rates nor do they tend to reassure the citizenry about their safety.

- The community service model of neighborhood-team policing appears to be of some value in reducing burglaries, even without large increases in police manpower.

Because of the indicated uncertainties involved in projecting the patrol units to be deployed in 1985, estimations of required equipment will be based instead on projections of population served.

(2) Fire Radio Service

The following legislative programs are likely to affect the telecommunications requirements of fire service operations in Connecticut:

- Proposed establishment of an Office of State Fire Administration
- Federal Fire Prevention and Control Act
- Federal funding of emergency medical services.

1. Office of State Fire Administration

Legislation has recently been introduced to replace the Commission on Firefighting Personnel Standards with a Commission on Fire Prevention and Control having increased responsibilities and authority. The Commission would establish an Office of State Fire Administration which would centralize the following fire service activities:

- Administering State and Federal fire funds
- Collecting fire-related data
- Assisting in establishment of regional groups
- Coordinating mutual aid
- Disseminating fire service information
- Coordinating fire frequencies.

Required communications capability would include telephone service and access to the State and county fire radio networks.

2. Federal Fire Prevention and Control Act

The National Fire Data Center will collect, analyze, publish, and disseminate information related to prevention, occurrence, control, and results of fires. The states are to be a principal source of this information.

Connecticut will need to establish an effective data collection and handling system to comply with the National Center input requirement. Information handled will include fire reports and equipment inventories. The information will need to be collected at the local level, transferred to the State level for processing, and then forwarded to the National Center. Depending on time requirements, transmission and retrieval of fire data could be accomplished in part by electronic means. Cost of the data system, including transmission costs, would presumably be shared by the Federal Government.

3. Emergency Medical Service

The implementation of the emergency medical services program in Connecticut will result in the establishment of consolidated dispatch centers throughout the State. Although plans are incomplete, the program is certain to affect fire dispatching operations.

(3) Emergency Medical Services

Connecticut has recently applied for Federal assistance to provide improved emergency health care delivery.* Regional plans submitted describe the proposed program for emergency medical services (EMS). The scope and cost of the entire program will require several years for full implementation. About half the State is prepared to implement a basic life support system during fiscal year 1976; the rest, by the end of a 2-year period.

The EMS plans describe the communications facilities required in the State's 11 EMS planning regions. During FY76, four central dispatching facilities are planned:

- Waterbury (Central Naugatuck)
- New Haven (South Central)
- Colchester (Southeastern)
- Meriden-Wallingford.

* "Emergency Medical Service in Connecticut - 1975," prepared by Emergency Medical Service Division of the Commission of Hospitals and Health Care.

These locations are in addition to existing facilities in Tolland, Windham, and Killingly. Eventually, all 169 towns will be capable of accessing a designated agency for emergency medical assistance.

The requirements as identified in Connecticut's grant application differ in detail among the regions, but generally include the following needs:

- Capability for two-way communications between ambulances and hospitals
- Alerting capability for volunteer ambulance services
- Single emergency citizen access telephone number
- Centralized dispatching
- Direct two-way communications among all public safety agencies
- Direct two-way communications between ambulance and physician.

The planning regions are responsible for the implementation of these requirements.

8. FUTURE REQUIREMENTS OF LOCAL GOVERNMENTS

This subsection addresses the factors peculiar to local government which are likely to influence communications demand by 1985. The communications areas covered include law enforcement, fire service, and emergency medical service.

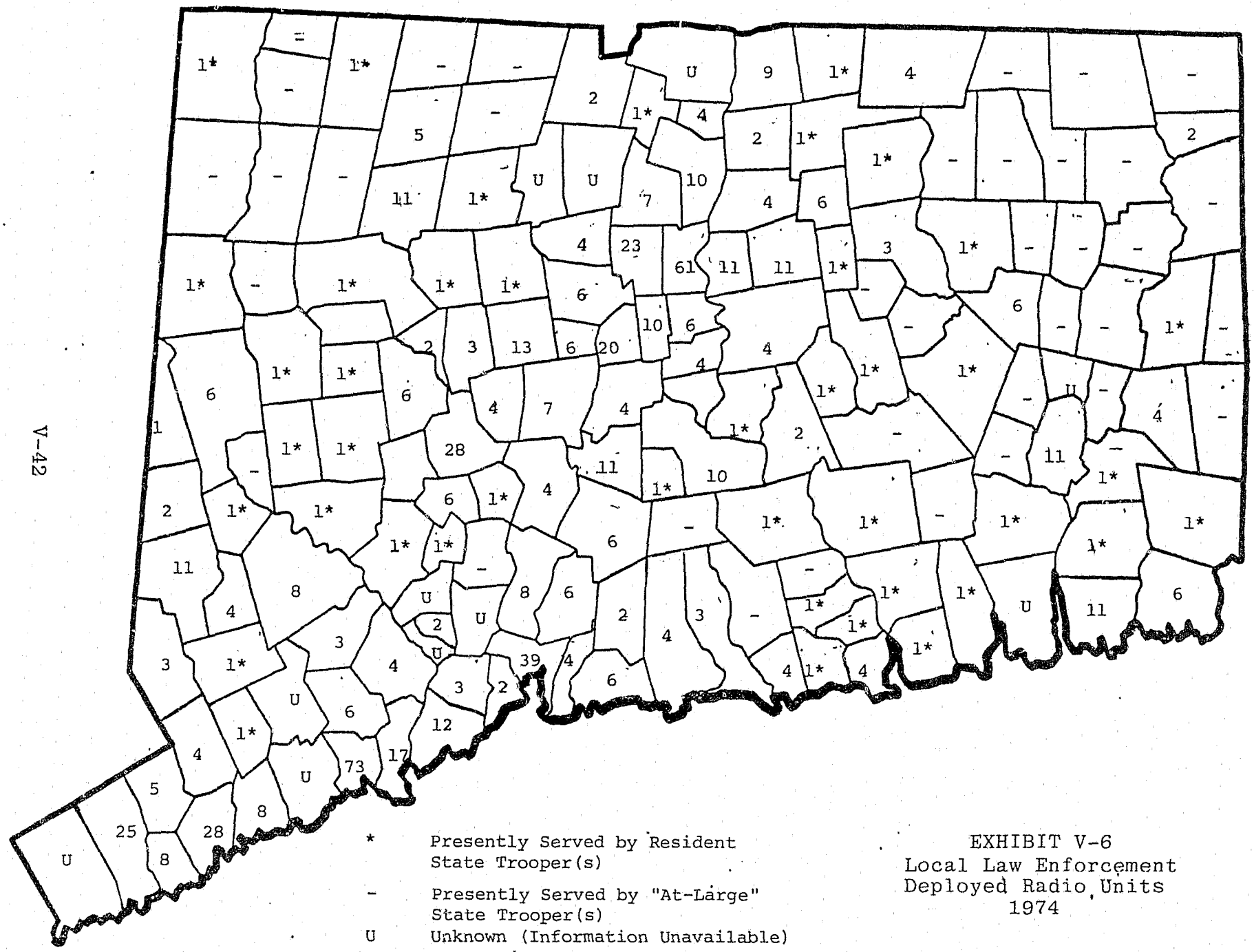
(1) Local Law Enforcement

The bulk of law enforcement operations and thus the greatest demand for radio communications occurs at the local level. Local law enforcement in Connecticut is performed by local police departments, resident State Troopers, constables, and "at-large" troopers who are responsible for a number of towns in addition to their normal functions as State Police. This subsection briefly describes local law enforcement communications in Connecticut and projects the aggregate requirements for 1985.

1. Summary of Findings

A survey of local police departments revealed that, of 77 responding departments, 69 operated full-time dispatching centers, with the remainder operating part-time facilities or using other centers for their dispatching. Throughout the State, a total of 107 radio frequencies are in use by these departments with 47 percent operating in the VHF low-band and the rest divided between the VHF high-band and the UHF band. The majority of these channels experience interference. The number of deployed radio units (mobile and/or portable) in each town at any one time varies from one (a part-time State Trooper) to over 70 (Bridgeport).

The degree of communications coordination between departments also varies widely. Over half of the responding departments have coordination with the State Police; slightly less than half have the ability to communicate with surrounding police departments. Coordination with the Highway Department (33 percent) and area hospitals (9 percent) is less widespread. A significant survey finding was the expressed need for greater coordination by approximately half of the responding departments.

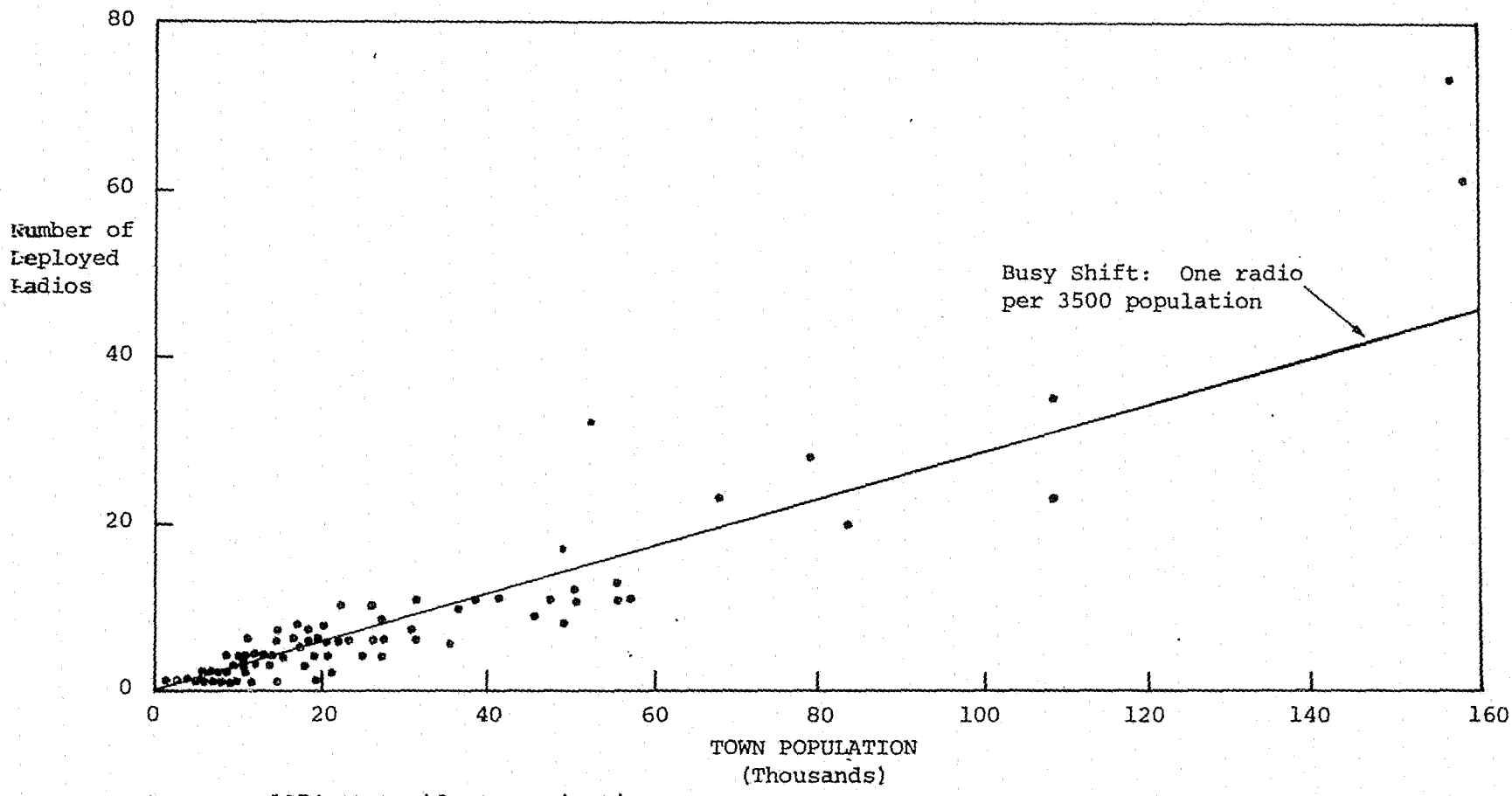


* Presently Served by Resident State Trooper(s)

\- Presently Served by "At-Large" State Trooper(s)

U Unknown (Information Unavailable)

EXHIBIT V-6
Local Law Enforcement
Deployed Radio Units
1974



Source: 1974 Statewide Communications Study Local Law Enforcement Survey

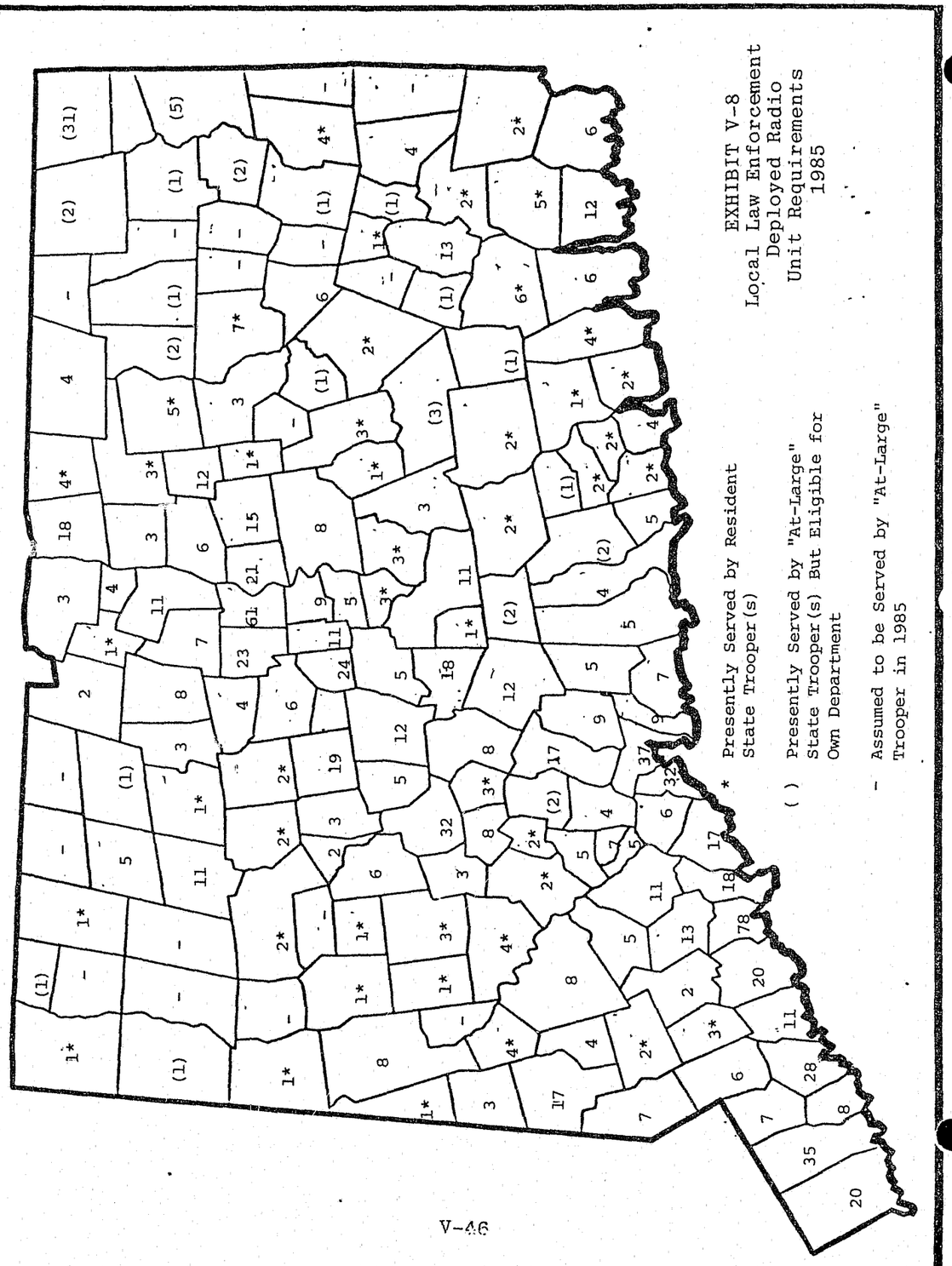
EXHIBIT V-7
Deployed Local Law Enforcement Radios versus Population 1974

The current communications status for local law enforcement agencies represents the results of "as needed" growth and "as available" restrictions. Some departments operate on lightly loaded, interference-free channels, while others experience heavy outside interference and busy channel conditions. Planning activities presently underway to alleviate these conditions are generally on an individual department basis and usually consist of new systems, dispatch centers, or additional radios and frequencies. Thus, there is no statewide approach or concept for provisions of local law enforcement communications.

2. Projected Radio System Requirements

The baseline of mobile communications system design is the number of mobile and portable radios in a given area. For local law enforcement communications, this relates closely to the population of the area. In order to develop an approximation of the number of radios deployed for this purpose in 1985, the current level of radios deployed in each was first determined. Exhibit V-6 shows the number of radios (mobile and portable units) deployed during the busy shift (typically 8:00 a.m. to 4:00 p.m.). Some 790 radios are estimated to be in use throughout the State during this period. This total is considered understated by perhaps 50 radios since some departments did not respond to the survey.

These numbers were then plotted against town population as reported in the 1970 census resulting in the "scatter diagram" shown in Exhibit V-7. This diagram indicates that, on the average, one radio is deployed on the busy shift for each 3500 people in the community served. Variations of 1:1200 to 1:20,000 to this average result from local conditions such as areas to be patrolled, population density, maximum range of a patrol unit, and crime statistics. Also, the relationship was developed using 1974 inventory applied to 1970 population statistics. However, for



determining the aggregate 1985 requirements for Connecticut, the one unit per 3500 population appears to be a suitable forecasting factor.

Population for 1985 was determined using projections from two sources. The approach used is described in Appendix A.

Based on these population projections, the number of deployed radio units was then determined for each town in Connecticut for 1985. In some cases, population changes were so slight the present number of deployed radios was more than adequate to meet the 1985 need. Exhibit V-8 shows these projected radio requirements. Based on these population projections, the number of deployed radio units was then determined for each town using the relationship developed from current data. Some 1070 radios are expected to be in use for local law enforcement purpose during the busy shift in 1985.

This projection is based upon the assumption that the present ratio of deployed radios to population provides adequate capabilities and, if extended to 1985, would provide equivalent capability. In the exhibit, towns marked with an asterisk are currently served by resident State Troopers, and this arrangement was assumed to continue. (The numbers shown for these towns and for towns without 1974 data indicate deployed radio unit requirements based on the 1:3500 ratio.) Towns with no entries were not expected to have formal departments and were assumed to be served by "at-large" State Troopers in 1985. In some cases, the projected population growth is large enough that establishment of a town police department is a possibility. In other cases, towns currently served by "at-large" troopers are projected to grow such that resident troopers could be considered. The actual decision as to how to provide law enforcement services rests with the individual towns. Exhibit V-8 represents only the required number of deployed radio units indicated by population projections.

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The projections apply to only those radios expected to be deployed during the busy shift. Total radio inventories for each town can be estimated from these projections given the ratio of deployed mobiles/portables to total mobiles/portables. This number will vary, depending on department operating procedure, from 1 to 1 (continuous use of the same radios by all shifts) to 4 or 5 to 1 (individual cars or portables for each officer, including all shifts, those on vacations, sick, etc.). No attempt has been made here to determine these ratios for each town, as this is a local policy decision.

Two items of Statewide importance which are dependent on the number of deployed radios are channel requirements and coverage areas. Since insufficient spectrum space exists to allow each department to have its own radio channel, and arbitrary frequency assessment often results in interference, channel sharing is indicated. It will be necessary, therefore, to allocate frequency resources to improve operational efficiency, not only for individual departments, but also regionally and Statewide. Knowing the number of deployed radio units projected for each town enables frequency allocation which ensures equitable channel loading and minimum interference.

The total number of radio channels required for local law enforcement in 1985 will be highly dependent on the choice of a Statewide approach for frequency allocation. Based on the number of deployed radios projected for the State (1070), and assuming coordinated usage to provide an average load of 30 radios per channel, approximately 36 radio channels will be required for dispatching. The number of separate frequencies required will be greater than this. Assuming two-frequency simplex and mobile relay operation, 72 frequencies will be needed for dispatching use.

Channels for coordination, surveillance, tactical use, etc., are estimated to require an additonal 40 frequencies based on the following:

- Estimated 200 radios
- 50 radios/channel loading
- Single frequency simplex.

The total radio frequency requirements in 1985 would therefore be approximately 112 frequencies representing some 76 channels for local law enforcement. The

TABLE V-4
1985 Requirements Local
Law Enforcement Communications

Total projected State population	3,662,450
Deployed radio units* (busy shift)	1,070
Dispatch channels (frequencies) (30 radios/channel)	36 (72)
Coordination channels (frequencies) (50 radios/channel)	20 (20)
Surveillance channels (frequencies) (50 radios/channel)	20 (20)
Coverage area of dispatch channel	One town minimum (Depends on system design concept)
Coordination objectives:	State Police Adjacent local police departments Local fire departments Ambulance/rescue (EMS) Others as required locally

* Includes radios used in local law enforcment by all concerned (State Police, local police departments, constables).

allocation of radio frequencies among local law enforcement agencies must consider current equipment status as well as propagation characteristics of the bands involved. Of primary concern is the physical separation of networks operating on the same frequency. For example, two-frequency simplex operation requires approximately 60 miles separation between base stations (each with a desired coverage radius of 17 miles) to avoid excessive interference at mobile receivers from the undesired base stations. This separation affects the reuse of frequencies, and can be reduced if smaller coverage areas can be accepted.

Considering the dimensions of the State, it appears that some reuse may be possible at the extremities, slightly lowering the total number of required frequencies; nevertheless, the total frequency requirements remain substantially the same as present assets (107 frequencies), assuming network reorganization can be accomplished. If the current approach is continued, total frequency requirements will be much higher, and unless a large block of channels becomes available, the present situation of crowded channels and interference will become more severe.

The requirements developed above represent Statewide totals and are summarized in Table V-4. Requirements of the individual departments must be considered in light of an overall State concept for local law enforcement communications. Further efforts in this area then will include evaluation of consolidated, shared, and centralized dispatching concepts and alternatives for coordination among law enforcement and other agencies.

(2) Fire Radio Service

Connecticut is provided fire protection by over 300 primarily volunteer, local fire departments. All towns presently have one or more fire departments. These are supplemented by the firefighting resources of the Forestry Unit within the Department of Environmental Protection, and numerous individual fire facilities at large institutions such as airports, hospitals, and universities. Although each department is autonomous, 14 county and regional fire service organizations have developed within the State. Within these regions, mutual aid agreements among the participating local departments have established coordination and cooperation.

TABLE V-5
Operational Communication Needs

1. REGIONAL OPERATIONAL NEEDS

CATEGORY	ALTERNATIVES (Nonexclusive)	RADIO REQUIREMENTS
Public Access	- 911 - Single Emergency Number - Free Emergency Number - Call Box	Call Box Channel
Dispatch	- Regional Center to Local Department - Regional Center to Mobiles	Dispatch Channel Remote Base Control
Within Region Coordination	- Local Department to Department - Mobile to Mobile - Agency to Agency - Mobile to Mobile	Coordination Channel(s)

2. LOCAL OPERATIONAL NEEDS

Public Access	- Direct from Public - Through Regional Center	N/A
Dispatch	- Local Base to Mobile - Regional Center to Mobile	Dispatch Channel
Working Fire	- Portable/Portable - Mobile/Mobile - Remote Equipment	Working Channel(s)
Coordination (Mutual Aid)	- Mobile/Mobile - Base/Base - Agency/Agency	Coordination Channel

1. Summary of Survey Findings

Basically, three levels of radio communications exist:

- Statewide system on 46.16 MHz
- County or regional systems on area frequencies
- Local communications using area or department frequencies.

An interface presently exists between the State and county fire radio networks and between the county networks and individual departments. Interfaces also exist between these networks and other agencies. Essentially, the system consists of a Statewide frequency on 46.16 MHz designated for interregional coordination, dedicated regional frequencies available to all departments within the region, and certain individual communications channels.

The fire services can effectively coordinate through their existing State and county mutual aid frequencies. Deficiencies continue to exist, however, because not all departments participate or are equipped with the county mutual aid frequency, and many departments utilize the mutual aid frequency as their primary channel for normal daily operations.

To overcome these deficiencies, some counties have licensed secondary frequencies for normal operations. However, this has been hampered by a lack of usable frequencies.

2. Projected Radio System Requirements

Communications requirements are categorized by the type of operational objective that is served by the information link. For fire services, these operational objectives are generally.

- Public access
- Dispatch
- Firefighting
- Coordination.

Furthermore, these operational objectives must be considered on both local and regional levels. Table V-5 lists these operational needs, alternatives, and radio requirements.

These needs are perceived as generalized communications requirements for fire service. The specific requirements for fire service of a particular department are determined by factors peculiar to the local environment.

Superimposed upon the regional and local needs are requirements peculiar to State operations such as interface with national warning systems, weather services, and State agencies, principally for purposes of coordination and dissemination of information.

A potential requirement is the capability to input and retrieve information from a State fire information data base. The information system is expected to be established in response to the need for obtaining, processing, and providing fire data to the National Data Center. Access to the data base would be required from regional dispatch centers and centers in larger cities. It is anticipated that, in time, a substantial amount of fire data will be accumulated and will need to be made available. The principal source of data would be fire reports, although other information would probably be accommodated (e.g., fire equipment inventory).

It is believed that population growth will not be a major influence on communication requirements. With over 300 local fire companies currently providing 100 percent Statewide coverage, expansion can be expected to be accommodated within existing departments. Thus, the effect on communications will be the addition of individual equipment. Present capacity is, in general, thought capable of handling the additional traffic.

A major influence that has been difficult to assess is the establishment of regional dispatching centers. EMS regional plans involve many different approaches to consolidation. The potential impacts upon operational fire service communications requirements appear to be in public access, dispatching and coordination, and the interconnections among the affected services. Fire and police departments will be relinquishing their participation in medical aid service where such arrangements exist. Requirements arising from this transition are recognized as peculiar to each EMS region.

A possible additional influence on 1985 operational requirements will be the availability of technological advances in personal communications gear and remote sensing and controlling equipment.

In summary, the 1985 operational requirements are believed to be similar to those of 1975. However, the existing communications systems are expected to evolve through refinements and improvements.

Connecticut is provided 100 percent land area fire protection by its numerous local departments. Presently, 14 mutual assistance regions exist within which internal coordination and dispatching communications links are in use. For those communities which are candidates for mutual aid participation, there is a requirement to identify the optimal geographic or political boundaries for formal regional coordination and cooperation. These may be on a county, county portion, or multiple county basis. Within these areas, regional communications links for coordination and dispatch must be provided.

State agencies and departments which interface with the Fire Service were identified. Table V-6 lists those coordination communications links that <u>are</u> considered essential and need to be accounted for in any future organizational structure, possibly by radio. The presentation illustrates the differing implications of coordination at a regional vs. local basis.

TABLE V-6
Coordination Communication Requirements

1. RADIO COORDINATION REQUIREMENTS FOR REGIONAL MANAGEMENT CENTERS

   - State Police
   - Local Police
   - Emergency Medical Services
   - Civil Preparedness
   - Other Regional Centers
   - Department of Environmental Protection (Forestry Unit)

   OTHER POSSIBLE REQUIREMENTS

   - Unique Categories (Individual Hospitals, Large Institutions, Universities, Airports, etc.)

2. COORDINATION REQUIREMENTS FOR LOCAL FIRE DEPARTMENTS
   (Direct or through Regional Management Center)

   - All of the Categories Above
   - Regional Management Centers
   - Other Departments in Mutual Assistance Regions
   - Other Departments involved in local Disaster Plans

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Regional requirements, most often on a point-to-point or base-to-mobile mode, include law enforcement, medical, and civil defense agencies. Other potential coordination requirements include links with agencies involved in firefighting activities, hospitals, universities, airports, and so forth.

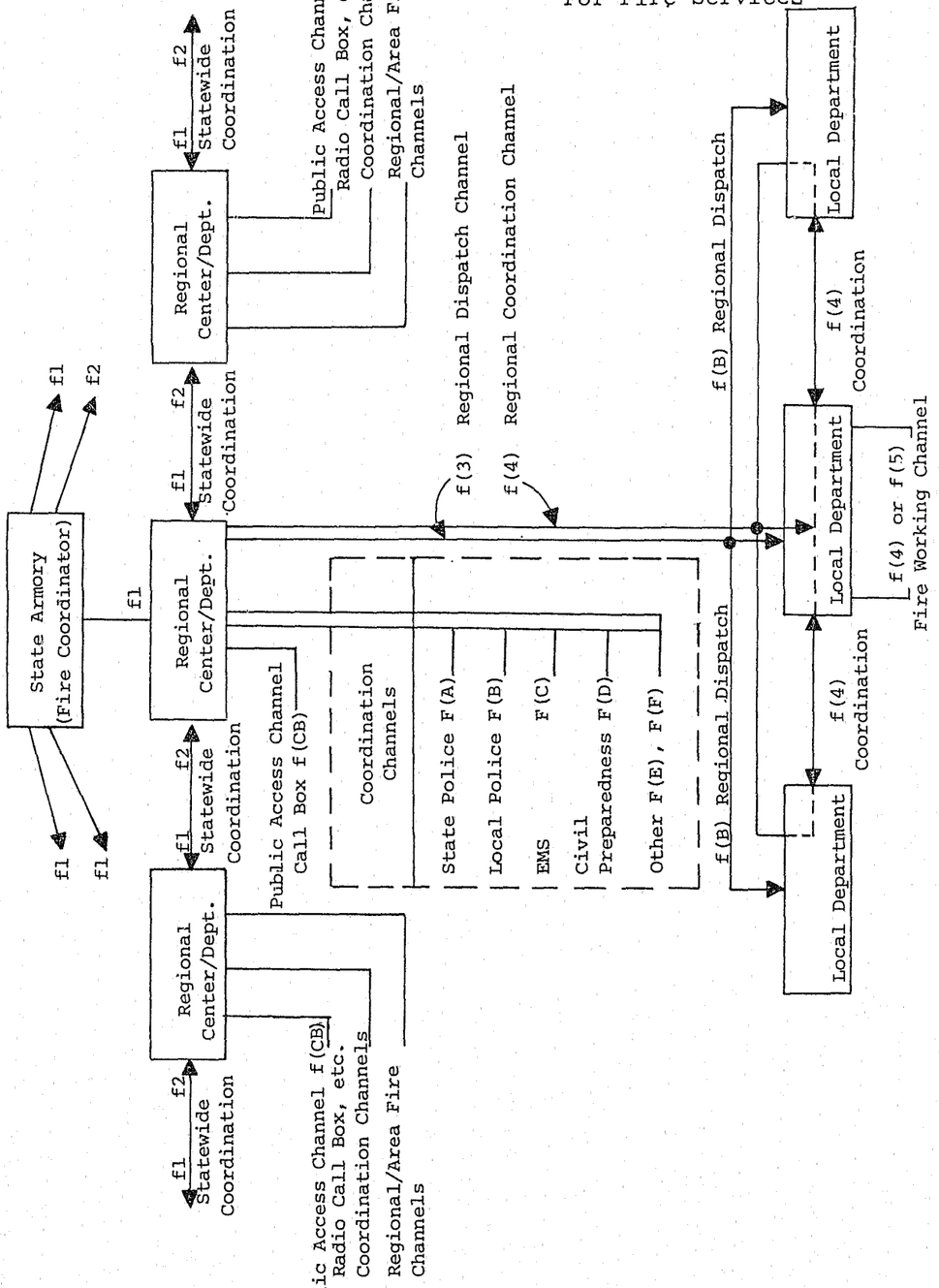
Local coordination requirements primarily involve links between individual fire departments within a region, usually base-to-mobile, mobile-to-mobile, and portable-to-portable operations. In addition, local coordination is often required with the same agencies identified as needing regional coordination. These links are satisfied (depending upon usage) through direct cross-band operation by the local departments or on a regional basis through some central coordination capability.

Review of the inventory collected in Report 1 reveals that there are conservatively at least 300 base stations and 2,000 mobiles operating in the fire radio service. The majority of frequencies used are in the VHF low band.

It is difficult to quantify anticipated equipment replacements. Radio systems are often costed on a life span of 10 to 15 years. System lifetime is related to the type of equipment, frequency of use, as well as environmental factors. It is possible that a majority of the existing equipments will require extensive repair or replacement in the next 10 years. Depending upon the adequacy of the present system to satisfy existing and future needs, these equipment replacements could provide the opportunity for improving the present system. On the other hand, it may be more desirable to effect system improvements through a definitive implementation program. In this case, incentives must be provided for replacement if premature retirement or modification of existing facilities is found necessary.

In either event, with the present inventory, Connecticut has much of the equipment and many of the frequencies it needs for an effective system. It is probable that a redistribution of these resources, based upon Statewide considerations, would provide improved service.

EXHIBIT V-9
Conceptualized Statewide Operational
Communications Requirements
For Fire Services



Referring to the operational objectives served by radio communications channels in the fire services, there are Statewide requirements for intra-regional coordination channels as well as regional and local requirements for individual company coordination and disptach channels. These requirements are illustrated in Exhibit V-9.

Two frequencies, [f(1) and f(2)], are for Statewide point-to-point and mobile-to-mobile communications, primarily at regional levels. Further, at the regional level, coordination channels with other public safety agencies [F(A) to F(F)], dedicated regional dispatch and mutual aid channels [F(3) and f(4)] and public access channels f(DB) are identified requirements. Within a region at the local level, each department requires common dispatch f(3) and coordination channels f(4) as well as dedicated working channels f(5) if required for its own use.

Although a conceptual presentation, these system requirements are presently fulfilled in many areas of the State. A Statewide coordination frequency is in use. Each county has a designated regional coordination channel frequency. The Tolland County mutual aid system utilizes many of the indicated required coordination channels. The capacity to fulfill these channel requirements on a Statewide basis appears to be within reach.

In order to determine the total number of communications channels and, in turn, the number of frequencies that would be required if this concept were employed, varying numbers of subregional organizations and channel-sharing arrangements were assumed and their effect on requirements analyzed. Channels for coordination with other agencies were excluded from the analysis, since these agencies are licensed on their own frequencies. Table V-7 lists the results of this analysis.

TABLE V-7
Channel Requirements

Number of Regions	Statewide Channels	Regional Dispatch/ Coordination Channels	Station Channels	Total
1	2	-	75 (4 depts./ch.)	77
10	2	20	50 (6 depts./ch.)	72
14	2	28	38 (8 depts./ch.)	68
20	2	40	30 (10 depts./ch.)	72

If there were no subregional areas, two Statewide and approximately 75 station channels are required (assuming 300 departments, four departments sharing one channel). As the number of subregions increases to 10, station channel requirements decrease to 50 (one channel shared by six departments) since it is assumed that much of the former traffic an be handled on the regional dispatch and coordination channels. For some regional areas, a minimum of required total channels is obtained. After this point, additional regional dispatch and coordination channels are not offset by a cooresponding decrease in the number of station channels, and further subdivision leads back to the present situation with each department operating relatively independently.

It would appear that, with 62 frequencies already licensed in the State, a redistribution of assignments would improve capability. Redistribution cannot be expected to occur easily, however, since individual license holders will be reluctant to relinquish their frequencies. It is inevitable that additional frequencies will be required in the future. Thus, the total number of channels and frequencies will undoubtedly be greater than the number of required frequencies.

(3) Emergency Medical Services

The Connecticut Commission on Hospitals and Health Care is the State agency responsible for coordinating the development of emergency medical services (EMS). Much comprehensive study and analysis of EMS in the State has been performed. The earliest of these efforts was the Report to the Governor by the Yale Trauma Program, Department of Surgery, Yale University School of Medicine in December 1972. Much of the data collected during this effort has been used to formulate new plans. MOre recently, the EMS Division of the Commission on Hospitals and Health Care prepared a Statewide program plan for EMS, "Emergency Medical Service in Connecticut, 1975," as an integral part of its grant application for Federal assistance under the EMS Systems Act of 1973. The radio system requirements presented here are substantially derived from these reports.

1. Summary of Survey Findings

Essentially, three categories of EMS radio system equipments are:

- Hospital systems
- Ambulance systems
- Dispatching systems.

Of the 65 hospitals in Connecticut listed by the American Hospital Association, 37 provide emergency service treatment. Two-way emergency medical communications capability is reported by 27 hospitals. However, only eight hospitals can communicate directly with an ambulance vehicle. The balance of 19 hospitals with two-way radio communications are limited to point-to-point radio communications between hospitals. There are ten hospitals with emergency room service that report no two-way medical service radio capability.

The survey conducted by the Yale Trauma Program in 1971 located 183 ambulance companies in Connecticut of which 166 provided emergency medical ambulance services. These consist of 76 volunteer companies, 54 municipal agencies, 35 commercial companies, and one hospital-operated service. These 166 agencies operate approximately 200 emergency vehicles which are located throughout the State. Although the Connecticut Ambulance Commission requires two-way radio equipment only in ambulances for hire, all but three ambulance operators report two-way radio capability. The predominance (73 percent) of fire department, police department, and other municipal agencies as operators of ambulance services has created a wide dispersion of radio frequencies in VHF range for EMS. The Yale survey shows 52 radio frequencies used for two-way communications by 98 ambulance services who dispatch approximately 200 vehicles. This is listed in Table V-8.

TABLE V-8
Distribution of Ambulance Dispatch Frequency

Number of Ambulance Operators	Number of Different Radio Frequencies	FCC Service Classification
59	15	Fire, Public Safety
14	13	Police, Public Safety
12	12	Special Emergency
4	4	Government/Local Govt.
4	4	Land Transportation
3	3	Business
2	1	Special Industrial
98	52	

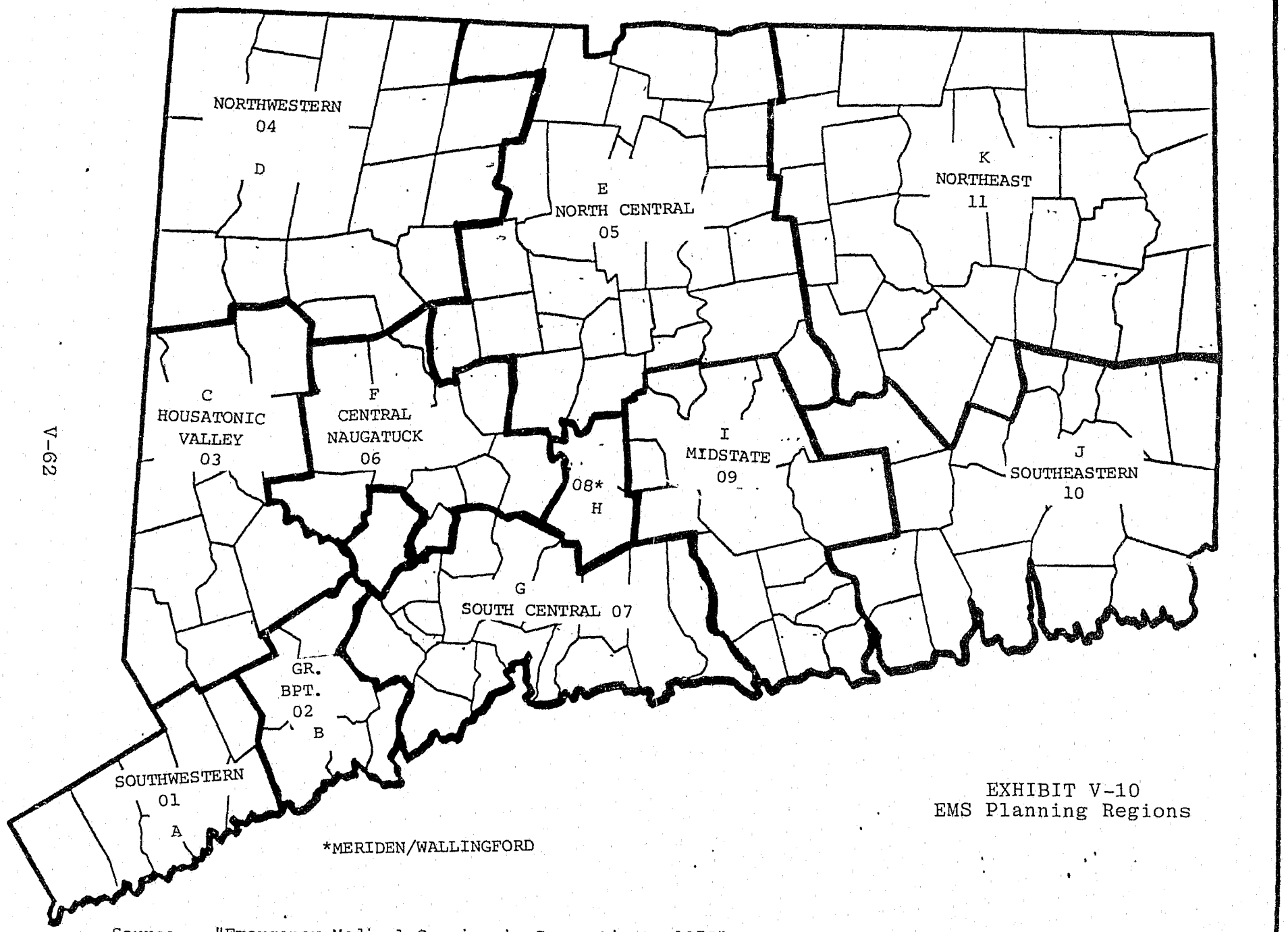


EXHIBIT V-10
EMS Planning Regions

Source: "Emergency Medical Service in Connecticut, 1975"

More than 80 percent of all EMS calls that require an ambulance are made to the local fire and police agencies. The number of these agencies that serve as input agencies to the emergency medical system are:

- Local police - 89 agencies
- State police - 11 barracks, 49 resident troopers
- Fire/rescue - 310 municipal or volunteer agencies.

Police and fire agencies dispatch 81 percent of the municipal ambulances and 65 percent of the volunteer ambulances. These two groups represent 78 percent of all ambulance resources available for EMS. However, only 31 percent of the municipal ambulances and only 14 percent of the volunteer ambulances are disptached by radio. Of the commercial operators, 90 percent dispatch their own equipment using at least 20 different radio frequencies.

Point-to-point hospital radio service on 155.340 MHz covers only 22 of the 37 hospitals that offer emergency room services. Adequate point-to-point emergency medical communications should include all 37 hospitals and provide coordination with other disaster control agencies such as the Civil Defense Communication Centers within the State. Also, none of the studies have shown adequate planning relative to interstate radio communication with hospitals and emergency services of the states adjacent to Connecticut. This point-to-point radio communications service should be different from the ambulance to emergency room radio services.

Only eight of 37 hospitals report the capability of two-way radio communication with ambulance vehicles at the scene or en route to the hospital. Of the eight, only two hospitals show direct communication between the emergency room and the ambulance.

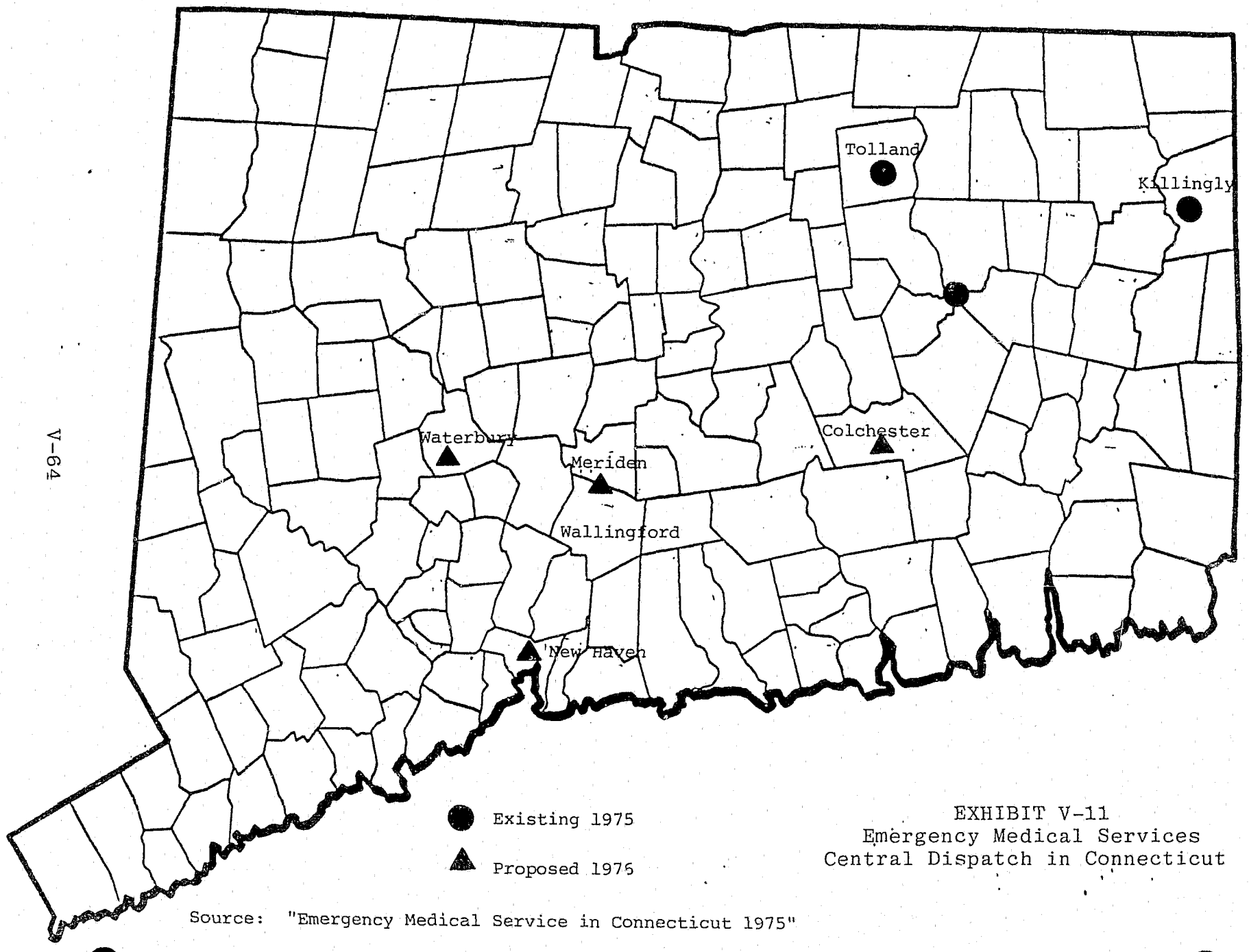


EXHIBIT V-11
Emergency Medical Services
Central Dispatch in Connecticut

Source: "Emergency Medical Service in Connecticut 1975"

Only 12 percent of the ambulance companies are capable of direct ambulance to emergency room two-way radio communication; this is using simplex and half-duplex. Data shows that 77 percent of all ambulance vehicles must exchange clinical medical information by simplex radio to the dispatcher and by telephone from the dispatcher to the hospital. A direct duplex radio channel is called for between the ambulance and the hospital emergency room.

Conservation of frequency resources necessitates reduction of the 52 frequencies now used to dispatch approximately 200 ambulance vehicles. Twenty-eight of these frequencies are associated with either fire or police public safety use and, being multiple service use frequencies, could not be recovered for other uses. However, 23 frequencies have only one user each. A channel loading analysis will likely indicate that significant conservation is possible through channel sharing. The largest concentration of ambulance vehicles in any one area numbers approximately 25 vehicles, making joint dispatching and channel sharing an attractive objective.

2. Projected Radio System Requirements

This subsection summarizes EMS radio requirements as identified in "Emergency Medical Service In Connecticut, 1975."

Emergency medical services require communications links pursuant to their operational needs. These have been categorized as:

- Public access
- Dispatch
- Clinical communications
- Coordination.

In their report and EMS communications plan, the Connecticut Commission on Hospitals and Health Care has addressed all of these areas. Public access medical emergency numbers are proposed; 911 systems for recovery of all emergency calls are encouraged. Eleven EMS regions have been defined as indicated on Exhibit V-10. Existing or proposed central dispatch centers are illustrated in Exhibit V-11. Utilization of the new UHF frequencies by the ambulances and 37 hospitals is proposed and communications zones (see

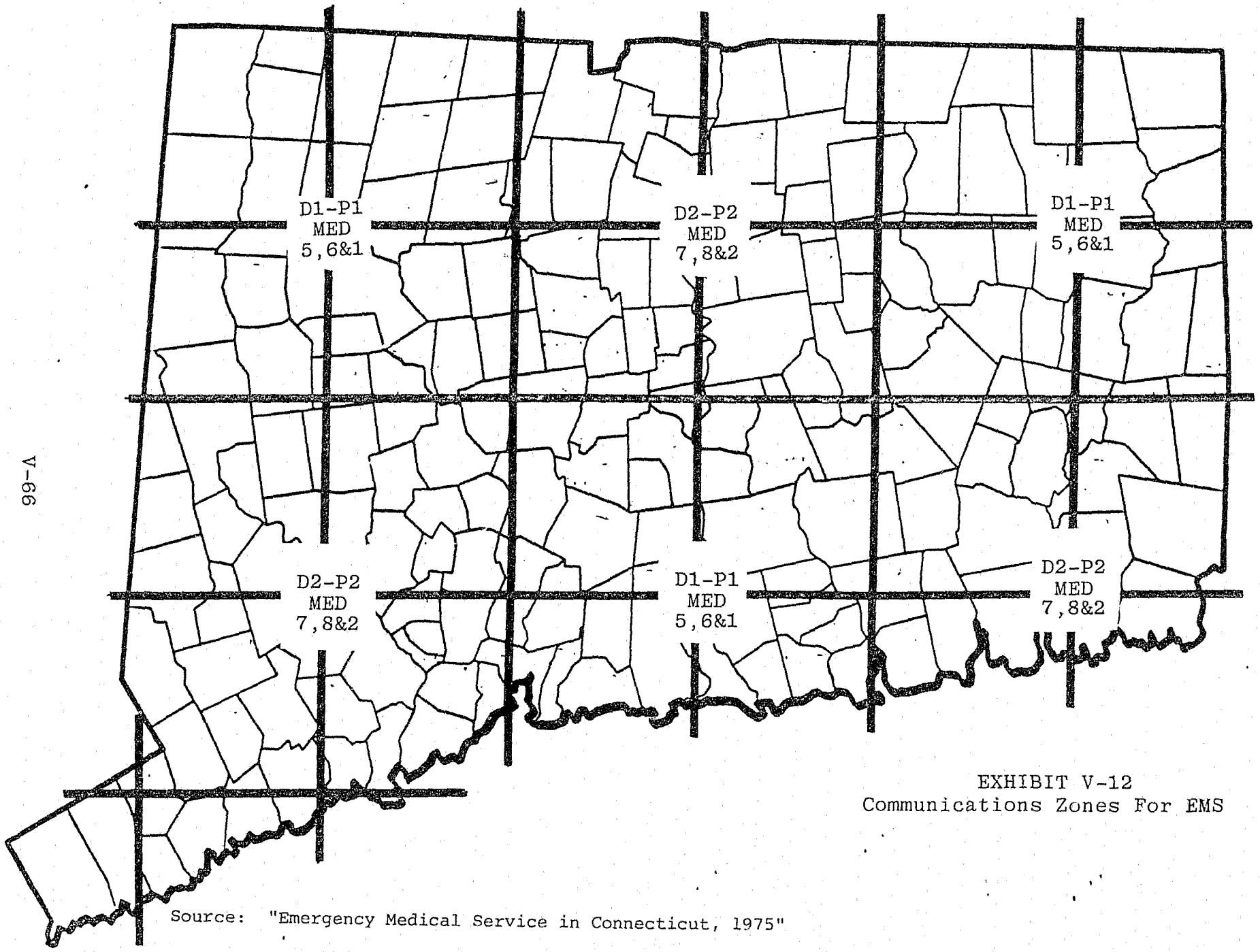


EXHIBIT V-12
Communications Zones For EMS

Source: "Emergency Medical Service in Connecticut, 1975"

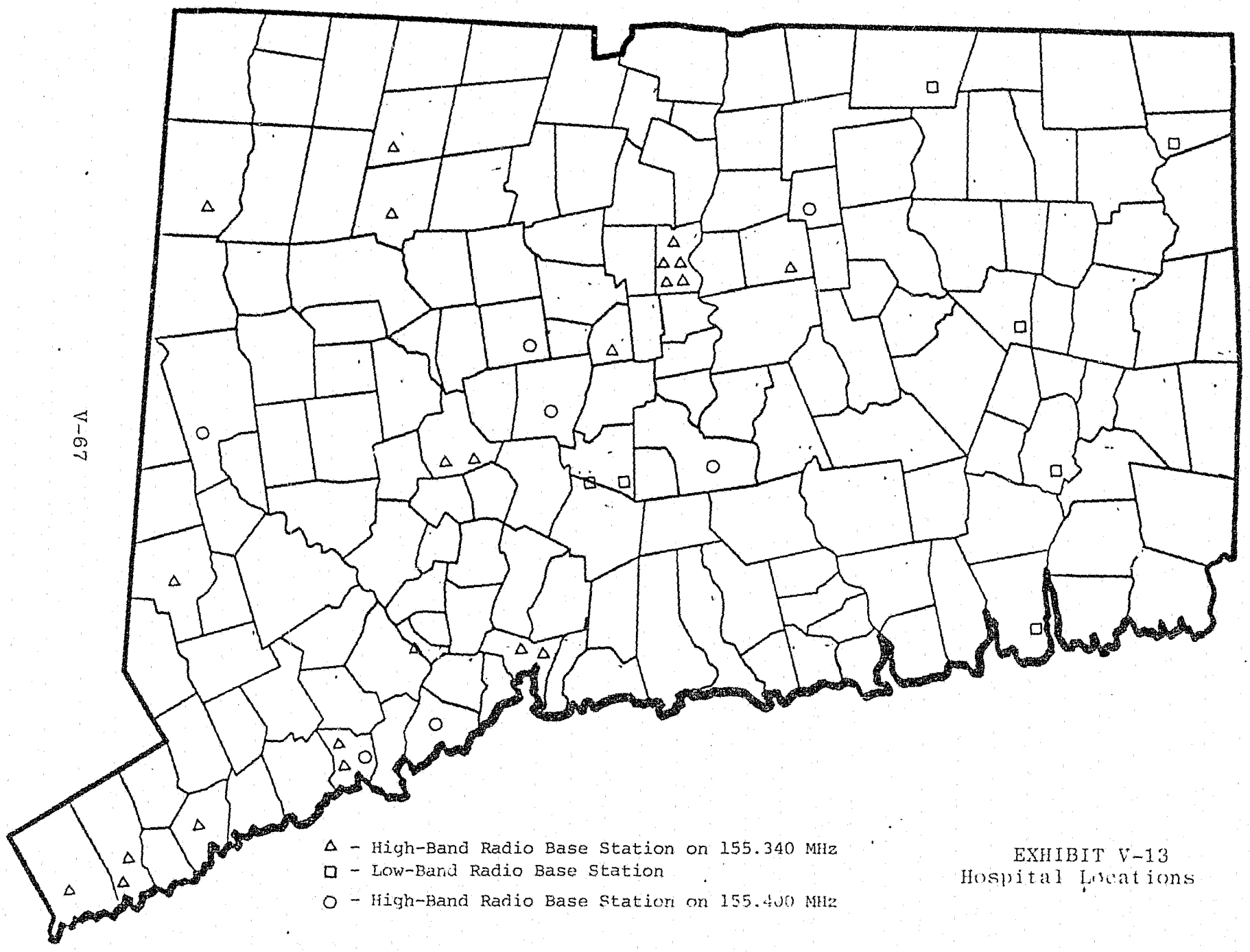


EXHIBIT V-13
Hospital Locations

TABLE V-9
EMS Coordination
Requirements

EMS Coordination Requirements

Component	Coordination Requirements
Hospitals	- Other Hospitals - Dispatch Centers - Disaster Agencies - Public Safety Agencies . Law Enforcement . Fire
Ambulances	- Other Ambulances - Adjacent Regional Hospitals - Law Enforcement Mobiles - Fire Service Mobiles
Regional Management Dispatch Centers	- Other Centers - Hospitals - Disaster Agencies - State Level Agencies - Unique Regional Resources - Public Safety Agencies . Law Enforcement . Fire

Exhibit V-12) have been created to coordinate frequency utilization. Coordination is achieved through a Statewide calling channel hospital radio network and interagency communications. The proposed system should satisfy all existing operational requirements.

Future requirements were identified by examining historical data on emergency service utilization. Emergency calls have increased at an 11:1 ratio over the population rate increase recently. A 27 percent increase in 1985 (3.853 million) over 1970 (3.032 million) population has been projected. Should the 11:1 ratio for calls for service versus population hold, almost three times (294,000) the number of calls for service in 1970 (98,000) can be expected in 1985. This estimate is unlikely to be exceeded. The major operational implications involved concern dispatch radio channels and the number of additional ambulances that will require radios.

Reliable communications must be provided wherever there is a likelihood that a link may be required. This involves different coverage areas for the differing communications subsystems. Several large centralized dispatching systems exist or are proposed. These centers require links with the ambulances and hospitals within their defined service area. Similarly, the hospitals require links with the ambulances and dispatch communications centers that serve them. Each EMS facility has a defined service area, within which its communications requirements will be satisfied. Exhibit V-13 locates those hospitals which presently have radio capability. Finally there is a requirement that the sum of these individual coverage areas will provide 100 percent Statewide coverage and, that at least one coordination channel meets this requirement individually.

Numerous information exchanges are not directly related to the provision of EMS but are important for effective overall management of all the public safety services. Communication links in this category are presented in Table V-9. In addition to the normal communications modes, hospitals often require emergency consultation with other hospitals and regional public safety system resources. Similarly, ambulances need the capability of exchanging information with operational mobiles and units of other services. Regional centers will serve as coordinators for the emergency service activities within their service area. As indicated, their coordination requirements are similar but also include other regional centers and State level contacts.

TABLE V-10
Present Radio
Equipment Capabilities

Present Radio Equipment Capabilities

1. Dispatch Centers

93 of 169 towns have means of dispatching ambulances by radio.

2. Hospitals

Point-to-Point Radio Capability

High Band	155.340 MHz	22 Hospitals
Low Band	33.88 MHz	2 Hospitals
Low Band	Civil Defense	4 Hospitals

Hospital/Ambulance Radio Capability

High Band	155.340 MHz	6 Hospitals
High Band	155.220 MHz	1 Hospital
Low Band	33.10 MHz	1 Hospital

3. Ambulances

All ambulance companies - approximately 200 vehicles have two-way radio capability for dispatch.

17 ambulance companies have two-way radio capability with hospitals

Source: "Emergency Medical Service in Connecticut, 1975"

Table V-10 presents an overview of the present radio equipment capabilities.

Extensive upgrading of the EMS communications system will occur if the $2.5 million proposed budget for EMS communications improvements is approved and funded. New as well as expanded central dispatch centers will be funded and new medical communications capabilities for ambulances and hospitals will be designed and implemented. The specific standards governing the implementation of these new capabilities were developed by the Commission on Hospitals and Health Care. Specific equipment requirements have been created for each of the 11 regions within Connecticut.

Consideration must be given to system growth over the next decade. As projected, there will be a possible three-fold increase in numbers of EMS requests. This could impact the dispatching workload and number of individual channels required. Conceivably, the number of ambulances providing service could increase from the present 200 to nearly 600 by 1985. Not only will additional mobile radios be required for these vehicles, but the number of different dispatching channels will correspondingly increase.

Presently, 52 different frequencies are in use by EMS providers. More than the needed number of required channels are presently in use; this contributes to coordination problems. The standards developed by the CHHC and the new FCC rules clearly identify what channels are actually required. These are summarized in Table V-11.

TABLE V-11
Channel Requirements

Category	Channels	Frequency
Ambulance Dispatch	2, 2-frequency pairs (D1, D2)	UHF
Medical Coordination	8, 2-frequency pairs (one channel reserved by Connecticut plan) (MED 1-8)	UHF
Medical Paging	7 single frequencies (P1-7)	VHF high and low band
Medical Intersystem Coordination	2 single frequencies (MED 9, 10)	155.340 MHz 155.280 MHz

Source: Connecticut Radio Frequency Utilization Table
"Emergency Medical Service in Connecticut, 1975"

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This allotment allows considerable flexibility and will more and more become a national standard as new systems are designed and implemented. Interagency coordination channels have not been identified since cross band operation on individual agency frequencies can fulfill this requirement.

END