PREFACE

This Emergency Medical Communications (EMS) Plan contains general background information and information regarding Statewide EMS communications planning. The plan focuses on factors necessary to ensure proper compatibility, interface, and coordination of local EMS communications within a statewide system. It is difficult for a document such as this to convey all of the current information needed regarding emergency medical communications, or to keep up with continuous change in technology and regulations. Changes to the Federal Communications Commission's (FCC), (http://www.fcc.gov/) Rules directly influence system configuration and the use of radio frequency spectrum. Equipment offered by manufacturers is constantly changing. There are also frequent changes in federal, state, and local policies as well as in funding issues. These all influence the EMS communications system design philosophy. EMS communications systems are constantly being developed and improved.

INTRODUCTION

This plan is patterned after the NHTSA planning guides “Planning Emergency Medical Communications”, Volumes 1 and 2. This plan will discuss history, background, direction, goals, and objectives required to develop a new statewide EMS Radio Communications System. It will also discuss the features and benefits of using trunking technology and the advantages that an open standard based system can provide. The management and control of the system will be discussed as well as the availability of shared use by state and local agencies. This plan leads towards a more standardized statewide emergency medical communications network that will help provide effective EMS communications. It will provide direction on common use and system design parameters. It is not restrictive to the development of local EMS communications systems and is not intended to dictate.

Compatibility must exist among EMS communications systems. Personnel within each organization must realize that their communication systems are part of a larger system that will interact with other EMS operations around the state, as well as operating with other types of communications systems. Without compatibility, system development becomes counterproductive due to interoperability concerns between different systems, and also due to deficiencies in required communications needs.

COLORADO HISTORY AND BACKGROUND

Colorado EMS Agencies have been utilizing radio communications since 1948. Initially, systems operated in the 50 MHz frequency band and were very inefficient. This era of mobile radio technology communications evolved very slowly compared to today's rapid technological advancements.

In 1971 the Division of Telecommunications was created within the Department of Administration to be the central state agency responsible for communications systems used by State government. This division also provided technical assistance to EMS agencies. Today, the division is designated as Telecommunication Services within the Department of Personnel Administration. Over the years, Telecommunications Services has strived to keep up with the advancements in technology and system improvements. One problem encountered is that current systems were developed for different agencies, at different times, without the ability to integrate the systems into a single statewide network. Available technology also limited system capabilities.

EMS communications is sometimes mistakenly simplified to the purchase of two-way radio equipment to be placed in an ambulance vehicle, or facility, without any insight into how the radio equipment will be used or how it fits into the overall statewide communications and emergency medical system. It is often thought of as only an ambulance talking to a facility, rather than in the sense of communications as a whole. EMS communications should be contemplated in a more classical meaning of *communications:* That is, as exchanges required to convey information and to respond to medical emergency situations, rather than as just equipment required for communication.

EMS communications are the exchanges of information necessary for the emergency medical system to function. The need to communicate commences with the occurrence of an emergency medical incident and continues through all of the phases of the incident. This includes detection, reporting, response, medical direction, and coordination with other agencies necessary to effectively handle the situation. EMS communications end only with the full resolution of the emergency situation.

While information exchanges between ambulance and facility personnel is important to EMS communications, EMS communications involves much more. EMS communications must be integrated into the aggregate of public safety communications and be capable of responding to a wide variety of communications needs.

After receiving input from the EMS community, the FCC, through FCC Docket 19880 (1973), eventually changed the utilization and availability requirements for some Special Emergency Radio Service (SERS) frequencies. Ten UHF frequency pairs in the 450 to 470 MHz range were assigned for medical service communications, allowing for the incorporation of mobile relays (repeaters) and electrocardiogram (EKG) telemetry. Four additional UHF frequencies were assigned to allow the use of vehicle mounted repeaters that facilitate patient-side medical communications.

In 1993, the FCC adopted the report and order creating the Emergency Medical Radio Service (EMRS) as a Public Safety Radio Service under Subpart B of Part 90 of the FCC Rules. These rules became effective April 2, 1993. This culminated several years of persistent lobbying by many dedicated individuals and organizations, including the National Association of State Emergency Medical Service Directors (NASEMSD), the International Municipal Signal Association (IMSA), and the International Association of Fire Chiefs (IAFC).

The EMRS was created after many years of frustration as a result of blocked transmissions and delays of emergency medical communications caused by overcrowding and sharing frequencies with incompatible radio users within the SERS. EMS users now are recognized by the FCC as full participants in the Public Safety Radio Services and receive the same considerations as other participants, including access to shared frequency pools. Several of the EMRS frequencies came from SERS, including the ten paired UHF MED channels.

Eligibility to license radio transmitters in the EMRS is limited to "persons or entities engaged in the provision of basic or advanced life support services on an ongoing basis." To ensure that only eligible entities obtain license, the FCC further requires that a statement prepared by the governmental body having jurisdiction over the state’s emergency medical service plans accompany applications for station license in the EMRS. The applicant should also be included in the state's emergency plan or otherwise supporting the application." This governmental body in Colorado is the Telecommunications Services representative positioned at the Colorado Department of Public Health and Environment, EMTS Department.

EXISTING SYSTEMS

In order to develop a new EMS communications system, it is first necessary to evaluate both strengths and weaknesses in existing systems. A majority of the systems in Colorado were designed in the VHF and UHF spectrum with 1970's technology. These systems could easily meet the needs of the users when they were implemented. Current EMS communications is accomplished via VHF, UHF, or 800MHz mobile radios with extensive use of cellular telephones as an alternative link. These communications systems are regionally based and are built around regional or local dispatch centers. These regional communications systems have evolved based on politics, population, terrain, and resource considerations. These varied considerations have resulted in a communications system that is tailored to meet the specific needs and desires of each region in the state. Citizen access, paging, dispatch, on-scene EMT communications, transport to facility communications, intra-system and inter-system mutual aid communications, all revolve around the regional dispatch. The local dispatch is the focal point for EMS communications in each region. The local dispatch will typically coordinate the activities of numerous agencies such as police, fire, EMS, highway, etc.

In the early 1970's, the Denver metropolitan area began using a UHF based system to link ambulances with emergency departments. The system became known as the Patch Matrix system. The technology for the Patch Matrix System has not been upgraded since the original equipment was put into service. The capital cost to replace the existing system, coupled with the ongoing personnel costs, required that an alternative be developed and implemented. An interim solution was formed: The Telephone Patch Access System.

This service was designed and implemented to be a short-term fix for the older UHF radio based technology until a new modern system for community wide ambulance and facility communications could be achieved. In the past, EMS communications systems have developed on a localized or fragmented basis. This happened when no larger-scale direction or guidance for system development was available. EMS providers were left on their own to conceive and implement communications systems by whatever means might be available to them. This approach, or the lack of an approach, resulted in not having an organized emergency medical communications system.

Wide area and local or facility based systems are the two major system types currently in use. Facility and local based systems are those used by facilities and medical centers. These systems are limited to a relatively small area of operation. Wide area systems are those used by dispatch

authorities and EMS transport agencies that require coverage over a larger geographic area.

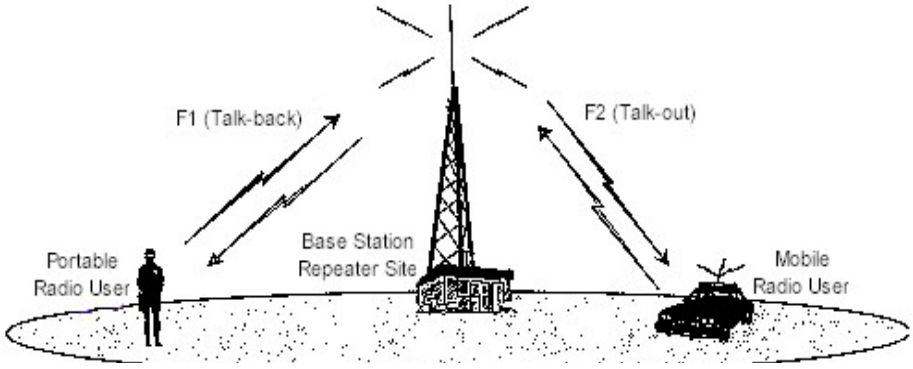
Both types of existing systems operate using analog transmission for voice only. Each agency is assigned a specific channel, or choice of channels, depending on their requirements. Operations for each agency are conducted on this channel(s), which during peak normal usage and major incident response, typically become over utilized. Each agency is restricted to operation on only their assigned channels. This type of operation is known as “conventional” technology.

The majority of the technology used in current systems was developed in the 1970’s. This technology severely limits the ability to use these systems for new applications. New equipment has replaced obsolete and worn out equipment, but the system technology (conventional / analog) has not been changed.

Since existing systems were developed for individual agencies during different time frames, many systems are redundant and provide the same coverage area and operational characteristics. This piecemeal implementation process has resulted in many problems, including the lack of a true statewide network, limited or no resource sharing, and poor or limited interoperability with other state and local agencies.

Most of the wide area and local area systems operate in the 150-160 MHz. range (VHF band), and in the 450- 470 MHz MED range (UHF band). A very limited number of systems operate in the 806-869 range (800 MHz. Band). Part 90 of the Federal Communications Commission Rules govern the operation of these systems. These rules also allocate a finite number of frequencies for specific uses. The type of use categorizes frequencies. This includes Local Government, Police, Fire, Highway Maintenance, Forestry Conservation, and Emergency Medical Services.

Typical Repeater Operation



The demand for these frequencies has exhausted allocations and it is virtually impossible to obtain new frequencies along the Front Range in either the VHF and UHF bands. Sharing of frequencies is a common occurrence resulting in system interference to varying degrees.

This problem is not unique to Colorado and is even more pronounced in heavily populated areas. This problem prevents expansion of existing systems and the creation of new systems when needed.

All of these characteristics provide the users with fragmented and inadequate networks. ***Many EMS agencies current requirements cannot be met simply because the old technology limits their ability to meet communications needs in today's information dependent society.***

RECENT DEVELOPMENTS

Recent developments have occurred in Colorado, which have an impact on the evolution of EMS and Public Safety Communication in this State. They are:

- **FCC Regulation Changes**
- **State Emergency Medical And Trauma Services Advisory Council**
- **Statewide Digital Trunked Radio System**

FCC Regulation changes

FCC Part 90 rules have changed regarding bandwidth in the VHF and UHF frequency bands. These changes will result in the eventual split of the current channels into four channels of narrower bandwidth. This change will encourage the implementation of the newer narrowband radio equipment or a move to 800 MHz. The State of Colorado has developed a plan to implement a statewide 800 MHz communications system that this plan is based on.

State Emergency Medical And Trauma Services Advisory Council

The Colorado Emergency Medical and Trauma Services Act was amended in July 2000 to create a state emergency medical and trauma services advisory council (SEMTAC). Telecommunications Services is represented on this council as "The manager of the telecommunication services of the Colorado Information Technology Services in the Department of Personnel, General Support Services, or the manager's

designee" in an ex officio, nonvoting position. A standing communications committee was formed by the council. A comprehensive communications plan is recognized as a necessary part of the emergency medical system.

Telecommunications Services, through the Colorado Department of Public Health and Environment, is available to provide technical assistance in developing a statewide communications plan. Telecommunications Services has a Digital Trunked Radio System Plan, which outlines a comprehensive, statewide, integrated communications system. This system is designed to utilize the newest radio communications technology to serve the needs of all state and local agencies including EMS.

Statewide Digital Trunked Radio System

The State of Colorado has completed several installation phases of the DTRS infrastructure that is enhancing communications for public-safety agencies in Denver, its suburbs, the metropolitan areas of Douglas and Jefferson counties and other areas of the State. It continues to be implemented in a series of phases.

Phase I of the project was completed in 1999 with partnerships developed between the State of Colorado, Douglas and Jefferson Counties. This method of partnering with local government has served as the model for current and future phases. The construction of up to 200 communications sites strategically located throughout the State are planned that will insure reliable communications to all participating agencies. As of today (January, 2006), there is seamless DTRS wireless coverage along the entire Eastern slope of Colorado and partial coverage on the Western slope. Infrastructure consists of 48 DTRS radio sites operating on Zone Controller-1 in Denver, 46 DTRS radio sites operating on Zone Controller-2 in Grand Junction and 20 DTRS sites operating on Zone Controller-3 in Loveland and 64 additional sites planned. Today there are over 430 agencies and approximately 23,000 wireless users using the DTRS. These customers are a combination of State, Federal and local government agencies.

When the statewide installation is complete, the 800 MHz Digital Trunked Radio System infrastructure will provide EMS, Trauma and public-safety agencies everywhere in Colorado access to sophisticated communications technology that would be much more costly for many agencies to purchase on their own. Installation and expansion of the system will continue as funding becomes available.

State engineers project the entire statewide system could include approximately 170 radio sites, most supporting approximately five channels. The system will provide approximately 95 percent mobile coverage throughout the state along major highways and will be compliant with the Project 25 standard for public-safety communications systems.

1998 / 1999 - Pilot Phase (Phase 1) - Complete

Deployment of the pilot phase of the digital trunked radio system equipment in the Denver metro area, which includes all or portions of the following counties:

Arapahoe	Denver	Douglas	Jefferson

Interoperability was accomplished immediately with portions of Jefferson, Arapahoe, and Douglas Counties with specific, but limited mutual aid resources.

During the rest of the phases, partnerships with local government agencies in all geographic areas are, or will be, established. These partnerships provide sharing of resources such as tower sites, equipment, and mutual access to compatible systems.

1999 / 2000 - Phase 2 - Complete

Deployment of the phase 2 of the digital trunked radio system equipment in the remainder of the Denver metro area which includes all or portions of the following counties:

Adams	Broomfield	Boulder	Clear Creek
Gilpin			

2000 / 2001 - Phase 3 - Complete

Deployment of phase 3 equipment in northeastern Colorado and the eastern plains which includes the following counties:

Cheyenne	Elbert	Kit Carson	Larimer
Lincoln	Logan	Morgan	Phillips
Sedgwick	Washington	Weld	Yuma

2001 / 2002 - Phase 4 - Complete

Deployment of phase 4 equipment in Southeastern Colorado which includes the following counties:

Baca	Bent	Chaffee	Crowley
Custer	El Paso	Fremont	Huerfano
Kiowa	Las Animas	Otero	Prowers
Pueblo	Teller	Park	

2002 / 2003 - Phase 5 – Partial build-out

Deployment of phase 5 equipment in Northwestern Colorado which includes the following counties:

Eagle	Garfield	Grand	Jackson
Lake	Mesa	Moffat	Pitkin
Rio Blanco	Rout	Summit	

2003 / 2004 – Phase 6 – Partial build-out

Deployment of phase 6 equipment in Southwestern Colorado which includes the following counties:

Archuleta			
Delta	Dolores	Gunnison	Hinsdale
La Plata	Montezuma	Montrose	San Miguel
Ouray	San Juan		

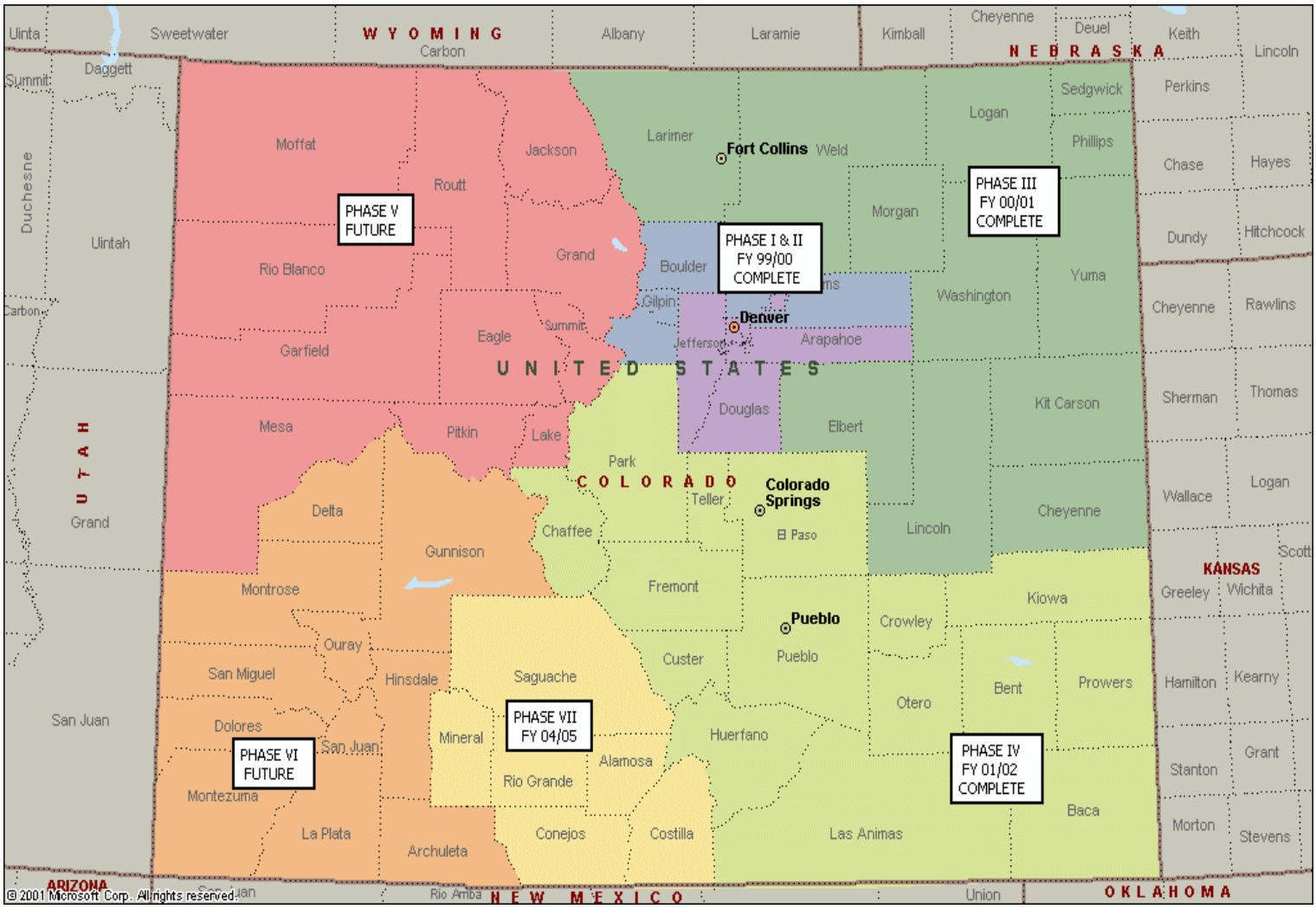
2004 / 2005 – Phase 7

Deployment of phase 7 equipment in Southwestern Colorado which includes the following counties:

Costilla	Conejos	Saguache	Alamosa
Rio Grande	Mineral		

Implementation dates assume funding is appropriated at amounts requested through the State's budget process or through Federal grants.

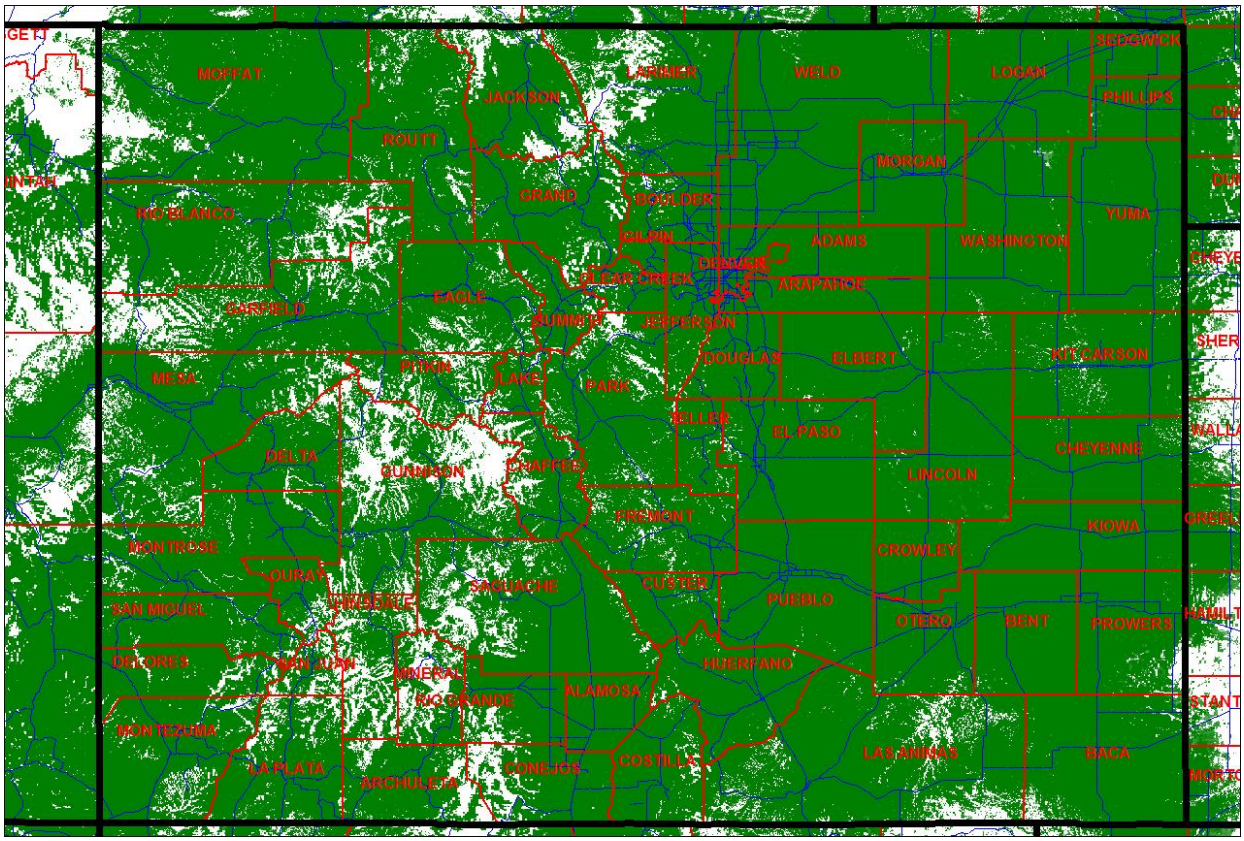
DTRS PHASE IMPLEMENTATION SCHEDULE MAP
As of 12/04



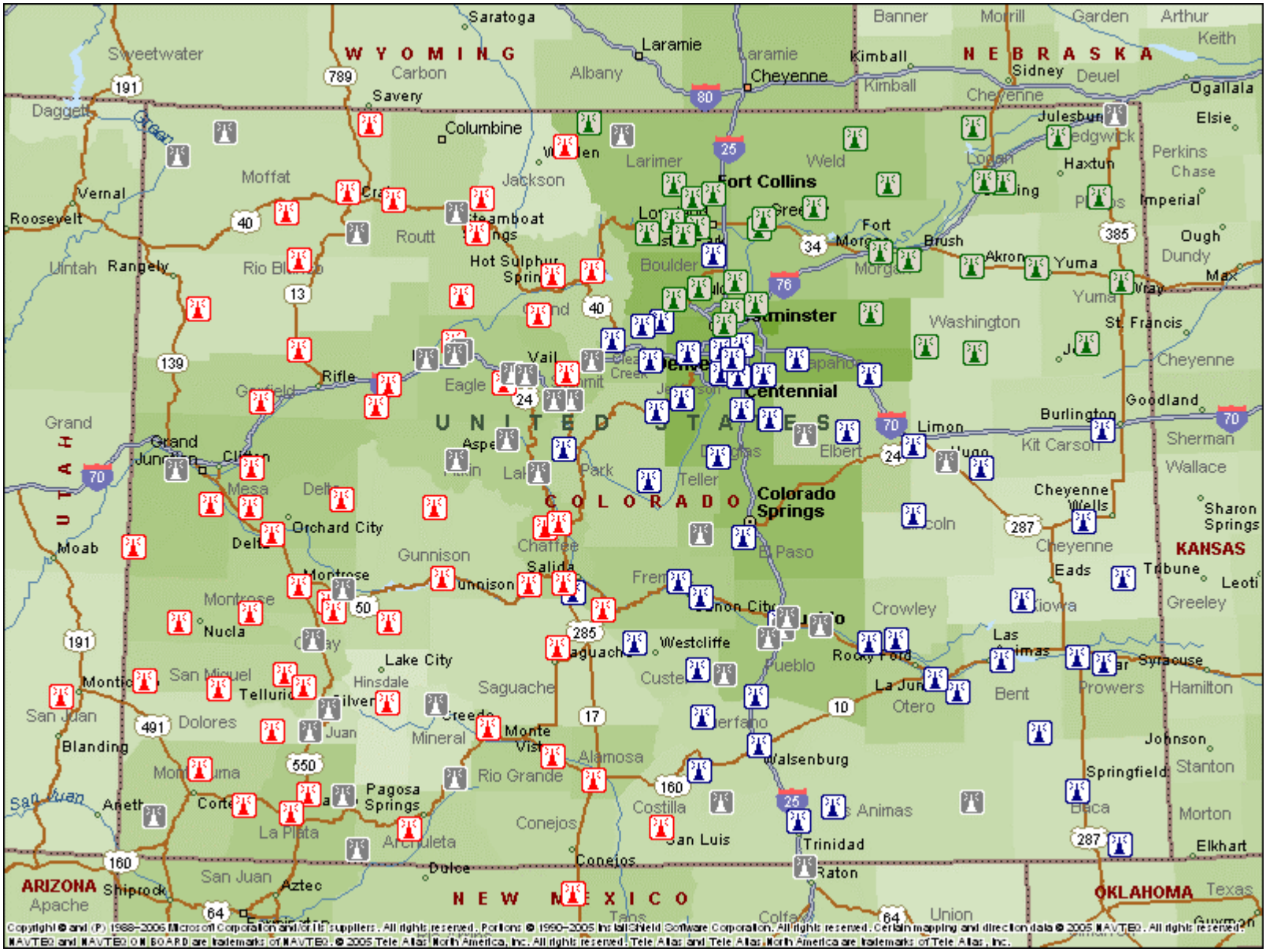
COLORADO STATE DIGITAL TRUNKED RADIO SYSTEM
MOBILE COVERAGE

After the DTR tower sites are built out, coverage on the statewide DTRS will be reflective of the map below.

State DTRS Build Out



State of Colorado Digital Trunked Radio Project August 2007



Blue indicates Sites on Zone 1

Red indicates Sites on Zone 2

Green indicates Sites on Zone 3

White on Grey indicates planned sites

Pushpins indicate approximate site location

Sites listed as of August 2007

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EMS COMMUNICATIONS NEEDS

The following EMS communications needs were derived from the Colorado Department of Public Health & Environment and the U.S. Department of Transportation planning guide. They show how the concepts of this discussion fit the Colorado EMS Communications plan to satisfy the national requirement of coordinated EMS communications.

1. Human health emergencies must be reported immediately to appropriate community agencies that manage and control EMS resources and services.

2. Appropriate EMS resources must respond to human health emergencies at any time and place.

3. Recognition of the need for and immediate response by EMS resources to life-threatening and serious human health emergencies must be provided quickly enough to maximize lifesaving and prevent serious, long-term disabilities.

4. EMS and other health organizations and professionals must marshal their individual and collective resources (staff, equipment, supplies, and facilities) and coordinate their responses in the shortest effective time to meet individual and mass human health emergency needs.

5. Dispatchers with special EMS training must provide guidance and direction via telecommunications to reporting parties at the scene of human health emergencies, pending the arrival of trained prehospital EMS personnel.

6. EMS must be coordinated with other public safety emergency services within the community through emergency operation centers or other means.

7. Special medical facilities such as emergency departments, intensive care and coronary care units, and burn and trauma facilities must be used as effectively as possible.

8. All appropriate vital human physiological information necessary during any health emergency must be transmitted from the site of the emergency to the proper monitoring and decision-making emergency medical professionals, and the medical facility should be notified of the number, condition, and estimated arrival time of patients.

9. Information on human health emergencies must be collected, recorded, and documented for EMS system managers to review, revise, and reorganize to meet changing conditions and needs.

10. Safe transfer between health care facilities must be provided for acutely and chronically ill patients.

11. Best use must be made of EMS and other medical resources in preventing or mitigating adverse effects of human health emergencies.

From this previous local and national EMS needs list of eleven items, the following EMS communications requirements can be extracted:

- *EMS Public Access* - Messages related directly to public access for reporting emergency medical situations to appropriate EMS-response organizations.

- *EMS Dispatch and Control* - Messages related to response, such as alerting, dispatching and controlling the movement of EMS units as well as providing direction to persons calling for help.

- *Medical Communications* - Messages related to patient care, transmission of physiological information and the exchange of patient assessment and treatment information among EMS personnel at the scene and medical personnel and physicians.

- *EMS Resource Coordination* - Messages necessary for effective EMS resource coordination relative to care and transportation of the patient.

- *Interdisciplinary Coordination* - Messages related to the coordination of EMS activities with police, fire, government, and other agencies or resources (such as public utilities and private contractors) that are required to handle EMS emergencies.

- *Disaster Coordination* - Messages related to the coordination of EMS, health, and medical activities with those of local, state and national disaster-response authorities.

OPERATIONAL DESCRIPTION

EMS communications begins with emergency medical incident detection and continues through personnel and equipment dispatch to respond to the emergency scene. Communications extends through the treatment of the patient at the scene and during the transportation of the patient to the facility. Emergency response must also be coordinated with other public safety services, such as law enforcement and fire services, and with other agencies involved in the emergency response.

The information exchanged is essential to effective EMS communications and is consolidated into the following five general categories or key points:

1. **PUBLIC ACCESS** to the EMS system.

2. **DISPATCH AND COORDINATION** of the resources, vehicles, equipment, and people required responding to the emergency.

3. **MEDICAL CONTROL COMMUNICATION**, including information exchange between the field EMS personnel and the facility, and the application of EKG telemetry when appropriate or required.

4. **INTERAGENCY COMMUNICATION**, consisting of that information exchanges necessary to coordinate the response of EMS personnel with those of the other public safety services.

5. **EDUCATION OF COMMUNICATIONS USERS** in communications equipment use, language and terminology standardization, medical dispatcher education and certification and standard emergency medical dispatch protocol development and use. Education also extends to citizens so they know whom to call, when to call, how to call, and what to expect when they call for emergency medical assistance.

EMS communications must take place between the people who operate and use the EMS system. To communicate effectively, they must know what information needs to be exchanged, whom to exchange the information with, and how to exchange the information. During the delivery of emergency medical services, communications are necessary between diverse groups of people who are at various locations.

From the scene where an emergency occurs, the people involved need quick access to emergency help without added confusion. The people involved need to talk to those who dispatch the field medical resources. The dispatchers should routinely monitor the field teams and vehicles to coordinate their rapid dispatch and provide them with directions to the

scene. The dispatcher may also advise the people at the emergency scene about how to take additional actions necessary to help preserve life or reduce suffering. Trained telecommunicators using a medically approved protocol should deliver this advice, sometimes referred to as “pre-arrival instructions”.

During the response, a dispatcher may need to communicate and coordinate with law enforcement, fire, or other agencies to coordinate EMS activities with these agencies. Interagency communications sometimes consists of requests from other public-safety agencies for emergency medical services.

After arriving at the scene, the field medical team needs to establish communications with facility medical personnel for medical control communications. The team also needs to send patient condition or status information to the facility or request medical direction and authorization. The situation at the scene may necessitate additional communications requirements. This is a particularly true in-large-scale emergency that involves several responding agencies.

When departing the emergency scene with a patient, the field team must notify the facility of the patient's condition as well as and the estimated time of arrival (ETA) so that the facility can be prepared for the patient. While the patient is en route to a facility or during emergency treatment, the facility receiving the patient may need to contact another medical facility for additional medical information or to arrange for transfer of the patient to a facility that provides a higher level of care.

When a field medical team travels outside of its normal service area to transfer a patient to a medical facility or to assist another area during a disaster, communications are necessary among that field team and medical facilities for coordination, notification and medical direction. These communications can provide assistance for people having difficulties (e.g., becoming lost or breaking down) or assistance in establishing necessary radio contact or frequency information.

When the field medical team has completed its response and leaves the medical treatment facility, it must report its operational status to the dispatcher. This action completes a typical EMS response cycle.

This brief overview of EMS communications and system operation shows the nature of communications involving five basic groups of people. These include:

1. The public needing emergency assistance

2. The dispatcher or telecommunicator
3. The field medical teams
4. The facility personnel
5. Other agencies involved in the emergency response

For the EMS communications system to function, the field teams, dispatchers, facility personnel, and the system users must know how to operate the telephone and radio equipment required for their communications. For example, the system users who use public telephones to call for emergency assistance must know which number to call.

The field teams dispatchers, telecommunicators, facilities and medical personnel must know how to operate their radio equipment and know the procedures for establishing and maintaining radio contact. ***If the people who must operate EMS communications equipment do not understand how the equipment or the system functions, they will not use it or may use it incorrectly.*** This lack of understanding leads to interference, miscommunication, confusion and frustration, which could result in system failure.

Education is a key point of EMS communications for local system administrators to consider. Education is perhaps the most important point. Knowledge and understanding of the EMS system is necessary so that the system functions smoothly and freely. These independent parts of the EMS system are people, including the system users, who administer EMS from their various locations. They must exchange information from their locations to coordinate activities.

PUBLIC ACCESS

IMPLEMENTING 9-1-1

Before emergency services can be rendered, the emergency service providers must be aware of the requirement for the service and the location where it is needed. In most cases, the request for service comes from the public citizen by telephone. Two problems exist with public access by telephone; delays or difficulties due to multiple emergencies or multiple telephone numbers, and the inability of the callers to effectively convey their needs or location.

Sometimes callers are unable to communicate effectively due to their lack of familiarity with an area, or because of communications barriers which can exist with persons who are blind, deaf, mute, or who speak a language other than English.

Some of the multiple emergency telephone number problems can be remedied by establishing a public safety answering point (PSAP) with a single number to call in a given area or district for all emergency services. The PSAP is usually part of an existing dispatch center or may be an autonomous agency established for this purpose.

CATEGORIES OF PUBLIC SAFETY ANSWERING POINTS

There are four general categories of public safety answering points (PSAP).

Referral - Personnel at the PSAP's answer the phone, ask pertinent questions, such as the nature of the emergency and location, and then advise the calling party of the proper number to call. The referral method is the least time-efficient and is not encouraged or recommended for any system and should be avoided unless there is no other option.

Relay - The PSAP answers the phone, acquires all necessary information from the caller and then relays the message to the appropriate agency. The caller does not interact or speak directly with the responding or dispatching agency and is not always available to answer further questions that may develop during a response.

Transfer - The PSAP answers the phone, asks pertinent questions and transfers the call directly to the appropriate responding agency. This method is more time-efficient and allows direct communications between the caller and the dispatching or responding agency.

Direct - The PSAP answers the phone, acquires all information from the caller, and then directly dispatches the necessary response units. This system is the most desirable.

CITIZEN ACCESS

The direct 9-1-1 PSAP system must be able to receive and process incoming calls that report emergencies and request emergency medical services. All citizens must be able to summon help rapidly in an emergency situation. A citizen must be able to call for police, fire, emergency medical service, rescue, and other emergency aid promptly, without confusion, and without having familiarity with a particular community. A system that is uniform locally, statewide, and nationwide could enable a citizen to do these things.

In areas where a 9-1-1 system has not been implemented, citizens must search through telephone directories for one of several separate police, fire, ambulance, and facility emergency department numbers when a medical emergency occurs. The lack of a 9-1-1-system delays emergency medical assistance, and in life-threatening and serious medical emergencies, can contribute to loss of life and permanent disabilities. Technically there is no reason why a basic or E-9-1-1 telephone number cannot be planned, engineered, and implemented by any county.

Upgrading basic 9-1-1 systems to 9-1-1 Enhanced systems may increase effectiveness of 9-1-1 services. With 9-1-1 Enhanced, the time required for processing individual 9-1-1 calls is decreased, permitting processing of a greater volume of calls per unit of time. This enables a system to handle the demands of a larger population and a greater volume of emergency calls during "busy hours."

9-1-1 SYSTEM DESCRIPTIONS

Basic 9-1-1 is the least expensive of 9-1-1 systems and is generally easy to implement if a telephone company's switching equipment can accommodate the change. When new equipment is installed, it is usually able to accommodate 9-1-1. Basic 9-1-1 can contain such features as Called Party Hold, Forced Disconnect, Ringback, and Dial Tone First.

9-1-1 Enhanced includes additional features beyond the basic 9-1-1 service, such as selective routing, which brings 9-1-1 calls into the appropriate center, depending on the area from which they originated. A telecommunicator assigned to calls from a specific area then can handle the calls. 9-1-1 Enhanced also includes the capability for automatic number identification (ANI) and automatic location identification (ALI), which flashes the caller's telephone number and address on the screen in front of the dispatcher. These features increase the reliability of a

response, as they enable the dispatcher to send help even when the caller is unable to speak. They also serve to reduce false or prank calls to the 9-1-1 center.

It is usually possible for a basic 9-1-1 system to convert to a 9-1-1 Enhanced system. It is less expensive when all municipalities agree to one public safety answering point (PSAP) and central dispatch, rather than maintaining separate dispatch centers, because of the lower costs created by reducing duplicated personnel and equipment.

WIRELESS E 9-1-1

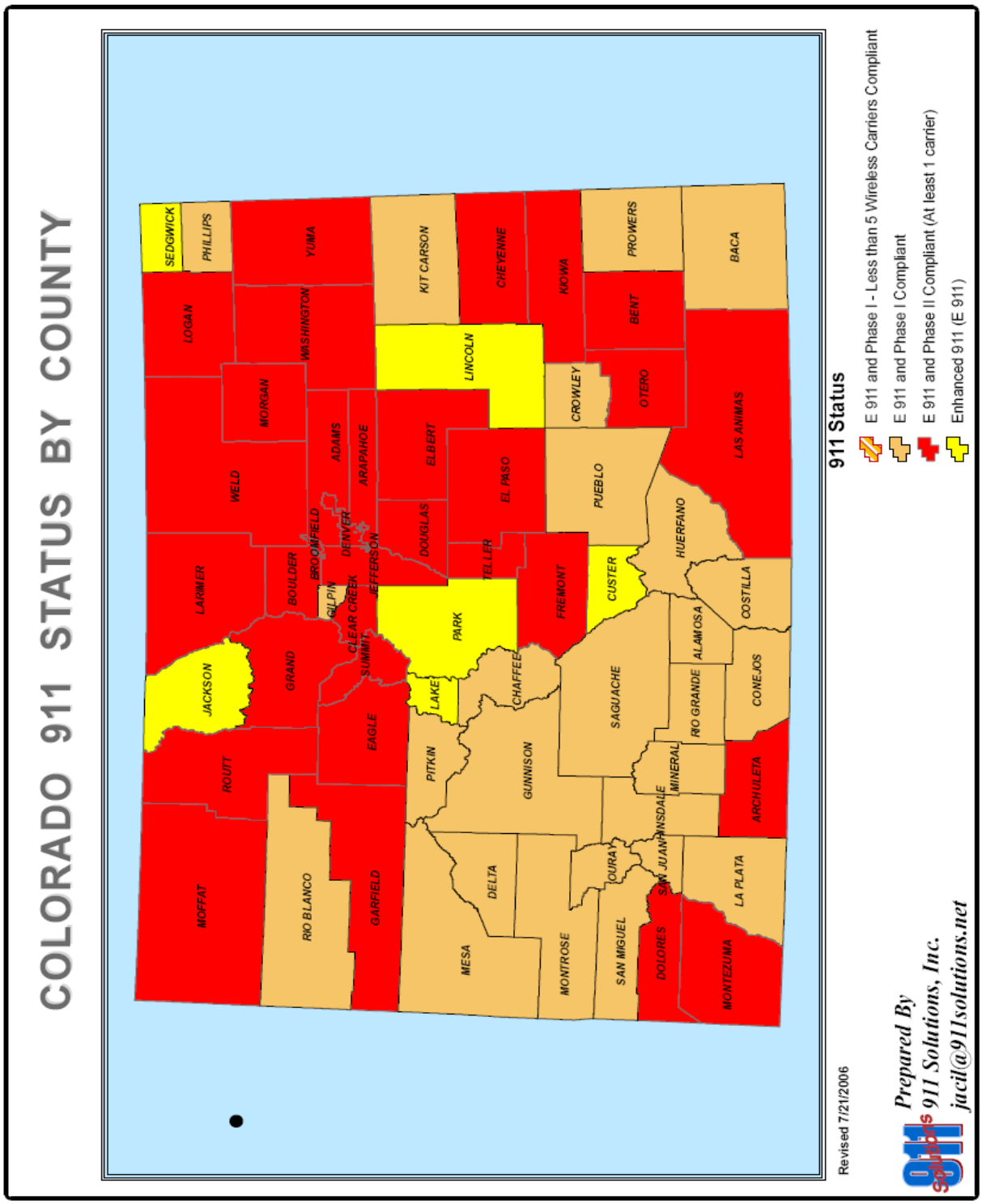
In 1996, the FCC adopted a Report & Order which established performance goals and timetables for the identification of the wireless caller's phone number and physical location when dialing the 9-1-1 emergency services telephone number. The rules apply to cellular, broadband PCS, and select Specialized Mobile Radio (SMR) carriers.

Under Phase I of the E 9-1-1 implementation, by April 1, 1998 wireless carriers must be able to identity the telephone numbers of their subscribers and locate subscribers to the nearest cell site. An analysis of the problem and the available technology indicate that these requirements can be met with relatively minor modifications to today's wireless networks, with no modification to user terminals.

Under Phase II of E 9-1-1 implementation, wireless communications carriers must be able to Locate 9-1-1 callers within one-tenth of a mile (a 125-meter radius) in 67% of all cases. This requirement must be met by October 1, 2001. These timetables and performance requirements for AU and ANI will be upheld under two conditions; the local government agency or Public Safety Answering Point (PSAP) shall request the E 9-1-1 information services from the wireless carrier, and a cost recovery mechanism for these services shall be established.

In an effort to spur wireless E 9-1-1 implementation, the FCC in February 1999, removed the requirement that a valid cost recovery mechanism be in place before a wireless carrier is required to process E 9-1-1 service calls.

As a result of these requirements several technology developments are underway to satisfy the FCC's E 9-1-1 mandate. Most are in early stages of development and it is unclear which technology will evolve to best serve E 9-1-1 callers. There are at least Thirteen (13) Development Projects underway using Angle of Arrival (AOA), Time Difference of Arrival (TDOA), Signal Strength, Smart Antennas, GPS, or multipath.


COLORADO 911 STATUS BY COUNTY
SEDGWICK
PHILLIPS
YUMA
KIT CARSON
CHEYENNE
KIOWA
PROWERS
BACA
LOGAN
WASHINGTON
LINCOLN
BENT
MORGAN
ADAMS
ARAPAHOE
ELBERT
CROWLEY
OTERO
LAS ANIMAS
WELD
BROOMFIELD
DENVER
DOUGLAS
EL PASO
PUEBLO
HUERFANO
LARIMER
BOULDER
GILPIN
JEFFERSON
TELLER
FREMONT
CUSTER
COSTILLA
CLEAR CREEK
PARK
ALAMOSA
JACKSON
GRAND
SUMMIT
LAKE
CHAFFEE
SAGUACHE
RIO GRANDE
CONEJOS
EAGLE
PITKIN
GUNNISON
MINERAL
ROUTT
ARCHULETA
MOFFAT
RIO BLANCO
GARFIELD
DELTA
OURAY
SAN JUAN
LA PLATA
MESA
MONTROSE
SAN MIGUEL
DOLORES
MONTEZUMA
911 Status
E 911 and Phase I - Less than 5 Wireless Carriers Compliant
E 911 and Phase I Compliant
E 911 and Phase II Compliant (At least 1 carrier)
Enhanced 911 (E 911)
Revised 7/21/2006
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DISPATCH & COORDINATION

EMS VEHICLE DISPATCH

On notification of the need for emergency medical service, the system must promptly dispatch EMS units to the emergency scene. The EMS system must keep track of the units and provide guidance that expedites vehicle movement to the scene, transportation to appropriate emergency medical facilities, and return to availability for further assignment.

A weakness of EMS communication systems in the past has been the lack of coordination between the various groups that are required to provide assistance in an emergency. Ambulance and rescue services, facility emergency departments, other emergency services provided by the fire service, law enforcement, and other public services have traditionally operated independently in many areas. Often, the only available communications link for this interagency contact is a cellular phone. Thus, emergency agencies have been poorly prepared to select and coordinate appropriate responses. They react much like the citizen who opens the telephone book to find a multitude of emergency numbers for various jurisdictional areas and types of services. This results in inefficiency, delays, and unreliable coordination of emergency response.

The procedures and equipment for communications between agencies must be regularly used and tested to ensure that the hardware functions properly and that personnel are familiar with and capable of operating the system.

MEDICAL EMERGENCY DISPATCH FUNCTIONS

A trained emergency medical dispatcher should continuously monitor the total emergency reporting system. On notification of an emergency, the dispatcher obtains information concerning the location and type of emergency and may provide advice on medical treatment for the victim before the arrival of a field medical team. The dispatcher also initiates and coordinates response by all agencies that are necessary to cope with the emergency.

The dispatcher directly dispatches emergency ambulance and rescue vehicles to the scene of an emergency in its service area or it may transfer necessary information to another dispatch authority. A dispatcher will make the decision as to the number of ambulances and type of emergency vehicles needed and will dispatch these to the scene of the emergency. Dispatchers must have the capability of activating a response by all EMS personnel and vehicles within their areas. The mode of activating this response or dispatch may be either by a direct telephone line to the emergency vehicle base or by radio on an appropriate

frequency. Where volunteer personnel are part of the system, some type of radio alerting capability is desired. Dispatchers should have two-way radio communications with the EMS vehicles to facilitate additional responses as the emergency is assessed by the medical team at the scene, as well as to dispatch additional EMS vehicles, wreckers, fire services, law enforcement officers, or to request special facility preparation.

Dispatchers must also continuously monitor the status of all EMS vehicles and field teams in their service areas so that the most rapid and effective response to an emergency can be initiated. Dispatchers must be able to determine the location of the emergency, provide direction and assistance to responding units, and monitor their progress.

The dispatcher should have direct communications with other emergency response agencies. This includes law enforcement, fire services, adjacent area dispatchers, and other local emergency support services. Communications with adjacent area dispatchers allows mutual backup and transfer of vehicles if necessary for emergency or disaster operations. The dispatcher also can be the receiving center for fire, police, and medical emergency requests. However, if this is not the arrangement, then the dispatcher must have direct telephone lines or other continuous communications capability to the fire and police agencies for coordination of an emergency response. This communication must take place rapidly, and without the possibility of confusion. Obtaining complete location, callback or location information is also required.

The dispatcher should have direct communications to all medical facilities involved with EMS in its service area. Current data on EMS treatment capabilities of all medical facilities and emergency support services in the service area should also be available. When requested, the dispatcher will use available facility resource information to direct the EMS vehicles to the nearest appropriate medical facility and notify that medical facility of the emergency type and estimated arrival time of patients.

The emergence of the World Wide Web has provided the dispatcher with another tool to coordinate activities.

The Colorado Department of Public Health and Environment has contracted with EMSystems for statewide use of its web-base communication tool created to streamline communications, support day-to-day information exchange and facilitate data collection on hospital emergency department status. Funding is provided (1/05) by The Health Resources and Services Administration through a grant known as the National Bioterrorism Hospital Preparedness Program. EMSystem meets the grant's requirement to establish a secure and redundant

communications system that allows connectivity among all agencies and healthcare entities responding to a terrorist event or other public health emergency. EMSystem provides hospital emergency departments, EMS transport providers, communications centers and emergency managers the ability to share real time day-to-day information concerning divert status, resource availability and communicated events that can potentially affect the provision of emergency medical services.

EMSystem has been in use in the Denver metropolitan area for over four years and is used to communicate divert status and availability of air transport services. The information provided by users of the system is secure and not accessible by the public. The use of the system dramatically reduces the number of telephone calls communication centers and hospitals make to determine the availability to receive a patient or transfer a patient to another hospital. The system also reduces the number of telephone calls needed to determine air transport availability. Emergency managers and communications centers will be able to post events that will impact the provision of medical care with real-time updates. Emergency managers can also run a virtual online communications center for tracking medical operations and coordination.

EMD-TRAINED TELECOMMUNICATOR

The emergency medical dispatcher (EMD) is the principal link between the public caller requesting emergency medical assistance and the EMS resource delivery system. As such, EMD's play an important role in the ability of the EMS system to respond to a perceived medical emergency. With proper training, program administration, supervision, and medical direction, EMD's can accurately query callers, select appropriate methods of response, provide pertinent information to responders, and give appropriate aid and direction for patients through the caller.

Through careful application and reference to written, medically approved, emergency medical dispatch protocols, sound decisions concerning EMS responses can be made in a safe, reproducible. and non-arbitrary manner. These benefits are realized by EMS systems when appropriate implementation, sound medical management, and quality assurance / quality improvement (OA/QI) at dispatch are provided within the EMD / EMS system.
The EMD's function is to promptly and accurately process calls for emergency medical assistance. The training and practice gained through-the use of a written or automated medical dispatch protocol is not sufficient to ensure continued medically correct EMD functioning. Their dispatch-specific medical training and focal role in EMS has developed to such a complexity that only through a correctly structured and appropriately managed quality assurance environment can the benefits of

their practice be fully realized. The philosophies of emergency medical dispatch have established new duties to which the emergency medical dispatch agency must respond. It is important that their QA / QI activities, including initial hiring, orientation, training, certification, continuing dispatch education, rectification, and performance evaluation be given appropriate managerial attention to help ensure the ongoing safety in the performance of the EMD.

Dispatch centers should be staffed with EMD-trained telecommunicators. The telecommunicators should be highly skilled in mobilizing all necessary extrication, rescue, transportation, and treatment resources required in providing optimum treatment for an emergency patient. They must have a good knowledge of the service area, including landmarks useful to directing field teams to emergency scenes. Also, because of the medical coordination required of these telecommunicators, they should have a working knowledge of the medical community. They must be able to speak clearly, hear well, make sound decisions, and stay calm in emergency crisis situations.

EMD is not a required function of a dispatch center in Colorado and there are no rules regarding its use. Many dispatch centers in Colorado provide this service.

DISPATCH PLANNING

Necessary communications links to and from the dispatch center may be accomplished in many ways. ***Radio communications should be the primary use.*** Many users share the radio frequency spectrum; therefore, when radio systems are used, operational procedures must be developed to limit radio use to that required for efficient coordination. The inventory of area communications systems should be reviewed to determine whether they meet the integrity for EMS communications.

It may be possible to achieve substantial cost savings to the area by eliminating duplicated functions or centers. For example, in an area in which three 24-hour dispatch centers dispatch for fire, police, and EMS, units are combined into a single center. Savings should accrue due to reduced facility costs and improved reliability for interagency communications and coordination. However, this approach may occasionally result in opposition from interagency partisan interests.

Planners must also consider whether using an existing communications link or system would impair the ability of the system to change or grow in the future. In some cases, the benefit of using existing communications links would not be lasting. For example, designing an EMS

communications system around an extensive, but aging, single channel or existing ambulance radio system might not be wise. Effective interagency coordination requires multi channel capability or use of a common communications platform such as the DTRS, so if an inadequate existing system was used, daily internal system operation might be difficult, and interface difficulties and adjacent evolving EMS systems could soon render the system obsolete.

Every type of communications link has a reliability level associated with it. Radio communications links are generally more reliable than telephone lines, whether they are cellular, dedicated, or public dial-up circuits. Planners should be cautious about designing around cellular telephone devices. Cellular systems can become overloaded by civilian use as there is no way to give priority to emergency responders.

PAGING SYSTEMS

Paging systems are single-frequency, one-way radio systems used for making people aware that they are being sought. Originally, local governments used voice pagers for calling out volunteer fire departments and EMS personnel. in Colorado, many of these are still in use. Alphanumeric pagers have alphanumeric readouts and are capable of storing a number of messages.

Very reliable commercial paging services are available in most regions of Colorado at reasonable subscription rates. Local police, fire, and EMS units already use many of these services. Alerts are given by a tone or a set of tones or by a built-in vibrator for use where tones are not permissible. There are many local and national suppliers of paging services and pagers.

Paging is accomplished at many different frequency bands including VHF, UHF, 800Mhz, and FM broadcast. Two standards used for alphanumeric paging are especially popular at this time, but others exist. These are the British Post Office standard, called POCSAG (Post Office Code Standardization Advisory Group), and Motorola's FLEX™ system.

Colorado and nationwide paging is accomplished by transmitting the paging information over telephone lines or via satellites to paging transmitters for retransmission. When it is necessary to page over a wide area, a multitude of paging transmitters is activated at the same time in a simulcasting fashion.

Since the DTRS is not capable of paging, some areas will need to adopt new or different paging techniques. In metro areas of Colorado where alphanumeric paging systems are subscribed to, there will be no adverse

effect in their communications operation when changing to DTRS. Where the majority of rural-area Colorado is still using voice / tone pagers, different procedures will need to be arranged depending on geographic areas. Some possibilities are converting current UHF Med systems over to paging after converting to DTRS, maintaining and upgrading the current VHF paging network, or building a new county or regional paging system to include all public safety agencies.

MEDICAL CONTROL COMMUNICATIONS

MEDICAL CONTROL AND COORDINATION

The EMS communications system must provide the field medical personnel with a communications channel that permits the exchange of treatment information while the patient is at the scene of the emergency and also while en route to a medical care facility. Also, to permit alerting of the medical facility prior to the patient's arrival, which allows coordination among medical facilities and services. With the advent of advanced life support (ALS) trained EMS personnel within an EMS service area, medical control communications between the administering physician or facility providing medical direction and the field medical team has been mandated in most jurisdictions.

TELEMETRY

To administer advanced cardiac life support, especially when an ALS program is early in the evolution of its system; biomedical telemetry from the EMS field team to a facility physician is occasionally desired, or in some areas is mandated. When mandated, an interconnection through the public telephone network may utilize the cellular telephone system for such communications. At the present time there are no provisions to use biomedical telemetry on the statewide DTRS. Standards are not included in this plan for telemetry equipment. There is currently no consensus on non-proprietary standards for exchange of digital EKG (telemetry) data. Twelve-lead, simultaneous EKG transmission may be required for some of the new treatment drugs such as tissue Plasminogin Activator (tPA). Future guidelines and standards need to be developed to address such issues in trunking.

INTEROPERABILITY COMMUNICATIONS

Medical emergencies often involve the response of various public safety and emergency service agencies that must be able to communicate and coordinate operations. When various services operate on different radio frequency bands, mechanisms such as cross-band operations, cross-frequency patching at radio consoles, inter-service use of common

radio frequencies, and other measures should be included in the EMS communications system design. Agencies that operate on the DTRS can coordinate by using one or more of the Mutual Aid Channel (MAC) talk groups. Co-location of communications centers or telephone lines among communications control centers for various emergency response agencies can also provide a coordinated response. Such communications are needed to support daily EMS operations and mutual aid agreements, and are also essential for mobilization and command and control of all emergency response units during disasters or large-scale emergencies.

CELLULAR TELEPHONE USE IN EMS FIELD OPERATIONS

Cellular telephone systems have been available in most areas of the United States since the mid1980s. The concept of cellular radio / telephone systems is to limit the actual coverage to the smallest possible area, which could allow the frequencies to be reused more often.

Early mobile telephone systems were designed so that each fixed site provided the maximum possible coverage to mobile radio / telephone units. These stations transmitted their signals at full power, regardless of the location of the associated mobile unit being served. With the improvements in control and switching technology**,** many stations may be implemented, with each having greatly reduced coverage. As mobile telephones move through their coverage areas, they may handle or pass the call off to another station (or cell).

Cellular system operators have begun offering services that emulate the functionality of two-way radios. Additional functions, besides traditional cell phone operation, are walkie-talkie type operation through the system or short range communications outside the system, one to many broadcast operation subject to group size limits, pager operation, access to the World Wide Web via cell phone, and access to data bases via wireless data services. The availability of these features, and other possible offerings, vary from system to system and may not be available in all markets.

Cellular systems should only provide supplemental communications coverage for EMS operations. Cellular coverage is provided over large areas, channel availability is high and operation is relatively simple. However, there are few advantages and several disadvantages that govern when cellular telephone use is acceptable in EMS systems.

Some of the advantages of cellular radiotelephone are:

- Good coverage is provided within some service areas.

- Other users do not usually monitor communications.
- Full duplex communications is possible.
- They can be used to provide biomedical telemetry operation.

Some disadvantages of cellular radiotelephone are:

- It is necessary to be registered within the system in order to use the telephone service.
- It is necessary to know the telephone numbers of the parties with which you wish to speak.
- It is not possible to temporarily interrupt an ongoing conversation (except with call-waiting-type features).
- Substantial fees are charged for system use.
- Cellular telephones are vulnerable because they rely on the existence and proper operation of fixed radio equipment, switching systems, and (when calling landline telephones) proper operation of the public switched telephone network.
- Central documentation (such as log recording) is more difficult to accomplish.
- The systems are subject to unavailability during periods of peak demand. Examples would be during traffic jams, rush-hour traffic, or during catastrophic events that attract media attention.
- No standard system has been established to ensure priority access to public-safety users. Varies by service provider.
- The federal Food and Drug Administration (FDA) must approve equipment that provides biomedical telemetry capabilities. There is a limited availability of FDA-approved biomedical telemetry equipment.
- The coverage area for the cellular system may be unfamiliar to the system user.
- Rural service areas are usually not covered or receive only limited or sporadic service.

EDUCATION OF COMMUNICATIONS USERS

COMMUNICATIONS PROTOCOL

An EMS communications protocol is a guideline for exchanging information during emergency operations. Effective protocols must use the elements in our academic system. Consider the information. The information must be of generic structure (vehicle status, unit assignment, resources use, patient information, and emergency traffic). Information discipline prevents overload and misunderstanding. Transmissions should include only relevant information and the message should be clear and brief. Use common terminology and plain language.

EMD TRAINING

In Colorado the authority to establish standardized training course curricula is found in CRS 25-3.5-201, which states that the EMSPD shall design specialized curricula for all persons who routinely respond to medical emergencies. In addition, the EMSPD has the authority to recognize training programs that provide training in the specified curricula that is designed by the EMSPD.

Although there are no provisions within the EMS Act for EMD certification, there are provisions for the state to issue course completion certificates to those dispatchers that have successfully completed an EMSPD approved training course. Recognizing the need to standardize training statewide, and recognize those dispatchers that have successfully completed an EMSPD approved training course, the EMSPD implemented an EMD Registry. This registry will maintain the names and other pertinent data for dispatchers that have successfully completed an EMSPD approved training course.

Based upon this authority, the Colorado Department of Public Health and Environment, EMSPD, working in consultation with the Emergency Medical Dispatch Committee of the State EMS Advisory Council, has established program standards. Agencies or training institutions desiring to be recognized as conducting a training course that meets the minimum standards set forth in the state's EMD Policy and Procedure Manual may make application for such recognition to the Colorado Department of Public Health and Environment, EMSPD. Dispatchers who successfully complete a department approved EMD training course may make application to the EMS Division. The Division will provide a course completion certificate and register the dispatcher in the EMD registry.

The Colorado EMD Policy and Procedure Manual provide the foundation for implementation and maintenance of the Colorado EMD program. It contains requirements for training groups, making application to be

approved by the EMS Division, requirements for dispatchers making application for course completion certificates, and provides information on the maintenance of the registry file.

911 LEGISLATION

In late 1999 the US House passed communications and public safety act S800, which makes 9-1-1 the universal number for all emergency calls. The legislation also directs the FCC to play an active role in supporting states to develop plans to upgrade their emergency communications systems.

GOALS AND OBJECTIVES FOR EMS

PLANNING TERMINOLOGY

Goals - Planning statements of broad direction, general purpose or intent. A goal is general and timeless and is not concerned with a specific achievement within a given period of time.

Objectives - Planning statements of a desired accomplishment that can be measured within a specified time frame and under determinable conditions. Attaining an objective moves the system toward a directly related goal.

Tasks - Planning statements that include the small increments of achievable work that are identifiable, assignable and measurable within an immediate time frame.

GOALS FOR EMS COMMUNICATIONS

GOAL 1 - EMS communications systems should meet the needs of emergency medical systems and nationally accepted standards of functional performance.

GOAL 2 - Local EMS communications systems should be compatible with, and should not interfere with, EMS communications systems in neighboring or adjacent areas within the state or in other geographic areas.

GOAL 3 - Local EMS communications systems should be compatible with, and should not interfere with, other types of communications systems.

GOAL 4 - EMS communications systems should make maximum use of state and other common resources, where this approach is appropriate and cost-effective.

EMS communications must meet the performance goals and objectives specified by those who use and are served by the systems. Ideally, the systems should satisfy every conceivable need. Realistically, constraints such as cost, political considerations, demographics, geography, social preferences, existing legislation, and time will limit what actually can be achieved.

In situations in which EMS communications require coordination among several political subdivisions that affect the health and safety of the population, it is appropriate for the Colorado Department of Public Health and Environment, EMSPD to take a coordinating role. Additionally, statewide planning for coordinated use of radio frequencies or DTRS talk

groups for EMS communications is necessary so that individual efforts do not become counterproductive to the system. The FCC Emergency Medical Radio Service (EMRS) Rules require that frequency coordination complies with state EMS communications plans where they exist.

State and local planning for emergency medical systems provides the authority to accomplish coordination in use of the available radio frequencies and/or DTRS talk groups and promotes multi-agency cooperation necessary to serve the public needs. Communities, counties, and RETACS are thereby provided with the guidance to achieve the performance goals and objectives for their EMS communications systems.

The performance goals and objectives should be considered by each EMS region for evaluating, planning, and implementing acceptable EMS communications systems. Determining the goals and objectives for an EMS communications system requires defining the specific role for each agency involved in the EMS communications system.

With few exceptions, the State of Colorado does not own or operate EMS communications systems. Instead, the state's EMSPD acts as a regulator, coordinator, and facilitator for statewide and local EMS and EMS communications systems.

EMS communications regions may be thought of as collections of smaller local EMS communications systems or areas. The state is not involved with the daily operation of these individual local communication systems, but it is concerned with the interfaces and interactions among them and the other elements that form a complete EMS system.

The first interface is between a local EMS system and the population it serves. The concern of the state's EMSPD is that the local system meets appropriate functional standards for performance. The state's EMSPD focuses on the result, including the character and quality of service provided to the population, rather than on the mechanics of how the service is provided. Items of interest include EMS communications training standards, and the degree to which the communications systems provide public access, medical communications for basic and advanced life support, and radio coverage.

A second interface is between local EMS communications systems and neighboring EMS service areas. There are two specific concerns.

First: The various communications systems must not interfere with one another. This requires consideration of coverage boundaries, allocation of frequencies, and real-time coordination of common frequencies. This

concern applies only to non-DTRS communications systems. Frequency management was addressed during the design of the DTRS.

Second: Systems should be able to cooperate constructively with one another in such matters as point-to-point communications and communications from within an area to mobile radio units that pass through the area from other regions.

The third interface is among a local EMS communications system and other types of emergency communications systems such as law enforcement, emergency management, fire services, and public utilities, within the same area and with neighboring areas.

With the creation of the EMRS by the FCC, EMS agencies maintain their eligibility in the Special Emergency Radio Service (SERS). For EMS communications using frequencies in the SERS, there is a concern about interference from school bus radio communications that are permitted by the FCC. In Colorado, a frequency-coordination process is in place through APCO and carried out as part of the statewide EMS communications system planning process to lessen instances of this interference.

The fourth interface is between the local system and the state EMSPD. The concern in this interface is ensuring that the population receives timely and appropriate emergency medical care according to national health-care standards as well as state statutes and regulations. Additional concerns are for efficient and effective use by the local systems of resources provided by the state or otherwise shared in common with multiple users.

These shared resources include; radio sites, wide-area repeaters, statewide microwave and telephone systems, various services such as communications maintenance, and combined purchasing.

Finally, the state's EMSPD is concerned with managing the state-level communications component of the EMS system. These management functions include: Ongoing planning; state and upper-level regional organization; personnel qualifications, standards, and training; direction of the EMS program by laws, rules, funding incentives; and the control of the EMS system by means of information feedback, analysis, evaluation, and corrective action.

In summary, the areas of concentration for the statewide goals are:

1. Functional performance standards

2. Interface and compatibility with other EMS systems

3. Interface with other types of public safety systems

4. Utilization of state and other common resources

5. National representation

6. State-level involvement

In this guideline, each of these areas is covered by a goal statement. Each goal statement is then followed by a listing of related objectives and a discussion of the implications of each objective. Progress can be made in many of these areas without substantial cost, while in other cases, the achievement of certain objectives may require considerable expenditures. These are therefore considered long-term objectives.

GOAL 1 - EMS communications systems should meet the needs of the state's emergency medical systems and nationally accepted standards of functional performance.

The state EMSPD is not extremely concerned with the internal details of the design or operation of the local EMS communications system. However, the state does work to ensure that commonly accepted performance standards that affect the result and delivery of service to the public are met. Resources, capabilities, and standards should be applied uniformly throughout the state as much as possible so that all residents and visitors receive the same level of service.

GOAL 1, Objective 1 - EMS requirements should be explicitly considered in plans for improvement of citizen-access communications.

Citizen-access systems, such as emergency telephone 9-1-1, must handle all types of emergencies and are inherently broader in scope than just EMS. Therefore, the state EMSPD does not have the responsibility in leading the development of citizen access systems such as 9-1-1. The state EMSPD supports the concept of 9-1-1 and ensure that all existing and future plans for improvement of citizen-access communications be reviewed at the regional level to ensure that the EMS requirements for citizen access are taken into account. These requirements include:

1. Within the state, there should be only one telephone number to call to request EMS assistance. The single number should be published on the inside cover of all telephone directories and prominently displayed on public telephones. Citizens should never have to look up emergency ambulance services in a directory's pages to request EMS. The number

should be immediately available. The calling public does not have to know their locations in relation to any jurisdictional boundaries to determine the proper emergency number to call.

2. There is no financial barrier to requesting emergency medical assistance. Coins are not required for emergency calls from public telephones. Long distance calls for EMS assistance should be free to the calling party.

3. A sufficient number of telephone lines should be provided into an EMS PSAP to ensure that no more than one EMS call in 100 attempts receives a busy signal during the average daily busy hour.

4. There should be sufficient answering positions at the emergency number location to ensure that at least 90 percent of the EMS calls are answered within 10 seconds, or with no greater than two or three rings, during the average busy hour.

5. Call-answering positions should be provided with written instructions or protocols for distinguishing EMS calls from other types of emergencies. Personnel staffing these positions should have EMD training that is adequate to enable them to use the protocols effectively.

6. EMS call transfer or information relay, if used, must be fast and reliable. "Call referral" (telling an emergency caller to hang up and call a different telephone number) must not be used for emergency calls.

7. If call transfer is used, the EMS caller should never have to talk to more than two people (e.g., the 9-1 -1 call answerer and the dispatcher).

8. Where feasible and appropriate, the development of alternative and backup systems for citizen access should be encouraged. Such systems may include the use of highway radio call boxes and cellular telephone 9-1-1 provisions.

GOAL 1, Objective 2 - EMS resources should be coordinated.

The local EMS communications system should be organized so that callers are guaranteed that the currently closest and most appropriate EMS response units will be assigned to their calls. The following points should be considered for effective resource dispatch centers:

1 . The appropriate dispatch center should always monitor and be aware of the current location, status, and capability of all response units in the geographic area, including private and public ambulances, fire department

EMS units, quick-response teams, first-responder units, or other EMS resources.

2. The appropriate dispatch center should have the authority and ability to optimize the allocation of resources by pre-assigning specific units to particular locations in anticipation of need and relocating units as conditions change.

3. The dispatch center should have appropriate written policies and procedures for the assignment of specific predetermined combinations of units to particular types of EMS incidents.

4. Private ambulance companies must not compete with one another or with the local fire department or rescue units in soliciting or in accepting EMS calls from within a common service area.

GOAL 1, Objective 3 - The EMS dispatch must be as direct as possible.

Ideally, the person who answers a call for EMS assistance is also the radio dispatcher who can directly contact the units to be assigned to the incident. However, one or more call transfer or information relays are commonly required before the emergency information gets to the response units that actually act on it. In all cases, the chain of communications must be as short, simple, and direct as possible.

Where the dispatcher must communicate with multiple units and locations for a given incident, the communications to all should occur simultaneously (or as near to simultaneously as possible) using common or similar means of communication. It is not unusual to find that an EMS dispatcher must first call some units on the radio, then contact others by different types of telephone arrangements, and then alert still others by several types of paging systems. These situations must be avoided and corrected. There must also be an arrangement for positive feedback and acknowledgement from each responding unit that the dispatch message has been correctly received, understood, and is being acted on.

GOAL 1, Objective 4 - Facility radio communications systems must meet state recommendations and conform to the state and local EMS plans.

A communications system supports communications between EMS personnel in the field and destination hospitals primarily for the purpose of coordinating patient arrival. Except in some rural areas, such systems are usually not centrally coordinated or ordinarily intended to support lengthy medical consultation or biomedical telemetry that may be needed for administering control of ALS procedures. The following apply to facility communications systems:

1. A facility communications plan must exist and be followed in conformance with the statewide-level plan. The plan must define the purpose and scope of the communications system and the local operating procedures in conformance with the statewide-level plan.

2. Each ambulance or patient-transporting emergency response unit should have a mobile radio that operates in accordance with the local plan.

3. Each ambulance or responding emergency medical unit that is equipped with a radio should be configured and equipped to communicate with any hospital emergency department within its coverage area and radio range.

4. Each hospital emergency department should be able to communicate with any radio equipped ambulance or emergency medical mobile unit for which that hospital is the closest or most appropriate emergency hospital facility.

5. Each EMS ambulance mobile radio or hospital base-station radio should be equipped with all of the standard channels designated by the local EMS plan, and with the state designated standard frequencies.

6. When the need exists for a base station to incorporate selective calling, a system with wide acceptance and compatibility must be adopted. One method for converting older systems to newer DTMF systems uses parallel decoders so that either encoder may be used. In locations where existing systems are not already equipped with dial encoders using interrupted tones, a more modern technology should be encouraged.

7. All radio controls in both the hospital and the mobile radio units must be clearly marked so that the standard operating channels are clearly displayed. Standard terminology should be used. Terminology such as regional, local, channel one, or other non-standard nomenclature should be avoided.

8. Per this plan, each facility throughout the state should be equipped with at least one Digital Trunked Radio located in the Emergency Department where pre-arrival and medical instructions can quickly and efficiently be established between field and facility personnel. Subscriber units, which include mobiles, bases, and portable field radios used by all facilities, will be the responsibility of each individual organization. State EMS grant money is one source available to qualifying agencies, while facilities should be able to absorb the additional cost of the DTR equipment and installation.

Costs to purchase, program and install a DTR will vary from facility to facility because of location, operational needs, and space requirements. Current projected cost estimates range from $6,000 to $10,000 per facility.

GOAL 1, Objective 5 - The communications system design should ensure continued EMS communications during major disasters.

EMS communications become particularly important during a disaster. In order to ensure that an EMS communications system can meet the special needs of a disaster and not become disabled by the disaster, the system design should consider the following requirements:

1. The public switched telephone network is susceptible to traffic overload and physical disruption during a major disaster. Leased private lines may be protected from traffic overload but are not protected from physical outage or failure. Therefore, the communications system design should provide alternative and backup communications links, such as radio or microwave links. Radio and microwave systems also may be damaged. However, replacement antennas, coaxial cable and other susceptible hardware should be made easily available. Telephone lines coming into communications centers should be buried and clearly marked, and otherwise protected from damage. Written records of line locations should be maintained and quickly available for reference during emergencies. If possible, alternate routing from multiple telephone company central offices should be used with alternate entrances at communications centers.

A designated radio channel or DTRS talk group may serve for point-to-point interhospital disaster coordination. A single frequency or talk group is susceptible to being quickly overloaded and abused during even minor emergencies. A mechanism for preventing overload should be incorporated into the system, including a practiced system discipline and alternative communications mechanisms. Multiple frequencies or talk groups and redundant radio equipment should be incorporated when feasible and practical.

2. Means should be provided to allow police, fire, and ambulance units from different agencies to communicate with each other during disaster operations. Available techniques include using common disaster channels or talk groups, multi-channel radios, and cross-banding or cross-patching of channels through the communications center's consoles. For those using 800 MHz trunked systems (or other trunked systems employed), dynamic regrouping capabilities should be planned for implementation.

3. Fixed communications facilities should be provided with adequate independent standby power sources, such as batteries or generators, to

avoid dependence on commercial power. The capacity of these power sources should be large enough to also support climate control.

4. Important locations within a service area should be served by more than one radio site so that communication is not totally lost in the event of radio site failure. Redundant equipment and geographic diversity for equipment locations should be incorporated if practical or feasible.

5. Sufficient telephone lines, radio channel capacity, operating positions, or rapid expansion capability, should be designed into a system to handle heavy communications traffic loads generated by disasters.

6. Disaster communications procedures must be well defined with emphasis on interagency coordination. Disaster procedures should be a straightforward expansion of the day-to-day procedures, rather than a radical change in any operating procedure.

7. A procedure should be established to implement communications paths with military, amateur, air, public utility, and other radio operations outside of the Public Safety Radio Service.

8. Disaster systems and procedures should be periodically exercised and tested. Such tests should be reviewed and corrections made where failures do or could occur.

GOAL 1, Objective 6 - EMS telecommunications users including field personnel, hospital personnel, and communications center personnel should be formally trained in both emergency medical services and radio communications techniques.

1. Problems can occur when medical care providers are not experienced in the use of telecommunications equipment, or when public safety communications center personnel are not familiar with the basic concepts and terminology of EMS. Sufficient cross-training must be provided in all disciplines to ensure that medical protocols and technical communications procedures are clearly understood and uniformly applied throughout the system and service area.

2. Formally recognized training programs, with certification for proficiency in communications techniques, procedures, equipment, and system concepts have been developed and made available statewide. Courses in telecommunications and individual special disciplines such as emergency medical dispatching is available and standardized.

GOAL 1, Objective 8 - EMS communications systems should meet technical standards applicable to all public-safety communications systems.

1. The communications system must meet all applicable FCC Rules and Regulations.

2. All emergency communications should be routinely recorded. The recordings should include date and time signals and should be preserved in accordance with local system plan requirements.

3. Where feasible, the radio coverage reliability should be at least 90 percent, probability of place and time, assuming inefficient portable antennas operating from within buildings in the service area.

4. All equipment should be reliable and easy to operate. It should be tested daily. Written procedures and logs should be maintained on all problem reporting, repair, and maintenance. All equipment should be periodically inspected (at least every six months) and tested by competent technicians. Repairs should be made promptly by trained and qualified personnel.

GOAL 1, Objective 9 - 800 MHz digital trunked radio communications systems that serve EMS must meet state recommendations.

Systems that operate at 800 MHz to serve EMS are typically part of a much larger public-safety communications system, and may operate in a trunked or conventional mode. These systems may support not only dispatch and coordination, but medical communications as well. The systems are normally designed to service a specific or wide area defined user population. The following apply to 800 MHz communications systems:

1. An 800 MHz communications usage plan must exist and be followed in conformance with the state-level 800 MHz plan. The plan must define the purpose and scope of the 800 MHz system and the local operating procedures in conformance with the state plan.

2. All emergency response units should have 800 MHz mobile radios that operate in accordance with the statewide plan.

3. Each responding emergency mobile unit that is equipped with an 800 MHz radio should be configured so it is able to communicate with any hospital emergency department within its service area or radio range.

4. Each 800 MHz EMS system should implement the national mutual assistance channels as listed in the National Public Safety Planning Advisory Committee (NPSPAC) Plan (see chapter on 800 MHz) and Appendix G of this manual.

5. Each hospital emergency department should be able to communicate with any 800 MHz radio-equipped emergency mobile unit for which that hospital is the most appropriate emergency hospital facility.

6. Every mobile unit that operates on 800 MHz frequencies should be equipped to operate in a conventional mode on all five national mutual assistance system channels as listed in Appendix G. Stations should be capable of operating in the simplex (direct), as well as half-duplex mode. Additional channels may be designated by the state EMS plan.

7. Each 800 MHz national mutual assistance conventional mobile relay station should be equipped with CTCSS to avoid nuisance interference. Common channels should use a tone frequency of 156.7 Hz.

8. Selective-calling equipment, where used on conventional (non-trunked) systems, should use Dual-Tone Multi Frequency (DTMF) signaling. Codes should be assigned by or coordinated with the state EMSPD.

9. All 800 MHz radio operator controls in both the hospital and the mobile radio units must be clearly marked with commonly known and consistent terminology.

10. Trunked 800 MHz EMS communications equipment should operate as part of, and support total public safety communications systems where they already exist. The economies of scale, improved channel utilization, and interoperability can only be realized when operating as part of a larger system.

11. All trunked 800 MHz radios should be configured so different functional needs such as dispatch, tactical coordination, and medical communications are served by separate "virtual channels." The advantages of trunked communications cannot be fully achieved if all EMS functions operate as if they are on only one channel.

GOAL 1, Objective 10 - EMS communications system planners should consider and establish communication channels required for emergency air-medical services, and establish communications services required to support such EMS services.

Enable all necessary EMS communications and provide sufficient means to ensure that air-medical EMS services are able to communicate with all necessary elements of other emergency medical and public-safety services. Establish a statewide plan to ensure that any air-medical rotor-wing aircraft can communicate with required ground EMS vehicles and hospitals.

1. Identify the necessary communications modes and potential frequency arrangements based on equipment space and antenna bandwidth limitations.

2. Secure support for authorization of such frequencies from the FCC, the Federal Aviation Administration, and certified frequency coordinators.

GOAL 2 - Local EMS communications systems should be compatible with, and should not interfere with EMS communications systems in neighboring areas or adjacent areas within the state or other geographic areas.

GOAL 2, Objective 1 - Coverage boundaries should be defined and respected. Nominal radio communications coverage boundaries between neighboring EMS systems should be mapped and mutually agreed on. Radio communications conduct should respect these boundaries to minimize interference outside the boundaries. This includes:

1. The use of directional antennas where feasible and appropriate.

2. The use of only the minimum antenna elevation and effective radiated power necessary to cover the communications service area.

3. The use of CTCSS where appropriate.

4. Strict adherence to "listen-before-talk" channel monitoring policies by all users.

GOAL 2, Objective 2 - Frequency allocation and use should be coordinated statewide and nationally when appropriate.

EMS dispatching may be performed on frequencies in various frequency bands or radio services. Frequency coordination services should be used in planning and selecting frequencies and in planning base-station radio coverage for EMS radio dispatching systems.

1. Statewide common intersystem emergency frequencies should be standardized and incorporated by all EMS communications systems.

2. The UHF frequencies of MED-1 through MED-10 and the narrowband channels MED-12 through MED-82 are subject to statewide use and must be assigned in accordance with a state frequency-use plan compatible with other EMS services and states.

The state EMS communications plan should be used as the framework for coordination of these channels. All mobile and portable radio equipment

on these frequencies should incorporate all of the MED-1 through MED-10 channels and the narrowband channels MED-12 through MED-82. The state EMS communications plan requires all eighteen channels be operational within each station, unless a specifically identified need is demonstrated.

3. The state EMSPD will assist with the frequency coordination process and establish a statewide frequency sharing pattern.

GOAL 2, Objective 3 - CTCSS tones and other control tones and codes should be coordinated statewide.

In the same way that frequencies are coordinated, CTCSS tones and selective calling addresses should be coordinated statewide. This function should be provided by the state OEMS. All agencies should advise the state office of the tones used. Records and databases should be established and maintained.

GOAL 2, Objective 4 - Regional and local systems should be interconnected with fixed radio links.

At least one frequency or trunking talkgroup should be designated within the state as the standard frequency for interhospital communications for coordinating resources or response. This frequency should be implemented in all hospital emergency departments and should extend to EMS dispatch and communications control centers to permit hospital resources to be effectively coordinated with other public-safety resources. Operating procedures should be uniformly established regionally and statewide.

GOAL 2, Objective 5 - Mobile radio unit parameters should be standardized statewide for intersystem compatibility and interoperability.

The objective of interoperability is to enable every EMS mobile radio unit to travel anywhere in the state -- whether on a mutual-aid assignment, a patient transport to a distant specialty care facility, or a disaster response while remaining in communications with a base EMS radio system at all times. Achieving this objective requires the following:

1. Adherence to a common statewide mobile radio frequency plan. All radios must be equipped with a common frequency. All UHF mobile radio units must be equipped with all MED-1 through MED-10 and narrow band MED-12 through MED-82 channels and standardized CTCSS tones with standardized tone-identification nomenclature.

2. Adherence to the statewide selective calling code assignments, equipment requirements, and procedures.

3. Adherence to the statewide coordinated CTCSS squelch-tone assignment, equipment, and procedures.

4. Establishment of equipment and procedures for effective "hand-off" of radio control of mobile radio units traveling from one system's coverage area to another. Statewide uniform training of communications operators, and users in system interface procedures.

5. Maintenance of records and data on systems, tone-code assignments, and common availability of this data.

GOAL 3 - Local EMS communications systems should be compatible with, and should not interfere with, other types of communications systems.

EMS systems should be coordinated with the law enforcement, fire, emergency management services, and other public-safety radio systems in their areas in terms of frequency use, site engineering, and intersystem communications.

GOAL 3, Objective 1 - EMS frequencies should be coordinated with other public safety frequencies.

Radio systems have the potential for mutually interfering with other nearby systems in the other public safety services, even if the systems operate on other frequencies. For this reason EMS frequency assignments, site selection, elevation and radiated power should be coordinated and examined each time systems are modified or expanded.

GOAL 3, Objective 2 - EMS systems should be "good neighbors" at shared radio sites.

Electronic equipment cannot be arbitrarily installed at a radio site without consideration of the effect on systems already using the site. Factors for consideration include:

1. Intermodulation, receiver desensitization, and transmitter noise analysis should be performed to predict likely levels of interference.

2. All radio equipment should include isolators, band pass or band notch cavity filters, or crystal filters when required.

3. The minimum number of antennas should be used and adequate spacing provided to avoid interference.

4. Directional antennas should be used where appropriate.

5. Minimum radiated power required should be used.

GOAL 3. Objective 3 - EMS radio systems should be compatible with other public safety radio systems for multi-agency operations:

Compatibility can be achieved in several ways. They are listed as follows in order of decreasing desirability:

1. EMS and other public safety radios can be equipped with one or more special common mutual operating frequencies.

2. Cross-channel radio patch equipment can be used at the common communications center to establish a temporary functional interconnection of multi-agency channels.

3. EMS radios can be equipped with some of the working frequencies of the other public-safety agencies and vice-versa.

4. Verbal relay of messages by a dispatcher is possible if the dispatch center has base stations, control equipment, or both on all of the multi-agency frequencies.

GOAL 4 - EMS communications systems should make maximum use of common resources where appropriate and cost-effective.

Cost savings can be achieved by sharing resources such as radio sites, microwave and telephone systems, and services such as centralized purchasing and training. This type of sharing also promotes an interchange of ideas, effective system interfaces, and standardization of equipment and procedures.

GOAL 4, Objective 1 - EMS communications system planners and users should be encouraged to share radio sites.

Many advantageous mountaintop radio sites and radio towers already have been developed. Some of these sites are operated by state agencies, such as the department of transportation, state highway patrol, and state educational organizations and universities. Some sites developed for specific EMS communications systems also may be advantageous to neighboring systems. System planners are encouraged to share sites using the following practices:

1. Identifying advantageous sites that could be shared.

2. Cataloging site characteristics such as the name of the owner or controller, telephone number, site location, elevation, frequencies in use, shelter or rack, tower space availability, types of towers available, and availability of commercial and standby electrical power and telephone service.

3. Developing uniform policies for cost allocation, site access, maintenance, and interference avoidance by means of appropriate use of cavities, filters, etc. It must be noted that radio frequencies and elements interact and may cause interference. In proposing co-location of radio equipment or shared use of sites and facilities, qualified engineering support should be consulted. Some radio frequencies are not easily co-located. This is especially true of frequencies in the VHF band among police frequencies, Emergency Medical Radio Service frequencies, and Special Emergency Radio Service frequencies due to the method used by the FCC for frequency assignment.

GOAL 4, Objective 2 - EMS communications system planners are encouraged to share state and common system components such as microwave and telephone where possible.

There are state-owned microwave systems for statewide interconnection of communications control centers, mountaintop radio sites, and for support of state services. These resources can be advantageously used in EMS communications systems for such purposes as control of remote base stations and repeaters, and as a backup or alternative to commercial telephone facilities. To encourage sharing of these resources the state should inventory them, make their characteristics and capabilities known to EMS planners, and develop policies for shared use.

GOAL 4, Objective 3 - EMS communications system planners are encouraged to make effective use of state provided services.

The state should act on behalf of local EMS systems to take advantage of economies of scale and efficiencies possibly not otherwise available to smaller systems. Examples of such opportunities include the following:

1. The state can provide centralized purchasing through state contracts.

2. Statewide communications-maintenance service arrangements could be developed.

3. The state can offer engineering design assistance to local EMS communications system planners.

4. The state OEMS should develop and provide standardized equipment specifications, requests for proposals, and contract boilerplate materials.

5. The state should sponsor EMS communications training programs.

GOAL 5 - The state OEMS acts as the representative of local EMS systems in dealing with federal agencies and national organizations.

The state OEMS acts as a fiscal agent in application and distribution of grants for EMS from a number of state or federal programs. There is a need for broadening the scope of these activities to encompass such functions as:

1. Monitoring activity at the federal and national level, including federal and private foundation grant programs as well as laws and rule changes affecting EMS communications systems.

2. Seeking out and securing additional new sources of communications funding.

3. Participating in the regulatory decision-making process at the federal level, particularly by commenting on FCC dockets that may affect EMS communications.

GOAL 5, Objective 1 - The state OEMS should monitor federal and national-level activity affecting EMS communications:

The state should have a systematic mechanism for maintaining awareness of EMS activity at the federal and national levels, assessing the effects of that activity to EMS communications, and communicating the findings to regional and local EMS planners.

Activities of interest include:

1. Announcements of new federal or private foundation grant programs, changes in existing programs, and grant awards or grant criteria.

2. Significant new advances in EMS communications technology or system management.

3. New or changed laws affecting EMS communications or requirements.

4. Changes in FCC rules and regulations, FCC dockets, and rule-making proceedings.

GOAL 5, Objective 2 - The state should take an active role in influencing federal laws and rule-making decisions.

Regional and local EMS communications system planners have limited opportunities to influence the development of federal laws and regulations that could have an effect on these systems. The state should have a program to channel the state and local efforts in this area. Such a program should include the following:

1. Review and comment on FCC notices of inquiry and rule-making proposals affecting EMS communications.

2. Review and comment on proposed regulatory changes in other federal agencies, such as the National Highway Traffic Safety Administration and the Department of Health and Human Services.

3. Use of a state's Washington, D.C. office in matters affecting EMS communications.

4. Informing elected state representatives of the significance of important issues affecting EMS communications.

GOAL 5, Objective 3 - A statewide EMS communications planning organization should be implemented.

The communications planning organization must encourage interregional cooperation, non-interference, use of shared and common resources, and standardization of overall system management. The organization should include state-level technical staff support. Each region should maintain a representative communications committee that meets regularly.

GOAL 5, Objective 4 - The state should strengthen its EMS communications resources and assist local and regional communications personnel in designing and evaluating systems, communications training, and communications implementation.

The state OEMS is concerned with and involved in technical communications matters. The state OEMS should have communications specialists either on staff or available from another agency, such as a state office of telecommunications engineering, who are responsible for the state's involvement outlined in the EMS communications plan.

This responsibility should include: Observation of functional performance standards; arbitration of intersystem interference problems; establishment and observance of compatibility standards; promotion of sharing and use of state and common resources; interface with federal and national

organizations; certifying eligibility of applicants for licensure in the EMRS; and overall EMS communications program management.

In addition, the state OEMS can help regional and local systems in several areas, including system specification development. The state should also provide or sponsor communications training programs for communications-center operators (professional telecommunicators), hospital communications equipment operators (physicians and nurses), and mobile communications equipment operators, including EMS personnel.

GOAL 5, Objective 5 - Mechanisms should be developed to provide information feedback on EMS communications, evaluation of the information, and corrective action.

These mechanisms include voluntary methods such as the use of periodic questionnaires, meetings, problem referrals, or other methods such as inspection or testing programs. All such programs should lead to prompt and effective solutions to identified problems or new system needs.

Each EMS planning region or area should establish and maintain an active EMS communications committee that meets regularly and maintains liaison with the EMS systems and providers within the region. The committee should be composed of local EMS service providers, telecommunications personnel, and communications-center directors. This local / regional communications committee should be active in system planning and improvement through frequency selection and recommendations for EMS communications within the area. This committee should be active in pursuing effective interoperability among public-safety systems.

EMS COMMUNICATIONS HISTORY

Facility radio systems of the past developed or emerged without statewide or central guidance. Two major factors influenced development of these systems: The FCC Special Emergency Radio Service (SERS) Rules and Regulations, and, the efforts of radio equipment manufacturers to produce equipment that fit these rules and could be easily marketed.

Most older facility-type radio systems operate in the ultra high band (UHF) or high-band, very high frequency (VHF) radio spectrum, on the frequencies 155.280 Megahertz (MHz) and 155.340 MHz or 155.400 MHz. In Colorado, the frequencies 155.340 MHz or 155.400 MHz have been used for "ambulance-to-hospital" communications. However, this varies from county to county.

Various radio plans met with varying degrees of success, but were often ineffective or became ineffective for several reasons, including:

- Disorganized use of radio frequencies
- Misuse of tone and dial-code protective circuitry
- Inappropriate or uncoordinated radio paging
- Lack of user familiarity with radio-equipment operation
- Non-standard or misused radio brevity codes
- Inappropriate use of radio
- Failure to monitor radio frequency prior to transmitting
- Overcrowding of some radio frequencies
- Non-standard frequency designations such as "area" or "region" frequency
- Insufficient training of radio-operator personnel

After receiving input from the US EMS community, the FCC, through FCC Docket 19880 (1973), eventually changed the utilization and availability requirements for some SERS frequencies. For example, the frequency 155.340 MHz was changed from being available only to "hospitals or ambulances that show they render coordination and cooperation with a hospital authorized to operate on the frequency" to " the frequency is authorized for the rendition and delivery of emergency medical services and may be designated by common consent as an intersystem mutual-assistance frequency under a wide-area medical communications plan." This type of use should be clearly established in the "first-tier" state EMS communications plan.

Ten UHF frequency pairs in the 450 to 470 MHz range were assigned for medical services communications, allowing for the incorporation of mobile relays (repeaters) and electrocardiogram (EKG) telemetry. Four additional UHF frequencies were assigned to allow the use of vehicle mounted repeaters that facilitate patient-side medical communications. Additional FCC rule changes prohibited the use of paging on the VHF frequencies except on frequencies specifically identified for that purpose.

On Jan. 14, 1993, the FCC adopted the report and order creating the Emergency Medical radio Service (EMRS) as a Public Safety Radio Service under Subpart B of Part 90 of the FCC Rules. These rules became effective April 2, 1993. This culminated several years of persistent lobbying by many dedicated individuals and organizations, including the National Association of State Emergency Medical Service Directors (NASEMSD), the International Municipal Signal Association (IMSA), and the International Association of Fire Chiefs (OAFC).

As mentioned earlier in this document, the EMRS was created after many years of frustration as a result of blocked transmissions and delays of emergency medical communications caused by overcrowding and sharing frequencies with incompatible radio users within the SERS. EMS users now are recognized by the FCC as full participants in the Public Safety Radio Services and receive the same considerations as other participants, including access to shared frequency pools. Several of the EMRS frequencies came from SERS, including the ten paired UHF MED channels. In addition to the frequencies acquired from SERS, five new pairs were designated in the 220/221 MHz frequency range. This new band of frequencies has not previously been used by the EMS community. The new 220 MHz band requires specialized narrow-frequency-band equipment. Careful thought and planning are required to effectively use this new and valuable resource.

Eligibility to license radio transmitters in the EMRS is limited to "persons or entities engaged in the provision of basic or advanced life support services on an ongoing basis." To ensure that only eligible entities obtain license, the FCC further requires that applications for station license in the EMRS "... be accompanied by a statement prepared by the governmental body having jurisdiction over the state's emergency medical service plans indicating that the applicant is included in the state's emergency plan or otherwise supporting the application."

This FCC Rule requirement gives the state some control over the communications required for EMS operations. The state of Colorado has taken this responsibility seriously, and established procedures to be followed for applicants to obtain the state letter of support.

The FCC additionally designated the IMSA/IAFC as the certified frequency coordinator for the EMRS. This designation requires that all applicants for EMRS radio license submit their application to IMSA/IAFC prior to receipt of radio license from the FCC. The NASEMSD has established liaison with the IMSA/IAFC. By FCC rule, the EMSPD is responsible for establishing the state emergency medical service plan and must participate in the radio license application process. This requirement will assist in obtaining control and jurisdiction over the radio frequencies used for emergency medical services.

HISTORY OF REFARMING THE MOBILE RADIO SPECTRUM

On July 2, 1991, the FCC issued a Notice of Inquiry to try to address the frequency congestion in the Private Land Mobile Radio (PLMR) service. This inquiry's purpose was to explore options to promote more effective and efficient use of the bands below 470 MHz in the PLMR.

Since 1968, the number of licensed PLMR stations has increased by more than 400 percent. In 1983, the FCC issued a report entitled "Future Private Land Mobile Telecommunications Requirements." This study projected significant frequency spectrum shortages in at least 21 markets (metropolitan areas) by the year 1990, with significantly larger shortages by the year 2000.

The FCC recognizes the need for acknowledging newer technologies and the need for more spectrum efficiency within PLMR. The current FCC regulations do not promote technological innovation within the PLMR. The goal of the FCC is to develop a regulatory environment for the spectrum below 470 MHz that will provide users the same technical flexibility and licensing options available at 800 MHz and above.

Although there is no disagreement that congestion is a major problem and the need for allowing innovations within the PLMR is essential, there was disagreement as to the methodologies to be employed and the time frames in which this should be achieved. Implementation of the proposed frequency refarming to increase spectrum efficiency involves initially splitting current radio frequencies into two smaller frequencies and then into four narrow frequencies as well as conversion from analog to digital modulation. This process would involve complete replacement of the communications infrastructure (including virtually all radio equipment) over a period of time. FCC RM-9332 establishes a January 1, 2013 deadline for migration to narrow band technology for Public Safety Radio Pool licensees.

EMERGENCY MEDICAL COMMUNICATIONS PLAN

The Colorado State Emergency Medical Communications Plan is established to assist local planners in developing EMS communications systems that consider all aspects of effective EMS communications, including statewide and interstate compatibility.

Statewide compatibility means that an EMS communications system performs in all areas of the state and is able to communicate with dispatch, facility, and with each other. Ambulances often travel outside of their own service areas to transfer patients to major or specialized medical facilities or to provide assistance during disasters. Statewide compatibility is required so that ambulances in every part of the state are able to communicate with facilities in other areas.

Basic EMS radio communications consist primarily of two-way voice communications used for directing emergency medical care, notification of patient transport, and vehicle dispatch. Advanced emergency medical communications are usually part of a medical communications network that may include EKG telemetry capability, patient-side communications, data communications, and wide-area radio coverage through the use of mobile relays. Frequency use and selective-signaling coordination are provided for radio systems in all frequency bands.

SYSTEM CONCEPTS

The 800 MHz radio component of the Emergency Medical Communications Plan is based on the Colorado State Digital Trunked Radio System. The system is modular in approach, facilitating phased implementation by the state, and by EMS providers within the state. This approach could allow the statewide DTRS to advance in an orderly fashion and help guard against premature obsolescence of any current system.

The DTRS is formatted around the use of wide-area coverage trunked (repeaters) interconnected throughout the state. These wide-area systems will provide “talkgroups” to all users of the system and have designated EMS talkgroups and "regional EMS talkgroups." These talkgroups will be standardized throughout the state.

Many system designs are provided for within this system structure and each of the following functional communications paths are accounted for.

This list is not intended to be an exhaustive listing of functional configurations, but is intended to give an insight into the flexibility of the DRTS.

- Facility to facility emergency communications
- Ambulance to facility
- Ambulance to ambulance
- Ambulance to dispatch
- Facility to dispatch
- Dispatch to dispatch
- First responder team to facility
- First responder team to ambulance
- First responder team to dispatch
- First responder personnel to other first responders
- Local EMS radio dispatching
- Helicopter to facility
- Helicopter to dispatch
- Ambulance to helicopter
- Helicopter to First responders

FACILITY CENTER COMMUNICATIONS

Facility radio communications systems must meet state recommendations and conform to the state and county EMS plans. A radio communications system supports communications between EMS personnel in the field and destination facilities primarily for the purpose of coordinating patient arrival. Except in some rural areas, such systems are usually not centrally coordinated or ordinarily intended to support lengthy medical consultation or biomedical telemetry that may be needed for administering control of ALS procedures. The following apply to all facility communications systems:

- A communications use plan should exist and be followed in conformance with the state-level plan. The plan must define the purpose and scope of the communications system and the local operating procedures in conformance with the state-level plan.
- Each ambulance or patient-transporting emergency response unit should have a mobile radio that operates in accordance with the state-level plan.

- Each ambulance or responding emergency medical unit that is equipped with a radio should be configured and equipped to communicate with any facility emergency department within its coverage area and radio range.
- Each facility emergency department should be able to communicate with any radio equipped ambulance or emergency medical mobile unit for which that facility is the closest or most appropriate emergency facility.
- Each EMS ambulance mobile radio or facility base-station should be equipped with all of the standard channels designated by the state-level EMS plan and with the state designated standard frequencies.
- Each EMS base station should be equipped to avoid nuisance interference caused by unintended or undesired radio communications. This can be accomplished by using continuous tone-controlled squelch systems (CTCSS) on conventional systems.
- When the need exists for a base station to incorporate selective calling, a system with wide acceptance and compatibility must be adopted. In locations where existing systems are equipped with dial encoders using interrupted tones, a more modern technology should be encouraged.
- All radio controls in both the facility and the mobile radio units must be clearly marked so the standard channels / talkgroups are clearly displayed. Standard terminology should be used. Terminology such as regional, local, frequency one, or other non-standard nomenclature should be avoided.

AIR-MEDICAL COMMUNICATIONS

EMS communications systems planners should consider and establish communication channels required for emergency air-medical EMS services, and establish communications services required supporting such EMS services.

Enable all necessary EMS communications and provide sufficient means to ensure that air-medical EMS services are able to communicate with all necessary elements of other emergency medical and public-safety services. Establish a statewide frequency plan to ensure that any air-medical rotor-wing aircraft can communicate with required ground EMS vehicles and facilities.

Installation and operation of land mobile radio equipment on board aircraft is subject to Federal Aviation Administration (FAA) and FCC rules and

regulations. For the purpose of this plan, Appendix G is provided as a guideline for implementing radio systems in aircraft, which use frequencies in the land-mobile and trunked radio service.

COMPARED ALTERNATIVES

The analysis of the following table was determined from technical requests proposed by the Colorado Department of Public Health & Environment, the EMS Communications Sub-Committee, and from the Colorado County EMS Plans. Multi-criteria analysis was used to evaluate the various technologies based upon a set of business and technical requirements.

EMS Agency Requirements ↓	Analog Conventional Radio VHF/UHF	Digital Trunked Radio	Analog Cellular	Digital Cellular	Satellite	(FRS) Family Radio Service
Immediate Connection	Yes	Yes	No	No	No	Yes
Party line Connection	Yes	Yes	No	No	Yes	Yes
Private Connection	Yes	Yes	Yes	Yes	Yes	Yes
Priority Access	No	Yes	No	No	No	No
Standards	No	Yes	Yes	Yes	No	No
Emergency Notification	No	Yes	No	No	No	No
Statewide Coverage	No	Yes	No	No	Yes	No
Multi-Media Transmission	No	Yes	No	Yes	Yes	No
FCC Compliant	No	Yes	Yes	Yes	Yes	Yes
Future Growth	No	Yes	Yes	Yes	Yes	No
Utilization of State resources	Yes	Yes	No	No	No	No
Continued communications during major disasters	Yes	Yes	No	No	Yes	Yes
Compatible with other public safety communication systems	Yes	Yes	No	No	No	No
Dispatched communications	Yes	Yes	No	No	No	No

THE CURRENT STATUS

An initial element of the system planning process includes data gathering and assessment of the current status of the system. The data gathering should not be the major effort of the communications planning process. Information should be gathered to assess the strengths and weaknesses of the existing systems and provide an understanding of the current

situation prior to applying effort to changing the system. Gathering inventory data and maintaining this information will also provide a method for tracking progress over the years that it takes to implement and improve systems. The inventory data constantly change and do not, in themselves, improve the system. The information gained during the inventory process by talking with users and determining their current status, needs, and system requirements will help in the planning process. The data additionally will help in determining budgets and in financial considerations.

Consider the purpose for collecting the data. It may initially serve three purposes: Determining possible weak points of the system; establishing a mechanism for measuring progress; and provides help in determining how many replacement DTRs will be needed.

Review the data considering the five key points of EMS communications addressed earlier and establish baseline data for the future.

Consider the following possible elements for data collection:

- The number of hospitals in the area, names, locations, coverage area, address, and telephone numbers
- The number of hospitals with two-way radios, the radio call signs, the frequencies or DTRS talk groups used, dial numbers or selective call equipment, and types of radio equipment
- The specific radio frequencies used for communications with ambulances for dispatch, coordination, or medical communications
- The number of ambulances in the region, location, and EMS service area
- The regional demographics of an EMS communications coverage area, such as the number of people living in the area, with adjustments for seasonal variations.
- The number of ambulances with two-way radios
- The radio frequencies used to communicate with hospitals
- The number of dispatch centers, their locations, the emergency 24-hour and business non-emergency telephone numbers, unlisted telephone numbers, and the names of contact persons
- The number and location of dispatch centers providing EMD services or "pre-arrival medical" instructions to callers
- The radio frequencies used to communicate with dispatch centers

- The number and locations of basic 9-1-1 telephone systems and Public Safety Answering Points (PSAPs), and the population and geographic area served by them.
- The number and locations of 9-1-1 enhanced emergency telephone systems, the population, and geographic areas served
- The services dispatched and coordinated from each dispatch or public safety communications center or system
- The number of telephone companies in the region and the geographic areas each serves
- The amount of any 9-1-1 telephone line surcharges
- The percentage of population and geography served by basic and enhanced 9-1-1 service, seven-digit telephone numbers and other emergency numbers
- The number of persons employed as public-safety telecommunicators, dispatchers, EMS telecommunicators, and emergency medical dispatchers
- The number of dispatchers formally trained or certified
- The projected EMS need, expressed as the number of medical emergencies per 1,000 population per year
- The number of ambulance daily, weekly, and annual dispatches that occur in each dispatch center
- The number of ambulance dispatch operations from extraneous sources other than the 9-1-1 center, such as from private ambulance services
- The average times required to dispatch an ambulance and field crew, including the time from detection, reporting, call processing, alerting, en route times, on scene times, transport times and communications air time
- Radio equipment information, including the quantities, manufacturer, type, model number, serial number, frequencies of operation, output power, approximate age, and availability of emergency electrical power for fixed equipment
- The antenna type, antenna height above the ground, elevation of the radio site above mean sea level and accurate geographic coordinates (note: this information is available from various national data base sources from radio call sign)
- Radio license call signs, names of licensee and radio service
- Reported substandard or inadequate EMS radio or communication systems and reason for inadequacy

- The percentages of the state geographic and population areas covered by radio systems operating in each radio spectrum, including VHF, UHF, and 800 MHz.
- The specific geographic coverage area of radio systems operating in each radio spectrum, including VHF, UHF, and 800 MHz.

Obviously, there are many more elements that can be counted, measured, and collected. The importance of each will vary on the agency doing the collection and the purpose of the data collection. Much of the technical information requires collection at the local level to assist in design of new communications systems. At times, the configuration of existing radio control consoles, types of stations controlled, type of control, and special features need to be accurately collected. This information is useful when specifying new communications control centers or consoles, and usually requires assistance from a technically knowledgeable individual.

The ease with which the data can be collected will vary depending on the type of system. Small rural volunteer services possibly never collect information or maintain records over long periods of time. Some major urban centers have computer-generated reporting systems that can produce overwhelming amounts of data. When collecting information about radio equipment or systems, the local radio maintenance shop should not be overlooked as a source.

Determine the indicators and information that will be collected. Establish the mechanism for collecting data constantly over a period of time. Collect the data and preserve it for comparison with future collections. Consider establishing a periodic method for regularly collecting data (e.g., through annual questionnaires to EMS providers and hospitals or with other functions such as ambulance inspections, hospital licensing inspections or provider update reports).

MIGRATION ISSUES TO TRUNKING

Ensuring interoperability with other agencies that may provide or require mutual assistance is one of the greatest challenges in any public safety communications system. Because EMS communications systems often serve multiple jurisdictions with differing communications systems, the problem is more apparent.

With technological advances, the public-safety community is being enticed to develop and operate highly sophisticated communications systems. These systems offer many advantages, but most are also built using proprietary technologies that are only available from one manufacturer or a small number of them. Manufacturers are quick to report about

increased efficiency and capability, but are quicker to ignore the questions of interoperability. Often, when the issue is debated, they insist that if all agencies purchase one company's system, there will be no interoperability problems. That assertion also has been proven to be incorrect.

Emergency medical communications planners should be aware of the pitfalls of these systems, and are encouraged to develop open systems. In rural areas, a single hospital may serve several localities over a wide geographic area. The hospital's decision to adopt a proprietary system and abandon older ones will reduce its ability to effectively communicate with field units. Field units from other jurisdictions could adopt an incompatible system for their daily operations, resulting in no communications with the receiving facilities.

Several measures can be employed to ease migration problems, but they require careful planning, often involve compromises, and may offer only limited relief. The most popular method is to "patch" old technologies with new, which can cause severe co-channel interference to users of the old system. These "patched" systems have resulted in dispatch communications being disrupted over large geographic areas during incidents that are confined to a relatively small area. The interoperability that they provide is also dependent on access to the proprietary system. These capabilities are lost if the mobile radio units travel outside of the system service area, or if the fixed end equipment fails.

The easiest approach to provide continued interoperability is to maintain, upgrade, and replace existing systems. Many hospitals and local governments are encouraged (by their vendors) to quickly remove old systems when new technologies are introduced, because "the old equipment is no longer needed." Their purpose in that encouragement is twofold. First, it would be embarrassing for the new technology to fail or perform inadequately during an important event, which might cause the users to fall back on the old system. The second reason is that once the open, alternative access method is removed, more sales of proprietary equipment and systems are likely.

As agencies migrate from VHF and UHF frequency bands to 800 MHz, they will question the need for a mutual-aid channel in a lower band, particularly when they feel that the 800 MHz mutual-aid channels serve that purpose. When the mutual-aid channel is in a band not already used by that agency, it will require them to employ or maintain additional or older equipment (fixed and/or mobile). This is the crux of their argument.

Before old systems are abandoned, owners should conduct an independent review or survey of surrounding agencies to determine the impact of removing the systems. Systems can then be maintained,

replaced, or upgraded as warranted to address that demand. These backup systems can also provide alternate access and basic capabilities in an independent, redundant manner that is not vulnerable to the primary system. These backup systems should be exercised and tested daily to ensure their continued operation and reliability, and to keep users familiar with them.

Until the newer technologies provide open access and ready availability from multiple vendors to the extent that older systems do, users should continue to provide access via those systems.

TRUNKING

The concept of trunking was originally developed by the telephone industry to allow the sharing of long distance telephone circuits. The term trunking means sharing of small number of talk paths (circuits or channels) by a large number of users. Trunking was introduced to radio systems in the late 1970's and a set of required system features and operational requirements for public safety systems was developed by APCO in Project 16 in the early 1980's. Since then, Project 25 has been adopted and includes requirements for common architecture and interoperability between different system vendors.

Trunking, as it applies to land mobile radio systems, is the automatic control and assignment of a small number of channels among a great number of users. It should be noted that trunking of radio channels may be applied to nearly any radio frequency spectrum, although 800 MHz is most favorable.

Emergency Medical Services (EMS) is a major component of the system requiring networking as well as regional control and coordination of services. Many rural areas of the state have inadequate communications for EMS systems allowing for comprehensive patient reporting, consultation with physician advisors, connection with major trauma centers (level I, II), and aeromedical evacuation and coordination. A trunked radio system design can evaluate the deficiencies and needs of EMS, and provide for effective control and coordination. ***It is intended that the Colorado State Digital Trunked Radio System should serve as the communications backbone for the new statewide EMS/TRAUMA system being developed as a result of recently enacted legislation.***

TRUNKING OPERATIONAL DESCRIPTION

Trunked radios use a small number of channels or repeaters (usually five to 20) as the trunks, and they are automatically steered to an idle channel

for conversation. This allows "virtual channels" to exist. The user, after obtaining a virtual channel, cannot tell that he doesn't have his own dedicated channel.

A trunked radio system allows the users to be automatically and dynamically assigned to an available channel within their area of operation. Trunked radio systems offer substantial efficiency over conventional system based on two fundamental principles.

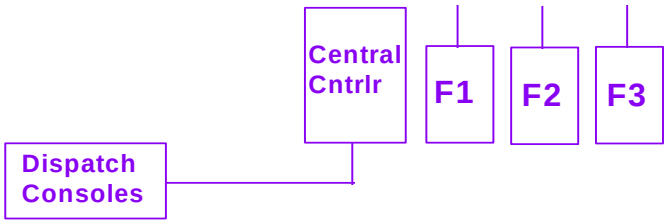
1) The percentage of time that any individual user requires a trunk is very small.
2) The probability that many users could require a trunk at the same instance is exceedingly small.

Emergency medical communications systems at 800 MHz are likely to operate in a trunked mode as part of a much larger public-safety communications system. Trunked systems provide improved channel availability, utilization, and interoperability with other disciplines. Very coarse FCC loading guidelines consider that one channel should be made available for each 100 trunked mobile and portable radio units.

The coverage needs of EMS communications systems often encompass several local jurisdictions, and may not fit neatly within the boundaries for other public-safety disciplines. Several different trunking methods are available from different manufacturers. Unfortunately, these methods are incompatible, and trunked radios from one manufacturer do not normally operate in the systems from other manufacturers. Even with radios of a similar manufacturer, system and unit identification is necessary.

The problem for current EMS is to be able to communicate with a large number of users from different jurisdictions who may have incompatible trunked systems. Five channels in the NPSPAC allocation were selected and set aside for mutual-assistance communications (ICall, ITAC-1, and ITAC-2, ITAC-3, ITAC-4). These channels were selected so they could be implemented in radios operating in the original allocations. They are to be operated in a conventional mode to provide the ability to communicate between systems operated by different system operators or systems installed by different manufacturers.

Trunking



TRUNKING IS THE MUTUAL SHARING OF A SMALL NUMBER OF COMMUNICATIONS PATHS (TRUNKS) AMONG A LARGE NUMBER OF USERS

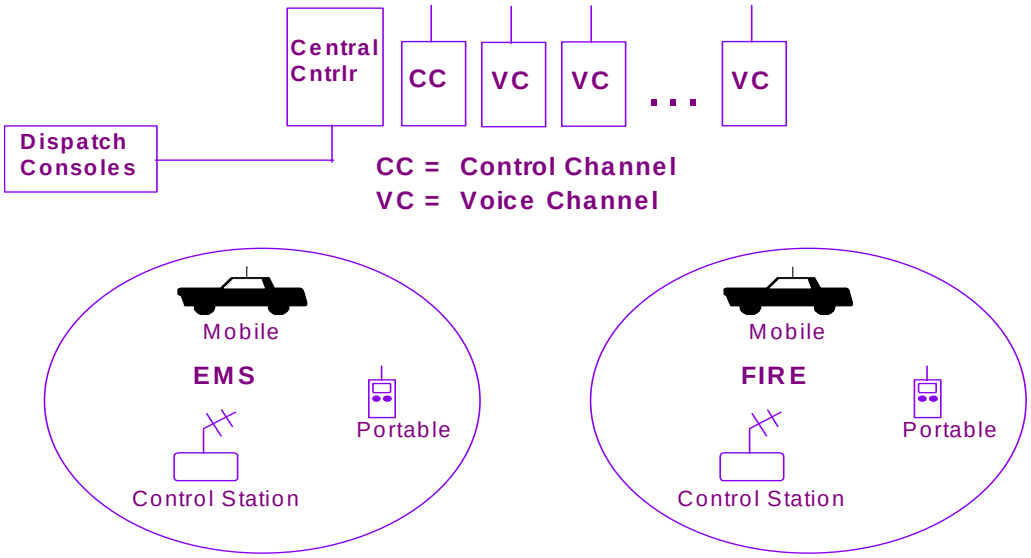
FEATURES AND BENEFITS

The capacity and capabilities of trunked systems are also greatly enhanced by the use of microprocessor chips to control the system and individual radios. The use of specialized software also provides new management capabilities. These components of the system allow the trunked system to organize radio users by talk groups rather that by frequencies or channels. This provides the effect of a private channel per talk group and the flexibility to reorganize and expand the system as the need arises.

Some of the advantages of digital trunking are:

- Virtually no waiting for a free channel.
- Pre-transmission monitoring to prevent interference is not necessary.
- Virtually no interference is caused to or received from others.
- Others cannot reliably monitor transmissions.

- There is no requirement for station identification of individual users.
- Interoperability problems between different agencies can be eliminated



EMS agencies that operate on the statewide, 800 MHz DTRS are part of a large public-safety communications system. Operation on the DTRS is Trunked. Conventional, non-trunked, 800 MHz repeater stations are strategically located throughout the state for operations that cannot take place on the Trunked system such as some interoperability scenarios. This system should support not only dispatch and coordination, but medical communications as well. The system was designed to service a specific defined user population. The following apply to the statewide DTRS 800 MHz communications system:

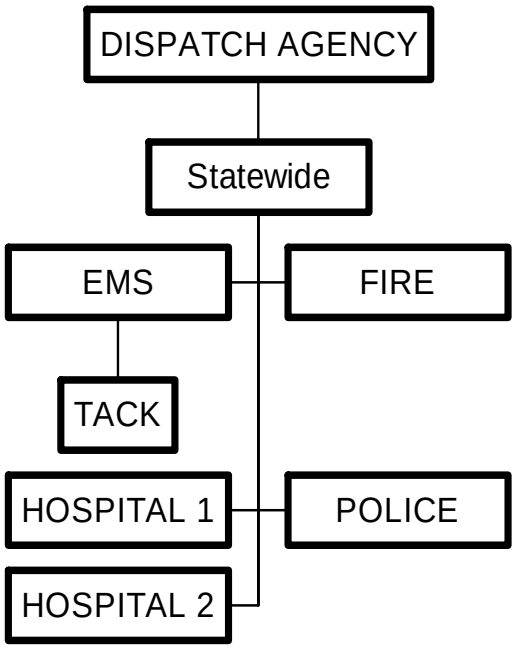
- A local 800 MHz communications usage plan must exist and be followed in conformance with this state-level 800 MHz plan. The plan must define the purpose and scope of the 800 MHz system and the local operating procedures in conformance with the state-level-plan.
- All emergency response units should have 800 MHz mobile radios that operate in accordance with the local and statewide plan.

- Each responding emergency mobile unit that is equipped with an 800 MHz radio should be configured so it is able to communicate with any facility ER within its service area or radio range.
- Each facility ER should be able to communicate with any 800 MHz radio-equipped emergency mobile unit for which that facility is the closest or most appropriate emergency facility.
- Every mobile unit that operates on 800 MHz frequencies should be equipped to operate in a conventional mode on all five national mutual assistance system channels as listed in Appendix E. Stations should be capable of operating in the simplex (direct), as well as half-duplex mode.
- All 800 MHz radio operator controls in both the facility and the mobile radio units should be clearly marked with commonly known and consistent terminology.
- Trunked 800 MHz EMS communications equipment will operate as part of, and support public safety communications systems where they already exist. The economies of scale, improved channel utilization, and interoperability can only be realized when operating as part of a larger system.
- All trunked 800 MHz radios will be configured so different functional needs (dispatch, tactical coordination, and medical communications), are served by separate "virtual channels." The advantages of trunked communications cannot be fully achieved if all EMS functions operate as if they are on only one channel.

SAMPLE TALK GROUP CONFIGURATION

Using the criteria established by State Telecommunication Services and the SEMTAC Communications Subcommittee, the following examples show how talkgroups could be configured for an EMS agency. These are only examples and each agency would have the ability to organize their talk groups as they choose within the criteria established by the State.

EMS AGENCY TALK GROUP CONFIGURATION



One primary and one tactical talk group could be available for each EMS agency or operational function. Talkgroups will only be assigned for those functions that actually exist and are necessary to provide effective communications.

Local Working Talkgroups

Each county or agency anticipating or actually using the Statewide DTRS will have a selection of local working talkgroup channels available. These channels will be distinctive and provide local radio coverage for daily communications functions. All agencies could be assigned primary and secondary working talkgroups. EMS agencies intending to operate on the DTRS State system must apply for and be granted authorization to use the system.

COLORADO DTRS FEATURES AND BENEFITS

Radio User Organization

64,000 Unit ID's - The system is capable of handling a very large number of radios.

Any Number of Units per Talk group - A talk group can be as small as 2 radios or as large as every radio in the system.

16,000 Talk groups - The system can provide a very large number of talk paths. Talk groups can be organized in any manner with virtually unlimited levels: Agencies, Districts, etc.

Call Types

Talk group Call - Normal conversation within a common group of users.

Individual Call - an individual user can dial another user and conduct a private conversation.

Emergency Call - By pushing the "Emergency" button on the radio users can alert the dispatcher immediately and display the ID of the calling unit.

Announcement Group Call - A dispatcher can give an "Emergency Call" to several groups simultaneously.

Trunking Features and Capabilities

Busy Queuing & Call Back - When all channels become busy the users are placed in a queue according to their priority level and are automatically alerted when it is their turn to talk.

Recent User Priority - A user is moved higher in the queue to complete a recent conversation, only when all channels are busy.

Automatic Retry - If a weak signal or interference prevents access to the system, the radio will automatically retry to gain access.

Continuous Assignment Updating - The system will continually update every radio as to the channel assignment and status.

Out of Range Tone - The user is alerted if the radio is out of range of the system.

Unit ID - Each radio transmits a unique ID that can include an alias, which can be the name, call sign or other special identifier of the user.

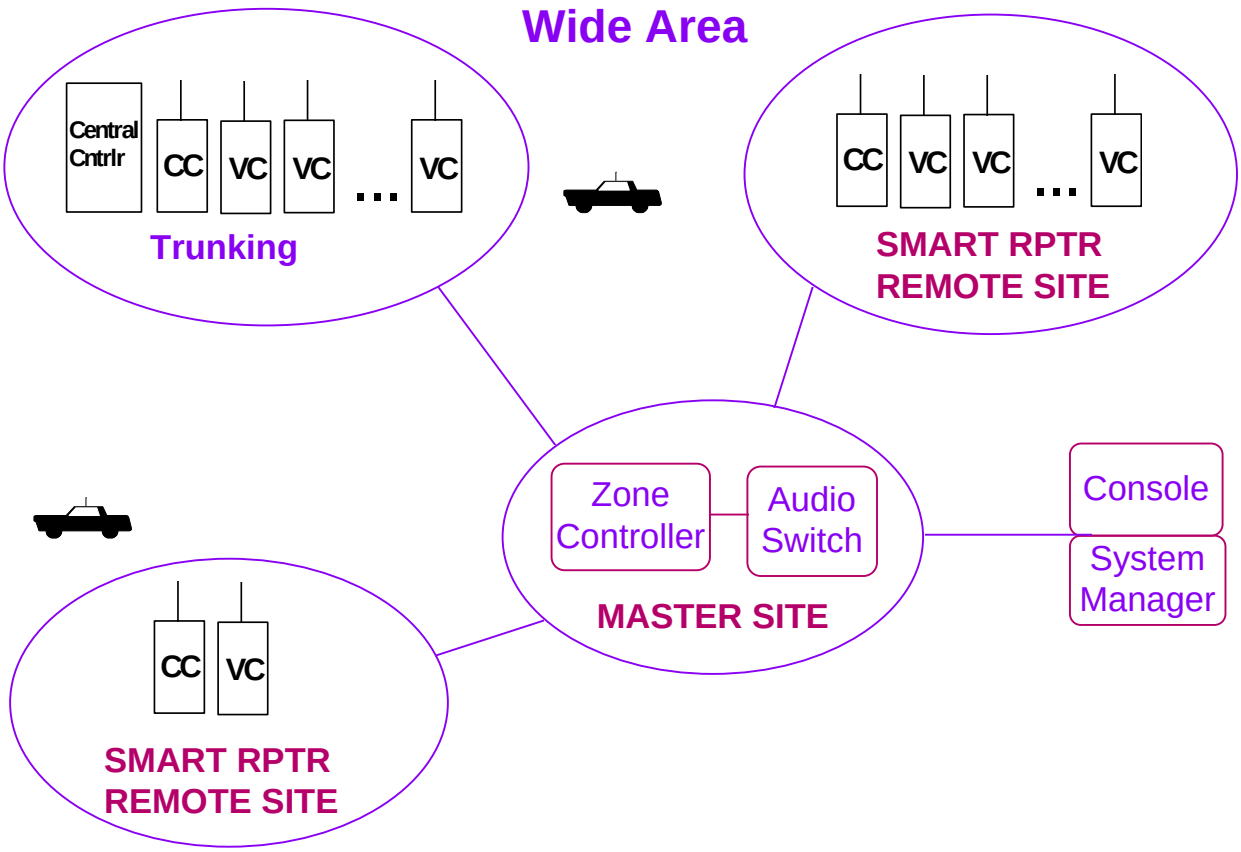
Priority Access - The system is capable of 10 levels of priority for placement in the queue when all channels are busy. An emergency always has priority 1.

Dynamic Regrouping - Using the system manager a dispatcher can move radios to new talk groups for special activities or emergency operations.

Selective Radio Inhibit - A lost or stolen radio can be remotely disabled, preventing unauthorized access to the system.

Talk group Merge - A dispatcher can merge individual talk groups into 1 group for special activities or emergencies.

Perhaps the two greatest benefits of trunking compared to conventional systems are the ability to share resources among a large number of users and the capability of interoperability when all users are sharing a common system. A statewide system expands these benefits to the State and will allow users to have wide area communications capability, well beyond their current systems. The system will also provide statewide roaming capability for users who travel in all areas of the State. Agencies have identified the lack of coverage and the lack of interoperability with other agencies as the two biggest deficiencies of their existing systems.

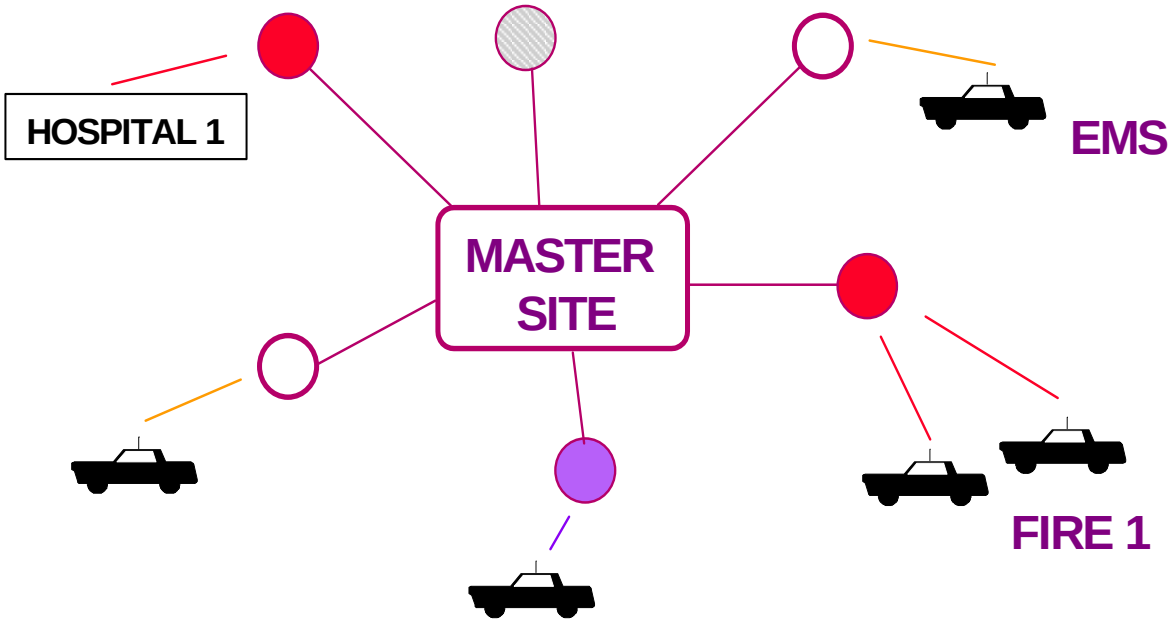


The system also provides the capability for communications to occur across the State. An EMS transport in Durango is able to communicate with a Facility in Sterling simply by utilizing the facility's common talk group; no special setup or user actions are necessary.

TRUNKING OPERATIONAL AND SYSTEM REQUIREMENTS

GENERAL SYSTEM CAPABILITIES

Wide Area
DYNAMIC SITE ASSIGNMENT



Wide Area: **USERS OCCUPY CHANNELS ONLY AT SITES NEEDED TO SUPPLY COVERAGE**

System Flexibility

- Repeater and Non-repeater operations.
- Concurrent Data and Voice capabilities.
- Easily configured talk groups for intra-agency and inter-agency/multi-jurisdiction operation/coordination.

- Widely configurable talk groups, some very large, including hundreds or even thousands of units, and some very small.
- Local and Wide area talk groups. Wide area talk groups would allow users in widely separated parts of the state to communicate with each other.
- Talk groups on a statewide basis.
- Many users certainly need to monitor talk groups that they would not normally be allowed to transmit on.
- Some talk groups will be usable, continuously, across large geographic areas.

Basic Functionality's

- Voice dispatch.
- Car-to-car voice.
- Data dissemination from dispatch centers.
- Local system interconnects for early warning systems.

System Interconnectivity for coordination and mutual aid

- Linking trunked digital to conventional analog networks.
- NLEEC and State Ch # 3 availability.
- Compatibility with existing specialized equipment.

System Coverage

- The current system designed provides 90% coverage 90% of the time statewide. For some areas this level of coverage represents a significant improvement. For others, it may not be adequate. A higher percentage of coverage overall may be cost prohibitive (e.g., raising statewide ceilings to 95% coverage for 95% of the time) in metropolitan areas and particularly in institutional facilities.

System Reliability

- The current system is fault-tolerant although individual hardware pieces could fail. These failures should not impact the operations of the system assuming they are repaired in a timely manner. The system architecture should provide considerable fault tolerance. Improved performance should be expected due to automated features of "smart radio systems" which will deploy

adjacent repeaters in other sites to maintain talk groups at optimal levels.

- The system should provide reliable, clean, interference-free communications. There should be no interruptions or degradation of service when routine maintenance is being performed. Redundancy or "fault-tolerance" should allow for scheduled maintenance as well as system failure, and switch automatically to alternative facilities.

System Capacity

It should be understood that trunked systems by their nature provide a much higher capacity for communications than conventional systems. In light of this fact, what are the projections for users' needs that could outstrip this additional capacity?

- The possibility of more directed and 'private' conversations may create a use that has primarily been satisfied by telephones today.
- The possibility of wide area communications could add additional burden on the system.

DISPATCH AND COMMUNICATION CENTERS

Administration of Systems

- Agencies definitely need control of their talk groups. It should be understood that while some agencies are geographically bound, others are not. Talk groups need to be rapidly re-configurable. In emergency operations, new field units may need to be added to talk groups that were not planned for in the engineering of pre-plans.
- Define and limit the number of talk groups usable by each agency. This prevents a particular agency from saturating the system and preventing access by other users.
- Administrative help from the state could be used for smaller agencies that ordinarily do not have a need for personnel proficient in administering the system.

Operational Characteristics

- Provide supervisory capabilities to prevent misuse of private trunks

- Provide system utilization data to monitor the system loading in real-time.
- Provide system and field unit utilization history.
- Provide lockout for malfunctioning or illegal field equipment.
- Provide user-friendly diagnostics, designed for dispatch personnel, not just system technicians.
- Dispatchers will be able to configure simultaneous broadcast over multiple talk groups within the agency and the talk groups of other agencies by agreement. These talk groups may or may not be geographically local. The voice source may be within the comm-center or may be from a field unit, or some other comm-center.
- The logical control point for activation of emergency public warning systems is in dispatch centers. Warnings initiated by one center must be easily disseminated to geographic areas affected by the hazard, as well as to other centers that may have adjacent warning and response authority.

Documentation and Recording of Transactions

- All digital/analog communications (voice or data encrypted or non-encrypted) will be capable of being recorded as required.
- For legal/liability and statistical analysis/management purposes. (This includes unit-to-unit field transmissions in various talk-groups that would not normally be monitored by a dispatcher in a Communications center)

TALK GROUPS DEFINED

Talk Groups are defined by user group needs. A typical local talk group might include a geographic area defined by the city limits (or slightly beyond) of a city or town. A regional talk group might include multiple jurisdictions within a county (e.g., several cities, towns, county government, and interactive agencies on a federal, state, and local level). The geographic “service area” Dispatch Communications Center (which customarily provides system access to the public for enhanced 9-1-1 service, and controls/coordinates the dispatching of EMS responders in that service area) would define the local, regional and statewide/interstate talk groups needed to provide comprehensive communications services to that area. A statewide / interstate talk group might enable an authorized user to communicate with units of his own agency throughout the state. Regional and local user group agencies would also be able to interconnect with agencies in adjoining states which may border their jurisdictions.

Additionally, local jurisdictions may be provided access to statewide talk groups in specific applications. For example, an ambulance transporting a patient from southwest Colorado to Denver would be able to continuously access his/her home dispatch communications center in Durango, as well as any number of communications centers, which serve the areas as the ambulance, is passing through on the way to Denver. If EMS personnel require assistance at any time during the trip, they are never out of reach of either home jurisdiction, or the jurisdictions through which they are passing. EMS personnel may be able to directly access the facility which is the ultimate destination.

TALK GROUP CLASSIFICATION

Talk Groups are classified, as noted previously, according to use on local, regional, and statewide/interstate categories. Within these categories are subsets of user groups that have been defined according to function. Within the general categories, would be layers of different jurisdictions (e.g., state, local, etc.) Some tailoring and modification of structure could be necessary for each “service area” or jurisdiction to meet specific local, regional, or statewide needs.

MUTUAL AID NETWORKS/CHANNELS

Existing mutual aid channels/networks are dispersed among different bands (VHF, UHF, and 800 MHz) according to service category of law, fire, EMS search and rescue, and federal/state/local jurisdiction. It is necessary to consider these existing channels and to determine appropriate digital trunked radio complementary channels and networks that could interface with them, and/or eventually replace them.

EXISTING MUTUAL AID NETWORKS/CHANNELS

LAW

N.L.E.E.C (1 VHF) nationwide analog channel (155.475 MHz).

C.L.E.E.R. (1 UHF) eastern front-range coordination for metro areas (460.425 MHz).

FIRE

F.E.R.N. (3 VHF) nationwide analog channel 154.280 MHz, 154.265 MHz, 154.296 MHz). AIRNET (1 VHF) airborne fire suppression net (U.S.F.S.).

WORKNET (1 VHF) regional wildland fire suppression (U.S.F.S.).

EMS

Ten wideband EMS (UHF) channels (nationwide authorization) for ambulance to facility, etc., and eight (UHF) narrow band channels.

Two H.E.A.R. (hospital emergency administrative radio) VHF channels 155.280, 155.340 MHz, five VHF narrow band channels (VHF MAC 1-5), plus other special emergency channels (VHF, UHF) in various areas.

One N.S.A.R. (1 VHF) nationwide use for mountain search and rescue and volunteer and National Ski Patrol coordination (155.160 MHz).

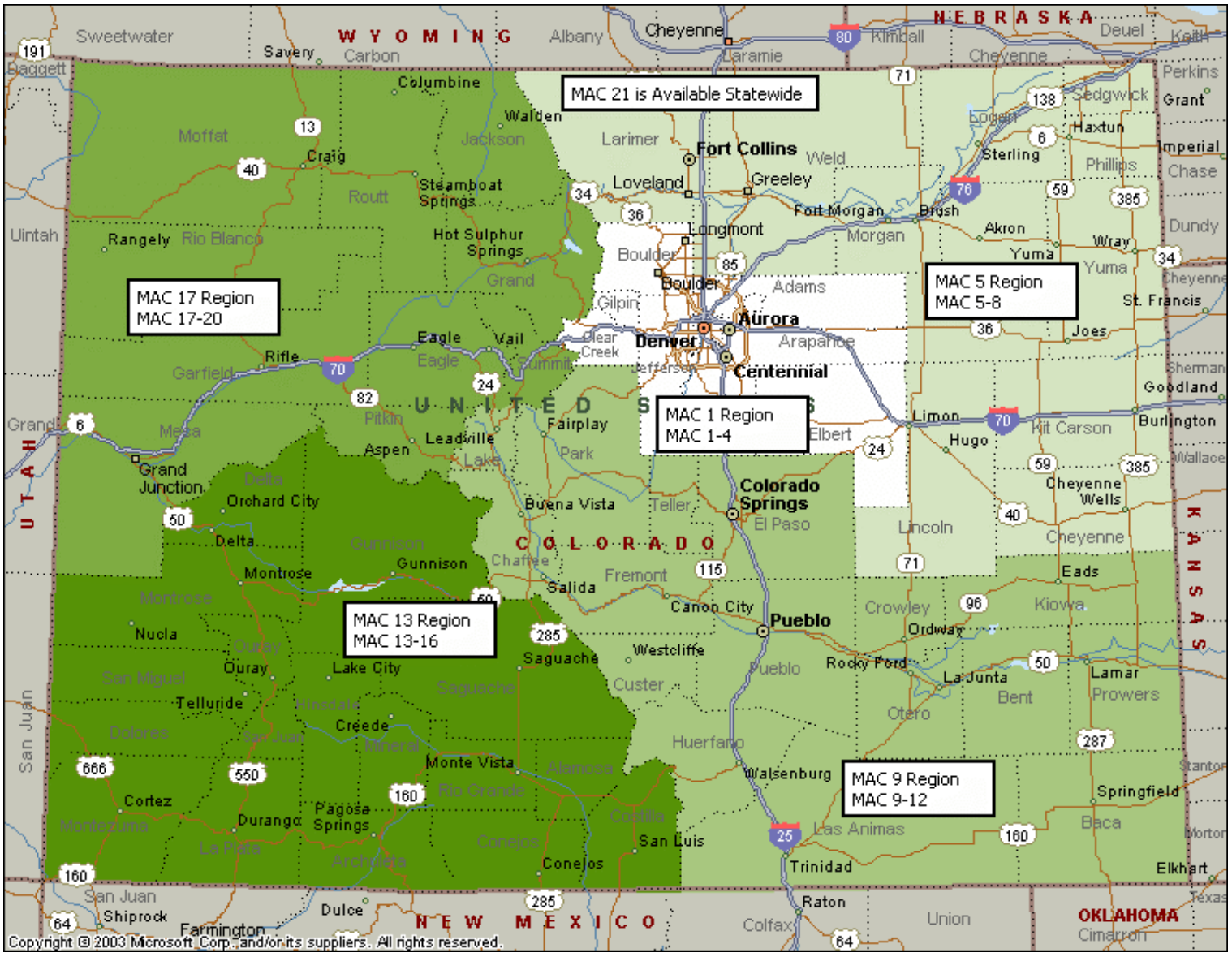
800 MHz

Five 800 MHz CONVENTIONAL MUTUAL AID CHANNELS - ICALL, ITAC-1, ITAC-2, ITAC-3, ITAC-4.

Twenty-one DTRS TRUNKING MUTUAL AID CHANNELS – Five regions with four talk groups per region and one state-wide talk group.

State of Colorado Digital Trunked Radio MAC Channels Assigned by Region

MACS listed as of 5-16-06



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INTEROPERABILITY BETWEEN VHF/UHF and 800MHZ

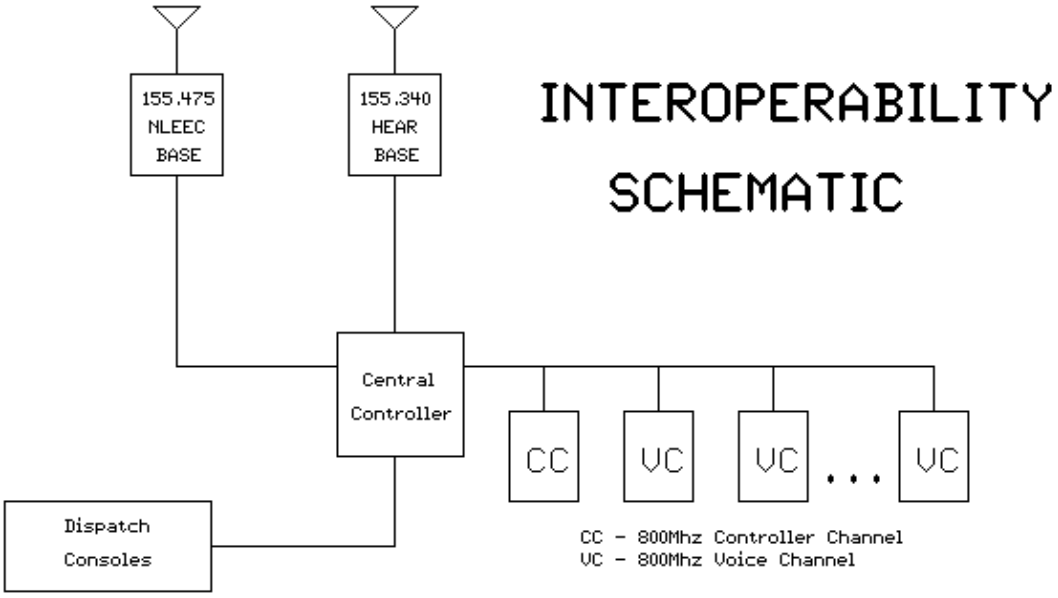
Ensuring interoperability with other agencies that may provide or require mutual assistance is one of the greatest challenges in any public safety communications system. Because EMS communications systems often serve multiple jurisdictions with differing communications systems, the problem is more apparent.

With technological advances, the State of Colorado has developed and operates a highly sophisticated DTRS communications system.

In rural areas, a single facility may serve several localities over a wide geographic area. The facility's decision to adopt the DTR system and abandon older ones could reduce its ability to effectively communicate with field units not using DTRS. Field units from other jurisdictions could adopt an incompatible system for their daily operations, resulting in no communications with the receiving facilities.

Several measures can be employed to ease migration problems, but they require careful planning, often involve compromises, and may offer only limited relief. The most popular method is to "patch" old technologies with new. The interoperability that they provide is also dependent on access to the DTR system. These capabilities are lost if the mobile radio units travel outside of the system service area, or if the fixed end equipment fails.

The best approach to provide continued interoperability is to upgrade and replace existing systems with the states new DTRS. As agencies migrate to 800 MHz, they could question the need for a mutual-aid channel in a lower band, particularly when they feel that the 800 MHz mutual-aid channels serve that purpose. When the mutual-aid channel is in a band not already used by that agency, it will require them to employ or maintain additional or older equipment (fixed and/or mobile). Before old systems are abandoned, owners should conduct an independent review or survey of surrounding agencies to determine the impact of removing the systems.



DIGITAL TRUNKING

The system will utilize two technologies not currently utilized by the majority of the systems operated by the State and local agencies. The first technology is trunking and the second is digital transmission. Each of these technologies offers substantial improvement in capabilities over today's systems. The combination of these two technologies will create a new wireless system, with many new features that will allow the user to have access to various types of voice applications for Emergency Medical Services.

FREQUENCY BAND

One of the biggest issues in the final design was what frequency band should be utilized. The majority of the previous systems used by State and local agencies operated in the 150-160 MHz (VHF) band.

The assignment of frequencies for EMS and public safety is governed by the Region 7 (Colorado) Public Safety Plan. The Plan was submitted and approved by the FCC and provides specific eligibility requirements, frequency allocations, and system design considerations. The State has been assigned numerous channels for statewide use. There are also numerous channels that are unassigned and may be used for future growth as required.

The FCC has initiated a complete re-write of the rules for all frequencies below 800 MHz and above 50 MHz. This re-write is commonly referred to as "Part 88". The proposed changes in Part 88 include allowing trunking in the VHF band, splitting channels to create more channels, and limitations on transmitter power. The most notable affect of Part 88 could be the complete replacement of all VHF radio equipment currently in use by state and local government agencies. There is an extended time frame to allow for amortization of the existing equipment with a January 1, 2013 deadline for migration to narrowband technology (RM-9332). Frequencies in the 800 MHz band are not affected by Part 88.

Initial estimates indicate the cost of the system could be 20 - 30 % higher to use 800 MHz compared to VHF. Part 88 will have a significant effect on the VHF band for many years to come and this band will be in a state of dynamic change. The lack of additional channels and this uncertainty of the VHF band have made 800 MHz the best choice for the new system. There are an adequate number of channels for the system with more channels available for future growth.

SYSTEM COVERAGE

The other significant factor in selecting the band is the radio signal coverage area from each transmitter. The mountainous terrain in the State plays a critical role in the range of the transmitters. The general rule is the higher the frequency the shorter the range but this has proven not totally accurate. Testing within Phase 1 has proven coverage that far exceeds what was available on VHF. The VHF band provides somewhat greater range than 800 MHz under normal circumstances, although it is possible to compensate for the loss of range at 800 MHz and gain coverage with high gain antenna systems that are not possible in the VHF range. Initial computer generated coverage maps in the 800 MHz band show a slight reduction in coverage compared to the VHF band. This loss could require additional sites to fill the holes created at 800 MHz.
One simple and cost effective method to fill the coverage holes could be sharing of sites owned by local agencies. This would eliminate the cost to construct additional sites. The only cost would be to interconnect these sites to the State network. Sharing of sites would also make it easier for Non-state agencies to share the system.

The coverage design criteria is to provide coverage in 90% of the State, 90 % of the time for a mobile radio operating outdoors for the wide area portion of the system. Local or facility based systems will be designed for the specific requirements of each facility. Non-state agencies that participate in the system, whose needs are not met by the initial coverage criteria will be addressed on a case by case basis. Costs associated with improved coverage will be the responsibility of that agency.

SYSTEM MANAGEMENT ADVISORY COMMITTEE

A System Management Advisory Committee has been established. The purpose of the System Management Advisory Committee, known as the Consolidated Communications Network of Colorado, Inc. (CCNC) will be to provide direct input on the management and control of the system especially for non-state agencies. The CCNC will also be instrumental in resolving special situations or non-standard uses and participation of the system. Information on the CCNC can be found at http://www.ccnc.org.

DTRS USER FEES

Fees to access the system are a possibility for two reasons. The first is to provide a pay back mechanism for the initial system cost and the second is to fund ongoing system maintenance, management, and upgrades. There are two variables in determining if fees will be assessed. If the initial funding does not require pay back and if ongoing funding for maintenance and upgrades is provided from general fund money, then no user fees will be necessary. As of April, 2005, user fees aren't assessed.

The methodology for determining the user fees could be a monthly or yearly flat rate per subscriber unit. The actual rates have not been determined. The rate could be tiered with minimum rates being assessed for basic service and higher rates for advanced services such as data transmission and encryption.

The CCNC has identified that there could be multiple membership levels of non-state agency participation in the system. The multiple levels will give EMS agencies a choice to select the level that meets their operational needs and financial ability.

The DTRS will provide services to a large number of state and local agencies in Colorado. In addition, the system will be available to several types of membership by other organizations, including state, county, municipal government agencies, and certain EMS service organizations. The rules for eligibility are defined in the Region 7 Public Safety Plan. Once an organization qualifies under the eligibility rules, it can participate in the DTRS via any of the following types of membership.

CLIENT MEMBER

CCNC furnishes DTRS services to the user. This will typically be a smaller EMS agency, often in a rural area. The CCNC furnishes a client the use of the existing DTRS network. Depending on the entity, the State may be reimbursed for any capital and service costs, though such clients would generally "piggy-back" on existing state services, without requiring the state to construct additional facilities on their behalf. Client members

will be expected to pay for their own radios and a monthly or yearly service fee.

INTEGRATED MEMBER

These members would generally be small-to-medium size EMS users who have chosen to abandon (or have refrained from building) their own radio systems, but have asked the State of Colorado to specifically include facilities to meet their needs in an augmented Colorado State network. The Integrated member would generally pay the State to build and operate a system for the user, and would probably pay a fee for services. Unlike the Client User, the integrated member would require a modification or addition to be made to the State network. An Integrated Membership would be advantageous for a typical smaller system, where the incremental cost of adding to the Colorado System would be considerably less expensive than the construction of a whole new separate small system. Such a membership might not be advantageous if providing the needed facilities required substantial modifications or additions to the Colorado System, costing more than separate facilities.

COOPERATING MEMBER

In this case, the member (e.g. a county) builds its own network primarily to meet its own needs. However, the system is designed to meet exact compatibility and operational specifications, so that the user's system can be easily integrated as a major node of the statewide network. The system remains county property and is under the control of county personnel. However, it is fully integrated into the statewide net for the purpose of shared operation for users outside of the county. This includes complete operation of encryption keys, various use authorizations, etc. Under exceptional circumstances, the county might be required to provide priority service to particular EMS operations.

The Colorado State network is not intended to exist as an independent network in the territory served by a Cooperating System. It will exist only as a virtual network using the physical facilities of the Cooperating System. In some areas, state microwave links might traverse the geography of a Cooperating System. In some cases, the Colorado system might need to augment the capacity or the features of a Cooperating System, in order to meet anticipated State system needs. In this situation, the State would reimburse the Cooperating system for the additional incremental costs, as well as a prorated share of maintenance and operations costs. In addition, the State of Colorado would furnish and maintain the hardware, software, databases, and personnel required to integrate Cooperating Systems into the State network.

In exchange for participation as a Cooperating member, the Cooperating member would gain access to the State of Colorado system on a statewide basis. In general, the system would operate seamlessly, allowing any user to follow identical procedures no matter whether a State System or a Cooperating member was serving him. In various areas throughout the state, some special features (like broadband digital data links) might not be available, depending on exactly which features had been implemented locally.

ASSOCIATED MEMBER

The Associated Member, like the Cooperating Member, has built its own system, following Colorado state standards to maintain system to system compatibility. An Associated Member would be granted the use of the Colorado system on an occasional and non-binding basis. Foreign use of the Associated System would be on an occasional and non-binding basis. Priority use of the system by a foreign user would only occur on a voluntary basis. There would tend to be a lower degree of integration between an Associated Member and the Colorado State system, and foreign users might not enjoy the use of a full range of services.

Because an Associated member would have no legal obligation to permit long-term sharing by other State system users, the State system would generally need to provide its own parallel coverage of Associated System territory. The state would generally not provide additional capacity or pay any construction costs of Associated member systems. The total costs of the independent systems would be expected to be larger than the total cost associated with a Cooperating member or Integrated member systems.

Associated membership might be useful where high-priority agency missions (or turf issues) cause administrative difficulties in temporarily subordinating the agency mission to foreign control of assets, or where equipment / frequency band incompatibility prevent a full implementation of Cooperating Membership. Associated membership might be used on a voluntary basis to mutually share trunked loading of a limited number of channels and to obtain state coverage of areas near Associated member transmitter sites and vice versa, or to gain additional capacity during planned special events.

Some agencies might initially choose Associated membership, with Cooperating membership being a later option.

CHANGING MEMBERSHIP CATEGORY

There will always need to be the possibility of changing the status of members. For example, a small town may grow and decide to require the

State to provide some additional facilities, thus switching from being a client member to an integrated member. Each such change will have to be negotiated, and the particulars of each case will affect the way in which costs are divided or charged. General principles, however, should dictate that the agency initiating the change should bear a substantial part of the costs, that shared equipment and land should return to its original owner, and that sharing should be encouraged whenever possible.

Two problems will occur when an integrated member withdraws from the system, leaving an area without coverage for the State users; obviously, a maximum amount of time should be allowed for such a change to occur. In addition, the change from a single system to two less-efficient smaller systems may require substantial additional funds to be expended by both parties. On the other hand, combining two independent systems into a single more efficient system may not result in immediate cost savings, because of the expense of reconfiguring systems and equipment.

PRIORITY USE DURING EMERGENCIES

In addition to exact compliance to system protocols and databases, the total system (state and member networks, alike) would be pledged to operate according to a pre-arranged set of priorities for certain scenarios. Under normal circumstances, of course, there would be adequate system capacity, and there would be no need to choose which users would obtain service. These priorities would occur only under very extreme circumstances. These circumstances could include presidential visits, extreme natural disasters (Big Thompson Flood), riots, etc.

The use of priorities must be treated seriously; without them many of the federal agencies (for example) will not judge the system sufficiently robust to rely on in times of stress. Lacking clear priority rules, these agencies will build their own independent, expensive, frequency-hungry systems, instead of participating in the Colorado statewide network. If they join the Colorado system, they will be able to pay for additional capacity, coverage, and robustness, which will be of great benefit to the other users during the 99.999% of the time when priorities are not required.

It should be noted that priorities are not merely “pulling rank.” Particular functions would have different levels of priority, depending on the nature of the emergency. These will be agreed to in advance, according to user inputs, and should represent the best judgment on how to employ vital public communications resources during exceptional circumstances. During these circumstances, personal or bureaucratic convenience will be required to give way in the face of needs that have been judged more important to the public welfare. This means, however, that Cooperating

members may very occasionally need to concede the highest priority to an outside user.

CONSTRUCTION FUNDING AND OPERATING EXPENSES

Client members, where most EMS agencies will fall under, will have expenses that will include purchasing their own radios, and possibly, a nominal annual user fee. Integrated members would need to pay a substantial share of the construction cost (the incremental cost of their part of the system), and annual fees for maintenance and the cost of providing service. Cooperating members and Associated members would pay for the cost of building and operating their own systems, though perhaps the state would contribute a portion of the cost savings from otherwise having to build a separate state network in a Cooperating coverage area. The State of Colorado would pay for building and operating the network infrastructure, including network management, and for the sites and radios needed to service all of the state agencies.

It will be expensive to manage a state-wide network, from the standpoint of managing the network day-to-day, as well as purchasing and implementing the dispatch and network management software and hardware. The administrative system controlling the entire network will be operated and administered by the State of Colorado. The State will enforce performance and reliability standards, so those users can be assured of receiving the needed level of service. This would include maintaining the daily database of what users are authorized across the network, the safekeeping of encryption keys and other restricted data, the operation of several dispatch centers, and the administration of the entire system.

The State of Colorado will manage the overall Colorado State network. In addition, the Integrated and Associated members will need to purchase, operate, and manage their individual local systems, which may be interconnected as parts of the state-wide network. The local member networks will require their own set of compatible hardware and software, dispatchers, databases, trunked base stations, etc.

Some monthly operating fees might be assessed to use the system. Site / network software is available to allow user traffic to be measured. Some compensation might be required if a Cooperating or Associated system used much more or much less service throughout the state than it provided to state functions within its own area.

OVERALL SYSTEM ARCHITECTURE

The architecture of the statewide system described above consists of:

- A number of compatible trunked sites

- A network connecting and coordinating the trunked sites
- An administrative system controlling the network.

Some of the trunked sites would be owned and operated by the State of Colorado, while others would be owned and operated by Cooperating and Associated users. All sites would rigorously conform to PROJECT-25 standards and Colorado state conventions, as necessary. The State of Colorado would control the connecting network. It would include microwave links, leased fiber, common carrier DS1, etc., as well as the software and hardware needed to coordinate the use of the multiple sites, the data bases of user authorizations, and other data.

In some cases, the Cooperating or Associated systems would be multiple-site systems connected with their own network, so the Colorado network would be a network of networks.

A user organization will provide long-term policy guidance to the state for the operation of the statewide system. This group will ensure that the state hears member complaints, requests for new services, etc. The details of this organization's rights and obligations have not yet been determined.

SYSTEM COST AND FUNDING

Perhaps the most frequently asked question up to this point is how much will the system cost and where will the money come from. Early estimates have ranged from 60 -120 million dollars. Telecommunication Services is the lead agency in the development of the system. Now that this plan is completed, development of the financial plan for converting agencies over to trunking will be a priority for all participating organizations.

With the completion of the PROJECT 25 standard, several manufacturers are gearing up to market equipment. Actual costs and equipment being available will follow.

Where will the money come from? The majority of backbone and fixed equipment costs will be the state's responsibility since they will be the largest users.

The cost of the system has 3 major components: Backbone, subscriber units, and fixed equipment. The backbone includes repeaters, antenna systems, system interconnect equipment, new transmitter sites and the network management system. Subscriber units include the mobile and portable field radios used by all participating agencies. Fixed equipment includes dispatch consoles and control stations.

The majority of the system will use existing transmitter locations owned and operated by state and local agencies. The existing state sites will be interconnected using the existing state microwave network that was upgraded from an analog system to a high capacity digital system, in order to support the trunked radio system.

New transmitter sites will be required where existing sites will not provide the required coverage. New sites will attempt to share existing sites and towers owned and operated by private and commercial entities. There will be a need to establish new sites where there are no other alternatives available.

SUBSCRIBER EQUIPMENT COST

Subscriber equipment cost includes the mobile and portable radios each EMS agency will need to use the system. These costs are the easiest to estimate as the state has current price agreements with Motorola, EF Johnson and Kenwood. All VHF and UHF equipment currently in use will remain for inter-agency interoperability.

The use of PROJECT 25 equipment will allow for various vendors to provide subscriber equipment through a competitive bidding process. The competitive bidding process will include high, mid and low tier equipment, which will allow the user to select the most cost and application effective radio. New PROJECT 25 radios from different manufactures are projected to be available in the future at substantially lower costs.

OPERATING COSTS

Estimating the ongoing operating costs for the system are probably even more difficult than estimating the equipment cost. The use of new technology including the network management and control system should enable Telecommunications to operate the new system for close to the same cost as the present system. New digital equipment is highly reliable and not subject to multiple failures. Subscriber equipment will have very few field repairable components that should also keep the operating cost consistent with the current system. Telecommunications' annual expenditures includes all fixed state, subscriber, communications center, sites, towers, and microwave equipment. Since the new system is very dynamic, the operating cost at a single site or area is not easily identifiable.

SYSTEM MAINTENANCE

The primary responsibility for system maintenance will be with Telecommunications. As the primary management and control agency they will be able to monitor the status of the entire system, including local

agency systems that are interconnected to the state system. The network management system will allow immediate reporting of any system failure or malfunction. Many problems will be reported and repaired without the users even being aware there was a problem. This is largely due to the built in system redundancy. Telecommunication Services has technicians on call 24 hours a day, operating from 13 locations in the state. These technicians are required to respond to system problems within 2 hours. They will all have the ability to access the network management system from their local shop or their own residence via a laptop computer and modem. This will allow them to very rapidly determine the problem and take appropriate action. Telecommunication Services has established a network control center where all of the different state operated networks is monitored 24 hours a day. The control center will act as a central notification point for all system problems.

Local agencies that construct their own systems and interconnect them to the state system will be responsible for the maintenance of their systems. Arrangements for contractual maintenance of local systems by Telecommunication Services will be evaluated on a case by case basis.

GRANT INFORMATION

The Department of Local Affairs, Division of Local Government has published a Local Government Grant and Loan Directory. This directory lists all of the various grants and loans available for various projects and systems. The directory is available on the Internet at: http://www.dola.state.co.us/fs/20grant.htm. These are a few programs that might be used for funding EMS trunked radios. Most of the programs that may apply are under the Public Facility and Public Safety sections.

The possible programs listed include:

- Community Development Block Grant Loan Fund
- Rural Telecommunications Projects
- Energy & Mineral Impact Assistance Grants and Loans
- Local Government Gaming Impact Grant Program
- Emergency Medical Services Grants
- Community Facility Program
- Local Law Enforcement Block Grants
- Search and Rescue Fund
- Local Victim Assistance & Law Enforcement Grant
- Local Law Enforcement Block Grants

- Law Enforcement Assistance Fund
- State Snowmobile Program

Many of these grant programs require a town or county to be the applicant and indicate a high priority for radio system funding. Contact the agency and person listed in the directory to obtain additional information about a specific program. It is important to fully explain how the radio system is a vital part of the operational requirements, which is the primary purpose of the grant program.

ELIGIBILITY

Applicants satisfying one or more of the following eligibility criteria may apply for authorization to operate on the statewide DTRS.

- State departments, state institutions, state agencies, law enforcement and public safety political subdivisions of the state. Other local, state and governmental entities or public safety related nonprofit organizations that directly support any agency described above. Private for profit organizations that maintain contracts to provide EMS services with the state or other local governments will also be eligible.

MIGRATING COSTS

As a single agency, county or multi-county RETAC, forecast a plan in one to three year phases to equip key ambulances, dispatch centers and hospitals with new DTRS radios, a complete inventory of all communications equipment must first be performed to budget proposed costs. List all hospitals and inventory EMS radio equipment. List all dispatch centers and inventory EMS radio equipment. List all EMS agencies and inventory EMS radio equipment by: Ambulance, First Response Vehicles, Other Mobiles, Portables, Ambulance Garages, Other.

Phase 1 - Determine what key ambulances, dispatch centers and hospitals will first need to be equipped with DTR's. Evaluate what loading effect the EMS community will have on the system and develop a budget for the additional DTR repeaters added to the system. Include application and annual fees for each DTR in the project. After the total budget is compiled, apply for a provider grant toward obtaining this phase.

Phase 2 - Determine what key portables per agency will need to be equipped with DTR's. Budget application and annual fees for each portable DTR projected. After a budget is projected, apply for a provider grant toward obtaining this phase.

Phase 3 - Determine what remaining portables and mobiles will still need to be equipped with DTR's. Budget application and annual fees for each DTR projected. After a budget is projected, apply for a provider grant toward obtaining this phase.

RECOMMENDATIONS

EMERGENCY MEDICAL SERVICES SUPPORT

Emergency Medical Services (EMS) is a major component of the system requiring networking as well as regional control and coordination of services. Many rural areas of the state have inadequate communications for EMS systems allowing for comprehensive patient reporting, consultation with physician advisors, connection with major trauma centers (level I, II) and aeromedical evacuation and coordination. A statewide trunked radio system design should evaluate the deficiencies and needs of EMS, and provide for effective control and coordination.

- Consult with the Colorado Department of Public Health; Prehospital Care Program in developing DTRS needs propagation and penetration studies, and future expansion.
- Develop DTRS features similar to those specified for other public safety components, which allow for interactive communications, control, and coordination, and provide a system architecture or platform to support emerging technologies.
- Close cooperation and coordination with emergency management officials at Federal, state, and local levels, as well as liaison with local emergency management councils (coalitions of public and private organizations) is necessary to implement and administer this technology.
- A complete inventory of all communications equipment must first be performed to budget proposed costs. List all hospitals and dispatch centers inventory EMS radio equipment. List all EMS agencies and inventory EMS radio equipment by: Ambulance, First Response Vehicles, Other Mobiles, Portables, Ambulance Garages, Other.

- Complete the agency profile form (Appendix F) and send to the address listed on the form so that a program can be determined for participation in the DTRS.

TASK ASSIGNMENT

EMS agencies interested in joining the Statewide DTRS should first contact their county dispatch authority to determine whether the county is currently pursuing 800 MHz. If your county is designing a new trunking system and plans to interface with the state, you will be required to connect with and support that specific system. If there is no county strategy for trunking, contact the Colorado Department of Public Health; Prehospital Care Program along with State Telecommunication Services to provide a survey to determine parameters for establishing number and type of talk groups. From this survey, a delineation of the number and type of talk groups necessary for each "service area" communications center can be developed.

If the statewide DTRS coverage area does not meet your expectations, and you plan to connect, then it will be the responsibility of the EMS agency to commission for any new sites and equipment needed to provide the additional coverage.

TRUNKING OVERVIEW

DEFINITION AND OVERVIEW

Trunking allows the communications needs of a large number of users to be efficiently met by sharing a small number of trunks (communications paths.) Trunking by definition is the automatic and dynamic allocation of a small number of radio frequencies among many users. The effectiveness of trunking is predicated on two fundamental characteristics of the system user's need for communications:

- The percentage of time that any individual user requires a trunk is very small.
- The probability that many users well require a trunk at the same instance is exceedingly small.

Although trunking technology has played an important role in the telephone industry for nearly a century, the application of trunking technology to radio dispatch communications was first accomplished in the late 1970's. This was made possible by two developments:

- New technologies (large-scale integrated circuits and microprocessors) became available to reliably implement more complex systems in a cost-effective manner.
- In response to channel congestion problems, the FCC ruled that large (more than five channels) 800 MHz systems shall be trunked.

The most obvious benefit of a trunked radio system is its increased efficiency - the ability to reduce radio user waiting times. In addition, because trunking technology is computer software driven, it has opened up a number of system management capabilities to the user. In broad terms, trunking allows:

- The organization of radio users by talkgroups rather than by frequencies.
- The effect of a private channel per talkgroup, no monitoring is necessary.
- The flexibility to reorganize and expand the system as the need arises.

The features of a typical trunked radio system are described below. The use of specific characteristics is only to assist in the systems descriptions and may vary among the various systems.

SEQUENCE OF OPERATIONS

A basic trunked system consists of the following:

a) A grouping of transmitter/receiver (T/R) paired channels with one repeater per channel pair.

b) A dedicated control channel, which receives radio user service requests and sends responses to service, requests.

c) Multi-frequency mobiles, portables and/or control stations with microprocessor controlled logic circuitry.

d) A system central controller who provides the intelligence to perform channel switching functions.

User groups access the trunked radio system via mobile, portable and/or control station radio equipment. Typical trunking communications is group oriented; one member talks while all others listen. The primary level of organization is the talk group. Multiple talkgroups can be organized into fleets, with a maximum of 16,000 talkgroup/fleet combinations supported on a system. In this simple example, there are two talkgroups and a dispatcher position in each of three fleets shown.

In a typical 5-channel system with no communications in progress, all of the mobiles, portables, and control stations are silently monitoring the system control channel.

A typical call sequence proceeds as follows:

a) The dispatcher for EMS agency 2 wants to talk to members of talkgroup A. He depresses his push-to-talk button that automatically sends a burst of data to the central controller via the control channel. This data constitutes a request for a voice channel.

b) The system central controller reviews the status of all the voice channels and selects an unused channel, channel #2 in this case. The central controller then sends an outbound burst of data, via the control channel, directing all agency 2, talk group A radios over to channel #2. All of the idle (not assigned to a voice channel) radio units receive the outbound instructions.

c) Only radios in talkgroup A of agency 2 respond to the outbound instructions and automatically switch to channel #2. Radios not associated with talkgroup A will disregard the instructions and remain on the control channel. The individual who initiated the call will then have his transmitter automatically activated and will be able to communicate with other members of the talk group. Any radios in the talkgroup otherwise engaged or not turned on to the system when the talkgroup call is initiated will be signaled and automatically directed to the talkgroup call in progress once their call ends, or when they turn on to the system.

The total elapsed time from press of the PTT by the initiating party until the beginning of the message is heard by the receiving talkgroup members is typically much less than ½ second for a single site system.

Under normal operations, no two user groups making a talkgroup call would ever be assigned the same voice channel at the same time, eliminating the need for one group to monitor another. Note that each talk group has, in effect, a private channel for the duration of its messages.

In the event that dispatcher 2 wants to talk to all members of his organization: A trunked system also allows a fleetwide call (announcement call) to be made. The call sequence is similar to that of the talkgroup call. However, in this case, all radios in talkgroup A and talk group B of agency 2 respond to the outbound instructions to move over to the assigned voice channel.

A mobile or portable initiated call sequence is identical to that of the dispatcher. A summary of the call sequence is as follows.

- Radios synchronized to the control channel (silently monitoring.)
- Originating radio operator presses PTT.
- Inbound channel request is sent to the system central controller.
- Outbound channel assignment is broadcast to all idle radios on the system.
- All radios in the talkgroup called automatically switch to the assigned voice channel.
- Originating radio transmitter is automatically activated.
- Call messages are exchanged.

- Call is completed.
- Radios return to monitoring control channel.
- Voice channel available for reassignment.

SIGNALING

The Statewide DTRS is comprised of many types of equipment. System central controllers, base station repeaters, mobile and portable radios, and control stations. A data communications network ties these entities together to achieve efficient systems operation.

Most data signaling takes place over the control channel. Requests for service are sent from system users to the system central controller over the control channel. Similarly, channel assignments and commands from the central controller are sent to individual radio units over the control channel. Information is assembled into a sophisticated coding format, with sufficient error detection and correction capabilities to assure system reliability. The statewide DTRS uses a dedicated control channel that is always available to receive data packets. Advantages to a dedicated control channel are:

- Increases reliability in accessing the system, because signaling attempts are repeated automatically (Automatic Retry).
- Increases system efficiency and reduces user wait times during the busy periods.
- Can direct a user, who was previously engaged, to a talkgroup conversation already in progress (Continuous Assignment Updating).
- Permits orderly processing of busy period backlogged calls on a first in first out basis (Queuing).
- Performs many non-voice system features such as dynamic regrouping, call alert, and status/message.
- Allows maximum data throughput; no time is spent on mobile scanning.

Additional low frequency, low deviation signaling occurs over the voice channels. Continuous tone, sub-audible signals are transmitted by mobiles and portables, and digital sub-audible signals are transmitted from base to mobile. These signals are necessary to provide misdirected radioprotection, priority monitor, and call update information.

SYSTEM CAPACITY AND RESPONSE

Although busy periods are of short duration, trunked systems must be designed to accommodate peak hour message traffic. System

performance characteristics are therefore stated in relation to busy hour (worst case) periods. This section will address system capacity and performance on typical public safety and private industrial systems. Statistical data derived by monitoring airtime usage of public safety and commercial system users is provided as a tool for estimating the capacity of new systems.

Keep in mind that there is no simple rule in determining loading requirements. The following graphs are provided to serve as a reference tool and illustrate the trade off between system loading, number of channels, and estimated access times. When planning system capacity, take into consideration the set of circumstances that produced the statistics below and make adjustments accordingly. Variables, which influence system performance, include how users use the system, the number of talk groups on the system (many talkgroups increase the chance of simultaneous usage and delay). The type of users (dogcatchers could have very different call patterns than EMS Agencies), use of individual calling capabilities (Private Conversation, etc.), and how priority levels are assigned to groups on the system. The type of system also affects access times; single site, simulcast or automatic multiple site select.

System access time includes time elapsed between the instant the radio operator presses his PTT and completion of the channel assignment. Access times could be lengthened by inbound or outbound signaling delays or any voice channel blocking. The public safety loading statistics represent a system with: More talkgroups than channels (approximately three times as many), equal priority for all users, minimal individual calling, an average of 10 second call lengths, and 3 calls per unit (typical of police operations) during the busy hour.

System usage levels on most industrial systems fall between those on public safety and commercial systems, with public safety being the worst case and commercial Specialized Mobile Radio (SMR) the best. SMR loading statistics assume equal priority for all users, 18-second call lengths, 7.6 second hold times, and 1 message per unit per hour.

Although system loading is planned with the worst case in mind, access times are typically far faster during normal (non-busy) operation.

FLEETMAPPING

The fleetmapping process presents alternatives for configuring talkgroups on a trunked radio system. The fleetmap is the software “code” stored in the central controller memory, which holds the talkgroup and individual identities (personalities), or each radio on the system.

In trunked systems, there are trade-off's between the number of talkgroups and individual IDs that can be supported as represented by a fleet size code. (Fleet refers to a grouping of radio IDs. How talkgroups are grouped into fleets will affect the operation of certain features.) With trunked systems, fleet boundaries are not necessary and there are no restrictions on talkgroup and individual ID combinations up to a limit of 64,000 total IDs and 16,000 talkgroups total per system.

In either case, there will be a trade-off between the number of talkgroups and the efficiency of channel usage. A greater number of talkgroups may result in greater utilization of channel resources. In addition, in dispatch oriented applications (e.g. public safety), the number of talkgroups formed should not exceed the capabilities of the dispatchers. Typically, one dispatcher can handle up to 8 talkgroups.

Regardless of the type of system, the fleetmapping process begins with identifying:

- Who needs to talk to whom on the system and how individuals should be grouped into talkgroups, and;
- Expansion needs; how many radios will be added to the system.

USER CONVENIENCE FEATURES

There are many benefits and features offered in a trunked radio system. This section provides a functional description of each feature and differentiates between basic trunking features, inherent in all trunked systems and advanced trunked features.

There are several conveniences built into a trunked radio system that are not available on conventional systems. The following features simplify radio operations for the user and are inherent to various degrees in all trunked systems.

Busy Queuing and Callback

Although trunked systems are considerably more efficient than conventional systems, there may still be times when all of the voice channels are busy or when channels with special call processing capabilities are busy.

If a radio user depresses the PTT while all the system channels are in use, he will hear a series of busy tones until a channel is assigned or he releases the PTT. A continuous tone will be heard when the PTT is depressed and the radio is out of range or the system is out of service.

For convenience, any users requesting system access during a busy period will be put in a queue. On a FIFO (first in first out) basis, when a channel does become available, the system central controller will notify the first mobile by "calling him back". A talk permit tone heard on the operator's radio alerts him of the call back. This feature allows the radio user to put the microphone down in a busy situation and wait for the callback, instead of continually keying in an effort to gain channel access.

Multiple Priority Levels

In addition to giving priority to recent users, trunked systems provide multiple levels of priority to allow system access to the most critical users during busy periods. Users and groups may be assigned a particular priority level and in the event of a busy, channel requests are processed according to priority on first come first served basis. The system manager via a System Manager Terminal or through SIMS can control assignment of priority levels. One level of priority (EMS) can be assigned to a talk group via the console.

Eight levels of priority are available on a trunked system. An emergency call (described later) will always take the highest priority on a trunked system.

Automatic Retry

Automatic Retry is a feature built into trunked systems to ensure system access and eliminate the need for a radio user to rekey or remain keyed in an effort to gain a channel. When the radio operator pushes his PTT, the radio sends a burst of data to the system central controller via the system control channel to request a voice channel. To ensure that the request gets through in the event of weak signal levels or interference, the radio unit will automatically continue to send a channel request until the central controller acknowledges the request, or until approximately 4 seconds have passed. Usually, because of effective system throughput, the acknowledgment takes place on the first try and therefore automatic retries are infrequent to minimize the possibility of contention on the first try.

Recent User Priority

To ensure uninterrupted communications, recent user priority has been designed into trunked systems. This assures that users who have previously been assigned a voice channel will receive priority over other system users of the same priority. Recent user status ends if a PTT is not activated within 10 seconds of the channel assignment ending.

Ergonomics

Trunked radios have been designed to be user friendly. Depending on the trunked radio model various display options keypad controls and indicator tones are provided to make the radio easy to use.

CALLING/OPERATING CAPABILITIES

Trunked radio systems offer the radio user a variety of calling capabilities to suit a variety of communications needs. The following types of calls are available as features or options on the radios and/or console.

Talkgroup Call

The talkgroup is the primary level of organization for communications on a trunked radio system. Radios assigned to a given talkgroup will be provided with “talkgroup call” and will under normal operation, only be able to communicate with other members of the same talkgroup. This provides the effect of a private channel down to the talkgroup level.

The capability of allowing radio users of the same fleet to selectively move between talkgroups of that fleet is optionally provided on the radio unit with a manual switch or keyboard. A trunked system supervisor can also change a radio user’s talkgroup assignment via the dynamic regrouping option available on trunked trunking terminals.

Fleet Call

Fleet calls can be made on trunked systems. It allows simultaneous communications to all members of the talkgroups of a fleet, utilizing a single channel resource. Fleet calls can only be made from a radio unit with the capability programmed into its code plug and which is enabled in the central controller database.

Fleet calling capability should be assigned with care because of the airtime it requires to set up this kind of call. When a fleet call is placed, the user must wait for others in his fleet engaged in conversation to dekey their mics before the fleet call can begin. Others in the fleet will get a busy signal if they try to make a call after a fleet call has been initiated but has

not yet been granted a channel. Calls initiated during this period will not be placed in a queue and must be reinitiated after the fleet call.

A fleet call is transmission trunked (described in System Design Flexibility). Other radios in the fleet will not be able to transmit until the fleet call ends. After the fleetwide announcement has been made and the user dekeys, the fleet will return to normal dispatch calling operation.

Multi-Group Call

A multi-group call is used to describe a call involving multiple talkgroups at the same time and refers to a fleetwide call or an announcement call on trunked systems. Multi-group calls can be initiated by a dispatcher or a field radio user. The groups to be addressed in a multi-group call are pre-programmed into the radio unit or dispatch equipment.

Announcement Call

An announcement call is the feature used to make a multi-group call on trunked systems. This feature can be optioned to operate similarly to a fleet call (the caller must wait for other members of the fleet to dekey before he can transmit). With an interrupt, a user initiates a multi-group call; his call will immediately interrupt other conversations in progress without waiting for other users to dekey. However, those radio users who are transmitting on a voice channel will not hear the announcement call until they dekey. They will then join the announcement call if it is still in progress.

System Call

A system wide call operates similarly to a fleet call and has similar ramifications regards to air time usage. System calls can only be placed from a console. When a system call has been placed, the user must wait for all users on the system to dekey and join the system call. All other users will get a busy if they try to make a call during this period. These call attempts will not be queued and must be reinitiated after the system call is completed. The system call is transmission trunked. After the system wide announcement is completed and the user dekeys, the system will return to normal dispatch operations.

Dual Mode Operation

Dual mode capability is a standard feature of most trunked radios. Conventional repeaters are often designed into a trunked system to extend coverage to fringe areas. In order for a user to communicate in the conventional mode, his radio unit must be programmed with a

conventional frequency. Trunked radios are equipped with a “smart” PTT. While in the conventional mode, if the channel is busy when the radio user presses his PTT, the radio will not transmit but will monitor the channel. To transmit the user must press the PTT a second time.

Repeater Talkaround

Repeater talkaround gives a radio user the capability to talk “radio to radio” when out of range of the trunked radio infrastructure, or when there is a special need to directly talk “ radio to radio”. Talkaround is an option programmed into the radio. It utilizes a conventional channel that is not a part of the trunked system.

To achieve talkaround, the radio user who wishes to initiate a call switches his radio over to the talkaround mode. At this time, his radio can transmit on the same frequency at which the radio he is calling receives messages, and therefore bypasses the trunked system. The user called must be instructed, or by a pre-established procedure, must also switch over to the talkaround mode in order to respond to the call.

Talkgroup Merge

Talkgroup merge is a dispatch function in trunked systems which allows multiple talkgroups to be merged together to talk on one voice channel. It is a function that only a trunked console can carry out. Efficiency is a major benefit of this feature since only one channel is used. Also, once it is set up, merging occurs very quickly. Two types of talkgroup merge are available, multi-select and patch. With multi-select, the merge is activated when the dispatcher is transmitting. Users in the merged group automatically return to their original talkgroups at the end of the conversations. With patch, users remain in the patched group until the dispatcher manually ungroup them. All radio users in the patch group hear any user transmitting.

Roaming

Direct access roaming is the capability for a radio user to move about a large geographic area and be able to switch to different systems to meet his communications needs at different locations. It is a capability inherent in all trunked systems. The individual radio must be programmed to directly access all systems he wishes to roam to as well as be enabled on those systems by their system managers. When the user moves out of range of one system and into range of another, he must manually switch over to the new system by turning a selector knob or pressing a keypad (depending on the radio). The ability to automatically switch systems is provided with System Search & Lock.

ACKNOWLEDGMENTS

The development of this State EMS Communications plan has taken many hours of intensive work. It would not have been possible for the Colorado Department of Public Health & Environment to develop such a thorough plan without the assistance of Telecommunication Services. The input, ideas and discussions from Telecommunication Services examined each aspect of the new system and the results are well documented. While it is impossible to name everyone, there are several people and organizations that provided exceptional services in the development of this plan.

- State of Colorado DTRS Plan
- NHTSA State-Level Planning Guide
- Colorado State Telecommunication Services

  Paul Nelson – Director, Telecommunication Services

  Larry Brooks – DTRS Engineering Manager

  Mike Borrego – DTRS Project Engineer
- Colorado Department of Public Health & Environment

  D. Randy Kuykendall – Chief, Emergency Medical and Trauma Services
- Colorado State Emergency Medical & Trauma Advisory Council

  Communications Sub-committee

APPENDIX

APPENDIX A - RADIO FREQUENCIES FOR PAGING

Federal Communications Commission Rules provide the following seven radio channels allocated exclusively for radio paging in the Special Emergency Radio Service (available to EMS agencies):

FREQUENCY (MHz)
35.64
35.68
43.64 (physically handicapped only)
43.68
152.0075
157.450 (30-watt limit)
163.250

In addition to these seven Special Emergency Radio channels, the 929-930 MHz (paging only) is available to EMRS eligible entities on a shared basis with other Part 90 radio services.

"Alert paging" on a secondary, non-interference basis for alerting EMS personnel to respond to an emergency situation, is allowed on most other high-band VHF EMRS frequencies (refer to Table 1 and 2). Note: Frequency 155.340 MHz is specifically excluded from any paging operations. Alert paging is allowed on a secondary basis only if the channel is used primarily for two-way voice communications. Secondary alert paging may be used for one-way alerting of ambulance and rescue squad personnel.

Within the UHF band, secondary alert paging is allowed only on MED-9 and MED- 10.

APPENDIX B - RADIO FREQUENCIES FOR EMRS

Emergency Medical Radio Service Frequencies (MHz)

VHF HIGH BAND

BASE OR MOBILE

* 155.325 ... Biomedical telemetry allowed in some areas.

155.340 ... Biomedical telemetry allowed in some areas.

May be designated by common consent as an intersystem mutual-assistance frequency under an area-wide medical communications plan.

* 155.355 ... Biomedical telemetry allowed in some areas.

* 155.385 ... Biomedical telemetry allowed in some areas.

* 155.400 ... Biomedical telemetry allowed in some areas.

MOBILE-ONLY

150.775

150.790

BASE/MOBILE

** 220.9025/221.9025
** 220.9075/221.9075
** 220.9125/221.9125
** 220.9175/221.9175
** 220.9225/221.9225
** 220.8025/221.8025 ... Public Safety/Mutual Aid (except PS)
** 220.8075/221.8075 ... Public Safety/Mutual Aid (except PS)
** 220.8125/221.8125 ... Public Safety/Mutual Aid (except PS)
** 220.8175/221.8175 ... Public Safety/Mutual Aid (except PS)
** 220.8225/221.8225 ... Public Safety/Mutual Aid (except PS)
** 220.8275/221.8275 ... Public Safety/Mutual Aid (except PS)
** 220.8325/221.8325 ... Public Safety/Mutual Aid (except PS)
** 220.8375/221.8375 ... Public Safety/Mutual Aid (except PS)
** 220.8425/221.8425 ... Public Safety/Mutual Aid (except PS)
** 220.8475/221.8475 ... Public Safety/Mutual Aid (except PS)

* Licensees may transmit one-way alert paging to ambulance and rescue squad personal on a secondary basis on these frequencies.

** See FCC rules 47 CFR, part T for “Regulations Governing Licensing and Use of Frequencies in the 220-220 MHz Band”.

APPENDIX C - SHARED EMRS RADIO FREQUENCIES

Shared with all other Public Safety Radio Services

453.050/458.050
453.100/458.100
453.150/458.150
453.200/458.200
453.250/458.250
453.300/458.300
453.350/458.350
453.400/458.400

453.450/458.450
453.500/458.500
453.550/458.550
453.600/458.600
453.650/458.650
453.700/458.700
453.750/458.750
453.800/458.800
453.850/458.850
453.900/458.900
453.950/458.950

Paging licensees as of March 20, 1991 may continue to operate on primary basis until Jan. 14, 1998.

Highway radio call box operations first licensed prior to March 31, 1980 permitted in accordance with FCC Rules §90.17(c)(11).

Intra- and intersystem mutual assistance allowed.

Licensees may transmit one-way alert paging to ambulance and rescue squad personnel on a secondary basis on these frequencies.

APPENDIX D - SPECIAL EMERGENCY RADIO SERVICE

The following frequencies are available for assignment to stations in the Special Emergency Radio Service (Public Safety), together with the class of stations to which they are normally assigned. Note that this is not a complete listing of all frequencies available. The reader is referred to the FCC Rules Part 90.53 for more specific information and complete up to date frequency listings.

Frequency or band	Class of station(s)	Limitations
Megahertz:		
33.02	Base or mobile	3, 25
33.04	do	25
33.06	do	3, 25
33.08	do	25
33.10	do	3, 25
35.02	Mobile	27
35.64	Base	4
35.68	do	4
37.90	Base or mobile	3, 25
37.94	do	3, 25
37.98	do	3, 25
43.64	Base	4, 28
43.68	do	4
45.92	Base or mobile	25
45.96	do	25
46.00	do	25
46.04	do	25
47.421	do	5, 25
47.46	do	25
47.50	do	25
47.54	do	25
47.58	do	25
47.62	do	25
47.66	do	25
72.00 to 76.00	Operational-fixed	6

Frequency or band	Class of station(s)	Limitations
Megahertz:		
152.0075	Base	4,31

155.160	Base or mobile	25
155.175	do	25
155.205	do	25
155.220	do	25
155.235	do	25
155.265	do	25
155.280	do	25
155.295	do	25
157.450	Base	4, 11
163.250	do	4
169-172	Mobile	33
450-470	Fixed	12
453.025	Base	26
453.075	do	26
453.125	do	26
453.175	do	26

Explanation of assignment limitations appearing in the frequency table:

(1) Appropriate frequencies in the band 2000-3000 KHz that are designated in Part 80 of this chapter as available to Public Ship Stations for telephone communications with Public Coast Stations may be assigned on a secondary basis to Special Emergency fixed stations for communications with Public Coast Stations only, provided such stations are located in the United States and the following conditions are met:

(i) That such fixed station is established pursuant to the eligibility provisions of §90.47 and that the isolated area involved in an island or other location not more than 480 km (300 statute miles) removed from the desired point of communications and isolated from that point by water.

(ii) That evidence is submitted showing that an arrangement has been made with the Coast Station licensee for the handling of emergency communications permitted by §80.453 and §90.47(d) of this chapter.

(iii) That operation of the Special Emergency fixed station shall at no time conflict with any provision of Part 80 of this chapter and further, that such operation in general shall conform to the practices employed by Public Ship Stations for radiotelephone communications with the same Public Coast Station.

(2) This frequency is shared with the Local Government Radio Service where it is available for State Guard operations.

(3) This frequency is shared with the Highway Maintenance Radio Service.

(4) This frequency will be assigned only for one-way paging communications to mobile receivers. Transmissions for the purpose of activating or controlling remote objects on this frequency are not authorized.

(5) This frequency is reserved for assignment only to national organizations eligible for disaster relief operation under §90.41.

(6) The frequencies available for use at operational fixed stations in the band 72-76 MHz are listed in §90.257(a)(1). These frequencies are shared with other services and are available only in accordance with the provisions of §90.257.

(7) Frequencies in this band are available only for one-way paging operations in accordance with §90.494 of this part.

(8) [Reserved]

(9) The frequencies in the band 10.55-10.68 GHz are available for Digital Termination Systems and for associated internodal links in the Point-to-Point Microwave Radio Service. No new licenses will be issued under this part but current licenses will be renewed.

(10) [Reserved]

(11) Operations on this frequency are limited to 30 watts transmitter output power. The requirements for secondary fixed use of frequencies in this band are set forth in §90.261.

(12) to (20) [Reserved]

(21) Part S contains rules for assignment of frequencies in the 806-824 MHz and 851-869 MHz bands.

(22) Assignment of frequencies above 928 MHz for operational fixed stations is governed by Part 94 of this chapter.

(23) This frequency band is available in this service subject to the provisions of §90.259.

(24) Available only on a shared basis with stations in other services, and subject to no protection from interference due to the operation of industrial, scientific, or medical (ISM) devices. In the 2483.5-2500

MHz band, no applications for new or modification to existing stations to increase the number of transmitters will be accepted. Existing licensees as of 7-25-1985, or on a subsequent date following as a result of submitting an application for license on or before July 25, 1985, are grandfathered and their operation is co-primary with the Radio Determination Satellite Service.

(25) A licensee regularly conducting two-way communications operations on this frequency may, on a secondary basis, also transmits one-way alert-paging signals to ambulance and rescue squad personnel.

(26) Paging licensees as of March 20, 1991 may continue to operate on a primary basis until January 14, 1998.

(27) This frequency is available in this service only to persons eligible under the provisions of§90.38(a) for operation of transmitters having a maximum power output of three watts using Al A, Al D, A2B, A2D, F1 B F1 D, F2B, F2D, G1 B, G1 D, G2B, or G2D emission. This frequency is also available in the Business Radio Service on a coequal basis with the Special Emergency Radio Service users.

(28) No new licenses will be granted for one-way paging under §90.487 for use on this frequency after Aug. 1, 1980. This frequency is available to persons eligible for station licenses under the provisions of §90.38(a) on a coequal basis with one-way paging users under §90.487 prior to Aug. 1, 1985, and on a primary basis after Aug. 1, 1985. Only Al A, A1D, A2B, A2D, F1B, F 1 D, F2B, F2D, G 1 B, G 1 D, G2B, G2D emissions and power not exceeding 10 watts will be authorized. Antennas having gain greater than 0 dBd will not be authorized. Transmissions shall not exceed two seconds duration.

(29) [Reserved]

(30) Rules concerning the use of this band for narrowband operations are set forth in §90.271.

(31) This frequency is removed by 22.5 KHz from frequencies assigned to other radio services. Utilization of this frequency may result in, as well as be subject to, interference under certain operating conditions. In considering the use of this frequency, adjacent channel operations should be taken into consideration. If interference occurs, the licensee may be required to take the necessary steps to resolve the problem. See §90.173(b).

(32) [Reserved]

(33) Frequencies in this band will be assigned for low-power wireless microphones in accordance with the provisions of §90.265.

APPENDIX E - 800MHZ PUBLIC SAFETY NATIONAL PLAN

FCC

PART 90--PRIVATE LAND MOBILE RADIO SERVICES Subpart B--Public Safety Radio Pool Sec. 90.16. The Commission has established a National Plan, which specifies special policies and procedures governing the Public Safety Pool (formally Public Safety Radio Services and the Special Emergency Radio Service). The National Plan is contained in the Report and Order in General Docket No. 87-112. The principal spectrum resource for the National Plan is the 821-824 MHz and the 866-869 MHz bands. The National plan establishes planning regions covering all parts of the United States, Puerto Rico, and the U.S. Virgin Islands. The Commission has accepted the regional 7 plan for Colorado.

The National Public Safety Planning Advisory Committee (NPSPAC) has specified specific channel assignments in the 800Mhz band for mutual aid. The FCC for nationwide allocation of the NPSPAC channels adopted this technique.

REGION 7 PLAN MUTUAL AID CHANNELS

- **Regional Interoperability for Common Channels**

In accordance with the National Plan for 821-824/866-869 MHz, interoperability among federal, state, and local governments during both routine and disaster operations will take place primarily on the five Common Channels as identified in the National Plan. Additionally, through the use of S-160, a special record note applied to the Federal Government frequency assignment that applies the conditions under which the Federal Government may obtain authorization to use a non-Federal Government frequency, or equivalent agreements, a licensee may permit federal use of a non-federal communications system. Such use, other than the five Common Channels, is to be in full compliance with the Commission's requirements for government use of not-government frequencies (Title 47 CFR, Sec. 2.103).

Licensees are allowed to count as additional loading, a factor of two percent for federal interoperability agreements. With respect to the NPSPAC plan for region 7, no other channels other than the five national Common Channels, plus the Statewide Tactical channels are authorized to meet this region's interoperability requirement.

- *Common Channel Implementation*

The implementation of the common channels designated by the National Plan will be separated into two categories of users primary and secondary.

1) Primary User: A Primary User is an agency that operates on five (5) or more channels. The Primary User will be required to have the capability of operating on the Regional Calling Channel. The Calling Channel will be implemented as a full mobile relay. Wide area coverage transmitters will be installed to maximize regional coverage.
Primary users may be required to provide satellite receiver feeds into this wide area transmitter's area of coverage. A watch will be maintained on this channel using control stations. Any or all agencies in the Regional Planning area may be required to operate a control station for the purpose of monitoring and rendering assistance on the Calling Channel. Each Primary User may be required to provide sufficient satellite receivers for in-street mobile coverage within their system area. All licensees are encouraged to operate additional stations on any or all of the four-(4) remaining Common Channels.

Tactical Channels will be geographically assigned throughout the region. Each Primary User will be required to sponsor, individually or jointly, one or possibly two localized mobile relays to cover specific geographic areas, in order to provide a fixed number of working channels in an area. Depending upon the needs in an area, multiple channels could be implemented. The placement and coverage of these systems will be controlled by the Regional Review Committee to permit frequency reuse within the Region. Talk-around on all four tactical channels will provide additional on-scene communications to supplement the localized mobile relay. In addition, talk-around will also provide on-scene communication in areas where there exists no localized mobile relay.

2) Secondary User: A Secondary User is an agency that will operate on four (4) channels or less. All Secondary Users shall, as a minimum, operate a base station for continuous monitoring of the National Calling Channel. All Secondary Users shall maintain a radio watch for the purpose of monitoring and rendering assistance on the Calling Channel.

A secondary user whose area is encompassed by a primary user may apply for a waiver from the Regional Review Committee for full time monitoring of the National Calling Channel. The secondary user will be required to have a station of the National Calling Channel.

Users of these channels include federal, state, and local disaster management agencies; police, fire, and providers of basic and advanced life support services. Other eligible, such as school buses, volunteer emergency corps, Red Cross, Radio Amateur Civil Emergency Service (RACES), Amateur Radio Emergency Services (ARES), Salvation Army,

etc., under the National Plan may also participate on a secondary basis in support of the preservation of life and property during an emergency. These eligible may be called upon by the controlling agency when specifically enrolled in a documented emergency plan of a recognized emergency management agency.

The use of automatic or operator-assisted connection of these Common Channels the switched telephone network is prohibited, without a specific waiver from the Regional Review Committee.

- *Calling Channel*

The calling channel shall be used to contact other users in the Region for the purpose of requesting incident related information and assistance. This channel shall not be used as an ongoing working channel. Once contact is made, an agreement upon which tactical channel to use is recommended for continued communications.

- *Tactical Channels (TAC1 - TAC4, STAC5)*

TAC1-4 channels are reserved for use by those agencies in need of conducting inter-agency communications. Incidents requiring multi-agency participation will be coordinated over these channels by the agency controlling the incident. Individual tactical channels may be designated for use by various services on an incident basis by the controlling agency. In the event of multiple incidents requiring the use of these channels, channels shall be designated by mutual agreement between controlling agencies. STAC5 is intended to be used at low power for SWAT, DIVE teams, etc. Portable repeaters are also allowed at low power operation. ***In no case shall control of these channels remain with any single agency beyond the termination of a declared emergency.***

- *Channel Use*

Plain language will be used on all five Common Channels at all times, and the use of unfamiliar terms, phrases or codes will be kept to a minimum, unless deemed necessary for security purposes. The use of these channels for intra-system normal dispatch and routine agency operations is strictly prohibited. Normally, the five Common Channels are to be used only for activities requiring communications between agencies not sharing any other compatible communication system. ***Under emergency situations, one or more Tactical Channels may be assigned by the controlling agency at the time of the incident.***

- *CTCSS Tone Requirement*

All mobile and portable radios operating in the 821-824/866-869 MHz band shall be equipped to operate on the five Common Channels using CTCSS tone squelch of 156.7 Hz. All mobile relay base stations operating on these common channels shall be equipped to operate using CTCSS tone squelch of 156.7 Hz. They shall be equipped to operate as a mobile relay station on demand, but shall normally operate in the repeat disable mode.

- **Network Operating Method**

A network will be established on the calling channel, "Call". This network will be wide area to cover large sections of the Region. Multiple networks may be required to fully cover the out-lying areas of the Region.
Primary Users are required to have the capability of operating on the Calling Channel. Secondary Users are required to have the capability of monitoring the Calling Channel. Communications systems on TAC 1 - TAC 4 will be implemented by agencies on a voluntary basis.

Every primary geographic section of the Region is intended to be covered by at least one of the working channels. In secondary areas Common Channels will be utilized through mobile to mobile talk-around. Mobile relays on TAC 1 - TAC 4 will be on a limited coverage design to permit reuse of the channel several times within the Region and in adjacent regions.

Designator	Primary Use	Base Freq.	Offset
ICALL	Calling	851.0125	-45 MHz
ITAC-1	Mutual Aid #1	851.5125	-45 MHz
ITAC-2	Mutual Aid #2	852.0125	-45 MHz
ITAC-3	Mutual Aid #3	852.5125	-45 MHz
ITAC-4	Mutual Aid #4	853.0125	-45 MHz
STAC-5	Portable/Mobile	853.7875	-45 MHz

APPENDIX F - DTRS USER APPLICATION INSTRUCTIONS

CCNC APPLICATION PROCESS

Users wishing to participate in the Consolidated Communications Network of Colorado, Inc. (CCNC)/ Colorado Digital Trunked Radio should follow the following steps:

1. Complete *Initial Participation Application* and the *Participation Agreement*. Each agency must apply individually and not on another's behalf.
   a. *Example*: The County dispatch center applies on its behalf and the agencies they dispatch for. Each agency must complete the *Initial Participation Application* apply individually.
2. **Applications and Participation Agreements need to be submitted together**. If each is not received together, the application cannot be processed or acted upon until all documentation is received and complete. Applications and Participation Agreements may be obtained from the CCNC Website (www.ccncinc.org).
3. Mail/Deliver the original to Consolidated Communications Network of Colorado, Inc., 9008 North U.S. Highway 85, Unit E, Littleton, CO., 80125-9915.
4. Once the application packet is received by CCNC, the Administrative Assistant will enter it into a database before being forwarded to the Technical Committee. ***Applications hand delivered by an applicant at a Technical Committee meeting will not be considered until the Administrative Assistant has processed them.***
5. Coordinate with State or authorized entity and the CCNC Technical Committee Chair a feasibility and loading evaluation.
6. The CCNC Technical Committee will discuss the application at a CCNC Technical Committee meeting and make a recommendation to the Executive Committee as to the application status. The applicant is encouraged to attend or have a representative attend the technical committee meeting(s), as well as the monthly Board Meetings.
   a. The CCNC Technical Committee shall evaluate and determine all system loading impacts that may arise from approval of the proposed new member agency. The Technical Committee may recommend approval with stipulations and/or conditions on the application based upon the evaluation.
   b. If there are errors and/or questions concerning the documentation during the evaluation by the Technical Committee, the application will be placed in a pending status at the Technical Committee level until a resolution to the issues has been determined.
   c. If the CCNC Technical Committee recommends approval of the application, the application shall be forwarded to the Executive Board of Directors who may approve the application. If the Executive Board of Directors does not approve the application, the application shall be placed into a pending status where it will be reopened for review upon availability of frequencies, or resolution of the reason for denial.
7. If an unfavorable recommendation is made, the CCNC Technical Committee will notify the applicant as to the reason(s).
8. Any pending applications will be reviewed quarterly for changes that would modify the applicant's status.

9. The applicant will coordinate with the State of Colorado and an authorized programming agency for templates being built.
10. The applicant is encouraged to begin attending monthly CCNC meetings and may participate in committee meetings on topics that they may be interested in.

Current versions of the *Initial Participation Application* and the *Participation Agreement* can be found at http://www.ccncinc.org/index.php?module=main-join

APPENDIX G - RADIOS FOR AIRCRAFT UTILIZATION

With regard to public safety radios for utilization in aircraft, the Federal Aviation Regulations (FAR) and the Federal Communications Commission (FCC) have established standards that require radios to meet certain design criteria for aircraft installation. Some of these standards are incorporated by reference to standards of the Radio Technical Commission for Aeronautics (RTCA). Selection of a radio system for public safety use maybe accomplished by either A (Aircraft radio equipment), or B (Mobile radio equipment), or C (Hand-held portable radio equipment) as follows:

- Install a radio system specifically designed for aircraft service.
- Install a mobile radio such that the radio is compliant with current FAA and FCC rules. Specifically, a licensed avionics technician would modify the mobile radio and aircraft for installation. These modifications may include the following:

1) The installation of a 28VDC to 12VDC converter with the rated amperage and duty cycle required by the radio.

2) The installation of a universal interface apparatus that will provide the radio A, with the ability to generate "side tone. " Further, this interface device would allow audio access (transmit and receive) to the radio via the aircraft's existing internal communications system (ICS). Additionally, this component will provide:

- Isolated transmitter keying PTT (Push-to-Talk),
- Isolated receiver audio input (balanced or matching),
- Isolated receiver audio output (balanced or matching),
- Internal receiver/side-tone audio amplifier.
- Microphone impedance output adapter (balanced or matching) with adjustable output.

3) Control of background lights on the radio control head, so as to not disturb or interfere with the pilot's ability to view the flight control instruments of the aircraft. (FAR 23.138 1, instrument lights for aircraft)

4) When designing a mounting bracket configuration for the radio equipment, consider environmental parameters, which would include installation of the system such that in the event of an aircraft mishap or

accident, the radio and radio control head, would remain secured. (FAR 43 & FAR 23.561)

5) Revise the mobile radio control head harness as required for the aircraft installation. Replace the wiring harness provided for the radio control head with a wiring harness that is flame resistant and will not emit toxic fumes if burned. (FAR Part 23.1365)

6) Modification of the mobile radio control head advisory lights to eliminate red transmit light and yellow channel-busy light so as not to indicate an aircraft malfunction to the pilot. (FAR Part 23.1322)

7) Reduce the RF output power of the radio to 10 watts (FCC Rule section Part 90.423(a)(2)) or request modification of FCC license(s) for approval of an exception to the 10-watt RF power output limitation on board aircraft (if necessary) in accordance with FCC Rules.

C: Install a hand-held portable radio with a "vehicular adapter" such that the radio is compliant with current FAA-FAR's and FCC rules. Specifically, a licensed avionics technician would modify the portable radio, "covert-a-com" and aircraft for installation. While similar, these modifications are listed separately from Scenario B and may include the following:

1) The "pilot in command" is ultimately responsible for the safe operation of the aircraft. If the portable radio is operated in a "hand-held" fashion, it should be done so as the "pilot in command" is allowed to perform their duties without unreasonable concentration or fatigue. This provision may limit the utilization of a hand-held portable radio on board the aircraft to an ancillary crewmember or the co-pilot, provided the radio had no effect on other aircraft components. Speaker/microphone or speaker/microphone/antenna (SMA) use on a portable radio may be acceptable with the aforementioned understanding. Unless the portable radio is used in conjunction with a "covert-a-com, the remaining steps in this scenario do not apply.

2) The installation of a 28VDC to 12VDC converter with the rated amperage and duty cycle required by the radio and its associated "vehicular adapter."

3) The installation of a universal interface apparatus that will provide the radio with the ability to generate "side tone." Further, this interface device would allow audio access (transmit and receive) to the radio via the aircraft's existing internal communications system (ICS). Additionally, this component will provide:

- Isolated transmitter keying PTT (Push-to-Talk).
- Isolated receiver audio input (balanced or matching).
- Isolated receiver audio output (balanced or matching).
- Internal receiver/side-tone audio amplifier.
- Microphone impedance output adapter (balanced or matching) with adjustable output.

4) Control of background lights on the portable radio and vehicular adapter, so as to not disturb or interfere with the pilot's ability to view the flight control instruments of the aircraft. (FAR 23.1381, instrument lights for aircraft)

5) When designing a mounting bracket configuration for the vehicular adapter and portable radio equipment, consider environmental parameters which would include installation of the system such that in the event of an aircraft mishap or accident, the vehicular adapter and portable radio equipment would remain secured. (FAR 43 & FAR 23.561)

6) Revise the vehicular adapter wiring harness to include additional cable length as required for the aircraft installation. Replace the wiring harness provided for the vehicular adapter with a wiring harness that is flame resistant and will not emit toxic fumes if burned. (FAR Part 23.1365)

7) Modification of the portable and vehicular adapter advisory lights to eliminate red transmit light and yellow channel-busy light so as not to indicate an aircraft malfunction to the pilot. (FAR Part 23.1322)

8) Limit the RF output power of the portable radio/vehicular adapter to 10 watts (FCC Rule section Part 90.423(a)(2)) or request modification of FCC license(s) for approval of an exception to the 10-watt RF power output limitation on board aircraft (if necessary) in accordance with FCC Rules.

9) When utilizing a "covert-a-com" device, the battery must be restricted from recharging. It should be removed before inserting the portable radio into the vehicular adapter; or else, the charging circuit should be disabled in the vehicular adapter. This restriction is for compliance with FAR 23.1353.

The essence of this portable installation guideline is to prevent distractions to the pilot in command." These guidelines are also intended to prevent the portable radio battery from charging and potentially discharging dangerous gasses into the cockpit of the aircraft. Safety to the aircraft and its crew is paramount.

Completing the aircraft installation in any of the above scenarios would also require:

1) Installation of an aircraft antenna with regard to wind loading at high speeds, (in excess of 150 knots) constant vibration, limited ground plane, and potential interference to or from the aircraft's existing communications or navigational equipment. (RTCA 160 C)

2) Appraising cost estimates for the radio equipment and installation as well as the cost associated with modifying the aircraft and for providing a new weight and balance on the aircraft (FAR Part 91).

3) Submitting FAA Form 337 received from a FAA-licensed repair station to apply for FAA approval of each completed aircraft installation in accordance with FAR Part 43.34-2a.

Per FCC Rule Section 90.423, any aircraft flying at an altitude of 1.6-km (1 mile) or more shall not be permitted to communicate on any frequencies within the applicable Private Land Mobile Radio Service. Any aircraft communications on frequencies in the Private Land Mobile Radio Service operate on a secondary basis to land-based systems. "Secondary basis" means that any aircraft radio communications causing/receiving interference to/from landbased radio stations must correct the interference or cease operations on the suspect frequencies in the aircraft. This affects most, if not all, fixed-wing aircraft. There are phone systems available such as "Flightphone," "Airphone," "Flightlink," and "Air-to-Ground" (not Cellular phones) that may provide alternative means of communications. With the potential for land-based radio interference and the aforementioned secondary basis to which aircraft communications is subjected, aircraft radios that operate in the Private Land Mobile Radio Service should have a label or placard to read, "maximum operation of this radio is 5,280' AGL by regulation of FCC".

APPENDIX H – CO STATE MICROWAVE SYSTEM

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AUTHORIZED AGENCIES MAY REQUEST A COPY OF THE STATE

MICROWAVE SYSTEM FROM TELECOMMUNICATIONS SERVICES

GLOSSARY OF TERMS AND ACRONYMS

800 Megahertz - The frequency band where public safety trunked systems operate. The frequencies are between 806 and 869 Megahertz.

ADDRESS - Actual id given to any radio unit. They could be the combination of system, agency, fleet, sub-fleet, and individual.

AGENCY - First level of structure with the system. Examples include EMS, fire dept. or police dept.

ALS - Advanced Life Support: Allowable procedures and techniques used by Paramedics and EMT-Intermediate personal to stabilize patients who exceed basic life support procedures.

ALIAS - Proper names instead of Unit ID, Subfleet of Fleet characters.

ALL CALL - Console feature that allows dispatcher or supervisor to communicate to all system radios at one time. Used for major traumas or emergencies.

AMBULANCE – A ground vehicle providing patient care transportation capability, specified equipment capability, and qualified personal.

ANALOG - The varying of frequency and amplitude of sounds or voice with no alterations or changes.

ANNOUNCEMENT GROUP - This is a form of fleet-wide call, with the announcement group consisting of any number of talk groups on the system; this may be message or transmission trunked; there is talkback capability possible also.

APCO - Associated Public-Safety Communications Officials Inc. An International professional organization with over 11,000 members from federal, state, local government and equipment vendors in all aspects of public safety communications.

AUTOMATIC VEHICULAR LOCATION (AVL): Subsystem that interfaces with radio system to communicate actual location of vehicle in a premapped geographic grid via RF.

BAUD - The rate at which data is transmitted.

BLS - Basic Life Support: Basic non-invasive pre-hospital care used by EMT's and the lesser trained certified First Responders to stabilize critically sick and injured patients.

BSI - Base Station Identifier. The BSI, which usually operates at the lowest frequency, is the Morse code identification that automatically occurs at regular intervals from one of the trunked repeaters.

CAD - Computer-Aided Dispatch. The current convention in public safety radio communications dictates use of computers in order to answer requests for emergency service more efficiently.

CAI - Common Air Interface. A part of the APCO Project 25 standards that define the basic structure for the equipment including, channel access method, data rate, spectrum efficiency and vocoder.

CALL QUEUING - When all channels on the system are busy, the call request is held in a first-in-first-out queue. The caller and all members of the groups are notified that a call request has been queued. Upon channel assignment, the caller is alerted and is allowed to proceed with push-to-talk (PTT).

CALL RETRY - Feature that is used by radio when unsuccessful in acquiring a requested channel. The radio will continue to request a channel until successful or has attempted 8 times. This is not apparent to the radio operator.

CCIC - Colorado Crime Information Computer

CHANNEL ACCESS TIME - The time between depression of the PTT switch by the radio operator and the unsquelching of audio at the receiving radios. Fast access time contributes to system efficiency.

CHANNEL DROP TIME - The time between radio un-key and when the channel is actually available for another call. Fast drop time contributes to system efficiency.

CONNECT TONE - The Connect Tone is a sub-audible tone (below 300 Hz) that is transmitted by a mobile or portable to the system, any time the unit is keyed. The program of the mobile or portable determines the specific frequency of this tone.

CONSOLE - Control center in dispatch center. Unit is microprocessor controlled and is tailored to dispatcher needs with single and multi configurations available.

CONTROL CHANNEL - This is the channel of the system upon which outbound system updates and responses to service requests occurs; and it is the conduit for all interactions to gain access to trunking resources by radio units.

CONVENTIONAL - Assigning a specific channel for a specific dedicated use or a non-trunked channel.

DATA TERMINALS - Terminals that support the transmission of data via RF, which include displays and keyboards.

DIGITAL - Encoding analog information into a code made up of 0's and 1's

DIGITIZATION - The conversion of continuous analog waveform to binary digital data. See vocoding.

DISCONNECT TONE - The sub-audible tone that is generated by a mobile or portable and transmitted to the trunked system upon de-keying is called a Disconnect Tone.

DISPATCH - Normal operating mode of the system. Communications are limited to single group and dispatcher. All in-group hear only own group and dispatcher is communicating to single group.

DYNAMIC REGROUPING - Over-the-air programming of field units. Multiple talk groups could be added into a radio unit while the radio is active in the field. Optionally, field units can be forced to communicate on designated talk groups.

EMSPD – Colorado Dept. of Public Health & Environment, Emergency Medical Services & Prevention Department.

EMD – Emergency Medical Dispatch.

EMERGENCY - Emergency switches are available on every radio. When depressed, the first available channel is assigned to the user—highest priority is assigned to an emergency user. Emergency indicators are lit on user group radios.

ENCRYPTION - Digitalization and scrambling of the voice signal to prevent unauthorized monitoring of the message over the airwaves.

ETHERNET - A Local Area Network (LAN) of IBM PC's used in some TRUNKED system configurations having the SIMS option.

FACILITY - Location where patient is transported or admitted to. Examples are Trauma I-V centers, Hospitals and Clinics.

FAIL-SAFE - System feature that allows the system to continue to operate and trunk in channels or site controller fail to operate properly.

FAIL SOFT - This is an automatic fall back mode of communication offered in the event that the trunking central controller fails, all four control channels fail, or failure of all voice channels. The repeaters independently enter the failsoft mode when the central controller no longer controls them. This is a form of carrier squelch community repeater operation.

FAULT TOLERANT ARCHITECTURE - A design and implementation philosophy that permits a system to continue operating in the event of failure of major components.

FCC - *Federal Communications Commission*

FDMA - Frequency Division Multiple Access. A method for improving spectrum efficiency by splitting an existing channel into 2 or more separate channels

FIFO - First-In, First-Out. Queue. In the case of a busy trunked system, individual requests for service will be handled in a FIFO manner.

FIRMWARE - Memory-type IC's, such as EEPROM's, which are programmed to contain software-like instructions are commonly referred to as Firmware.

GROUP - Combination of radio users that have been linked together for communications. May be defined from the system manager position or dynamically reconfigured as needed.

GROUP PRIVACY - Groups do not have the ability to listen to groups other than their own. The result is privacy.

GROUP REGROUP - This is the mechanism to temporarily join dissimilar trunking talk-groups for calls upon a single channel resource.

HANG TIME - The time a channel remains keyed after release of the C by transmitter. GE allows adjustable hang time from 0 to 55 seconds.

IDENTIFICATION (ID) - A number associated with field radios, the unit id that uniquely identifies the radio. This number, referred to as logical id, is automatically sent anytime the radio transmits.

IMBE - Improved Multi-Band Excitation. A method use to change an analog signal to a digital signal.

INDIVIDUAL - Lowest level of system structure. Example: car 54, 3rd precinct, traffic control, police dept. Each individual has a unique id.

INDIVIDUAL CALL OR I-CALL - A private call on a trunked system from one field radio to another field radio or from the dispatcher to or from a field radio.

LZ – Landing Zone: A designated area to land helicopters.

LOG IN - A transmission from a field radio that occurs automatically, informing the system about the active status, talk group selection and specific operating site, if part of a multisite network.

MCI – Mass Casualty Incident: An incident with several patients or an unusual event associated with a large degree of casualties, airplane crash, terrorism, has-mat, etc.

MESSAGE TRUNKING - The working channel remains assigned to a call for the duration of the group transmission. When the caller unkeys, the channel remains active until the group conversation is completed or the channels hang time is reached. The channel is not available for reassignment until the group conversation is done or the channel times out.

MULTISITE - A network of multiple sites in a system. Each system networked may have a different number of working channels. To prevent RF interference, adjacent systems do not use the same RF frequencies.

MUX - This word is a shortened version of multiplex.

MULTIPLEX - Combining of multiple data channels onto a single high bandwidth transmission channel. Data streams are interleaved on bit or byte basis [Time Division Multiplexing (TDM)] while analog signals are frequency translated and placed on a high frequency carrier [Frequency Division Multiplexing (FDM)].

MULTIPLEXER - Device that combines several communications channels on to a single channel of higher bandwidth (or line speed). The term multiplexer commonly assumes both multiplexing and demultiplexing within the same device.

NCIC - National Crime Information Computer

NETWORK - An intelligent wide area network links systems. Users may roam from one system to another while the network controller, either a multisite controller (msc) or integrated multisite and console (imc) controller, automatically track location and status.

NETWORK MANAGEMENT SYSTEM - Hardware and software used to control, monitor and report the system functions and operations.

NPSPAC - National public safety planning advisory committee that developed & proposed a plan for use of 821-824 and 866-869 MHz portion of band. Included in plan is new channelization scheme.

PATCH - This is a form of group regrouping in which the joined groups are allowed to carry on normal message trunking operations between and among all the separate member groups of the call, upon a single channel resource. This is a feature, which allows a console operator to connect a mobile group to a conventional group or another system. It also allows connection of a group to telephone lines.

PERSONALITY PROM - A Programmable Read Only Memory chip which stores the radio's individual digital ID and other special function firmware that gives it it's own unique identity.

PRIME SITE - This term applies to the primary equipment site of a Trunked Simulcast system where all Simulcast audio processing occurs. RF channel resource management also takes place here; the Central Site Controller (CSC) in the Prime Site controls the Remote Site Controller (RESC) in the Remote Site with a data link message that is usually sent via microwave.

PRIORITY - Preassigned levels (up to 8) which determine the order in which users are assigned channels on a system. Emergency, if used, is the highest level of priority.

PRIORITY SCAN - Operation is determined by mode of operation. <u>In conventional</u> mode, system operates by sampling channels for activity and

opening squelch to receive messages. In trunked mode, the radio receives all groups for which it has been programmed for scan (up to 50).

PTT - This acronym is short for “Push-To-Talk”.

PTT-ID - Push to talk identification. This is an optional feature that allows a SIMS or TIP user to view the identity of callers when they press their PTT.

REMOTE SITE - In a Simulcast system, the Remote Site repeater is configured the same as that of the Prime Site. The main difference between Prime and Remote Sites is the fact that the repeater site is slaved to the Prime Site.

SELECT ENABLE/DISABLE - This is a feature to restrict the movement of a subscriber unit from the assigned dynamic identity. If the unit has been select disabled, the user of the subscriber unit will not be able to change to another identity position until the reprogramming or select disable has been canceled.

SELECTIVE (RADIO) INHIBIT - An important feature to public safety users which allows a SIMS operator to instantly and effectively “put to sleep” a mobile or portable unit in the field. Misplaced or stolen radios, over which sensitive communications could be heard, can be effectively silenced permanently by the SIMS operator. The target radio must be turned on and within system range in order for this feature to be effective.

SIMS - System Information Management System. SIMS is an optional Local Area Network (LAN) of PC’s that can observe Push-to-Talk ID’s, Dynamically Regroup radios, Selectively Inhibit, radios and perform other functions depending on options on the system.

SIMUL-SELECT - A feature available to console dispatcher. Two or more groups are simultaneously selected for the same transmission from the dispatcher—but remain separate groups. Response from radio users is by group and only members of each unique group are able to hear the response.

SIMULCAST - A wide area coverage system configuration that makes use of simultaneous transmission of the same information upon the same frequencies throughout a large coverage area; parameters of the transmitted information is matched for each repeater of a given frequency.

SITE CONTROLLER - Computer system located at the site which controls all system activity, channel assignments, logging, supports test and alarm unit, and communicates to system manager via dedicated line or dial up modem.

SMR - Special Mobile Radio. FCC classification used by entrepreneurial operators of 800 MHz trunked systems that service the business and industrial markets.

SMT - System Manager's Terminal. A hard-copy terminal connected either directly to its dedicated RS-232 port at the rear of the controller, or remotely via data modems. The SMT can be used to diagnose system problems at a remote location and to change system parameters such as "repeater hold time".

STATUS MESSAGES - Use in CAD system to communicate without voice to users or dispatcher.

STORM PLAN - This contingency plan is used by trunked systems for special situations, like natural disasters. This feature allows the user to preset emergency procedures, such as dynamic regrouping, dynamic failsoft, and selector disable to several radios. By having this plan available to the SIMS operator, emergency situations are more likely to be handled in a quicker and more logical manner.

SUPERGROUP - This is the talkgroup that all the member groups of a group regrouping are joined in and use as their new common trunking talkgroup.

SUPER REGROUP - This is the mechanism to temporarily join dissimilar trunking talk-groups for calls upon a single channel resource.

SYSTEM ID - This is the special identification upon the control channel to identify the particular trunking system using this control channel; this is used by the subscriber units to verify they are operating upon the correct trunking system; it is sent about every 3 seconds on the control channel.

SYSTEM MANAGER - Computer used for system configuration, dynamic reconfiguration, down load of data from site, analysis of logging information, and other management tasks.

SYSTEM MANAGER PORT - The RS232 communication port on the Central Controller. In a system with SIMS, this port is connected to the System Manager Interface computer.

SYSTEM WATCH - A diagnostic tool used to monitor system activity, providing real time display of all call activity as it occurs.

TALK-AROUND - In a normal trunked system all communications uses a repeater to extend the range of the radio. Talk-around bypasses the repeater and talks directly to another unit. Units in the talk-around mode are operating in a conventional mode.

TDMA - Time Division Multiple Access. A method for improving spectrum efficiency an existing channel by allocating specific time slots to each user.

TALKGROUP - A talkgroup is the primary level of organization of users on a trunked radio system. Other talk groups do not hear Talkgroup activity.

TRAFFIC LOGGING - A function performed by the site controller. Records each transmission id and group as well as time of day and duration. Is sent to system manager for data management.

TRANSMISSION TRUNKING - The working channel remains assigned to a call for the duration of the caller's transmission. When the caller unkeys, the system immediately de-allocates the channel, making it available for reassignment. Equivalent to a zero-second hang time, transmission trunking increases call throughput, resulting in fewer queued calls.

TRIAGE – The act of sorting patients by the severity of their medical condition.

TRUNKING - The sharing of a number of talk paths among many users. A method by which multiple channels are accessed for user needs. Channel assignments are more efficient than systems where channel access is limited to a single channel or require manual user channel switching.

UHF - Ultra High Frequency. The frequencies between 450 and 470 Megahertz

UNIT ID - Unique id that has been assigned to radio. Id is transmitted at beginning and end of each transmission and is logged by the site controller.

UPS - Uninterruptible Power Supply.

VHF - Very High Frequency. These are the frequencies between 150 and 174 Megahertz.

VOCODER - An electronic device used to convert analog voice signals to a digital signal.

VOTING - The process by which geographically separated receivers pass their received signals to a common point at which the signals are "voted" and only the best signal is passed on for use.

VOX - Voice Operated Transmit.

VOICE CHANNEL - In a Trunked system, a Voice Channel is a RF channel that is an available voice communication channel resource. For example, a ten-channel trunked system has one Control Channel and nine voice channels.

WORKING CHANNEL- All repeater channels except the single control channel operate as working channels. Radios communicate in all modes, analog voice, digital voice or digital data, via a working channel.