System Release 7.17
ASTRO® 25
INTEGRATED VOICE AND DATA

Fleetmapping and Band Plan Management

NOVEMBER 2016

MN003274A01-A

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Document History

Version	Description	Date
MN003274A01-A	Original release of the *Fleetmapping and Band Plan Management* manual	November 2016

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About Fleetmapping and Band Plan Management

This manual provides an overview of an ASTRO® 25 Integrated Voice and Data (IV&D) system, describes the methodologies used to configure radio users and groups with the goal of optimizing system resources, provides content to assist with fleetmapping decisions and covers frequency band plan organization and management.

A fleetmap determines how the radio communications for each user group of an organization is controlled. Through controlling communications between different user groups and between individuals within a group, the radio communications system resources are used efficiently.

What is Covered in This Manual

The manual covers the following chapters:

- Chapter What is an ASTRO 25 System? on page 27 provides an overview of the ASTRO® 25 system.
- Chapter Frequency Band Plan Management on page 37 provides a description of the considerations for frequency band plan organization and management.
- Chapter Fleetmapping Technical Overview on page 79 describes how radio users and talkgroups are organized for fleetmapping.
- Chapter Fleetmapping Configuration on page 97 describes how to configure your system for fleetmapping.
- Chapter Fleetmapping Operation on page 109 provides examples and supporting materials for fleetmapping including a system checklist, contingency planning considerations, and examples of what might be found in a memorandum of understanding.
- Chapter Fleetmapping Reference on page 115 provides blank forms to assist with fleetmapping configuration and tracking.

Helpful Background Information

Motorola Solutions offers various courses designed to assist in learning about the system. For information, go to http://www.motorolasolutions.com/training to view the current course offerings and technology paths.

Related Information

See the following documents for associated information about the radio system.

Related Information	Purpose
Standards and Guidelines for Communication Sites	Provides standards and guidelines that should be followed when setting up a Motorola Solutions communications site. Also known as the R56 manual. This manual may be purchased on CD 9880384V83, by calling the North America

Table continued…

Related Information	Purpose
	Parts Organization at 800-422-4210 (or the international number: 302-444-9842).
System Overview and Documentation	Provides an overview of the ASTRO® 25 new system features, documentation set, technical illustrations, and system-level disaster recovery that support the ASTRO® 25 radio communication system.
Unified Network Configurator	Covers the use of Unified Network Configurator (UNC), a sophisticated network configuration tool that provides controlled and validated configuration management for system devices including routers, LAN switches, site controllers, and base radios, and is used to set up sites for the ASTRO® 25 system. UNC has two components: VoyenceControl and Unified Network Configurator Wizards (UNCW).
Provisioning Manager	Provides a description of the Provisioning Manager server application, includes information to tailor this application for system use, and contains information to provision your ASTRO® 25 radio communication system with various system-level, user-level, and device-level configuration parameters required for proper system operation. This manual also includes reference and troubleshooting information to ensure efficient and effective use of this application.
Call Processing and Mobility Management	Describes at depth the behavior of various ASTRO® 25 system infrastructure components and subscriber radios as they process calls and manage subscriber mobility.
Conventional Data Services	Provides descriptive and procedural content relating to the ASTRO® 25 conventional data feature which includes a description of the feature, a descriptions of the role of the components supporting this feature, a description of how conventional data call processing is implemented and how data messages are processed. Additional information provided includes procedures for installation, configuration, operation, and troubleshooting.
Conventional Operations	Provides information regarding conventional channel resource operating characteristics in standalone systems or ASTRO® 25 radio communication systems with K Series, L Series or M Series.
K Core Conventional Architecture Engineer Guide	Provides information identifying the conventional architectures of the Conventional Hub Sites and Conventional Base Radio Sites in the AS-

Table continued…

Related Information	Purpose
	TRO® 25 Conventional & Integrated Data System supported by the K core.
Dynamic Dual Mode for TDMA Operations	Provides information describing the Dynamic Dual Mode (DDM) architecture and the TDMA (Time Division Multiple Access) technology used ASTRO® 25 systems. This includes the use of APCO 25 Phase 2 TDMA.
Enhanced Telephone Interconnect	Provides information describing the Enhanced Telephone Interconnect solution employing equipment supporting voice-over-IP (VoIP) to allow individual subscriber units the ability to access the Public Switched Telephone Network (PSTN).
ISSI 8000/CSSI 8000 Intersystem Gateway Feature Guide	Provides information associated with the ISSI 8000 / CSSI 8000 feature in an ASTRO® 25 system. This manual inculdes information to install, configure, manage and troubleshoot the Intersystem Gateway (ISGW) server applicaiton supporting the ISSI 8000 / CSSI 8000 feature which provides an enhanced interconnectivity solution for P25 compatible systems and third-party consoles to interface with the ASTRO® 25 system.
Master Site – Infrastructure	Covers site-level information required to install and maintain equipment at the ASTRO® 25 system master site.
Radio Control Manager	Includes information and procedures on the use of the Radio Control Manager (RCM) application to monitor radio events, issue and monitor commands and make informational queries of system status.
Radio Features	Includes the information and procedures required to configure subscribers to operate on the ASTRO® 25 system.
GGM 8000 System Gateway	Provides information relating to the installation, configuration and management of the GGM 8000 Gateway as used at in various network locations.
Trunked Data Services	Describes the implementation and use of data services on ASTRO® 25 systems, specific to the Classic Data and Enhanced Data functionalities, and the High Availability for Trunked and HPD feature.

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Chapter 1

What is an ASTRO 25 System?

An ASTRO® 25 system is a radio communications system that allows a radio user to make trunking or conventional calls over a wide geographic area. Users at any location within the coverage area can press the push-to-talk (PTT) button on their radios to make calls to any valid group or individual located anywhere in the coverage area. The coverage area can spread over thousands of miles.

The system includes a complex network of computer servers and workstations, high-speed Local Area Networks (LAN), Wide Area Network (WAN) facilities, sophisticated databases, management software, and Radio Frequency (RF) equipment.

The ASTRO® 25 system allows communication within a single zone or across multiple zones, and allows users from different zones to be combined into talkgroups so that users can communicate across geographic coverage areas using a wide range of communication capabilities.

1.1 ASTRO 25 System Architectures

An ASTRO® 25 Integrated Voice and Data (IV&D) system supports trunking and/or conventional radio communications by employing the following system architectures:

- ASTRO® 25 single zone, non-redundant (L1) zone core or redundant (L2) zone core (IV&D) system architecture employing sites primarily supporting trunking channels with support for conventional channels. Conventional (mutual aid) channels in this architecture are supported by a centralized conventional architecture.
- ASTRO® 25 single zone, non-redundant (M1) zone core or redundant (M2) zone core (IV&D) system architecture employing sites that support trunking and/or conventional channels. Conventional channels in this architecture are supported by the centralized conventional architecture or distributed conventional (subsystem) architecture.
- ASTRO® 25 multi-zone capable, redundant (M3) zone core (IV&D) system architecture employing sites that support trunking and/or conventional channels. Conventional channels in this architecture are supported by the centralized conventional architecture or distributed conventional (subsystem) architecture.
- ASTRO® 25 conventional (IV&D) system architecture with a non-redundant (K1) core or redundant (K2) core employing sites that support conventional (only) channels in a distributed conventional architecture.

NOTICE: For a more detailed look at the L and M zone core architectures in an ASTRO® 25 IV&D system, see the *Master Site – Infrastructure* manual.

For a more detailed look at the K zone core architectures in an ASTRO® 25 Conventional IV&D system, see the *K Core Conventional Architecture Engineer Guide* manual.

1.2 ASTRO 25 System Elements

The basic components of the ASTRO® 25 Integrated Voice and Data system are the following:

- **Radios** (portable, mobile, base stations, consolettes)
- **Sites** (master site, console sites, repeater sites, and 3600 sites)
- **Zones** (composed of multiple sites)

- **System** (single zone, multiple zone, or standalone)

Radios in an ASTRO® 25 radio communication system consist of portable, mobile, base station or consolette devices that provide a radio user with the ability to communicate by sending voice and/or data to other users allowed to interface with the radio communication system.

Radio users are located in various “sites” in the system where a voice and/or data call made by a radio user in one site is received by a radio user in another site to complete the communication. In its most simple form, a site contains radios, radio users, and radio user equipment (antennas, ...) located in a geographical area. In some system architectures, sites in the system are supported by a zone. A zone represents a group of sites supported with zone core equipment. Equipment at a zone core (or equipment at a site in system architectures without a zone core) is designed to process radio user calls in an efficient and effective manner.

Therefore, voice and/or data communication between radio users can be a simple call from a radio user in one site to another radio user within that same site, a call from a radio user in one site to a radio user in another site within the same zone (intra-zone), or a call from a radio user in a given site in one zone to a radio user in another site in a different zone (inter-zone). The system architecture, the radio equipment being used, and system features available determine the sophistication and complexity of the calls that can be made in the system.

From simple system architectures that employ basic equipment to support simple calls, to complex system architectures that support Local Area Network (LAN) architectures and Wide Area Network (WAN) architectures, the various system elements provide various features and services that can be made available.

User configuration information is shared within and between the zones and each zone in the system is supported by a Local Area Network (LAN). In large system architectures, the LANs are interconnected through a high-speed transport network to form a Wide Area Network (WAN) where user configuration information, call processing information, along with audio and data can be sent throughout the system.

Calls in a single zone system are supported by equipment at a single zone core and calls in a multi-zone system are supported by equipment at each zone core in the system. Calls in system architectures that do not employ a “zone” architecture are supported by equipment at designated sites. For example, the ASTRO® 25 Conventional IV&D system architecture with a non-redundant (K1) or redundant (K2) core is of the “distributed conventional (mesh) architecture” and in this architecture one of the Conventional Hub Sites is designated and established as the K core. The K core is a conventional hub site that contains equipment to support conventional calls in this system. Standalone system architectures employing only basic system elements do not require “zone core” or “core” equipment to process calls.

1.3 ASTRO 25 System Characteristics

ASTRO® 25 systems include the following characteristics:

- **Scalable platform**

  The multi-zone capable redundant (M3) ASTRO® 25 system architecture supports seven zones, 100 sites per zone and up to 15,000 devices. The single zone, non-redundant (M1) or redundant (M2) system architecture supports up to 24 sites. The single zone, small scale, non-redundant (L1) or redundant (L2) system architecture supports 1–5 sites.

- **IP Packet-based infrastructure**

  The ASTRO® 25 system includes an IP Packet-based infrastructure that uses IP multicast technology. This technology allows digital calls to be set up, processed, and torn down in an IP packet-based environment.

- **Ability to transport vocoded and encrypted audio**

The ASTRO® 25 system digital platform supports the use of industry standard vocoding (digitizing) protocols for voice transmission. The transport core provides the ability to transparently pass vocoded and encrypted audio. Once voice is vocoded and/or encrypted at a source, the digital information is passed all the way through the network with no conversions required. Conversion to the original audio format is required only at the destination receiver or console.

- **Circuit-based console support**

  The M core system architectures support the operation of circuit-based consoles in a packet-based environment.

- **IP-based console support**

  The M core and L core systems support the operation of IP-based consoles in a packet-based environment.

- **Secure operation**

  The ASTRO® 25 system supports radio-to-radio and radio-to-console secure (encrypted) operation.

- **High Performance Data (HPD) support**

  The core systems support the use of High Performance Data services up to 96000 bps. These data services use dedicated subscriber radios and dedicated base radios to provide mobile data devices with wireless access to fixed enterprise data networks through the ASTRO® 25 system infrastructure.

- **IP Packet-based Integrated Voice and Data (IV&D) data support**

  The M core and L core systems support the use of data services at 9600 bps. These data services use subscriber radios and voice channels to provide mobile data devices with wireless access to fixed enterprise data networks through the ASTRO® 25 system infrastructure.

- **Transport Core and IP Protocol Layer**

  For larger system architectures at the center of the ASTRO® 25 system is a transport core designed to carry voice, data, and management information through Internet Protocol (IP) packets. IP is the Internet layer protocol that defines how data is transferred across the network, how devices are addressed, and how to route data appropriately. IP defines a universal/global addressing method and it defines how to fragment, transport, and reassemble data packets. For more details, see The Transport Core on page 31.

1.3.1
Multicast Technology

IP multicast routing, commonly referred to as “multicast”, is a method of transmitting messages (datagrams) between a number of sites that are part of a multicast group. This differs from the unicast, which transmits messages between two endpoints, and broadcast, which transmits messages from a single source to all hosts on a network.

Multicast employs a concept known as a Rendezvous Point (RP), in which a router or a set of routers is identified as an RP for an associated multicast group address range. The function of the RP is to receive multicast transmissions from an originating site, and then fan them out to other sites and zones, creating a multicast "tree" for each multicast group.

Multicast is closely aligned with the talkgroup concept. With multicast, the transmitting radio's audio is distributed to the appropriate sites by the RP router. Without multicast, the transmitting unit would have to send a separate copy of each packet of a transmission to each receiving site. Multicast transmissions are sent only to those sites which have subscribed or "joined" the specific multicast group. Once the join message is received, the routers propagate multicast traffic to the appropriate sites and zones. Multicast trees for audio traffic are set up on a service request and are present only during the call.

1.3.1.1
The Call Model

When and where to use: The main purpose of an ASTRO® 25 system is to provide voice and data communication services to subscribers and dispatchers throughout the system. The following Call Model describes how a talkgroup voice call is serviced by the system.

Process:

1. A radio user presses the PTT switch to talk to other users in the talkgroup. The radio transmits a Call Request on the RF control channel at the site. The control channel receives the Call Request and forwards it to the site Ethernet LAN. Before placing the Call Request packet on the site Ethernet LAN, the base station encapsulates the Call Request message in a User Datagram Protocol (UDP)/IP datagram with the zone controller destination IP address.

   NOTICE: UDP is a transport layer protocol that resides on top of the IP. UDP provides a transaction-oriented, best-effort delivery service. IP is the internet layer protocol tasked with defining how data is transferred across the network, how devices are addressed, and how to route data appropriately. IP defines a standard addressing method and it defines how to fragment, transport, and reassemble data packets.

2. The IP packet network routes the Call Request packet to the zone controller. Upon receiving the Call Request message, the zone controller checks an internal database to determine the location of all members in the requested talkgroup (such as RF sites and remote dispatch sites locations). The zone controller then assigns a multicast group address to the call and sends the assigned multicast group address to all the participating RF sites, remote dispatch resources. This message is referred to as a Call Grant message and is sent in an IP datagram.
3. Upon receiving the Call Grant message, the RF and dispatch sites extract the IP multicast address from the Call Grant. The assigned voice channels at ASTRO® 25 repeater site, the comparators at simulcast subsystems, the MCC 7500 consoles generate a group Join message. The group Join message is an IP control packet.
4. Upon receiving the IP group Join message, the RF and dispatch site routers communicate with RP routers in the system to set up an IP multicast distribution tree. This tree is used to distribute the voice payload traffic to all the sites participating in the call.
5. The radio begins transmitting the vocoded audio on the assigned RF voice channel at its site. The voice channel receives the audio and the audio is placed in an IP datagram destined to the assigned IP multicast address (as assigned in the Call Grant). The IP multicast packet is placed on the Ethernet LAN.
6. The IP multicast audio stream is distributed to all the RF and dispatch sites through the Gateway/Rendezvous Point router and IP multicast tree.
7. If the first user dekeys and a second member of the talkgroup transmits while the call is still active (repeater call hangtime has not expired), the same multicast tree is used. The voice channel receives the vocoded audio at the new source site. The vocoded audio is placed in an IP packet destined for the Gateway/Rendezvous Point router of the group. The IP packet flows down the same IP multicast tree generated earlier by the routers.
8. When the call is over (expiration of the message timer), the sites (RF or dispatch) generate an IP group Leave message. The Leave messages cause the multicast tree to be taken down.

   NOTICE: The preferred mode of operation for an ASTRO® 25 system is message trunking with PTT-ID. This parameter is programmed in the system, through the Provisioning Manager (PM) as message trunking, and in the radios through their programming software, as PTT-ID.

1.3.2
The Transport Core

The transport core at the master site supports the logical and physical structure with the following components and functions:

- Ethernet LAN switch
- Gateway routers
- Core routers
- Exit routers

NOTICE: The following description does not apply to ASTRO® 25 single zone, small scale, non-redundant (L1) or redundant (L2) system architecture with an L core.

1.3.2.1
Ethernet LAN Switch

The Ethernet LAN switch provides the Layer 2 connectivity for all clients, servers, and routers within the master site of an ASTRO® 25 system network. Some systems provide a two-switch configuration with a dedicated CPU and power supply for each switch. The switch uses a network management framework to provide proactive fault management.

The two-switch Ethernet LAN configuration is a chassis-based solution equipped with redundant power supplies for each chassis, dedicated CPUs, and Layer 2 port cards.

1.3.2.2
Gateway Routers

Gateway routers are used for devices that are multicasting beyond their local LAN, and support the following:

- Zone controller (control router functionality)
- Packet data gateway (data router functionality)
- Network management
- Maintenance of a list of all active rendezvous points and the group prefixes served by each device

1.3.2.2.1
Core Routers

Core routers perform routing of control, audio, data, and network management traffic within the zone. The core routers have two Ethernet ports that connect into the Ethernet LAN switch for all LAN-based traffic. They also have two WAN modules that interface to the Cooperative WAN Routing (CWR) network for all intrazone traffic. If a primary core router is lost, the redundant core router assumes the role of the primary device. This one-to-one core router redundancy increases system availability.

The number of core router pairs required depends on the number of channels in the zone. Core routers use Frame Relay to communicate with the sites through the CWR network. Your organization also has the option of incorporating the Ethernet site links into its backhaul strategies. The core routers provide proactive fault management through the fault management subsystem.

Core routers maintain the list of all active rendezvous points and maintain the group prefixes served by each device.

NOTICE: The ASTRO® 25 single zone, small scale, non-redundant (L1) or redundant (L2) system architecture with an L core employs the use of the GGM 8000 Core Gateway. The Core Gateway functions to support intrazone network traffic (core) and network traffic required by zone core devices that multicast beyond the local LAN (gateway). See the *GGM 8000 System Gateway* manual for more detailed information regarding the Core Gateway.

1.3.2.2.2
Exit Routers

Exit routers perform the routing of control, audio, data, and network management traffic between zones. If a primary exit router is lost, the redundant exit router can assume the role of the primary device. This one-to-one exit router redundancy increases system availability.

The number of exit router pairs required is dependent upon the bandwidth and physical WAN links between zones. Routers must be added in pairs to increase capacity, with a maximum of two pairs (one pair if Ethernet InterZone links are implemented). The exit router uses Frame Relay to communicate with other zones through the CWR network. Your organization also has the option of incorporating Ethernet InterZone links into its backhaul strategies. The exit routers provide proactive fault management through the fault management subsystem.

1.3.3
Functional Subsystems

The following sections describe the functional subsystems in an ASTRO® 25 radio communication system:

- Call Processing Subsystem on page 32.
- Network Management Subsystem on page 32.
- Dispatch Console Subsystem on page 33.
- Enhanced Telephone Interconnect Subsystem on page 34.
- Data Communication Subsystem on page 34.
- Radio Frequency Subsystems on page 34.

1.3.3.1
Call Processing Subsystem

The call processing subsystem is a functional part of the ASTRO® 25 trunking system, with components primarily associated with the master site.

The zone controller provides trunking call processing for RF subsystems, console subsystems, and Enhanced Telephone Interconnect subsystem devices. The zone controller is the central processing hardware and software at the master site providing call processing and mobility management for the system.

The redundant zone controller configuration provides automatic switchover to the standby controller if a loss of wide area communications is detected due to a failure internal to the active zone controller. Notification can be sent to the user if other components fail, allowing the user to manually switch to the standby controller if desired.

1.3.3.2
Network Management Subsystem

The Network Management Subsystem (NMS) is a functional part of the ASTRO® 25 trunking system, with components primarily associated with the master site.

The network management subsystem is based on the client/server networking model. The NMS meshes and scales with the other ASTRO® 25 system infrastructure elements across the packet-switched network. The NMS uses the Microsoft Windows operating system as the platform for the client personal computer (PC) workstation applications.

The application and database servers run unattended. The server applications run on Sun Microsystems Solaris™ or Red Hat Enterprise Linux OS.

Network management is a set of software tools that supports the management of a complex radio communications system and its component parts, which include radios, computers, and inter-networking components. Network management tools support the maximization of resource availability while helping to minimize system downtime and maintenance costs.

Network management applications used in the system can be divided into two categories:

Private Radio Network Management (PRNM) applications:

- Affiliation Display
- ATIA Log Viewer
- Dynamic Reports
- Historical Reports
- Radio Control Manager (RCM)
- Radio Control Manager Reports (RCM Reports)
- Software Download Manager
- Unified Network Configurator (UNC)
- Provisioning Manager (PM)
- ZoneWatch

Transport Network Management (TNM) applications:

- InfoVista (optional)

Another network management tool that can be used in an ASTRO® 25 system is Motorola Solutions Supervisory Control and Data Acquisition Network Fault Management (MOSCAD NFM). MOSCAD NFM is an optional component that can provide a common method for controlling certain system equipment (such as tower lights and power generators) and for collecting and forwarding data concerning the state of system equipment such as channel banks, microwave, and time reference. MOSCAD NFM can also be used to gracefully shut down the zone controller in total loss of power conditions.

1.3.3.3
Dispatch Console Subsystem

Each console site in the Dispatch Console subsystem can have one or more console user positions. Each console user monitors a number of talkgroups, multigroups and/or agencygroups and conventional resources. The IP-based MCC 7500 consoles connect directly to the ASTRO® 25 system IP packet-switched infrastructure. MCC 7500 consoles use the IP packet protocols for passing call control data and call audio through the system. The Archiving Interface Server (AIS) is an interface between the IP packet-switched infrastructure and a voice logging recorder.

A Conventional Talkgroup channel provides group separation of digital voice communications on a conventional channel to MCC 7500/7100 Dispatch Consoles. Conventional Talkgroups are supported on conventional talkgroup channels. In this feature, console user is not able to hear a conventional talkgroup they are not monitoring, but is able to see activity that would interfere with their conventional talkgroups and to tell if it was due to a subscriber, console or emergency call. See the *Conventional Operations* manual for Conventional Talkgroups.

A feature that can be optionally used is the ACIM conventional channel. By connecting a consolette to the console site's GGM 8000, it is possible for the dispatch console to communicate to talkgroups that may otherwise be unavailable. Another use for the ACIM conventional channels are fallback scenarios, where the link between a Site and the Zone Core is severed. A consolette may then be installed to wirelessly enable some communication features. Consolettes may be trunked subscribers and are programmed with talkgroups and tied back into the system at console or RF sites.

1.3.3.4 Enhanced Telephone Interconnect Subsystem

The ASTRO® 25 Enhanced Telephone Interconnect subsystem provides a means to connect the radio system with the Public Switched Telephone Network (PSTN). This subsystem enables a subscriber to initiate and receive calls through the PSTN. The IP Private Branch Exchange (PBX) server is used to provide the interface to the PSTN and performs all of the telephone switching functions and number handling operations required by the PSTN. The IP PBX server-to-radio interface consists of a Session Initiation Protocol (SIP) control plane and a Real Time Protocol (RTP) media (voice) plane. The SIP control plane uses a SIP Trunk between the Zone Controller and the IP PBX server for signaling. The media (voice) plane uses RTP transport between the Telephone Media Gateway (TMG) and the IP PBX media gateway or other IP-based endpoints. The IP PBX server in the Enhanced Telephone Interconnect subsystem can interface with another IP PBX server for the tie trunk support using a SIP trunk. See the *Enhanced Telephone Interconnect* manual for more information on the Enhanced Telephone Interconnect subsystem.

1.3.3.5 Data Communication Subsystem

The data communication subsystem supports the data communication features and functions in your ASTRO® 25 trunked communication system. The data communication subsystem handles the IP transport of data over trunked data channels that currently exist in the same pool of channels used to support voice communication. The data communication subsystem provides a wireless extension of your data network through the Motorola Solutions radio communication network to mobile data devices. A Packet Data Channel (PDCH) represents the radio frequency resources used for the IP transport of data in the integrated voice and data communication system. Characteristics associated with the IP transport and handling of a PDCH are similar to those associated with the IP transport of voice.

NOTICE: See the *Conventional Data Services* manual for more detailed information on conventional data services.
See the *Trunked Data Services* manual for more detailed information on trunked data services.

1.3.3.6 Radio Frequency Subsystems

To accommodate various coverage areas and system feature requirements, the following types of Radio Frequency (RF) subsystems are available in the ASTRO® 25 trunking communication system:

- **ASTRO® 25 system repeater site**. A single-solution, RF communication site. Each ASTRO® 25 repeater site consists of two site controllers, up to 28 ASTRO® 25 site repeaters, an Ethernet LAN, and one or two site routers.

  NOTICE: The ASTRO® 25 repeater site can have trunking and other RF resources. It can support both HPD and conventional operations.

- **Multisite Subsystems – Simulcast**. Two types of simulcast subsystems are available: circuit-based and IP-based. Circuit-based simulcast subsystems are not used in ASTRO® 25 single zone, small scale, non-redundant (L1) or redundant (L2) system architecture with an L core. In either simulcast subsystem, the simulcast prime site is the central control location for the other subsites in the subsystem. Because the site controller at the simulcast prime site provides control of the simulcast subsites for the subsystem, the ASTRO® 25 system recognizes and treats each simulcast subsystem as a single site. Depending on your system configuration, a simulcast subsystem can contain up to 32 subsites, each with up to 30 base radios.

NOTICE: The ASTRO® 25 Multisite Subsystem can have trunking and other RF resources. It can support both HPD and conventional operations.

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Chapter 2

Frequency Band Plan Management

This chapter provides a high-level description of frequency band plan organization and management and describes the function it serves within your system.

2.1 Frequency Band Plan Overview

Frequency band plans provide radios the parameters needed to translate the channel number in a call grant to the actual TX and RX frequencies of the assigned channel. A maximum of 16 possible band plan elements may be used. These band plan elements are common to all sites in the system and are used to identify the RF frequencies that may be used. Each band plan element defines a group of 4096 possible FDMA channels and a group of 2048 possible TDMA channels, that can be used for RF channel assignment in the system. Each element contains the following information.

- Element identifier number 1 to 16
- Base Frequency – The lowest site transmit frequency defined by the table.
- Channel spacing – The separation between adjacent channels.
- TX/RX offset – The value added to the site transmit frequency to determine the corresponding site receive frequency. (Used for implicit channel assignments only).
- TX/RX offset sign – Defines whether the corresponding site receive frequency is above or below its transmit frequency. (Used for implicit channel assignments only).
- Channel bandwidth – Channel bandwidth is always 12.5 kHz.
- FDMA/TDMA flag – Defines whether the element is used for FDMA calls or TDMA calls.

2.1.1 Foreign System Frequency Band Plan

System configurations with the ISSI 8000/CSSI 8000 solution support roaming of subscribers to foreign systems (ASTRO® 25 or third party). This feature requires the configuration of the **Foreign System Frequency Band Plan** object in the Unified Network Configurator (UNC) application. A foreign system frequency band plan is sent from UNC to zone controllers and advertised over the air to subscribers, allowing them to roam to a foreign system. One frequency band plan per foreign system is required. The frequency band plan of a foreign system is not identical to the local ASTRO® system – the data should be obtained from the foreign system administrators.

In the Foreign System wizard in UNC, you can select one of the two band plan types for a foreign system:

- **Coordinated Band Plan** – If you choose this option, the foreign system band plan exactly matches that of the local system and the settings in the Foreign System Frequency Band Plan object for that foreign system are not used.
- **Uncoordinated Band Plan** – If you choose this option, use the Foreign System Frequency Band Plan wizard to configure a frequency band plan for the foreign system band plan.

See the *ISSI 8000/CSSI 8000 Intersystem Gateway Feature Guide* manual for details.

2.1.2
Implicit and Explicit Channel Assignment Methods

Frequency band plan organization and management allows for the implicit or explicit mode of channel assignment for trunking operations.

2.1.2.1
Implicit Channel Assignment Method

Implicit assignments specify the channel number and the band plan element number for only the base station TX frequency of the assigned site channel. The base station RX frequency for the site channel is determined by the subscriber radio from the TX-RX offset parameter in the band plan element. TX-RX frequency pairs in the 700 MHz, 800 MHz, and 900 MHz bands are normally assigned with a fixed offset between the two frequencies so channel assignments in these bands are almost always done implicitly using default band plan elements. Custom band plan elements can be defined to do implicit channel assignments, usually for the VHF and UHF bands.

The advantage of the implicit method of channel assignment is the fact that only a single channel number has to be sent over the air which allows for more efficient use of control channel capacity. It also optimizes system delay performance since each assignment takes less time to be sent over the air. The disadvantage of implicit assignment is that there can be only a maximum of 16 unique transmit to receive offsets within the system. This may not be enough values to support implicit channel assignments for all stations in a system with VHF or UHF frequencies.

For the implicit method, when the RX-TX differential of a station pair is equal to the TX/RX offset in an existing element, knowing one of the frequencies implicitly defines the other. For a repeater and subscriber with a channel number of “N” and a band plan element with Base Frequency and Channel Spacing, the corresponding transmit and receive frequencies are:

- (FDMA) Repeater TX = Subscriber RX = (Base Frequency) + N * (Channel Spacing)
- (FDMA) Repeater RX = Subscriber TX = (Base Frequency) + N * (Channel Spacing) + (TX/RX Offset sign) (TX/RX Offset)
- (TDMA) Repeater TX = Subscriber RX = Base Frequency + (ROUNDDOWN (N/2)) * Channel Spacing
- (TDMA) Repeater RX = Subscriber TX = Base Frequency + (ROUNDDOWN (N/2)) * Channel Spacing + (TX/RX Offset sign) (TX/RX Offset)

NOTICE: ROUNDDOWN (N/2) for an even number = N/2. ROUNDDOWN (N/2) for an odd number =(N -1)/2.
For TDMA band plan elements, there are two channel numbers associated with each TX/RX frequency as the least significant bit of the channel number is used to signal which of two TDMA slots on the frequency is being used. For VHF and UHF frequencies, it may take twice as many TDMA band plan elements to cover the same frequency range as the corresponding FDMA band plan element.

2.1.2.1.1
16 ID Method Channel Assignment OSP

The 16 ID method of channel assignment uses Outbound Signaling Packets (OSPs) to signal a subscriber unit of a channel frequency assignment. Implicit in each OSP is the Tx frequency information. The subscriber is able to determine the correct Rx frequencies of channels given just the Tx frequencies. Hence, the reference to “implicit” OBT. Each OSP defines a 16-bit “channel” field. This field is composed of two sub-fields:

- Channel Identifier Field
- Channel Number Field

2.1.2.2
Explicit Channel Assignment Method

Explicit assignments specify a channel number and band plan element number for the TX frequency of the assigned site channel and a separate channel number and a band plan element number for the RX frequency of the assigned site channel. For example, since the VHF (136–174 MHz) is not organized into predefined TX and RX pairs (where there is a fixed offset relationship between TX and RX frequency pairs), there are no default band plans for this band. The channel frequencies in these bands may need to be assigned explicitly to remain within the 16 total band plan limit for the system.

For a repeater and subscriber with a channel number of “T” for the transmit frequency and a band plan element with Base Frequency A and Channel Spacing A, the corresponding transmit and receive frequencies are:

- (FDMA) Repeater TX = Subscriber RX = (Base Frequency A) + T * (Channel Spacing A)
- (TDMA) Repeater TX = Subscriber RX = Base Frequency A + (ROUNDDOWN (T/2)) * Channel Spacing A

For a repeater and subscriber with a channel number of “R” for the receive frequency, and a band plan element with Base Frequency B and Channel Spacing B the corresponding transmit and receive frequencies are:

- (FDMA) Repeater RX = Subscriber TX = (Base Frequency B) + R * (Channel Spacing B)
- (TDMA) Repeater RX = Subscriber TX = Base Frequency B + (ROUNDDOWN (R/2)) * Channel Spacing B

NOTICE: ROUNDDOWN (N/2) for an even number = N/2. ROUNDDOWN (N/2) for an odd number =(N -1)/2
For TDMA band plan elements, there are two channel numbers associated with each TX/RX frequency. For VHF and UHF frequencies, it may take twice as many TDMA band plan elements to cover the same frequency range as the corresponding FDMA band plan element.

2.1.2.3
Implicit vs Explicit Channel Assignment – Considerations

The Explicit channel method means, that Tx and Rx frequencies are assigned to the subscriber. The Explicit assignment method is different than the implicit method in the following ways:

- Explicit method is less efficient because explicit channel grants require more transmission time.
- Is intended for use where unstructured frequency plans are the only option.
- Designed to cover a whole band in a few elements, thus freeing up elements for use in other bands.
- Increases the probability that you can add another frequency to the system later, without having to redesign your band plan.

It is possible to use a combination of implicit and explicit assignments within the system and even within a single site. Each channel is designated within the site controller Network Management configuration whether it is sent to a subscriber using an implicit or explicit channel grant. Any band plan element used in the system can be used for both implicit and explicit grants so there is no need to reserve some band plan elements only for implicit and other elements only for explicit use. The tx offset field in the band plan element is ignored by a radio receiving an explicit grant.

NOTICE: A single channel may be configured to support only implicit or explicit channel assignment operation. If the station is used for both FDMA and TDMA operation, then the FDMA and TDMA band plan elements used on the channel are used in the same implicit or explicit mode.

The Project 25 explicit method of channel assignment is most similar to the method of channel assignment used with 3600 OBT systems. In the Project 25 explicit method, both the transmit and receive frequencies are signaled in the initial channel grant Outbound Signaling Packets (OSPs). A combination of explicit and implicit (16 Identifier) grants may be seen on a site that is explicit-capable.

While the 16 Identifier method uses Trunking Signaling Blocks (TSBKs) for all OSPs, the Project 25 explicit method uses Multiple Block Trunking (MBT) for many of the larger OSPs. The Mobile Subscriber Unit (MSU) internally keeps time so that it knows frame sync boundaries and does not need to re-acquire timing when returning to the control channel from the adjacent site RSSI scan. The MSU knowledge of frame sync boundaries is based on the use of triple block TSBKs. To minimize changes to the MSU, the system follows all single data block MBTs by a Short Terminator Data Unit (STDU) so that explicit grant MBT OSPs occupy the same (75 ms) control channel time as a triple block TSBK. A unit-to-unit voice service grant MBT already occupies two data blocks and is identical in length to a triple block TSBK.

Generally speaking, an explicit grant, or update is sent on the control channel when a call is assigned to an explicit channel, and an implicit grant or update is sent on the control channel when a call is assigned to a 16 ID channel (regardless of whether the control channel is explicit or implicit).

NOTICE: It is possible to “mix” both the Implicit 16 ID method and the Explicit channel assignment method at the same RF site.

2.2
Functions Supported by Frequency Band Plans

Frequency band plan organization and management increases the capability of the system. You can add ASTRO® 25 repeater sites in the 700 MHz, 800 MHz 900 MHz, VHF and UHF bands to the system. The major functions for frequency band plan support include:

- Association of Public Safety Communications Officials (APCO) Project 25 control and traffic channel standards.
- Overlapping band plans.
- Site controllers and ASTRO® 25 Repeaters that allow inter-operation between individuals and talkgroups that can only operate within one range of the full band (sub-band restricted) and those that can operate in the full band (not sub-band restricted).
- Better utilization of 700 MHz frequency resources based on subscriber radio capability by enabling Dynamic sub-band restriction channel selection.
- Configuration of a foreign system frequency band plans to support roaming of subscribers to foreign systems (ASTRO® or third party). See Foreign System Frequency Band Plan on page 37 for details.

NOTICE: Sub-band restriction is a way to support the efficient and effective use of channel resources operating in various frequency bands by enabling the system to evaluate talkgroup or subscriber radio capabilities which use those channel resources.

2.2.1
Operating Bands

Subscriber radios and consolettes operate in many segments of the radio spectrum. Radio Frequency (RF) bands supported by Motorola Solutions systems include:

- VHF: 136 MHz – 174 MHz (full band range) with two possible sub-band ranges of 136 MHz – 162 MHz or 146 MHz – 174 MHz
- UHF Full Band Range 1: 380 MHz – 435 MHz (full band range) with two possible sub-band ranges of 403 MHz – 433 MHz or 438 MHz – 470 MHz
- UHF Full Band Range 2: 435 MHz – 524 MHz (full band range) with two possible sub-band ranges of 450 MHz – 482 MHz or 482 MHz – 512 MHz
- 700 MHz

- 800 MHz
- 900 MHz

Different radios support different frequency ranges within these various bands. Systems may use several radio models that are not capable of operating on identical frequency ranges. Systems may also have RF channels that not all radio models can synthesize. When this is true, the system should be programmed to use the Sub-Band Restriction (SBR) feature where radios are assigned only to frequencies where their hardware can operate.

Sub-band restriction (SBR) must be configured in Provisioning Manager (PM) and Unified Network Configurator (UNC) for the following:

- Subscriber Radio
- ACIM Consolette
- Talkgroup
- RF Channel

2.3
Frequency Bands Supported for Subscribers

Motorola Solutions subscriber radios support the following VHF and UHF frequency ranges:

- VHF band and sub-band ranges
- UHF band 1 and sub-band ranges
- UHF band 2 and sub-band ranges

See the user guide for your specific radio model for additional information.

CAUTION: The band plan elements in use in the system must be configured identically in the subscriber radios and in the infrastructure. Any mismatch can result in missed calls or lost audio. Problems caused by mismatched band plans can be very time consuming and difficult to solve. Motorola Solutions subscriber radios do not learn the band plans in use in the system via control channel messages.

2.3.1
Sub-Band Restriction and Channel Assignments

Subscriber radios that can only operate in a portion of a frequency band or a specific frequency band are considered "restricted" to that portion of the frequency band and may be identified as Sub-Band Restricted (SBR) radios. While not "sub-band" restricted, subscriber radios that ONLY operate in the 800 MHz band in systems that provide 700 MHz and 800 MHz channel resources may be considered "restricted" to that band and identified as SBR radios.

For instance, to support talkgroup calls for SBR radios that operate in RF sites providing both 700 MHz and 800 MHz channel resources, a talkgroup can be configured to use S-SBR for channel selection. When a talkgroup is configured to use static SBR for a call, the system assigns an 800 MHz channel to the call though all radios registered at a site may be not-SBR radios capable of operating in the 700 MHz and 800 MHz band. With this method, channel utilization is based on the SBR status of the talkgroup.

An alternative method for channel utilization is available where an RF site provides 700 MHz and 800 MHz channel resources and the system employs SBR radios and not-SBR radios. A Dynamic Sub-Band Restriction method (D-SBR) method can be enabled to determine channel utilization. This method is based on the capabilities of the mobile/portable radios and can improve utilization of 700 MHz channel resources at an RF site providing both 700 MHz and 800 MHz channels.

SBR is also useful in the case where a system may contain a mixed 700/800 MHz site, but may have 800 MHz only capable bi-directional amplifiers (BDA) being used. Talkgroups used with these BDAs can be programmed for SBR to cause them to only use the 800 MHz channels and stay within the BDA RF passband. Dynamic SBR can be used for VHF and UHF bands as well. If either of these bands are subdivided into frequency ranges that are sub-bands of the full band and radios exist that can only operate on the sub-band, then D-SBR can be used to select the correct channel for a call.

2.3.2 VHF Band and Sub-Band Ranges for Subscribers

The VHF Full Band Range (136 MHz - 174 MHz) is supported by the Motorola Solutions XTS 5000, XTS 2500 portable radios and XTL 5000, XTL 2500 mobile radios. The ASTRO Spectra® Plus mobile radio currently can only support one sub-band at a time, either the 136 MHz - 162 MHz or the 146 MHz - 174 MHz.

If an RF site has frequencies running from 136 MHz - 174 MHz, the XTS 5000, XTS 2500, XTL 5000, and XTL 2500 operates as not sub-band restricted radios operating in the full 136 MHz – 174 MHz band range, while all ASTRO Spectra® Plus mobiles can only operate in one of the two possible sub-bands at such a site.

The VHF band is also supported by the Motorola Solutions APX 6000, APX 7000, APX 7000XE, portable radios, and APX 6500, APX 7500 mobile radios.

2.3.3 UHF Band 1 and Sub-Band Ranges for Subscribers

The UHF Full Band Range 1 (380 MHz - 435 MHz) is supported by Motorola Solutions XTS 5000, XTS 2500 portable radios, and XTL 5000, XTL 2500 mobile radios. ASTRO Spectra® Plus mobiles radios currently can support operation in only one sub-band at a time, either the 403 MHz – 433 MHz or the 438 MHz – 470 MHz sub-band.

If an RF site has frequencies running from 380 MHz - 435 MHz, the XTS 5000, XTS 2500, XTL 5000, and XTL 2500 operates as not SBR radios operating in the full 380 MHz – 435 MHz band range while all ASTRO Spectra® Plus mobiles can only operate in one of the two possible sub-bands at such a site.

The UHF band 1 is also supported by the Motorola Solutions APX 6000, APX 7000, APX 7000XE portable radios and APX 6500, APX 7500 mobile radios.

2.3.4 UHF Band 2 and Sub-Band Ranges for Subscribers

The UHF Full Band Range 2 (435 MHz - 524 MHz) is supported by the Motorola Solutions XTS 5000, XTS 2500 portable radios and XTL 5000, XTL 2500 mobile radios. ASTRO Spectra® Plus mobile radios currently can support operation in only one sub-band at a time, either 450 MHz – 482 MHz or 482 MHz – 512 MHz sub-band.

If an RF site has frequencies running from 435 MHz - 524 MHz, the XTS 5000, XTS 2500, XTL 5000, and XTL 2500 operates as not SBR radios, operating in the full 435 MHz – 524 MHz band range. All ASTRO Spectra® Plus mobiles can only operate in one of the two possible sub-bands at the site.

The UHF band 2 is also supported by the Motorola Solutions APX 6000, APX 6000XE, APX 7000, APX 7000XE portable radios and APX 6500, APX 7500 mobile radios.

2.3.5 Dynamic Dual Mode Support for Subscribers

Dynamic Dual Mode operation is supported by various types of subscriber radios.

In an ASTRO® 25 system, the APX subscriber radios are Dynamic Dual Mode (FDMA/TDMA) capable to allow them to operate in RF subsystems providing support for Dynamic Dual Mode (DDM).

The APX 6000/6500/7000/7500 subscriber radios are Motorola Solutions P25-capable subscribers that use a Motorola Solutions voice channel in the two slot TDMA mode. These subscriber radios employ AMBE+2 enhanced full rate vocoding for FDMA calls and AMBE+2 enhanced half rate vocoding for TDMA-capable calls. The AMBE+2 Enhanced Full-Rate (EFR) is fully interoperable and backwards-compatible with the IMBE full-rate vocoder used in FDMA (APCO Phase 1). APX radios support FDMA and TDMA in the following bands: 700 MHz, 800 MHz, 900 MHz, UHF (bands 1 and 2), and VHF.

2.3.6

Frequency Bands Supported – by Radio Frequency Subsystem

The following table summarizes the communication frequency bands supported by each radio frequency subsystem in the system.

Table 1: RF Subsystem and Frequency Bands Supported

RF Subsystems	Frequency Bands Supported
ASTRO® 25 repeater sites	800 MHz, 700 MHz, 900 MHz, UHF, VHF
GTR 8000	700 MHz, 800 MHz, 900 MHz, UHF, VHF
Simulcast subsystem (Multisite subsystem)	800 MHz, 700 MHz, 900 MHz, UHF, VHF
Single Transmitter Receiver Voting Subsystem (Multisite subsystem)	UHF, VHF

2.4

Frequency Band Plan Management – Theory of Operations

This section provides information to support band plan management and includes a summary of frequency band structures for various frequency bands, describes band plan management considerations for Dynamic Dual Mode operations, and provides a view of band plan elements (channel spacing, offset, etc.) for appropriate band plan management in the system. Tx and Rx frequencies shown in the tables are for the site. Under TIA standard requirements, the channel numbering system accommodates up to 4096 FDMA channel numbers or 2048 TDMA channel numbers per band plan element.

2.4.1

Frequency Band Structure – Digital 800 MHz

The parameters for the Digital 800 MHz frequency band structure are shown in the following table.

Table 2: 800 MHz Band Structure

Parameter	Digital 800 MHz – Description
Receive Frequency Range	806 – 824.99375 MHz
Transmit Frequency Range	851.00625 – 869.99375 MHz
Transmit to Receive Offset	-45 MHz
Base Receive Frequency	806.00625 MHz
Channel Separation	12.5 kHz in the public safety spectrum. All other channels are normally assigned at 25 kHz steps. The default band plan for 800 MHz uses 6.25 kHz steps.
Bandwidth	19 MHz from 806 MHz – 825 MHz

2.4.2
Frequency Band Structure – Digital 700 MHz

The parameters for the Digital 700 MHz frequency band structure are shown in the following table.

Table 3: 700 MHz Band Structure

Parameter	Description
Receive Frequency Ranges	794.00625 MHz – 805 MHz
Transmit Frequency Ranges	764.00625 MHz – 775.99375 MHz
TX/ RX Offset	30 MHz
Base Transmit Frequency	762.00625 MHz
Base Receive Frequency	794.00625 MHz
Channel Separation	12.5 kHz

Each of the 700 MHz repeaters has a consistent separation between transmitting and receiving. Frequencies in this range are assigned in contiguous blocks, and not as individual entities.

2.4.3
Frequency Band Structure – Digital 900 MHz

The parameters for the Digital 900 MHz frequency band structure are shown in the following table.

Table 4: 900 MHz Band Structure

Parameter	Description
Receive Frequency Ranges	896.01250 MHz – 900.99375 MHz
Transmit Frequency Ranges	935.01250 MHz – 940.99375 MHz
TX/ RX Offset	–39 MHz
Base Transmit Frequency	935.01250 MHz
Base Receive Frequency	896.01250 MHz
Channel Separation	12.5 kHz

2.4.4
700 MHz, 800 MHz and 900 MHz: FDMA/TDMA Band Plans

The TDMA band plans allow a single band plan identifier to cover the entire band plan (default band plan) where the identifier uses 12.5 kHz channel spacing rather than 6.25 kHz channel spacing.

Motorola Solutions band plans, which support a TDMA-capable system, in the ASTRO® 25 system are provided as follows:

Table 5: Default ASTRO 25 Band Plans

Band Plan Number	Base Frequency (MHz)	Channel Spacing (kHz)	TX/RX Offset (kHz)	Channel Separation (kHz)	Channel Type (TDMA, FDMA)
1	851.00625	6.25	-45000	12.5	FDMA
2	762.00625	6.25	+30000	12.5	FDMA
3	851.01250	12.5	-45000	12.5	TDMA
4	762.00625	12.5	+30000	12.5	TDMA
5	935.01250	12.5	-39000	12.5	FDMA
6	935.01250	12.5	-39000	12.5	TDMA

NOTICE:
If defaults define frequency bands or FDMA/TDMA types that are not used in a particular system and are not anticipated to be needed in the future, the unnecessary default band plans may be deleted or modified and reused.

For a given channel spacing, an FDMA band plan element can handle channels that span a frequency range equal to the channel spacing* 4095. For a given channel spacing, a TDMA band plan element can handle channels that span a frequency range equal to the channel spacing* 2047.

Band plans for VHF and UHF frequencies are custom and tend to require more band plan elements than the 700/800/900 MHz bands. Existing VHF and UHF band plan elements should be updated to support a TDMA-capable system because existing radios need to be reprogrammed.

2.4.5
Considerations for Operation on Offset Channels

Country border areas or special circumstances sometimes require operation on channels that are not available as part of the pre-defined default band plans.

The default FDMA band plan elements (see Table 5: Default ASTRO 25 Band Plans on page 45) for the 700 MHz and 800 MHz bands can accommodate channels that are offset by 12.5 kHz or 6.25 kHz from normal US FCC channel centers without any custom band plans. The frequencies are simply configured as they would be for non-offset channels.

The default TDMA band plan elements (see Table 5: Default ASTRO 25 Band Plans on page 45) for the 700, 800, and 900 MHz bands and default FDMA operation at 900 MHz can only accommodate operations that are offset by 12.5 kHz from normal channels. In cases where 6.25 kHz offset operation is required, an extra band plan is required for each band that will be used.

For example, if 700 MHz TDMA operation is required on 6.25 kHz offset channels a new band plan should be added such as:

Table 6: 700 MHz TDMA offset channel Band Plan

Band Plan Number	Base Frequency (MHz)	Channel Spacing (kHz)	TX/RX Offset (kHz)	Channel Separation (kHz)	Channel Type (TDMA, FDMA)
7	762.0125	12.5	30000	12.5	TDMA

By starting the base frequency of the new band plan 6.25 kHz higher in frequency than the existing 700 MHz TDMA band plan, all 700 MHz TDMA channels spaced at 6.25 kHz can be accessed by using a combination of both the new and default 700 MHz TDMA band plans.

800 MHz TDMA operation with 6.25 kHz spacing can be achieved in a similar manner with a 6.25 kHz downward adjustment in base frequency:

Table 7: 800 MHz TDMA offset channel band Plan

Band Plan Number	Base Frequency (MHz)	Channel Spacing (kHz)	TX/RX Offset (kHz)	Channel Separation (kHz)	Channel Type (TDMA, FDMA)
7	851.00625	12.5	-45000	12.5	TDMA

These new band plan elements need to be added to via the UNC to the system level frequency band plan object and distributed throughout the system. Any new band plan elements required can be appended to the existing table following the last currently used band plan element. For details regarding adding new band plan elements for system distribution, see Infrastructure Programming on page 60.

After this has been done, the UNC RF site channel configuration object can be used to assign the new band plan element for the required offset channels. See the "Configuring Frequency Band Plans on a Channel" section in the *Unified Network Configurator* manual.

NOTICE: Subscriber radios must all be programmed via CPS (Customer Programming Software) or POP25 to incorporate the newly defined custom band plan elements.

2.4.6

Use of UHF and VHF Frequency Bands

VHF and UHF frequency bands do not have the same structure as the 800 MHz band. Historically, assignment of VHF and UHF frequencies took place at a time when trunking in two-way radio systems did not exist, so the random assignment of frequencies had no impact on conventional system operation.

Since it is possible to integrate other bands with 800 MHz systems, "unpredictable" VHF frequency assignments lead to a lack of consistency in separation between transmit and receive frequencies in a repeater pair and to an unpredictable relationship between the pairs. The transmit frequency of a repeater pair may be higher or lower than the receive frequency and the relationship may be reversed in the adjacent frequencies.

The UHF band is more structured than the VHF band, but the structure is not consistent across the entire UHF band. Different frequency separations are used in different parts of the band. As in the VHF band, the frequencies are used for many different types of applications ranging from dispatch to telemetry.

When using VHF and UHF frequency bands, some of the infrastructure equipment and all the subscriber radios must be configured with channel definition information. The information serves as the key to translating frequency information to and from the channel numbers.

Adding new frequencies to a system require careful planning, especially when the new frequency does not fall within the currently configured channel definitions on the system. In those cases, all subscriber radios and FNE would have to be programmed with new or extra channel element definitions.

2.4.7
Other Band Planning Design Considerations

Before developing a frequency band plan to support your system, review the following considerations.

Large, wide area systems often require that frequencies be reused. A system designer can apply RF coverage design standards to determine the necessary geographical separation required for safe reuse, but coverage overlap is only one of the issues that must be explored when implementing frequency reuse in trunked system design.

Equally important in a reuse design is to ensure that no adjacent sites use the same control channel frequencies. Site-to-site mobility problems manifest themselves in both 800 MHz systems and OBT systems if this requirement is not met.

The definition of “adjacent site” refers to any site where a trunked subscriber is currently affiliated. An “affiliated to” site have a list of other sites considered to be adjacent, that is, sites that the subscriber could potentially roam to if the subscribers RSSI sampling indicated the need to change for better coverage. The subscriber is informed of the frequencies of the adjacent sites via Adjacent Site Broadcast messages.

In 800 MHz systems, duplicated adjacent site control channels have both their transmit and receive frequencies match. In OBT, either or both the transmit and receive frequencies could match. Duplication of either transmit, or receive control channel frequency at adjacent sites cause subscribers to have mobility problems.

If two adjacent sites have the same transmit control channel frequency, but different receive frequencies, a subscriber keep only one ASB entry for both sites. If the subscriber decides via RSSI to roam, it may roam to the site where ASB entry it kept. If so, the roam is successful. However, there is an equal chance that the subscriber roams to the site, where ASB it did not keep – if that happens, the subscriber is unable to talk back to the new site because it calculates an incorrect transmit frequency for the new site. As a result, the subscriber is unable to affiliate, and loses trunked communications. While there are several recovery scenarios for the subscriber, it is far better to avoid the design error that causes the problem in the first place.

CAUTION: Do not duplicate the control channel (CC) transmit frequencies at adjacent sites in OBT designs. Duplicating control channel receive frequencies at adjacent sites can also affect system operation. While that scenario may be of lesser likelihood, it is still best to avoid it in a band plan design.
Do not duplicate the control channel receive frequencies at adjacent sites in either 800 MHz, or OBT designs. If a subscriber has its affiliation request rejected at one of the sites, it is effectively locked out of both sites.

The control channels at a VHF or UHF site should not be mapped to a single band plan identifier, even if the frequencies allow it. Control channel information is signaled over the air, just as traffic channel assignments are, and subscriber units depend on receiving this information about their current affiliated site as well as adjacent sites. Changes to a single identifier that is used in designating control channel frequencies could disrupt system operation. Using more than one identifier helps ensure that any change in band plan structure does not disrupt system operation.

A radio should have as many of the site control channels programmed into it as possible. This ensures that the radio is able to find a control channel even if the band plan element describing a control channel changes. Control channels received via the over-the-air adjacent site broadcast messages can be impacted and made invalid if the band plan element used by an ASB message is changed.

2.4.8

Call Capacity Limits – Sites Using Explicit Channel Assignments

FDMA/TDMA capable RF sub-systems support up to 28 channels at ASTRO® 25 Repeater sites and up to 30 channels within IP based simulcast sub-systems. The maximum number of channels can only be supported if all the channels at a site have channel frequencies that are defined implicitly. The zone controller (ZC) allows no more than 36 implicit active calls at any site. An active call is considered to be an assigned FDMA call, an assigned TDMA call, or an assigned IV&D data channel. Stated another way, the sum of active FDMA calls + active TDMA calls + assigned IV&D data channels is not allowed to exceed 36. Any sub-sequent call requests above 36 are busied by the ZC, even if there are free channels with no assignments.

The limit of 36 active calls is too high for the Control Channel to maintain when the site must support explicit calls. The call limit must be reduced based on the number of explicitly defined channels at the site. This is due to explicit packets being longer than implicit packets and by that increasing the access times for all calls. In releases prior to A7.7, the site was physically limited to a maximum of 15 stations.

The system auto-calculates the call capacity limits for all sites. The values are based on the number of channels with explicitly defined frequencies at each site. This limit is calculated based on information provided in the following table.

Table 8: Site Call Load Capacity vs Channels Supported

# of Explicit Channels	Site Call Load Capacity (SCLC)	FDMA-Only Site – Voice & Data	TDMA-Only Site – Voice Only
0	36	28 or 30 (depending on site type)	19
1	24	25	13
2	22	23	12
3	18	19	10
4	16	17	9
5	14	15	8
6 or more	12	13	7

NOTICE: The above table is a guideline. It is likely that sites processing FDMA and TDMA calls are somewhere between all FDMA call traffic and all TDMA call traffic.

For sites that only do FDMA voice and data, the maximum site size equals SCLC + 1 Control Channel. For sites that only do TDMA voice (no data), the maximum usable site size equals SCLC/2 + 1 Control Channel. A site that needs to support a mixture of FDMA, TDMA and data calls requires an analysis by the field engineer to determine the proper number of repeaters for the site. For these type sites, the number of channels needed at the site varies between the two table entries for each SCLC. Additional channels allow more simultaneous FDMA calls to be handled but the channels are under utilized when most of the calls are made in the TDMA mode. Site Call Load Capacity is identified above as “SCLC”.

2.5

Developing a Frequency Band Plan

Developing a band plan starts by understanding the elements of a band plan.

Band plan elements are common to all sites. There is a single set of up to 16 band plan elements that is distributed from the Unified Network Configurator (UNC) to all sites. If a system consists of sites in more than a single band (such as a system with 800 MHz sites and other sites that are in the VHF band), the band plan elements remain common to all sites.

For systems with only 700 MHz, 800 MHz and/or 900 MHz channels, the band plan elements shown in 700 MHz, 800 MHz and 900 MHz: FDMA/TDMA Band Plans on page 44 are all that are needed. For systems with VHF and/or UHF channels, custom band plan elements are required. The number of elements available for these frequencies is 16 minus the number of elements needed for the 700 MHz, 800 MHz and/or 900 MHz channels. In addition, adding new frequencies to an existing system requires careful planning, especially when the new frequency does not fall within the currently configured channel definitions on the system. In those cases, all subscribers radios and FNE have to be programmed with new or additional channel element definitions. When possible, band plan elements should be left unused to cover possible expansions in the future.

The following section explains how to determine a band plan manually. However, it is not recommended to attempt to develop a band plan when there are UHF or VHF sites in the system. Motorola Solutions field engineers have specialized tools that automate the task of developing band plan elements to support the system channel frequencies.

NOTICE: Consult the Motorola Solutions field engineers for help in developing band plans for systems with VHF or UHF frequencies.

2.5.1
Process Steps for Developing a Band Plan

Use the following process for developing a band plan for FDMA or FDMA/ TDMA-capable systems. This process is an example of a methodology that can be followed when creating a band plan for VHF or UHF frequency bands.

Process:

1. Separate the site TX/RX pairs by frequency band (VHF, UHF, and 700/800/900 MHz).

   Step example: Plan the expansion of the system. Any 700/800/900 MHz channels are first assigned to the default band plan elements shown in 700 MHz, 800 MHz and 900 MHz: FDMA/ TDMA Band Plans on page 44. Remember that two elements each are needed for 700 MHz and 800 MHz channels if TDMA is supported in the system.

2. Separate the VHF and UHF frequency pairs by FDMA and TDMA capable pairs.

   NOTICE: Frequency pairs that are FDMA/TDMA capable must appear in both lists.

3. Separate all UHF FDMA frequencies and all UHF TDMA frequencies into groups that have the same TX/RX offset and sign.

   Determine the FDMA groups: Start with the lowest frequency in each group. Look for an integer (channel spacing) that can be divided into each member (usually 5.0 kHz, or 6.25 kHz). However, any value that is a multiple of 125 Hz can be used. The group may have to be subdivided into several groups that have common channel spacing. Verify that the difference between the maximum and minimum receive (or transmit) frequency in each group divided by the channel spacing is an even integer less than 4096. If the difference is greater, the group must be further subdivided to fit within the range. When completed, each group constitutes one band plan element.

   Determine the TDMA groups: Start with the lowest frequency in each group. Look for an integer (channel spacing) that can be divided into each member (usually 5.0 kHz, or 6.25 kHz). However, any value that is a multiple of 125 Hz can be used. The group may have to be subdivided into several groups that have common channel spacing. Verify that the difference between the maximum and minimum receive (or transmit) frequency in each group divided by the channel spacing is an even integer less than 2048. If the difference is greater, the group must be further subdivided to fit within the range. When completed, each group constitutes one band plan element.

4 Separate all VHF FDMA frequencies and all VHF TDMA frequencies into groups that have the same TX/RX offset and sign.

Determine the FDMA groups: Start with the lowest frequency in each group. Look for an integer (channel spacing) that can be divided into each member (usually 2.5 kHz, 5.0 kHz, or 6.25 kHz). However, any value that is a multiple of 125 Hz can be used. The group may have to be subdivided into several groups that have a common channel spacing. Verify that the difference between the maximum and minimum receive (or transmit) frequency in each group divided by the channel spacing is an even integer less than 4096. If the difference is greater, the group must be further subdivided to fit within the range. When completed, each group constitutes one band plan element.

Determine the TDMA groups: Start with the lowest frequency in each group. Look for an integer (channel spacing) that can be divided into each member (usually 2.5 kHz, 5.0 kHz, or 6.25 kHz). However, any value that is a multiple of 125 Hz can be used. The group may have to be subdivided into several groups that have a common channel spacing. Verify that the difference between the maximum and minimum receive (or transmit) frequency in each group divided by the channel spacing is an even integer less than 2048. If the difference is greater, the group must be further subdivided to fit within the range. When completed, each group constitutes one band plan element.

NOTICE: The Transmit Offset must be an integer multiple of the channel spacing in steps 3 and 4.
In some cases, it may be better to use explicit definitions for the frequencies in steps 3 and 4. This use eliminates the need to reprogram new tables into the subscribers later. Use Explicit definitions if:

- There are few pairs in any of the groups created in steps 3 and 4 of this procedure.
- The system is planned to be expanded in the future.
- There are more than 16 groups defined from following the previous steps of this procedure.

5 Count the number of groups created in steps 1-4.

The total number must be 16 or less. If more than 16 exist, frequencies must be discarded or defined explicitly to get down to the required number. It is highly recommended that at least one element is left unused to allow for future changes if necessary.

6 Convert implicit groups to explicit as needed.

For UHF groups, separate the frequency pairs into FDMA and TDMA groups with a common channel spacing and list the frequencies from low to high. Then group those FDMA frequency pairs that fall within a 4095*channel spacing range together. Group all TDMA frequency pairs that fall within a 2047*channel spacing range together. Each group forms an explicit UHF band plan element.

If there are too many elements in step 5, some of them need to be made explicit. For VHF groups, separate all the frequency (not pairs) into FDMA and TDMA groups with a common channel spacing and list the frequencies from low to high. Then group those FDMA frequency pairs that fall within a 4095*channel spacing range together. Group all TDMA frequency pairs that fall within a 2047*channel spacing range together. Each group forms an explicit VHF band plan element.

7 Assign each of the band plan elements a unique band plan number from 1 through 16.

For each band plan, list the lowest subscriber receive frequency (base frequency), the channel spacing, and the TX/RX offset and sign. This is the data needed to program the system.

8 Assign band plan elements to each VHF and UHF frequency.

Assign a band plan element to each VHF and UHF transmit and receive frequency and note whether the assignment type is implicit or explicit. Verify that any frequency that can be both

FDMA and TDMA is assigned using either an implicit element in both cases or an explicit element in both cases. Mismatches point to a missing band plan element.

9 Group the frequencies by the site they are assigned to.

Verify that any site using explicit channel assignments remain with the voice call limits defined in: Call Capacity Limits – Sites Using Explicit Channel Assignments on page 48. Frequencies may have to be swapped between sites or channels removed from sites to fully use all the resources at a site.

10 Program the subscribers.

Program the band plan elements into the subscriber radios using the CPS application.

11 Program the infrastructure equipment.

Program the sites band plan elements using the CSS application.

2.5.2
Creating a Band Plan with Mixed Frequencies

The process for creating a band plan with mixed frequencies demonstrates band plan development for a system with structured and unstructured frequency pairs.

The initial frequency/channel configuration that system planners receive for an actual system, may be analyzed in a manner shown in the example. By doing the analysis when the channel becomes known, system planners can anticipate the configuration tasks that are required, the intra-system and inter-system interference and site compatibility issues, and they may be able to suggest some rearrangement of frequencies to minimize the effect of unique TX-RX frequency pairs.

The sample system includes sites with frequencies in the 800 MHz, 700 MHz, UHF, and the VHF bands. See Process Steps for Developing a Band Plan on page 49 to create the band plan.

2.5.2.1
Mixed Band – FDMA/TDMA Band Plan for DDM-capable Systems

The following table demonstrates a band plan for systems employing a mix of frequency ranges. The frequencies are separated into plans as the first step in developing the band plan. 700 MHz and 800 MHz channels are not shown in this list since the default band plan elements can be used for them. If the system used FDMA only for the 700 MHz and/or 800 MHz frequencies, one default FDMA band plan element for each frequency band would be required.

If the system used TDMA for the 700 MHz and/or 800 MHz frequencies, one TDMA band plan element for each frequency band would also be required. 700 MHz, 800 MHz and 900 MHz: FDMA/TDMA Band Plans on page 44

NOTICE: These frequency bands would use 1-4 band plan elements out of the 16 available. If the system does not use these bands, and there are no future plans to use them, then all 16 band plan elements are available to use for the VHF and UHF frequencies.

Table 9: System Frequencies, UHF and VHF Bands

Station RX	Station TX	Station RX	Station TX
500.0875	503.0875	151.2725	158.9775
500.4750	503.4750	151.2875	153.9275
500.4875	503.4875	151.2875	156.0525
500.5125	503.5125	151.2875	159.0150

Table continued…

Station RX	Station TX	Station RX	Station TX
500.5250	503.5250	151.2950	153.8900
500.5500	503.5500	151.2950	159.3000
500.6250	503.6250	151.2950	159.3675
500.6625	503.6625	151.3100	158.8500
500.6875	503.6875	151.3250	155.4600
500.7125	503.7125	151.3250	158.8800
151.3025	153.9425	151.3325	153.8225
151.2725	154.9350		

2.5.2.2

Creating UHF Band Plan Elements

To compute the offset for determining commonality, separate all UHF frequencies into groups that have the same TX/RX offset and sign. See Process Steps for Developing a Band Plan on page 49. Note that multiple groups may be required to define all the channels that could be assigned in the VHF and UHF frequency bands. Repeat the process for separating the VHF frequencies.

In the following table (showing an example of UHF frequencies by offset), all the frequency pairs have a common TX/RX offset and are close to each other. Each station frequency and the TX/RX offset are divisible by 6.25 kHz and 12.5 kHz.

Table 10: UHF Frequencies Grouped by Offset

Frequency Pair #	Station RX in MHz	Station TX in MHz	TX/RX Offset in MHz
1	500.0875	503.0875	-3.000
2	500.4750	503.4750	-3.000
3	500.4875	503.4875	-3.000
4	500.5125	503.5125	-3.000
5	500.5250	503.5250	-3.000
6	500.5500	503.5500	-3.000
7	500.6250	503.6250	-3.000
8	500.6625	503.6625	-3.000
9	500.6875	503.6875	-3.000
10	500.7125	503.7125	-3.000

With 6.25 kHz channel spacing assigned to the UHF frequencies as shown in the following table, one implicit FDMA element can be created to cover these frequencies since they all fall within a 25.5 MHz range (6.25 kHz * 4095 channels). A single implicit TMDA can cover channels that span a 12.7 MHz range (6.25 kHz * 2047 channels).

NOTICE: Keep in mind that selection of the base frequency has to account for the following three factors:

- Future expansion plans.
- The operating range of the subscribers, specifically, the operating band of mobile radios.
- Relationship of the receive and transmit frequencies. It is possible for transmit frequencies to be above or below the receive frequency.

The assumption, in this example, is that the need for future expansion is limited and the assigned frequencies are close to the current frequencies. The base frequency for the 2 elements can be selected to put these frequencies in the middle of the frequency spread covered by each element. This would be at approximately the lowest TX frequency - (element frequency span -(highest assigned TX freq-lowest assigned TX freq))/2. This frequency must be evenly divisible by the chosen channel spacing.

For the FMDA element, this would be ~ 12.5 MHz ((6.25 kHz * 4.095 k-(503.7125 – 503.0875))/2) down from 503.0875 MHz for a base frequency of 490.5875 MHz.

For the TMDA element, this would be ~ 6.1 MHz ((6.25 kHz * 2.047 k-(503.7125 – 503.0875))/2) down from 503.0875 MHz for a base frequency of 496.9875 MHz.

The resulting band plan elements for this example are shown in the following table.

Table 11: UHF Band Plan Elements – Example

Base Frequency (MHz)	Channel Spacing (kHz)	Tx/Rx Offset (MHz)	Channel Separation (kHz)	Channel Type
490.5875	6.25	- 3.000	12.5	FDMA
496.9875	6.25	- 3.000	12.5	TDMA

2.5.2.3
Creating VHF Band Plan Elements

Separate all VHF frequencies into groups that have the same TX/RX offset. It generates results as shown in the following example table where VHF frequencies are arranged in ascending order, grouped by offset.

Table 12: VHF Frequencies Grouped by Offset

Frequency Pair #	Station RX in MHz	Station TX in MHz	TX/RX Offset in MHz
1	151.3325	153.8225	– 2.4900
2	151.2950	153.8900	– 2.5950
3	151.2875	153.9275	– 2.6400
4	151.3025	153.9425	– 2.6400
5	151.2825	153.4935	– 3.6525
6	151.3250	155.4600	– 4.1350
7	151.2875	156.0525	– 4.7650
8	151.2725	158.9775	– 7.7050
9	151.2875	159.0150	– 7.7275

Table continued…

Frequency Pair #	Station RX in MHz	Station TX in MHz	TX/RX Offset in MHz
10	151.3100	158.8500	– 7.5400
11	151.3250	158.8800	– 7.5550
12	151.2950	159.3000	– 8.0050
13	151.2950	159.3675	– 8.0725

Analysis of the example table where VHF frequencies are grouped by offset will yield the following factors to consider in mapping the VHF frequencies to elements on the band plan:

- Unlike the UHF frequencies, the VHF frequencies yield only two pairings that share a common TX/RX offset, pairs 3 and 4.
- The channel spacing that can be divided into all frequency pairs and their offset without generating a remainder is 2.5 kHz.

So far up to 4 elements have been assigned for 700 MHz and 800 MHz frequencies and 2 for UHF. That leaves 10 elements for the VHF frequencies. That means that there are not enough plan elements left to make only implicit channel assignments for all frequency pairs

Let us assume, in this example, that the need for future expansion is limited and the assigned frequencies are close to the current frequencies. The spread between the highest frequency and the lowest frequency is ~8.1 MHz. With a 2.5 kHz channel spacing, an FDMA element can span 10.2 MHz (4095*2.5 kHz) but a TDMA element can only span 5.1 MHz (2047*2.5 kHz). That means 1 FDMA element and 2 TDMA elements are required to do explicit channel assignments for these frequencies. By choosing the TX offset to be 2.6400 MHz in the 3 elements, we can do implicit channel assignments for frequency pairs 3 and 4.

The base frequency for the FMDA element can be selected to put these frequencies in the middle of the frequency spread covered by the element. This would be at approximately the lowest frequency - (element frequency span +highest assigned freq-lowest assigned freq)/2. This frequency must be evenly divisible by the chosen channel spacing.

For the FMDA element, this would be ~ 1.070 MHz ((2.5 kHz * 4.095 k- (159.3675 – 151.2725))/2) down from 151.2725 MHz for a base frequency of 150.2025 MHz.

For TMDA, you can center the system frequencies across the 2 elements. The base frequency for the first element would be ~ 1.070 MHz ((2*2.5 kHz * 2.047 k-(159.3675 – 151.2725))/2) down from 151.2725 for a base frequency of 150.2025 MHz. The base frequency of the second element would be the next 2.5 kHz step up from the last element covered by the first band plan element or 2.5 kHz*2048 + element 1 base frequency =155.3225.

The resulting band plan elements for this example are shown in the following table.

Table 13: VHF Band Plan Elements – Example

Base Frequency (MHz)	Channel Spacing (kHz)	Tx/Rx Offset (MHz)	Channel Separation (kHz)	Channel Type
150.2025	6.25	–2.6400	12.5	FDMA
150.2025	6.25	–2.6400	12.5	TDMA
150.3225	6.25	–2.6400	12.5	TDMA

2.5.2.4
Calculating the UHF Receive and Transmit Channel Numbers

Band plan elements for the UHF frequencies for FDMA and TDMA were developed to be implicit. From the following table , that can be verified and the channel number for each frequency pair can be determined.

Table 14: UHF Band Plan Elements – Example

Base Frequency (MHz)	Channel Spacing (kHz)	Tx/Rx Offset (MHz)	Channel Separation (kHz)	Channel Type
490.5875	6.25	- 3.000	12,5	FDMA
496.9875	6.25	- 3.000	12.5	TDMA

2.5.2.4.1
FDMA Channel Numbers for Implicit UHF Frequencies

To calculate the channel numbers for implicit FDMA frequencies, subtract the base frequency from the station TX frequency and divide the result by the channel spacing per the FDMA band plan element in Calculating the UHF Receive and Transmit Channel Numbers on page 55.

Table 15: FDMA Channel Numbers for Implicit UHF Frequencies – Example

Station TX (MHz)	Station RX (MHz)	Base Frequency (MHz)	Channel Spacing (kHz)	Channel Number
503.0875	500.0875	490.5875	6.25	2000
503.4750	500.4750	490.5875	6.25	2062
503.4875	500.4875	490.5875	6.25	2064
503.5125	500.5125	490.5875	6.25	2068
503.5250	500.5250	490.5875	6.25	2070
503.5500	500.5500	490.5875	6.25	2074
503.6250	500.6250	490.5875	6.25	2086
503.6625	500.6625	490.5875	6.25	2092
503.6875	500.6875	490.5875	6.25	2096
503.7125	500.7125	490.5875	6.25	2100

2.5.2.4.2
TDMA Channel Numbers for Implicit UHF Frequencies

To calculate the channel numbers for slot 0 of implicit TDMA frequencies, subtract the base frequency from the station TX frequency and divide the result by the channel spacing per the TDMA band plan element in Calculating the UHF Receive and Transmit Channel Numbers on page 55. These are always even numbers. For the corresponding slot 1 channel numbers, add 1.

Table 16: TDMA Channel Numbers for Implicit UHF Frequencies – Example

Station TX (MHz)	Station RX (MHz)	Base Frequency (MHz)	Channel Spacing (kHz)	Channel Number Slot 0	Channel Number Slot 1
503.0875	500.0875	490.5875	6.25	1952	1953
503.4750	500.4750	490.5875	6.25	2076	2077
503.4875	500.4875	490.5875	6.25	2080	2081
503.5125	500.5125	490.5875	6.25	2088	2089
503.5250	500.5250	490.5875	6.25	2092	2093
503.5500	500.5500	490.5875	6.25	2100	2101
503.6250	500.6250	490.5875	6.25	2124	2125
503.6625	500.6625	490.5875	6.25	2136	2137
503.6875	500.6875	490.5875	6.25	2144	2145
503.7125	500.7125	490.5875	6.25	2152	2153

2.5.2.5 Calculating the VHF Receive and Transmit Channel Numbers

For the example, the band plan elements for the VHF frequencies for FDAMA and TDMA were developed to be explicit except for frequency pairs 3 and 4. From the following table , that can be verified and the channel number for each frequency pair can be determined.

Table 17: VHF Band Plan Elements – Example

Base Frequency (MHz)	Channel Spacing (kHz)	Tx/Rx Offset (MHz)	Channel Separation (kHz)	Channel Type
150.2025	6.25	–2.6400	12.5	FDMA
150.2025	6.25	–2.6400	12.5	TDMA (element 1)
150.3225	6.25	–2.6400	12.5	TDMA (element 2)

2.5.2.5.1 FDMA Channel Numbers for Explicit VHF Frequencies

To calculate the receive channel numbers, subtract the base frequency from the receive frequency, and divide the result by the channel spacing. To calculate the Transmit channel numbers, subtract the base frequency from the transmit frequency and divide the result by the channel spacing. The result is shown in the following table.

Table 18: FDMA Channel Numbers for Explicit VHF Frequencies – Example

Station TX (MHz)	Channel Number)	Base Frequency (MHz)	Channel Spacing (kHz)	Station RX (MHz)	Channel Number
151.3325	452	150.2025	2.5	153.8225	1448
151.2950	437	150.2025	2.5	153.8900	1475
151.2875	implicit	150.2025	2.5	153.9275	1490
151.3025	implicit	150.2025	2.5	153.9425	1496
151.2825	432	150.2025	2.5	153.9350	1884
151.3250	449	150.2025	2.5	153.4600	2103
151.2875	434	150.2025	2.5	153.0525	2340
151.2725	428	150.2025	2.5	153.9775	3510
151.2875	434	150.2025	2.5	153.0150	3523
151.3100	443	150.2025	2.5	153.8500	3459
151.3250	449	150.2025	2.5	153.8800	3471
151.2950	437	150.2025	2.5	153.3000	3639
151.2950	437	150.2025	2.5	153.3675	3666

2.5.2.5.2

TDMA Channel Numbers for Explicit VHF Frequencies

To calculate the TDMA receive channel numbers for slot 0, subtract the base frequency from the receive frequency, and divide the result by the channel spacing. To calculate the TDMA transmit channel numbers for slot 0, subtract the base frequency from the transmit frequency and divide the result by the channel spacing. These are always even numbers. For the corresponding slot 1 channel numbers, add 1. See the following tables for an example of TDMA channel numbers for implicit VHF TX and RX Frequencies.

Table 19: TDMA Channel Numbers for Implicit VHF TX Frequencies – Example

Station TX (MHz)	TDMA element	Base Frequency (MHz)	Channel Spacing (kHz)	Channel Number Slot 0	Channel Number Slot 1
151.3325	1	150.2025	2.5	904	905
151.2950	1	150.2025	2.5	874	875
151.2875	1	150.2025	2.5	implicit	implicit
151.3025	1	150.2025	2.5	implicit	implicit
151.2825	1	150.2025	2.5	864	865
151.3250	1	150.2025	2.5	898	899
151.2875	1	150.2025	2.5	868	869

Table continued…

151.2725	1	150.2025	2.5	856	857
151.2875	1	150.2025	2.5	868	869
151.3100	1	150.2025	2.5	886	887
151.3250	1	150.2025	2.5	898	899
151.2950	1	150.2025	2.5	874	875
151.2950	1	150.2025	2.5	874	875

Table 20: TDMA Channel Numbers for Implicit VHF RX Frequencies – Example

Station RX (MHz)	TDMA element	Base Frequency (MHz)	Channel Spacing (kHz)	Channel Number Slot 0	Channel Number Slot 1
153.8225	1	150.2025	2.5	2896	2897
153.8900	1	150.2025	2.5	2950	2951
153.9275	1	150.2025	2.5	2980	2981
153.9425	1	150.2025	2.5	2992	2993
154.9350	1	150.2025	2.5	3786	3787
155.4600	1	150.2025	2.5	110	111
156.0525	1	150.2025	2.5	584	585
158.9775	1	150.2025	2.5	2924	2925
159.0150	1	150.2025	2.5	2954	2955
158.8500	1	150.2025	2.5	2822	2823
158.8800	1	150.2025	2.5	2846	2847
159.3000	1	150.2025	2.5	3182	3183
159.3675	1	150.2025	2.5	3236	3237

2.5.3

Band Plan Changes and Activation

For a well-defined band like 700, 800 or 900 MHz, a single element can describe every possible frequency that can be used. Channels can be added without the need for an element change. For a band like VHF, where the frequency pairing is almost random, adding channels almost certainly require element changes if explicit frequency assignments are not used for some channels. Changing the elements in a live system requires careful planning and must be performed in a specific sequence.

CAUTION: Subscriber radios can lose the ability to correctly synthesize either traffic channels or control channels if changes to band plans are not performed in a specific order. All subscriber radios in a system must be brought current with any added or modified band plan element information before any channels in the system that use those elements are put into service. All band plan changes must be entered into system subscribers via Customer Programming Software (CPS), and into all system sites via the Unified Network Configurator (UNC) Frequency Band Plan wizard.

Changes to the band plan may be required by the addition of new frequency pairs to the system, or changes to existing frequency pairings. New channels can be added to the system without problems if the frequencies can be described by one of the existing band plan elements. Existing channels can have their frequencies changed without problems if the new frequencies can be described by one of the existing band plan elements and the channels are disabled while the changes are being made. In both cases, the CSS is used to program the frequencies into the stations and the CSS or the UNC is used to reprogram the site controllers with the new channel mappings for the affected channels.

NOTICE: A site may go into Failsoft mode if all of its control channel-capable stations need to be disabled for frequency changes.

Programming the system up front with the Explicit tables for the frequency band being used makes it unnecessary to modify the band plan. However, this option is only available in ASTRO® 25 Release 6.2 or later and it does limit the site size and extract a performance price in assigning calls.

When changes to the band plan are needed it is highly recommended that you do not modify existing elements. Instead, add a new element to the plan that incorporates the desired changes. The channel mapping can then be changed to use the new element and the existing element is left unused. The unused element may then be changed in the future when another new element is needed. To lessen the impact of future changes, the up-front design should ensure that either the control channels at each site are not all mapped to the same element, or at least one is defined “Explicitly”. This ensures that there is at least one control channel at each site that is not affected by any single element change.

2.5.3.1 Adding a New Band Plan Element

Prerequisites: Use the Customer Programming Software (CPS) to add the new band plan element into all subscribers. If the Tx frequency of a control channel is being modified, update the Control Channel list with the new frequency. Any affected control channel capable station should have its Control Channel Capable flag set to “No” through the Unified Network Configurator (UNC) application.

When and where to use: Implement the following process to add a new band plan element.

NOTICE: A site may go into Failsoft mode if all control channel-capable stations are affected by the change.

Process:

1. Disable all currently active stations in the system that the band plan change affects.
2. Use Configuration/Service Software (CSS) to reprogram the existing stations with the new Tx and Rx frequencies.
3. Use UNC to program the new band plan element into the sites. See the *Unified Network Configurator* manual.
4. Use UNC to program the channel mappings into the sites. See the *Unified Network Configurator* manual.
5. Re-enable any stations that were disabled in Step 2.
6. Set the Control Channel Capable flag back to Yes for the stations affected in Step 1.

2.5.3.2 Modifying a Band Plan Element

When and where to use: When an already-in-use band plan element must be modified to accommodate channelization changes in the system, the process differs. Changes to band plan elements that are already in use in the system are disruptive to system operation, as the affected channels need to be taken out of service until the reprogramming is completed. Implement the following process to modify a band plan element.

Process:

1. Determine the properties (Rx bandwidth, channel spacing, base frequency and T/R offset) required of the new element.

- Rx bandwidth and channel spacing usually do not change; a different base frequency, and/or (more likely) a different T/R offset is required in a new element.

2 Enter the new element information into both CPS and CSS, in preparation for programming both subscribers and sites. Save the templates, but do not save them over the existing system templates.

- Retain the present programming templates until the system conversion has been successfully accomplished.

3 Identify all channels in the system that use the identifier that is going to be changed.

- An identifier is always associated with one or more system channels; this association was established at initial system commissioning.

4 Ensure that service can be maintained at all system sites for example, are any of the to-be-changed channels either a primary or secondary control channel at a system site?

- Changing the identifier of an in-use primary control channel can cause serious system disruption. Since channels affected by an identifier change must be temporarily removed from service, be prepared to “roll” site control channels to a channel that are not affected by the band plan element change.

5 Take the channels that use the to-be-changed identifier out of service.

- It is critical to ensure that channels whose identifier is changing are not “seen” either at their own site, or at adjacent sites.

6 Program the new identifier information into all system subscribers.

- All subscribers, including those units held in reserve as spares must be programmed before they are put into use in the system.
- Band plan programming of all system subscribers is required at system initialization, and when any changes to the system band plan structure are made.

7 Program the new identifier information into all system sites.

- Yo do not have to do steps 6 and 7 sequentially, so long as the identifier programming is completed system wide before any radio channels that use the new identifier are put into service.

8 Program the new channel info at the affected sites.

- Channels being added to the system may be brought into service after the sites have been prepared to identify the new channels correctly and the subscribers prepared to read the new identifiers.

9 Bring new/added system channels into service. Channels that were taken out of service previously can now be returned to service.

2.5.4
Infrastructure Programming

Infrastructure programming consists of the following:

- Configuring frequency band plan information in the Unified Network Configurator (UNC).
- Configuring frequency band plan information on a channel in the Configuration/Service Software (CSS) and UNC.
- Configuring sub-band restriction for channels in the UNC to Zone Controllers and Site Controllers. This is done in the Channel Wizard in the UNCW. See the “Updating a Channel Setting” section in the *Unified Network Configurator* manual.
- Configuring individual and talkgroup sub-band ranges in the UNC and Provisioning Manager (PM).

2.5.4.1
Frequency Band Plan Management

Frequency band plans must be kept consistent between all site controllers for the system to function properly. The Frequency Band Plan wizard in Unified Network Configurator (UNC) wizard is used to accomplish this consistency.

Though the Frequency Band Plan wizard allows the configuration of multiple band plans, only one of those band plans can be in use within the system. This band plan is considered to be the “Active” band plan and its contents are sent to the site controllers. It is possible to change the “Inactive” band plans and their contents are not sent to the site controllers.

2.5.4.1.1
Accessing UNC Wizards

The following procedure explains how to access the Unified Network Configurator (UNC) wizards.

Prerequisites: Frequency band plans must be kept consistent between all site controllers for the system to function properly.

When and where to use: Configuring Frequency Band Plans with UNC.

Procedure:

1. On the Network Management client where you set up VoyenceControl, double-click the Internet Explorer desktop icon.

   NOTICE: The names EMC Smarts™ and VoyenceControl are used interchangeably for this product.

   The Internet Explorer window appears.

2. In the address field of Internet Explorer, type `http://ucs-unc0<Y>.ucs:9080/UNCW` where ***<Y>*** is the number of the UNC server (`1` for the primary core UNC server, and `2` for the backup core UNC server). Press **Enter** or double-click the shortcut on your desktop if you created one on the NM client.

   The Unified Network Configurator Wizard login page appears asking you to enter the username and password. (For easy access to the application, create a desktop shortcut).

3. Enter the `<username>` and `<password>`. Click **Submit**.

   The Unified Network Configurator Wizard home page appears.

4. Select the desired wizard from the list of available wizards on the left side.

   The data form for the desired wizard appears on the right side of the window.

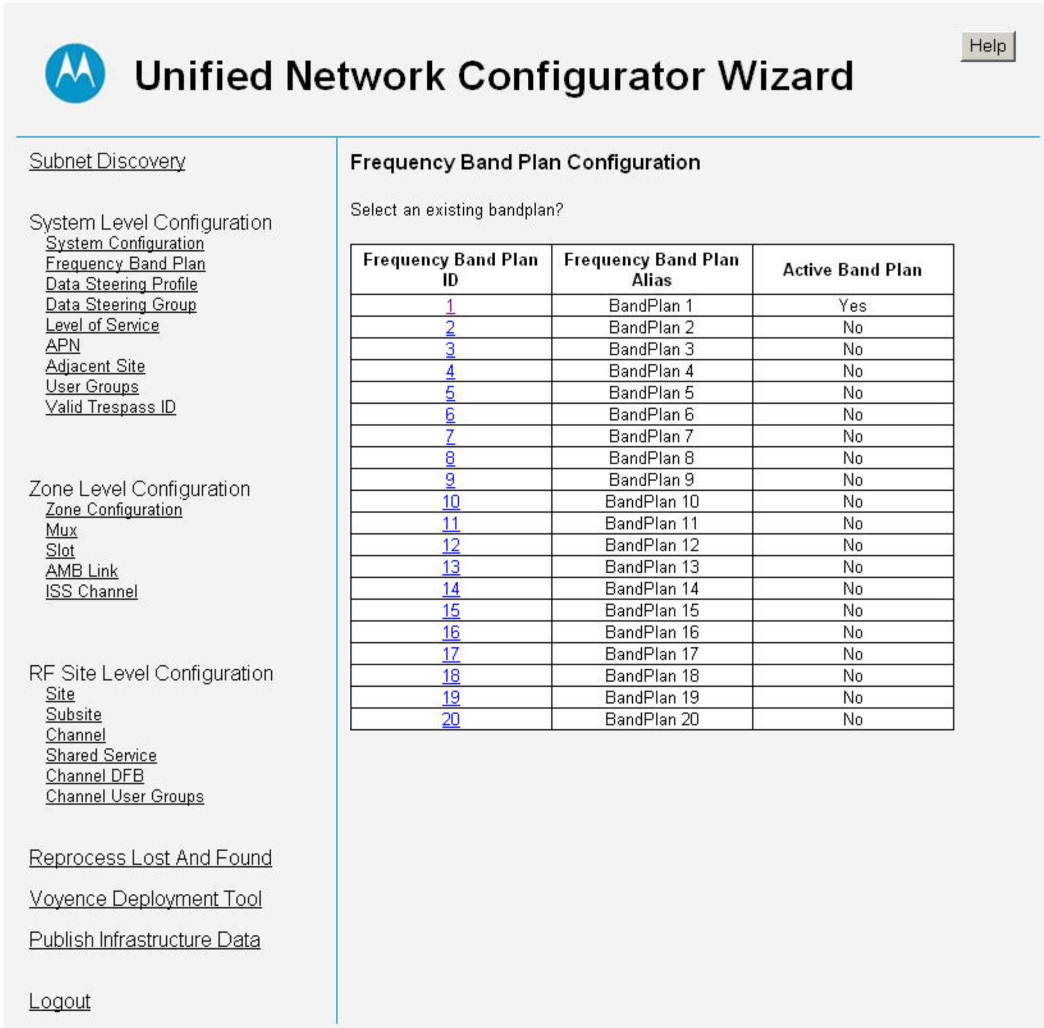
2.5.4.1.2
Managing Individual Band Plans

When and where to use: Use this process to manage an individual band plans.

Procedure:

1. From the list of available wizards on the left side of the Unified Network Configurator Wizard, select **Frequency Band Plan**.

Figure 1: Unified Network Configurator Wizard – Frequency Band Plan Configuration Window



The right side of the window is updated with a list of band plans.

2 Select the Frequency Band Plan ID of the band plan you want to modify.

The right side of the window is updated with the Frequency Band Plan form for the selected band plan.

3 Update the desired fields and select the **Submit** button.

NOTICE: To cause a different band plan to be placed in the “Active” state, set the Active Band Plan field in the Frequency Band Plan Configuration form to **Yes**.

UNC processes the update request and the band plan data is updated. If the band plan updated is the active band plan, the content is also distributed to the device.

4 Open the **Schedule Manager** in UNC and approve the pending remedy job.

2.5.4.1.3

Frequency Band Plans Configuration on a Channel

The frequency band plans for a channel are configured in the site controller using both Configuration/Service Software (CSS) and Unified Network Configurator (UNC).

In the CSS Channel Configuration window, select the frequency band plan table associated with these channels transmit and receive frequencies for the **TX Band Element** and **RX Band Element** fields.

Channels are configured in the Channel Wizard when using the UNC Wizard. See the “Updating a Channel Setting” section in the *Unified Network Configurator* manual.

2.5.4.2
Sub-Band Restricted Channel Configuration

Configuration of a channel as a sub-band channel is done in the Unified Network Configurator Wizard (UNCW). Range databases specify ranges of subscriber unit individual IDs and talkgroup IDs capable of sub-band and full-band operation and are downloaded to the zone and site controllers.

Sub-band operation is used by zone controllers and site controllers to manage the infrastructure resources, radios, and talkgroups. Sub-band operation permits site controllers and repeaters to operate and inter-operate among individuals and talkgroups that are sub-band and non-sub-band capable. Properly identified resources make the following types of communication possible:

- Sub-band restricted radio to sub-band restricted private radio private calls
- Sub-band restricted radio to unrestricted radio private calls
- Talkgroup calls when all members of the talkgroup are sub-band restricted
- Talkgroup calls when some members of the talkgroup are sub-band restricted and some have no band restriction
- Multigroup calls when all talkgroup members are sub-band restricted
- Multigroup calls when some talkgroups are sub-band restricted and some talkgroups have no band restriction
- Supergroup calls
- Telephone interconnect calls
- Emergency calls

2.5.4.2.1
Sub-Band Restriction Channel Selection

The default for the channel selection method is “Static”. The default SBR Channel Selection parameter causes the use of S-SBR channel . To use D-SBR , the Channel Selection parameter must be configured to “Dynamic” for the talkgroup, the multigroup or all the talkgroups involved in a supergroup call. This parameter is configured using and is downloaded to all zone controllers in the ASTRO® 25 system. See the “Group Objects” section in the *Provisioning Manager* manual. When changing the values in PM, they must be distributed to Unified Network Configurator (UNC). See “Adding Managed Devices to the Provisioning Manager” and “Distributing Configuration Changes” sections in the *Provisioning Manager* manual.

2.5.4.2.2
SBR Radio ID Tables and Talkgroup Tables

The SBR Individual Radio ID table and the SBR Talkgroup table are configured using Provisioning Manager (PM) and downloaded to all zone controllers in the ASTRO® 25 system. See the “Group Objects” section in the *Provisioning Manager* manual. When changing the values in PM, they must be distributed to UNC. See “Adding Managed Devices to the Provisioning Manager”and “Distributing Configuration Changes” sections in the *Provisioning Manager* manual.

These tables are also used by the site controllers (GCP8000 Simulcast SC, GCP8000 Repeater SC, PSC9600 Repeater SC) for S-SBR execution during site trunking mode.

The following two methods are available to configure these tables for site controller usage:

- Unified Network Configurator (UNC) – global (centralized) configuration for the download
- Configuration/Service Software (CSS) – local configuration

NOTICE: Since the SBR Individual Radio ID table and the SBR Talkgroup tables are system-level tables distributed to all zone controllers and site controllers, it is preferable to configure them from a central location rather than locally using CSS. First the changes should be done in PM and distributed to UNC. Using CSS is not recommended because the data must be distributed to the ZC and SC. The SBR settings for radios and talkgroups are set in the PM only – see “Group Objects” section in the *Provisioning Manager* manual. When changing the values in PM, they must be distributed to UNC. See “Adding Managed Devices to the Provisioning Manager”and “Distributing Configuration Changes” sections in the *Provisioning Manager* manual. After the changes are made in PM and distributed to UNC, any remedy job must be approved to distribute the data to the ZC and SC.

2.5.4.2.3
Sub-Band Ranges Configuration

The following two types of tables in the Unified Network Configurator Wizard (UNCW) are used to control sub-band operation in the system.

Restricted talkgroups ID table

A table that allows configuration of up to 128 contiguous, not-overlapping ID ranges for talkgroups that are restricted to operate only on sub-band channels. This table is sent to all zone controllers, for use in wide area calls, and to site controllers for use in site trunking.

Restricted radios ID table

A table that allows configuration of up to 128 contiguous, not-overlapping ID ranges for individuals that are restricted to operate only on sub-band channels. This table is sent to all zone controllers, for use in wide area calls, and to site controllers for use in site trunking.

IMPORTANT: The start and end ranges of the individual and talkgroup IDs must fall within the ranges specified in the home zone mapping object in Provisioning Manager (PM). Improper mapping results in subscribers being unable to access the system.

2.5.4.2.4
Configuring a Radio Sub-Band Restricted Map

IMPORTANT: When entering radio sub-band restricted map data, the entire range of radio IDs (0 – 16777215) must be mapped across the index entries. Failure to do so results in an error message.
Special consideration should be given to assigning the working and foreign radio IDs as either sub-band restricted or not based on the foreign subscribers that are expected to roam into the system. All working and foreign radio IDs must be assigned as either sub-band restricted or all must be assigned as non-restricted. See the *ISSI 8000/CSSI 8000 Intersystem Gateway Feature Guide* manual for details.

When and where to use:
Use this procedure to configure the restricted radio parameters for sub-bands stored in the site controller.

Procedure:

1. Log in to the Unified Network Configurator Wizard (UNCW).

   The UNCW main window appears.

2. Under System Level Configuration in the navigation tree, select **Radio Sub-Band Restricted Map**.

3 In the **Sub-Band Restricted Map Configuration** screen, click the desired field name to display information about the field.

4 Enter the appropriate values in the required fields using the following options:
   - To save changes, click **Submit**.
   - To clear the fields and enter new values, click **Reset**.

5 Open the **Schedule Manager** in VoyenceControl, submit, and approve the remedy jobs.

   NOTICE: The names EMC Smarts™ and VoyenceControl are used interchangeably for this product.

   UNC applies the configuration change.

2.5.4.2.5

Configuring a Talkgroup Sub-Band Restricted Map

IMPORTANT: When entering talkgroup sub-band restricted map data, the entire range of talkgroup IDs (80000000 – 80065535) must be mapped across the index entries. Failure to do so results in an error message.
Special consideration should be given to assigning the working talkgroup ID ranges as either sub-band restricted or not based on the subscribers that are expected to use the foreign systems. All working talkgroup ID ranges must be assigned as either sub-band restricted or all must be assigned as non-restricted. See the *ISSI 8000/CSSI 8000 Intersystem Gateway Feature Guide* manual for details.

When and where to use: Use this procedure to configure the restricted talkgroup parameters for sub-bands stored in the site controller.

Procedure:

1 Log in to the Unified Network Configurator Wizard (UNCW).

   The UNCW main window appears.

2 Under System Level Configuration in the navigation tree, select **TGMG Sub-Band Restricted Map**.

3 In the **TGMG Sub-Band Restricted Map Configuration** screen, click the desired field name to display information about the field.

4 Enter the appropriate values in the required fields using the following options:
   - To submit the changes, click **Submit**.
   - To clear the fields and enter new values, click **Reset**.

5 Open the **Schedule Manager** in VoyenceControl, submit, and approve the remedy jobs.

   NOTICE: The names EMC Smarts™ and VoyenceControl are used interchangeably for this product.

   UNC applies the configuration change.

2.5.4.3

Frequency Band Plans Configuration with UNC

You can enter and store 20 frequency band plans in Unified Network Configurator (UNC), but only one frequency band plan is actively used by the system at any one time. UNC verifies that the site controllers are in compliance, which includes checking the band plan parameters. If a site controller is not in compliance, a remedy job is scheduled to fix it. Approve in the Schedule Manager within VoyenceControl.

NOTICE:
The frequency band plans can be configured in UNC only.

The names EMC Smarts™ and VoyenceControl are used interchangeably for this product.

2.6 Call Processing and Sub-Band Restriction

Careful planning during the fleetmapping stage of system design enhances accomplishment of call processing tasks in systems that include OBT sites, OBT zones, or combinations of OBT sites and zones.

The Sub-Band Restriction feature takes into account that some radio models cover only part of the total frequency range in a particular band, whereas, infrastructure uses some frequencies that are outside of this range.

There are two methods for channel selection for mixed RF sites that contain both sub-band restricted (SBR) channels and unrestricted (not-SBR) channels. These are Static SBR (S-SBR) and Dynamic SBR (D-SBR). S-SBR defines ranges of individual radio IDs and talkgroup IDs that can be designated as either Sub-Band Restricted (SBR) or not-SBR.

For a talkgroup, if at least one radio that can be affiliated with the group is SBR, then the Talkgroup is configured as SBR. Channel assignment for the group calls using S-SBR is made based on the SBR status of the talkgroup. If an RF site supports both SBR channels and not-SBR channels, an SBR channel is assigned if the radios present at the RF site are affiliated with an SBR talkgroup.

Channel selection using S-SBR may result in poor utilization of not-SBR channels. This is due to the static nature of the channel selection algorithm based on configured SBR status. If all the talkgroups affiliated radios registered at an RF site are not-SBR radios, an SBR channel is still assigned since the talkgroup is configured as an SBR talkgroup. However, if all the radios registered at this site are not-SBR radios, a not-SBR channel could have been selected instead.

D-SBR channel selection determines the channel to assign at an RF site based on the capabilities of the radios that are present at the site rather than the SBR status of the talkgroup that they are affiliated with. If all radios present at the RF site are not-SBR, D-SBR assigns a not-SBR channel though the talkgroup that these radios are affiliated with is an SBR talkgroup. By assigning a channel that matches the capabilities of the radios registered at the site, more efficient usage of the channels can be achieved.

2.6.1 Wide Area Mode of Operation – Sub-Band Restriction

Sites can operate in different frequency bands. Call processing assigns a sub-band channel, if one exists at a site, for calls involving sub-band individuals and talkgroups.

If a site has sub-band channels in service but all of those channels are busy, then the call is busied. If no sub-band channels are programmed at a site or all sub-band channels are out of service, call processing rejects a call request initiating at that site or assigns an unrestricted channel if the call is initiated at another site.

If a site only had one sub-band channel, and it is currently operating as the Control Channel, call processing allows sub-band subscribers to register. Call processing issues a reject if a sub-band subscriber initiates a group or individual call at such a site.

2.6.1.1 Wide Area Trunking – Static Sub-Band Restriction

When the system is in wide-area trunking mode, the Static Sub-Band Restriction (S-SBR) method of channel utilization is used for the following types of calls, regardless of the SBR channel selection parameter setting:

- Emergency calls
- Private (unit-to-unit) calls
- Telephone interconnect calls
- IV&D calls

2.6.1.2 Wide Area Trunking – Dynamic Sub-Band Restriction

When the system is in wide-area trunking mode, the Dynamic Sub-Band Restriction (D-SBR) method of channel utilization is used only if the SBR channel selection parameter is set to “Dynamic”. This usage applies for the following types of calls:

- Talkgroup calls
- Multigroup calls
- Supergroup calls

2.6.1.3 Talkgroup Call

Call processing permits inter-operation among sub-band and full band individuals affiliated to the same talkgroup. Talkgroups are flagged as sub-band based on inclusion in the sub-band restricted ID table or by member affiliation. Talkgroups that are flagged as having sub-band members require sub-band channels at all sites where sub-band channel resources exist, otherwise unrestricted channels are assigned. Sites where sub-band restricted subscribers are registered must have sub-band channels, otherwise the subscribers cannot initiate calls.

Talkgroups may have a mixture of different frequency bands across the system. For example, a talkgroup may consist of subscribers that operate in 800 MHz sites, subscribers that operate in VHF low range sites, and subscribers that operate in VHF high range sites (band unrestricted channels).

The affiliated members at the VHF low range site cause the controller to flag this talkgroup as a sub-band restricted talkgroup. Channels for such a talkgroup are assigned as follows:

- Unrestricted channels are assigned at the 800 MHz site (there are no sub-band restrictions in this band).
- Unrestricted channels are assigned at the VHF high range site that contains no sub-band (VHF low range) channels.
- A sub-band restricted channel is assigned at the VHF low-range site even if talkgroup members in the VHF high range are also registered at the site.

If the system has VHF sites with low range and high range voice channels, assignments take place as follows:

- Sites with both sub-band restricted channels and unrestricted channels assign a sub-band channel for talkgroups flagged as having sub-band members.
- Sites with both sub-band restricted channels and unrestricted channels, but with all sub-band channels busy, cause the call to be placed in the busy queue.
- Sites with both sub-band restricted channels and unrestricted channels, but all sub-band channels are out of service, cause the call to be rejected if the call is initiated at this site. The site assigns an unrestricted channel if the call originates at a different site. If a high range channel is assigned, low range members present at the site cannot participate in the call as they have no way of generating the appropriate frequency.

NOTICE: The example using VHF sites with low and high range voice channels is just one scenario. Sub-band restriction can be used any time there is a wider range of frequencies within a single RF band (that is, VHF, UHF, 700/800/900 MHz) available to some radios than to other radios.

Sites that have only one sub-band channel, that is currently operating as the Control Channel, create some unique operating conditions.

2.6.1.3.1
Site with Single Sub-Band Channel Operating as Control Channel

The following table lists some possible scenarios that can occur when a talkgroup is flagged as sub-band restricted and has at least one member at such a site. These conditions can occur in any band that uses sub-band restrictions.

Table 21: Site with Single Sub-band Channel Operating as Control Channel

Subscriber At This Site	Sub-band Restricted Flag	Requesting Subscriber	Results
✓	✓	✓	Call processing issues a reject since the requesting subscriber is not able to use an unrestricted channel.
✓	✗	✓	Call processing assigns an unrestricted channel if available. The subscriber receives a busy signal if there are no unrestricted channels available.
✓	✓	✗	The site is not included in the call if this is the only subscriber at the site affiliated to the requesting talkgroup. If there are other members of the talkgroup at the site and they are not sub-band restricted, call processing assigns an unrestricted channel if available. The requesting subscriber receives a busy signal if there are no unrestricted channels available.
✓	✗	✗	Call processing assigns an unrestricted channel if available. The requesting subscriber receives a busy signal if there are no unrestricted channels available.

2.6.1.4
Private Call Processing

The following table describes the processing results when the target and initiating radios are in the same zone but different sites.

Table 22: Target and Initiating Radios in the Same Zone, Different Sites

If the Sub-band Restriction flag is set this way:				And the Channel Status (either site) is:		Then the call is:
Initiating Radio	**Target Radio**	**Channel Initiating Site**	**Channel Target Site**	**Busy**	**Out of Service**	
✓	✓	✓	✓	✗	✗	Accepted and sub-band restricted resources are assigned to the call.
✓	✓	✓	✓	✓	✗	Placed in the busy queue.
✓	✓	✓	✓	✗	✓	Rejected.
✓	✓	✗	✓	NA	NA	Rejected.
✓	✓	✓	✗	NA	NA	Rejected.
✗	✓	✓	✓	✗	✗	Assigned with sub-band restricted channels at both sites.
✓	✗	✓	✓	✗	✗	Assigned with sub-band restricted channels at both sites.
✗	✓	✓	✗	✗	✗	Rejected. Both subscribers must have sub-band channels available.
✗	✓	✗	✓	NA	NA	Rejected. Both subscribers must have sub-band channels available.
✓	✓	✓	✗	NA	NA	Rejected. Both subscribers must have sub-band channels available.
✓	✗	✗	✓	NA	NA	Rejected. Subscribers at initiating site do not have sub-band channels available.
✗	✗	✗	✗	✗	✗	Assigned to unrestricted channels.

Table continued…

If the Sub-band Restriction flag is set this way:				And the Channel Status (either site) is:		Then the call is:
Initiating Radio	Target Radio	Channel Initiating Site	Channel Target Site	Busy	Out of Service	
✗	✗	✓	✓	✗	✗	Assigned to unrestricted channels if available, otherwise it is assigned to the sub-band restricted channels.

2.6.1.5

Different Zone Private Calls

The following table describes the processing results when the target and initiating radios are in different zones.

Table 23: Target and Initiator in Different Zones

If the Sub-band Restriction flag is set this way:				And the Voice Channel status is:		Then the call is:
Initiating Radio	Target Radio	Channel Initiating Site	Channel Target Site	Initiating Zone	Target Zone	
✓	✓	✓	✓	Available	Available	Accepted and sub-band restricted resources are assigned to the call.
✓	✓	✓	✓	Available	Busy	Placed in the busy queue.
✓	✓	✓	✓	Busy	Available	Placed in the busy queue.
✓	✓	✗	✓	Unrestricted channels available	Available	Rejected. The initiating radio is sub-band restricted and does not have sub-band resources available.
✓	✓	✓	✗	Available	Unrestricted channels available	Rejected. The target radio is sub-band restricted and does not have sub-band re-

Table continued…

If the Sub-band Restriction flag is set this way:				And the Voice Channel status is:		Then the call is:
Initiating Radio	Target Radio	Channel Initiating Site	Channel Target Site	Initiating Zone	Target Zone	
						sources available.
✓	✓	✓	✓	Available	Out of service	Rejected.
✓	✓	✓	✓	Out of service	Available	Rejected.
✓	✗	✓	✓	Available	Available	Accepted and sub-band restricted resources are assigned to the call.
✓	✗	✓	✗	All resources available	Unrestricted channels available	Accepted. The initiating radio is assigned sub-band restricted resources while the target radio is assigned unrestricted resources.
✓	✗	✗	✓	Unrestricted channels available	Available	Rejected. The initiating radio is sub-band restricted and does not have sub-band resources available.
✗	✓	✓	✓	Available	Available	Accepted and sub-band restricted resources are assigned to the call.
✗	✓	✗	✓	Unrestricted channels available	Available	Accepted. The initiating radio is assigned unrestricted resources while the target radio is assigned sub-band restricted resources.

Table continued…

If the Sub-band Restriction flag is set this way:				And the Voice Channel status is:		Then the call is:
Initiating Radio	Target Radio	Channel Initiating Site	Channel Target Site	Initiating Zone	Target Zone	
✗	✓	✗	✓	Unrestricted channels available	Out of service	Rejected.
✗	✓	✓	✗	Unrestricted channels available	Unrestricted channels available	Rejected.
✗	✗	✓	✓	All resources available	All resources available	Accepted. Unrestricted resources are assigned.
✗	✗	✓	✓	Unrestricted channels not available	Unrestricted channels available	Accepted. Sub-band restricted resources are assigned at the initiating site.
✗	✗	✓	✓	Unrestricted channels available	Unrestricted channels not available	Accepted. Sub-band restricted resources are assigned at the target site.
✗	✗	✗	✗	Unrestricted channels busy	Unrestricted channels available	Placed in the busy queue.
✗	✗	✗	✗	Unrestricted channels available	Unrestricted channels busy	Placed in the busy queue.

2.6.1.6
Multigroup Call

The zone controller ensures that sub-band channel resources are assigned to multigroups containing both sub-band and unrestricted band users. Any multigroup flagged as having sub-band members are processed the same way as a talkgroup having sub-band members.

A multigroup with an ID that is not part of the sub-band restricted range cannot include any radios or talkgroups that are sub-band restricted. A multigroup that is sub-band restricted can include full band members since a full band radio can be assigned to a sub-band restricted channel.

2.6.1.7
Group Regrouping

Any sub-band restricted talkgroup that becomes part of a supergroup automatically makes the supergroup sub-band restricted. All sites in the supergroup call that have a sub-band channel in service assign a sub-band channel, if available, to the call.

2.6.1.8
Patch Calls

Sub-band restricted talkgroups cannot be added to an active patch call unless the patch already includes sub-band restricted members. If the active patch does not include sub-band restricted members, the talkgroup with sub-band members may be added once the patch call ends.

2.6.1.9
Private Calls

Private calls that include the console are processed as follows:

- Private calls to and from a console are supported to subscribers in any band.
- For console initiated private calls, the channel assignment is based on whether the target ID is part of a sub-band restricted range or not.

Private calls when the target and initiator are in the same zone are processed as follows:

- For private calls between two sub-band subscribers, both subscribers must have sub-band channel resources available in their respective sites for the call to be assigned.
- The controller rejects requests for private calls from sub-band restricted radios if the sub-band voice channels are not available due to failure.
- If either target or initiating subscriber is in a sub-band range, call processing assigns a sub-band channel at all sites in the call.
- If an initiating subscriber is unrestricted and the target is sub-band restricted, call processing issues a reject if there are no sub-band voice channel resources in service at the target location.
- If neither target nor initiating subscriber ID belongs to a sub-band range, call processing assigns a full band channel if available, otherwise a sub-band channel is assigned to the call.

Private calls when the target and initiator are in different zones are processed as follows:

- If either target or initiating subscriber is in a sub-band range in the User Configuration Server (UCS), call processing assigns a sub-band channel at the site in the zone containing the sub-band subscriber.
- If all sub-band channels at the sub-band users site are being used by other calls, the call receives a busy.
- A sub-band subscriber locked onto a sub-band Control Channel whose site has no sub-band voice resources in service causes a call to receive a reject when attempting to call the sub-band user.
- If an initiating subscriber is in a sub-band range in the UCS and the sub-band voice channels are not in service at its site due to failures, the sub-band subscriber receives a reject.
- If an initiating subscriber is not sub-band, but the target is sub-band, and a sub-band voice channel resource is not in service at the target subscribers zone, call processing rejects the call.
- Call processing assigns an unrestricted channel if available, otherwise a sub-band channel is assigned, if neither the target ID nor the initiating subscriber ID is part of the sub-band ranges in the UCS.

2.6.1.10
Emergency Alarm and Emergency Call

Emergency calls are processed as follows:

- If a site has only one sub-band channel and it is currently operating as the Control Channel, the controller allows the subscriber to affiliate but rejects any requests for an emergency call due to the lack of voice channels.

- Emergency alarms are processed through the Control Channel and do not require a voice channel. If a sub-band subscriber initiates an emergency alarm, the alarm processes normally.

2.6.1.11
Dynamic Regrouping

Call processing rejects a request to dynamically regroup a sub-band subscriber to a talkgroup that is not flagged as having sub-band members. However, a request to dynamically regroup an unrestricted subscriber to a talkgroup flagged as having sub-band members is processed based on the availability of resources.

2.6.1.12
Interconnect Calls

Processing interconnect calls are based on the ID of the individual radio. The system supports two types of interconnect calls:

- **Subscriber-to-landline**: Sub-band users performing subscriber-to-landline calls require a sub-band Control Channel and a sub-band voice channel. If there is only one sub-band voice channel at the sub-band users site and it is assigned to another call, a sub-band interconnect call request receives a busy. If a sub-band subscriber locks onto a sub-band Control Channel and that site has no sub-band voice channels in service, the zone controller records the subscribers registration but issues a reject to any requests for service from that subscriber.
- **Landline-to-subscriber**: A sub-band Control Channel and a sub-band channel are required when a landline initiates a landline-to-subscriber call involving sub-band users. The landline user receives a busy if all sub-band channels at the target site are being used by other calls. A sub-band subscriber locked onto a sub-band Control Channel whose site has no sub-band voice resources in service causes a landline to receive a reject message when attempting to call the sub-band user.

2.6.2
Site Trunking Mode of Operation – Sub-Band Restriction

The Site trunking mode of operation, as a fallback position to normal wide area trunking, always uses the Static Sub-band restriction method of channel utilization to optimize system performance. The Dynamic SBR (D-SBR) method of channel utilization is used by the Zone Controller in wide area trunking mode.

In ASTRO® 25 repeater sites, the site controller supports local programming through the Configuration/ Service Software (CSS) of up to 128 individual and talkgroup sub-band range tables. The site controller settings for the 128 ranges are used only in site trunking. The site controller handles sub-band channel user steering for talkgroups, private calls, and emergency calls in site trunking independent of the frequency band.

Local configuration of a channel as sub-band is done by the user at the site controller through CSS. The channel configuration is set by the user at the channel level at each site for any sub-band channel that needs to be set up at the site. Only sites intended to support sub-band channel users need to mark channels as sub-band. Default for the channel sub-band field is “Yes”.

2.6.3
Failsoft Mode of Operation – Sub-Band Restriction

Sub-band restricted radios must be programmed for repeater Failsoft frequencies that are within the sub-band restricted frequency range where the radio can operate. The Failsoft frequencies in use at the site and configured in both the sub-band restricted and not sub-band restricted radios must be from the common sub-band frequency range.

2.7
Flexible 700/800 MHz Mixed Site & Talkgroup User Operation

The Motorola Solutions Flexible 700/800 Mixed Site and Talkgroup User Operation capability, is sometimes referred to as Dynamic Sub-band Restriction (D-SBR). Dynamic Sub-Band Restriction (D-SBR) provides a solution to the problem where 700 MHz channels may be underutilized at sites that employ both 700 MHz and 800 MHz channels (mixed sites). This problem is solved by dynamically determining the type of channel resource needed at a site based on the type of sub-band radios that are registered at a particular site for the call. The D-SBR channel selection algorithm executes in the Zone Controller and complements the currently used Static Sub-Band Restriction (S-SBR) channel selection method. D-SBR can be used by the Zone Controller in wide area trunking mode and applies to both single zone and multi-zone ASTRO® 25 systems.

2.7.1
Static Sub-Band Restriction (S-SBR) – 700/800 MHz Mixed Site Scenario

For RF sites that support both 700 MHz and 800 MHz channels, when prior releases radios (those that can only operate at 800 MHz frequencies) and newer radios (those that can operate at both 700, and 800 MHz) are to be supported, the system must be able to make channel assignments so that the radios are assigned to a channel that it can support. The traditional method used for channel assignment in this environment is called Static Sub-Band Restriction (S-SBR).

Channel assignment for group calls using S-SBR is made based on the SBR status of the talkgroup. If an RF site supports both 800 MHz and 700 MHz channels, an 800 MHz channel will be assigned if the radios present at the RF site are affiliated with an SBR talkgroup. The problem with channel assignment based on S-SBR is that 700 MHz channels are underutilized due to the static nature of the channel selection algorithm based on configured SBR status.

Consider the following scenario: A talkgroup is configured as an SBR talkgroup since the talkgroup can contain both SBR and non-SBR affiliated radios. An RF site supports both 700 MHz and 800 MHz channels, and all the radios registered at this RF site are non-SBR radios (capable of both 700 MHz and 800 MHz operation). Based on the static S-SBR algorithm, an 800 MHz channel will be selected since the talkgroup is configured as an SBR talkgroup. However, since all the radios registered at this site are non-SBR radios, a 700 MHz channel could have been selected. This results in underutilized 700 MHz channels and an increased possibility that 800 MHz channels will not be available when needed.

2.7.2
Dynamic Sub-Band Restriction (D-SBR)

Sometimes referred to as Dynamic Sub-Band Restriction (D-SBR), the Motorola Solutions Flexible 700/800 MHz Mixed Site, and Talkgroup User capability provides for improved 700 MHz channel usage in systems having a large percentage of sub-band restricted radios in operation. Customers who want to expand their system to include 700 MHz channels to operate alongside 800 MHz channels and employ a mix of both SBR radios and non-SBR radios benefit from this feature. While this solution is specifically targeted for 700/800 systems, the solution also applies to other bands such as VHF and UHF.

2.7.2.1
Dynamic Sub-Band Restriction – Capabilities

Flexible 700/800 MHz Mixed Site & Talkgroup User capability defines a dynamic sub-band restriction (D-SBR) channel selection algorithm which determines the channel to assign at an RF site based on the capabilities of the radios that are present at the site rather than the SBR status of the talkgroup that they are affiliated with. By assigning a channel that matches the capabilities of the radios registered at the site, more efficient usage of the channels can be achieved resulting in fewer calls that are queued due to busy channels.

The SBR Talkgroup and SBR Individual Radio ID tables are used by S-SBR to make channel selection decisions. The SBR Individual Radio ID table can also be used by D-SBR to make channel selection decisions. There are up to 128 ranges of individual radio IDs and 128 ranges of talkgroup IDs that can be defined containing SBR status.

To accommodate customers whose systems do not contain mixed sites with SBR and non-SBR channels or do not contain a mixture of SBR radios and non-SBR radios, a mechanism to enable/ disable the usage of D-SBR on a talkgroup/multigroup basis is provided. In situations where examination of the SBR status of each radio registered at a site is not necessary, D-SBR can be left in the disabled state and the system continue to use existing methods for channel selection.

Flexible 700/800 MHz Mixed Site & Talkgroup User capability addresses the scenario that occurs when an SBR radio loses the signal at its current site during a voice call and roams into another site and registers. If its newly selected site has a non-SBR channel assigned to that talkgroup call, the talkgroup call becomes transmission trunked and be reassigned a sub-band channel upon the next PTT.

2.7.2.2

Dynamic Sub-Band Restriction – Considerations

Transmission trunking a talkgroup call causes the call to be torn down when the active talker de-keys without waiting for the hold time-out or immediately if the call is in hold time-out. Considerations need to be understood regarding the impact to the radio user as follows:

- The roaming SBR radio user may experience an audio gap after switching sites before the call is transmission trunked and an SBR channel can be assigned on the next PTT. The duration of the audio gap depends on the amount of time that elapses between the SBR radio registering at the new site and the active talker dekeying.
- A busy condition may be encountered if an SBR channel is not available upon the next PTT following transmission trunking.

Improvements in channel utilization realized through the usage of D-SBR may be considered an “acceptable trade-off” when the considerations are understood regarding possible impact to the radio user.

2.7.2.3

Dynamic Sub-Band Restriction – Call Types Supported

To maximize channel utilization improvement, while minimizing or preventing any adverse effects that may be caused by D-SBR, usage of D-SBR is limited to a normal group calls since these types of calls make up most calls in the ASTRO® 25 system.

The D-SBR channel selection algorithm can be used for the following types of group calls:

- Single Talkgroup calls
- Multigroup calls
- Supergroup calls

Channel selection for other types of calls continues to be achieved using current methods, including S-SBR, for various reasons. These call types and the rationals for not using D-SBR for channel selection are as follows:

- Channel selection for IV&D data calls utilizes a configurable parameter to determine the type of channel requested. As a result, D-SBR is not used for IV&D data calls; its usage is limited to voice calls only.
- Unit to Unit calls continue to use the current, traditional method of channel selection. If at least one member of the Unit to Unit call is SBR, then an SBR channel is selected at all sites involved. Using

D-SBR for this type of call may result in the call needing to be transmission trunked following a roaming scenario. Since the call setup procedure for these calls requires user interaction which would be objectionable if the call needs to be re-setup following transmission trunking, D-SBR is not used for Unit to Unit calls.

- Telephone Interconnect calls continue to use the current S-SBR algorithm since the channel selected for the radio is based on the SBR status of the radio.
- Emergency calls continue to use the current S-SBR algorithm. These calls have an extended hang time to ensure that the radios remain on the channel and avoid the possibility of missing audio. If an SBR radio roams into a site during an emergency call that is on a non-SBR channel, the roaming radio could miss significant important audio because it cannot join the call until an SBR channel can be assigned. It is for this reason that emergency calls do not use the D-SBR channel selection algorithm.
- Calls that are initiated while an RF site is in Site Trunking mode also continue to use the S-SBR algorithm. D-SBR is only used by the Zone Controller in wide area trunking mode.

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Chapter 3

Fleetmapping Technical Overview

This chapter provides an introduction and technical overview of fleetmapping and associated organizational requirements and considerations for an ASTRO® 25 radio system.

3.1 Fleetmapping Introduction

The Motorola Solutions ASTRO® 25 system is a complex and sophisticated multizone wide-area communications system. To maximize its benefits, you must properly plan for, set up, and manage your system. The Motorola Solutions engineering team works with your organization to plan, and set up your system. Accurate operational requirements are needed to ensure a successful system plan. By properly configuring the ASTRO® 25 system to meet your operational needs, your organization has the most efficient and effective communications system available.

If your system is already installed and operational, you need to understand the requirements of your system and plan for system expansion and changes as the needs of your organization continue to change.

NOTICE: The ASTRO® 25 system can support both APCO-compliant Phase 1 FDMA calls and Phase 2 TDMA calls. Trunked TDMA supports all call types that are supported by trunked FDMA. FDMA-only radios or radios at FDMA-only sites can interact with Dynamic Dual Mode (FDMA/TDMA) capable subscribers. ASTRO® 25 systems can use Phase 2 TDMA.

3.2 Organizing Your System

You can maximize the communication effectiveness of your system by translating the operation requirements of your organization into a list of supported features. The result of identifying and formalizing this information is often referred to as fleetmapping.

3.3 Fleetmapping Overview

Fleetmapping is the process of configuring the features and programming parameters of a system to function according to the unique operational requirements of each participating agency. Fleetmapping can be thought of as:

- Assigning talkgroups to the radios issued to personnel.
- Assigning talkgroups to the dispatcher control positions.
- Defining the feature subsets available to the personnel using the radios and dispatcher control positions.

A fleetmap determines how the radio communications for each user group of an organization is controlled. Through controlling communications between different user groups and between individuals within a group, the radio communications system resources are used efficiently.

Fleetmapping also provides a structured approach to the management of many radio users and provides the opportunity to plan for expansion or changes within an organization.

One of the key benefits of ASTRO® 25 system trunking is the way users can be organized. Most ASTRO® 25 system radio users are organized into talkgroups, multigroups (also known as announcement groups in radio programming), and agencygroups.

- A talkgroup is a group of radios that can share calls and messages as a group. The normal communications of a talkgroup do not require interaction with other talkgroups. Typically, the radio user communicates with members of their own talkgroup.
- A multigroup is a group of talkgroups. Multigroups usually comprise talkgroups that have a common functional responsibility.
- An agencygroup is a group of multigroups that periodically need to interact with each other.

For ASTRO® 25 system hardware that supports AMBE vocoding (for example, base radios, consoles) for Dynamic Dual Mode (FDMA/TDMA) operation, talkgroups, and multigroups are designated with one of the following Access Types: FDMA-only, TDMA-only, or Dynamic. See the *Call Processing and Mobility Management* manual for more details.

3.3.1 Talkgroup Call between ASTRO 25 Radios and 3600 Radios

The ASTRO® 25 radio system has one fleetmap and all radios on the system must have a unique individual ID within the ASTRO® 25 system fleetmap. Additionally, all talkgroups on the system must have a unique talkgroup ID within the ASTRO® 25 system fleetmap.

Therefore, if more than one trunked system is being connected to a single ASTRO® 25 system network, then the system fleetmap must be coordinated such that there are no overlapping IDs used among the various user groups.

An ASTRO® 25 system has an ID range of 1 to 16,777,215, but only has capacity to support 128,000 individual IDs within this range. A 3600 radio only understands an ID range of 1 to 65534. If the ID assigned to an ASTRO® 25 system radio or console is greater than 65534, then it cannot Private Call or Call Alert a 3600 radio and the PTT-ID of the ASTRO® 25 system radio or console does not appear on the display of a 3600 radio.

For maximum interoperability among 3600 and ASTRO® 25 radios, they should be programmed within the 3600 individual ID fleetmap range which is 700001 to 765534 excluding 708128 to 708191.

NOTICE: Individual IDs appear in the ASTRO® 25 system Provisioning Manager database with the corresponding ID as in 3600 SmartZone® system without the initial “7”. That is 00001 to 65534 excluding 08128 to 08191.

An ASTRO® 25 system has capacity to support 16,000 talkgroup IDs. These 16,000 talkgroup IDs can be selected from a range of 1 to 64,000 talkgroup IDs.

A 3600 radio only understands an ID range of 4,095 talkgroup IDs, from 1 to 4,095. Therefore, for any talkgroup that must operate on a 3600 site and include 3600 radios, the talkgroup ID must be in the range of 800001 to 804095 (800508 to 800511, and 804095 are reserved talkgroup IDs).

NOTICE: If the talkgroup is a TDMA-only talkgroup (for example, talkgroup used exclusively at ASTRO® 25 system sites), it can be in the entire range of 64,000 talkgroup IDs.

For talkgroups that provide interoperability between 3600 and ASTRO® 25 system radios, a talkgroup in the 1 to 804095 range must be used so that both 3600 and ASTRO® 25 system radios can receive the call signaling.

NOTICE:
The 3600 sites do not support TDMA talkgroups. When a talkgroup call that includes both ASTRO® 25 TDMA Dynamic Dual Mode (DDM) site and 3600 (FDMA) sites is initiated, the zone controller changes the call to a FDMA-only call. The entire call operates in FDMA mode on the DDM site. The 3600 sites and/or users cannot participate in a talkgroup that is assigned as TDMA-only in Provisioning Manager. For full individual service support, fulfill the following conditions:

- The 3600 sites and/or subscribers IDs have to be within the range from 1 to 65 534, excluding values from 8128 to 8191.
- The radios at the 3600 sites or interacting with the 3600 site (console or ASTRO® 25 system subscribers) have to be in the specified range, otherwise the request are denied.
- If a talkgroup service is initiated by a subscriber outside the range (mentioned in the first bullet of this list) and a radio on a 3600 site receives the service, then the receiving radio does not display the source radio ID, but plays the voice.

3.4
Talkgroups, Multigroups and Agencygroups

Assigning radios into trunking or conventional radio groups helps the dispatcher to manage calls.

A talkgroup is a group of radios that can share calls and messages as a group. The normal communications of a talkgroup do not require interaction with other talkgroups. Typically, the radio user communicates with members of their own talkgroup.

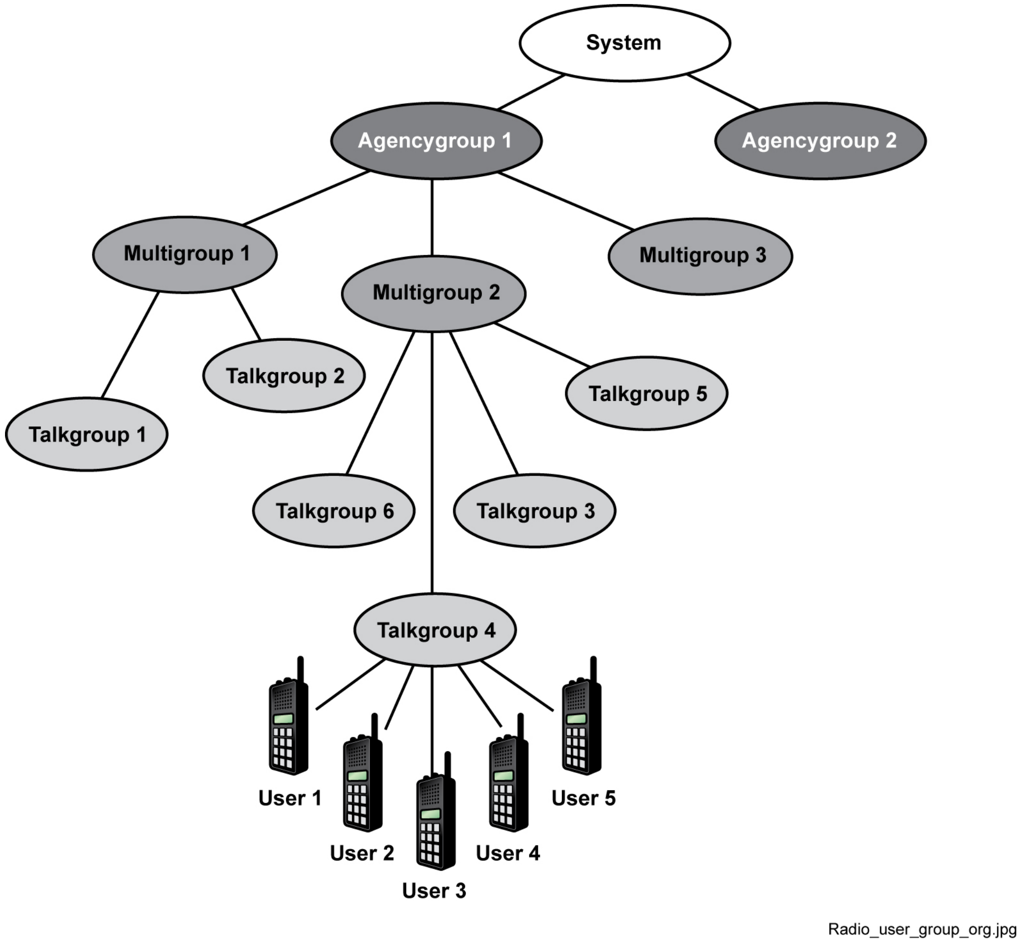
A multigroup is a group of talkgroups. Multigroups are made up of talkgroups that have a common functional responsibility.

An agencygroup is a group of multigroups that periodically need to interact with each other.

NOTICE: A talkgroup can only belong to one multigroup. A multigroup can only belong to one agencygroup.

The following figure shows how radios, talkgroups, multigroups, and agencygroups are organized within a system.

Figure 2: Radio User, Talkgroup, Multigroup, and Agencygroup Organization



In conventional two-way radio technology, a channel is equivalent to a talkgroup and is created by assigning a different frequency to each agency or group. For example, a municipality may have separate repeaters on different frequencies for its police, fire, and public works departments. In conventional two-way radio, only users with large systems can afford to devote separate channels for each talkgroup.

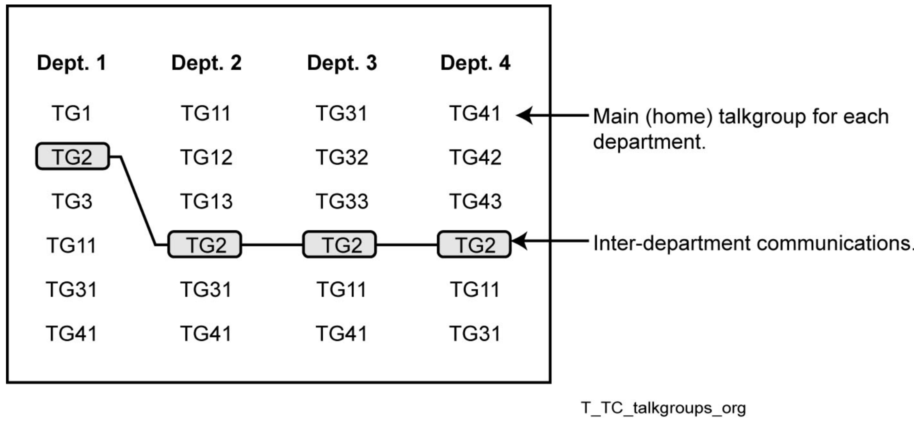
Trunking provides a much more dynamic and economical means of organizing talkgroups.

Conventional talkgroups are similar to trunking talkgroups for the console operator and subscriber user. They are both talkgroup based grouping mechanisms, and the voice transmissions are the same. See the *Conventional Operations* manual for Conventional Talkgroups.

An example of a talkgroup might be the maintenance section of a public works department. An example of a multigroup might be the public works department. An agencygroup may, for example, consist of a group of all special services multigroups.

The following figure shows an example of how four departments can be divided into talkgroups. The main (or home) talkgroup for each department is shown across the top. In addition to their main (home) talkgroups, other talkgroups can be assigned to the user radios to support inter-department communications.

Figure 3: Example of Talkgroups in an Organization



To maximize the efficiency of your ASTRO® 25 system, it is important that your organization accurately identifies the various radio users and their associated talkgroups, multigroups, and agencygroups.

Motorola Solutions suggests the use of a spreadsheet program such as Microsoft Excel to assist you in developing your fleetmap. A spreadsheet program provides flexibility to create a fleetmap that can be easily updated and quickly sorted for analysis. In addition, fleetmapping forms can be used as an aid for capturing your fleetmapping requirements.

3.5

Organizing Your Fleetmap

Identifying the needs of your organization is necessary while planning a fleetmap.

Some of the factors to consider when creating or planning changes to the fleetmap are:

- Identifying a functional fleetmap design team
- Identifying radio users
- Organizing radio users into talkgroups
- Organizing talkgroups into multigroups
- Organizing multigroups into agencygroups
- Assigning IDs and aliases
- Identifying home zones
- Identifying priority levels

Other factors to consider when creating or planning changes to the fleetmap are covered in Fleetmapping Configuration on page 97. These factors include:

- Determining feature assignments
- Determining secure voice requirements
- Determining data services requirements
- Organizing P25 band plan identifiers
- Determining system access requirements
- Determining subscriber programming requirements

3.5.1
Identifying a Functional Fleetmap Design Team

To develop a fleetmap, form a design team of key representatives from your system managers, technicians, and operators to create plans that are most effective for radio users and system operators.

3.5.2
Identifying Radio Users

Determine your organizational structure from the perspective of a radio user to establish a fleetmap. Consider the needs of both portable and mobile radio users. The following table shows an example of how radio users can be distributed in an organization.

Table 24: Radio Users

Dept	Sub-Dept	User Name
Operations	Dept. Head	Casey
	Assistant	Zembrow
	Control Room	Control Room
	Tactical	Rogan
	Tactical	Reed
	Tactical	Willis
Maintenance	Dept. Head	Gerard
	Roads	Garcia

3.5.3
Identifying Data Services Users

Determine your organizational structure and requirements from a data users perspective to establish a fleetmap. Consider the needs of both portable and mobile radio users.

Typical considerations data users must evaluate include but are not limited to:

- How many data users are there?
- How is roaming being implemented?
- How many talkgroups are there and what are their relative sizes?
- How many zones are there?
- Are some sites denied to particular users?
- How are permissions and IDs allocated?

3.5.4
Organizing Radio Users into Talkgroups

Once you have identified all individual users, identify, and define any functional group of radio users who need to use the system to communicate with each other regularly. These functional groups of radio users are the foundation of establishing talkgroups.

Keep in mind the following points as you organize a functional group of radio users into talkgroups:

- A larger number of talkgroups with few users often requires a greater number of channels.
- Talkgroups with many users often use channels at a greater number of sites.

- Other factors that can affect the number of talkgroups in your system include:
  - Geographic coverage requirements. Each site with an affiliated user requires a channel for a single talkgroup call.
  - Frequency of subscriber conversations on the system.
  - Console operator monitoring talkgroup requirements.
  - Type of infrastructure being employed by radios users such as DDM-capable (FDMA/TDMA) subscriber radios and the capability of the sites to support Dynamic Dual Mode operation.

NOTICE: The system does not allow an FDMA-only radio to be dynamically regrouped to a TDMA-only talkgroup. See the *Radio Control Manager* manual for details.

When using classic conventional channels, conventional talkgroups configured in the infrastructure are not assigned to only one channel. The console transmits this Talkgroup ID used on the air interface. There is no talkgroup separation on receive at the console.

When using conventional talkgroup channels, the talkgroups are assigned to a conventional talkgroup channel. Such talkgroups cannot be used on a different conventional talkgroup channel or be used for trunking. Each conventional talkgroup channel uses a unique set of talkgroups so there is no overlap between conventional talkgroup channels. There is no control channel used with conventional talkgroups. The talkgroup being used is indicated at the start of digital voice transmission. See the *Conventional Operations* manual for Conventional Talkgroups.

All conventional radio and talkgroup IDs using conventional talkgroup channels must be home IDs. All talkgroups on a conventional channel are recommended to be home to the zone that maintains the connection to the conventional channel.

When migrating from a conventional channel, assign a talkgroup for every conventional user group accessing the channel that you are replacing. If user groups can justify more talkgroups, you can assign the available talkgroup resources.

Determine the traffic patterns of individual users so that zone, site, and talkgroup assignments can be associated with each user. Your talkgroup organization may be different than the formal reporting structure of your organization. See the following table.

Table 25: Radio Users and Talkgroups

Dept	Sub-Dept	User Name	Talkgroup
Operations	Dept. Head	Casey	TG-1
	Assistant	Zembrow	TG-1
	Control Room	Control Room	TG-1
	Tactical	Rogan	TG-2
	Tactical	Reed	TG-2
	Tactical	Willis	TG-2
Maintenance	Dept. Head	Gerard	TG-1
	Roads	Garcia	TG-3

Certain users may need to communicate with talkgroups other than their primary talkgroup. Identify those individuals and the corresponding talkgroups. This can be done as part of your spreadsheet program.

For example, the radio users (subscribers) would be listed in the left-hand column underneath the names of the talkgroup to which the individual users belong. Later, the rows across the top of the spreadsheet may be used to indicate the various channel selector positions on the radios to which each of the talkgroups is assigned. For each user, an "X" is placed under the talkgroup with which the user must communicate.

When organizing your ASTRO® 25 system, remember that individual users, radios, talkgroups, multigroups, and agencygroups all have different requirements. Subsequently, they also have different parameters associated with them. See the following table.

Table 26: Radio Users and All Assigned Talkgroups

User	TG-1	TG-2	TG-3	TG-4	TG-5
Talkgroup 1					
Casey		X	X	X	X
Zembrow		X	X	X	X
Control Room		X	X	X	X
Gerard			X	X	X
Talkgroup 2					
Rogan					
Reed					
Willis					
Talkgroup 3					
Garcia				X	X

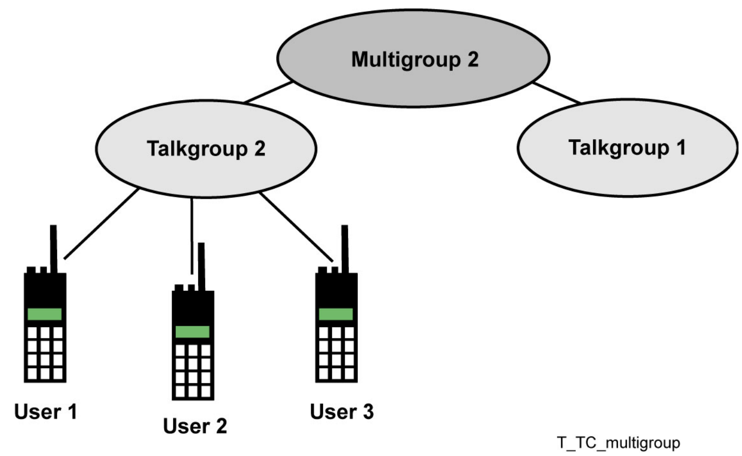
3.5.5

Organizing Talkgroups into Multigroups

A multigroup (also known as an announcement group) is a group in which two or more talkgroups are combined.

Based on the considerations for organizing talkgroups, establish your multigroups. Consider those groups of people who may occasionally need to hear a message from a single manager or supervisor. A talkgroup can only belong to one multigroup in an ASTRO® 25 system. However, not all talkgroups have to be in multigroups. The following shows an example of how a multigroup is organized.

Figure 4: Talkgroups Organized into a Multigroup

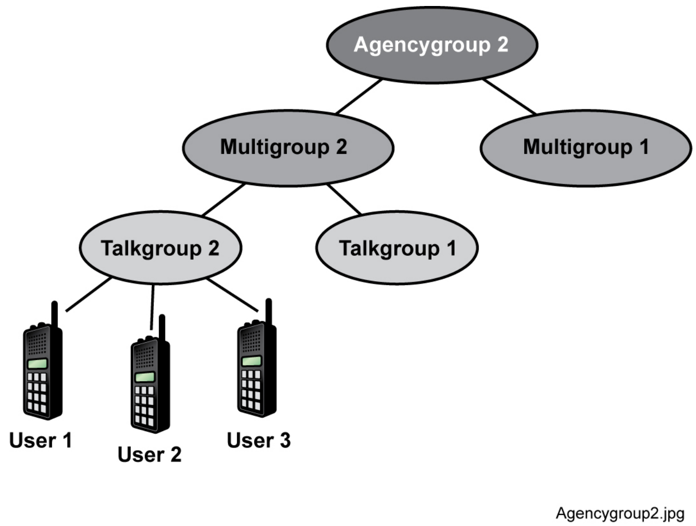


NOTICE: Each multigroup can support a maximum of 15 talkgroups.

3.5.6
Organizing Multigroups into Agencygroups

An agencygroup consists of up to 16 multigroups. Based on the considerations for organizing multigroups, establish your agencygroups. A multigroup can only belong to one agencygroup in an ASTRO® 25 system. However, not all multigroups have to be in agencygroups. The following shows an example of how an agencygroup is organized.

Figure 5: Agencygroup



NOTICE: Each agencygroup can support a maximum of 16 multigroups.

3.5.7
Assigning IDs and Aliases

Each radio, talkgroup, multigroup, agencygroup, conventional talkgroup, and console in the system must have a unique ID number and alias.

3.5.7.1
Identifying Radio IDs

Radio IDs for an ASTRO® 25 system range between 1 and 16,777,211. The following table lists the reserved numbers.

Table 27: Reserved ID Numbers

Reserved Number	Description
16,777,212	Radio Control Manager (RCM) as a system-wide ID
16,777,213	System default ID
16,777,214	Registration
16,777,215	All units*
16,777,217	SZ$DEF record

* Note that this number is reserved in TIA standards but the ASTRO® 25 system does not support “all unit” or “system wide” calls.

NOTICE: The Unit ID is a number from 1 to 16,777,211 that uniquely identifies each radio. The Unit ID represents the radio assigned to a dispatch application (or Archiving Interface Server application) that the console user uses to communicate with other resources in the system. This Unit ID must be unique among all console users on the system.

As a general practice, create contiguous ID ranges, but allow room for future expansion. In the following table, the fire department has a current requirement for 1200 IDs. However, the department may need up to 2000 IDs in 12 months. Assigning the IDs during planning saves future re-programming of radios and subscriber records.

Table 28: Example of ID Ranges

Range of IDs	Group
1-2000	A County
3000-4000	B County
5000-6000	Police Department
10,000-12,000	Fire Department
20,000–25,000	Data Service Users
25,000–27,000	Foreign Subscribers

To support automatic roaming of foreign subscribers onto an ASTRO® 25 network, a range of subscriber IDs needs to be reserved for use by the roaming subscribers. IDs are assigned when foreign subscribers register. Enough IDs are needed to support twice the maximum number of foreign subscriber units on the system at the same time. (When the system runs out of reserved IDs, additional foreign subscribers cannot register on the system).

Radio ID ranges are defined in the Radio ID Home Zone Mapping object in the Provisioning Manager application. All systems (single or multiple zone) require range definitions.

Two types of radio ID ranges are available to support roaming subscribers:

- **Working ID Range** – a range of individual IDs reserved for temporary allocation to foreign subscribers that roam into this system. Foreign subscribers are those with a Subscriber Unit ID that has a WACN and/or System ID that is different from the current system. The individual IDs in this range do not have a Radio User or Console User record in the local database.
- **Foreign ID Range** – a range of individual IDs which are home to another system. This is used when two systems share WACN/System ID but each system owns one or more ranges of the individual ID space. The only configuration where foreign IDs are supported is when a Console Subsystem Interface (CSSI 8000) is used to connect third party consoles to the ASTRO® 25 system. The consoles in the console system require a range of individual IDs to assign to the third-party consoles. The individual IDs in this range do not have a Console User record in the local database.

NOTICE: Reserve the range early to avoid re-programming subscribers.

NOTICE: Roaming of foreign subscribers is supported in configurations with the ISSI 8000/ CSSI 8000 solution, which allows an ASTRO® 25 system to communicate with other P25-compatible systems (ASTRO® 25 or third party). See the *ISSI 8000/CSSI 8000 Intersystem Gateway Feature Guide* manual for details.

3.5.7.2
Identifying Talkgroup, Multigroup, Agencygroup, and Conventional Talkgroup IDs

Group IDs consist of an 8-digit decimal number beginning with 80,000,001. Talkgroups, Multigroups, Agencygroups, and Conventional Talkgroups are created from the same pool of 8-digit decimal numbers. The following table lists the reserved numbers for talkgroups, multigroups, agencygroups, and conventional talkgroups.

Table 29: Reserved Group ID Numbers

Reserved Number	Description
80,000,000 80,065,535 and greater	Reserved for system purposes.
80,065,535	Reserved for addressing all groups in a zone-wide call. **NOTICE:** APCO Project 25 reserves this number, but a Motorola Solutions ASTRO® 25 system does not support system-wide calls.
80,065,537	Reserved for the SZ$DEF default record.

NOTICE: You can create a combined total of 16,000 talkgroups, multigroups, and agencygroups IDs on a system using this set of decimal numbers. They can be anywhere in the range from 80,000,001 to 80,065,534.
For conventional talkgroup ID limitations, see the *Provisioning Manager* manual.

To support affiliation of subscribers/dispatchers to foreign talkgroups on an ASTRO® 25 network reserve a range of group IDs for use by the foreign talkgroups. IDs are assigned when a foreign talkgroup is first affiliated on the system. Enough IDs are needed to support twice the maximum number of foreign talkgroups on the system at the same time. When the system runs out of reserved IDs, more foreign talkgroups cannot register on the system.

Talkgroup ID ranges are defined in the Home Zone Map object in the Provisioning Manager application. All systems (single or multiple zone) require range definitions.

NOTICE: Reserve the range early to avoid re-programming subscribers.

NOTICE: Affiliation of subscribers and dispatchers to foreign talkgroups is supported in configurations with the ISSI 8000 solution, which allows an ASTRO® 25 system to communicate with other P25-compatible systems (ASTRO® 25 or third party). See the *ISSI 8000/CSSI 8000 Intersystem Gateway Feature Guide* manual for details.

3.5.7.3
Identifying Console IDs

MCC 7500 consoles only require a single unique unit ID that can be used for all the talkgroups on that MCC 7500 console.

3.5.7.3.1
Console ID Assignments in MCC 7500 Console Sites

Each dispatch console in the MCC 7500 subsystem is identified by two unique IDs which are assigned in the Provisioning Manager application. The two unique identifiers are:

Dispatch Console ID – used by the network management configuration and fault reporting applications to uniquely identify the physical dispatch console. It is also used to identify the dispatch console when the dispatch console operate on a conventional radio channel. There is one, and only one, Dispatch Console ID associated with a dispatch console.

NOTICE: The Dispatch Console ID is a unique number from 1 to 563. This is the identifier for a console within a given zone that you configure using Provisioning Manager. See the *Provisioning Manager* manual for more information on configuring the parameters.

Trunking System Unit ID – used by the trunking system to uniquely identify the physical dispatch console when the dispatch console operate on a trunked talkgroup or private call, as well as uniquely identify the radios used in the trunking system when they operate on a trunked talkgroup or private call.

For conventional talkgroups, Conventional Unit ID that defines the console is taken from the Trunking System Unit ID range. Consoles can use the same IDs for transmitting with both, conventional talkgroups and trunked talkgroups. Therefore consoles can dynamically change from transmitting on a conventional TG to transmitting on a trunking TG without switching IDs.

NOTICE: The range of possible Unit ID numbers is 1 to 16,777,211. For conventional talkgroups, avoid using IDs greater than 10,000,000. See the *Provisioning Manager* manual for more information.

3.5.7.3.2
Alias Assignments in MCC 7500 Console Sites

Every Dispatch Console ID and Trunking System Unit ID also has an alias associated with it. Aliases are typically names or words that describe the user or the physical unit, and they are used in the radio system to make the various interactions more user-friendly. For example, when a radio user transmits on a trunked talkgroup, the alias associated with the Trunking System Unit ID of the radio (rather than the Trunking System Unit ID itself) is displayed on the dispatch console, so the dispatcher can see who is transmitting. When a Dispatch Console ID or Trunking System Unit ID is created in the network management subsystem, a default alias is automatically created for it.

NOTICE: The alias can be up to 16 characters, and the characters |, @, _, ", , ', and % cannot be used. Cannot prefix with SZ$ or ZC$ (in any case size combination).

Alias information for the dispatch console is sent to the console subsystem from the network management subsystem. Provisioning Manager transmits user aliases to the console subsystem, and Unified Network Configurator (UNC) transmits hardware aliases. See the *Provisioning Manager* and *Unified Network Configurator* manuals for details on how aliases are downloaded from the network management subsystem.

The user may edit the default aliases to make them more meaningful. For example, the user may change a Dispatch Console ID alias to “Fire Dispatch 1” or a radio Trunking System Unit ID alias to “Lt. Vasquez”. Because there are two IDs associated with a dispatch console, it is possible for the two aliases to be different. Depending on how the user wishes to use the dispatch console, it may be advantageous to make the two aliases identical. For example, the Dispatch Console ID alias and Trunking System Unit ID alias for a particular dispatch console may both be changed to “Fire Dispatch 1”. This allows parallel dispatch consoles to see the same alias whether the dispatcher transmits on a conventional resource or on a trunking resource. Both aliases must be changed to do this. Changing only one of the aliases does not automatically change the other. Each console logging recorder also requires a unique ID, so that the resources that must be recorded may be programmed.

3.5.7.3.3
Assigning Radio Aliases

You can assign an alias to each radio user.

MCC 7500 console aliases are configured in PM only.

Although anything can be used as an alias, when assigning aliases for each radio user, the users last name is often used. Since unique names are required, no two radio users may have the same alias. The following table shows examples of radio user aliases.

Table 30: Radio User Alias

Last Name	First Name	Alias	User Priority Level
Casey	Jim	Casey	10
Zembrow	Bob	Zemb	10
Rogan	Kyle	Rogan	10
Reed	Josh	Reed	10
Willis	Frank	Willis	10
Gerard	Phil	Gerard	10
Garcia	Manny	Garcia	10
Kelly	Susan	Kelly	10
Stack	Dave	Stack	10
Kriener	Rich	Kriener	10

3.5.7.3.4

Assigning Talkgroup, Multigroup, and Agencygroup Aliases

Name your talkgroup, multigroup, agencygroup, and conventional talkgroup aliases consistently in Provisioning Manager (PM), and subscribers throughout the system. Display radios and consoles identify talkgroups by alias. Name your talkgroups, multigroups, agencygroups, and conventional talkgroups with the alias you would like displayed. Consider any character limitations when assigning aliases.

NOTICE: In PM, the talkgroup, multigroup,agencygroup, and conventional talkgroup alias can each be up to 16 characters. The characters * and ? cannot be used. If you want talkgroup aliases to be consistent across PM, consoles, and subscribers, be aware of subscriber limitations. Some radio models may allow more or fewer characters than PM or consoles. The following table shows an example of talkgroup aliases.

Table 31: Example of Talkgroup Alias

Dept.	Sub-Dept	User Name	Talkgroup	Talkgroup Alias
Operations	Dept. Head	Casey	TG-1	OPS1
	Assistant	Zembrow	TG-1	OPS1
	Control Room	Control Room	TG-1	OPS1
	Tactical	Rogan	TG-2	TAC
	Tactical	Reed	TG-2	TAC
	Tactical	Willis	TG-2	TAC
Maintenance	Dept. Head	Gerard	TG-1	OPS1
	Roads	Garcia	TG-3	ROADS
	Roads	Kelly	TG-3	ROADS

Table continued…

Dept.	Sub-Dept	User Name	Talkgroup	Talkgroup Alias
	Parks	Stack	TG-4	PARKS
	Parks	Kriener	TG-4	PARKS

You can assign multigroup ID numbers and aliases in a similar manner as you do for talkgroup IDs. However, be aware of the home zone of the associated talkgroups when configuring multigroups. All talkgroups in a multigroup must have the same home zone. See Identifying Home Zones on page 92 for more information.

The following table shows the multigroup alias relationships with their associated talkgroups.

Table 32: Multigroup Alias

Multigroup Alias	Multigroup ID Number	Talkgroup Alias	Talkgroup ID Number
CORP	80000011	EDS	80000003
		HR	80000515
OPS	80000512	OPS1	80000516
		OPS2	80000517
MAINT	80000015	PARKS	80000009
		ROADS	80000010
N/A (talkgroup not in a multigroup)	N/A (talkgroup not in a multigroup)	FC1	80000005
		FC2	80000513

You can assign agencygroup ID numbers and aliases in a similar manner as you do for talkgroup and multigroup IDs. All multigroups that are assigned to the agencygroup must have the same home zone as the agencygroup. See Identifying Home Zones on page 92 for more information.

The following table shows the agencygroup alias relationships with their associated mulitgroups.

Table 33: Agencygroup Alias

Agencygroup Alias	Agencygroup ID Number	Multigroup Alias	Multigroup ID Number
SERV	80050001	CORP	80000011
		OPS	80000512
		MAINT	80000015
SPEC	80050002	SPEC1	80000061
		SPEC2	80000062

3.5.8

Identifying Home Zones

An ASTRO® 25 system offers great flexibility in handling radio users communication across a wide area where communication boundaries are transparent to the radio user.

To provide and maintain this flexibility, it is important to understand radio user mobility patterns to effectively design and set up the system. Mobility patterns influence the allocation of sites to a given zone, the number, and type of channels at a site, the location of console positions, logging recorders, core routers, and network management (NM) clients.

To determine the allocation of sites to a zone, a number of variables must be considered. In addition to assigning radio users to talkgroups, another important consideration is to determine the most important talkgroups that would use each site. Understanding the location of most radio users and monitoring consoles of a talkgroup influences the selection of the home zone for that talkgroup or other such system resource.

A home zone is a zone assigned to a particular ID, such as a radio user ID (subscriber or console user), a talkgroup ID, multigroup ID, agencygroup ID, or conventional talkgroup ID. Each ID is assigned to a zone based on ID ranges configured using the Home Zone Map object in the Provisioning Manager (PM) application.

The User Configuration Server (UCS) and the PM application provide a single and centralized point of data entry to prevent any mismatched records when establishing home zone data. Once the data is entered in to PM, the complete database is downloaded through UNC to the zone controllers. The zone controllers use this information to establish their Home Location Register (HLR). The HLR is a zone-specific database supporting call processing and mobility management for the system.

IMPORTANT: In order to avoid improper system operation, assign Talkgroup Home Zone Map ranges that include Conventional Talkgroups to the zone which contains the Conventional Talkgroup Channel to which the Conventional Talkgroup is assigned.

3.5.8.1

Home Location Register

The HLR of a zone is a database that contains information for subscriber radios and talkgroups that have home zone assignment to that zone. This information includes:

- Privileges and capabilities of radios
- Current zone location of radios
- Talkgroup affiliation of radios
- Capabilities of talkgroups
- Current zone location of talkgroups

NOTICE: All talkgroups in a multigroup must have the same home zone. All multigroups in an agencygroup must have the same home zone.

3.5.8.2

Importance of Home Zone Assignments

Three basic principles are associated with ASTRO® 25 system call processing that leads to the requirement of home zone assignment:

- Distribution of call processing: The zone controllers communicate between themselves when setting up and supporting calls. No centralized physical device processes all multiple zone calls.
- Distribution of responsibility: Each zone in the system is responsible for activities within its zone. If a multiple zone call occurs, each zone controller is responsible for obtaining the necessary resources within its zone to support the multiple zone call. Each zone controller is also responsible for assigning the necessary resources in its zone for routing audio to the appropriate resources within its zone.
- Single point of control: One zone is assigned to have overall control of a call and is called the controlling zone. The determination of the controlling zone is based on the type of call-such as group calls or individual calls.
  - For group calls, the controlling zone is the home zone of the group.

- For private calls, the controlling zone is the current zone of the initiator of first audio.
- For interconnect calls, the controlling zone is the zone containing the media gateway used for the call.

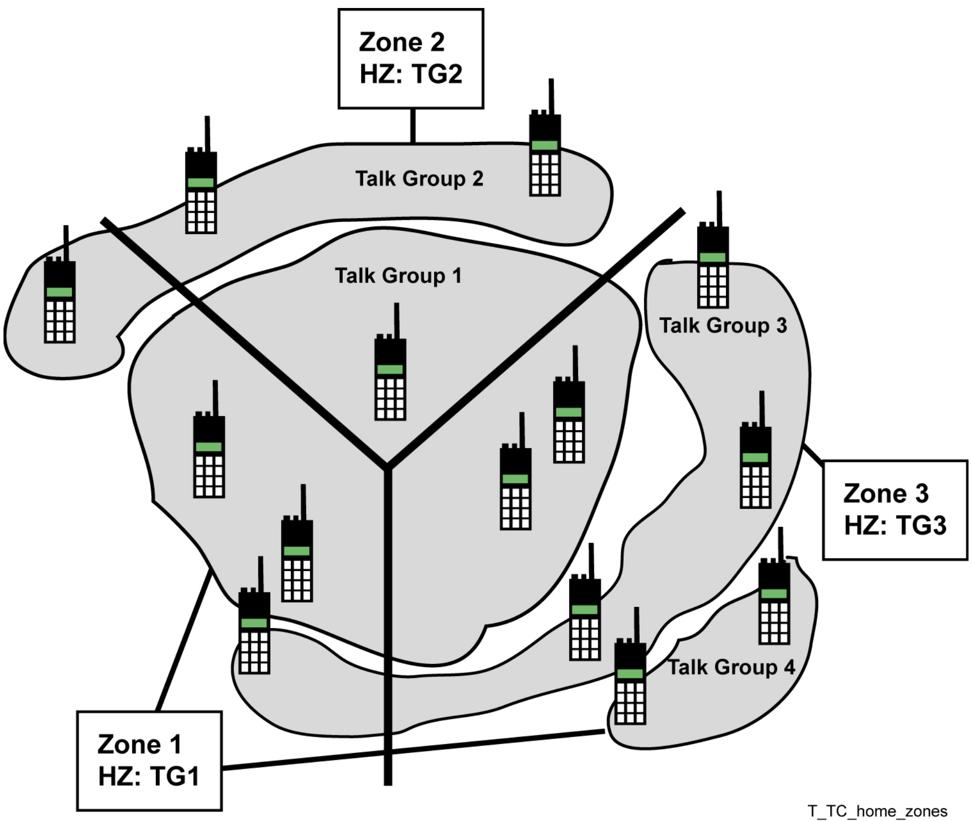
3.5.8.3
Home Zones for Talkgroups and Subscribers

The home zone of a talkgroup is the zone that is responsible for controlling all group calls of the talkgroup, and is the location where the talkgroup attributes are stored.

The home zone of a subscriber radio is the location where the subscriber radio attributes can be retrieved. It may not necessarily be the controlling zone of the subscriber radio individual calls.

As a rule, assign subscriber radios to a closely aligned home zone. The following shows an example of home zone assignment.

Figure 6: Example of Home Zones



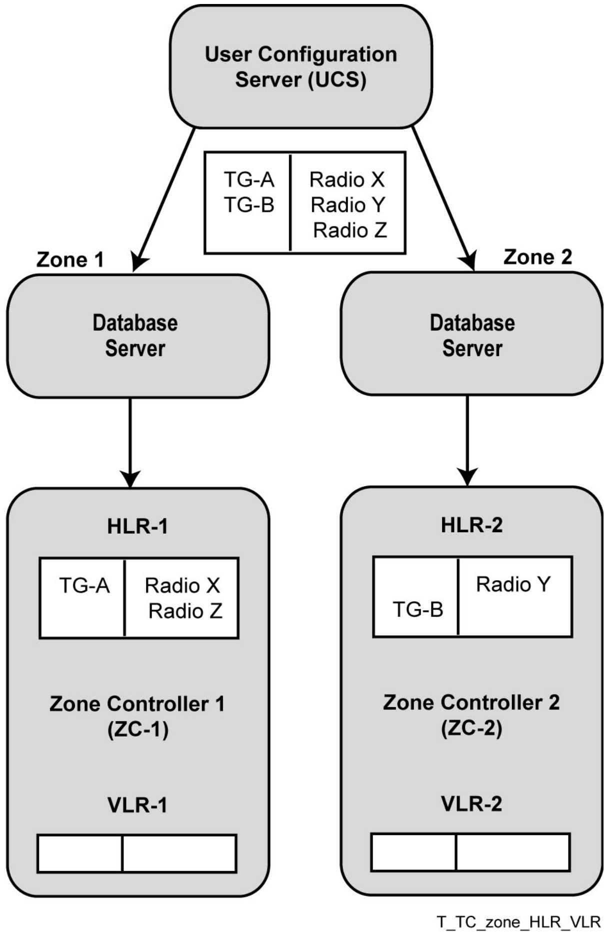
3.5.8.4
Visitor Location Register

Beside the zone HLR, each zone controller also contains a dynamic database, called Visitor Location Register (VLR). The VLR only has information regarding those radios and talkgroups that are currently affiliated in the zone. This information includes:

- Privileges and capabilities of radios in this zone that are downloaded from the designated HLR.
- Current location of radios to a radio frequency (RF) site level.
- Capabilities of talkgroups in this zone that are downloaded from the designated HLR.
- Current location of the talkgroup to an RF site level.

The following shows the HLRs and VLRs per zone.

Figure 7: HLRs and VLRs per Zone



3.5.9

Identifying Priority Levels

A priority level is a number assigned to a radio, talkgroup, multigroup, or agencygroup (with the Provisioning Manager (PM) software) to provide the ASTRO® 25 system with a way to prioritize call requests for system (channel) resources.

When busies occur, radios and groups are granted channels in order of their priority levels first and then in order of their entry in the busy queue (first in, first out).

Priority levels can be set for two types of calls: dispatch and interconnect. Within dispatch, one can have group and individual priority. Priority level 1, the highest level, is reserved for emergency calls. A system manager can assign nine other priority levels (referred to as levels 2 through 10) for each type of call.

In responding to call requests, ASTRO® 25 system follows these priority rules:

- Emergency calls are the highest priority.
- Group and individual calls are handled according to their priority level.
  - Group calls and individual calls with the same priority level are handled in order of their occurrence (first in, first out).
  - When the system is in a busy state and two users have the same priority level, a recent user is granted a call request before a new user.

NOTICE: Recent user priority allows 10 seconds for re-entry into the recent user queue and up to two re-entries. These values are not customer programmable and apply to the entire system. This feature allows for more conversational continuity when there is a busy queue.

Chapter 4

Fleetmapping Configuration

This chapter details organizational requirements relating to fleetmapping.

4.1

Determining Feature Assignments

Based on the requirements of your organization, the Motorola Solutions engineering team designs a system configuration that identifies:

- Number of sites
- Type of sites, IV&D, Console, HPD Overlay
- Number of channels
- Home zone assignments
- Number of console operator positions
- Infrastructure/radio equipment (voice and data capable)

Understanding the equipment that your system has and which features the equipment supports can help you to assign radios and features to individual users. These features include:

- Private call
- Enhanced telephone interconnect
- Data services
- Scan type
- Emergency services
- Secure capable
- Talkaround (or Direct)

You may not want all users to have access to all features a radio may provide. For example, you may want to limit Private Call to supervisory personnel. Or, you may want to limit talkaround capability to specific functional groups. You need to identify which features you want individual users to have in your fleetmap so that the radios can be properly set up and programmed.

In addition, Private Call can be set up with different calling options. For example, Unlimited Call capability means that the radio user can use the radio keypad to enter the ID number of anyone they wishes to reach. Call List capability means that people who can be called are limited to a pre-programmed call list that can be selected from the radio menu display. The AIS recording device does NOT record Private Calls.

CAUTION: Activating unlimited Private Call on large numbers of subscribers could produce adverse system performance including loss of valuable RF channels to process group voice and data calls. Every Private Call generated consumes one valuable RF channel on a Motorola Solutions trunked system temporarily preventing that channel from being utilized for group voice and data call processing.

4.2 Determining Home Zone Assignments

There are several factors that determine the home zone of a talkgroup. These factors relate to the minimization of InterZone calls, failure modes, and the location of the console and logging recorder resources of a talkgroup. Although the ASTRO® 25 system is designed to handle InterZone calls, users do not want to always have to incur the additional access time. An InterZone call can occur under the following situations:

- When talkgroup/multigroup/agencygroup/conventional talkgroup members are affiliated to multiple zones. This includes radio users, console operator positions, and logging recorder interface modules. If a multizone call requires a device or element that has failed, the call is processed without this device or element. For example, if Talkgroup A has affiliated members in Zone 3 and the link between the home zone and Zone 3 is down, the call is set up without Zone 3.
- When a radio user in another zone moves over to this talkgroup.
- When a talkgroup is in a single zone that is not their home zone.
- When a console operator in another zone affiliates to a talkgroup in this zone through a pre-select or assignable channel control module/window.
- When a radio user roams out of the talkgroup home zone.
- When a radio user Private Calls a user in another zone.
- When the home zone of a talkgroup is changed.
- When a radio user involved in a Private Call roam into another zone and continues the call.
- When a radio user making a telephone interconnect call in one zone roams into another zone.

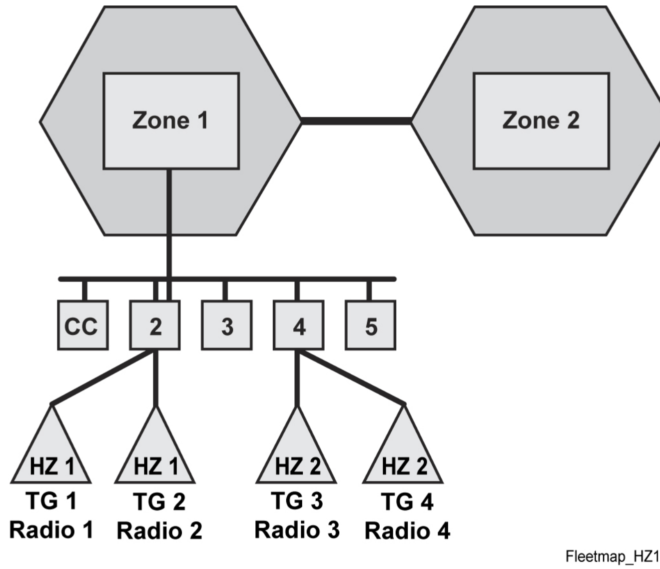
Another consideration is the failure modes of the system. With multiple zones being involved in a call, there are more elements to coordinate in order to complete the process. If one of the elements in the process happens to be less reliable than the others, then the probability of failure increases. With multiple zones, related zone equipment, and a possibly unreliable transport medium connecting the zones together, the probability of keeping all the zones connected together goes down. Assigning the home zone of a talkgroup to a zone where most of the users are located minimizes the impact of a failure.

IMPORTANT: To avoid improper system operation, include Conventional Talkgroup Channel with assigned Conventional Talkgroups to the Home Zone .

If some talkgroups are frequently patched together, the system administrator must assign such talkgroups to the same home zone. The system requires the home zone for a talkgroup be available for a *group regroupable* console patch. Group regroupable means that all talkgroups assigned to a given home zone in a patchgroup that are affiliated to the same site are assigned to one voice channel. If a talkgroup is not group regroupable, only an *audio patch* is performed on the talkgroup. Audio patching requires one voice channel per talkgroup per site.

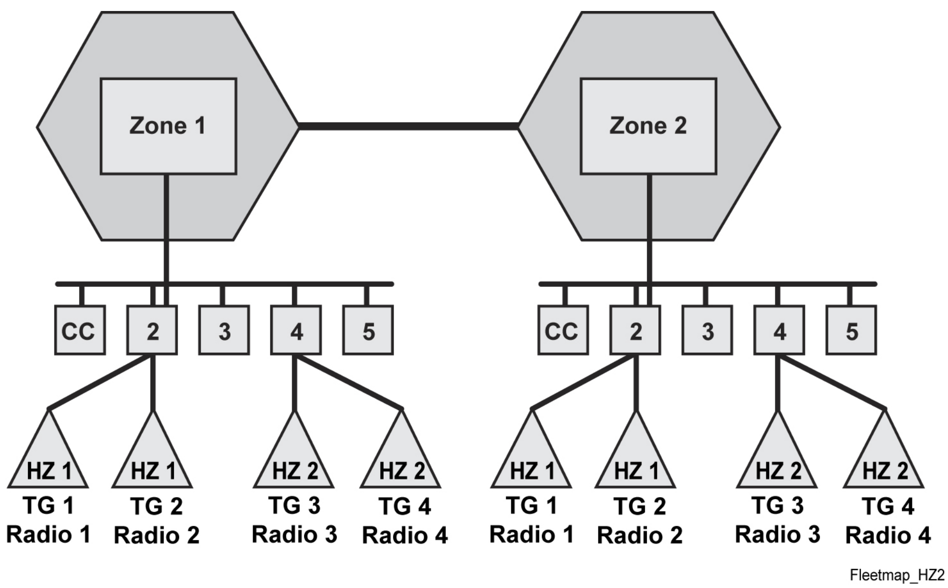
When talkgroups from multiple home zones need to be consistently patched together, the system administrator must be careful when determining the number of voice channels to assign to a site. For example in Figure 8: Home Zone Mapping Between Two Zones on page 99, a console operator patches 4 talkgroups together (TG 1 through 4), two talkgroups home to Zone 1 (TG 1 and 2), and two talkgroups home to Zone 2 (TG 3 and 4). If these four radios, one from each of the talkgroup, are affiliated to the same site, two repeaters (channels 2 and 4) are assigned to each call. TG 1 and 2 are group regrouped, as well as TG 3 and 4. It is due to the creation of a *supergroup* for the talkgroups of each home zone. The trade-off is to either make these frequently patched talkgroups home to the same zone or allocate more repeaters at the respective sites.

Figure 8: Home Zone Mapping Between Two Zones



If, in Figure 9: Resource Allocation for Supergroups on page 99, all four talkgroups (TG 1 through 4) were present in Zones 1 and 2 and were patched together in a supergroup, two resources at each site are needed for communication.

Figure 9: Resource Allocation for Supergroups



The supergroups for Talkgroups 1 and 2 are contained in Zone 1 while the supergroup for Talkgroups 3 and 4 are in Zone 2. If the InterZone trunking is lost between Zones 1 and 2 and this patching operation is performed from Zone 1 for these four talkgroups, each site where Talkgroups 3 and 4 are present need an individual resource for each Talkgroup (3 and 4). If there are multiple talkgroups in the supergroup, the sites need more resources for the call to take place. This is due to an “audio patch” like operation when groups that are isolated from their home zone are patched together.

IMPORTANT: All working IDs reserved for foreign subscribers roaming onto an ASTRO® network must be assigned a home zone to the zone where the Intersystem Gateway (ISGW) is deployed. The zone where the ISGW is deployed is the home zone for all foreign talkgroup calls. See the *ISSI 8000/CSSI 8000 Intersystem Gateway Feature Guide* manual for details.

NOTICE: See the *Provisioning Manager* manual for details regarding home zone mapping configuration.

4.3
Processing Radio Traffic

Mobility patterns drive the allocation of sites to a given zone, the number of voice channels at a site, the location of console positions, logging recorders and more importantly, fleetmapping of the system. There are multiple considerations when determining the allocation of sites to a zone. One of the most important variables is to determine the most important talkgroups using this site. Knowing this, the system administrator must determine where the required elements of this talkgroup (such as console operator positions, logging recorders, and the other sites that this talkgroup's members access) are located. The required elements for this important talkgroup should be located in the same zone for optimal system performance.

Assigning important talkgroups by pre-defined jurisdictional boundaries or operating area boundaries is preferred. Keeping these operational areas in a given zone also serves to minimize InterZone calls. Failure conditions of the system must also be considered as they relate to mobility patterns. Knowing where radios roam to and the location of the console operators to whom they speak might drive a decision to connect a site to a specific zone. Knowing where most radio users are and monitoring consoles of a talkgroup in a system dictates the selection of the home zone for that talkgroup. The home zone for a talkgroup offers many benefits. These advantages besides the failure scenario benefits, include console audio routing and Radio Control Management event routing.

Talkgroups calls can take place across multiple zones in an ASTRO® 25 system. There are two scenarios in which this can occur. The first is where the talkgroup normally operates in multiple zones. For example, a team has to coordinate across an entire region. These calls are always multizone calls. In this case, the zone with the larger number of radios should be the home zone for the talkgroup. In some cases this home zone selection could be overruled by the location of a console being the selected home zone. The more dynamic scenario is when users travel across zone boundaries converting a single zone call into a multizone call. There are a few basic types of this scenario, with the most common one where a talkgroup mostly stays in a zone but an occasional user travels to another zone. For example, a utility crew operates in Zone 1 all the time, but once a week the supervisor has to travel to headquarters for a meeting. In this case, the obvious choice is to make Zone 1 the home zone for this talkgroup.

4.4
Determining Data Services

The data user must determine what type of data services are required. In general, standard IV&D trunking requires relatively long connections while Transit25 transmissions are typically of much shorter duration. IV&D users expect to have high levels of voice communication and fewer data traffic calls while Transit25 and HPD users expect the opposite.

The IV&D and ASTRO® 25 Conventional with Integrated Data features allow data users to use the ASTRO® 25 system to exchange data messages with host computers residing in other networks. The customer's goal is that his repairman, patrolman, or delivery driver can maintain contact with central services while remaining "on site" or "enroute". Packet data messaging enables a number of useful applications. For example, customers may:

- Dispatch mobile operators to incident scenes or job locations.
- Make inquiries for information from centralized databases.
- Send messages over wireless data services.

The Transit25 service provides integrated voice and data communications between a dispatch center and a large fleet of vehicles, and tracks the location of a large fleet of vehicles. Communications between a vehicle and dispatcher are primarily carried out through data services.

NOTICE: See the *Conventional Data Services* manual for more detailed information on conventional data services.

NOTICE: See the *Trunked Data Services* manual for more detailed information on trunked data services.

4.5 Determining Secure Voice Requirements

ASTRO® 25 system supports secure voice capabilities and features. The secure encrypted voice service is a supplementary service to the following call types:

- **Talkgroup call** (a call containing radio user members of a group established in the system)
- **Multigroup call** (a call containing talkgroup members established in the system – also known as Announcement group call)
- **Agencygroup call** (a call containing a multigroup having top priority)
- **Private call** (a call between two radio users)
- **Interconnect call** (a call between a radio user and the Public System Telephone Network – PSTN)
- **Supergroup call** (a call between a group of radio users established by a console operator)

Individuals and talkgroups can be configured in Provisioning Manager (PM) to use three modes – secure, clear, or both.

The setting for individual calls is configured in the radio user record. The individual setting determines the secure capability for private calls and interconnect calls and has no impact on what the radio user can do in the talkgroup.

The setting for group calls is configured in the TGMG Capabilities Profile record. The talkgroup setting determines what type of a call is permitted in the talkgroup, regardless of the settings of the individuals using the talkgroup.

4.5.1 Voice Encryption

Secure voice (aka voice encryption) is an overlay service that allows radios or consoles on properly equipped and configured systems to transmit and receive protected audio (digital or analog encryption) using either a standard or a proprietary encryption algorithm.

To support voice encryption, multiple keys may be used with a single key pre-configured for use by each working group or special call type (emergency calls, private calls, dynamic regrouping). A set of keys in the infrastructure may also be configured for the telephone interconnect, with the appropriate key selected when a particular user makes an encrypted phone call.

The assignment of keys to various call types must be configured in the radio, Telephone Media Gateway (TMG), and Provisioning Manager (PM). In order to provision the system, you must have appropriate system administration privileges, such as:

- Access to radio CPS programming equipment.
- A hand-held Key Variable Loader.
- Access to the user configuration area of PM. The radio receives a busy indicator if more encrypted calls are received than the TMG can handle.

4.6
Determining System Access Requirements

Once you have identified how you want to organize your system, you need to create and assign security groups for restricting access to the ASTRO® 25 system databases. Creating and assigning security groups for restricting access to the ASTRO® 25 system databases requires the availability of the Security Partitioning option where you can control user access to a specific part of the ASTRO® 25 system database.

4.6.1
Security Groups

In order to manage access to the large amount of database information in an ASTRO® 25 system, related records are organized into security groups to define what records can be accessed by each user.

Factors that affect how the database records are organized into security groups can include the following:

- Location (talkgroups, base radios in city A or city B)
- Type of device (infrastructure or subscribers)
- Organization (police radios or fire radios)
- Type of record (security records used by a security manager or fault records used by service technicians)

The association of a radio to a user is made using the subscriber ID or alias. This association is performed in Provisioning Manager (PM) application by creating records. Security group are created for logical groups used to partition subscriber and infrastructure components, and every record within the system is assigned to a security group. The system comes with one default security group (SYSTEM). You cannot delete or modify the SYSTEM security group, but you can use it to quickly create new records. If your agency has purchased the Security Partitioning option to create additional security groups, you can create as many security groups as you need. When you add a new security group, close and reopen the application for the new group to appear in the available list. Once a security group is created it cannot be deleted, only modified.

The range for the Security Group parameter in PM is 1 to 16 characters and you cannot use: |, @, _ , ", , ’, and % when naming the group.

Security groups manage the access to PM and are assigned at the same time that you create the record. See the “PM Configuration” chapter of the *Provisioning Manager* manual and the “Radio Features – Configuration” chapter of the *Radio Features* manual for procedural information.

4.6.2
User Access Rights

In order to limit and control what users can do, each user on the system is given a set of access rights.

Access rights determine which applications a user can open. When a user account is created, you assign access rights for the available ASTRO® 25 system applications.

Access rights are used to assign the functions a user can perform on a security group (the user must have access to the security group). Each user on the ASTRO® 25 system is given a set of access rights. These access rights can be classified as follows:

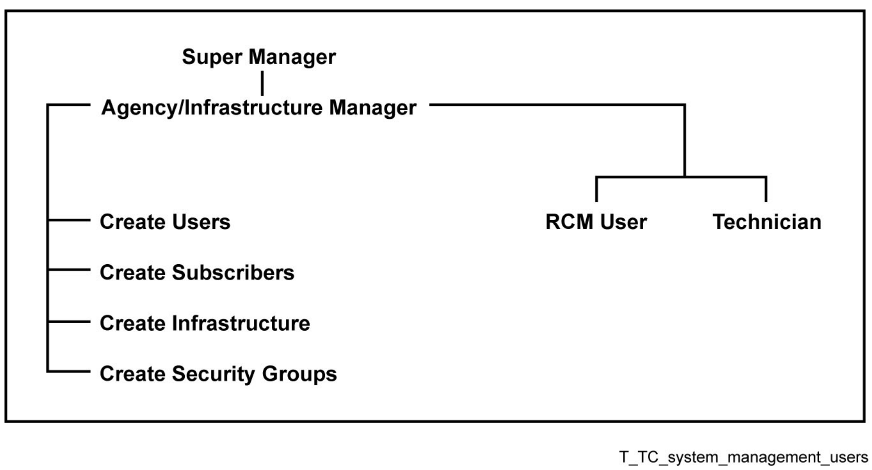
- **User Access** – This access right lets a user log on to the system by entering an assigned user name and a password. The system then lets the user perform only those functions to which the user has been given access rights.
- **Zone Access** – This determines the zones the user can access.

- **Application Access** – This determines the applications (for example, ZoneWatch, RCM) the user can open.
- **Object Creation Access** – This determines whether a user can create an object or simply view the existing objects in Provisioning Manager (PM) or Unified Network Configurator (UNC).
- **Operation Access** – This determines the functions a user can perform. Categories of operation access rights are:
  - Read – View any object record belonging to the security group.
  - Insert – Add records to the database belonging to the security group.
  - Update – Update a record belonging to the security group.
  - Delete – Delete a record belonging to the security group.

For example, when changing the security group for a given object such as a talkgroup, the user must have Delete access rights in the current security group and Insert and Update access rights in the new (target) security group.

In addition, management users who create subscribers must have at least Read access rights to the security groups of those management users who created the site infrastructure objects. If they do not, no sites appear on the Valid Sites list for those management users trying to create subscribers. The following *Hierarchy of System Management Users* illustration shows a hierarchy of system management users.

Figure 10: Hierarchy of System Management Users



4.6.3 User Account Types

Four typical types of system management user accounts can be defined for your ASTRO® 25 system. These types depend on the organization setup and whether you have purchased the Security Partitioning feature or the Radio Control Manager option.

4.6.3.1 Super Manager – User Account Type

The Super Manager user account type is the highest-level system user. The Super Manager is configured at the factory and cannot be changed, except for the password.

In any ASTRO® 25 system, a Super Manager has special access rights to the entire system, and is the one who generally administers and maintains the system. The Super Manager can access all files and perform any task within the system.

NOTICE: Be careful when using the Super Manager account. It is a large responsibility to have total power over the entire system. Use the Super Manager privileges as little as possible. Do not use this account for your routine work on the system.

4.6.3.2
Agency/Infrastructure Manager – User Account Type

The Super Manager sets up the access rights for the Agency Manager/Infrastructure Manager. This is the highest user level after the Super Manager. At least one Agency/Infrastructure Manager with full access rights to perform any task within the system must be established to protect Super Manager logins. The role could also be divided between two people.

Depending on your system, the Super Manager and Agency/Infrastructure Manager may be the same person. The Agency/Infrastructure Manager should be able to create other users, set their access privileges, and view their functions.

4.6.3.3
RCM User – User Account Type

The access rights for the Radio Control Manager user are generally defined at a level below the Agency/Infrastructure Manager. The RCM user generally has limited access to other functions within the system. The Radio Control Management option is required for this user feature.

4.6.3.4
Technician – User Account Type

The Infrastructure Manager sets the access rights for the technician based on different classes of technicians, if any, and the type of tasks they perform, such as diagnostics or re-configuration of peripheral equipment. The Technician is generally a user defined at a level below the Agency/Infrastructure Manager. This user generally has system wide access to infrastructure devices within Unified Network Configurator (UNC).

4.6.4
Planning Database Access

Once users are defined, gather the information necessary to build the security for your system. This planning process involves determining the responsibilities of each and their access and restrictions for specified objects.

- Determine who your users are:
  - Super Manager
  - Agency Managers
  - Infrastructure Managers
  - RCM Users
  - Technicians
- Determine the responsibilities for each user.
- Determine which applications each user needs to use.
- Determine dispatcher responsibilities.
- Determine technician responsibilities. Some may be limited to acknowledging and deleting alerts and alarms. Others may modify configuration parameters of devices.
- Determine who is responsible for creating user accounts.
- Define the security groups (requires the security partitioning feature).

- Determine which users require access rights to create objects and which objects they can create.
- Determine operation access rights that users need.

The following table shows sample questions that can be used to help plan each user account for access to applications and each of the database areas.

Table 34: Questions to Ask Database Users

Database Type	Database Users	Questions
Applications	All users on the system.	• Which applications will each user be allowed to access?
Subscriber	Individual agencies to control and monitor radio users and dispatchers.	• What agencies will use the system? • Does each agency have its own manager? • Will this manager access only the agency database? • Can this manager access multiple agency databases?
Infrastructure	• Service organizations to maintain and service the system. • Agencies to include sites for monitoring system device status.	• Is there one central service organization or multiple service organizations? • What are the service regions? • Are there different levels of service technicians? • What types of access will service technicians have to the database for devices in their region? Can they acknowledge and delete alerts/alarms, run diagnostics, or modify configuration parameters for system devices? • Are agencies restricted to certain sites within the wide area system?
RCM Users	RCM Users to operate within their assigned responsibilities.	• How are RCM Users organized? • Is there one user for the system or multiple users assigned to specific security groups across the system? • For which radios and talkgroups is the RCM User responsible? • If the RCM User has the regroup capability, what talkgroups in their agency can they access? • What talkgroups outside of their agency do they have access to?
Services	Technicians to manage alerts.	• Will there be different classes of technicians?

Database Type	Database Users	Questions
		• Will some technicians only be allowed to acknowledge or delete alerts and run diagnostics? • Will some technicians be allowed to modify the configuration parameters of devices?

4.7

Determining Subscriber Programming Requirements

This description of subscriber programming is intended to help you start thinking about how your radios can be programmed as you begin to plan for your ASTRO® 25 system. Motorola Solutions suggests that you work with your Motorola Solutions Engineering team to define the specific features and capabilities you want to program into your subscriber units.

Subscriber units and their associated feature sets are typically arranged by templates and sorted by Unit IDs. Each radio must have a unique Unit ID. Beside the hardware options, features such as Enhanced Telephone Interconnect and Private Call can have pre-programmed call lists.

Each radio is assigned a template, which specifies how the radio is programmed. A template ID designates each template and identifies the Customer Programming Software (CPS) computer file.

The naming convention for the Template ID is same as the Microsoft Windows file naming convention. For Customer Programming Software, the file name can contain up to 255 characters. File names cannot include any of the following characters: forward slash (/), backslash (\), greater than sign (>), less than sign (<), asterisk (*), period (.), question mark (?), quotation mark ("), pipe symbol (|), colon (:), or semicolon (;).

The general nomenclature for the template can be set up to provide specific features for a given set of users. For example, the HQ-TD-01 template ID can be used to indicate the following:

- HQ is the agency (Command Headquarters) to which the radio is assigned.
- TD is the division (Traffic Division) of the agency.
- 01 is the post, or location number.

The following show some sample templates.

Table 35: Sample Templates

Unit ID	Description	Location	Remote Mount	Horn & Lights	Secure	Direct Mode Operation
TEMPLATE: HQ-TD-01			**RADIO MODEL: XXXXXXX**			
742001	HQ Traffic	Gratiot	X	X		
742003	HQ Traffic	St. Clair	X	X		
742005	HQ Traffic	Macomb	X	X		
TEMPLATE: DOC-A-12			**RADIO MODEL: XXXXXXX**			
740243	Director	Lansing			X	X
740245	Dep. Director	Lansing			X	X
740247	Supervisor	Lansing			X	X

4.7.1 Subscriber Range Assignments

Templates can also describe how talkgroup, multigroup, and agencygroup ranges are organized. The following tables provide examples of how ranges can be defined and assigned to groups.

Table 36: Example of Ranges

Range	Radio IDs	Description
1	1 – 700	Agency-specific talkgroups (A)
2	701 – 1500	Agency-specific talkgroups (B)
3	1501 – 1600	County talkgroups
4	1601 – 1650	Non-agency talkgroups
5	1651 – 1700	District talkgroups
6	1701 – 1800	Mutual aid talkgroups
7	1801 – 1900	Special event talkgroups
8	1901 – 2000	Foreign subscribers

Table 37: Sample Range Assignment

Type	Alias	Talkgroup ID	Multigroup	Agencygroup
TEMPLATE: HQ-TD-01		**RANGE 1**		
Talkgroup	HGTD1	80000001	District 1	Region 1
Talkgroup	HGTD3	80000003	District 1	Region 1
Talkgroup	HGTD5	80000004	District 1	Region 1
TEMPLATE: HQ-TD-01		**RANGE 7**		
Talkgroup	Event1	80001801	None	None
Talkgroup	Event2	80001823	None	None
Talkgroup	Event3	80001824	None	None

4.7.2 Radio Button Assignments

The subscriber radio button configurations are determined by the capabilities of the subscriber radios and the types of features that are programmed into the radios such as Private Call, Secure capability, and Enhanced Telephone Interconnect.

Many subscriber radio buttons are "soft" buttons, meaning that their specific function can be programmed using the Customer Programming Software (CPS). It is necessary for you to determine the capabilities you want assigned to the buttons.

4.7.3 Radio Programming and the System Database

It is important to remember that whatever is programmed into the radios must also be supported by a proper setup in the system databases. Conflicts between the system subscriber records and the subscriber programming can result in the loss of feature availability or loss of system access to the subscriber.

4.7.4
Subscriber Dynamic Dual Mode Support

In an ASTRO® 25 system, the APX subscriber radios are Dynamic Dual Mode (FDMA/TDMA) capable to allow them to operate in RF subsystems providing support for Dynamic Dual Mode (DDM). The APX 6000 and APX 7000 portable subscriber radios, and the APX 6500 and APX 7500 mobile subscriber radios support DDM. The APX 6000/6500/7000/7500 subscriber radios are Motorola Solutions P25-capable subscribers that use a Motorola Solutions voice channel in the two-slot TDMA mode. These subscriber radios employ AMBE+2 enhanced full-rate vocoding for FDMA calls and AMBE+2 enhanced half-rate vocoding for DDM-capable calls. The AMBE+2 enhanced full-rate (EFR) is fully interoperable and backwards-compatible with the IMBE full-rate vocoder used in FDMA (APCO Phase 1). APX radios support FDMA in the following bands: 700 MHz, 800 MHz, and VHF. They support TDMA in the 700 MHz, 800 MHz, UHF, and VHF bands.

Chapter 5

Fleetmapping Operation

This chapter details tasks to perform for successful operation of your ASTRO® 25 system.

5.1

ASTRO 25 System Checklist

The following checklist displays various tasks and requirements you need to consider to successfully operate your ASTRO® 25 system.

- Identify members of the functional design team.
- Identify departments and individual users.
- Organize radio users into talkgroups, multigroups, and agencygroups.
- Assign IDs and aliases to individuals and talkgroups.
- Identify priority levels for group and individual calls.
- Determine features sets for individual users and radios.
    - Private call
    - Enhanced telephone interconnect
    - Scan type
    - Emergency services
    - Secure capable
    - Data capable
    - Talkaround
- Determine secure key assignments.
- Determine system access requirements.
- Determine subscriber programming requirements.
- Determine dispatch position programming requirements.
- Determine site installation requirements.

5.2

Contingency Planning

For your ASTRO® 25 system, you can use various types of contingency planning. The specific plans that you implement and how those plans are implemented depend upon the communications requirements of your organization and how your system is used.

5.2.1

Dynamic Regrouping Plans

Dynamic regrouping enables individuals from different talkgroups to be brought together to communicate in the case of special situations.

Dynamic regrouping allows a supervisor or dispatcher to change the talkgroup assignments of individual radios without any action required by the radio operators.

Regrouping assignment can be initiated rapidly, but not instantaneously. For example, radios you want to be regrouped must be turned on, in range, and listening only to the control channel. Therefore, regrouping is best suited for pre-planned activities or occasional changes from normal routine. It is NOT intended for emergency responses such as high-speed chases or for rapid deployment on a per incident basis. Use the following Dynamic Regrouping Plans table to identify regrouping plans.

Table 38: Dynamic Regrouping Plans

Plan Number	Dynamic Regrouping Plan Name
Plan 1	
Plan 2	
Plan 3	

5.2.2
Storm Plans

Storm plans enable a system manager to construct a regrouping of radios and radio users in advance of some anticipated situation such as severe weather, plane crashes, or civil disturbances.

When activated, a pre-constructed storm plan would automatically regroup specified radios into specified talkgroups. Storm plans allow the dispatcher to store a regrouping plan for critical situations and to change communication patterns when required. Use the following table to identify storm plans.

Table 39: Storm Plans

Plan Number	Storm Plan Name
Plan 1	
Plan 2	
Plan 3	

5.2.3
Radio Allocation and Control Plans

Radio allocation and control plans require consideration of the following factors to plan for contingencies:

- Distribution (How radios be distributed? By whom? When?)
- Radio maintenance and upgrades (What happens when a radio breaks? Does the service shop clone a broken radio to a substitute? Will substitutes be available off the shelf? What is your strategy when large groups of radios need software upgrades?)
- Selective inhibit (What happens when a radio is stolen or lost?)

5.2.4
Failure Mode Analysis Plans

Consider developing the following documents to plan for contingencies:

- A failure mode matrix
- A fault priority level matrix
- “What-if” scenarios
    - Loss of a site

- Loss of a channel
- Loss of a station
- Loss of other components in the system

5.2.5
Emergency Backup Plans

Consider the following factors when planning for contingencies:

- Determine the level of system fault. (What is wrong?)
- Confirm whether all automatic modes have occurred. (What are they? Who does it?)
- Determine whether manual intervention is required. (What? Who?)
- Determine whether extra technical assistance is required. (Who is there? Who needs to be there?)
- Begin logging actions.
- Escalate as required.

5.2.6
Escalation Plans

Escalation plans identify personnel required to respond to various types of problems.

An escalation plan, for example, might identify first-level escalation as the person to be initially contacted in order to resolve the problem. If no response or solution can be established by first-level escalation within a certain time, second-level escalation would be necessary. See the Escalation Process on page 112 for more information. Use the following table to identify the appropriate personnel for each type of problem listed.

Table 40: Escalation Plans

	Type of Problem
	Subscriber Programming Problems
First Level Responsibility:	
Second Level Responsibility:	
Third Level Responsibility:	
	Other Subscriber Problems
First Level Responsibility:	
Second Level Escalation:	
Third Level Escalation:	
	Infrastructure Equipment Problems
First Level Responsibility:	
Second Level Escalation:	
Third Level Escalation:	
Fourth Level Escalation:	
	Network Link Problems
First Level Responsibility:	

Table continued…

Type of Problem
Second Level Escalation:
Third Level Escalation:
Fourth Level Escalation:
Networking Equipment Problems
First Level Responsibility:
Second Level Escalation:
Third Level Escalation:
Fourth Level Escalation:

5.2.6.1
Escalation Process

When and where to use: Use the escalation process when trying to resolve a problem.

Process:

1. Notify the person with the first level of responsibility.
2. If there is no response or solution within a reasonable amount of time (as defined by your particular contingency plan), notify the second-level person.
3. If there is no response or solution within a reasonable amount of time (as defined by your particular contingency plan), notify the third level person.
4. If there is no response or solution within a reasonable amount of time (as defined by your particular contingency plan), notify the fourth level person.

5.2.7
Dynamic Dual Mode - Band Plan Considerations

TDMA band plan elements are added to the User Configuration Server (UCS) and the subscriber. A TDMA band plan identifier is different from FDMA in that it allows the system to make a call grant assignment with the "slot" information (slot 1 or slot 2) as part of the "channel number" within the call grant.

An ASTRO® 25 system supports up to 16 band plan elements. The DDM-capable site requires both an FDMA and TDMA-capable band plan element, which is an important consideration when planning your system. FDMA band plan identifiers are required for all channels so that TDMA-only or DDM channels can be assigned for IV&D data, Base Station Identification (BSI), or control channel functions.

5.3
Developing a Memorandum of Understanding

Your organization requires a Memorandum of Understanding (MoU) to assist with inter-agency communications among other agencies with similar trunked radio systems.

NOTICE: Use these examples only as general guidelines to help you think about how to set up an MoU for your organization if you have not already done so. These examples may not be indicative of the MoU required for your specific system and neighboring agencies.

An MoU is useful in large geographical areas where multiple public safety agencies work together. The MoU ensures that these different agencies collaborate effectively by agreeing to use a common trunked radio system vendor, improve quality and timeliness of inter-agency communications during law enforcement mutual aid operations, and provide other agencies with direct access to their radio systems for coordination with neighboring law enforcement agencies. In such an agreement, the parties may agree to the following:

1 Each agency allows the other agencies to directly access their respective public safety trunked radio systems.

2 Each agency shares all information necessary to configure and program radio users for operation on their respective public safety trunked radio system.

3 All programming information and parameters are considered CONFIDENTIAL and are not disseminated to any party included in the MoU without the express written consent of the respective agencies.

4 Direct access is reserved for emergency, priority, or other incidents where its use creates a significant advantage to law enforcement. Direct access may also be used to provide pre-arranged activities, such as funeral escorts.

5 Direct access during priority or emergency incidents is encouraged. Agencies are encouraged to develop guidelines that permit field users to directly access neighboring trunked systems in a timely manner by notifying their dispatcher before switching. Telephone coordination between dispatch centers is not necessary.

6 If two agencies share a common border, it is recommended that agencies share the appropriate “dispatch” and “primary tactical” talkgroup used in the adjacent jurisdictions and/or “districts,” “patrol areas,” or “beats.”

7 Plain English is used for all mutual aid communications. Avoid jargon, “10–codes”, and slang.

8 Field units identify themselves by stating their unit name and unit designator. For example, Airport 131, Goddard Unit Three Forty Four.

9 When communicating with field units from other jurisdictions, dispatchers must identify themselves by stating their agency name.

10 Once the need for communicating directly with a neighboring jurisdiction is established, the field user must inform their home dispatcher of their intention to switch systems, and make the switch only after the dispatcher provides acknowledgment and clearance.

11 When calling a neighboring jurisdiction, the field user shall state their unit identification as described above, the word “to” and the name of the agency that they are calling. The field user then waits for a response before giving any additional information. For example, “Goddard Unit Three Forty Four to Callahan County”.

12 If the channel is not currently in use, the dispatcher from a neighboring jurisdiction should respond immediately. If a channel is in use, the dispatcher then asks that the calling user “stand by.” For example, “Callahan County to Goddard Unit Three Forty Four, go ahead”.

13 After the call is acknowledged, the calling user states the reason that they are calling and what, if any action the neighboring agency needs to take.

14 Once the initial contact is established and the reason given for the call, the communication proceeds until the call is complete. Before returning to their home radio system and channel, the calling user must state their unit designator and inform the neighboring dispatcher that they are switching back to their regular channel. For example, “Goddard Unit Three Forty Four, I have no further traffic. I am switching back to Goddard PD Channel 1”.

15 In the case of “long term” or “static” events where mutual aid assistance is being requested, a supervisor needs to contact the neighboring agency or cause the neighboring agency to be contacted, and a formal request mutual aid assistance initiated. If approved, the neighboring agency provides resources and assistance for the requesting agency. The assisting agency should then be provided with the talkgroup or channel where communications for the mutual aid operation are being conducted by the requesting agency. The assisting agency must determine the appropriate units to respond to the event, and provide that information to the responding units at the time of dispatch. Once all information is received, the responding units can switch to the designated talkgroup on the trunked radio system of the requesting agency and initiate contact as already defined.

16 Complaints of abuse or unauthorized operation by users from neighboring jurisdictions are encouraged to be resolved at the field supervisor level as soon as possible after an alleged incident occurs. If the complaint cannot be resolved at this level, or if the severity warrants escalation, a complaint should be made in writing to the jurisdiction involved in the claim. Written complaints should include the date and time the incident occurred, then the nature of the complaint, the six-digit radio ID number, the name of the persons who witnessed the offense, and, if available, an audio recording of the offense. Complaints of abuse or unauthorized operation are resolved according to the established internal procedures of the organization, and a written response detailing actions taken should be provided to the complaining agency within 30 days of the initial complaint.

17 New law enforcement agencies may be added by amendment to this Memorandum from time to time, subject to the approval of the agencies.

18 Nothing in this Memorandum shall be construed as to prohibit any individual agency from entering into mutual aid agreements with separate law enforcement entities not included in this Memorandum. Under no circumstances, shall any agency disseminate the programming parameters of another Agency to any third party without express written approval from the other agency.

19 Each agency assumes full responsibility for all costs associated with programming their radios for direct access.

20 During times of law enforcement mutual aid operation, each agency makes every reasonable effort to provide the same level of communications support to units from neighboring agencies as they would their own units.

21 Each agency designates a representative to serve on a Mutual Aid Communications committee. On an annual basis, the chair of this committee is rotated through all member agencies, by alphabetical order. These representatives meet as required to identify and resolve any issues that arise during mutual aid or direct access. If a representative of an agency is no longer available due to reassignment, the agency shall appoint a new representative and inform the committee chairperson in writing.

Chapter 6

Fleetmapping Reference

This chapter contains forms you can use for fleetmapping within your system.

6.1
Fleetmapping Forms

You may want to make copies of the following forms and use them to write down your system plans as an aid in working with Motorola Solutions engineers to develop your fleetmapping templates. These forms are designed to get you thinking about the implementation of your system and the tables provide you with a place to make notes related to your system planning.

The following forms are provided in this section:

- Current and Future Equipment Quantities on page 115
- Available Sites on page 116
- Individual Radio Users on page 116
- Serial Number to Radio ID on page 117
- Radio User to Radio IDs on page 118
- Talkgroup IDs and Aliases on page 118
- Multigroups and Associated Talkgroups on page 119
- Agencygroups and Associated Multigroups on page 119
- Radio Users Assigned to Talkgroups on page 120
- Communications and Radio Features Mapping on page 121
- Console IDs on page 121
- Secure Keys on page 122
- Talkgroup Zone Matrix on page 123

NOTICE: These forms are designed to assist you with your system planning. Motorola Solutions provides detailed templates with the Fleetmapping training course.

6.1.1
Current and Future Equipment Quantities

The following form is a table that can be used to record information pertaining to current and future equipment. The first row in the table provides an example of how to fill in this form when developing your fleetmapping plans.

Table 41: Current and Future Equipment Quantities Form

Radio/Console Type	Quantity Today	Quantity in 5 Years
MCC 7500 Dispatch Console	3	7

Table continued…

Radio/Console Type	Quantity Today	Quantity in 5 Years

6.1.2
Available Sites

The following Fleetmapping Form is a table that can be used to record Site Number and Site Alias information.

Table 42: Available Sites Form

Site Number	Site Alias

6.1.3
Individual Radio Users

The following table can be used to record individual radio users.

Table 43: Individual Radio Users Form

Last Name	First Name	Alias	User Priority Level

Table continued…

Last Name	First Name	Alias	User Priority Level

6.1.4
Serial Number to Radio ID

The following Fleetmapping Form is a table that can be used to record serial numbers for radios.

Table 44: Serial Number to Radio ID Form

Radio Type (for example, XTS 3500)	Radio Serial Number	Radio ID	Dept./Unit

6.1.5 Radio User to Radio IDs

The following Fleetmapping Form is a table that can be used to record radio user alias, radio ID number, vehicle number, radio type, and radio tag information.

Table 45: Radio User to Radio IDs Form

Radio User Alias	Radio ID Number	Vehicle Number	Radio Type (for example XTS 3000)	Radio Tag

6.1.6 Talkgroup IDs and Aliases

The following Fleetmapping Form is a table that can be used to record talkgroup ID number, talkgroup alias, department names, and talkgroup priority level information.

Table 46: Talkgroup IDs and Aliases Form

Talkgroup ID Number	Talkgroup Alias	Department	Talkgroup Priority Level

Table continued…

Talkgroup ID Number	Talkgroup Alias	Department	Talkgroup Priority Level

6.1.7 Multigroups and Associated Talkgroups

The following Fleetmapping Form is a table that can be used to record multigroup ID number, multigroup alias, and talkgroup alias information.

Table 47: Multigroups and Associated Talkgroups Form

Multigroup ID Number	Multigroup Alias	Talkgroup Alias

6.1.8 Agencygroups and Associated Multigroups

The following Fleetmapping Form is a table that can be used to record Agencygroups and Associated Multigroups.

Table 48: Agencygroups and Associated Multigroups Form

Agencygroup ID Number	Agencygroup Alias	Multigroup Alias

Table continued…

Agencygroup ID Number	Agencygroup Alias	Multigroup Alias

6.1.9
Radio Users Assigned to Talkgroups

The following Fleetmapping Form is a table that can be used to record radio user alias, priority level alias, primary talkgroup alias, and talkgroup priority level information.

Table 49: Radio Users Assigned to Talkgroups Form

Radio User Alias	User Priority Level	Primary Talkgroup Alias	Talkgroup Priority Level

NOTICE: For systems supporting Dynamic Dual Mode, talkgroups may be configured as FDMA-only, TDMA-only, or Dynamic. When a subscriber radio (configured using CPS) registers to the system, the radio registration message identifies whether the subscriber radio is FDMA-only or DDM-capable (FDMA or TDMA capable). Also when the MCC 7500 console goes into service, it informs the zone controller of its capability (FDMA or TDMA-capable).

6.1.10
Communications and Radio Features Mapping

Create a Communications Between Departments Form similar to the following to identify communication between departments. Use an X to map the requirement.

Table 50: Communications Between Departments Form

Department Name	Dept 1	Dept 2	Dept 3
Dept 1			
Dept 2			
Dept 3			

Create a Radio Features Mapping table like the following to identify radio features used by each department. Indicate Yes or No (Y/N) for each feature or enter a number where indicated.

Table 51: Radio Features Mapping

Radio Features	Dept 1	Dept 2	Dept 3
Private Call			
Interconnect			
Scan			
Channels (number)			
Encrypted			
Call Alert			
Priority Level (number)			
Roaming			
Emergency Button			
Group Call			

6.1.11
Console IDs

The following Fleetmapping Form is a table that can be used to record Console Alias, Console ID Number Talkgroup Alias, and Talkgroup ID number information.

Table 52: Console IDs Form

Console Alias	Console ID Number	Talkgroup Alias	Talkgroup ID Number

Table continued…

Console Alias	Console ID Number	Talkgroup Alias	Talkgroup ID Number

6.1.12
Secure Keys

The following Fleetmapping Form is a table that can be used to record secure key numbers associated with talkgroup alias and talkgroup ID numbers.

Table 53: Secure Keys Form (Talkgroup)

Talkgroup Alias	Talkgroup ID Number	Secure Key Number

The following Fleetmapping Form is a table that can be used to record secure key numbers associated with multigroup alias and multigroup ID numbers.

Table 54: Secure Keys Form (Multigroup)

Multigroup Alias	Multigroup ID Number	Secure Key Number

Table continued…

Multigroup Alias	Multigroup ID Number	Secure Key Number

The following Fleetmapping Form is a table that can be used to record secure key numbers associated with agencygroup alias and agencygroup ID numbers.

Table 55: Secure Keys Form (Agencygroup)

Agencygroup Alias	Agencygroup ID Number	Secure Key Number

6.1.13
Talkgroup Zone Matrix

The following Fleetmapping Form is a table that can be used to record zone, talkgroup ID, talkgroup alias, department name, and location information.

Table 56: Talkgroup Zone Matrix

Zone	Talkgroup IDs	Talkgroup Aliases	Department	Location

Table continued…

Zone	Talkgroup IDs	Talkgroup Aliases	Department	Location