System Release 7.17
ASTRO® 25
INTEGRATED VOICE AND DATA

Trunked IP Simulcast Subsystem Infrastructure

NOVEMBER 2016

MN003367A01-B

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Document History

Version	Description	Date
MN003367A01-A	Original release of the *Trunked IP Simulcast Subsystem Infrastructure* manual.	November 2016
MN003367A01-B	Second release of the *Trunked IP Simulcast Subsystem Infrastructure* manual. This update includes the following new and updated topics: • Intra-Prime Site Link Transport Design Constraints on page 74 • Intra-Prime Site Link Bandwidth on page 75	November 2016

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About Trunked IP Simulcast Subsystem Infrastructure

This manual provides an introduction to the IP simulcast subsystem infrastructure and includes procedures for installing and configuring the IP simulcast subsystem.

NOTICE: For information on TDMA operation in an IP simulcast subsystem, see the *Dynamic Dual Mode for TDMA Operation Feature Guide*.

What Is Covered In This Manual?

This manual contains the following chapters:

- ASTRO 25 Trunked IP Simulcast Subsystem Description on page 31 provides a description of the IP simulcast subsystem.
- ASTRO 25 Trunked IP Simulcast Subsystem Technical Overview on page 51 provides additional explanation of the components and functions of the IP simulcast subsystem.
- ASTRO 25 Trunked IP Simulcast Subsystem Installation on page 79 provides installation information for the different hardware and software configurations of the IP simulcast subsystem.
- ASTRO 25 Trunked IP Simulcast Subsystem Configuration on page 97 provides configuration information for the IP simulcast subsystem using the Configuration/Service Software and Unified Network Configurator.
- ASTRO 25 Trunked IP Simulcast Subsystem Optimization on page 99 provides optimization information for the IP simulcast subsystem.
- ASTRO 25 Trunked IP Simulcast Subsystem Operation on page 103 provides operations information for the IP simulcast subsystem.
- ASTRO 25 Trunked IP Simulcast Subsystem Troubleshooting on page 119 provides troubleshooting information for the IP simulcast subsystem.
- ASTRO 25 Trunked IP Simulcast Subsystem Maintenance on page 145 provides maintenance information for the IP simulcast subsystem.

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 to 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. This manual may be purchased on CD 9880384V83, by calling the North America Parts Organization at 800-422-4210 (or the international number: 302-444-9842).

Table continued…

Related Information	Purpose
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.
Authentication Services	Provides information relating to the implementation and management of the Active Directory (AD) service, Remote Authentication Dial-In User Service (RADIUS), and Domain Name Service (DNS) in ASTRO® 25 systems.
Call Processing and Mobility Management	Describes the behavior of various ASTRO® 25 system infrastructure components and subscriber radios as they process calls and manage subscriber mobility.
Centralized Event Logging	Provides information relating to the implementation and management of the Centralized Event Logging feature available for ASTRO® 25 systems. This feature enables capturing operating system events generated by most devices in ASTRO® 25 systems. This manual includes information about the server and client function required for the feature.
Conventional Operations	Provides information regarding conventional channel resource operating characteristics in standalone systems or K core, L core, or M core ASTRO® 25 systems.
Dynamic Dual Mode for TDMA Operation Feature Guide	Provides information describing the Dynamic Dual Mode (DDM) architecture and the Time Division Multiple Access (TDMA) technology used by ASTRO® 25 systems, including the use of APCO 25 Phase 2 TDMA.
Dynamic System Resilience Feature Guide	Provides information necessary to understand, operate, maintain, and troubleshoot the Dynamic System Resilience (DSR) feature that adds a geographically separate backup zone core to an existing zone core to protect against catastrophic zone core failures.
Fault Management Reference Guide	Provides a system-level perspective on fault management, troubleshooting, and preventive maintenance methodologies applicable to ASTRO® 25 systems.
Flexible Site and InterZone Links	Describes the Flexible Site and InterZone Links feature, also referred to as Ethernet links, that provides alternate connectivity options for linking zones and sites in ASTRO® 25 systems.
G-Series Equipment System Release User Guide	Provides information and procedures to downgrade the software of the G-Series equipment (GTR 8000, GCM 8000, GCP 8000, GPB 8000, and GPW 8000) to meet the operating characteristic of the ASTRO® 25 system.
GCM 8000 Comparator	Covers the installation, configuration, and management of the GCM 8000 Comparator that supports voting, multicast, and simulcast operation modes.
GCP 8000 Site Controller	Describes the installation, configuration, and management of the GCP 8000 Site Controller used in ASTRO® 25 circuit

Table continued…

Related Information	Purpose
	and IP simulcast prime sites, repeater sites, HPD sites, and conventional sites.
GGM 8000 System Gateway	Provides information relating to the installation, configuration, and management of the GGM 8000 Gateway used in various network locations.
GGM 8000 Hardware User Guide *S2500 Hardware User Guide* *S6000 Hardware User Guide*	Available on the Motorola Online website https://businessonline.motorolasolutions.com. To access the manual, select **Resource Center** → **Production Information** → **Manuals** → **Network Infrastructure** → **Routers and Gateways**.
GPW 8000 Receiver	Includes information about the GPW 8000 Receiver, standalone GPB 8000 Reference Distribution Module (RDM), and standalone Expansion Hub (XHub) which provide inbound coverage for subscriber radios. This manual provides instructions on how to install and configure the GPW 8000 Receiver and the standalone GPB 8000 Reference Distribution Module and standalone Expansion Hub components that support the GPW 8000 Receiver.
GTR 8000 Base Radio	Provides information required to install, configure, and maintain the GTR 8000 Base Radio which provides the RF interface for voice, data, and control traffic transmissions between the infrastructure equipment and subscriber radios.
GTR 8000 Expandable Site Subsystem	Includes information about the GTR 8000 Expandable Site Subsystem (containing base radio, site controller, XHub, and RDM components) which provides the RF interface for voice, data, and control traffic transmissions between the infrastructure equipment and subscriber radios.
MAC Port Lockdown	Provides information on the implementation and management of MAC Port Lockdown for standard Ethernet ports on Hewlett-Packard (HP) switches and for the internal switch of GCP 8000 Site Controllers and GPB 8000 Reference Distribution Modules (RDMs) in ASTRO® 25 systems. Additionally, the document contains instructions for configuring supplemental Ethernet port security, including the implementation of fiber optic ports on HP switches.
Master Site Infrastructure Reference Guide	Covers site-level information required to install and maintain equipment at the ASTRO® 25 system master sites.
MLC 8000 Setup Guide	Provides site-level information and sequences for implementing the MLC 8000 device applied as an analog conventional comparator for analog IP-based simulcast and non-simulcast voting, and as a subsite link converter for conventional analog, digital and mixed mode channels.
MOSCAD Network Fault Management Feature Guide	Provides information required to install, configure, manage, and use the MOSCAD® Network Fault Management (NFM), an optional ASTRO® 25 systems solution that provides tools to configure, monitor, and control auxiliary sys-

Table continued…

Related Information	Purpose
	tem devices, such as tower lights or power and environmental equipment, in communication sites.
Network Time Protocol Server	Provides an introduction to the components that comprise the Network Time Protocol (NTP) server, including detailed procedures for the TRAK 9100 NTP server installation and configuration and for the Field Replaceable Units (FRUs) replacement.
S6000 and S2500 Routers	Provides information relating to the installation, configuration, and management of the S6000 and S2500 routers used in various network locations.
Securing Protocols with SSH	Provides information on the implementation and management of the Secure Shell (SSH) protocol for secure transmission of data between devices in ASTRO® 25 systems, including configuration sequences that minimize downtime when adding this feature to a system that is already in operation.
Simulcast Site Reference	Provides information on the implementation and management of components for the Simulcast Site Reference (SSR) and Global Navigation Satellite System (GNSS) receiver that provide the required time reference in ASTRO® 25 systems.
SNMPv3	Provides information relating to the implementation and management of the SNMPv3 protocol in ASTRO® 25 systems.
Software Download Manager	Provides information on using the Software Download Manager (SWDL) application to transfer and install software in an ASTRO® 25 Repeater subsystem, a High Performance Data (HPD) subsystem, a Simulcast subsystem, an STRV Subsystem, or ASTRO® 25 Express System.
System LAN Switches	Provides use of Hewlett-Packard (HP) switches in ASTRO® 25 systems, including LAN switches and backhaul switches. In addition to common procedures for installation, configuration, operation, and troubleshooting of the switches, this manual provides information for specific ASTRO® 25 system sites and features that HP switches can support.
Terminal Servers LX Series	Covers installation, configuration, and management of the In-Reach® 8000 (LX-4000S) series Terminal Server which supports a network management connection to servers and network transport equipment in the zone.
Trunked IP Simulcast Subsystem Prime Site	Covers the installation, configuration and management of an ASTRO® 25 trunked systems IP simulcast prime site employing the GCP 8000 Site Controller and GCM 8000 Comparator.
Trunked IP Simulcast Subsystem Remote Site	Covers the installation, configuration, and management of ASTRO® 25 trunked systems IP simulcast remote site employing GTR 8000 Base Radios or the GTR 8000 Expandable Site Subsystem.

Table continued…

Related Information	Purpose
Unified Event Manager	Covers the use of Unified Event Manager (UEM) that provides reliable fault management services for devices in ASTRO® 25 systems.
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 ASTRO® 25 systems. UNC has two components: VoyenceControl and Unified Network Configurator Wizards (UNCWs).

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Chapter 1

ASTRO 25 Trunked IP Simulcast Subsystem Description

This chapter provides a high-level description of IP simulcast subsystem and the function it serves on your system.

1.1 ASTRO 25 Trunked IP Simulcast Subsystem Overview

NOTICE: For information on TDMA operation in an IP simulcast subsystem, see the *Dynamic Dual Mode for TDMA Operation Feature Guide*.

An ASTRO® 25 Trunked IP Simulcast Subsystem is a Multi-Site RF (radio frequency) subsystem consisting of an IP simulcast prime site and up to 32 subsite capacity (IP simulcast remote sites) to provide radio coverage to a large area. In addition to supporting simulcast operations, an IP simulcast subsystem can also support voting, data steering, and console interface operations.

Simulcast operation is a radio system topology that uses multiple transmitters on the same frequency in separate locations to transmit the same signal. Simulcast operation is desirable in areas where frequencies are scarce and in areas where physical barriers (for example, mountains and buildings) can cause deficiencies in signal coverage.

Voting operation in a radio system topology employs multiple receivers on the same frequency in separate locations to support a “receive” coverage area equal to the “transmit” coverage area for the subsystem.

With the voting operation, the signal transmission from a subscriber radio may be received by multiple base radio receivers transported to the simulcast prime site, where the signals are processed by devices known as comparators. The comparators perform a “voting” operation to produce the best composite signal (best quality signal) that can be transmitted through the system (routed through the zone core and base radio transmitters).

The remote sites provide the RF coverage of the simulcast subsystem. The remote sites can be up to a maximum of either 15 or 32 physically separate subsites or either 14 or 31 physically separate subsites, with one remote site installed at the same physical location as the prime site. This is known as a colocated remote site. The system treats the entire simulcast subsystem (prime site and all remote sites) as a single site.

A simulcast subsystem with receive-only subsites is a subsystem with a prime site and multiple remote sites. It is basically the same as a regular simulcast subsystem but allows the addition of one or more subsites that do not include transmitters. These subsites are known as receive-only. Receive-only sites extend the talkback range in a simulcast subsystem.

An IP simulcast subsystem can have up to 30 channels with each channel assigned up to either 15 or 32 subsite capacity. These channels can operate in the 700 MHz, 800 MHz, 900 MHz, UHF-R1 (380 -435 MHz), UHF-R2 (435-524 MHz), and VHF (136 -174 MHz) frequencies. See the *Conventional Operations* manual for a listing of the trunked and conventional channel combinations available.

NOTICE: 900 MHz is supported only in trunked channels within a GTR 8000 Expandable Site Subsystem and in receive only remote sites with GPW 8000 receivers.

1.2 ASTRO 25 Trunked IP Simulcast Prime Site Configurations

The following configurations are available for an IP simulcast prime site for up to 32 subsite capacity:

- Trunked IP Simulcast Prime Site – Non-Redundant Comparator Configuration (15 Subsite Capacity)
- Trunked IP Simulcast Prime Site – Non-Redundant Comparator Configuration (32 Subsite Capacity)
- Trunked IP Simulcast Prime Site – Redundant Comparator Configuration (15 Subsite Capacity)
- Trunked IP Simulcast Prime Site – Redundant Comparator Configuration (32 Subsite Capacity)
- Trunked IP Simulcast Prime Site – Geographic Redundancy Configuration

Each standard or high availability configuration can support the following network options:

- Colocated Remote Site
- Point-to-Point Components
- Colocated Prime Site at the Master Site
- Receive-only Remote site

1.2.1 Trunked IP Simulcast Prime Site with Non-Redundant Comparator Configuration (15 Subsite Capacity)

The standard configuration prime site with a 15 subsite capacity is available in a non-redundant or redundant link configuration. The standard configuration consists of redundant site controllers, two Ethernet LAN switches, and either a redundant or non-redundant prime site router (more than two T1 links or Ethernet) or site gateway (Ethernet or two T1 links or less) providing the interface to the zone core. The prime site supports a subsite access router pair (T1/E1 or Ethernet) or a subsite access gateway pair (Ethernet) as the interface link to the subsystem remote sites.

The prime site supports up to 30 non-redundant GCM 8000 Comparators, which interface directly to the Ethernet LAN switches.

The standard configuration prime site supports voting, simulcast, and multicast operations for conventional channels and simulcast operations for trunked channels. Support at the prime site can accommodate channels that are all trunking, all conventional, or a combination of trunking and conventional channels.

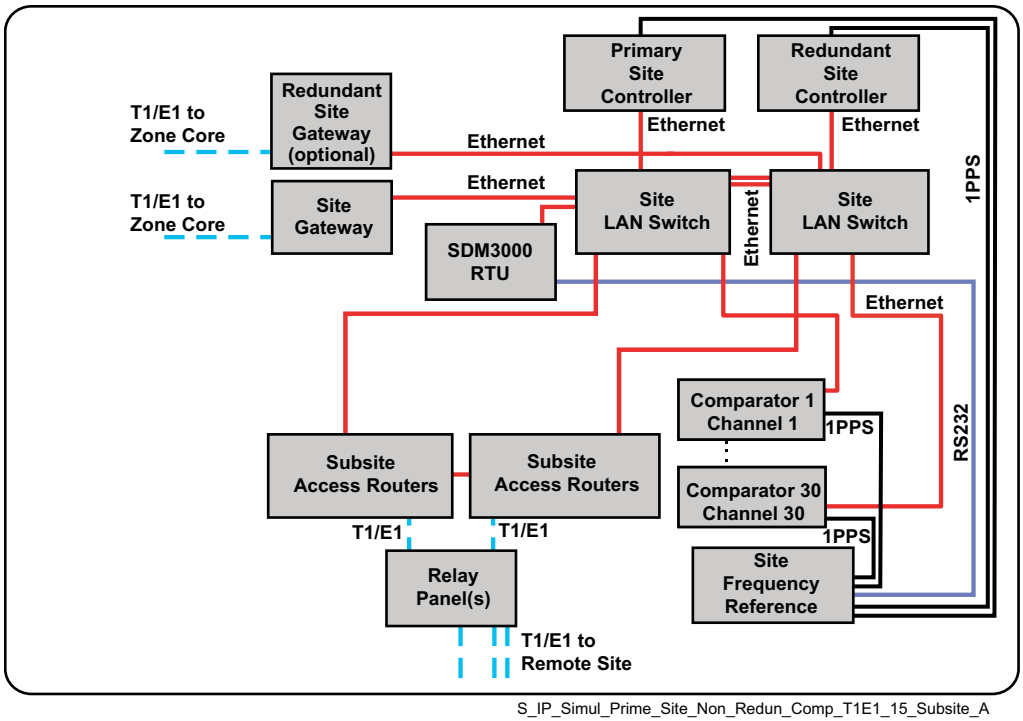
CWR patch panels are required for subsystems with T1/E1 links. A 15 subsite capacity prime site requires the following number of CWR panels, depending on the link configuration:

- Single site links – one CWR patch panel
- Dual/single link combinations – one or two CWR patch panels
- Dual site links only – two CWR patch panels

When using Ethernet links, each subsite access router or gateway is connected to a backhaul switch.

For more information on adding conventional voting, simulcast, and multicast channels to an ASTRO® 25 trunked site, see the *Conventional Operations* manual.

Figure 1: ASTRO 25 IP Simulcast Prime Site – Non-Redundant Comparator Configuration (15 Subsite Capacity) with T1/E1 Links To The Remote Subsite



S_IP_Simul_Prime_Site_Non_Redun_Comp_T1E1_15_Subsite_A

1.2.2

Trunked IP Simulcast Prime Site with Non-Redundant Comparator Configuration (32 Subsite Capacity)

A standard configuration prime site with a 32 subsite capacity is the same as a standard configuration prime with a 15 subsite capacity, except there are three Ethernet LAN switches and an additional subsite access router or gateway pair. Switches #1 and #2 are paired between the two subsite access router or gateway pairs and switch #3 is connected to both subsite access router or gateway pairs.

The prime site supports up to 30 non-redundant GCM 8000 Comparators, which interface directly to the Ethernet LAN switches.

The standard configuration prime site supports voting, simulcast, and multicast operations for conventional channels and voting and simulcast for trunked channels. Support at the prime site can accommodate channels that are all trunking, all conventional, or a combination of trunking and conventional channels.

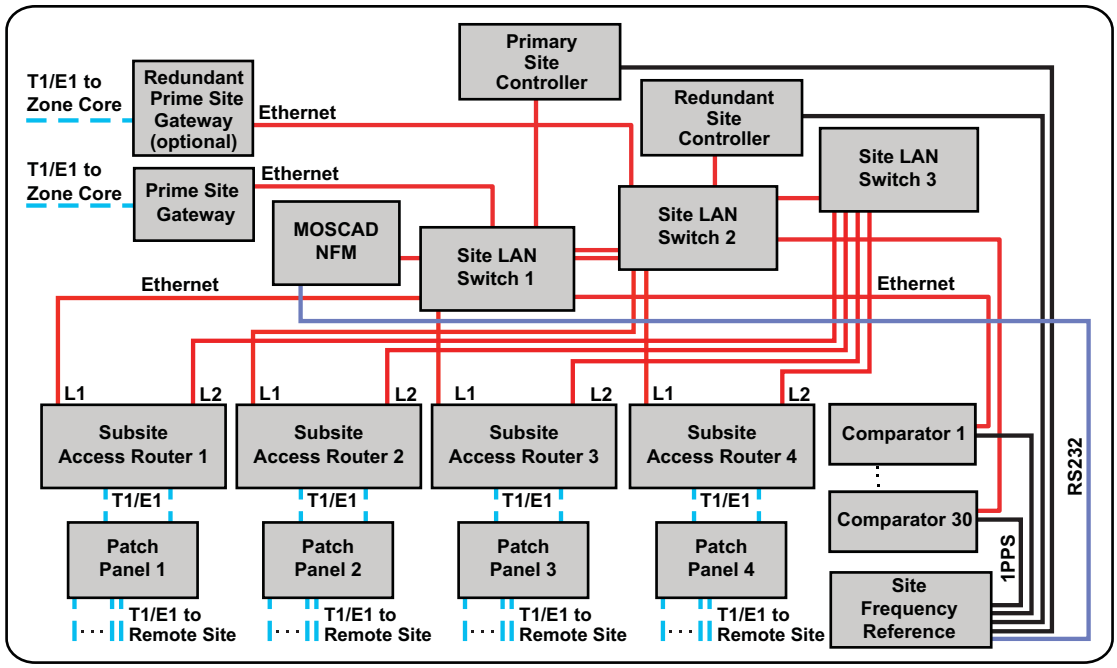
Cooperative WAN Routing (CWR) patch panels are required for subsystems with T1/E1 links. Additional CWR patch panels for T1/E1 links from each subsite access router pair are required for a 32 capacity prime site, depending on the following configurations:

- Single site links – two CWR patch panels.
- Dual/single link combinations – three or four CWR patch panels.
- Dual site links only – four CWR patch panels.

When using Ethernet links, each subsite access router or gateway is connected to a backhaul switch.

NOTICE: A 32 subsite capacity configuration is available in M1, M2, and M3 system configurations.

Figure 2: ASTRO 25 IP Simulcast Prime Site – Non-Redundant Comparator Configuration (32 Subsite Capacity) with T1/E1 Links To The Remote Subsite



S_IP_Simul_Prime_Site_Non_Redun_Comp_T1E1_32_Subsite_B

1.2.3

Trunked IP Simulcast Prime Site with Redundant Comparator Configuration (15 Subsite Capacity)

A 15 subsite capacity Redundant Comparator configuration prime site supports two 48-port Ethernet LAN switches, redundant comparators, and a subsite access router or gateway pair. Switches #1 and #2 are paired between the two subsite access router or gateway pairs and connect to the redundant comparators.

For redundant comparator configuration, if one of the switches fails, the redundant comparator on the other switch activates and restores channel capacity.

The prime site supports up to 30 channels are supported with a redundant comparator pair per channel.

In a 15 subsite configuration, site LAN switch #1 connects to:

- Prime site router or gateway
- Primary site controller
- Comparators supporting redundant preferred comparators with odd-numbered channels and redundant non-preferred comparators with even-numbered channels
- Subsite access router or gateway 1

In a 15 subsite configuration, site LAN switch #2 connects to:

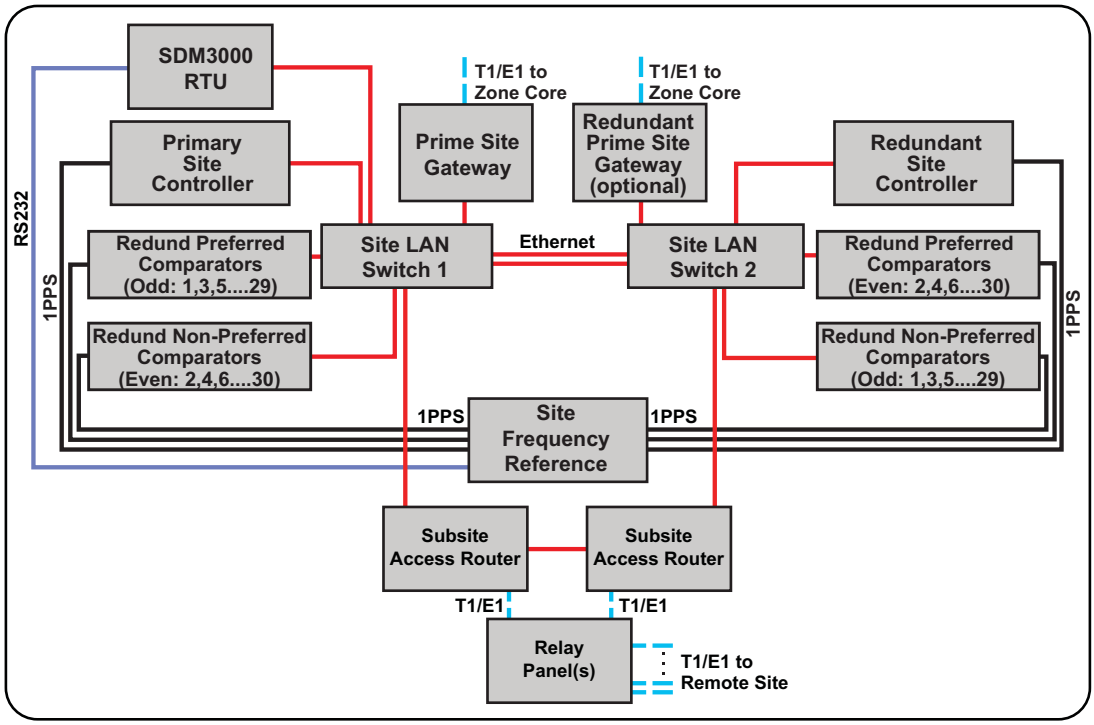
- Redundant site router or gateway (if installed).
- Redundant site controller.
- Comparators supporting redundant preferred comparators with even-numbered channels and redundant non-preferred comparators with odd-numbered channels.
- Subsite access router or gateway 2.

Cooperative WAN Routing (CWR) patch panels are required for subsystems with T1/E1 links. The total number of CWR patch panels are required for a 15 subsite capacity prime site is as follows:

- Single site links – one CWR patch panel.
- Dual/single link combinations – one or two CWR patch panels.
- Dual site links only – two CWR patch panels.

When using Ethernet links, each subsite access router or gateway is connected to a backhaul switch.

Figure 3: ASTRO 25 IP Simulcast Prime Site – Redundant Comparator Configuration (15 Subsite Capacity) with T1/E1 Links to the Remote Subsites



1.2.4

Trunked IP Simulcast Prime Site with Redundant Comparator Configuration (32 Subsite Capacity)

A Redundant Comparator configuration prime site with a 32 subsite capacity is the same as a Redundant Comparator configuration prime site with a 15 subsite capacity, except there are three Ethernet LAN switches and an additional subsite access router or gateway pair. Switches #1 and #2 are paired between the two subsite access router or gateway pairs and switch #3 is connected to both subsite access router or gateway pairs.

Up to 30 channels are supported with a redundant comparator pair per channel.

In a redundant comparator configuration, if one of the switches fails, the redundant comparator on the other switch activates and restores channel capacity.

In a 32 subsite configuration, site LAN switch #1 connects to:

- Prime site router or gateway.
- Primary site controller.
- Half of the comparators supporting redundant preferred comparators with odd-numbered channels and redundant non-preferred comparators with even-numbered channels.

- Site LAN switch #2
- Subsite access router or gateway #1 and #3

In a 32 subsite configuration, site LAN switch #2 connects to:

- Redundant site router or gateway (if installed).
- Redundant site controller.
- Half the comparators supporting redundant preferred comparators with even-numbered channels and redundant non-preferred comparators with odd-numbered channels.
- Site LAN switch #3
- Subsite access router or gateway #2 and #4

In a 32 subsite configuration, site LAN switch #3 connects to:

- Site LAN switch #2.
- Subsite access router or gateway #1, #2, #3, and #4.

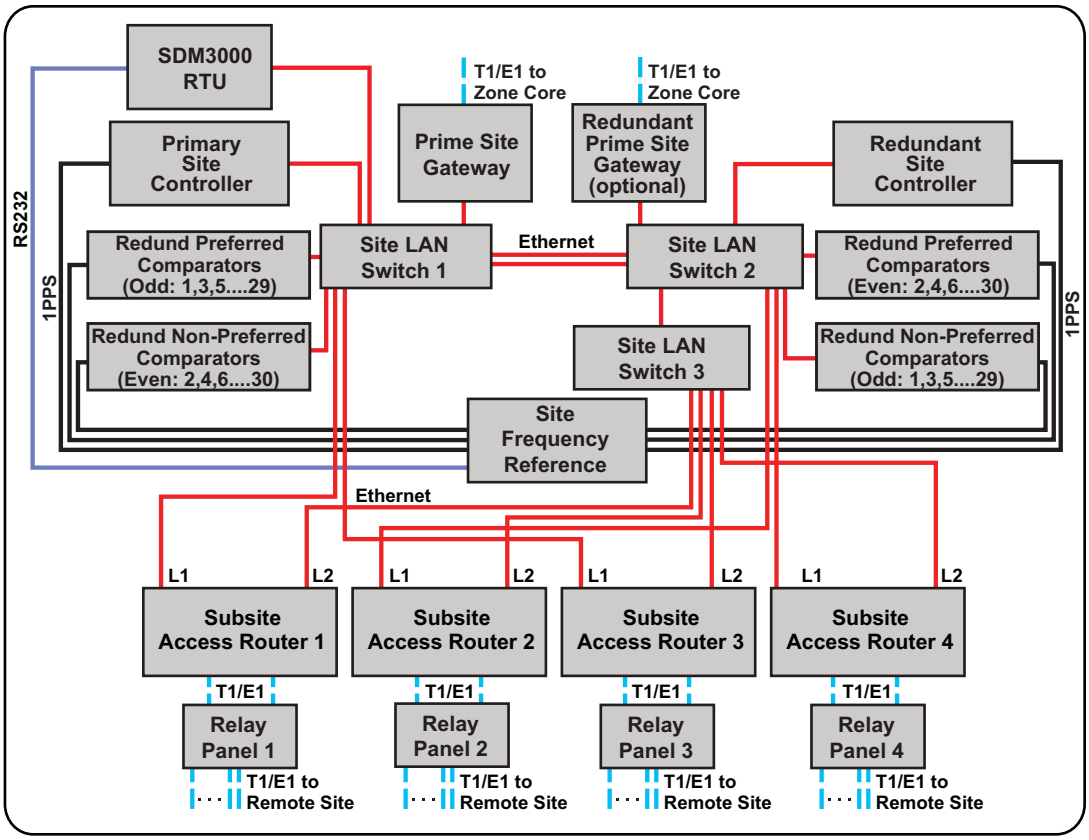
Cooperative WAN Routing (CWR) patch panels are required for subsystems with T1/E1 links. Additional CWR patch panels for T1/E1 links from each subsite access router pair are required for a 32 capacity prime site, depending on the following configurations:

- Single site links – two CWR patch panels.
- Dual/single link combinations – three or four CWR patch panels.
- Dual site links only – four CWR patch panels.

When using Ethernet links, each subsite access router or gateway is connected to a backhaul switch.

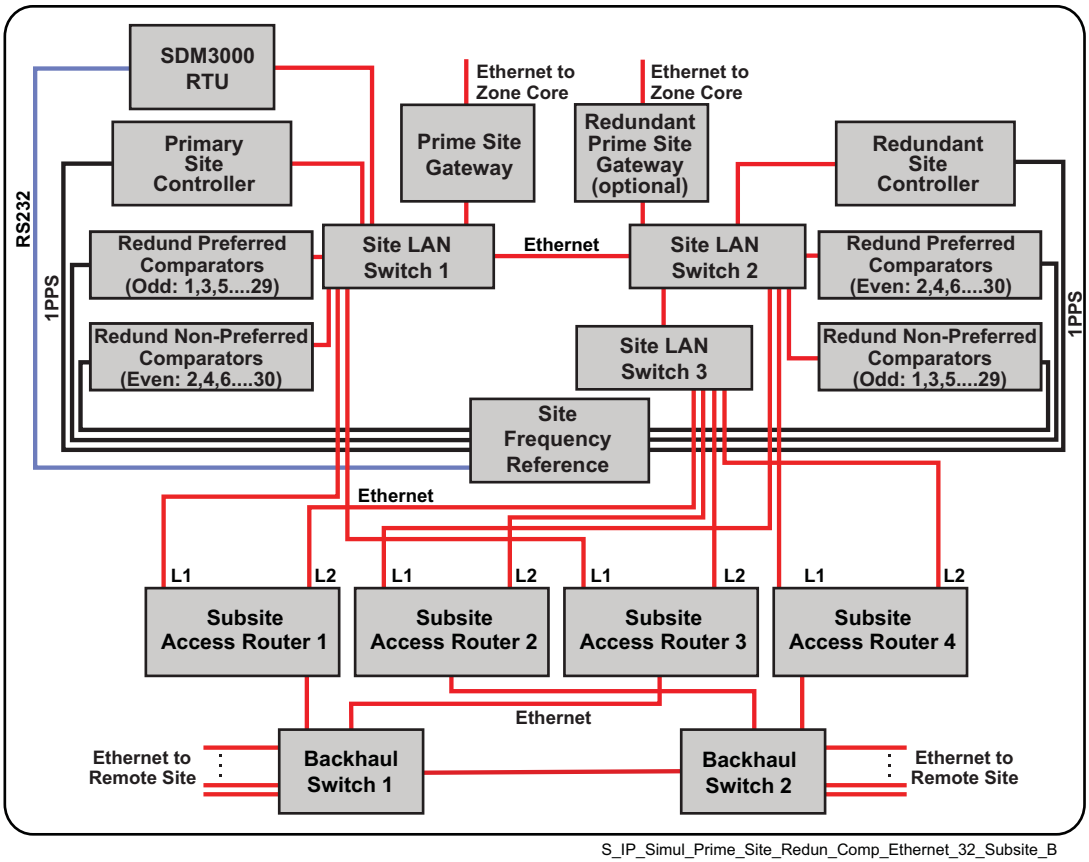
NOTICE: A 32 subsite capacity configuration is available in M1, M2, and M3 system configurations.

Figure 4: ASTRO 25 IP Simulcast Prime Site – Redundant Comparator Configuration (32 Subsite Capacity) with T1/E1 Links to the Remote Subsites



S_IP_Simul_Prime_Site_Redun_Comp_T1E1_32_Subsite_B

Figure 5: ASTRO 25 IP Simulcast Prime Site – Redundant Comparator Configuration (32 Subsite Capacity) with Ethernet Links to the Remote Subsites



S_IP_Simul_Prime_Site_Redun_Comp_Ethernet_32_Subsite_B

1.2.5

Trunked IP Simulcast Prime Site with Geographic Redundancy Configuration

A Trunking Prime Site with Geographic Redundancy (TPSGR) configuration provides two geographically separate simulcast prime site locations to protect against failure of one of the prime site locations. Although the site is split into two halves, it still appears to the system as a single prime site. Each half of the Simulcast prime site is referred to as a split-prime site. The primary prime site designates the split-prime site which is equipped with Site Controller 1 and Site Controller 2. The other split-prime site is the secondary prime site and is equipped with Site Controller 3.

During normal operation, the site controllers and comparators at the primary prime site are the preferred active components providing wide area service. The site controller and comparators at the secondary prime site only activate upon failure of the Primary Prime Site and activation logic favors the redundant preferred comparators. Under normal conditions, all comparators at the primary prime site are active.

For geographically redundant prime sites, it is critical to configure which comparators are preferred for the redundant pairs. The comparator activation logic utilizes this information to automatically activate the comparators with the desired configuration. Only one comparator of the pair is configured as the **redundant preferred**. The redundancy function of the comparators is configured through Configuration/Service Software (CSS) and Unified Network Configurator (UNC). All comparators connected to:

- LAN switch #1 at the primary prime site must be set to **redundant preferred**.

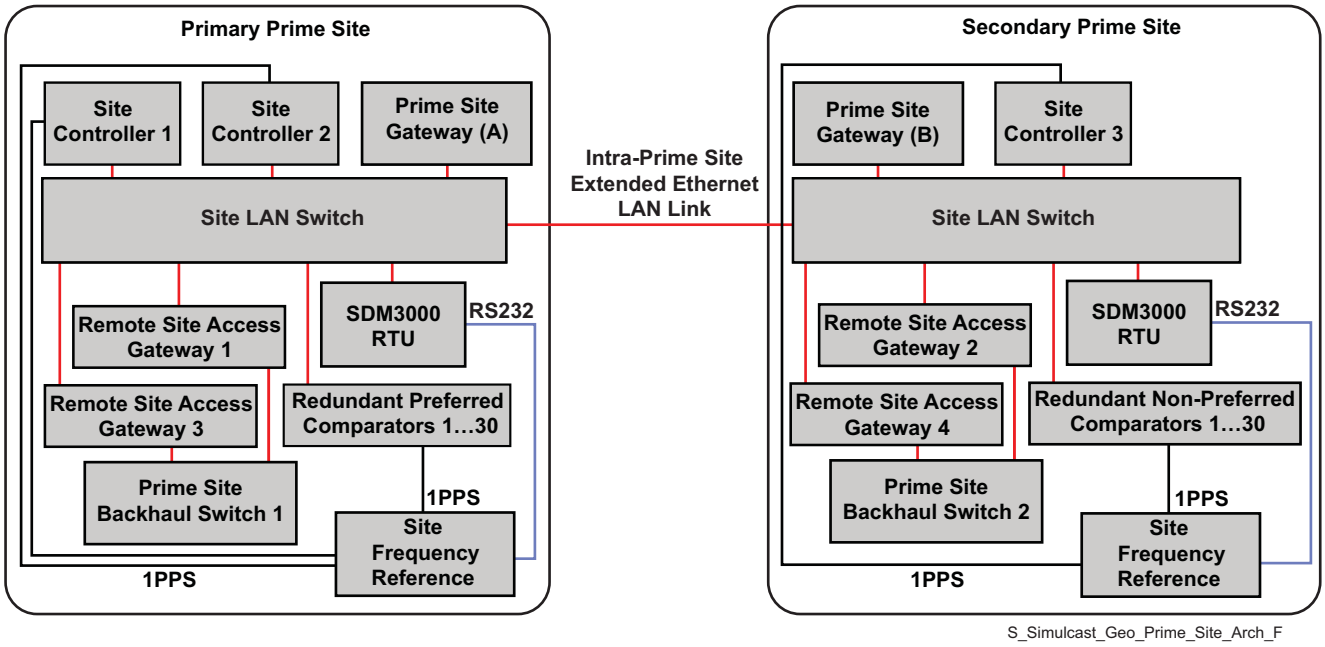
- LAN switch #2 at the secondary prime site must be set to **redundant non-preferred**.

If either comparator is not configured to the proper redundancy value, this error may result in both comparators activating to an undesirable configuration resulting in the loss of wide area operation in the event of a switch failure. To ensure this type of failure does not occur, the comparator reports a new fault when it detects an improperly configured redundant comparator.

When site resources are spread across the primary prime site and secondary prime site, the failure or total destruction of a prime site location does not result in the loss of wide area radio communications for any significant period. If the primary prime site fails, the site equipment at the secondary prime site is utilized for wide area operation. The subsystem experiences a brief outage due to the duration it takes for the standby comparators to transition to the active state (followed by base radio switchover) and the time it takes for Site Controller 3 to activate and set up a site control path with the zone controller. The total time to restore wide area operation is less than 60 seconds.

The primary prime site and secondary prime site interface through an intra-prime site extended ethernet LAN link. The following diagram shows the basic relationship between the Primary Prime Site and Secondary Prime Site supporting the TPSGR configuration.

Figure 6: ASTRO 25 IP Simulcast Prime Site Geographic Redundant Configuration



During failover to the secondary prime site, a brief outage occurs. A brief outage causes subscriber radios to scatter to adjacent sites (if available). In addition, when the control channel is restored, the control channel briefly broadcast that the site is in site trunking due to the time it takes to establish a site control path with the zone controller.

ASTRO® 25 system configurations supporting geographic redundancy of the Trunked IP Simulcast Prime Site include M1/M2/M3 zone core.

NOTICE: The geographically redundant prime site feature is not supported for a system employing an L1/L2 zone core and Non-DSR (M1).

The following summarizes the supported system configuration characteristics:

- IP Simulcast Trunking (15 subsite and 32 subsite Redundant Comparator configuration only).
- Ethernet site links (T1/E1 not supported).
- Single subsite link and dual subsite links.
- Non-DSR (M2/M3) and DSR configurations (M1/M3).

- FDMA and Phase 2 TDMA.
- Supported for voice and data services.
- Colocated HPD site at subsites or a primary prime site.
- Colocated Conventional site at subsites or primary prime site.
- Intra-prime site links are not encrypted.
- High Availability subsites and Standard subsites
- Receive only trunking sites

NOTICE: For M1 configurations, DSR is required to provide the necessary transport connectivity to the primary and secondary prime site.

The LAN switches required to terminate the intra-prime site link at each prime site is configured for a fixed 10 Mbps or 100 Mbps data rate. The data rate required for these links is driven from the number of subsites and channels in the system configuration.

Two TRAK devices are utilized, one at the primary prime site and one at the secondary prime site, to provide a timing reference to the comparators and site controller at each location.

Up to 30 channels are supported with a redundant comparator pair per channel.

In a Primary Prime site, LAN switch #1 connects to:

- Site Controller 1 and 2 (SC1, SC2).
- Prime Site Gateway (A).
- Redundant Preferred comparators (even and odd-numbered channels).
- Subsite access router or gateway 1 (15 subsite capacity).
- Subsite access router and gateway 1 and 3 (32 subsite capacity).
- Intra-Prime Site Extended Ethernet LAN link to Site LAN switch #2.

In a Secondary Prime site LAN switch #2 connects to:

- Site Controller 3 (SC3).
- Prime Site Gateway (B).
- Redundant Non-Preferred comparators (even and odd-numbered channels).
- Subsite access router or gateway 2 (15 subsite capacity).
- Subsite access router or gateway 2 and 4 (32 subsite capacity).
- Intra-Prime Site Extended Ethernet LAN link to Site LAN switch #1.

When using Ethernet links, each subsite access router or gateway is connected to a backhaul switch.

1.2.6
Trunked IP Simulcast Prime Site with Colocated Remote Site

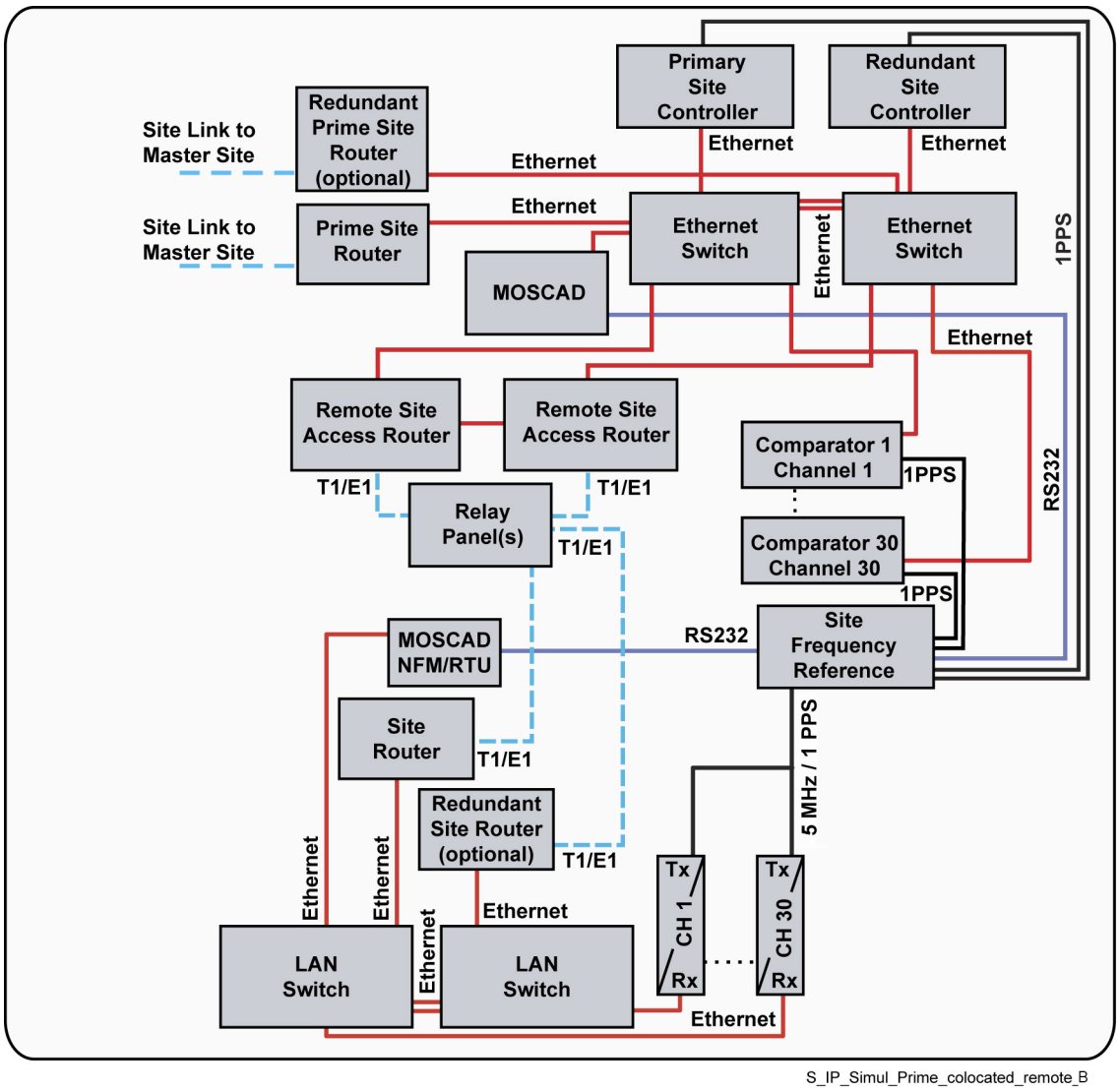
Combining a trunked IP simulcast prime site and a trunked IP simulcast remote site in the same physical location is often economically desirable.

With T1/E1 links, the T1/E1/FT1/FE1 link from the colocated remote transport device (site router or gateway) is connected directly to the relay patch panel. With Ethernet links, the colocated remote transport device (router or gateway) interfaces to a backhaul switch, to support transport to the prime site infrastructure where remote site access routers or gateways route IP traffic between the prime site and the colocated remote site.

A Trunked IP Simulcast Prime Site with a colocated remote site can be trunked RX-only Remote Site.

NOTICE: When setting up transport devices to support Ethernet site links, the type of backhaul network along with other considerations must be taken into account. See the *Flexible Site and InterZone Links* manual for more details.

Figure 7: ASTRO 25 Trunked IP Simulcast Prime Site Standard Configuration with Colocated Remote Site (T1/E1 Links, 15 Subsite Shown)



1.2.7

Trunked IP Simulcast Prime Site with Point-to-Point Components

A trunked IP simulcast prime site standard configuration with Point-to-Point components configures to the fault manage radio transmission equipment using either T1/E1 links or Ethernet links.

See the *Fault Management Reference Guide* for more details regarding Fault Management using PTP components.

Figure 8: ASTRO 25 Trunked IP Simulcast Prime Site Standard Configuration With Point-to-Point Components Using T1/E1 Links (15 Subsites Shown)

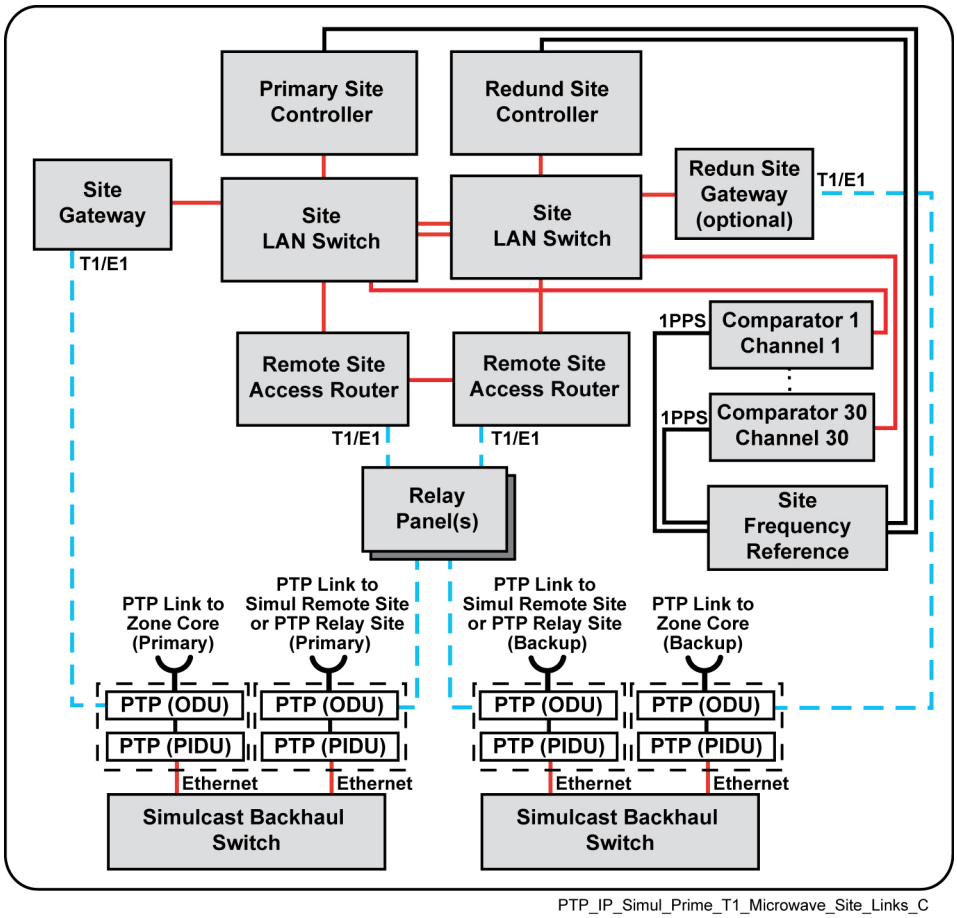
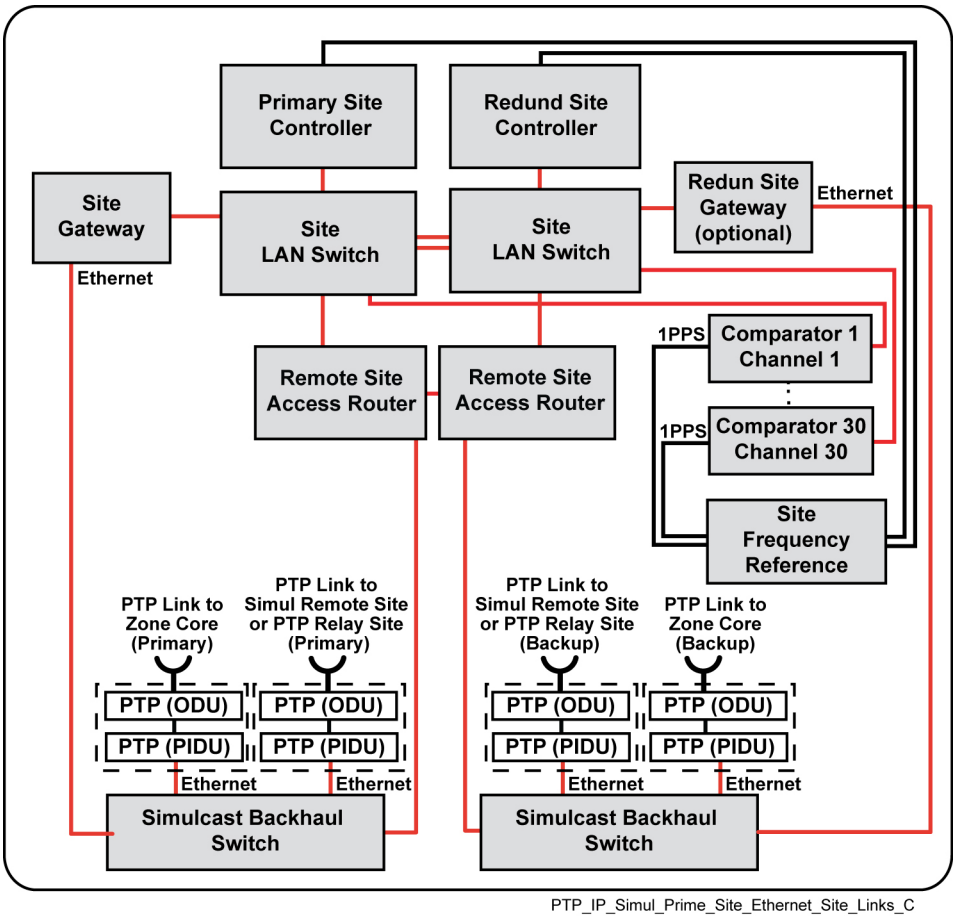


Figure 9: ASTRO 25 IP Simulcast Prime Site Standard Configuration With Point-to-Point Components Using Ethernet Links (15 Subsites Shown)



1.2.8
Colocated Prime Site at the Master Site

Combining an IP simulcast prime site and master site (zone core) in the same physical location is often economically desirable.

With T1/E1 links, the T1/E1/FT1/FE1 link from the colocated transport device (prime site router or gateway) is connected directly to a relay patch panel. With Ethernet links, the transport device for the prime site (prime site router or gateway) interfaces to a backhaul switch to support transport to/from the prime site and zone core.

NOTICE: When setting up transport devices to support Ethernet site links, the type of backhaul network along with other considerations must be taken into account. See the *Flexible Site and InterZone Links* manual for more details.

If the prime site is colocated with the master site, only one TRAK 9100 Simulcast Site Reference (SSR) with a 9300 SSR DDU unit is required to serve the master site and prime site. For more information on colocated prime sites with the master site, see the *Master Site Infrastructure Reference Guide*.

1.3
ASTRO 25 Trunked IP Simulcast Remote Site Configurations

The following configurations are available for an IP simulcast remote site:

- Standard Configuration

- High Availability Configuration
- Trunked Receive-only Remote Site Configuration

Each standard or high availability configuration can support the following site network options:

- Point-to-Point Components

1.3.1
Trunked IP Simulcast Remote Site Standard Configuration

A trunked IP simulcast remote site with a GTR 8000 Expandable Site Subsystem in a standard configuration, configures connections from the base radios to the site frequency reference and the LAN switches through the XHubs.

Figure 10: ASTRO 25 Trunked IP Simulcast Remote Site with GTR 8000 Expandable Site Subsystem — Standard Configuration

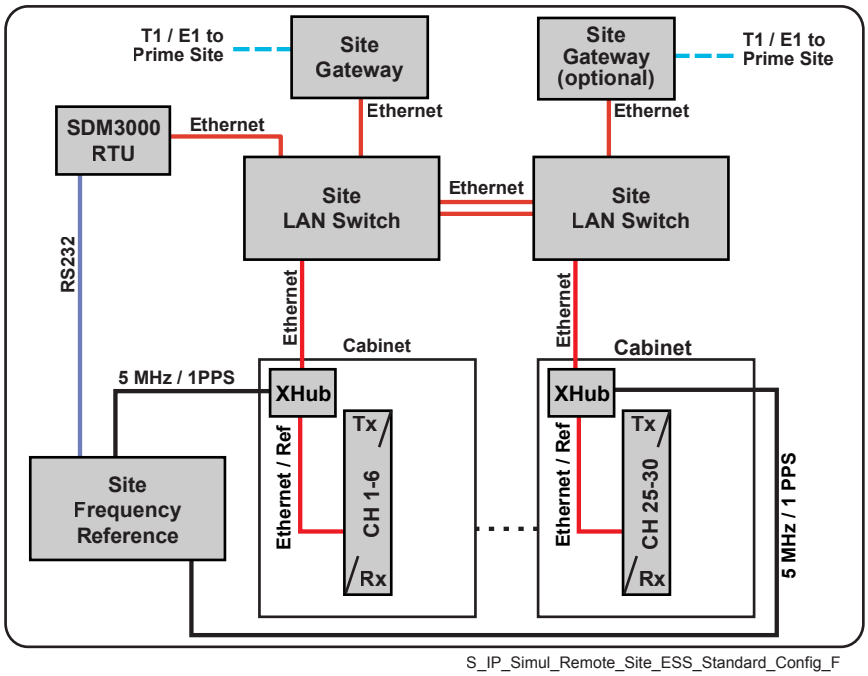
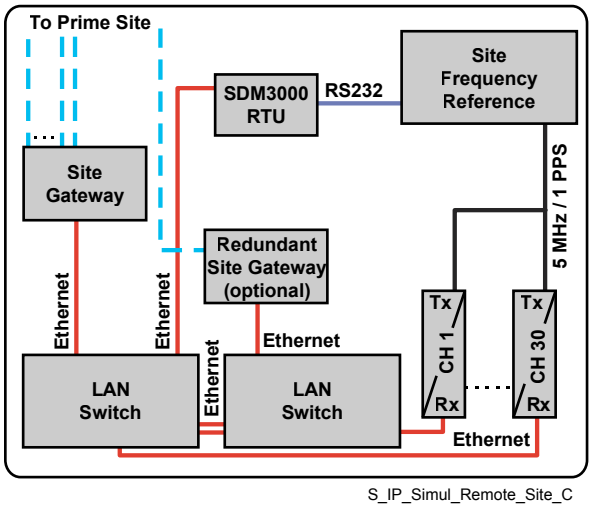


Figure 11: ASTRO 25 Trunked IP Simulcast Remote Site — Standalone Base Radio Configuration



1.3.2

Trunked IP Simulcast Remote Site with High Availability Configuration

An ASTRO® 25 trunking system high availability configuration in the IP simulcast remote site provides integrated Ethernet LAN switching and integrated site reference distribution to the base radios and receivers through the GPB 8000 Reference Distribution Modules (RDMs) within a GTR 8000 Expandable Site Subsystem, eliminating the external HP LAN switches and TRAK 9100 Simulcast Site Reference at the remote site.

Two RDMs are installed in the first cabinet/rack utilizing two Global Navigation Satellite System (GNSS) units as timing reference sources to all the base radios at the remote site.

High availability configuration is intended to ensure that a single point of failure for the switching function or time reference does not cause the loss of any channels at a remote site.

XHubs allow the RDM to support additional GTR 8000 Expandable Site Subsystem cabinets/racks with channels beyond what the RDM can support on its own. One RDM supports up to five XHubs with each XHub supporting up to six base radios.

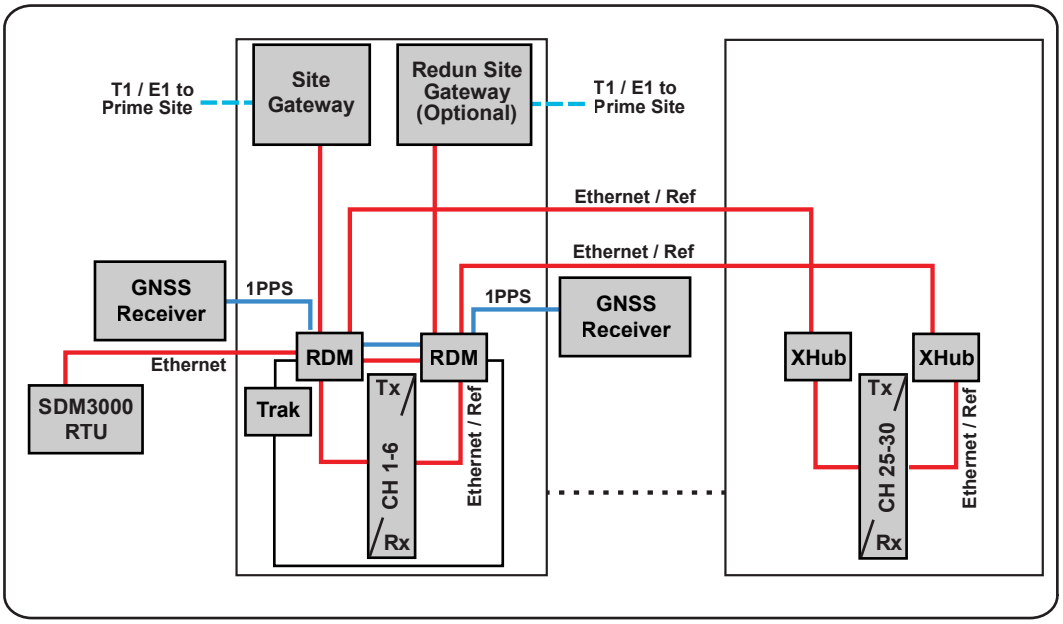
An IP simulcast remote site in a high availability configuration is configured with one or two integrated gateways within the first cabinet/rack and up to six GTR 8000 Expandable Site Subsystem cabinets/racks.

For detailed information on the IP simulcast remote site high availability configuration, see the *GTR 8000 Expandable Site Subsystem* manual.

A trunked IP simulcast remote site with a GTR 8000 Expandable Site Subsystem in a high availability configuration is configured with integrated LAN switching and site frequency reference from the GPB 8000 Reference Distribution Modules to the base radios. Two GNSS units supply 1PPS signaling to the RDMs.

NOTICE: A simulcast remote site configured with high availability can be paired with any prime site configuration.

Figure 12: ASTRO 25 Trunked IP Simulcast Remote Site with GTR 8000 Expandable Site Subsystem — High Availability Configuration with Extended Holdover



1.3.3

Trunked IP Simulcast Remote Site with Point-to-Point Components

A trunked IP simulcast remote site configuration configures standalone base radios with Point-to-Point components used to fault manage radio transmission equipment using T1/E1 links.

A trunked IP simulcast remote site configuration using standalone base radios with Point-to-Point components configures to fault manage radio transmission equipment using Ethernet links. See the *Fault Management Reference Guide* for more details regarding Fault Management using PTP components.

Figure 13: ASTRO 25 Trunked IP Simulcast Remote Site With Point-to-Point Components Using T1/E1 Links

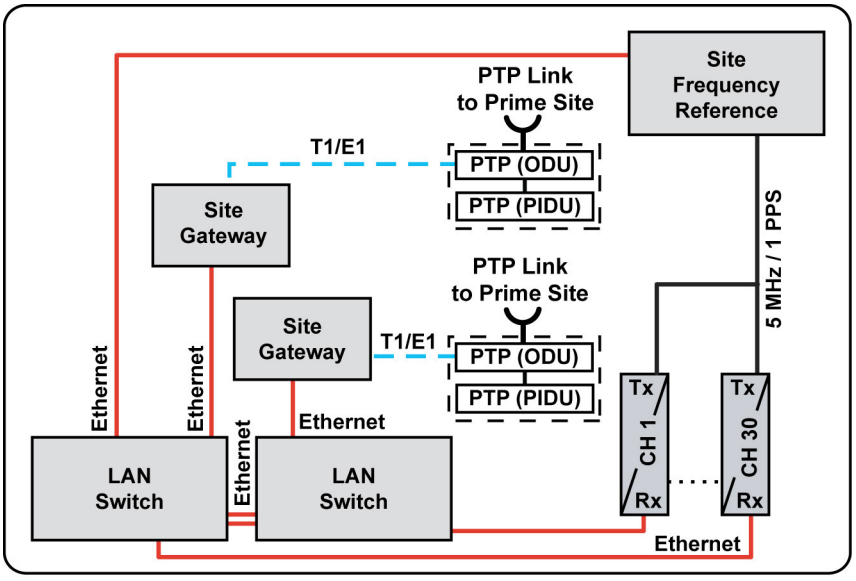
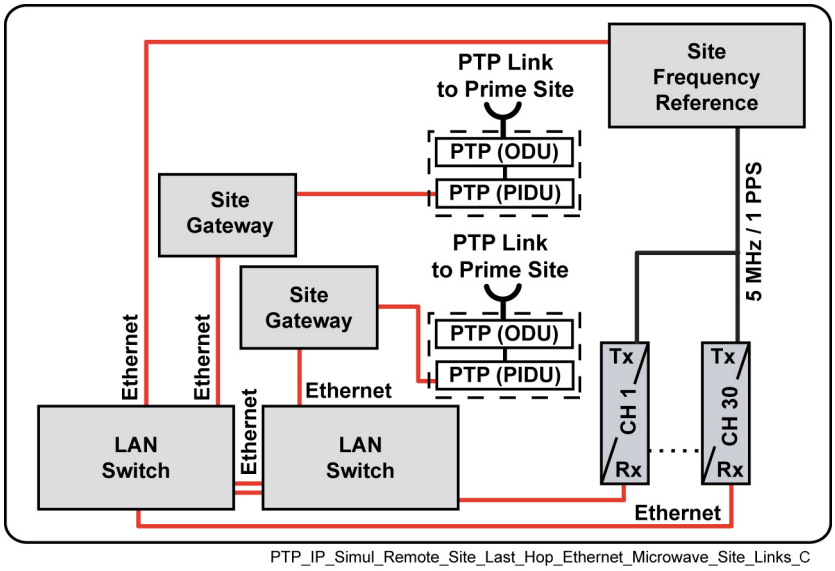


Figure 14: ASTRO 25 Trunked IP Simulcast Remote Site With Point-to-Point Components Using Ethernet Links



1.3.4
Trunked IP Simulcast Receive-Only Remote Site Subsystem

Trunked receive-only remote sites are part of a simulcast subsystem with receive only subsites or Single Transmitter, Receiver Voting (STRV) subsystem. The receive-only subsite is the same as a regular simulcast subsystem but allows the addition of one or more subsites that do not include transmitters. These subsites are known as receive-only. Trunked Receive-only remote sites are equipped with:

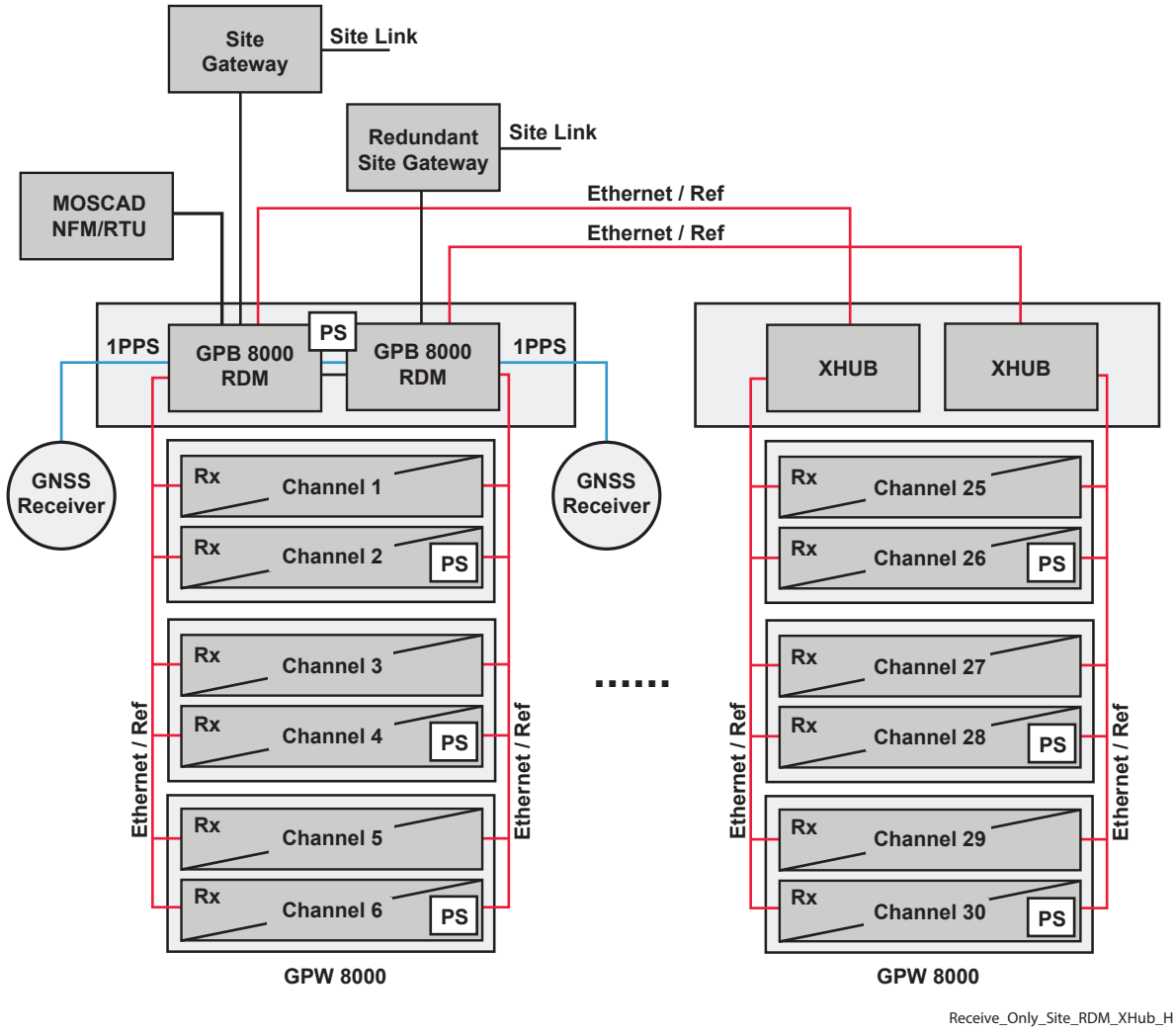
- GPW 8000 Receivers - Dual slot chassis with one or two receiver modules.
- GPB 8000 Reference Distribution Modules (RDMs) and Expansion Hubs (XHubs) in a standalone configuration.
- S2500 Routers or GGM 8000 Gateways (T1/E1 or Ethernet).
- Two Global Navigation Satellite System (GNSS) units with RDM.
- TRAK devices (optional).

NOTICE: The RDMs and XHubs in a standalone configuration are used only in receive-only trunked sites, and are installed in a standard rack with the GPW 8000 Receivers.

Receive-only trunked remote sites use the RDMs in standalone configuration with GPW 8000 Receivers to provide the time reference distribution and switching functions. The XHub (cabinet and site) is fault managed along with other devices at the remote sites (RDM, TRAK, GNSS units, GPW 8000 Receivers).

A receive-only trunked remote site can be paired with transmit remote sites in a standard or High Availability configuration.

Figure 15: Simulcast Trunked Receive-Only Remote Site Configuration



A trunked receive-only remote site (equipped with only receivers and no transmitters) can be part of a Multicast or STRV subsystem and can be co-located with the prime site. A remote site must be a transmit or a receive-only site and a mixture of transmit and receive-only stations are not supported. The receivers allow the addition of one or more receive-only subsites to their IP simulcast subsystem. The receiver expands low power “talk-in” coverage to match high power “talk-out” coverage without deploying additional transmit sites.

Trunked Receive-only remote sites operate in the following modes:

FDMA-only voice and IV&D data operation

A 1PPS time reference signal is not required at receive-only remote sites. The RDM provides a 10 MHz frequency reference to the GPW 8000 Receivers. A Site reference device is not required in a receive-only remote site co-located at a prime site for Frequency Division Multiple Access (FDMA)-only and IV&D (time launching of signals from multiple transmitters is not required on a single-transmitter system).

TDMA or Enhanced Data operation

Although a receive-only site cannot transmit, a 1PPS time reference signal is required to provide time synchronization to the GPW 8000 Receivers. GNSS units or a TRAK are necessary to provide 1PPS signaling inputs to the RDMs, which distribute 1PPS/5 MHz time and frequency references to the GPW 8000 Receivers. Site reference devices are required at a receive-only remote site co-located at a prime site for Time Division Multiple Access (TDMA) or for Enhanced Data.

The 1PPS/5 MHz signals to the receivers are provided by the RDM based on the optional 1PPS inputs received from the Simulcast Site Reference (GNSS units and/or TRAK for extended holdover).

RDMs provide switching functions at the remote site and support up to six GPW 8000 Receivers. The XHubs are used to support up to six additional receivers.

Channel failures at a trunked receive-only remote site are communicated to the Network Management subsystem through the IP network.

1.4 Single Transmit Receive Voting STRV Subsystem

The Single Transmitter, Receive Voting (STRV) subsystem is similar to a Simulcast Subsystem with a Prime Site and various remote sites (sub-sites) which supports voting of inbound signals, but the STRV subsystem employs a single transmitter. A Single Transmitter, Receiver Voting (STRV) subsystem covers a single geographic area with a single transmitter (in contrast with Simulcast which includes multiple transmitter sites).

STRV topology maximizes frequency and cost efficiency in those areas that can be covered by a single, high-powered transmit site. An STRV subsystem is considered part of a Multi-Site subsystem where the prime site is the central control location for all other sites in the subsystem. An STRV subsystem has the following characteristics:

- Provides radio communication support in the 700 MHz, 800 MHz, 900 MHz, UHF-R1 (380 -435 MHz), UHF-R2 (435-524 MHz), and VHF (136 -174 MHz) frequencies.
- Contains many of the same components found in a Simulcast subsystem except for site reference devices.
- Supports up to 30 RF channels.
- Geographic Redundancy of the Prime Site is not supported in an STRV subsystem.
- Data channels are supported.

An STRV subsystem consists of the following:

- One prime site with or without a collocated remote site and with the same components as a Simulcast prime site.
- Site Reference device is not required in prime site for FDMA-only and IV&Data (Time launching of signals from multiple transmitters is not required on a single-transmitter system). Site Reference devices are required in Prime Site for TDMA or Enhanced Data.
- One remote transmit site with transmit and receive functionality.
- One or more receive only remote sites that extend the talkback range.
- Prime Site with one collocated transmit or receive only remote site.

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Chapter 2

ASTRO 25 Trunked IP Simulcast Subsystem Technical Overview

This chapter explains how the IP simulcast subsystem works in the context of your system.

2.1 Trunked IP Simulcast Prime Site Components

A prime site includes either a single site link or dual site link to the master site, and two or three Ethernet LAN switches, and a WAN link to each remote site.

The prime site and prime site with receive-only subsystem, is connected to the master site through either one or more T1(s) or E1(s), a Fractional T1, an E1 (FT1/FE1), or Ethernet link; or redundant T1, E1, or Ethernet links. Subsite access routers or gateways work in pairs to route the traffic to each remote site through a T1/E1/FT1/FE1 or Ethernet link. Dual site links to remote sites support both T1/E1 and Ethernet in dual link configurations. Hybrid site links require no more than two physical E1/T1 links.

Redundant GCP 8000 Site Controllers, access routers or gateways, prime site routers, and up to 30 comparators (standard configuration) or 60 comparators (redundant comparator configuration) are connected to the IP prime site Ethernet LAN switches. All communication between the site controllers and the comparators is accomplished through the switches.

The equipment used in the IP simulcast subsystem prime site and simulcast with receive-only subsystem configuration is as follows:

- Redundant GCP 8000 Site Controllers
- Two HP 2610 or HP 2620 Ethernet LAN Switches (standard configuration, 15 subsite capacity)
- Two Ethernet LAN Switches (non-redundant and redundant comparator configurations, 15 subsite capacity, geographically redundant configuration, 15 or 32 subsite capacity)
- Three HP 2620: Two HP 2620-48 and One HP 2620-24 Ethernet LAN Switches (non-redundant and redundant comparator configurations, 32 subsite capacity)
- GCM 8000 Comparators (trunked and IP conventional)
- TRAK 9100 Simulcast Site Reference (No TRAK 9100 for FDMA-only/IV&D data, TRAK 9100 required for TDMA/Enhanced Data for a single transmitter, receiver voting (STRV) subsystem). In a single transmitter receiver voting (STRV) subsystem, TRAK 9100 is only required in prime site for TDMA/Enhanced Data operation and not required for FDMA-only/IV& data.
- TRAK 9300 Simulcast Site Reference (prime site colocated at the master site)
- Global Positioning Satellite Antenna
- Prime Site S6000 Routers (T1/E1 or Ethernet link), or
- Prime Site GGM 8000 Gateway (T1/E1 or Ethernet link)
- One Subsite Access S6000 Router pair (T1/E1 or Ethernet link) (15 subsite capacity) or
- One Subsite Access GGM 8000 Gateway pair (Ethernet link) (15 subsite capacity)
- Two Subsite Access S6000 Router pairs (T1/E1 or Ethernet link) (32 subsite capacity) or
- Two Subsite Access GGM 8000 Gateway pairs (Ethernet link) (32 subsite capacity)

- One CWR patch panel (single T1/E1 site link) (15 subsite capacity) or
- One or two CWR patch panels (dual/single T1/E1 site links) (15 subsite capacity) or
- Two CWR patch panels (dual T1/E1 site links) (15 subsite capacity)
- Two CWR patch panels (single T1/E1 site links) (32 subsite capacity) or
- Three or Four CWR patch panels (dual/single combination T1/E1 site links) (32 subsite capacity) or
- Four CWR patch panels (dual T1/E1 site links) (32 subsite capacity)
- Two backhaul switches (Ethernet link) (15 and 32 subsite capacity)

2.1.1 GCP 8000 Site Controller

The GCP 8000 Site Controller is the control interface between the IP simulcast subsystem and the zone controller. The site controller performs the following functions:

- Translates mobility and call service control messages received from the channels into the protocol required for interfacing to the zone controller.
- Translates mobility and call service control messages received from the zone controller into the protocol required for interfacing to the channels.
- Maintains a mobility database uploaded to the zone controller as part of the recovery process when the site transits from Site Trunking to Wide Area Trunking.
- Supervises subsystem resources that include determining channel status and remote site status based on status information received from the channels and reported to the Unified Event Manager (UEM) and also indicates to the zone controller the capabilities of the channels at the site. The zone controller uses the channel capabilities for resource allocation.
- Performs trunked data call processing while in Site Trunking.
- Supports Site Trunking and Failsoft failure modes.
- Receives the 1PPS from the TRAK 9100 Simulcast Site Reference and Global Positioning Satellite and then provides a unique launch time reference for the comparators and base radios.

NOTICE: 1PPS for the GCP 8000 Site Controller is not used for a Single Transmitter, Receiver Voting (STRV) subsystem FDMA-only or IV&D data.

The standard installation uses two site controllers in a redundant configuration. The site controllers automatically determine the active and standby site controller operation. The standby site controller monitors the Trunking Status Pulses (TSPs) sent by the active site controller and active site controller monitors the standby site controller via periodic pings. There are two ZC-RF Site Control Paths (SCPs) between the zone controller and the simulcast subsystem. Each SCP goes to one site controller. Upon failure of the active site controller, the standby takes over as the active site controller.

In order for the two site controllers to properly transition between standby and active operational modes, the site controller module assigned as site controller 1 must be installed in the upper slot of the chassis, and the site controller module assigned as site controller 2 (SC2) must be installed in the lower slot of the chassis.

In a geographic redundant configuration, the trunked prime site is separated into two separate locations to protect against failure of one of the prime site locations. One of the two geographically separate prime site locations is designated as the primary prime site while the other prime site location is designated as the secondary prime site. The primary prime site is equipped with two site controllers, site controller 1 (SC1) and site controller 2 (SC2), and the secondary prime site is equipped with site controller 3 (SC3) and activates on the failure of the primary prime site.

During normal operation, the site controllers and comparators at the primary prime site are the preferred active components providing wide area service where all the comparators at the primary

prime site are active since the activation logic favors the redundant preferred comparators. The site controller and comparators at the secondary prime site only activate upon failure of their redundant counterparts at the primary prime site.

See the *GCP 8000 Site Controller* manual for detailed information on the site controller.

2.1.2
Ethernet LAN Switches

An IP simulcast prime site in a non-redundant comparator configuration, features two or three 24-port HP 2610 or HP 2620 Ethernet LAN switches paired together to form the core of the prime site LAN. The switches are linked such that, if one switch fails, the site remains operational (wide area trunking) through the redundant site controllers and half the comparators remaining connected to the other functional switch.

For non-redundant comparator configurations:

- If the prime site is configured for 15 subsite capacity, one switch connects to the prime site router or gateway, the active site controller, all the comparators supporting odd-numbered channels, and remote site access router or gateway 1. The other switch connects to a redundant site router or gateway (if installed), the standby site controller, all the comparators supporting even-numbered channels, and remote site access router or gateway 2.
- If the prime site is configured for 32 subsite capacity, there are three switches. Switches 1 and 2 are paired between the two remote site access router or gateway pairs and switch 3 is connected to both remote site access router or gateway pairs.

An IP simulcast prime site utilizing a redundant comparator configuration supports redundant comparators to form the core of the prime site LAN. When site resources are spread across two Ethernet LAN switches, greater availability is achieved. The prime site is linked such that if one comparator fails, the channel remains operational through its redundant comparator, or if an Ethernet LAN switch fails, the site remains operational through the remaining comparators connected to the second Ethernet LAN switch.

For redundant comparator configurations (non-geographically redundant configuration):

- If the prime site configured for 15 subsite capacity, the 48-port HP 2620 Ethernet LAN switch 1 connects to the prime site router or gateway, the primary site controller, redundant preferred comparators supporting odd-numbered channels, redundant non-preferred comparators supporting even-numbered channels, and subsite access router or gateway 1. The second 48-port HP 2620 Ethernet LAN Switch connects to the redundant prime site router or gateway (if installed), the redundant site controller, redundant preferred comparators supporting even-numbered channels, redundant non-preferred comparators supporting odd-numbered channels, and subsite access router or gateway 2.
- If the prime site configured for 32 subsite capacity, the 48-port HP 2620 Ethernet LAN switch 1 connects to the prime site router or gateway, the primary site controller, redundant preferred comparators supporting odd-numbered channels, redundant non-preferred comparators supporting even-numbered comparators, and subsite access routers or gateways 1 and 3. The second 48-port HP 2620 Ethernet LAN Switch 2 connects to the redundant prime site router or gateway (if installed), the redundant site controller, redundant preferred comparators supporting even-numbered channels, redundant non-preferred comparators supporting odd-numbered channels, and subsite access routers or gateways 2 and 4. The third 24-port HP 2620 Ethernet LAN Switch 3 connects to Ethernet LAN switch 2 and subsite access routers or gateways 1, 2, 3, and 4.

An IP simulcast prime site in a geographic redundant configuration geographically separates a Redundant Comparator prime site (15 or 32 capacity) into two separate locations. Each half of the prime site supports one HP 2620 Ethernet LAN switch. When site resources are spread across the primary prime site and secondary prime site, the failure or total destruction of a prime site location will not result in the loss of wide area radio communications for any significant time.

For geographically redundant configurations:

- For either 15 or 32 subsite capacity configurations in the primary prime site, subsite, the 48-port HP 2620 Ethernet LAN switch 1 connects to the prime site router or gateway A, site controller 1 (SC1) and 2 (SC2), redundant preferred comparators supporting all channels, and subsite access router or gateway 1 and 3.
- For either 15 or 32 subsite capacity configurations in the secondary prime site, the 48-port HP 2620 Ethernet LAN switch 2 connects to the prime site router or gateway B, site controller 3 (SC3), redundant non-preferred comparators supporting all channels, and subsite access router or gateway 2 and 4.
- The switches are linked between the primary and secondary prime site with intra-prime site extended singular switch link such that if one switch fails, the site remains operational through the redundant/third site controller and the remaining comparators connected to the functional switch. If either switch fails, there is still a path to a prime site router or gateway for connectivity to the master site.
- The LAN switches required to terminate the intra-prime site link at each prime site is configured for a fixed 10 Mbps or 100 Mbps data rate. The data rate required for these links is driven from the number of subsites and channels in the system configuration.
- Two TRAK devices are utilized, one at the primary prime site and one at the secondary prime site, to provide a timing reference to the comparators and site controller at each location.

If the prime site configuration includes only one router or gateway (single prime site link configuration), the router or gateway connects to one LAN switch only. The entire subsystem is therefore dependent on this one switch for its connection to the master site.

The switches are linked such that if one switch fails, the site remains operational through the redundant site controllers and the remaining comparators connected to the functional switch.

If the prime site configuration includes two routers or gateways (dual prime site link configuration), each router or gateway connects to a corresponding switch. If either switch fails, there is still a path to a prime site router or gateway for connectivity to the master site.

A connection is also made to the MOSCAD NFM, if installed at the site.

See the *System LAN Switches* manual for more information on the HP 2610 or HP2620 Ethernet LAN Switches.

2.1.3
GCM 8000 Comparator

The GCM 8000 Comparator chassis can hold two separate comparator modules to support two different channels. The maximum number of modules per chassis is two.

The comparator performs payload distribution by way of an IP network topology for an IP simulcast prime site with trunking and conventional channels.

In trunked operation, the comparator receives Inbound Signaling Packets (ISPs) from remote or colocated subsite base radios (ultimately received from subscriber radios through the RF). The comparator copy rejects these ISPs, forwarding only the first received copy onwards to the site controller. Additionally, the comparator controls the sequencing of the Outbound Signaling Packets (OSPs) received from the site controller when transmitting these packets to the remote or colocated subsite base radios for transmission on the control channel. On voice and data channels, the comparator controls the creation and sequencing of the embedded or standalone link control information (based on messages received from the site controller), sent out on the channel providing extra control information to subscriber radios using that voice or data channel. The comparator also supports fallback states when communication to the site controller or between the site controller and the zone controller is lost or limited.

Each comparator module collects all the data of a single channel from all remote sites. The comparator receives voice and data packets and compares them. The comparator chooses the best received signal from all received signals to build the signal sent to the base radio transmitters. The single data stream is routed to the master site. The comparator forwards outbound audio from the master site to the base radios / receivers at the remote and receive-only remote sites.

NOTICE: Site Trunking and Failsoft modes of operation are supported for fallback operation. See the Troubleshooting section.

The comparator performs the following functions within an IP simulcast subsystem:

- Simulcast (trunked and conventional)
- Multicast (conventional)
- Voting (trunked and conventional)
- Data Steering (trunked and conventional)
- Console Interface (conventional)
- Redundancy (trunked)
- Geographic Redundancy (trunked)

NOTICE: Conventional comparators that are co-located and share a network with a trunked IP simulcast subsystem are limited to topologies of up to 15 subsites. Conventional comparators within an all conventional IP prime site have topologies of up to 64 subsites. See the *GCM 8000 Comparator* manual or *CSS Online Help* for configuring for 64 subsites.

2.1.3.1 Simulcast Function

The simulcast function (trunked or conventional) is performed when multiple base radios in separate locations broadcast the same signal on the same frequency at the same time (simultaneously). This function helps to ensure that a particular geographic area (typically comprised of physical barriers such as mountains, buildings, and other barriers) is covered. The comparator module receives an absolute time reference (1 pulse per second) from a local Global Navigation Satellite System (GNSS) receiver and uses this time reference to generate the simulcast launch time values. The comparator module embeds these simulcast launch time values into the packets that are sent to the remote site base radios. This launch time instructs the base radios at the remote sites to launch the packet at the same precise time, enabling the simulcast operation. To select the best quality audio signal, the site employs a voting operation.

For a Multi-Site Single Transmitter, Receiver Voting subsystem (with only a single transmitter) supporting FDMA-only voice and IV&D data operation, simulcast function of time launching of signals from multiple transmitters does not apply because an STRV subsystem has only a single transmitter. The comparator does not require a Simulcast Site Reference for the time reference (1 pulse per second) and the transmit launch time is not assigned. To support TDMA or Enhanced Data operation in a trunked IP Single Transmitter, Receiver Voting subsystem, launchtimes are used to provide the time alignment required for TDMA voice or Enhanced Data in the base radios. The Simulcast Site Reference is required (even with a single transmitter) to provide the time reference to the comparators for generating the launch time.

2.1.3.2 Multicast Function

Multicast function (conventional only) is performed when multiple base radios can transmit and receive, operating on different frequencies, and can still receive copies of the same voice or data from the comparator. To implement multicast function, the site employs (requires) a voting operation to establish the best quality signal for transmission.

2.1.3.3
Voting Function

The voting function is required for simulcast operation (trunked or conventional), but can be used without simulcast in a conventional or trunked topology.

Voting function is performed when multiple base radio receivers, operating on the same frequency in separate locations, receive a subscriber radio transmission signal and route the signals to a voting comparator. The comparator processes (compares or votes) the audio received from the multiple base radio to establish a best quality composite signal to be used for transmission (simulcast transmission or non-simulcast transmission).

The voting function (comparing signals received from those multiple base radios establishes the best quality outbound signal for transmission) is independent from the method used for transmission. While simulcast employs a voted signal, a voted (or composite) signal can also be transmitted on a single base radio transmitter (non-simulcast transmission).

2.1.3.4
Data Steering

Data steering for conventional only is performed when the inbound data request of a subscriber radio is sent to the comparator by the base radio. The comparator then forwards the identity of the best voted base radio to the Packet Data Gateway (PDG) so the outbound data response from the Customer Enterprise Network (CEN) can be routed to the appropriate base radio and then transmitted to the subscriber radio.

Data steering for simulcast occurs when the system transmits payload data packets only at the most recently recorded transmit remote sites. Data steering requires that the comparator know the best remote site for each subscriber on the packet data channel. The information is gathered from inbound messages from the subscriber on the control channel (trunked channels only) and from inbound data and responses on the packet data channel (trunked and/or conventional). All messages are sent to all remote sites, but addressed to only one remote site which causes all but one of the simulcast base radios to ignore the message. This creates the effect of site steering to a single transmitter. Messages are still time launched as when simulcasting packets, to allow the comparator to retain control, and keep a common pacing engine in the comparator.

The comparator selects the appropriate remote site that actually sends data packets over the air and it multicasts packet data payload to all connected base radios and receivers. This means that all base radios/receivers receive all packets, even if they are not going to transmit them. When sending packet data payload in a conventional IP simulcast, multicast, or Trunked IP Simulcast or Single Transmitter, Receiver, Voting (STRV) subsystem, the comparator fills in the subsite number of the base radio recorded as the best transmit remote site for the CAI ID to which the data payload is addressed.

For simulcast operation in a trunked or conventional IP subsystem, when sending packet data payload XIS messages to the base radio, the comparator indicates the simulcast launch time of the message in the first PDU XIS frame. If the comparator is to send packet data payload to a subscriber unit but does not have an associated remote site address in its database, the comparator indicates that the data payload is simulcasted.

2.1.3.5
Console Interface

The conventional comparator can interface to conventional base radios for supporting console management functions. The conventional comparator can also provide connectivity to the MCC 7500/7100 Console through an MCC 7500 AUX I/O Server for supporting voting control commands and conventional comparator status information.

2.1.3.6

Redundancy Function

In an IP simulcast prime site configured for comparator redundancy, two redundant comparator modules provide for a single channel. The two redundant comparators, operate in an active/standby configuration for protection against a single comparator or LAN switch failure at the site. One module acts as the active comparator and the second module as the standby comparator. Upon failure of an active comparator or failure of a LAN switch, the associated standby comparators become active.

If unavailable comparators were previously active, the associated standby comparators that are attached to a different LAN switch become active. Any failed voice/data channels using the unavailable comparators recover to operational after the switchover.

The active comparator manages operations at the site and sends a periodic heartbeat message to the standby comparator every 500 msec. The standby comparator monitors the periodic heartbeat messages from the active comparator. When a component fails (LAN switch or comparator), the standby comparator becomes active when it detects the failure of the active comparator.

During the switchover process, the newly active comparator must transit through the initialization process. Any calls on the failed comparator or LAN switch are interrupted or terminated. Channels using any active comparators connected to other operating LAN switches continue undisturbed. If a subscriber radio remains keyed on a failed channel during the switchover, the base radio can enter Illegal Carrier state as it does for existing Illegal Carrier scenarios or enter Local Failsoft mode, depending on how the base radio is configured.

In a Trunked IP Simulcast Prime Site Geographic Redundancy (TPSGR) subsystem, redundancy of the comparators is split between two separate sites. During normal operation, the redundant preferred comparator at the primary prime site is the active comparator for the channel. The redundant non-preferred comparator only activates upon losing communication with the redundant preferred comparator at the primary prime site. When communication is restored between the redundant comparators, the redundant preferred comparator at the primary prime site becomes the active comparator, unless a call is already in progress on the redundant non-preferred comparator. The redundant preferred comparator returns to active status once the channel becomes idle.

If the redundancy value of the comparators is incorrectly configured in a TPSGR subsystem, improper operation or suboptimal operation may result. The comparator reports a configuration error when an improperly configured redundant comparator is detected. To ensure that this type of failure does not occur, only one comparator of the pair should be designated as **Redundant Preferred**.

Valid redundancy configuration combinations for TPSGR subsystems and non-TPSGR subsystems are:

- Redundant – Redundant
- Redundant Preferred – Redundant Non-Preferred
- Redundant Non-Preferred – Redundant Preferred

NOTICE: For geographically redundant prime sites, only one comparator of the pair is configured “redundant preferred”. If either comparator is not configured to the proper redundancy value, improper operation may result.

The redundancy function of the comparators is configured through Configuration/Service Software (CSS) and Unified Network Configurator (UNC). All configuration parameters of each redundant pair of comparators must be kept in sync manually using CSS. Status of the redundancy state or when a standby comparator fails is reported to the system manager through CSS, UNC, Unified Event Manager (UEM), or MOSCAD.

2.1.4
TRAK 9100 Simulcast Site Reference

The TRAK 9100 SSR derives a 1PPS signal from the satellite signal through a Global Navigation Satellite System (GNSS) antenna and sends it to the comparators and site controllers. The comparators use the 1PPS signal as a frequency reference at the prime site, and provides the reference to the base radios at a remote site in a standard configuration, so that all the devices involved in the transmission of the audio have a common timing source (GNSS).

The TRAK 9100 Simulcast Site Reference (SSR) is used in an IP simulcast prime site. The TRAK 9100 SSR supplies a highly accurate time and frequency reference signal to the comparators and site controllers at the prime site. The comparators and site controllers use the time reference to compute transmission launch time to the base radios at remote sites in a standard configuration.

If a prime site is geographically redundant, two TRAK 9100 SSR devices are required (one at the primary prime site and one at the secondary prime site) to provide a timing reference to the comparators and site controller at each location.

If a prime site is colocated with the master site, only one TRAK 9100 SSR along with a TRAK 9300 SSR DDU unit is required to service both the master and prime sites. A maximum of three TRAK 9300 SSR DDUs can be connected to a TRAK 9100 SSR. If the prime site is colocated with a remote site, only one TRAK 9100 SSR is required to service both the prime and remote sites.

For a Trunked IP Single Transmitter, Receiver Voting (STRV) subsystem configured with FDMA-only and IV&D data, a TRAK 9100 is not required in a prime site.

For more details on the TRAK 9100 Simulcast Site Reference, see the *Simulcast Site Reference* manual.

The following modules are installed in the TRAK 9100 SSR:

- GNSS receiver with a rubidium oscillator
- GNSS receiver with a double oven oscillator
- AC/DC power supplies
- Digital Distribution Modules (DDMs)
- Frequency Distribution Modules (FDMs)
- Telecommunications modules (TEL)
- Fault Sense Unit (FSU) module

Figure 16: TRAK 9100 SSR Network Time Reference – Front View

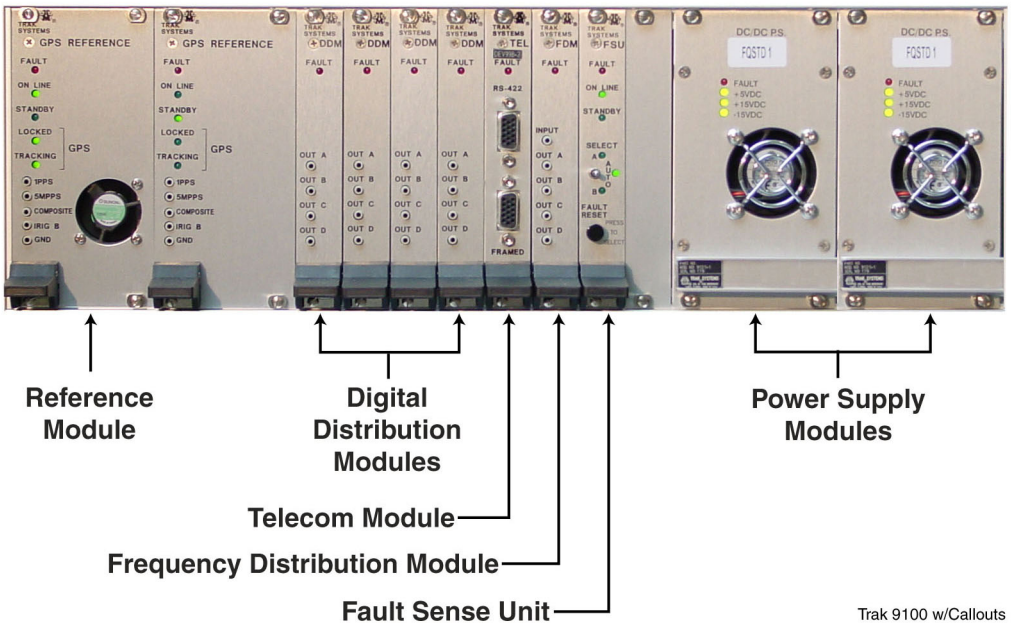
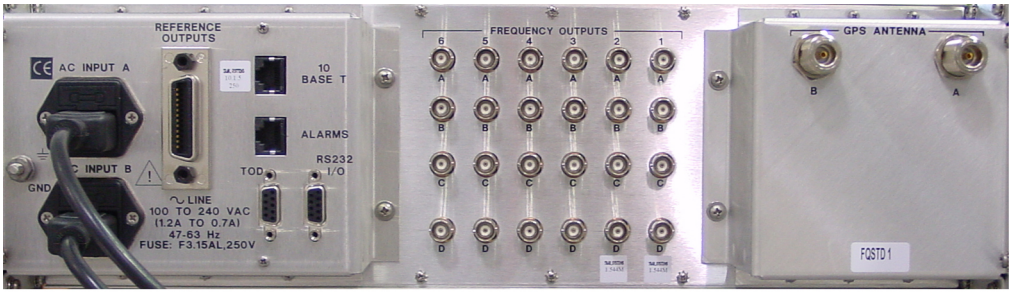


Figure 17: TRAK 9100 SSR Network Time Reference – Rear View



The TRAK 9100 SSR is configured for redundant operation for reliability. The redundant configuration consists of one GNSS rubidium oscillator module as the main frequency reference, another GNSS double oven oscillator module as a standby reference unit, and two power supplies.

2.1.4.1 GNSS Antenna

The TRAK 9100 Simulcast Site Reference (SSR) uses Global Navigation Satellite System (GNSS) signals to derive a high-precision 1PPS reference signal to the site controllers and comparators, so that all devices involved in the audio transmission have a common timing source (GNSS).

2.1.5 Routers or Gateways

This section provides information regarding the prime site routers or gateways and remote site access routers or gateways.

For specific information on the routers or gateways and their interfacing modules, see the *GGM 8000 System Gateway* or *S6000 and S2500 Routers* manual.

2.1.5.1
Prime Site Router or Gateway

The prime site router or gateway provides transport between the IP simulcast prime site and zone core. These transport devices can support either T1/E1 site links or Ethernet site links.

For T1/E1 site link support with a site link requiring more than two T1 links, the prime site router is employed with an UltraWAN module. For T1/E1 site link support for a site link requiring two or less T1 links, the prime site gateway can be employed with a built-in T1/E1 port providing transport to/from the zone core. With T1/E1 site links, audio and control traffic intended for the zone core (inbound traffic) is sent to the transport device over the prime site LAN where it is encapsulated into frame relay for delivery over a T1/E1. Outbound frame relay traffic from the zone core is carried over a Permanent Virtual Circuit (PVC) to the transport device (prime site router or site gateway). These transport devices function to terminate the PVC and frame relay, to distribute audio and control traffic to the prime site LAN, where it is processed by the site controllers or comparators.

As an option, the prime site may be deployed with dual prime site routers and dual WAN links to the Zone Master site. This configuration yields path diversity for the prime site link. The dual prime site router configuration is not supported on non-redundant links to the Zone Master site. In a non-redundant link configuration, the Zone Master site is configured to switch a single WAN link between redundant network equipment, but there is only a single prime site router.

If conventional channels are supported in the subsystem, the site configuration is slightly different. The transport devices deliver frame relay traffic over T1/E1 through the channel bank, which multiplexes conventional and trunking system traffic into separate timeslots for channelized T1/E1 delivery to the zone core.

For Ethernet site link support, the site gateway can be employed as the transport device to the zone core. The site gateway uses a built-in Ethernet port providing transport to/from the zone core. The site gateway is the appropriate solution to provide Ethernet transport device between the IP prime site and zone core, however, the prime site router can be used as well.

Regardless of the type of transport or transport device used, the transport device is interfaced to the Ethernet LAN switch. See the *S6000 and S2500 Routers* or *GGM 8000 System Gateway* manual for interfacing details.

2.1.5.2
Subsite Access Router or Gateway

There is one subsite access router or gateway pair at a prime site configured for 15 subsite capacity. An additional subsite access router or gateway pair must support a prime site configured for 32 subsite capacity. The subsite access routers or gateways provide the IP network routing interfaces between the prime site and all remote sites. Subsite access routers are deployed in a CWR routing arrangement using either T1/E1 links to relay patch panels or Ethernet links to backhaul switches, which serve as the endpoints for each of the prime site links. Subsite access gateways can only be deployed using Ethernet links to backhaul switches.

A standard prime site configuration utilizes a direct connection between the backhaul switches (trunk ports) for backhaul switch management. In a geographically redundant prime site configuration, the direct connection between backhaul switches is no longer present due to geographic separation.

See *GGM 8000 System Gateway* manual for interfacing details about the remote site access router or gateway used in an IP simulcast prime site.

2.2
Trunked IP Simulcast Remote Site Components

The critical components of a remote site in an IP simulcast subsystem are:

- Standard Configuration
  - GTR 8000 Base Radios or GTR 8000 Expandable Site Subsystems
  - HP 2620 Ethernet LAN Switches
  - TRAK 9100 Simulcast Site Reference
  - S2500 Routers or GGM 8000 Gateways (T1/E1 or Ethernet link)
- High Availability Configuration
  - GTR 8000 Expandable Site Subsystem with GPB 8000 Reference Distribution Modules
  - GGM 8000 Gateways or S2500 Routers (T1/E1 or Ethernet link)
  - Two Global Navigation Satellite System (GNSS) units
- Trunked Receive-only Remote Site subsystems
  - GPB 8000 Reference Distribution Modules (RDMs) and Expansion Hubs (XHub) in a standalone configuration
  - GPW 8000 Receivers
  - S2500 Routers or GGM 8000 Gateways (T1/E1 or Ethernet)
  - TRAK devices (optional)
  - Two Global Navigation Satellite System (GNSS) units with RDM

2.2.1 Base Radios

The GTR 8000 Base Radio or GTR 8000 Expandable Site Subsystem provides the RF link between the IP simulcast subsystem prime site and the subscriber/mobile radios.

The base radio captures inbound signals through the external receive (RX) antennas from the subscriber/mobile radios. It then amplifies, filters, and demodulates the signals into the digital voice and data packets that are forwarded to the prime site.

For outbound signals, the base radio maps the digital voice and data packets to discreet voltage levels, which are then used to modulate an RF carrier. The modulated RF carrier is amplified and may be combined with other RF channels, filtered, and routed to the transmission (Tx) antennas.

For detailed information on the base radios, see the *GTR 8000 Base Radio* or *GTR 8000 Expandable Site Subsystem* manual.

2.2.2 Ethernet LAN Switches

NOTICE: The external Ethernet LAN switch is used only in a standard configuration.

The HP 2620 Ethernet LAN switches in a standard configuration interface with the remote site router or gateway to the base radios. If the number of base radios is 14 or less at the remote site, only one switch is required.

Each LAN switch provides connectivity for a 10/100Base-T LAN. The LAN switches are connected to each other through a Gigabit stacking interface that makes it possible to provide a management communication link with up to 30 base radios. The two-switch configuration also provides a degree of protection in case of a switch failure. If one of the switches fails, a management link still exists to the base radios connected to the unaffected switch, and the audio services are not affected.

For a standalone GTR 8000 Base Radio configuration, odd-numbered base radios are connected to one LAN switch and even-numbered base radios are connected to the other. For a GTR 8000 Expandable Site Subsystem in a standard configuration, the option to choose which channels to

configure in each rack/cabinet, such as even channels and odd channels in different racks/cabinets is available. Another option available is to select the connections made to the racks/cabinets from the LAN switches.

The LAN switches send SNMP events back to the Unified Event Manager (UEM).

NOTICE: The 10Base-T LAN is not the default Ethernet port setting for the base radio. To set the correct port speed and duplex, see CSS or the *System LAN Switches* manual.

2.2.3
TRAK 9100 Simulcast Site Reference

The TRAK 9100 Simulcast Site Reference (SSR) in a standard configuration is a Global Navigation Satellite System (GNSS)-based frequency and time reference unit. The signal requirements the SSR provides for the simulcast subsystem are 1PPS (Pulse Per Second), 5 MHz, and 1PPS + 5 MHz composite signals. At the remote site, the SSR provides composite (1PPS + 5 MHz) to the standalone GTR 8000 Base Radio and 1PPS and 5 MHz to each GTR 8000 Expandable Site Subsystem cabinet/rack.

The TRAK 9100 Simulcast Site Reference (SSR) is used in standard, high availability, and receive-only (optional) remote site configurations.

An IP simulcast remote site standard configuration uses signals from the GNSS to simultaneously synchronize the audio from multiple transmitters. A GNSS unit is used in the IP simulcast subsystem for launch times. The TRAK 9100 SSR uses the satellite signal to derive a high precision 1PPS signal used in the IP simulcast subsystem for time launching. By launching signals at the same time from multiple sites, destructive interference of the transmitted signals in overlap area is minimized.

The TRAK 9100 SSR provides precise time and frequency output signals to support Network Time Protocol (NTP) services and simulcast site (frequency) reference functionality. The NTP services ensure that fault logging services, statistics, and other time-critical procedures are synchronized. The following NTP servers (TRAK devices) can be installed as an option to provide NTP services:

- For an M1 zone core: TRAK 9100-8E, TRAK 8835-2M, or TRAK 8835-3M
- For an L1/L2, M2 or M3 zone core: TRAK 9100-8E or TRAK 8835-3M

For additional information on NTP services, see the *Network Time Protocol Server* manual.

For an IP simulcast remote site with a high availability using a GTR 8000 Expandable Site Subsystem configuration and a receive-only remote site with Time Division Multiple Access (TDMA) or Enhanced Data operation, an optional backup for the frequency and time references is supplied to the receiver is available either through a TRAK 9100 SSR or TRAK 8835-3M. The backup SSR provides an extended holdover of at least 72 hours when redundant GNSS or certain GPB 8000 Reference Distribution Modules (RDMs) failures occur. If an optional TRAK SSR at the remote site is used as an extended holdover backup, the RDMs can be configured in the following configurations to either provide support or act as a replacement for the GNSS units:

- Each RDM connected to a GNSS unit
- One RDM connected to a GNSS unit
- No RDMs connected to a GNSS unit.

Since the TRAK 9100 SSR does not support SNMP, the optional MOSCAD NFM monitors the relay outputs from the TRAK 9100 SSR. MOSCAD NFM forwards any alarm from the TRAK 9100 SSR as an event to the Unified Event Manager. It is then viewed in the Unified Event Manager Active Alarms Window.

The TRAK 9100 supports SNMPv3 by using the 9104-14 Fault Sensor Unit (FSU) module. The TRAK devices send Simple Network Management Protocol (SNMP) traps to the Unified Event Manager (UEM) to provide centralized fault management. SNMPv3 support does not impact using MOSCAD to provide TRAK management.

For detailed information on the TRAK devices in different configurations, see the *Simulcast Site Reference* manual.

2.2.3.1
GNSS Antenna

The TRAK 9100 Simulcast Site Reference (SSR) uses Global Navigation Satellite System (GNSS) signals to derive a high-precision 1PPS reference signal to the site controllers and comparators, so that all devices involved in the audio transmission have a common timing source (GNSS).

2.2.4
TRAK 8835 Site Reference

The TRAK 8835-8M Site Reference incorporates a multi-channel Global Navigation Satellite System (GNSS) unit, disciplined oven crystal oscillator, time, and frequency signal generation, in compact form factor enclosures. The TRAK 8835-3M incorporates a multi-channel GNSS unit, rubidium oscillator, time, and frequency signal generation, in a compact form factor enclosure. The following outputs are available:

- 10 MHz on the BNC connector (front panel)
- 1PPS on the BNC connector (front panel)
- 5 MHz on the BNC connector (dongle adapter)
- composite (1PPS + 5 MHz) on the BNC connector (dongle adapter)

The TRAK 8835-3M Site Reference uses GNSS signals to drive a high-precision 1PPS, 5 MHz, or composite (1PPS + 5 MHz) references. These references are provided to all base radios, comparators, and site controllers, so that all devices involved in the audio transmission have a common timing source (GNSS).

For an IP simulcast remote site with high availability using a GTR 8000 Expandable Site Subsystem configuration and receive-only remote site with Time Division Multiple Access (TDMA), or Enhanced Data operation, an optional backup for the frequency and time references is supplied to the base radio or receiver either through a TRAK 9100 SSR or TRAK 8835-3M. The backup Simulcast Site Reference (SSR) provides an extended holdover of at least 72 hours when redundant GNSS units or GPB 8000 Reference Distribution Module (RDM) failures occur. If an optional TRAK SSR at the remote site is used as an extended holdover backup, the RDMs can be configured in the following configurations to either provide support or act as a replacement for the GNSS units:

- Each RDM connected to a GNSS unit
- One RDM connected to a GNSS unit
- No RDMs connected to a GNSS unit

For an IP simulcast receive-only remote site with TDMA /Enhanced Data or GTR 8000 Expandable Site Subsystem with high availability remote site, both configurations use two GNSS units and a TRAK for longer duration frequency holdover to provide reference through the RDM.

2.2.5
Remote Site Routers or Gateways

The remote site router or gateway provides the IP network routing interface between the remote site and the prime site. For T1/E1 links to the prime site, the remote site router or gateway interfaces to the prime site through a WAN Link. For Ethernet links to the prime site, the remote site router or gateway uses an Ethernet connection to a backhaul switch and then through a WAN Link. In the dual remote link configuration, two remote routers or gateways are deployed, one for each remote link.

For specific information on the routers or gateways and their interfacing modules, see the *GGM 8000 System Gateway* or *S6000 and S2500 Routers* manual.

2.2.6
GPB 8000 Reference Distribution Module (RDM) and Expansion Hub (XHub)

As remote site components, the Reference Distribution Module (RDM), and Expansion Hub (XHub) components can be found in a GTR 8000 Expandable Site Subsystem or receive–only standalone configuration.

2.2.6.1
GPB 8000 Reference Distribution Module (High Availability Configuration)

In an IP simulcast remote site configured for high availability, each GPB 8000 Reference Distribution Module (RDM) within the GTR 8000 Expandable Site Subsystem prime cabinet/rack provides integrated Ethernet LAN switching and integrated site reference distribution to the base radios. This configuration ensures that a single point of failure in the reference or switch does not cause the loss of any channels at the site.

2.2.6.1.1
Integrated Ethernet LAN Switches

Both RDMs maintain a built-in Ethernet LAN switch providing each base radio at the site with two Ethernet LAN switch connections. The base radios determine which switch to use based on the condition of the RDMs.

2.2.6.1.2
Network Time Protocol (NTP) Sources

Network Time Protocol (NTP) provides a clock synchronization mechanism to the RDMs and other NTP clients at the site. In a high availability configuration, the NTP clients must use the TRAK at the prime site as the primary time source and an ntp02.zoneN device at a zone core as the secondary time source. The RDMs at the site also act as a Network Time Protocol (NTP) time source.

2.2.6.1.3
Dual GNSS Unit Function

Each RDM has a connected Global Navigation Satellite System (GNSS) unit that provides the necessary references to either of the RDMs. A high-stability ovenized crystal oscillator within the RDMs train to the Global Navigation Satellite System (GNSS) units. The RDMs then generate the output time reference to the base radios.

Both GNSS units are active and provide protection against a single GNSS unit failure/interference at a receive-only site with TDMA/Enhanced data.

If an optional TRAK SSR at the remote site is used as an extended holdover backup, the RDMs can be configured in the following configurations to either provide support or act as a replacement for the GNSS units:

- Each RDM connected to a GNSS unit.
- One RDM connected to a GNSS unit.
- No RDMs connected to a GNSS unit.

The Time Reference for the RDMs must be configured in Configuration/Service Software (CSS). For details, see **Site Controller Configuration & Service Help → GPB 8000 Reference Distribution Module (RDM) → Service Screens → Reference Service Screen** in the *CSS Online Help*.

The CSS indicates whether the GNSS capability is configured. The RDMs indicate the alarms for GNSS service to Unified Event Manager and MOSCAD Network Fault Management.

2.2.6.1.4
Time Synchronization and Frequency Reference Function

The RDMs provide a 1PPS and 5 MHz time reference to the base radios. The time reference synchronizes the transmissions from the base radios. The high stability frequency reference provides a reference for both the transmit and receive frequency synthesizers in the base radios. The time and frequency reference is supplied from the RDMs to the base radios through the backplanes of the GTR 8000 Expandable Site Subsystem.

The Configuration/Service Software (CSS) indicates whether the Global Navigation Satellite System (GNSS) capability is configured. The RDM indicates the alarms for GNSS service to Unified Event Manager and MOSCAD NFM.

2.2.6.2
Standalone GPB 8000 Reference Distribution Module

NOTICE: The standalone RDM components are supported only for use with a trunked GPW 8000 Receiver in a Receive-only trunked site.

In a Receive-only trunked site, each GPB 8000 Reference Distribution Module (RDM) within the rack provides integrated Ethernet LAN switching and integrated site reference distribution to the GPW 8000 Receivers. This configuration ensures that a single point of failure in the reference or switch does not cause the loss of any channels at the site.

The standalone RDMs are composed of one chassis that holds two RDM modules and used only in receive-only trunked sites, and are installed in a standard rack including:

- GPW 8000 Receivers
- Expansion Hubs (XHubs) in standalone configuration

Site architectures supported include:

- Trunked IP Simulcast Subsystem with Receive-Only Subsite (Receive-only remote site)
- Trunked IP Single Transmitter, Receiver Voting (STRV) Subsystem (Receive-only remote site)
- Colocated Trunked Receive-Only remote site at the Prime Site

In a receive-only remote site, each RDM within the rack provides integrated Ethernet LAN switching and integrated site reference distribution to the GPW 8000 Receivers. This configuration ensures that a single point of failure in the reference or switch does not cause the loss of any channels at the site.

The use of integrated Ethernet LAN switches, Network Time Protocol (NTP) sources, dual Global Navigation Satellite System (GNSS) units, and time synchronization and frequency reference functionality perform the same as a GPB 8000 Reference Distribution Module in an IP simulcast with high availability configuration.

2.2.6.3
Standalone Expansion Hubs

The standalone Expansion Hubs (XHubs) are composed of one chassis that holds two XHub modules. They are used only in receive-only trunked sites, and are installed in a standard rack including:

- GPB 8000 Reference Distribution Module (RDM) in standalone configuration

- GPW 8000 Receivers

NOTICE: The standalone XHub is supported only for use with a trunked GPW 8000 Receiver.

Site architectures supported include:

- Trunked IP Simulcast Subsystem with Receive-Only Subsite (Receive-only remote site)
- Trunked IP Single Transmitter, Receiver Voting (STRV) Subsystem (Receive-only remote site)
- Colocated Trunked IP Simulcast Receive-Only remote site at the Prime Site

The XHub has three modes of operation:

Normal Mode
The XHub extends the switching and interface capabilities of the GPW 8000 Receivers or RDMs. In normal mode, the RDM configures the Ethernet switch.

Impaired Normal Mode
Occurs when one of the links between the RDM and the XHub is lost. The other XHub remains active to pass the traffic.

Standalone Mode
Requires External 5 MHz and 1PPS, either as separate signals or as one combined 5 MHz/1 PPS signal. 1PPS generates the 5 MHz frequency reference for the GPW 8000 Receivers even if it is not used by the GPW 8000 Receiver.

2.2.7 GPW 8000 Receiver

An ASTRO® 25 Trunked receive-only remote site is supported in the IP Multi-Site subsystem by using GPW 8000 Receivers.

A trunked GPW 8000 Receiver consists of one or two transceiver modules, a fan module, and a power supply. GPW 8000 Receivers use a dual-slot chassis which supports up to two receiver modules.

The GPW 8000 Receiver supports the 700 MHz, 800 MHz, UHF, 900 MHz (trunking only), and VHF frequency bands and receive Compatible 4-level Frequency Modulation (C4FM) for traffic channel communications. See the *GPW 8000 Receiver* manual.

2.3 Network and Ethernet Links in an IP Simulcast Subsystem

The GCM 8000 Comparators at the IP simulcast subsystem prime site encapsulate the IP Network audio into Ethernet packets, which are then sent to a router or gateway for encapsulation as frame relay packets. A T1/E1 or Ethernet link is used to transport the frame relay packets containing voice, site control information, and network management information between the prime site and the zone core.

Remote sites communicate with the prime site through the IP network of the IP simulcast subsystem. The IP Network links are interfaced to the RF base radio equipment (one per base radio) to carry the voice traffic, control channel traffic, packet data traffic, and network management traffic.

2.4 Trunked IP Simulcast Subsystem Network Topology

The IP network of an IP simulcast subsystem supports the following network traffic types:

IP simulcast subsystem voice traffic
The voice channel links interface directly to the comparator for audio routing to the IP simulcast subsystem remote sites in the form of IP network.

IP simulcast subsystem trunking control

The trunking control link to the IP simulcast subsystem remote site uses the IP network.

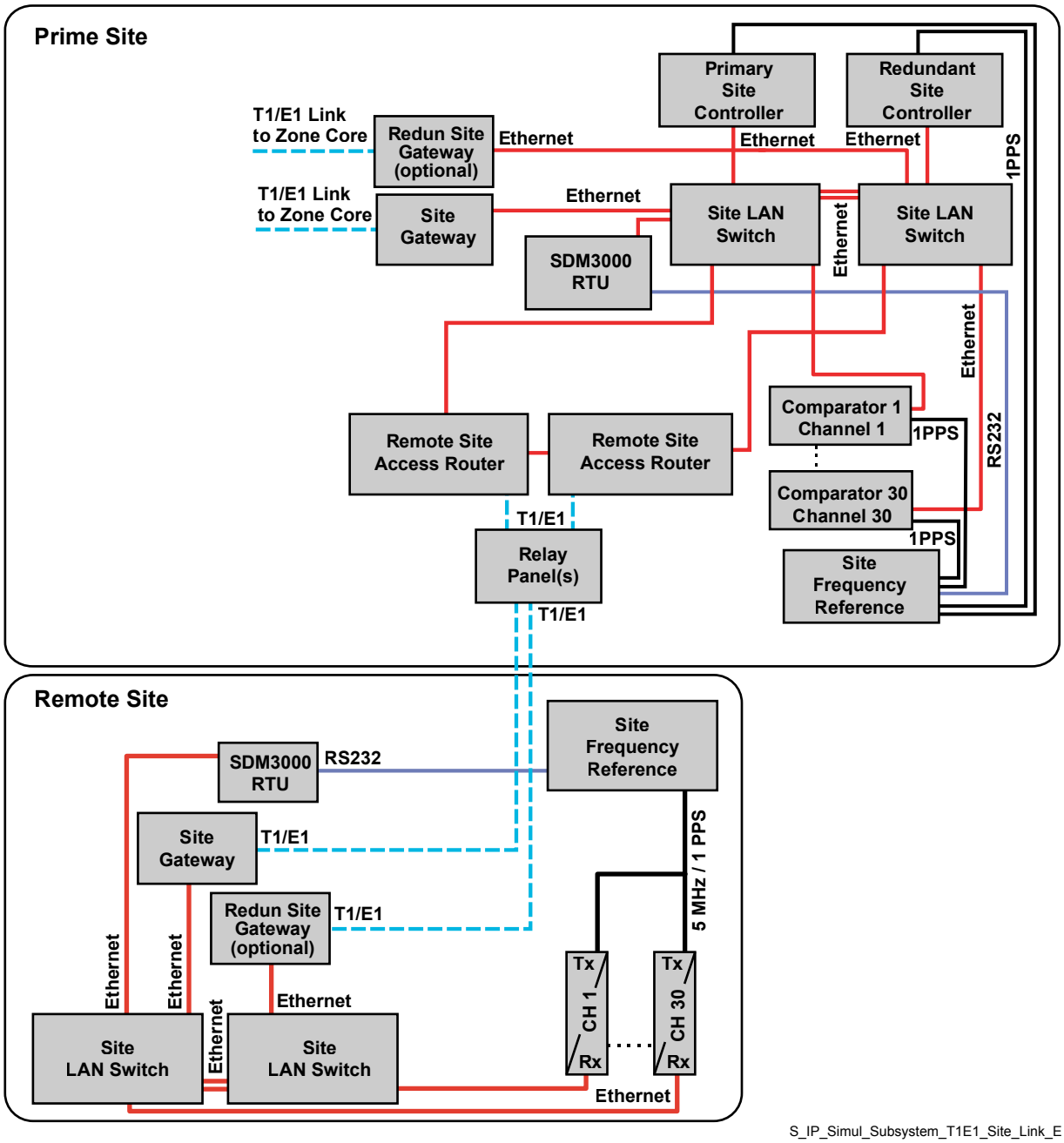
IP simulcast subsystem packet data

Packet data channel traffic to the IP simulcast subsystem remote site uses the IP network.

IP simulcast subsystem network management

Network management between the IP simulcast subsystem prime and remote sites is established through the IP simulcast subsystem prime site network.

Figure 18: ASTRO 25 Trunked IP Simulcast Subsystem — Standard Configuration (15 Subsite Capacity Shown with T1/E1 Links To The Remote Subsites)



S_IP_Simul_Subsystem_T1E1_Site_Link_E

The comparators support the system operation as part of an IP simulcast subsystem. Traffic (voice data) flows through the comparators for routing to the remote sites and master sites through the IP network links.

The comparator collects all the data for a single channel from all the sites. The comparator selects the best received frames from all its inputs and routes a single data stream to the master site. In the reverse direction, the comparator forwards outbound audio from the zone core to the base radios at the remote sites. Analog or mixed-mode (analog and digital) operation is not supported. The voted audio from the comparator is sent to the zone core as IP packets, where they are routed to all the required destinations.

The site control path from the prime site is connected to the prime site LAN. In addition, the site controllers and the comparators also reside on the prime site LAN. The prime site routes call processing traffic between the zone controller and the site controller. There are no separate data links to the remote sites. The trunking control link to the remote sites uses the IP network links.

The site controller acts as the control interface between the IP simulcast subsystem and the zone controller, and supervises the IP simulcast subsystem resources. An IP simulcast subsystem uses two site controllers in a redundant configuration.

The network management link from the prime site network system is connected to the prime site LAN to establish network management between the zone core and the prime site. Network management between the prime and remote sites is established through the prime site network.

IP simulcast subsystem operation requires a 1PPS input reference to the comparators and site controllers from a Global Navigation Satellite System (GNSS) site reference to synchronize the launchtimes. At a remote site using a standard configuration, standalone base radios receive a composite (1PPS+5 MHz) and the base radios inside a GTR 8000 Expandable Site Subsystem receive a 1PPS and 5 MHz reference signal from a GNSS site reference. All the required software for controlling launchtimes is included in the site controller and comparator software packages. The TRAK 9100 Simulcast Site Reference (SSR) supplies a highly accurate 1PPS time reference signal to the comparators and site controllers. The site controller uses the time reference to apply an index to the individual timing pulses, and distributes the index to the comparators and base radios over the IP network. The comparators use the time reference to compute transmission launchtimes. The TRAK 9100 SSR is configured with redundant power supplies, GNSS receivers, and oscillators.

In an IP Simulcast Subsystem Receive-only Remote Site with receive-only or STRV subsystem configurations, in the following operations:

For TDMA or Enhanced Data operation

Receivers receive a 1PPS and 5 MHz reference signal from the GPB 8000 RDM through the Global Navigation Satellite System (GNSS) unit (and/or TRAK for extended holdover backup).

For FDMA-only voice or IV&D operation

No GNSS unit (or TRAK) required for FDMA only voice or IV& Data operation.

In a Trunked IP Single Transmitter Receive–only Voting STRV subsystem with one single transmitter, the 1PPS input reference may be required depending on whether TDMA or Enhanced Data operation is supported.

For FDMA-only voice and IV&D Data operation

Synchronization of the launchtimes is not necessary and 1PPS from TRAK or GNSS unit site references is not required to the comparators and site controllers, base radios at the single transmit remote site and receivers at receive-only remote sites. At the single transmit remote site in standard configuration, TRAK site reference is required to provide 5 MHz to the standalone base radios.

For TDMA and Enhanced Data operation

Synchronization of the launchtimes using 1PPS reference is required to provide the time alignment required to the comparators and site controllers, base radios at the single transmit remote site and receivers at receive-only remote sites. Same TRAK or GNSS unit site references are used at IP simulcast subsystem.

At a remote site with a high availability configuration, the base radios inside a GTR 8000 Expandable Site Subsystem receive a 1PPS and 5 MHz reference signal from the GPB 8000 Reference Distribution Module through the GNSS unit (antenna/receiver). The TRAK 9100 SSR at the prime site provides the primary Network Time Protocol (NTP) time source to remote site.

NOTICE: The 1PPS port on the rear of the site controllers and comparators are high impedance. An external termination is needed to properly terminate the cable connected to the input. It is recommended that a BNC "T" and a 50 ohm BNC termination be connected to the input to terminate the cable.

2.4.1 Site Links

A link is defined as both the physical and logical connections between two entities. This section describes the site links within the IP simulcast subsystem.

For details regarding these transport devices, see the *S6000 and S2500 Routers* or *GGM 8000 System Gateway* manual.

2.4.1.1 Prime Site with Single or Dual Links to Master Site

A prime site router or gateway connects a prime site to the master site to process the physical and logical data link to support communication between the zone controller and the site controller. The physical connection is used to set up the logical T1/E1 or Ethernet links. If Ethernet links are deployed, the prime site router or gateway interfaces to the master site using an Ethernet connection to a backhaul switch. Dual prime site routers or gateways provide the highest level of redundancy to the subsystem. Single point failures can occur at a prime site router or gateway, without bringing the subsystem out of wide area operation. A dual prime site link to the zone master site, yields path diversity for the RF site link. Dual prime site links with redundant transport paths provide higher reliability than a single link implementation.

NOTICE: When setting up transport devices to support Ethernet site links, the type of backhaul network along with other considerations must be taken into account. See the *Flexible Site and InterZone Links* manual for more details.

The prime site router or gateway provides a WAN interface that handles all the traffic to and from the zone for the RF site including voice, control, data, and network management traffic. The prime site router or gateway also provides the connection between the site LAN and the transport network.

For more information, see the *Flexible Site and InterZone Links* manual.

2.4.1.2 Single and Dual Subsite Link Configurations

As an option, some or all subsites in a Multi-Site subsystem may be deployed with dual subsite WAN links to the prime site. This configuration yields path diversity for the subsite link and enables the use of redundant subsite routers and subsites within the subsystem.

2.4.1.3 Prime Site to Remote Site Links

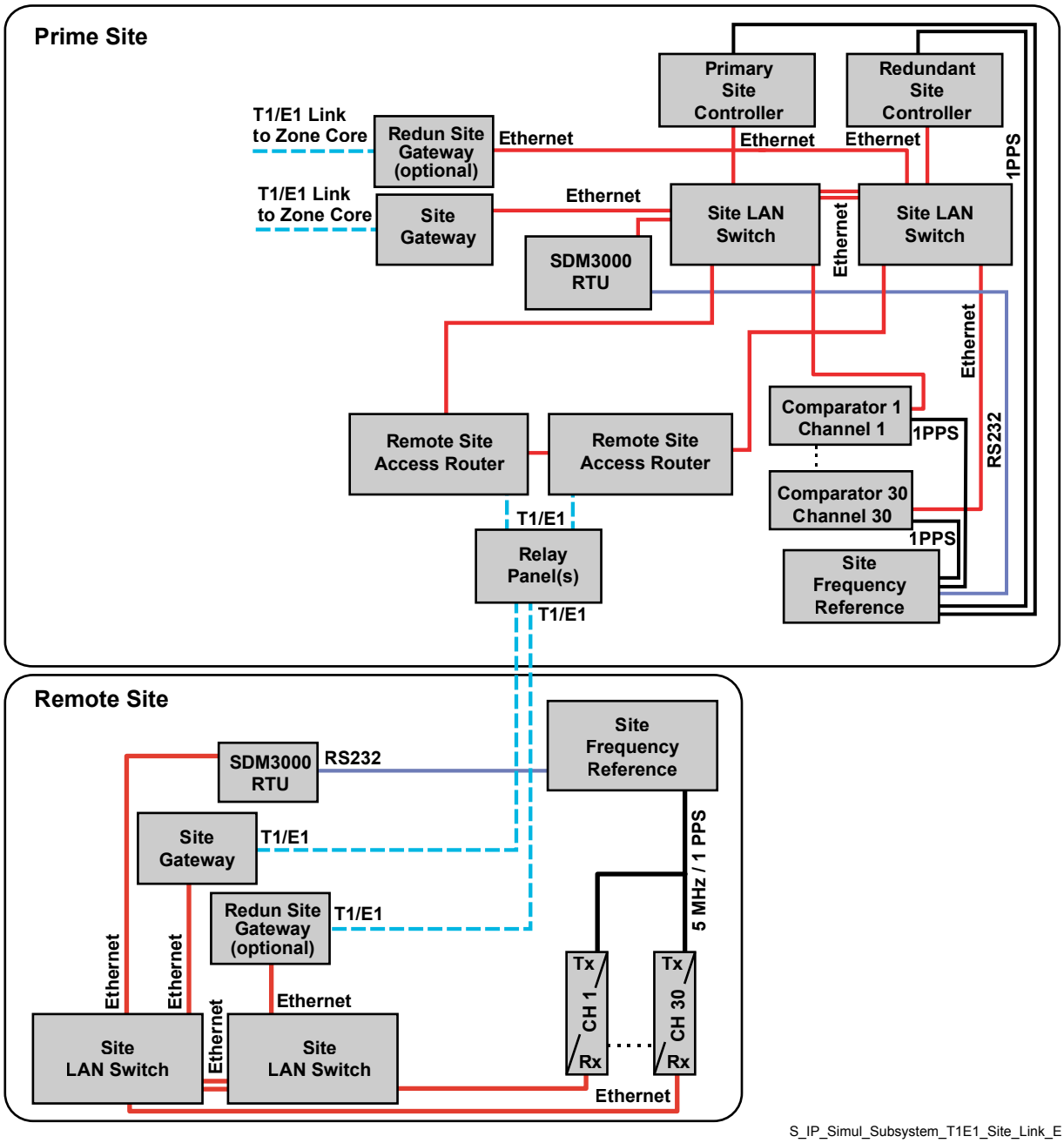
The remote site access routers or gateways at the prime site provide a WAN interface for the IP network connections to the remote sites. The remote site access routers or gateways carry all air interface payload (voice, control, and data) and infrastructure network management traffic, provide IP traffic prioritization for packets, and fragment large IP packets communications to and from the remote site. Dual remote site routers or gateways at the remote site provide the highest level of redundancy at

the remote site. Single point failures can occur at a remote site router or gateway, without bringing the remote site out of wide area operation. A dual remote site link to the prime site yields path diversity for the RF site link. Dual remote site routers or gateways, together with redundant transport paths, provide higher reliability than the single link implementation.

2.4.1.3.1
Single or Dual T1/E1 Links

The IP simulcast subsystem using T1/E1 links allow for redundant WAN links to be deployed between the prime site and the remote site. The following diagram shows a representative configuration, with a mix of single, and redundant remote site links. For each dual-linked site, each remote site access router has its own relay patch panel which is simply a pass-through connection for one of the remote site links. For each single-linked site, the remote site access routers must be configured to handle either redundant links or non-redundant links. A given module cannot support a mixture of redundant and non-redundant links. This restricts the combination of redundant and non-redundant site links that can be deployed within a subsystem. When a subsystem has a maximum of 15 remote sites there is a limitation of a mixture of 12 redundant and non-redundant remote site links.

Figure 19: Single or Dual T1/E1 Links — Standard Configuration, 15 Subsite Shown



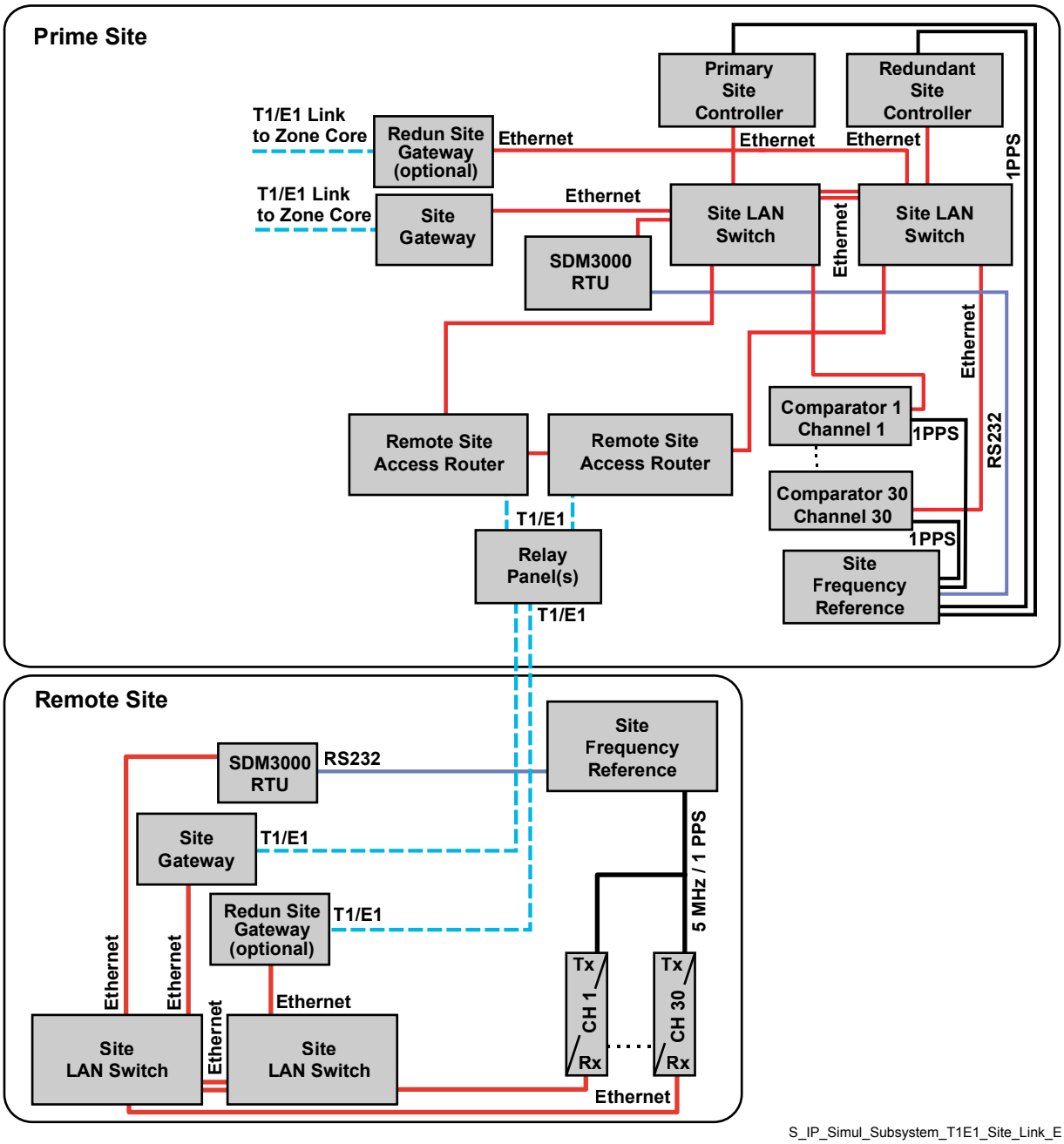
S_IP_Simul_Subsystem_T1E1_Site_Link_E

2.4.1.3.2

Single or Dual Ethernet Links

The IP simulcast subsystem allows for optional single or dual Ethernet links (WAN) to be deployed between the prime site and any or all remote sites. Figure 20: Single or Dual Ethernet Links — Standard Configuration, 15 Subsite Shown on page 72 shows a representative configuration, with a mix of single, and redundant remote site links. For each dual-linked site, each remote site access router or gateway employs a separate backhaul switch to support the Ethernet remote site link interface. For each single-linked site, the remote site access routers or gateways must be configured to handle either redundant site links or non-redundant site links.

Figure 20: Single or Dual Ethernet Links — Standard Configuration, 15 Subsite Shown



S_IP_Simul_Subsystem_T1E1_Site_Link_E

Two Ethernet switches are deployed at the simulcast prime site per the standard configuration. For prime sites equipped with two switches, each switch is connected to the other and, as together, form the core of the prime site LAN. Together, these two switches are connected to both the active and standby Simulcast Site Controllers, to all comparators in the simulcast prime site, to the prime site routers, and to the subsite access routers. Both switches are active simultaneously and communicate to all Simulcast Site Controllers and comparators on the LAN.

As described in the preceding paragraph, the standard configuration distributes prime site IP devices evenly between two Ethernet switches. A single point of failure to one of these Ethernet switches remove half of the remote site channels from service. For some customers, this is deemed an unacceptable level of fault tolerance. Customers desiring improved availability in the event of a switch failure may choose to spread the site resources over four Ethernet switches that are set up in a mesh

configuration, rather than two. This configuration may lessen the impact on overall availability of resources due to the failure of a single switch.

2.4.1.3.3
Redundant Subsite Access Routers

For subsites with single subsite WAN links, the subsite access routers are connected to the WAN link in a cooperative WAN router (CWR) arrangement. If one of the subsite access routers fails, the other subsite access router in the CWR pair assumes control of the router subsite links which fail. This arrangement ensures that subsite access routers do not constitute a single point of failure within the subsystem.

For any subsite with dual subsite WAN links, the subsite's two WAN links are permanently connected to two different subsite access routers. CWR WAN link switching is not used for these links.

2.4.1.4
Hybrid Site Link Overview

The Hybrid Site Links configuration is a flexible way of connecting a redundant zone core to redundant remote sites in ASTRO® 25 systems. The Hybrid Site Links configuration allows redundant connections between the zone core and a remote site by using different connection types. Before the introduction of this configuration, the primary and redundant site links had to be of the same type, either E1/T1 or Ethernet links. This configuration enables mixing of E1/T1 and Ethernet site links, where the primary could be an E1/T1 and the secondary could be an Ethernet link, or an Ethernet link as the primary or E1/T1 as the secondary link.

Hybrid site links are available in the M2 and M3 system configurations with Dynamic System Resilience (DSR), and M3 system configuration without DSR. The Hybrid Site Links configuration connects redundant zone cores to the following remote sites:

- ASTRO® 25 Repeater Site (ISR)
- IP Simulcast Prime Site
- Network Manager/Dispatch Console Site (MCC 7500/7100 Dispatch Console only)
- Conventional-only Site (Centralized Conventional Architecture)

The hybrid links support flexible transport types by employing transport devices such as redundant GGM 8000 site gateways and S6000 core routers. The transport between a primary core router and primary site gateway, or a secondary core router and secondary site gateway within the same site must be either of the T1/E1-to-T1/E1 or Ethernet-to-Ethernet transport type. For sites that require more than one T1/E bandwidth, the Hybrid Site Links configuration supports up to two T1/E1 links bundled together.

A site gateway supports one connection type, either redundant Ethernet or T1/E1 WAN terminations. A core router can support T1/E1 terminations for some sites and Ethernet terminations for other sites.

NOTICE: The GGM 8000 replaces the MNR S6000 for all Ethernet configurations; all T1/E1 configurations require an MNR S6000.

For more information regarding S6000 core routers, see the *S6000 and S2500 Routers* manual.

For more information about GGM 8000 site gateway transport devices, see the *GGM 8000 System Gateway* manual.

2.4.1.5
Geographically Redundant Prime Site with Intra-Prime Site Link

To support the geographic redundancy feature, the primary prime site, and secondary prime site interface through an intra-prime site link. The *split-prime sites* are connected to each other through an

extended LAN link referred to as the intra-prime site link. The LAN link operates at a fixed speed of 10 Mbps or 100 Mbps (end-to-end). The speed required is dependent on the subsystem size. Each prime site LAN switch provides a single port (49) for this connection.

The intra-prime site link is an extension of the prime site LAN. LAN protocols are typically not designed to run over WAN links and failures on the intra-prime site link are critical to overall performance of the subsystem. Given that LAN messaging is typically more sensitive to link impairments than WAN messaging, it is critical that intra-prime site backhaul designers meet the transport specifications specified in this section.

2.4.1.5.1
Intra-Prime Site Link Failure

Intra-prime site link failure has no impact on call processing as long as the Primary Prime Site is not impacted and is running under normal operating conditions. For operating characteristics associated with other incidents including intra-prime site link failure, see “Troubleshooting” section.

2.4.1.5.2
Intra-Prime Site Link Transport Design Constraints

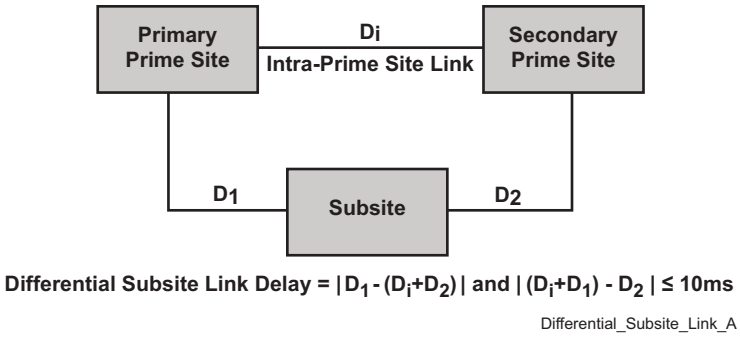
Proper performance and design of the intra-prime site link backhaul used to support the Geographically Redundant Simulcast Prime Sites is critical for proper operations.

The following are requirements and considerations for proper backhaul design to support the Geographically Redundant Simulcast Prime Site configuration:

- One end-to-end transparent 10 Mbps or 100 Mbps Ethernet link is required.
- Highly available ethernet backhaul design (redundant paths) is required to minimize the risk of entering *split-brain*. Upon failure within the backhaul, an alternate bidirectional path must be established within 800 ms.
- Once a transport path is up in one direction, the backhaul design must ensure bi-directional packet flow in less than 100 ms.
- The backhaul design must ensure that no network looping occurs as a result of failure or recovery of a link within the backhaul or during normal operation.

  NOTICE: It is highly recommended that standards-based protocols (for example, ITU G. 8032 for ring topologies) be used for backhaul designs.
- Dedicated bandwidth is essential if the link is shared with other traffic. In other words, throughput must not be impacted by other traffic on the same physical transport.
- Subsite links must not rely on the same physical transport as the intra-prime site link whether the subsite is remote or collocated unless an alternate path to the primary prime site is available if the intra-prime site link goes down.
- One-way latency on the intra-prime site link (end-to-end between LAN switches) must be ≤ 5ms.
- For a given subsite, current design constraints for Ethernet Site Links require that the redundant subsite link latency for each link is within 10 ms of each other. For geographically redundant prime sites, the intra-prime site link is considered a link segment along the path to the subsites and must be factored into this calculation: Differential Subsite Link Delay = $| D_1 – (D_i + D_2) |$ and $| (D_i + D_1) – D_2 | \leq$ 10ms (refer to the following figure).

Figure 21: Differential Subsite Link Delay



NOTICE:

- D_i = Intra-prime site link between the primary and secondary site
- D_1 = Subsite link between the primary prime site and subsite
- D_2 = Subsite link between the secondary prime site and subsite

- The intra-prime site link must be factored into the overall budgets for latency, jitter, and packet loss, like any other link segment along the backhaul.
- The backhaul must support 802.1q frame format. For certain operations, the Ethernet frames sent from the prime site LAN switches on the intra-prime site link (port 49) could be as large as 1522 bytes (max limit for 802.1q). Transport designers must ensure that Ethernet frames of this size could be sent between the primary prime site and secondary prime site. It is assumed that appropriate adjustments are made to the backhaul if the backhaul requires Q-in-Q tagging (increase the maximum transmission unit (MTU) size so to support the extra bytes associated with Q-in-Q tagging).
- The prime site LAN switches apply Quality of Service (QoS) prioritization to the LAN traffic. Given that the packets are ordered by the LAN switches, the backhaul must preserve the order of these packets.
- Intra-prime site link traffic is tagged on VLAN 12. If Q-in-Q tagging is not used, the backhaul design must ensure that this VLAN number is not being utilized by other services.
- The bandwidth required for the intra-prime site link is calculated by using different methods depending on the system configuration. For more information, see Intra-Prime Site Link Bandwidth on page 75.

2.4.1.5.3

Intra-Prime Site Link Bandwidth

A geographically redundant prime site has an intra-prime site link connecting the two split prime sites.

The intra-prime site link is provisioned with a data rate of either 10 Mbps or 100 Mbps. The method used to calculate the bandwidth needed is different depending on the system configuration.

Geographically Redundant – Without Simulcast (applies to Tsubs only)
For geographically redundant Trunking Subsystem (Tsub) configurations that contain neither a trunked nor a conventional simulcast subsystem, the intra-prime site link data rate is 10 Mbps.

Geographically Redundant - With Simulcast (Tsub or non-Tsub configurations)
For geographically redundant configurations that contain either a trunked or a conventional simulcast subsystem, or both, the intra-prime site link data rate is determined by the Tsub Capacity Index. If the Tsub Capacity Index is greater than 750, the Intra-Prime Site Link data rate is 100 Mbps. Otherwise, the Intra-Prime Site Link data rate is 10 Mbps.

NOTICE: Although “Tsub” is referenced in the term “Tsub Capacity Index”, the method described in this section also applies to non-Tsub geographically redundant prime site configurations, replacing the original rules.

The Tsub Capacity Index is a multiply-and-accumulate calculation, where channels/voice paths and call counts each have a weight associated with them.

Table 1: Trunking Subsystem Capacity Index

Audio Source	Number of Sources (N)	Weight (W)	Contribution
Trunked Repeater Voice Paths	N_{TR}[1]	1	$N_{TR}W_{TR}$
Trunked Simulcast Voice Paths	N_{TS}	1.5*(number of sub-sites)	$N_{TS}W_{TS}$
Digital Conventional Repeater Channels	N_{DCR}	1	$N_{DCR}W_{DCR}$
Digital Conventional Simulcast Channels	N_{DCS}	1.5*(number of sub-sites)	$N_{DCS}W_{DCS}$
Analog Conventional Repeater Channels	N_{ACR}	2	$N_{ACR}W_{ACR}$
Analog Conventional Simulcast Channels	N_{ACS}	6*(number of sub-sites)	$N_{ACS}W_{ACS}$
High Performance Data Channels	N_{HPD}	1	$N_{HPD}W_{HPD}$
Console Trunked Call Counts	N_{TCC}[2]	1	$N_{TCC}W_{TCC}$
Console Digital Conventional Call Counts	N_{DCCC}[2]	1	$N_{DCCC}W_{DCCC}$
Console Analog Conventional Call Counts	N_{ACCC}[2]	2	$N_{ACCC}W_{ACCC}$
Tsub Capacity Index			$\sum N_iW_i$

[1] Not applicable for non-Tsub configurations.

[2] For Tsubs, call counts may be calculated as if all dispatch consoles are aggregated at the same console site to account for resource redundancy within the Tsub. Note that these counts only apply for console sites within the Tsub. Call counts to channels internal and external to the Tsub should be considered. These counts are not applicable for non-Tsub geographically redundant simulcast configurations.

Intra-Prime Site Link Bandwidth Example – Non-Tsub Configuration

The following example illustrates how to calculate the Tsub Capacity Index for the following configuration:

- 20 voice paths, 20 subsite simulcast subsystem,
- 16 digital conventional repeater channels, and
- 7 analog conventional repeater channels

contributes 20*1.5*20 + 16*1 + 7*2 = 630 to the Tsub Capacity Index. Based on this calculation, a 10 Mbps intra-prime site link is required since the 630 value is below the 750 threshold.

Related Links

Intra-Prime Site Link Transport Design Constraints on page 74

2.5 Transmit and Receive in an IP Simulcast Subsystem

The IP simulcast subsystem simultaneously transmits information on one frequency throughout the entire subsystem from a base radio at each remote site. Global Navigation Satellite System (GNSS) input is used to synchronize these transmissions.

Each remote site uses base radios that transmit frequencies identical to those used by other remote sites within the subsystem. When a signal to be transmitted in an IP simulcast subsystem is received from the master site, it is routed to a base radio at each remote site in the subsystem. At a predetermined time, all the base radios broadcast the signals simultaneously on the same frequency.

The base radios at the remote sites in the subsystem pickup the signals transmitted by subscriber radios and route them to the prime site. The audio signals for a particular call are sent to a voting comparator at the prime site, where the best quality signal is determined. The best quality audio signal is passed from the comparator back to the base radios at each remote site in the IP simulcast subsystem and to the master site for routing through the system.

A trunked receive-only remote site (equipped with only receivers and no transmitters) can be part of a Simulcast, Multicast, or STRV subsystem and can be co-located with the prime site. A Remote Site must be a transmit or a receive-only site and a mixture of transmit and receive-only stations are not supported.

2.6 Call Processing

Call processing is the sequence of events that the system goes through to process a call request. A trunked system enables people to communicate with one another whenever required and from wherever they are in the coverage area. All communications within the system are processed as a call. A call is a specific instance of the system, providing a call service to a properly configured, registered, and affiliated user of the system. The basics of call processing in an ASTRO® 25 system includes, a description of the hardware components that are used in call processing, the types of calls available, and the flow a call takes as it makes its way through the system.

A portable or mobile interface to the ASTRO® 25 system is similar to the single site trunked system. Enhancements are made to the signaling that allows the radios to automatically register at their current site, notifies the system as they move through different sites, and receives control channel accessibility at adjacent sites.

2.7 Dynamic Frequency Blocking

The Dynamic Frequency Blocking (DFB) feature applies only to RF sites/subsystems in wide-area trunking mode. This feature allows ASTRO® 25 systems to operate with a small number of inter-channel interferences. The interferences are dynamically avoided by coordinating the use of channels known to interfere with channels at other sites in the system.

The system allows either a Frequency Division Multiple Access (FDMA) or Time Division Multiple Access (TDMA) call to block the assignment of the same frequency (DFB support) at an adjacent site that has been configured as a DFB-contending channel.

DFB continues to work on a channel basis, independent of FDMA or TDMA assignments.

The FDMA or TDMA calls are assigned to a DFB-capable channel. A single TDMA call on an interfering channel blocks the entire channel.

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Chapter 3

ASTRO 25 Trunked IP Simulcast Subsystem Installation

This chapter details installation procedures relating to the trunked IP simulcast subsystem.

3.1 Installing Hardware at the Prime and Remote Sites

This process provides guidelines and recommendations for installing racks, cabinets, and devices at prime and remote sites within an IP simulcast subsystem.

Process:

1. Prepare each site to comply with the Motorola Solutions requirements and specifications for the equipment, as listed in the *Standards and Guidelines for Communication Sites* (R56) manual. Other codes and guidelines that may apply to the location must also be met.
2. Inspect and inventory all racks, cabinets, cables, and other equipment with a Motorola Solutions representative to ensure that the order is complete.
3. Install all equipment using the site drawings and other documents provided by the Field Engineer. Use the installation standards and guidelines for placing and installing equipment.
4. Install all groundings for the racks and cabinets to protect against ground faults, electrical surges, and lightning in accordance with *Standards and Guidelines for Communication Sites* (R56) manual standards.
5. Connect all cables within each rack and between multiple racks (where required). Connect the subsystem to the overall facility system. For implementation of a Geographically Redundant Prime Site, see the expansion manual for details on when the intra-prime site link should be established.
6. Run a preliminary check of all sites before applying power and starting the initial software installations.

3.1.1 Required Tools for Hardware Installation

Various tools are required to install, optimize, and service the equipment in an IP simulcast subsystem. For information regarding the equipment and tools listed, contact the Motorola Solutions Support Center (SSC).

Obtain the following tools to install, optimize, and service the site equipment:

- Aeroflex R2670 Service Monitor APCO P25 Simulcast (5.1) Trunking Option
- Aeroflex IFR2975 or 3900 Series Service Monitor with P25 Options installed
- Personal Computer meeting the following specifications:
  - Operating System: Windows 10
  - Hardware Requirements:
    + Processor: 1 GHz or higher Pentium grade Processor
    + 2 GB RAM recommended for Windows 10

    + Hard Disk Space: 300 MB minimum free space (for a Typical Installation, including Help Text and Software Download) or 100 MB minimum free space (for Compact Installation)
    + Peripherals:
        - Microsoft Windows supported Mouse or Trackball
        - Microsoft Windows supported Serial Port for product communication
        - Microsoft Windows supported Ethernet Port for product communication
        - Microsoft Windows supported Printer Port for report printing
        - CD-ROM for software installation
- Configuration/Service Software (CSS) — DLN6455
- CSS DB-9 straight through serial cable
- 150 MHz 4-channel digital storage oscilloscope
- Transmission test set (TIMS Set)
- 50 Ohm terminated load
- Digital Multimeter (DMM)
- Antenna tester
- Terminal emulation software
- Null modem cable
- RS–232 cables with connectors
- Punch block impact tool
- MODAPT RJ-45 breakout device
- Remote RJ11/RJ45 cable tester (1,200 ft length maximum)
- PC cable tester with RG58, 59, 62, BNC, RJ-45, RJ11, DB-9, DB15, DB25, and Centronics 36-pin connectors
- Ethernet straight through cable to connect service technician computer and front service port of GCP 8000 Site Controller
- Electrostatic Discharge (ESD) field service kit
- Amprobe Instruments GP-1 earth tester
- AEMC 3730 clamp-on ground resistance tester
- Rhode&Schwarz NRT-Z14 Directional Power Sensor 25–1000 GHz 0.1–120W average reading powermeter for use when the R2670 service monitor is not available

Obtain the following networking tools to install and service the network:

- Fluke® One-Touch Assistant LAN tester
- NiMH rechargeable battery for Fluke
- T1/E1 or E1 test set (such as the Hewlett-Packard® HP37702)
- Serialtest® software with a ComProbe® and a SerialBERT option

3.2 Trunked IP Simulcast Prime Site Hardware Cabling

Hardware cabling in an IP simulcast prime site consists of the following equipment:

- GCP 8000 Site Controllers
- GCM 8000 Comparators

- Prime Site Routers or Gateways
- Remote Site Access Routers or Gateways
- Ethernet LAN Switches
- TRAK 9100 Simulcast Site Reference

3.2.1
Cabling the GCP 8000 Site Controllers

The site controller has ports on both the front and the back that allow it to connect to various devices.

For information on racking, mounting, grounding, cabling power, cabling connections, and interfacing modules, see the *GCP 8000 Site Controller* manual.

3.2.2
Cabling the GCM 8000 Comparator

The comparator has ports on both the front and the back that allow it to connect to various devices.

For information on racking, mounting, grounding, cabling power, cabling connections, and interfacing modules, see the *GCM 8000 Comparator* manual.

3.2.3
Cabling the Prime Site Routers and Gateways

For information on racking, mounting, grounding, cabling power, cabling connections, and interfacing modules, see the *S6000 and S2500 Routers* and *GGM 8000 System Gateway* manual.

3.2.4
Cabling the Ethernet LAN Switches

For information on the port assignments for each HP Ethernet LAN switch in your IP simulcast subsystem, see Chapter 2, "HP Switches – Determining Port Connections in ASTRO® 25 Systems" in the *System LAN Switches* manual.

3.2.5
Cabling the TRAK 9100 Simulcast Site Reference

For information on racking, mounting, grounding, cabling power, and cabling connections, see the *Simulcast Site Reference* manual.

3.3
Remote Site Hardware Cabling

Hardware cabling in an IP simulcast remote site consists of the following equipment:

- GTR 8000 Base Radios
- GTR 8000 Expandable Site Subsystem (includes GPB 8000 Reference Distribution Module)
- Remote Site Routers or Gateways
- Ethernet LAN Switches
- TRAK 9100 Simulcast Site Reference
- Cabling the TRAK 8835 Conventional Site Reference
- Cabling the GPW 8000 Receiver

- Cabling the Expansion Hub
- Cabling the Reference Distribution Module – Standalone

For Trunked Receive-Only configurations, see “Remote Site Components Installation” in the *Trunked IP Simulcast Remote Site* manual.

3.3.1
Cabling the GTR 8000 Base Radio

For information on racking, mounting, grounding, cabling power, and cabling connections, see the *GTR 8000 Base Radio* manual.

3.3.2
Cabling the GTR 8000 Expandable Site Subsystem

For information on racking, mounting, grounding, cabling power, and cabling connections, see the *GTR 8000 Expandable Site Subsystem* manual.

3.3.3
Cabling the Remote Site Routers or Gateways

For information on racking, mounting, grounding, cabling power, cabling connections, and interfacing modules, see the *S6000 and S2500 Routers* and *GGM 8000 System Gateway* manual.

3.3.4
Cabling the Ethernet LAN Switches

For information on port assignments for each HP Ethernet LAN switch in your IP simulcast subsystem, see Chapter 2, "HP Switches – Determining Port Connections in ASTRO® 25 Systems" in the *System LAN Switches* manual.

3.3.5
Cabling the TRAK 9100 Simulcast Site Reference

For information on racking, mounting, grounding, cabling power, and cabling connections, see the *Simulcast Site Reference* manual.

3.3.6
Cabling the TRAK 8835 Conventional Site Reference

For information on racking, mounting, grounding, cabling power, cabling connections, and interfacing modules, see the *Simulcast Site Reference* manual.

3.3.7
Cabling the GPW 8000 Receiver

For information on racking, mounting, grounding, cabling power, cabling connections, and interfacing modules, see the *GPW 8000 Receiver* manual.

3.3.8
Cabling the Expansion Hub

For information on racking, mounting, grounding, cabling power, cabling connections, and interfacing modules for Expansion Hubs in a High Availability configuration, see the *GTR 8000 Expandable Site*

Subsystem manual and the *GPW 8000 Receiver* manual for Expansion Hubs in a standalone configuration.

3.3.9
Cabling the Reference Distribution Module — Standalone

For information on racking, mounting, grounding, cabling power, cabling connections, and interfacing modules for the Reference Distribution Module in a High Availability configuration, see the *GTR 8000 Expandable Site Subsystem* manual and the *GPW 8000 Receiver* manual for the Reference Distribution Module in a standalone configuration.

3.4
Trunked IP Simulcast Subsystem Site Expansion for High Availability

This section provides the expansion process for upgrading Trunked IP Simulcast Subsystem Prime and Remote Site to High Availability Configuration.

3.4.1
Trunked IP Simulcast Subsystem Remote Site Expansion for High Availability

This expansion applies to trunked IP simulcast subsystem remote sites using GTR 8000 Expandable Site Subsystems.

Prerequisites:

- Verify that the base radios have been upgraded to the latest system release, before doing any feature expansion.
- Confirm this is an existing trunked IP simulcast remote site.
- Motorola Solutions-provided switch configuration files based on the layout for this high availability trunked IP simulcast subsystem remote site.
- Motorola Solutions-provided equipment and cable labels.
- Obtain the documentation referenced in the process.
  - *Centralized Event Logging*
  - *CSS Online Help*
  - *GGM 8000 System Gateway*
  - *GTR 8000 Expandable Site Subsystem*
  - *MAC Port Lockdown*
  - *MOSCAD Network Fault Management*
  - *S6000 and S2500 Routers*
  - *Securing Protocols with SSH*
  - *SNMPv3*
  - *Software Download Manager*
  - *System LAN Switches*
  - *Trunked IP Simulcast Remote Site*
  - *Unified Event Manager*

- *Unified Network Configurator*

3.4.1.1
Adding IP Simulcast Remote Site for High Availability (Off-site Pre-configuration)

Procedure:

1. Determine the existing site configuration (GTR 8000 Expandable Site Subsystem). See “Site View tab” in the *Software Download Manager* manual.

   NOTICE: Assumption: You are expanding the site to an IP simulcast remote site high availability configuration.

2. For GTR 8000 Expandable Site Subsystem Sites:
   a. Determine the number of GTR 8000 Expandable Site Subsystem cabinets (if adding additional channels, add more cabinets. BRs are reusable, need to install in the GTR 8000 Expandable Site Subsystem cabinet).
   b. Determine the number of conventional channels. (IP simulcast remote site high availability supports adding a conventional overlay to a site. Standalone BR or in GTR 8000 Expandable Site Subsystem).
   c. Determine the number of Conventional Channel Gateways (CCGWs)
   d. Determine the conventional channel type (IP, v.24, or mixed mode). IP conventional base radios interface to the RDM, others (mixed mode and v.24 digital base radios) connect to the CCGWs.
   e. Determine the presence of HPD Overlay.
   f. Determine the number of MOSCAD SDM3000 RTUs
   g. Determine if other MOSCAD Network Fault Management (NFM) components are present or need to be added. When you add the RDMs, you need to update the server GMC (Graphical Master Computer) software.
3. Obtain and set IP addresses for both GPB 8000 Reference Distribution Modules (RDMs). See “Setting the Device IP Address and Pairing Number in CSS” in the *GTR 8000 Expandable Site Subsystem* manual.
4. Install the latest system release software onto both RDMs: See “Replacing a GPB 8000 Reference Distribution Module” in the *GTR 8000 Expandable Site Subsystem* manual.
   a. Using a spare slot, install the RDMs (Assumption: You have a spare slot to do this step (GTR 8000 Expandable Site Subsystem)).
   b. Using a computer with Configuration/Service Software (CSS), connect the RDM to the SWDL Manager. Update RDMs before going to the site to minimize downtime on live systems.
   c. Use SWDL to perform a single device download (RDM FRUs ship as GCP 8000 Site Controllers and need to be converted).
   d. Use SWDL to transfer and install the software.
5. Take an inventory of the site configuration. For example, assess the site, create a checklist of auxiliary devices at the site. Make a plan for your RDM ports.
6. Using the information gathered in the proceeding steps, create a plan for the RDM LAN port usage. See “General Site Preparation Overview” in the *GTR 8000 Expandable Site Subsystem* manual.
7. Locate the expansion ports on the RDM (the five expansion ports on the front of the RDMs are cabled from the RDM to the Network Expansion Subpanel). See “GCP 8000 Site Controller and

GPB 8000 Reference Distribution Module Ports (Front)" in the *GTR 8000 Expandable Site Subsystem* manual.

8 Determine expansion ports on the RDM. See "Junction Panel Connections for a Trunked IP Simulcast (High Availability Configuration)" in the *GTR 8000 Expandable Site Subsystem* manual.

9 Determine required cables. See "Junction Panel Connections for a Trunked IP Simulcast (High Availability Configuration)" in the *GTR 8000 Expandable Site Subsystem* manual.

3.4.1.2 Adding IP Simulcast Subsystem Remote Site for High Availability (On-Site Prework)

Procedure:

1 For fielded GTR 8000 Expandable Site cabinets, install the cable connecting the XHub NET Aux ports to the junction panel. See "Junction Panel Connections for a Trunked IP Simulcast (High Availability Configuration)" in the *GTR 8000 Expandable Site Subsystem* manual.

NOTICE: Expansion cabinets keep the XHubs. Reuse the gray Network LAN cable. This step is in preparation for connecting to the junction panel.

2 Install the Global Navigation Satellite System (GNSS) unit and cabling. This step is in preparation for connection to the RDMs in the cabinet.

3 Mount the GNSS unit outside (One GNSS unit, which includes the antenna and a receiver/modem, is installed for each RDM). See "Installing the GNSS Units" in the *GTR 8000 Expandable Site Subsystem* manual.

4 Route the GNSS receiver cable from the remote GNSS unit to the junction panel. This cable connects the RDM to the GNSS unit through the junction panel. The connection step is later in this expansion. See "Junction Panel Connections for a Trunked IP Simulcast (High Availability Configuration)" in the *GTR 8000 Expandable Site Subsystem* manual.

5 Cut the cable and install a surge suppression device between the GNSS unit and rack. Record the length of the cable in feet. The cable has foot markers; record the length. This information is used to configure the GNSS Cable Offset later in this task flow. See "GNSS Unit Cable Length Delay Offset Calibration" in the *GTR 8000 Expandable Site Subsystem* manual.

3.4.1.3 Adding IP Simulcast Remote Site for High Availability (On-site Expansion)

Procedure:

1 Designate the primary cabinet of the GTR 8000 Expandable Site Subsystem (where base radios 1-6 reside). See "Junction Panel Connections for a Trunked IP Simulcast (High Availability Configuration)" in the *GTR 8000 Expandable Site Subsystem* manual.

IMPORTANT: Limit downtime to a total of 30 minutes or less.

NOTICE: The primary cabinet should be the first 6 channels.

2 Disable and power down the base radios and the site:

a Disable the remote subsite in Configuration/Service Software (CSS). See “Replacing a Subpanel on the GTR 8000 Expandable Site Subsystem Junction Panel” in the *GTR 8000 Expandable Site Subsystem* manual.

b Turn Off power supplies units and AC supply breakers. Power down all other expansion cabinets/racks connected to the primary cabinet. See “Replacing a Subpanel on the GTR 8000 Expandable Site Subsystem Junction Panel” in the *GTR 8000 Expandable Site Subsystem* manual.

3 From the primary cabinet, begin the process to install the RDMs:

a Disconnect the HP ProCurve switches from the XHubs in the primary cabinet. See “Junction Panel Connections for a Trunked IP Simulcast (High Availability Configuration)” in the *GTR 8000 Expandable Site Subsystem* manual.

b Disconnect the subsite TRAK from the primary cabinet. See “Junction Panel Connections for a Trunked IP Simulcast (High Availability Configuration)” in the *GTR 8000 Expandable Site Subsystem* manual.

c Remove both XHubs from the primary cabinet. See “Replacing the Expansion Hub” in the *GTR 8000 Expandable Site Subsystem* manual.

d Install the RDMs into the primary cabinet. See “Replacing a GPB 8000 Reference Distribution Module (RDM)” in the *GTR 8000 Expandable Site Subsystem* manual.

4 Update the subpanels by changing or adding new subpanels. See “Replacing a Subpanel on the GTR 8000 Expandable Site Subsystem Junction Panel” in the *GTR 8000 Expandable Site Subsystem* manual.

a Label all cables for the subpanel to be removed; then disconnect all cables from the subpanel.

b Remove Primary Subpanel 2 (XHub interface) in the upper right and replace with Primary Subpanel 1.

c Install Network Expansion Subpanel (Expansion interface) in the lower right.

d For conventional base radios, remove the old V.24 Subpanel in the upper middle and replace it with the Wireline V.24 Subpanel.

NOTICE: Optional: Applies to conventional internal or external base radios or external mixed mode conventional base radios at the high availability site.

5 On the primary cabinet, connect the Global Navigation Satellite System (GNSS) units to the Primary Subpanel 1/Remote GPS A using the GNSS Receiver Cable. See “Junction Panel Connections for a Trunked IP Simulcast (High Availability Configuration)” in the *GTR 8000 Expandable Site Subsystem* manual.

6 For the remaining Expansion cabinets (Optional):

7 Disconnect the LAN switches from all cabinets.

8 Disconnect the subsite TRAK. See “Cabling the TRAK 9100 Simulcast Site Reference” in the *Trunked IP Simulcast Remote Site* manual.

9 Install the subpanels. See “Replacing a Subpanel on the GTR 8000 Expandable Site Subsystem Junction Panel” in the *GTR 8000 Expandable Site Subsystem* manual.

a Remove Primary Subpanel 2 (XHub interface) in the upper right and replace with Expansion Subpanel 1.

b For conventional base radios, remove the old V.24 Subpanel in the upper middle and replace it with the Wireline V.24 Subpanel.

NOTICE: Applies to conventional internal or external base radios or external mixed mode conventional base radios at the high availability site.

10 Connect XHubs to RDM expansion ports. See “Junction Panel Connections for a Trunked IP Simulcast (High Availability Configuration)” in the *GTR 8000 Expandable Site Subsystem* manual.

11 For the remaining equipment, install the site routers/gateways. Can use either S2500 Routers or new GGM 8000 Gateways:

a Install the S2500 Routers. See “Installing an S2500 Router in a Rack” in the *S6000 and S2500 Routers* manual.

b Install the GGM 8000 Gateways. See “Rack-Mounting the GGM 8000” in the *GGM 8000 System Gateway* manual.

c Connect the site routers or gateways to RDMs. See “Junction Panel Connections for a Trunked IP Simulcast (High Availability Configuration)” in the *GTR 8000 Expandable Site Subsystem* manual.

12 Turn on Power supplies and plug-in AC outlets for BRs, RDMs, and site routers or gateways. Power on and enable the base radios and site. See “Junction Panel Connections for a Trunked IP Simulcast (High Availability Configuration)” in the *GTR 8000 Expandable Site Subsystem* manual.

13 Enable the remote subsite. See “Installing the GNSS Units” in the *GTR 8000 Expandable Site Subsystem* manual.

14 Ensure connectivity to the prime site: Verify Global Navigation Satellite System (GNSS) visibility (4 satellites) using the GPS Information screen in CSS. See “Setting the GNSS Unit Cable Length Delay Offset Calibration in the CSS, step 4” in the *GTR 8000 Expandable Site Subsystem* manual.

15 Configure GNSS Cable Delay Offset (Need 4 satellites for initial acquisition and only 1 satellite after that to maintain GNSS lock):

a Cable lengths less than 350 ft. using CSS. See “Setting the GNSS Unit Cable Length Delay Offset Calibration in the CSS” in the *GTR 8000 Expandable Site Subsystem* manual.

b Cable lengths less than 350 ft. using UNC. See “Setting the GNSS Unit Cable Length Delay Offset Calibration in the UNC” in the *GTR 8000 Expandable Site Subsystem* manual.

NOTICE: If cable length must exceed 350 ft., contact the Motorola Solutions Support Center (SSC).

16 Perform a Site Software Download of the latest software to both RDMs and all base radios. The SWDL is needed to synchronize the software between the base radios and the RDMs. See “Replacing a GPB 8000 Reference Distribution Module (RDM)” in the *GTR 8000 Expandable Site Subsystem* manual.

17 Verify that Wide Area Trunking has been restored. See Simulcast Subsystem Wide Area Trunking Mode on page 104.

18 Disconnect all ancillary devices from the switches: See: “HP Switches – Determining Port Connections in ASTRO 25 Systems” in the *System LAN Switches* manual.

- Ancillary devices include: CCGWs, Standalone Conventional Base Stations, HPD Site Controllers, MOSCAD.

19 Install the Expansion to Net Aux Conversion cable kits (optional): Cable kits are needed to convert unused RDM expansion ports to standard LAN ports and only needed to connect auxiliary devices.

a Install the Expansion to Net Aux Conversion cable (blue cable). This cable is used to convert the RDM expansion ports of the prime cabinet to standard Ethernet compliant Network Aux LAN ports. See “Expansion to Net Aux Conversion Cables” in the *GTR 8000 Expandable Site Subsystem* manual.

b Place blue “Net Aux” labels on the expansion panel to indicate that a particular port has been converted. See “Replacing a Subpanel on the GTR 8000 Expandable Site Subsystem Junction Panel” in the *GTR 8000 Expandable Site Subsystem* manual.

20 Connect the remaining ancillary devices to the LAN ports on the RDM (may choose to relocate this device or others for optimal cabling).

21 Connect the CCGW to the RDMs.

22 Re-rack the CCGW if necessary (Optional) (Use either S2500 Routers or new GGM 8000 Gateways):

a Install the S2500 Routers. See “Installing an S2500 Router in a Rack” in the *S6000 and S2500 Routers* manual.

b Install the GGM 8000 Gateways. See “Rack-Mounting the GGM 8000” in the *GGM 8000 System Gateway* manual.

23 Connect the CCGW to an available Net Aux port on the RDM or XHub. See “Junction Panel Connections for a Trunked IP Simulcast (High Availability Configuration)” in the *GTR 8000 Expandable Site Subsystem* manual.

NOTICE: Optional – if additional Net Aux ports are required, follow the procedure to install the optional Expansion to Net Aux Conversion cable.

24 Connect the conventional base radios.

25 Install the conventional base radios in available slots in the cabinets (optional). See “GTR 8000 Expandable Site Subsystem Installation” in the *GTR 8000 Expandable Site Subsystem* manual.

26 Configure the conventional base radios (installed in the cabinets) for 100 BaseT Full Duplex and Integrated Time Reference. See “Configuring the Parameters for a GTR 8000 Base Radio (Conventional)” in the *GTR 8000 Expandable Site Subsystem* manual.

NOTICE: Conventional base radios installed in the GTR 8000 Expandable Site cabinets default to internal time reference. You MUST configure these two settings to enable the High Availability feature.

27 Connect standalone IP conventional base radios to an available Net Aux port on the RDM or XHub (optional). See “Junction Panel Connections for a Trunked IP Simulcast (High Availability Configuration)” in the *GTR 8000 Expandable Site Subsystem* manual.

NOTICE: If additional Net Aux ports are required, follow the procedure to install the optional Expansion to Net Aux Conversion cable.

28 Connect Non-IP conventional base radios to the CCGW (optional). This can be V.24 conventional or mixed mode. See “Junction Panel Connections for a Trunked IP Simulcast (High Availability Configuration)” in the *GTR 8000 Expandable Site Subsystem* manual.

29 Verify conventional channel operation. See “GTR 8000 Expandable Site Subsystem Performance Testing with a Service Monitor for Integrated Voice and Data” in the *GTR 8000 Expandable Site Subsystem* manual.

30 Connect HPD Site Controllers (optional):

a Connect HPD Site Controllers to an available Net Aux port on the RDM or XHub. Optional – if additional Net Aux ports are required, follow the procedure to install the optional Expansion to Net Aux Conversion cable. See “Junction Panel Connections for a Trunked IP Simulcast (High Availability Configuration)” in the *GTR 8000 Expandable Site Subsystem* manual.

b Verify HPD operation. Make sure that an HPD call can be made. If more detail is required, then see “GTR 8000 Expandable Site Subsystem Performance Testing with a Service Monitor for HPD” in the *GTR 8000 Expandable Site Subsystem* manual.

31 Install/Update MOSCAD Network Fault Management (NFM) system components.

32 Connect MOSCAD RTUs to an available Net Aux port on the RDM or XHub. Optional – if additional Net Aux ports are required, follow the procedure in to install the optional Expansion to Net Aux Conversion cable. See “Junction Panel Connections (IP Simulcast High Availability Configuration)” in the *GTR 8000 Expandable Site Subsystem*.

33 Back Up the SDM3000 Builder Project. See “Backing up the SDM3000 Builder Projects in GMC Mode” in the *MOSCAD Network Fault Management Feature Guide*.

34 Converting Simulcast Subsites to High Availability Configuration. See “Enabling IP Simulcast Geographic Redundancy” in the *MOSCAD Network Fault Management Feature Guide*.

35 Enable RFDS in Existing SDM3000 Builder Project (Optional if RFDS exists). See “Enabling RFDS in SDM3000 Builder Projects” in the *MOSCAD Network Fault Management Feature Guide*.

36 Build GMC Configuration and Tags. See “Building GMC Configuration and Tags” in the *MOSCAD Network Fault Management Feature Guide*.

37 Configure SDM3000 RTU. See “Configuring SDM3000 RTUs with Eclipse Radios” in the *MOSCAD Network Fault Management Feature Guide*.

38 Configure RFDS (Optional if RFDS exists). See “Configuring RFDS” in the *MOSCAD Network Fault Management Feature Guide*.

39 Start GMC Application and GWS to verify MOSCAD operation. See “Starting the GMC Application” in the *MOSCAD Network Fault Management Feature Guide*.

3.4.1.4

Adding IP Simulcast Remote Site for High Availability (Post Cleanup for Each Converted Subsite)

Procedure:

1 Remove IP simulcast remote subsite switch objects from the Unified Event Manager (UEM). See “Deleting Netwok Elements” in the *Unified Event Manager* manual.

2 Discover new RDMs in UEM:

- **a** Perform an IP Simulcast Remote Site – Subnet Discovery to discover the RDMs. See “Discovering Groups of Network Elements” in the *Unified Event Manager* manual.
- **b** Verify that UEM can receive RDM faults. See “Alarm Operations” in the *Unified Event Manager* manual.

3 Verify that other fault managers can receive RDM faults:

- **a** Verify SDM3000 RTU Operation with RDM. See “Verifying SDM3000 RTU Operation with the RDM” in the *MOSCAD Network Fault Management Feature Guide*.
- **b** View alarms and status information with CSS. See in the *CSS Online Help*.

4 Remove the Simulcast Remote Subsite Switch objects from the UNC. See “Deleting a Device” in the *Unified Network Configurator* manual.

5 Discover the new devices in Unified Network Configurator (UNC). See “Performing Device Discovery with the UNCW Discovery Wizard” in the *Unified Network Configurator* manual.

6 Configure the subsite for the new NTP server relationships (Applies to devices that have not been configured):

- **a** Configure RDMs to point to the simulcast prime site TRAK for primary time source and ntp02.zoneN for secondary in CSS or UNC (The RDMs at the site act as the Network Time Protocol (NTP) time source). Contact your system administrator, Motorola Solutions Support Center (SSC), or the local Motorola Solutions field representative for details.

b Configure base radios to point to primary and secondary RDMs. This is done in CSS or UNC (The base radios use RDM A as the primary NTP time source and use RDM B as the secondary NTP time source). Contact your system administrator, Motorola Solutions Support Center (SSC), or the local Motorola Solutions field representative for details.

c Configure GGM 8000 Gateways or routers. Contact your system administrator, Motorola Solutions Support Center (SSC), or the local Motorola Solutions field representative for details.

7 Complete the configuration of RDMs. See “Device Configuration in CSS” in the *GTR 8000 Expandable Site Subsystem* manual.

8 Configure SNMPv3 credentials (Optional):

a Configure SNMPv3 for RDMs (the user credentials are optional and can be reconfigured after the reset while in CSS). See “Changing SNMPv3 Configuration and User Credentials in CSS” in the *GTR 8000 Expandable Site Subsystem* manual.

b Configure SNMPv3 for CSS. See “Changing SNMPv3 Configuration and User Credentials in CSS” in the *GTR 8000 Expandable Site Subsystem* manual.

c Configure SNMPv3 for UNC. See “UNC Configuration for SNMPv3” in the *SNMPv3* manual.

9 Configure SSH (Optional - For IA customers, to restore custom security configurations and credentials):

a Review the Process. See “Configuring SSH for Devices at an RF Site” in the *Securing Protocols with SSH* manual.

b Configure SSH for RDMs using CSS. See “SSH Configuration for RF Site Devices and VPMs Using CSS – Overview” in the *Securing Protocols with SSH* manual.

c Configure SSH using CSS to add the RDMs to the known host list. See “Adding a Device to the CSS Known Hosts List” in the *Securing Protocols with SSH* manual.

d Configure SSH as the mechanism for UNC management of the RDM in VoyenceControl. See “Verifying Secure Mode/Updating Known Hosts List for UNC Management of a Device” in the *Securing Protocols with SSH* manual.

10 Configure Centralized Event Logging (Optional). See “Enabling/Disabling Centralized Event Logging on Devices with CSS” in the *Centralized Event Logging* manual.

11 Lock down the RDM and XHub switch ports using the MAC Port Lockdown subsite wizard (Optional. Note: XHubs are configured through the RDMs as they have their own integrated Ethernet switch). See “MAC Port Lockdown Procedures for GCP 8000 Site Controllers, GPB 8000 Reference Distribution Modules and XHubs – Overview” in the *MAC Port Lockdown* manual.

12 Dispose of unnecessary equipment (Optional):

a Dispose of the old TRAK receiver, Global Navigation Satellite System (GNSS) antennas, and cables (The IP simulcast remote site high availability expansion eliminates the TRAK units and associated equipment, the switch at the remote site, and the XHubs in the primary GTR 8000 Expandable Site Subsystem cabinet).

b Dispose of the old LAN switches and XHubs (replaced by RDMs).

3.4.1.5

Adding IP Simulcast Remote Site for High Availability (Post Expansion Cleanup)

Procedure:

1. Remove IP simulcast remote subsite switch objects from the Unified Event Manager (UEM) See “Deleting Network Elements” in the *Unified Event Manager* manual.
2. Discover new RDMs in UEM:
   a. Perform an IP simulcast remote site — Subnet Discovery to discover the RDMs. See “Discovering Groups of Network Elements” in the *Unified Event Manager* manual.
   b. Verify that UEM can receive RDM faults. See “Alarm Operations” in the *Unified Event Manager* manual.
3. Verify that other fault managers can receive RDM faults:
   a. Verify SDM3000 RTU Operation with RDM. See “Verifying SDM3000 RTU Operation with the RDM” in the *MOSCAD Network Fault Management Feature Guide*.
   b. View alarms and status information with CSS. See the *CSS Online Help*.
4. Remove the simulcast remote subsite switch objects from the UNC. See “Deleting a Device” in the *Unified Network Configurator* manual.
5. Discover the new devices in Unified Network Configurator (UNC). Include RDMs and new conventional base radios. See “Performing Device Discovery with the UNCW Discovery Wizard” in the *Unified Network Configurator* manual.
6. Configure the subsite for the new NTP server relationships. This applies to devices that have not been configured.
7. Complete the configuration of RDMs:

   NOTICE: Contact your system administrator, Motorola Solutions Support Center (SSC), or the local Motorola Solutions field representative for details.

   a. Configure RDMs to point to the simulcast prime site TRAK for primary time source and ntp02.zoneN for secondary in CSS or UNC.

      NOTICE: The RDMs at the site act as the Network Time Protocol (NTP) time source.

   b. Configure base radios to point to primary and secondary RDMs. This is done in CSS or UNC.
   c. Configure the GGM 8000 Gateways or routers.
8. Complete the configuration of RDMs. See “Device Configuration in CSS” in the *GTR 8000 Expandable Site Subsystem* manual.
9. Configure SNMPv3 credentials (optional): The user credentials are optional and can be reconfigured after the reset while in CSS.
   a. Configure SNMPv3 for RDMs. See “Changing SNMPv3 Configuration and User Credentials in CSS” in the *GTR 8000 Expandable Site Subsystem* manual.
   b. Configure SNMPv3 for CSS. See “Changing SNMPv3 Configuration and User Credentials in CSS” in the *GTR 8000 Expandable Site Subsystem* manual.
   c. Configure SNMPv3 for UNC. See “UNC Configuration for SNMPv3” in the *SNMPv3* manual.
10. Configure SSH. (Optional – for IA customers, to restore custom security configurations and credentials):

a Review the process. See “Configuring SSH for Devices at an RF Site” in the *Securing Protocols with SSH* manual.

b Configure SSH for RDMs using CSS. See “SSH Configuration for RF Site Devices and VPMs Using CSS – Overview” in the *Securing Protocols with SSH* manual.

c Configure SSH for CSS to add the RDMs to the known host list. See “Adding a Device to the CSS Known Hosts List” in the *Securing Protocols with SSH* manual.

d Configure SSH as the mechanism for UNC management of the RDM in VoyenceControl. See “Verifying Secure Mode/Updating Known Hosts List for UNC Management of a Device” in the *Securing Protocols with SSH* manual.

11 Configure Centralized Event Logging (optional). See “Enabling/Disabling Centralized Event Logging with CSS” in the *Centralized Event Logging* manual.

12 Lock down the RDM and XHub switch ports using the MAC Port Lockdown subsite wizard (optional). See “MAC Port Lockdown Procedures for GCP 8000 Site Controllers, GPB 8000 Reference Distribution Modules and XHubs – Overview” in the *MAC Port Lockdown* manual.

NOTICE: XHubs are configured through the RDM as they have their own integrated Ethernet switch.

13 Dispose of unnecessary equipment (optional):

a Dispose of the old TRAK receiver, Global Navigation Satellite System (GNSS) antennas, and cables.

NOTICE: The IP simulcast remote site high availability expansion eliminates the TRAK units and associated equipment, the HP ProCurve switch at the remote site, and the XHubs in the primary GTR 8000 Expansion Subsystem cabinet.

b Dispose of the old HP ProCurve LAN switches and XHubs (replaced by RDMs).

3.4.1.6
Adding IP Simulcast Remote Site for High Availability (Post Expansion Verification)

Procedure:

1 Monitor fault managers for problems.

2 Monitor links and components with UEM See “Alarm Operations” in the *Unified Event Manager* manual.

3 View status and alarm information with MOSCAD. See “Fault Management Monitoring Tools” in the *MOSCAD Network Fault Management Feature Guide*.

4 View alarms and status information with CSS. See the *CSS Online Help*.

5 Monitor centralized event logs for problems. See “Viewing Logs on the Centralized Event Logging Server or Linux Event Logging Clients” in the *Centralized Event Logging* manual.

3.5
Software Installation

Software installation in an IP simulcast subsystem consists of the following:

- Application software on the GCP 8000 Site Controller (active and standby)
- Application software on the GCM 8000 Comparator
- Application software on the GTR 8000 Base Radio
- Application software on the GPB 8000 Reference Distribution Module

3.5.1

Pre-Installation Requirements and Considerations

Review the following list of requirements and considerations before installing the software. If you do not have any of the following information, contact your system administrator or the local Motorola Solutions field representative.

- Ensure that the software installation process does not negatively affect the operating condition of the system during critical or heavy system usage.
- Verify that you have appropriate network administrative rights or privileges in your Windows operating system which are required to install the software. These rights are governed by your login ID. If you have any questions, contact your network administrator.
- Ensure that the following CD-ROMs are available before starting any software installation activity:
  - Configuration/Service Software CD-ROM
  - GCP 8000 Site Controller CD-ROM
  - GTR 8000 Base Radio CD-ROM
  - GCM 8000 Comparator CD-ROM
  - GPB 8000 Reference Distribution Module CD-ROM
  - GPW 8000 Receiver CD-ROM
- Identify and review all procedures required to complete the software installation process before starting installation.
- Obtain the IP addresses of the affected devices before installing any software. See your site-specific IP plan for this information.
- Notify the Motorola Solutions Support Center (SSC) and your operations group before starting any procedures that could affect system performance.

3.5.2

Required Tools for Software Installation for IP Simulcast Subsystem

To configure the IP simulcast subsystem devices, obtain the following equipment and software:

- Computer workstation or laptop
- Serial cable
- Configuration/Service Software (CSS)
- Software Download Manager (SWDL)
- CSS online help
- CD drive
- Ethernet cable

3.5.2.1

Software Download Manager

The Software Download Manager (SWDL) is an application that can transfer only, install only, or transfer and install new software to devices. The new software can be installed either locally at a site or on the Network Management subsystem. Individual devices not connected to the system can be downloaded using single device mode.

NOTICE: Throughout this manual, the name SWDL is used to refer to the Software Download Manager application.

Software Download Security Transfer Modes

A software download can be performed using the following security transfer modes:

Clear SWDL

Transfers the software without security, based on the File-Transfer Protocol (FTP)

Secure SWDL

Transfers the software as encrypted, based on the Secure File-Transfer Protocol (SFTP)

NOTICE: All secure sequential and simultaneous transfers use the Diffie-Hellman group exchange. The Diffie-Hellman group exchange is used for devices supporting Diffie-Hellman group exchange. The Diffie-Hellman group exchange enhances the security of Secure Shell (SSH) protocol initial key exchange. See the *Software Download Manager* manual for details.

Before initiating transfer, SWDL connects to the site in the zone to discover all devices. The transfer mode of all devices is displayed in the SWDL window. It is important that all devices have the same SWDL transfer mode. Otherwise, SWDL flags a mismatch of the SWDL transfer modes across site devices.

SWDL provisions the credentials for Secure SWDL as part of initiating the SWDL operation. No user intervention is required. For a single device, Secure or Clear SWDL is configured based on the SWDL Transfer Mode configuration within the Configuration/Service Software (CSS). The Unified Network Configurator (UNC) can be used to schedule and configure all devices in the system at once.

For information on how to configure the secure or clear SWDL transfer mode, see the *Unified Network Configurator* manual and “Configuring Devices for Security” in the *CSS Online Help*.

Software Download Transfer Methods

A software download can be accomplished in two ways:

Site Software Download

Allows you to transfer and install application software from any location within a network. The Software Download Manager resides on the Network Management Client computer and a service computer/laptop loaded with the CSS application. From either of the computers, you can select device types to download software. Site Software Download allows you to select the zone, site, device types, and software download operation to perform. When performing a site software download, the site controller coordinates the software transfer for all trunked base radios, receivers, comparators, and reference distribution modules installed at the site. A site software download can only be performed on a trunked ASTRO® 25 system.

NOTICE: Trunked GPW 8000 Receivers in a circuit simulcast configuration are not supported using a site software download.

Single Device Software Download

Allows you to transfer and install software to a single instance of a device (such as one base radio). This feature gives the technician the ability to install different versions of software. Single device software download is done from a service computer/laptop loaded with the CSS application either connected directly to the device or connected to the network.

NOTICE: Conventional devices and 3600 base radios are supported only in single device software download.

Site Software Download Functionality

When SWDL is connected from a central remote location, SWDL performs a site software download to the site controllers, then to the comparators and base radios or receivers installed at the site. Both active and standby site controller modules have two flash memory banks for storing software. The device application is run from RAM, and is loaded from the active flash memory bank after a reset. One bank is active while the other bank is inactive. The transfer of the software using SWDL is a background process, without interruption of services at the site, that loads the software into the inactive

bank. The site controller executes the software from one bank, while software is simultaneously downloaded to the inactive bank. The transfer and install are done in the background. An install causes the site controller to reset and load the RAM from the bank that was installed with the new software.

NOTICE: For geographically redundant prime sites, a site software download should not be attempted while the third Site Controller (SC3) is in the active state.

SWDL communicates with the site controllers to determine the number of existing remote sites and the number of channels. SWDL considers a channel or remote site to be accessible if its status is “Not Unconfigured.” This term means that the site must be set up with a service computer/laptop with CSS or a network management client before software download is performed on the site.

The system downloads software to the site controllers, comparators, base radios, or receivers as a unit. Use SWDL to transfer software to each device type, then perform an install operation. During the transfer, the operation designates a proxy for each device type at each LAN. Site controllers proxy for comparators, and base radios or receivers proxy for each other. The proxy cross-transfers the software to other devices on the LAN. Using proxies minimizes system downtime. Transfers to the LAN are done simultaneously except for the site controller and comparators.

Software installation is done on a channel-by-channel basis, starting with the highest number channel. When a channel software download occurs, the base radio or receiver which incorporates that channel is processed along with the comparator for that channel. For example, if channel 3 was being downloaded, comparator 3 and the base radios or receivers for channel 3 at each of the remote sites would be installed simultaneously.

SWDL operation can be fault managed through Unified Event Manager (UEM), syslog, local SWDL log files, user messages, and device reports.

For further information on SWDL, see the *Software Download Manager* manual.

The operating software can also be loaded using the UNC. See the *Unified Network Configurator* manual to perform single device software downloads (ruthless download) to the devices.

See the *G-Series Equipment System Release User Guide* for SWDL instructions specific to the operating characteristics of your existing system release.

3.5.2.2
Using Configuration/Service Software

Configuration/Service Software (CSS) is used to configure and service the parameters for the site devices in an IP simulcast subsystem. The devices that are configured using CSS are:

- GCM 8000 Comparator
- GTR 8000 Base Radio
- GCP 8000 Site Controller
- GPB 8000 Reference Distribution Module
- GPW Receivers

See the documentation of the individual site devices for configuration details.

3.5.3
Software Installation Scenarios

Motorola Solutions installs all software before shipping the equipment to the intended installation site. Software Download Manager (SWDL) is used to transfer and install software updates to devices in an IP simulcast subsystem as needed.

You may be required to perform software installation procedures for various scenarios, some of which are listed in Table 2: Software Installation Scenarios for IP Simulcast Subsystem Devices on page

96. If you encounter a scenario that does not appear in the tables, contact the Motorola Solutions Support Center (SSC).

Table 2: Software Installation Scenarios for IP Simulcast Subsystem Devices

Device	Scenario Requiring Software Installation	Overview of Installation
GCP 8000 Site Controller	Downloading the site controller application software.	Install site controller application software using Software Download Manager.
	Failure of site controller application software download performed using the Software Download Manager.	Ensure that both site controllers and all comparators are set to communicate on the same Virtual Local Area Network (VLAN).
	Failure of automatic cross-loading of site controller application software from one site controller to the other.	Reload the software using the Software Download Manager.
	Site controller application software has corrupted.	
GCM 8000 Comparator	Comparator application software has corrupted.	Reload the software using the Software Download Manager.
	Field repair has occurred that requires application software to be reloaded.	Install comparator application software using Software Download Manager.
GTR 8000 Base Radio/GPW 8000 Receiver	Field repair has occurred that requires application software to be reloaded.	Install base radio application software using Software Download Manager.
GPB 8000 Reference Distribution Module	Field repair has occurred that requires application software to be reloaded.	Install reference distribution module application software using Software Download Manager.

Chapter 4

ASTRO 25 Trunked IP Simulcast Subsystem Configuration

This chapter details configuration procedures relating to the IP simulcast subsystem.

4.1 Configuration Constraints

Configuration of the equipment in each site of the IP simulcast subsystem is outlined by the in-built documentation of your system. The in-built documentation provides the settings for all parameters of the equipment comprising the IP simulcast subsystem. Using the in-built documentation as your configuration aid, ensures that you configure the IP simulcast subsystem devices to a known baseline.

IMPORTANT: Do not deviate from the specified settings without following the proper change procedures for your organization. If the change procedures are not followed properly, then troubleshooting becomes more difficult if a problem due to configuration arises.

The parameter settings can be categorized into three groups:

- The Federal Communications Commission (FCC), with your state or local frequency coordinators, determines which frequencies are assigned to the system and which sites get specific frequencies. Setting the frequencies incorrectly could lead to interference within your system and other systems in your region, as well as possible legal problems.
- The system design requires certain settings for proper operation. For example, the Configuration/Service Software (CSS) for the base radio allows for only Common Air Interface (CAI), Improved Multi-Band Encoder (IMBE) in the Station Type field.
- Specific requirements or design of your system determines other parameters. An example would be how many frames the Fade Tolerance is set for in your system.

4.2 Using Configuration/Service Software to Configure Components

Configuration/Service Software (CSS) is used to configure and service the parameters for the site devices in an IP simulcast subsystem. The devices that are configured using CSS are:

- GCM 8000 Comparator
- GTR 8000 Base Radio
- GCP 8000 Site Controller
- GPB 8000 Reference Distribution Module
- GPW 8000 Receivers

See the documentation of the individual site device for configuration details.

4.3 Using Unified Network Configurator to Configure an IP Simulcast Subsystem

When and where to use:
The Unified Network Configurator is a tool for setting up general zone-level parameters for the devices at the prime and remote sites during system commissioning and when maintaining or expanding the system. The Unified Network Configurator (UNC) must discover and manage the devices in the IP simulcast subsystem.

Some of the system infrastructure of the IP simulcast subsystem must be configured using the UNC application. Some configuration parameters, such as Zone ID and Site ID, are defined at installation.

This process describes the high-level steps to configure the devices in an IP simulcast subsystem using UNC. See the *Unified Network Configurator* manual for configuration details.

Process:

1. Use the Unified Network Configurator Wizard to:
   - Discover devices
   - Upload configurations for the devices
   - Generate changes for non-compliant devices
2. Approve jobs (if any).

4.4 Using UNC to Configure the Sites and Channels in an IP Simulcast Subsystem

When and where to use:
Some of the system infrastructure of the IP simulcast subsystem must be configured using the Unified Network Configuration (UNC) application. Some configuration parameters, such as Zone ID and Site ID are defined at installation.

To configure the IP simulcast subsystem in the UNC, use the Multi-Site object. This process describes the high-level steps to configure IP simulcast subsystem in the UNC. See the *Unified Network Configurator* manual for configuration details.

IMPORTANT: If any of site configurations are changed in the CSS, the configurations must be discovered in the UNC for the zone controller to recognize the configuration changes.

Process:

1. Create IP simulcast subsystem record in the UNC.
2. Create remote site records for the IP simulcast subsystem.
3. Create channel records for the IP simulcast subsystem in the UNC.

4.5 Configuring for TDMA Operation

For information on configuring an IP simulcast subsystem for TDMA operation, see the *Dynamic Dual Mode for TDMA Operation Feature Guide*.

Chapter 5

ASTRO 25 Trunked IP Simulcast Subsystem Optimization

This chapter contains optimization procedures and recommended settings relating to the IP simulcast subsystem.

5.1 Inbound Optimization

The arrival times for all receive signals of a channel must be synchronized so that they are voted accurately by the GCM 8000 Comparator responsible for the channel. This is called inbound optimization and it is achieved using the Get Link Delay feature using CSS.

NOTICE: The comparator or base radios cannot respond to the ping request if they are currently active. In this case, the CSS does not give an error. The link delay field simply remains blank. The Get Link Delay feature only functions when no activity is on the channel.

5.1.1 Setting the Link Delay Values

The arrival times for all receive signals for a channel must be synchronized so that they are voted on accurately by the GCM 8000 Comparator responsible for the channel. This is achieved using the Get Link Delay feature through the Configuration/Service Software (CSS).

For information on how to configure the Link Delay Feature, see the "Updating the Link Delay Feature" in the Comparator Configuration Service Help section in *CSS Online Help*.

5.1.2 Logging Delay Values in the System Log

Whenever the Get Link Delay feature is used, it is recommended that the delay values displayed are recorded in a system log. In this manner, the integrity of the links can be assessed. A properly functioning infrastructure should not experience significant changes in delay over time (over 5 msec).

The log should note the following data:

- Date
- Link alias and type
- Delay value for each link

5.1.3 Adjust Receiver Multicoupler System Gain

See the *GTR 8000 Base Radio* and *GTR 8000 Expandable Site Subsystem* manuals for Adjusting Receiver Multicoupler System Gain.

5.2 Outbound Optimization

When and where to use:
Before any adjustment or optimization at the ASTRO® 25 IP simulcast subsystem at a site, the channel being optimized must first be removed from service by the Unified Network Manager. See the *Unified Network Manager* documentation for details.

Process:

1. Verify that the Global Navigation Satellite System (GNSS) receivers at the prime and remote sites are installed and operational. See Site GNSS Verification on page 100.
2. See Reference Signal Verification on page 100.
   - Verify that each GCP 8000 Site Controller and each GCM 8000 Comparator has operational 1PPS signal.
   - Verify that each standalone GTR 8000 Base Radio has operational composite signal.
   - Verify that each GTR 8000 Expandable Site Subsystem cabinet/rack has operational 1PPS and 5 MHz signal for a standard configuration.
   - Verify that each GTR 8000 Expandable Site Subsystem cabinet/rack has operational 1PPS and 5 MHz signal for a high availability configuration.
3. Set the simulcast launch time delay. See Configuring Launch Time Delay Parameter on page 101.

5.2.1 Site GNSS Verification

Verify that the Global Navigation Satellite System (GNSS) receivers at the prime and remote sites are installed and operational. This may be accomplished in any one of the several ways:

- Unified Event Manager current alarms may be used to determine that all base radios are satisfied with their GNSS inputs.
- Network Manager current alarms may be used to determine that all base radios are satisfied with their GNSS inputs.
- The GNSS receivers front panel indicators may be examined at each of the sites.
- The serial port of the site GNSS receivers may be used to determine that the GNSS receiver is properly operating and has satellite lock.
- External output alarm reporting from the GNSS standards may be monitored.

5.2.2 Reference Signal Verification

Verify that each GCP 8000 Site Controller and each GCM 8000 Comparator has operational 1PPS signal. Each standalone GTR 8000 Base Radio has composite (1PPS+5 MHz) input and each GTR 8000 Expandable Site Subsystem cabinet/rack has 1PPS and 5 MHz input for a standard configuration or 1PPS and 10 MHz input for a high availability configuration. This can be verified in either of the following ways:

- Network Manager current alarms can be used to determine that all site Global Navigation Satellite System (GNSS) standards are properly operating.
- The CSS error log can be examined at each base radio, comparator, and site controller.

NOTICE: The 1PPS port on the rear of the site controller and comparator is high impedance. An external termination is needed to properly terminate the cable connected to the input. It is recommended that a BNC "T" and a 50 Ohm BNC termination be connected to the input to terminate the cable.

5.2.3
Configuring Launch Time Delay Parameter

When and where to use:
This procedure explains how to adjust the fixed delay value that the GCM 8000 Comparator adds to the current time before time stamping data sent to the GTR 8000 Base Radio.

Procedure:

1. Connect to the GCM 8000 Comparator with the CSS application and select the Channel in the system tree from the left pane of the display.
2. Determine the Simulcast Channel Launch Time Delay value for the simulcast subsystem. This value should be equal to 75 ms plus the longest Remote Site WAN link delay in the subsystem. For example, if the longest network Remote Site WAN link delay in the subsystem is 10 ms, then the Launch Time Delay value for the subsystem should be 85 ms.
3. In the **Simulcast Channel Launch Time Delay** field, type the value determined in step 2.
4. When completely finished configuring the device, select **File** → **Save** or **File** → **Save As** from the menu.
5. **File** → **Write Configuration To Device** from the menu to write the configuration data to the device.

5.3
Preferred Control Channel Comparator and Ethernet LAN Switch Configuration (Non-TPSGR Prime Site)

The preferred control channel comparator for the simulcast subsystem must be connected to Ethernet Switch 2. If the subsystem has more than two control-capable channels and only two Ethernet switches in its prime site LAN, then the two highest-preference control-capable channels must be connected to Ethernet Switch 2. If the subsystem has more than two control-capable channels and four prime site Ethernet LAN switches, then the highest preference control-capable channel should be connected to Switch 2 and the next highest can be connected to any of Switches 2, 3, or 4.

This configuration can be done in one of two ways:

- By the UNC, configure the site’s preferred control channel to be a channel whose comparator is already connected to Ethernet Switch 2, or
- Move the Ethernet cable for the preferred control channel’s comparator from Ethernet Switch 1 to Switch 2 and update the switch port configuration so that the affected ports report alarms correctly).

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Chapter 6

ASTRO 25 Trunked IP Simulcast Subsystem Operation

This chapter details the tasks that you perform once the IP simulcast subsystem is installed and operational on your system.

6.1 Simulcast Subsystem Modes of Operation

Many of the modes of operation available in a Simulcast Subsystem are similar in name to the modes of operation available in an ASTRO® 25 Repeater Site. But there are operational differences between an ASTRO® 25 Repeater Site and a Simulcast (Multi-Site) Subsystem. These differences and some similarities are described in the following sections.

NOTICE: Simulcast subsystem with Receive only subsites and Single Transmitter, Receiver Voting (STRV) subsystems, are both types of Multi-Site subsystems and have the same modes of operation as a simulcast subsystem.

The operational modes for both circuit-based and IP-based simulcast subsystems include the following:

- Wide-area trunking
- Site Trunking
- Site Failsoft: Site (Subsystem) Failsoft and Local Failsoft
- Local Failsoft at remote site
- Site Off

Simulcast Channels States of Operation

The operational modes for both circuit-based and IP simulcast subsystems include the following:

- Enabled
- Malfunctioned
- Impaired
- User Disabled
- Unconfigured state

Simulcast Subsites States of Operation

The operational modes for both circuit-based and IP simulcast subsites include the following:

- Enabled
- Malfunctioned
- User Ignored
- Unconfigured

Simulcast Subsystem Resource Voting

Resource Voting impacts the criteria to enter, or not to enter failsoft. For details, see Simulcast Subsystem – Resource Voting on page 108.

6.1.1
Simulcast Subsystem Wide Area Trunking Mode

Both circuit-based and IP simulcast subsystems remain in wide-area trunking as long as the following resources are available and functioning properly:

- The site control path (transport link, zone controller, gateway router, LAN switches, and core router at the Master Site/Zone Core)
- One site router/gateway
- One prime site controller
- One site switch
- At least one voice channel and associated comparator
- At least one control channel
- The resource Voting rules given in section Simulcast Subsystem – Resource Voting on page 108 dictate that the sub-system should NOT enter failsoft mode.

NOTICE: The site control path includes any transport link between the subsystem and Master Site/Zone Core, zone controller, gateway router, WAN and LAN switch, and core router equipment.A functioning site control path results from good communications between the prime site controller and the zone controller.

NOTICE: For an IP simulcast subsystem, with a redundant configuration, the LAN maintains wide-area trunking performance if a single switch fails. In a geographically redundant configuration, an outage could occur briefly before restoration of wide-area trunking.

6.1.2
Simulcast Subsystem Site Trunking Mode

When a simulcast subsystem loses the site control path due to a failure in the transport link or site control path equipment, and the subsystem enters site subsystem trunking mode. The subsystem continues to provide trunked voting/simulcast operations. In site trunking mode, subscriber radios can continue to communicate with members of their talkgroup registered at the site subsystem.

NOTICE: Communication outside the subsystem, communication with console operators, and centralized telephone interconnect are not available when the subsystem is in site trunking mode.
Any subsite designated as an essential subsite must have the required resources to provide trunking services. For details, see the description of an essential subsite in Simulcast Subsystem – Resource Voting on page 108.

6.1.3
Simulcast Subsystem Failsoft Mode

There are two types of Failsoft available depending on the type of site/subsystem:

- Site Subsystem Failsoft is available for both Circuit-based and IP-based Simulcast subsystems.
- Local Failsoft is only available for IP Simulcast Subsites which are part of M1, M2, M3, or L core system configurations. Local Failsoft is a configurable item on each base radio.

NOTICE: An ISR site enters an in-cabinet repeat mode for failsoft. A Simulcast or STRV type system enter sub-system wide failsoft with repeat happening through comparator voting.

Site Subsystem Failsoft
can be used when a major failure such as the loss of all Site Controllers at an ASTRO® 25 Repeater Site or a Simulcast Subsystem Prime Site occurs. When this type of major failure occurs, the subsystem can no longer maintain a control channel for use by the subscriber radios operating

within the site/subsystem. When this happens, the subscriber radios try to locate another control channel at another repeater site or simulcast subsystem. If the subscriber radios cannot locate another control channel on which to operate and if the following conditions are met, the subscriber radios operate in Site Failsoft:

- One or more channels within the site/subsystem have been configured for Site Failsoft.
- The subscriber radios are configured for Failsoft operation.

With these conditions met, the subscriber radio enter a two-way conventional mode of operation on a given Failsoft channel. While in Failsoft, subscriber radio is limited to communicating only with other subscriber radio on the same Failsoft channel. The channel transmits a beep tone used for Failsoft to notify the radio user that the subscriber radio is operating on a Failsoft channel.

NOTICE: Failsoft call traffic is still being voted and simulcasted by the available channel resources.

The subscriber radios can be configured for the following modes of Failsoft operations:

- Failsoft by last known control channel – all talkgroups at a site/subsystem use the last known control channel transmit/receive frequency pair in a conventional mode
- Failsoft by Personality – subscriber radio uses a predefined channel transmit/receive frequency pair in a conventional mode for all talkgroups configured under a given personality in the subscriber radio.
- Failsoft by Talkgroup – subscriber radio uses a predefined channel transmit/receive frequency pair in a conventional mode for a specific talkgroup
- Failsoft Disabled – subscriber radio displays an “Out of Range” indication and no site-based RF communications are possible

Subscriber radios automatically exit Failsoft operation when a control channel is detected and the subscriber radio has synchronized with the site/subsystem.

Local Failsoft can be used when a critical failure occurs involving the IP Simulcast Prime Site, or the links between the IP Simulcast Primary Site and an IP Simulcast Subsite are not functioning. Critical failures can be caused by either of the following:

- The comparators at the Simulcast Prime Site are inoperable
- An IP Simulcast Subsite has lost its links to the comparators at the IP Simulcast Prime Site

Under this type of failure, and if one or more of the Multi-Site Base Radio (MsBR) at a subsite have been configured for Local Failsoft, the MsBR enters Local Failsoft mode based on its configuration. MsBRs configured for Local Failsoft transmit a special Failsoft message indicating Local Failsoft.

The timing of the Local Failsoft alarm tone is different than the Site Failsoft beep tone, so that the radio user is able to distinguish between Local Failsoft and Site (subsystem) Failsoft.

The base radio automatically exits Local Failsoft operation, after detecting that the link to the comparator has been reestablished, or when the Local Failsoft configuration has been disabled on the base radios. The subscriber radios automatically exit Failsoft operation when a control channel is detected and subscriber radio has synchronized with the control channel.

NOTICE: Any channels frequencies in use for Local Failsoft must be disabled at all other subsites, while Local Failsoft base radios are transmitting to avoid RF interference between the base radios at the different subsites. Use caution when configuring MsBRs for Local Failsoft. As the MsBR in Local Failsoft mode key locally on a simulcast frequency, destructive interference occurs on the same channel if other sub-sites of the simulcast sub-system transmit on the channel and are within the RF coverage range of the MsBR.

6.1.4
Simulcast Subsystem Local Failsoft at Remote Site

Local Failsoft can be used when a critical failure occurs involving the IP Simulcast Prime Site, or the links between the IP Simulcast Primary Prime Site and an IP Simulcast Subsite are not functioning. This could be caused by either of the following:

- The comparators at the Simulcast Prime Site are inoperable
- An IP Simulcast Subsite has lost links to the comparators at the IP Simulcast Prime Site

Under this type of failure and if one or more of the base radios at a subsite have been configured to transmit a special Failsoft LC message, a subscriber enters Failsoft mode based on its programming.

The timing of the Local Failsoft beep tone is different than that of the Site Failsoft beep tone, so that the radio user is able to distinguish between Local Failsoft and Site Failsoft.

The base radio automatically exits Local Failsoft operation, after detecting that the link to the comparator has been reestablished, or when the Local Failsoft configuration has been disabled on the base radio. The subscribers automatically exit Failsoft operation when a control channel is detected and the subscriber has synchronized with the base radio.

NOTICE: Any channels frequencies in use for Local Failsoft must be disabled at all other subsites, while Local Failsoft base radios are transmitting. This is to avoid RF interference between the base radios at the different subsites.

Local Failsoft is supported by channels configured for FDMA or TDMA mode are supported, but channels in Local Failsoft only operate in FDMA mode.

IMPORTANT: It is important that Local Failsoft channels need to be configured and managed correctly to ensure the simulcast remote sites operating in local failsoft do not interfere with the operation of the rest of the system. Only one or two critical simulcast remote sites are recommended to be chosen for local failsoft coverage. For each channel operating in Local Failsoft mode at the remote site due to link malfunction between the prime site and the critical remote sites, the channel may need to be manually disabled for the rest of the system to prevent RF interference since the rest of the subsystem may remain trunking in site wide failsoft.

A base radio automatically exits out of Local Failsoft operation to the available states after detecting that the link to the comparator has been reestablished or that the Local Failsoft has been disabled on the base radio.

Local Failsoft is configured on each base radio in the Configuration/Service Software (CSS). See the *CSS Online Help*.

6.1.5
Simulcast Subsystem Site Off Mode

Site Off is a mode of operation initiated from the diagnostics capability of the Unified Event Manager (UEM). In this state, the subsystem is not available to the subscriber radios. Site Off de-keys the control channel, making it unavailable for subscriber radios to lock to.

Within the operational boundaries of the subsystem states, the remote sites may be found in one of the four states:

- Enabled
- Malfunctioned
- User ignored
- Unconfigured (unused)

6.1.6
Simulcast Channel States of Operation

IP Simulcast subsystem channels may be in any of the following states:

- Enabled
- Malfunctioned
- Impaired
- User Disabled
- Unconfigured state

Enabled State
When a channel is in the Enabled state, the channel is eligible for assignment in the Multi-Site subsystem.

Malfunctioned State
When a channel is in the Malfunctioned state, a resource fault somewhere on the channel has caused the channel to be marked as unusable for call processing. Testing may still be done on the channel. The channel is not precluded from being a Failsoft channel.

Impaired State
When a channel is in the Impaired state, a resource fault has occurred somewhere on the channel, but the resource in the malfunctioned state is located in a Malfunctioned or User Ignored subsite. The channel is still used for call processing, but reduced system coverage may result.

User Disabled State
When a channel is in the User Disabled state, the user has requested that the channel is not to be used for call processing. User Disabled channels may be tested, and may be used for Failsoft channels.

Unconfigured State
If a channel number is unused, the channel is reported to be in the Unconfigured state.

6.1.7
Simulcast Subsystem Subsite States

Each subsite may be in one of the following states:

- Enabled
- Malfunctioned
- User Ignored
- Unconfigured

Enabled State
When the subsite is in the Enabled state, the subsite operates as a fully functional part of the Simulcast or STRV subsystem.

Malfunctioned State
When individual resource faults degrade the capabilities of the subsite below a defined threshold, the system places the subsite in the Malfunctioned state. When a subsite is in the Malfunctioned state, the system disregards the state of the individual resources at the subsite so that they do not affect the channel states in the rest of the subsystem. The subsite continues to participate in the operation of the subsystem where it cans.

User Ignored State
When the user does not want the state of the individual resources at a subsite to affect the channel states in the rest of the subsystem, the user may request to put the subsite in the User Ignored state. Operationally, the User Ignored state is equivalent to the Malfunctioned state.

Unconfigured State

If a subsite number is unused, the subsite is reported to be in the Unconfigured state.

6.1.8
Simulcast Subsystem – Resource Voting

When a simulcast subsystem experiences malfunctions, the use of resource voting is the method the simulcast subsystem uses to maximize the number of channels and subsites available for use.

The simulcast subsystem implements “resource voting” to manage the simulcast subsystem resources (channels). The resource voting algorithm collects resource capabilities for the simulcast subsystem and either enables or disables resources based on the current capabilities in the subsystem. Having multiple subsites becomes an asset instead of a liability since the subsites can be removed from the resource voting pool when they are experiencing significant difficulties. The simulcast subsystem degrades gracefully to provide a continuum of available services.

Each simulcast subsite (remote site) is assigned an availability number. The availability number is a parameter that the customer can configure via Unified Network Configurator (UNC) or Configuration/ Service Software (CSS). It specifies the percentage of subsite channels that must experience malfunctions before the subsite is removed from service (placed in the malfunctioned state). Since subsite channel malfunctions affect the status of the channel across the entire IP simulcast subsystem, it is important to have a mechanism that prevents significant problems at a single remote site from bringing down the entire subsystem.

The availability number can have a value from 1 to 100. The default value is 50. For example, for a 10-channel subsystem, a subsite with an availability number of 50 is put in the malfunctioned state if 5 subsite channels at that subsite are in a failed state.

The availability number 100 has special meaning. A subsite with an availability number of 100 is called an essential subsite. Customers assign an availability number of 100 to subsites that provide critical RF coverage. Critical subsites need to be on the air at all costs, even if it means that the entire IP simulcast subsystem is in Failsoft mode. Essential subsites are in the failed state if all of their subsite channels are unavailable (for example, from a link failure). However, if the essential subsite is capable of supporting a wide area Failsoft channel, then the rest of the simulcast subsystem channels follow the capability of the essential subsite’s channels.

A subsite can be put in the malfunctioned state even if its availability threshold is not reached. If all non-essential subsite’s control channels experience malfunctions, then the subsite is put in the malfunctioned state, so that the rest of the IP simulcast subsystem can establish a control channel. If channels 1-4 at a non-essential subsite malfunction, the subsite is put in the malfunctioned state even though its availability number is 50 or higher.

Once a subsite is in the malfunctioned state, all IP simulcast subsystem channels that are out of service due to problems at the subsite in the failed state are returned to service. The subsite in the malfunctioned state is included in all call activity; it participates to the best of its ability. The IP simulcast subsystem channels that are returned to service are in the impaired state; the channels are in use, but not all channel’s resources are functioning properly.

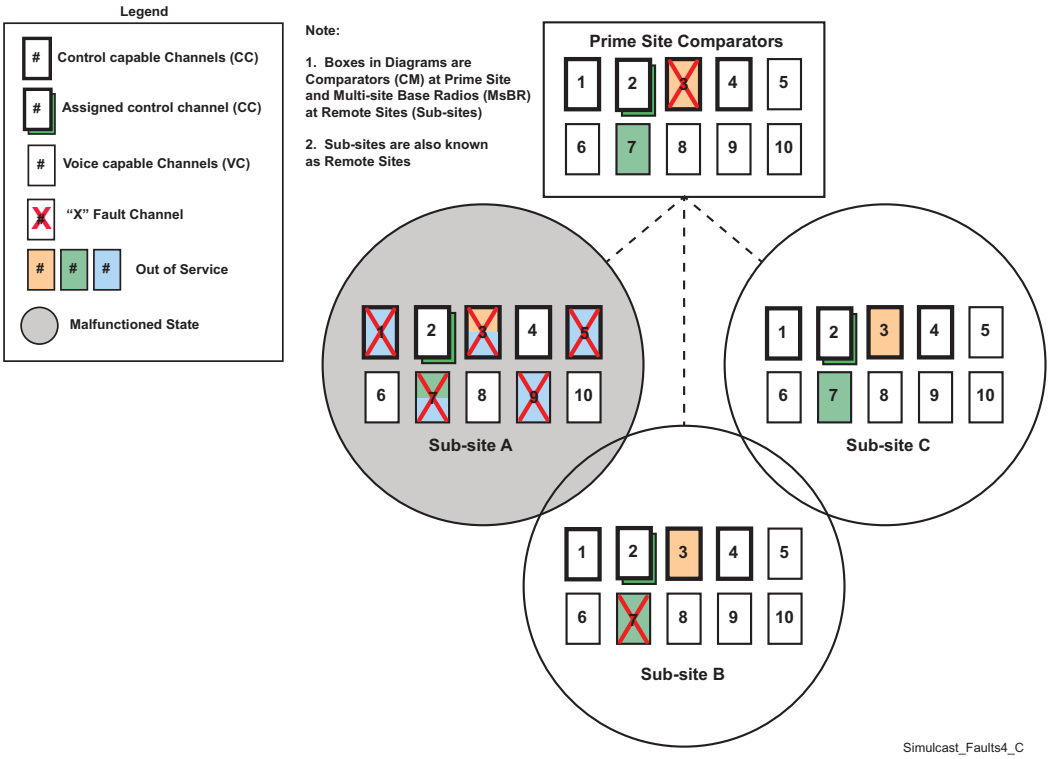
The computation of the percentage of subsite channels in the malfunctioned state is based on the number of channels that are programmed to be traffic capable, minus the number of channels that are user disabled. Channels that are unconfigured are ignored in this calculation: MSC = (CM/(CT-CD))x100.

- MSC is the percentage of Malfunctioned Subsite Channels (channels in the malfunctioned state)
- CM is the number of traffic channels at the Simulcast or STRV remote site which are in the malfunctioned state
- CT is the total number of traffic channels
- CD is the number of user disabled traffic channels

Aside from user-disabled channels, the determination of a state of a subsite is based solely on the state of the equipment at that subsite. Comparator capabilities do not affect the state of the subsites.

In the figure below, the transmitter combiner serving the odd channels of remote site A is in the malfunctioned state. Remote site A is in the malfunctioned state since five of its 10 channels are in the malfunctioned state and the remote site availability number is 50. Channel 3 is still out of service because of the comparator failure, and channel 7 is still out of service due to the channel failure at remote site B. Channels 1, 5, and 9 are in the impaired state. Since the transmitter combiner is causing the channel failures, the impaired channels at remote site A operate normally for the receive side of the channel, but no transmissions originate from remote site A for the impaired channels.

Figure 22: Remote Site-A Put in the Malfunctioned State Because of Availability Number Trigger



6.1.8.1
Single Transmitter Receiver Voting Subsystem

The subsite availability number for transmit subsite for a Single Transmitter, Receiver Voting (STRV) subsystem should be set to 100 in the Unified Network Configuration (UNC). This results in the following operation:

- Station failures at the transmit subsite result in channels being taken out of service.
- If the transmit subsite has failed and cannot support one control channel and one voice channel, then the entire subsystem enters Failsoft.

6.1.8.2
Trunked Receive-Only Remote Sites

For Receive-only remote sites in a Simulcast subsystem with Receive-only subsites and Single Transmitter, Receiver Voting (STRV) subsystems there is an option to configure a lower number, unless subsite coverage is important that channel failures resulting from receiver failures at the subsite are priority to loss of coverage in the area. Setting the subsite availability number to a minimum value of one results in the following:

- A receiver failure at the receive-only subsite. The subsite has malfunctioned and the channel associated with the failed receiver continue to operate across the subsystem.
- The malfunctioned subsite continues to operate however coverage is not guaranteed since the site controller continues to assign channels with the failed subsite.
- The channel that becomes available is in an “impaired” state. Station failures at the transmit subsite result in channels being taken out of service.

6.2 Details on Malfunction Operation

The goal of the IP simulcast subsystem is to receive and vote on signals from all subsites (remote sites), and to transmit an identical signal from all transmit sites. When a resource at a single subsites malfunctions, the corresponding resources at the remaining subsites must also be removed from service. For example, if the transmitter on channel 2 at remote Subsite A malfunctions, then channel 2 is in the malfunctioned state for all subsites in the IP simulcast subsystem. Channels may be malfunctioned because of equipment or link malfunction, or channels may be User Disabled.

6.3 Control Channel Rollover

NOTICE: The content in this section is not applicable to a conventional IP Multi-Site Subsystem.

When the control channel moves from one RF channel to another, it is referred to as the control channel rollover. Control channel rollover requires subscribers to scan for the new control channel.

NOTICE: The control channel no longer rolls over every 24 hours in current ASTRO® 25 Systems as was done in early Trunking systems.

6.4 Illegal Carrier Events

Base station and receiver devices in a Multi-Site subsystem monitor their receivers for unwanted RF activity such as an illegal carrier event. If a base station or receiver detects an illegal carrier above the desired signal threshold for longer than the configured period when the channel is not assigned as a traffic channel, the channel is removed from service for the duration of the illegal carrier event. See the Dynamic Network Access Code section for more details.

NOTICE: The site controller does not assign a Dynamic Frequency Blocking (DFB) channel while it is being used by an adjacent site/subsystem. All interference on DFB channels is considered to be a signal from a properly assigned DFB channel elsewhere in the system.

6.5 Conventional Multi-Site Operation

Conventional Multi-Site operation does not interface to the trunked system but, uses the network for configuration and fault reporting. Subscriber radios communicate radio-to-radio or can communicate in a console interface configuration.

See the *Conventional Operations* manual for additional information on configuration and fault reporting in a Conventional architecture.

If a conventional base radio in a Multi-Site subsystem loses communication with the comparator at the prime site, the base radio enters Fallback In-Cabinet Repeat mode. While in this mode, the base radio repeats all payload received on the air interface for the duration of the communication failure with the comparator. When communication with the comparator is restored, the base radio exits this mode and

returns to normal simulcast/multicast/voting operation. This mode of operation is configurable and only applies to base radios with full transmit/receive capability, not receive-only stations.

NOTICE: This conventional mode of operation is not to be confused with Local Failsoft within a simulcast subsite. Fallback In-Cabinet Repeat and Local Failsoft appear to be similar in operation but are separate functions within a subsystem.

6.6 Dynamic Network Access Code (DNAC)

Trunked radio systems that implement a frequency reuse plan are susceptible to interference. The dynamic network access code is used to reduce co-channel and co-site interference. The NAC serves as the ASTRO® 25 digital equivalent of connect tone. Each site can have one of the 16 unique NACs allowed within the system. The subscriber decodes the NAC associated with the control channel at a site and uses it for both transmit and receive on the ASTRO® 25 voice channel at that particular site. By determining a portion of the NAC via the trunked system ID, interference protection is provided from nearby systems as well as between sites in the customer system. Dynamic NAC (DNAC) is used in both wide and site trunking.

The Base Radio also supports DNAC functionality. The Base Radio validates the NAC received from the subscriber. The following table summarizes the actions the Base Station takes upon validation of the NAC.

Table 3: Base Station Actions Upon Validation of NAC

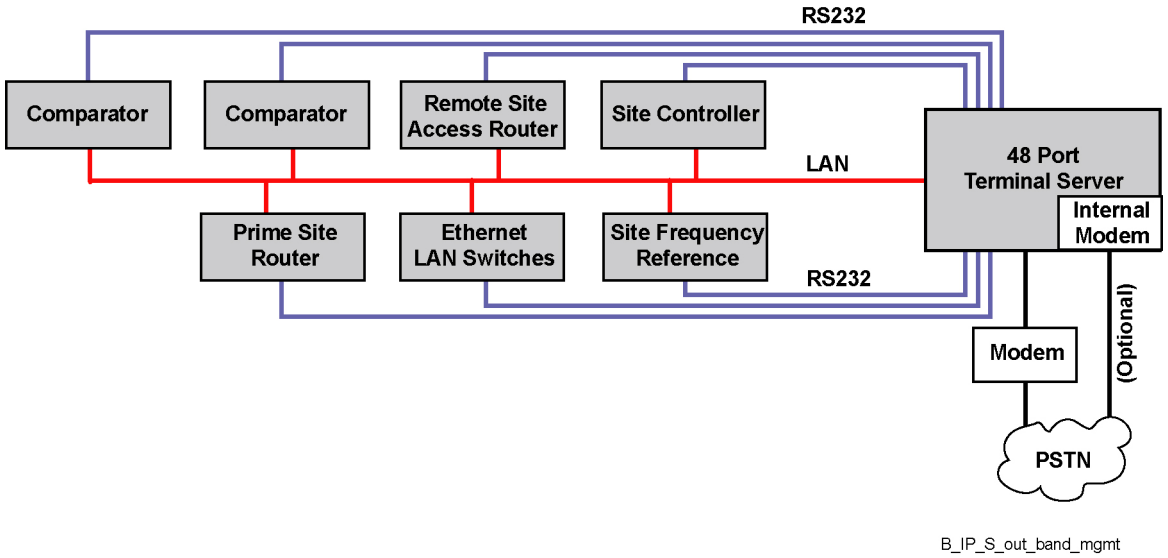
	Channel Assigned	Channel Not Assigned
Valid NAC	• Do nothing since the carrier is Valid	• If level threshold is exceeded, proceed to Illegal Carrier state.
Invalid NAC	• If level threshold is exceeded, activate Carrier Malfunction Timer (CMT) and, after timer expiration, proceed to Illegal Carrier state.	• If level threshold is exceeded, activate Carrier Malfunction Timer (CMT) and, after timer expiration, proceed to Illegal Carrier state.
Carrier Activity with No NAC	• If level threshold is exceeded, activate Carrier Malfunction Timer (CMT) and, after timer expiration, proceed to Illegal Carrier state.	• If level threshold is exceeded, activate Carrier Malfunction Timer (CMT) and, after timer expiration, proceed to Illegal Carrier state.

Interference protection works differently for Phase 2 TDMA. The System ID, WACN ID, and NAC are used to produce a unique superframe sized (4320 bit) scrambling sequence. This sequence is exclusive-or'ed with the transmitted and received data. If either the Site or Subscriber is receiving scrambled with the wrong sequence, it will not decode that data. To the station, the wrong sequence looks like Carrier Activity with No NAC.

6.7 Out-of-Band Management

At an IP simulcast subsystem prime site, a terminal server can be employed for out-of-band management. Out-of-band management implementation at an IP simulcast subsystem prime site provides serial access to various prime site components.

Figure 23: Terminal Server – Out-of-Band Management at the IP Simulcast Subsystem Prime Site



Out-of-band management is typically provided to the following IP simulcast subsystem prime site components:

- GCP 8000 Site Controller
- GCM 8000 Comparator
- Remote Site Access Router or Gateway
- Prime Site Router or Gateway
- Ethernet LAN Switches
- TRAK 9100 Simulcast Site Reference

See the *Terminal Servers LX Series* manual.

6.8 Adding ASTRO 25 Trunked IP Remote Site

When and where to use:
Use this procedure to add a new trunked remote site to an existing IP simulcast subsystem or receive-only remote site to an existing IP simulcast or Single Transmitter, Receiver Voting (STRV) subsystem.

While adding the new remote site to an existing IP simulcast subsystem, perform a Transfer and Install operation using SWDL. Follow this process to install the software for a new remote site.

NOTICE: Do not purge the software from the existing remote sites before doing the transfer.

SWDL attempts transfer to one proxy device at each remote site. The GTR 8000 Base Radio chosen as a proxy checks the version of the software to see if it already has it. In a high availability or receive-only remote site configuration, the GPB 8000 Reference Distribution Module serves as the proxy. In case of the existing remote sites, the proxy determines that it already has the software and does not try to re-transfer it. Only the new remote site gets full transfer because it did not initially have the software.

NOTICE: For IP simulcast subsystems with 32 subsite capacity, the limit of the call model is reached sooner with fewer subscribers per simulcast site as compared to existing system configurations. Due to wider geographic spread, less collisions take place, thus increasing the number of successful input messaging attempts.

Process:

1. Connect and install the hardware for the new remote site.
2. Verify that the new remote site is configured and its status is **not unconfigured**.

   NOTICE: SWDL only downloads to remote sites and channels that are not unconfigured.
3. Use SWDL to import the software from CD to PC.
4. Use SWDL, perform a base radio Transfer and Install operation to the new remote site. The device chosen as a proxy checks the version of the software to see if it exists on the device. The proxy determines if the software version exists on the remote site and informs all other devices to crossload the specified software version.
5. Configure the remote site through CSS.
6. Create the remote site through UNC.
7. Manage the remote site through UNC by doing the following:
   a. Discover new base radios using the UNC Discovery Wizard (use the Multicast Remote site discover type to discover the base radios).
   b. Refresh the site using the UNC Site Wizard. This causes the UNC to "relearn" the site configuration.

6.9 Adding a Channel

When and where to use:
While adding a new channel to an existing IP simulcast subsystem, perform a Transfer and Install operation using SWDL. While adding a new channel, use this process to install the software on the new base radios and comparator.

Process:

1. **NOTICE:** If the status of the new channel is unconfigured, the Software Download Manager does not recognize it in the subsystem.

   Use SWDL to import the software from CD to PC.
2. Using SWDL, perform a Transfer Only operation to a base radio at each remote site. The device chosen as a proxy checks the version of the software to see if it exists on the device. The proxy determines if the software version exists on the remote site and informs all other devices to crossload the specified software version.
3. Install the base radio new channel:
   a. Connect the hardware for the new channel.
   b. Using SWDL, perform an Install Only operation.
   c. Configure the channel through CSS.
   d. Create the channel through UNC.
   e. Manage the channel through UNC by doing the following:
      1. Discover new channels using the UNC Discovery Wizard (use the Multicast Remote site discover type to discover the channels).

2. Refresh the site using the UNC Site Wizard. This causes the UNC to “relearn” the site configuration.

f. Verify the new channel configuration.

4. Install the comparator new channel:
   a. Connect the hardware for the new channel.
   b. Using SWDL, perform a Transfer and Install Only operation.
   c. Configure the channel through CSS.
   d. Create the channel through UNC.
   e. Manage the channel through UNC by doing the following:
      1. Discover new channels using the UNC Discovery Wizard (use the Multicast discovery type to discover the channels).
      2. Refresh the site using the UNC Site Wizard. This causes the UNC to “relearn” the site configuration.
   f. Verify the new channel configuration.

   NOTICE: If the status of the new comparator is unconfigured, the Software Download Manager does not recognize it in the remote site.

5. Install the comparator:
   a. Connect the comparator hardware to the LAN.
   b. Verify that the comparator is configured on the same VLAN as the rest of the site controllers and comparators.
   c. Verify that the site controller has the correct version of the comparator software marked as being “In Use.”

   The current software is crossloaded to the comparator from the site controller when the appropriate VLAN is set on the new comparator.

6. Configure the comparator through CSS.
7. Create the channel through UNC.
8. Manage the comparator through UNC by doing the following:
   a. Discover new comparators using the UNC Discovery Wizard (use the Multicast discovery type to discover the comparators).
   b. Refresh the site using the UNC Site Wizard. This causes the UNC to “relearn” the site configuration.

6.10 Data Steering at Simulcast Sites

Simulcasting data has two drawbacks:

- The outbound error rate within simulcast sites causes more retransmissions due to the relatively poor data block error rate under larger delay spread conditions.
- The poor performance is compounded by the large slot times achievable with maintaining a simulcast transmission for status symbols.

To resolve these issues use ASTRO® 3.0 conventional simulcast - site steering operation. Site steering transmits payload data packets only at the most recently recorded transmit sub-site. This requires that the comparator determines the best subsite for each subscriber on the packet data channel. The information is gathered from two areas:

- Inbound messages from the SU on the control channel – trunked only.
- Inbound data and responses on the packet data channel.

All messages are sent to all sub-sites, but addressed to only one, causing all but one of the Simulcast base stations to ignore the message. This creates the effect of site steering to a single transmitter. Messages are still time launched as when simulcasting packets to allow the comparator to retain control and keep a common pacing engine in the comparator.

NOTICE: In a single transmitter receiver voting subsystem for FDMA-only and IV&D Data operation, base stations do not use the time launching information that the comparator sends, since this is unnecessary in a configuration with only a single transmitter site.

6.10.1 Comparator

The comparator selects the appropriate sub-site that actually sends data packets over the air. The comparator multicasts packet data payload to all connected base stations and receivers. This means that all base stations/receivers receive all packets, even if they are not going to transmit them.

When ending packet data payload in a trunked IP Multi-Site subsystem or a conventional IP Multi-Site simulcast/multicast/STRV subsystem, the comparator fills in the subsite number of the base station recorded as the “best” transmit sub-site for the CAI ID to which the data payload is addressed. For simulcast operation in a trunked or conventional IP Multi-Site subsystem, when sending packet data payload XIS messages to the base station, the comparator indicates the simulcast launch time of the message in the first PDU XIS frame.

When the comparator is to send packet data payload to a subscriber unit but does not have an associated subsite address in its database, the comparator indicates that the data payload is simulcasted using the broadcast subsite number of $FF.

NOTICE: This is considered to be a rare exception case and not expected to happen.

6.10.2 Base Station and Outbound Packet Data Payload

During simulcast data steering only the selected base station transmits outbound packet data payload. When receiving XIS packets containing outbound packet data payload, the base station examines the subsite number field and only processes those packets that have a match the base station’s subsite number or that are addressed to the broadcast subsite number of $FF.

6.10.3 Data Steering and Sub-site Mobility

NOTICE: The content in this section is not applicable to a conventional IP Multi-Site Subsystem.

Maintaining the correct sub-site mobility information is important in site steering data and is accomplished with the following two methods:

- First, by selecting the “best” sub-site from the respective ISPs sent on the control channel.
- Second, by selecting the best sub-site on all inbound data payload transmissions that occur on the PDCH.

When determining the best sub-site for a subscriber, and the subscriber’s ISP or inbound data signal is received from at least one transmit site, the comparator ignores signals received from receive-only sites. While a given user is assigned to a PDCH, the comparator is responsible for tracking the most recent sub-site information. Before a user is assigned to a specific PDCH, the sub-site information is

maintained in separate queues in the comparators until the user is physically present on a PDCH. Since the comparators are on an Ethernet LAN, they are able to quickly share sub-site mobility information with each other.

The methodology for doing this involves having the comparator assigned as a control channel to gather the sub-site mobility information and distribute to all other comparators at the site (on the LAN). All comparators have the most recent mobility information when they are assigned as a PDCH.

6.10.4
Comparator and Sub-site Mobility

NOTICE: The content in this section is not applicable to a conventional IP Multi-Site Subsystem.

Subscriber Unit Assigned to a PDCH

For each Subscriber Unit (SU) assigned to a packet data channel, the comparator maintains the last "best" sub-site. A comparator assigned for packet data records the best voted site for each inbound transmission received on the packet data channel on a PDU-by-PDU basis. A comparator assigned for packet data maintains the sub-site information record for at least 120 active users on the packet data channel. All comparators, however assigned, maintain the sub-site information record for at least 120 users that are transitioning from the control channel to a packet data channel.

Subscriber Unit Requesting Data Service

For each Subscriber Unit (SU) requesting data service on a control channel, the comparator records the last "best" sub-site. All comparators assigned for control channel operation select the best sub-site when decoding. To allow the SU to move within a set of simulcasted sub-sites, special PDCH validation rules must be obeyed. The infrastructure must ensure that the channel is keyed occasionally to satisfy the SU’s need to validate the PDCH. It is possible that a continuous stream of outbound data can be sent to one particular sub-site in site-steering mode. If a subscriber unit is not in the coverage of that particular site, the SU may not be aware that it is on a valid PDCH, but only out of coverage of the currently transmitting site. This operation is not required in the single transmitter with receiver voting subsystem configuration.

NOTICE: While assigned for packet data service, the comparator ensures that there is at least one simulcast transmission every 15 seconds. In the event that the comparator does not simulcast any transmissions within a 15 second window, it sends a group addressed control message at least once every 15 seconds.

6.10.5
Data Steering with Receive-only Subsite

The comparator directs data transmissions for a subscriber unit to the subsite and determines the best signal for the subscriber based on:

- Signal strength
- Measurements performed on the data from the subscriber
- Control channel transmission from the subscriber

Data steering in a receive-only subsite is configured through the Unified Network Configurator (UNC) by setting the **Transmit Remote Site ID**. This configuration provides a relationship or mapping, of each receive-only remote subsite to a transmit remote subsite. This message is sent to the comparator for data site steering.

In a subsystem with receive-only sites, if the subscriber's most recent data or control channel transmission was only received by the receive-only subsites, the comparator must determine the

transmit subsite to be used for data transmission to the subscriber. The Transmit Remote Site ID assists the comparator in this decision.

6.11 Data Operation in Simulcast Subsystems

NOTICE: Data operation is not applicable to a conventional IP Multi-Site Subsystem.

When a simulcast channel is assigned for data service:

- Subsites operate independently when passing data traffic.
- Subsite location is tracked for each subscriber assigned to the channel.
- Outbound data is subsite-steered to the target subscriber.
- The subsite is keyed long enough to transmit data and perform site-switching cleanup.

A data-assigned channel occasionally simulcasts when:

- Group control LCs destined for subscribers are known to be on the channel.
- Transmitting an outbound packet to a “lost subscriber.”
- Every 15 seconds to signal a valid PDCH.

6.11.1 Multiple Access Rules for a Simulcast Subsystem

In a simulcast subsystem a transmitter is not “always on” when the channel is assigned to data service. A subscriber unit roaming from one subsite to another places a premium on dekeying transmitters when they are not needed. The simulcast sub-system cannot source inbound channel busy bits unless a particular subsite is “busy.” Therefore, the subsystem operates in “ALOHA” mode much of the time. In ALOHA mode the following occurs:

- Subscribers transmit inbound data when ready.
- Channel access is less efficient than S-DSMA (1:2.5).
- Up to three subsites can source inbound packets - prime site handles all.
- Net effect is that a simulcast channel has access capacity roughly equal to a single repeater channel.

6.11.2 Busy Bit Operation in Simulcast Subsystems

Busy bit operation in a simulcast repeater site uses only busy and idle states. Busy bit operation in a simulcast subsystem. Operation is similar to slotted ALOHA operation except inbound packets vary in length. Slot interval is configurable and defaults to the same 60msec number used by ASTRO® 25 Repeaters.

6.11.3 Subscriber Unit on a PDCH

While on a packet data channel, the subscriber unit (SU) validates that it is still within range of the channel. If while on the packet data channel, the SU fails to decode valid Frame Sync and Network ID for 31 consecutive seconds, the SU issues a “Cancel Service Indication” on the control channel and then enters a control channel search.

6.11.4
Comparator PDCH Behavior

The comparator begins operation as a packet data channel upon receiving an indication from the Site Controller. Upon receiving a PD_Chan_Grnt, the comparator commences operation as a PDCH and sends an indication to the base stations/receivers that they are in the PDCH mode. Upon receiving a PD_Deassign or Chan_Grant (voice), the comparator ceases operation as a PDCH and sends an indication to the base stations/receivers that they are no longer in the PDCH mode.

6.11.5
Base Radio/Receiver PDCH Behavior

The base station/receiver operates as PDCH upon receiving an indication from the comparator. While in PDCH mode, the base station/receiver receives data packets with only a valid NAC. The base station/receiver does not consider data packets with a valid NAC as illegal carrier. When the base station/receiver is assigned as a PDCH it can be idle or not transmitting and receive unsolicited inbound traffic with valid NAC. Upon receiving the appropriate command, the base station/receiver ceases operation as a PDCH. If the base station/receiver does not receive any activity from the comparator for a period of 31 seconds from which it can deduce it is still assigned as a PDCH, the base station/receiver ceases operation as a PDCH and returns to the IDLE state.

While in PDCH mode the base station/receiver:

- Considers illegal carrier to be present if the Illegal Carrier Signal Level is exceeded and a valid NAC is received with any voice channel packet.
- Reports internally the presence of illegal carriers that exceed the CSS/SNMP-defined illegal carrier level for more than two seconds.
- Reports through the network management path (if available) the presence of illegal carriers that exceeds both the illegal carrier signal level and the carrier malfunction timer.
- Reports through the call processing path (AIS) that the station is not available for call assignment in the presence of illegal carriers that exceed both the illegal carrier signal level and the carrier malfunction timer.

Chapter 7

ASTRO 25 Trunked IP Simulcast Subsystem Troubleshooting

This chapter provides fault management and troubleshooting information relating to the IP simulcast subsystem.

7.1 Simulcast Subsystem Trunked Call Processing Modes of Operation

The following operational modes for IP-based simulcast subsystem include the following:

- Wide-area trunking
- Site trunking
- Site (subsystem) Failsoft
- Local Failsoft
- Site Off

For information on fault management and troubleshooting information relating to Simulcast Subsystem Modes of Operation, see the *Call Processing and Mobility Management* manual.

7.2 General Troubleshooting

This table provides general troubleshooting instructions for the Trunked IP Simulcast Subsystem.

Table 4: General Troubleshooting

Problem	Troubleshooting
General connectivity problems	**1** If you have access to the equipment, check the LEDs to verify if each piece of equipment is connected and operational. **2** In Configuration/Service Software (CSS), check the condition of the device and all associated devices and links. **3** Verify the configuration of the device through CSS. Verify if the IP address for the device is correct. In CSS, send a diagnostic command to enable the device. **4** For a standalone base radio, verify that the Domain Name Service (DNS) Hostname for the base radio is correct. If the DNS Hostname was incorrect and then corrected, further corrections may be needed on the DNS server, Unified Network Configurator (UNC), and Unified Event Manager (UEM). See the Troubleshooting chapter in the *Authentication Services* manual.

Table continued…

Problem	Troubleshooting
	5 Verify if the physical cabling is firmly connected and is in good condition. Check for any sharp bends or kinks in cabling. Test suspected cabling for noise, continuity, attenuation, and crosstalk. Replace the cabling if necessary. **6** Run ping, traceroute, pathping, and other network administration commands to identify any link or intermediate devices (switch, routers, or gateways) with high latency or connection problems. **7** If the connection fails to operate normally, send a restart command to the device through CSS. Consider cycling power to the device if necessary. **8** If the device still fails to operate properly, create a backup of the current configuration, then reinstall the software and reconfigure the device. **9** Replace the device if necessary.
Device does not power up	**1** If you have access to the equipment, check the LEDs to determine which equipment is connected and operational. **2** In CSS, check the alarms for the device. **3** Check the power cabling and verify if the power source for the device is supplying the appropriate voltage. Connect the device to another power source or replace the power cabling if necessary. **NOTICE:** Check all power sources as there may be more than one. **4** Check for any physical damage to the modules and check whether the modules were properly grounded. **5** Replace any defective modules.
Device is in a continuous reset state	Assure reference inputs are connected to the appropriate input.
Front Fan Malfunction	In the event the fan assembly malfunctions, the base radio: **1** Logs an occurrence of the failure in the base radio local event log, which is retrievable through the configuration interface. **2** If connected to centralized fault management equipment (optional), the base radio transmits an alarm indication of “warning” severity to the fault manager to alert the system administrator of the failure. The alarm is associated with the base radio control module. **3** The base radio provides a local visual indication associated with the failure. **4** If the base radio detects the maximum operable temperature has been exceeded, the base radio transitions to a critical malfunction state. Log the state change and generate a fault indication if connected to the UEM.
The GPW 8000 Receiver reports an unexpected fault for the Power Supply. For a	A GEN 1 transceiver is incorrectly installed in the bottom slot of the dual-slot chassis with AUX PWR IN connected. The GEN 1 transceiver hardware does not support detection of the AUX PWR IN, may incorrectly report Power Supply Faults, and may go out of service.

Table continued...

Problem	Troubleshooting
Multi-Site GPW 8000 Receiver, the fault may be reported at a Major Failed or Critical Failed severity, which causes the device to be taken out of service.	Corrective Action: • Install the GEN 1 transceiver in the top slot of the dual-slot chassis. See “Replacing a GPW 8000 Receiver Transceiver Module” in the *GPW 8000 Receiver* manual. • Confirm that the Power Supply in the chassis is operational, and then disconnect the AUX PWR IN from the chassis.
The transceiver reports on the CSS **Status Panel** screen, that the Power Supply state is Shared, rather than reporting the actual chassis Power Supply state of Operational (Multi-Site GPW 8000 Receiver), AC or DC Power (Conventional GPW 8000 Receiver), or Failed (either Multi-Site or Conventional GPW 8000 Receiver)	A transceiver is installed in the top slot of the dual-slot chassis, but no transceiver is installed in the bottom slot. Connect the CSS to the bottom slot transceiver to verify the chassis power supply state.

7.3 Troubleshooting for a Geographically Redundant Trunking Prime Site

This section provides information on troubleshooting a Geographically Redundant Trunking Prime Site.

Table 5: Geographically Redundant Trunking Prime Site Failure Scenarios

Problem	Troubleshooting Steps
Site controller 3 (SC3) connectivity fault reported. No faults reported from transport equipment. At the Unified Event Manager (UEM), when the SC3 connectivity fault is reported, the following message for the “Intra-Prime Site Link” entity is displayed: **MAJOR MALFUNCTION, LOST COMMUNICATION**.	Site controller 1 or Site controller 2 (SC1, SC2) failure at the primary prime site. Intra-Prime site link is experiencing short fades.
SC1 or SC2 connectivity fault reported. No faults reported from transport equipment. At the UEM, when the SC1 and SC2 connectivity fault is reported, the following message for the “Intra-Prime Site Link” entity is displayed: **MAJOR MALFUNCTION, LOST COMMUNICATION**.	SC3 failure at the secondary prime.

Table continued…

Problem	Troubleshooting Steps
SC1 or SC2 connectivity fault reported and prime site router **BFD event-down** reported. At the UEM, when the primary prime site router **BFD event-down** fault is reported, the following message text for the Ethernet WAN interfaces 180.255.255.253 entity is displayed: **Down, Link Down**.	One of the following failures occurred: **1** LAN switch 2 failure at the secondary prime site. **2** If all devices on the affected network path are operating normally, test the Ethernet link at the site for connectivity if possible, or contact the service provider to determine if the Intra-Prime site link backhaul is down.
SC3 connectivity fault and prime site router **BFD event-down** is reported. At the UEM, when the secondary prime site router **BFD event-down** fault is reported, the following message text for the Ethernet WAN interfaces 180.255.255.254 entity is displayed: **Down, Link Down**.	One of the following failures occurred: **1** LAN switch 1 failure at the primary prime site. **2** If all devices on the affected network path are operating normally, test the Ethernet link at the site for connectivity if possible, or contact the service provider to determine if the Intra-Prime site link backhaul is down.
Primary prime site comparators are in standby, not active in a call and no Redundancy misconfiguration reports from the comparators.	Redundancy parameter is set to a valid combination for a redundant comparator pair, but not in accordance with the recommended setting for Trunking Prime Site with Geographic Redundancy (TPGSR). See “Software and Configuration Updates for Geographically Redundant Prime Sites” in the *Trunked IP Simulcast Subsystem Prime Site* manual for redundant comparator pair configuration.
Standby / Active comparators report “Redundancy” misconfiguration. At the UEM, when the Standby / Active comparators fault is reported, the following message for the “Comparator” entity is displayed: **MAJOR MALFUNCTION, INCORRECTLY CONFIGURED PARAMETER “REDUNDANCY”**	Redundancy parameter is not set to a valid combination for a redundant comparator pair, and not in accordance with the recommended setting for a Trunking Prime Site with Geographic Redundancy (TPGSR). See “Software and Configuration Updates for Geographically Redundant Prime Sites” in the *Trunked IP Simulcast Subsystem Prime Site* manual for redundant comparator pair configuration.
Prime site routers are reporting IPDV **Jitter** fault for the Intra-Prime site link. At the UEM, when the prime site router fault is reported, the following message for the Ethernet WAN Interfaces 180.255.255.253 or 180..255.255.254 entity is displayed: **Threshold value exceeded for Avg IPDV 99th percentile measurement**.	Excessive jitter is present on the intra-prime site link. Jitter is exceeding the configured thresholds. **NOTICE:** For IPDV, IPTD, and IPLR ethernet site link performance parameters, values are based on the service level agreement with the vendor providing the Ethernet backhaul. The ethernet thresholds must meet the Ethernet Site link specifications for Motorola Solutions.

Table continued…

Problem	Troubleshooting Steps
Prime site routers are reporting IPTD **Latency** fault for the Intra-Prime site link. At the UEM, when the prime site router fault is reported, the following message for the Ethernet WAN Interfaces 180.255.255.253 or 180.255.255.254 entity is displayed: **Threshold value exceeded for Avg round trip IPTD measurement**.	Excessive latency is present on the intra-prime site link. **NOTICE:** For IPDV, IPTD, and IPLR ethernet site link performance parameters, values are based on the service level agreement with the vendor providing the Ethernet backhaul. The ethernet thresholds must meet the Ethernet Site link specifications for Motorola Solutions.
Prime site routers are reporting IPLR **Packet Loss** fault for the Intra-Prime site link. At the UEM, when the prime site router fault is reported, the following message for the Ethernet WAN Interfaces 180.255.255.253 or 180.255.255.254 entity is displayed:**Threshold value exceeded for IPLR Loss Rate measurement**.	Excessive packet loss is present on the intra-prime site link. **NOTICE:** For IPDV, IPTD, and IPLR ethernet site link performance parameters, values are based on the service level agreement with the vendor providing the Ethernet backhaul. The ethernet thresholds must meet the Ethernet Site link specifications for Motorola Solutions.
Master Site Base Radios (MsBRs) report a Station Control Board **MINOR FAILED**, **SCB EXTERNAL REFERENCE** Alarm.	MsBRs that reside in a GTR 8000 Expandable Site Subsystem (ESS) without High Availability (no GPB 8000 in the ESS) reports this alarm whenever connectivity is lost with SC1 or when connectivity is lost to both SC2 and SC3. The alarm clears once connectivity has been restored to either SC1 and SC2 or SC1 and SC3.
During Force Active operation, (assuming some comparators are still active on the primary prime site), if any of the following events occur: • Random individual channels malfunction - lost calls, failed call setup, loss of wide area operation, switch to site trunking, or failsoft. • Access time increase. • Increased instances of "Busies". • Unexpected control channel rolls. • Audio impairments.	Excessive latency on the intra-prime site link. Excessive latency on the intra-prime site link is verified by IPTD Link Monitoring statistics and fault.
Increased number of call setup failures and degraded audio quality during “Force Active” operation.	Excessive jitter and packet loss on the intra-prime site links. Jitter and packet loss on the intra-prime site links are verified by IPDV and IPLR Link Monitoring statistics and fault.
Link failure events in the intra-prime site link backhaul results in noticeable audio holes or failed call setup events.	One of the following failures occurred: **1** Backhaul network is not compliant with 800ms transport constraint for failover.

Table continued…

Problem	Troubleshooting Steps
	2 Non-bidirectional flow is greater than 100ms after recovery of the transport path. See Intra-Prime Site Link Transport Design Constraints on page 74 for details on Intra-Prime Site link transport design constraints.
Link failure in the intra-prime site link backhaul, results in split brain operation (comparators at the primary prime site and secondary prime site activate).	Violation of a transport constraint since the intra-prime site link backhaul network took longer than 5 seconds to failover to an alternate path. See Intra-Prime Site Link Transport Design Constraints on page 74 for details on Intra-Prime Site link transport design constraints.
Recovery of the intra-prime site link results in improper operation (outages, failsoft for > 10 seconds).	Bi-directional flow transport constraint was not met. When packet flow is established in one direction, bidirectional flow must be established in the other direction within 100ms. See Intra-Prime Site Link Transport Design Constraints on page 74 for details on Intra-Prime Site link transport design constraints.
Network looping fault trap is reported from the site controller. Detected network loop events are reported to all registered fault managers and recorded in the technician event logs. At the UEM, when a network looping fault is reported from the site controller, the following message for the Site Controller entity is displayed: **MAJOR MALFUNCTION, SITE CONTROLLER DETECTED NETWORK LOOP**. **NOTICE:** Network loop events detected by the comparator are only recorded in the technician event logs. **NOTICE:** The site controller must be reset to clear this fault. Appropriate care should be exercised when resetting site controllers to ensure no loss of wide area operation. (i.e., do not reset all site controllers at the same time).	This fault is reported when another site controller is detected with the same IP address (that is, IP misconfiguration) or when the backhaul network is creating a network loop. Network looping can occur for example, upon a failure on the intra-prime site link backhaul or during recovery of the intra-prime site link backhaul. This is most likely due to misconfiguration of transport equipment within the backhaul. An outage could occur if the backhaul configuration is not repaired.
During split brain operation, several subsites are either not on the air (coverage holes) or providing interference.	The intra-prime site link backhaul network was not designed to TPSGR requirements. If the subsite links use the same physical transport as the intra-prime site link and the link is the sole path to the primary prime site (the link can fail simultaneously with the intra-prime site link), then coverage holes or interference occurs.

Table continued…

Problem	Troubleshooting Steps
	See Intra-Prime Site Link Transport Design Constraints on page 74 for details on Intra-Prime Site link transport design constraints.
During split-brain operation, wide area coverage is not available.	If the site links use the same physical transport as the intra-prime site link and the link is the sole path to the primary prime site (the link can fail simultaneously with the intra-prime site link), then a site control path cannot be established. See Intra-Prime Site Link Transport Design Constraints on page 74 for details on Intra-Prime Site link transport design constraints.
Software Download Manager (SWDL) operation or other services fail to connect to the secondary prime site equipment.	If latency, jitter and packet loss are within acceptable limits per the transport constraints, the intra-prime site link backhaul may not be configured to pass 1522 byte packets (802.1q MTU frame size). See Intra-Prime Site Link Transport Design Constraints on page 74 for details on Intra-Prime Site link transport design constraints.
During SWDL operation, site controllers continually reset.	Intra-prime site link or LAN switch failures occur during SWDL operation.
After setting SC3 to “Force Active”, the site does not enter wide area trunking.	Split brain operation occurred while SC3 is in “Force Active” mode. This failure mode requires manual intervention to recover. Set SC3 to **enabled** or **reset** to restore wide area trunking. After the intra-prime site link backhaul failure is resolved, **Force Active** mode may be utilized again at SC3.
After setting SC3 to **Force Active** or when setting SC3 to another state from **Force Active**, widespread subscriber radio scatter occurs to adjacent sites. Depending on the number of subscribers affected, widespread subscriber radio scatter may have a negative impact to adjacent site performance.	When **Force Active** mode is entered or released (used during a LAN switch upgrade procedure), the site transitions briefly into Site Trunking. If adjacent sites are configured, subscriber radios leave the site immediately upon detecting that the site is in Site Trunking. Widespread subscriber scatter could be avoided by setting the **Site Trunking Indication Holdoff Time** (site controller parameter) to a non-zero value.  **CAUTION:** When set to a non-zero value, the site controller delays reporting the site trunking state to subscribers at the site for the period indicated by the **Site Trunking Indication Holdoff Time Actual** parameter. This capability should only be used if absolutely necessary.

Table continued…

Problem	Troubleshooting Steps
During primary prime site recovery, widespread subscriber radio scatter occurs to adjacent sites. Depending on the number of subscribers affected, widespread subscriber radio scatter may have a negative impact to adjacent site performance.	During primary prime site recovery, the site transitions briefly into Site Trunking. If adjacent sites are configured, subscriber radios leave the site immediately upon detecting that the site is in Site Trunking. Widespread subscriber scatter is avoided by setting the **Site Trunking Indication Holdoff Time** (site controller parameter) to a non-zero value. **CAUTION:** When set to a non-zero value, the site controller delays reporting the site trunking state to subscribers at the site for the period indicated by the **Site Trunking Indication Holdoff Time Actual** parameter. This capability is only used if necessary.
There is an increased number of call setup failures and degraded audio quality when intra-prime site link is utilized (for example: secondary prime site comparator is active, primary prime site backhaul switch has failed). The Comparator technician logs indicate excessive jitter and/or excessive delay on the subsite links.	One of the following failures could be contributing factors: **1** Intra-prime site link does not meet the latency, jitter, and packet loss transport constraints. **2** Link delay and jitter buffer configuration in the comparator is incorrect or does not account for the intra-prime site link. **3** The 10ms differential subsite link delay constraint has been violated. Appropriate adjustments to the comparator **Subsite Link Minimum Jitter Buffer** value may be necessary if this design constraint cannot be met. Adjusting this value is not desirable, however, due to the negative impact on system access time and audio throughput.

7.4 Software Troubleshooting Tools

Table 6: Software Tools for Troubleshooting an IP Simulcast Subsystem

You can use this tool	To Diagnose
Unified Event Manager	• Site Links • Subsite Links • GCP 8000 Site Controller • GCM 8000 Comparator • GTR 8000 Base Radio • GPB 8000 Reference Distribution Module

Table continued…

You can use this tool	To Diagnose
	• GPW 8000 Receivers • TRAK 9100–8E, TRAK 8835–2M, and TRAK 8835–3M • Channel Banks • Ethernet LAN Switch • Prime Site Router or Gateway • Remote Site Router or Gateway • Remote Site Access Router or Gateway • Microwave antenna equipment (through point-to-point devices)
MOSCAD Network Fault Management	• GTR 8000 Base Radio • GCP 8000 Site Controller • GCM 8000 Comparator • GPB 8000 Reference Distribution Module • GPW 8000 Receivers • TRAK 9100 Simulcast Site Reference • TRAK 8835 Conventional Site Reference • Microwave Links • Channel Banks • TRAK 9100 SSR • RFDS – Tower Top Amplifier (via the digital input lines of the SDM3000) • RFDS – Receiver Multi-coupler • Hybrid Combiner
Configuration/Service Software (CSS)	• GCP 8000 Site Controller • GCM 8000 Comparator • GTR 8000 Base Radio • GPB 8000 Reference Distribution Module • GPW 8000 Receivers
Unified Network Configurator (UNC)	• GCP 8000 Site Controller • GCM 8000 Comparator • GTR 8000 Base Radio • GBP 8000 Reference Distribution Module • Prime Site Router or Gateway • Remote Site Router or Gateway • Remote Site Access Router or Gateway • GPW 8000 Receivers

Table continued…

You can use this tool	To Diagnose
	• Ethernet LAN Switch • Subsystem • Channels • Remote Site
ZoneWatch	• Channels
LED indicators and physical connections	• GCP 8000 Site Controller • GCM 8000 Comparator • GTR 8000 Base Radio • GPB 8000 Reference Distribution Module • GPW 8000 Receivers • Routers or Gateways • Channel Banks • Ethernet LAN Switches • TRAK 9100 SSR • Hybrid Combiner
3rd Party Applications	• Ethernet LAN Switches
Command line diagnostics	• Channel Banks • Routers or Gateways • TRAK 9100/TRAK 8835–3M SSR • Ethernet LAN Switches
Terminal Server (at the prime site)	• GCP 8000 Site Controller • GCM 8000 Comparator • GTR 8000 Base Radio • GPB 8000 Reference Distribution Module • GPW 8000 Receivers • Channel Bank • Routers or Gateways • Ethernet LAN Switches • TRAK 9100–8E/TRAK 8835–2M/TRAK 8835–3M SSR
Traffic Monitoring Device	Ethernet LAN Switches (HP 3500)

7.5 LED Indicators and Physical Connections

LED indicators and Physical connections are troubleshooting tools used to diagnose and troubleshoot the following individual links and components:

- GCP 8000 Site Controller

- GCM 8000 Comparator
- GTR 8000 Base Radio
- GPB 8000 Reference Distribution Module (RDM)
- GPW 8000 Receiver
- Routers or Gateways
- Ethernet LAN Switch
- TRAK 9100 Simulcast Site Reference
- Hybrid Combiner

7.6 Troubleshooting Process

When and where to use:
Use this process to isolate faults to the FRU level.

Process:

1. Regularly monitor links and individual components using the Unified Event Manager topology maps and MOSCAD NFM. Check the IP Network base radio links, comparator links, RDM, site control path, site manager links, and subsite manager links. Also check the condition of any microwave equipment, if applicable, through the Supported Systems root level container in Unified Event Manager.
2. Analyze on a regularly scheduled basis the Unified Event Manager Active Alarms Window, looking for patterns in alarms and alerts that may aid in isolating a fault.
3. Isolate a fault after initial alarm from Unified Event Manager.
4. Escalate the problem if you cannot isolate the faults.

7.6.1 Monitoring IP Simulcast Links and Components with UEM

Use Unified Event Manager (UEM) and MOSCAD NFM to monitor critical links and components in the system. Monitoring may take place remotely from a central operations center. Two types of monitoring include:

- Real-time monitoring of UEM Topology Maps, that alerts you of faults as they occur.
- Evaluation of UEM Active Alarms Window on a regularly scheduled basis.

7.6.2 Analyzing UEM Active Alarms Window

The Unified Event Manager (UEM) Active Alarm Window is useful for troubleshooting because it captures alarms that may occur intermittently or during off-hours. For example, you can review the Active Alarms Window to correlate reported loss of service with patterns of critical alarms for links and equipment.

When analyzing the Active Alarms Window, look for the following types of patterns:

- Failures sent with time stamps on or about the same time.
- Failures from related equipment:
  - Cards in the same device
  - Equipment is part of the same subsystem

Many devices are capable of sending out events that report both critical and non-critical events. Learn to distinguish between critical and non-critical events.

7.6.2.1
Point-to-Point Components

The IP simulcast remote site can be set up to provide a way for the Unified Event Manager to fault manage microwave antenna equipment by implementing PTP devices (Motorola Wireless Bridges) at the site.

See the *Fault Management – System Perspective* and *Unified Event Manager* manuals for details.

7.7
Site Link Troubleshooting

This section describes how to troubleshoot the site links.

7.7.1
Link Types

A link is defined as both the physical and logical connections between two entities. This table provides a detailed description of the link types used in an IP simulcast subsystem.

Table 7: IP Simulcast Subsystem Link Types

Link Name	Physical Description	Logical Description
Site Link	Connects master site and prime site. Fractional T1 (FT1), T1/E1, or Ethernet between the WAN switch/Cooperative WAN Routing (CWR) patch panel or backhaul switch at the master site and prime site router or gateway. Bandwidth may range from 384 Kbps to 1.536 Mbps, depending on the number of channels on your system.	Provides the physical connection, between the redundant core routers at the master site and prime site router or gateway. The physical connection is used to set up the logical links. Logical path is through redundant frame relay Permanent Virtual Circuits (PVCs). Control traffic uses both PVCs. All other traffic, including audio, uses one of the PVCs.
Remote Site Link	Connects the prime site to the remote site – T1/E1 or Ethernet connection through remote site access routers or gateways.	Provides the physical connection, which is used to create the logical connection between the IP Network (control and audio) of the remote site to the comparators at the prime site.
Hybrid Site Links	Connects a redundant zone core to redundant remote sites with redundant connections between the zone core and remote site by using different connection types.	Hybrid site links require no more than two physical E1/T1 links. Enables mixing of E1/T1 and Ethernet site links, where the primary could be an E1/T1 and the secondary could be an Ethernet link or an Ethernet link as the primary or E1/T1 as the secondary link.
Intra-Prime Site Extended Ethernet LAN Link	The Intra-Prime Site link connects two geographically separate simulcast prime site locations (primary and secondary prime site) in a Geo-	The LAN switches required to terminate the Intra-Prime Site link at each prime site is configured for a fixed 10 Mbps or 100 Mbps data rate. The

Link Name	Physical Description	Logical Description
	graphically Redundant (TPSGR) configuration.	data rate required for these links is driven from the number of subsites and channels in the system configuration.

7.7.2
Link Failure Causes

Link failure is the most probable cause for site trunking in an IP simulcast subsystem.

Typical causes for link failure are:

- Improper configuration (hardware and software)
- Interference due to extreme weather conditions
- Intermittent loss of carrier service
- Microwave equipment failure
- Physical obstructions in communications paths (for example, buildings, trees, and trains)
- Physical damage to copper or fiber optic lines

7.7.3
Link Failure Indicators

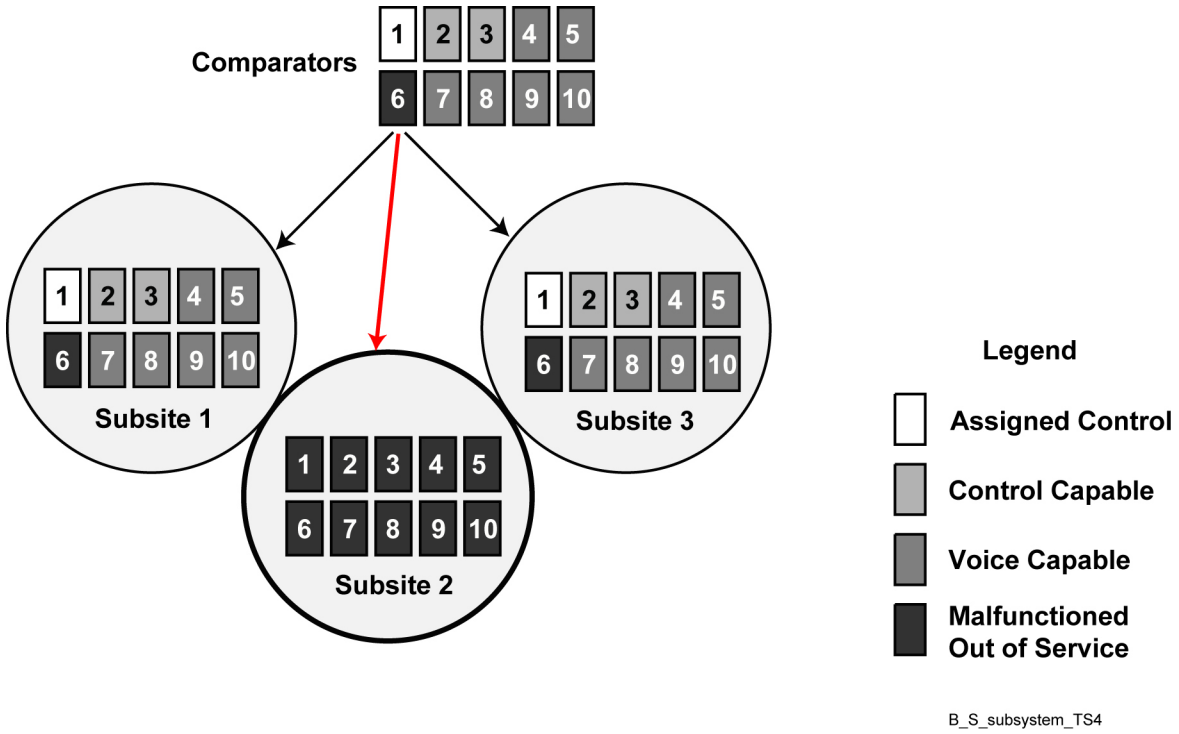
Possible indicators of link failure in the system are:

- Loss of audio - radio users report that calls are not getting through the system.
  - If radio users at other sites have lost audio communication, and users within the same site experience no loss of audio, the site is probably in site trunking mode.
  - If all the radios switch to the preassigned failsoft channel, then the site is in failsoft mode.
- Alarms in Unified Event Manager **Topology Maps and Active Alarms** Window indicating specific links have failed.
- Alarms from SDM RTU indicating microwave equipment failure.
- InfoVista reports indicating router problems (if InfoVista is supported). These reports may include a variety of Motorola Solutions network resource reports, and device reachability reports.
- LEDs on equipment to which the links attach.
- The radio of the user displays a site trunking indicator.

7.7.4
Site Link Failure

Loss of the transport media between the IP simulcast prime site and a remote site causes the remote site to be removed from service. For example, this figure shows the link between the prime site and remote site 2 as “malfunctioned”. This loss removes Remote Site 2 from service.

Figure 24: Loss of Site Link



7.7.4.1

Prime Site to Master Site

A link is defined as both the physical and logical connections between two entities. The following table provides a detailed description of the link type used in a prime site to master site.

Table 8: Prime Site to Master Site Link Type

Link Name	Physical Description	Logical Description
Site Link	Connects master site and prime site. T1/E1 or Ethernet between the WAN switch/Cooperative WAN Routing (CWR) patch panel or backhaul switch at the master site and prime site router or gateway. Bandwidth may range from 384 K up to three T1/E1 depending on the channels and/or encryption.	Provides the physical connection between the redundant core routers at the master site and prime site router or gateway. The physical connection is used to set up the logical links.

7.7.4.2
Prime Site to Remote Site Link Types

A link is defined as both the physical and logical connections between two entities. The following table provides a detailed description of the link type used in a prime site to remote sites.

Table 9: Prime Site to Remote Sites Link Type

Link Name	Physical Description	Logical Description
Remote Site Link	Connects the prime site to the remote site through the remote site access routers or gateways.	Provides the physical connection which is used to create the logical connection between the remote site IP links to the comparators at the prime site.

7.7.5
Troubleshooting Tools for IP Simulcast Subsystem Links

This table lists the recommended tools for troubleshooting IP simulcast subsystem links.

Table 10: Recommended Tools

If you are at...	Then use...
A Remote Site	Unified Event Manager (UEM) to evaluate/interpret real-time and archived alarms, and to monitor critical links and components.
	SDM RTU to evaluate/interpret real-time alarms on microwave equipment.
	Unified Network Configurator (UNC) to verify and change configurations.
	Configuration/Service Software (CSS) to verify the station usage of Local Failsoft at GTR 8000 Base Radios if configured for Local Failsoft or a subscriber to verify Local Failsoft operation with failsoft beep tones every 15 seconds.
The Link Location	Visual inspection of equipment LEDs and cables to verify proper configuration and operation at the equipment.

7.7.6
Troubleshooting Links

7.7.6.1
UEM to Regularly Monitor Links and Individual Components

Use Unified Event Manager (UEM) to monitor critical links and components in the system. Monitoring may take place remotely from a central operations center. Two types of monitoring include:

- Real-time monitoring of UEM Topology Maps.
- Evaluation of UEM Active Alarms Window on a regularly scheduled basis.

7.7.6.2

Analyzing UEM Active Alarms Window

The Unified Event Manager (UEM) Active Alarms Window is useful for troubleshooting because it captures alarms that may occur intermittently or during off-hours. For example, you can review the Active Alarms Window to correlate reported loss of service with patterns of critical alarms for links and equipment.

When analyzing the Active Alarms Window, look for these types of patterns:

- Failures sent with time stamps on or about the same time.
- Failures from equipment attached to particular links. For example, routers, switches, controllers, comparators, and base radios.
- Many devices are capable of sending out events that report both critical and non-critical events. Learn to distinguish between critical and non-critical events.

7.7.6.3

Verifying IP Simulcast Subsystem Configuration with UNC

Use the Unified Network Configurator (UNC) to verify and manage the configuration data of the zone controller and site equipment during system commissioning and later when you maintain or expand the system. Use UNC to verify the configurations of the zone controller and site equipment:

- Verify configuration and correct configuration errors
- Verify status and enable or disable status

7.8

Site Controller Failure Scenarios

Standard Configuration Site Controller Failure Scenarios

If the active Site Controller fails while the site is in Wide Area Trunking, the standby Site Controller immediately becomes the active controller, without causing interruption to any existing calls. The Zone Controller is still the call-processing controller for all existing calls.

If the active Site Controller failure while the site is in Site Trunking mode, the following events occur:

- The standby controller (SC2) immediately becomes the active controller.
- All existing calls being supported are transmission trunked and terminated.
- A subsequent PTT from a radio user whose call was terminated initiates a new call request to the newly active controller (SC2).
- The call continues as usual.

Table 11: Site Controller Failure Scenarios

Type of Failure	Site Mode
Active controller fails	Standby site controller takes over, simulcast subsystem remains in wide area trunking.
Active controller and one site link fail	Standby site controller takes over, redundant site link is used, simulcast subsystem remains in wide area trunking.
Active controller and both site links fail	Standby site controller takes over,simulcast subsystem enters into site trunking.

Table continued...

Type of Failure	Site Mode
Active controller and site switch fail	Standby site controller takes over, simulcast subsystem enters into site trunking.

Geographically Redundant Configuration Site Controller Failure Scenarios

If the standby / active controller (SC1, SC2) fails at the primary prime site while the site is in Wide Area Trunking, the standby controller (SC3) at the secondary prime site becomes the active controller, and results in the loss of wide area operation for a brief period. The Zone Controller is still the call-processing controller.

Table 12: Geographically Redundant Configuration Site Controller Failure Scenarios

Type of Failure	Site Mode
Active controller fails at the primary prime site (SC1)	Standby site controller (SC2) at the primary prime site takes over and remains in wide area trunking.
Active / Standby Controllers fail at the primary prime site (SC1, SC2)	After a brief outage, controller at the secondary prime site (SC3) takes over and restores wide area trunking.
Active controller at the secondary prime site (SC3)	A Site Controller at the primary prime site (SC1 or SC2) will activate if available and restore wide area.
Active controller at the primary prime site (SC1) and LAN switch 1 fail	After a brief outage, wide area is restored after site controller (SC3) and secondary prime site comparators go active.

7.9 Control Plane Failure

Troubleshooting control plane failure comprises the following:

- Troubleshooting Call Processing Failure
- Call Management/Mobility Management Failure

7.9.1 Troubleshooting Call Processing Failure

The zone controller is responsible for all registration, individual call, and group call processing in its zone. A failed zone controller results in the loss of system and zone trunking for that particular zone. All call requests, registration requests, and calls in progress are dropped. The zone also drops out of participation in all InterZone calls.

7.9.2 Call Management Failure

The zone controller is responsible for managing sites, enhanced telephone interconnect services, and other equipment in the zone to arrange calls. When the zone is in site trunking, services such as enhanced telephone interconnect and console operations are not available.

7.10 Resolving Call Processing Problems

The zone control is responsible for managing call processing in the zone. This process includes registration, individual calls, and group calls. If there are problems with call processing in the zone, you can troubleshoot the following components in the Generic Applications Server VMS for problems:

- Verify that the most current Subscriber Access Control (SAC) and infrastructure database records have been downloaded. You can verify this by viewing the Out of Sync flag in the UNC. To send the complete set of subscriber information, perform a forced initialization from the UNC to the zone controller.
- If there are continual problems accessing a particular type of service or feature, check the Provisioning Manager records and profiles for radio settings, talkgroup settings, fleetmapping, system settings, encryption keys, and so on. Also verify that zone-level settings (such as timeouts) in the UNC are configured appropriately.
- Check the loading of call traffic and InterZone channel utilization through the Historical Reports application. Reconfiguring Provisioning Manager and UNC settings adjust loading as necessary.
- Verify that timeouts and other subscriber settings are configured appropriately in the radios.
- Troubleshoot the zone controller host CPU card – The CPU card processes all the activities in the zone and generates grant, busy, or reject messages to the subscribers. The CPU card actively manages all the registration resources, call management activities in the zone and mobility management for talkgroups that are mapped to the zone. Use the Terminal Server, Unified Event Manager, and the UNC to evaluate the CPU card status.
- Troubleshoot the zone controller host Ethernet ports – The Ethernet ports send command messages and retrieves feedback from all sites in the zone. The Ethernet ports also communicate and send call processing command messages to other zones over the InterZone link. Use the Terminal Server, Unified Event Manager, and the UNC to evaluate the Ethernet ports status.

7.10.1 Loss of Packets Control Channels and Transport Network From the Prime Site

The Transport Network Subsystem for an IP /simulcast subsystem is constructed on the ability that no single network element failure or recovery can interrupt the flow of packets control data between the prime site and more than half of the subsystems subsites for more than 1 second.

If a loss of control data between the prime site occurs, and one or more of the subsystems subsites is lost for more than approximately 1 second, the subsites effected are no longer an active control channel for the subscriber units to use. Each subscriber unit that cannot find a valid control channel within the simulcast subsystem scatters to other sites/subsystems within the zone. This scattering of subscriber units all a once can be disruptive to the overall system. As long as half of the subsites are always operational, most of the subscriber units are expected to receive an RF signal strong enough to remain on the simulcast site subsystem.

For IP simulcast subsystems with 16 to 32 subsite capacity and geographically redundant prime sites with 1 to 32 subsite capacity, the Transport Network requires longer than 1 second to recover following a failure. To compensate for the subscriber unit scatter, the subscriber units are required to remain on the simulcast site subsystem for a longer duration following a control channel loss. A message is used to instruct the subscriber units to remain on the simulcast site subsystem for 10 seconds following the loss of a control channel. The subsite base radio automatically transmits this message upon loss of packets from the prime site.

7.10.2

Loss of Service Within a Zone

Within a zone, three standard types of service states are available for sites that affect call processing:

- Wide Area Trunking
- Site Trunking
- Site Failsoft

NOTICE: On some specially configured simulcast subsystems the use of Local Failsoft may be available. See Local Failsoft section for more information.

Table 13: Zone Call Service States

State	Definition
Wide Area Trunking	Wide area trunking is the normal state for a simulcast subsystem within a zone. In this state, the simulcast subsystem receives call processing instructions from the zone controller. A radio registered at the simulcast subsystem can communicate with any other radio in the system. The basic criteria for wide area trunking include an active RF site control path between zone controller and simulcast subsystem, an enabled audio gateway router in the zone, a control channel, and a voice channel at a simulcast subsystem.
Site Trunking	In a simulcast subsystem, the simulcast subsystem prime site controller performs the same function as the site controller in a repeater site. Communication to the console and enhanced telephone interconnect is lost when the system is in the site trunking mode. Site trunking mode is entered when the prime site loses communication with the zone controller. In this mode, the prime site takes over call processing responsibility. A radio registered at the simulcast subsystem can communicate only with other radios registered at the same site.
Site Failsoft	Losing all site controllers or losing all the control channels at a simulcast subsystem forces the simulcast subsystem into Failsoft mode. Basically, there is no trunking functionality. In this mode, and if configured with Failsoft capability, the individual channel become active (bring up their carrier) continuously. Individual radios can communicate in a conventional manner on fixed channels. The radios receive a data word from their repeater that instructs them to generate a tone at fixed intervals to indicate to the users that the simulcast subsystem is in Failsoft mode. Communication to the enhanced telephone interconnect is lost when in the failsoft mode. Depending on the design of the system

State	Definition
	some or all communication with consoles will also be lost when in failsoft mode.

7.10.3

Loss Of Site Routers/Gateways

The following describes the effects of a prime site router failure:

- Single Router Configuration – Failure of a single prime site router (in the single router configuration) causes failure of both ZC-RF SCPs and in turn forces the simulcast subsystem into Site Trunking mode. All existing calls being supported are transmission trunked and terminated during the switchover of call processing from the Zone Controller to one of the Simulcast Site Controllers.
- Dual Router Configuration – Failure of a single prime site router (in the dual router configuration), or one of the physical links to the master site is dropped, a site that was in Wide Area mode remains in Wide Area mode.

7.10.4

Loss of Subsite Access Routers

The following describes the effects of subsite access router failure:

- Subsite Access Router 1 Fails – When Subsite Access Router 1 fails, Subsite Access Router 2 switches the CWR patch panel to assume control of the WAN links of single-linked subsites that are connected to Subsite Access Router 1. An audio hole may be incurred on active calls in the subsystem. For dual-linked subsites, any IP traffic which was being routed through Subsite Access Router 1 is automatically re-routed onto the backup subsite WAN link and the associated subsite access router. An audio hole may be incurred on active calls in the subsystem.
- Subsite Access Router 2 Fails – When Subsite Access Router 2 fails while Subsite Access Router 1 is the active router in the CWR pair, there is no effect on single-linked subsites since all subsites' IP traffic is being routed through Subsite Access Router 1. For dual-linked subsites, any IP traffic which was being routed through Subsite Access Router 2 is automatically re-routed onto the backup subsite WAN link and its associated subsite access router. An audio hole may be incurred, but it is typically smaller than the audio hole incurred for single-linked subsites.
- Subsite Access Routers 1 and 2 Fail – When Subsite Access Routers 1 and 2 both fail, the prime site disconnects from the subsites and there is no communication.

7.10.5

Loss of Simulcast Channel Resources

The following provides a description of how simulcast channel resources are managed. This process of determining which simulcast subsystem channels are in service and which channels are out of service is called resource voting. The resource voting process is necessary as the loss of simulcast channel resources within a given remote site/subsite reduces the number channels available for use across the simulcast subsystem.

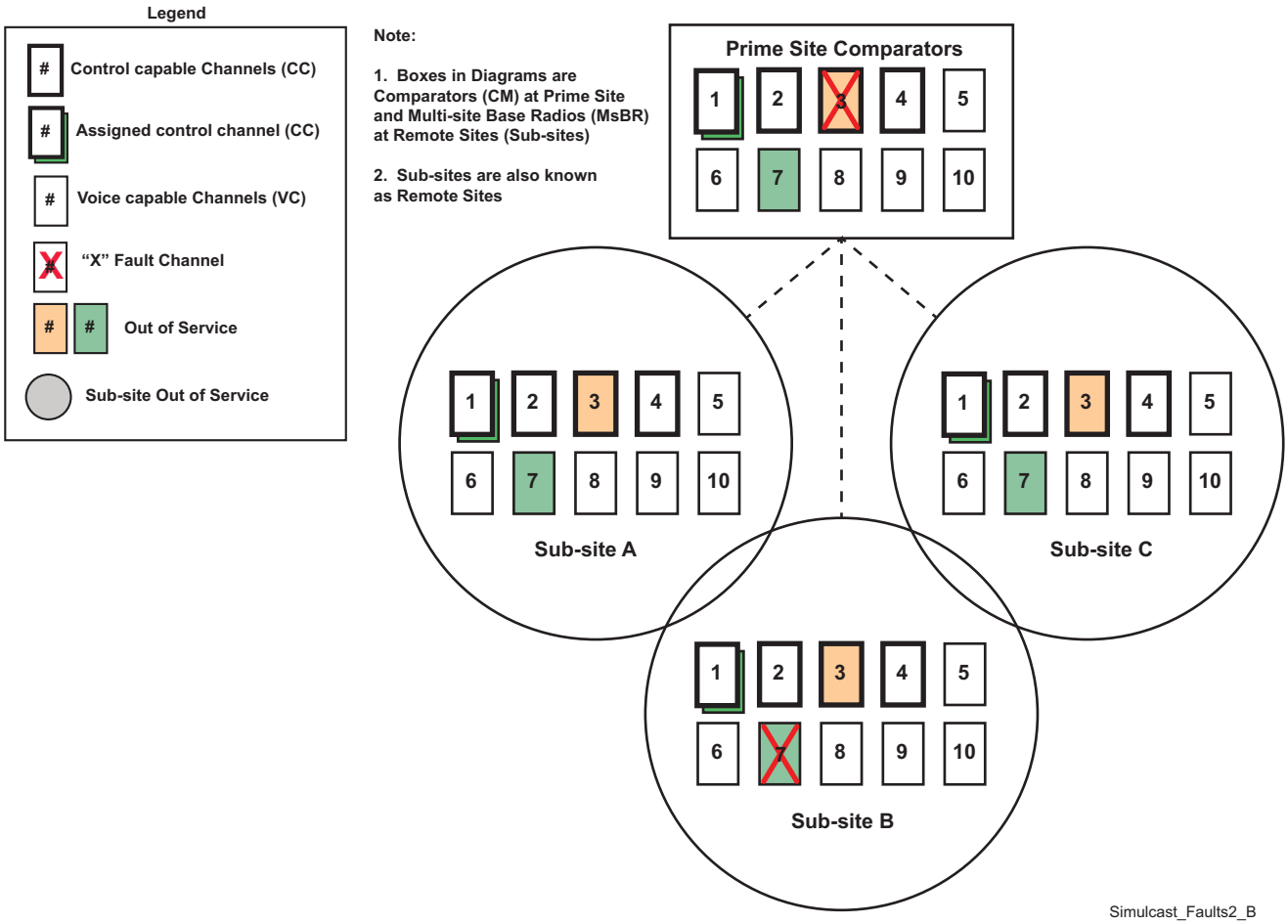
NOTICE: The resource voting rules are the same regardless of whether the subsystem is FDMA-only, FDMA/TDMA, or TDMA only capable.

A Comparator and Remote Site Channel Malfunction

If a comparator fails, its channel is removed from service. If a remote site channel fails, the channel is removed from service throughout the simulcast subsystem. The following diagram represents the malfunctions:

- A comparator malfunction on channel 3.
- A remote site channel malfunction on channel 7 at remote site B.

Figure 25: Comparator and Remote Site Channel Malfunction



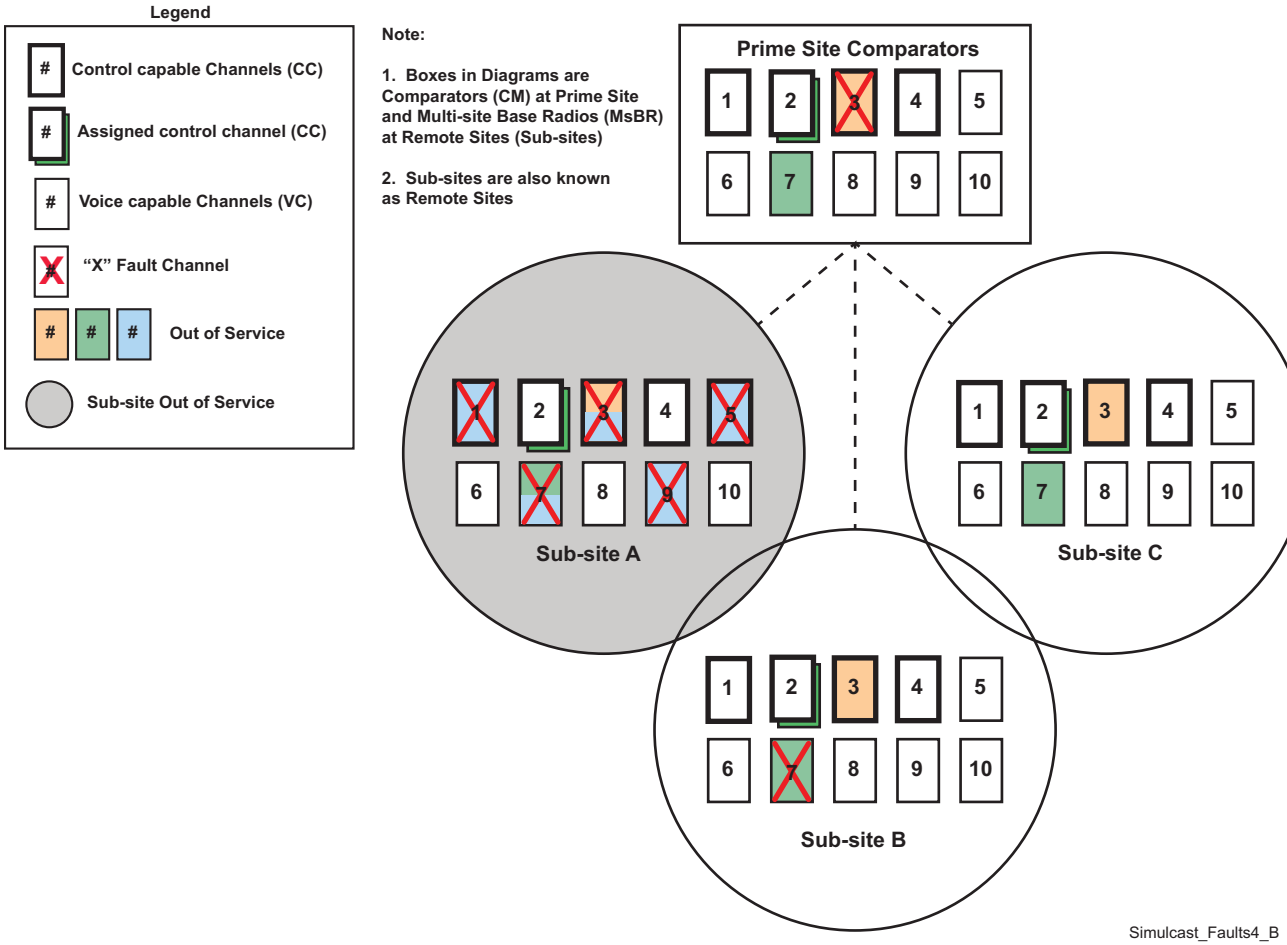
Both channel 3 and channel 7 are out of service for the entire simulcast subsystem because of these malfunctions.

Remote Site A Failed State – Availability Number Trigger

The following diagram represents a failed state:

- The transmitter combiner serving the odd channels of remote site A is in the malfunctioned state. Remote site A is in the failed state since five of its 10 channels are in the malfunctioned state and the remote site availability number is 50.
- Channel 3 is still out of service because of the comparator failure, and channel 7 is still out of service due to the channel failure at remote site B.
- Channels 1, 5, and 9 are in the impaired state. Since the transmitter combiner is causing the channel failures, the impaired channels at remote site A operate normally for the receive side of the channel, but no transmissions originate from remote site A for the impaired channels.

Figure 26: Remote Site A Failed State – Availability Number Trigger



NOTICE: The control channel assignment moved to channel 2. The Simulcast Site Controller differentiates between enabled and impaired channels, and moves the control channel assignment to the most capable channel.

The simulcast subsystem's resource voting algorithms provide availability robustness. Having multiple remote sites becomes an asset instead of a liability since the remote sites can be removed from the resource voting pool when they are experiencing significant difficulties. The simulcast subsystem degrades gracefully to provide a continuum of available services.

7.10.6
Ethernet Switch Restoration

When restoring a switch, either replacing a failed switch or during an upgrade, there is a small risk of not maintaining wide area trunking for a brief period. This could cause subscriber radios over a wide region to scatter to adjacent sites depending on the radio and system configuration. For this reason, the switch should only be restored during a scheduled maintenance window.

7.10.7
Loss of Expansion Hubs

Expansion Hubs (XHubs) expand the number of transceivers at a subsite to grow with the needs of a customer. Each Expansion Hub supports six transceivers.

NOTICE: If the system is using Expansion Hubs (XHubs) for expansion at a dual LAN remote subsite, two XHubs per Expandable Site Subsystem (ESS) are utilized to provide dual LAN operation to the MsBRs. If an XHub fails, the Multi-Site Base Radios detect the failure and automatically switch to the alternate LAN provided by the other XHub.

Failure of an XHub is detected by the system in the following ways:

- Multi-Site Base Radio – If an XHub fails, the GTR 8000 Base Radio reports a minor secondary control channel broadcast reference alarm. The failure is also shown at the Unified Event Manager as a single report on the base radio.
- Reference Distribution Module (RDM) – Two RDMs reside in the primary ESS for dual LAN remote subsites. These modules are utilized to fault manage the XHubs that reside in the other ESS racks. The RDM reports XHub related failures to the Unified Event Manager and any other registered fault managers.

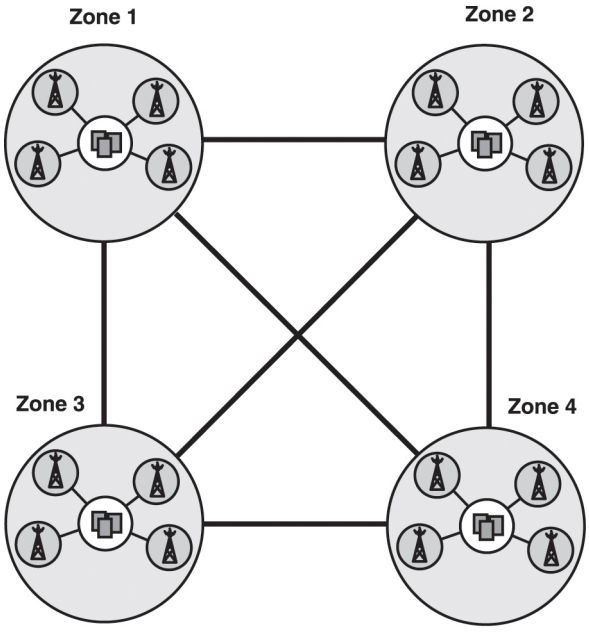
7.10.8
Loss of Service Between Zones

Loss of service between zones is a more complex situation since a zone may be functional overall, but may lose contact with one or more of the other zones.

InterZone trunking is a state between any pair of zones in a system. In a four-zone system, see Figure 27: Zone-to-Zone Service on page 141, there are six pairs of relationships between the zones in the system:

- Zone 1 to Zone 2
- Zone 1 to Zone 3
- Zone 1 to Zone 4
- Zone 2 to Zone 3
- Zone 2 to Zone 4
- Zone 3 to Zone 4

Figure 27: Zone-to-Zone Service



7.10.9
Resolving InterZone Communications Problems

The zone controller coordinates services with zone controller units in other zones. The zone controller shares command messages, mobility information, and coordinates audio calls with the other zones through the InterZone control path.

- Check the zone call processing status for each affected zone controller. Verify that all the zones are capable of InterZone trunking.
- Check the network configuration for each affected zone controller. Verify that the zone controller is given the appropriate zone number. If the zone controller is configured with the incorrect zone number, then all the IP addresses for that zone controller are incorrect.
- Check the InterZone channel loading through the Historical Reports application. Adjust the InterZone traffic by adjusting the home zone mapping for talkgroups or subscriber radios as necessary.
- The zone controller sends and receives InterZone control information through the Cooperative WAN Routing, LAN switch, exit router, and gateway router. Verify proper operation of the devices along these traffic paths.
- The CPU is responsible for managing all multizone operations that involve its zone. It also sends audio control routing command messages to the Telephone Interconnect Device (TID) and other devices in the zone as required.

7.10.10
Resolving 32 Subsite Capacity IP Simulcast Subsystem Interference

The larger number of subsites supported provides a greater likelihood of interference or the interfaces used within the subsystem where a specific range for the subsites are defined. Any interfaces that support messages originating from or destined for the subsites need troubleshooting to determine whether changes are required to enable support for up to 32 subsite capacity systems.

Table 14: Software Tools for Troubleshooting 32 Subsite Capacity Support

You can use this tool	To Diagnose
Configuration/Service Software (CSS)	• GCP 8000 Site Controller • GCM 8000 Comparator • GTR 8000 Base Radio
Unified Event Manager	• Subsite Links • GCP 8000 Site Controller • GCM 8000 Comparator • GTR 8000 Base Radio • Channel Banks • Remote Site Access Router or Gateway
MOSCAD Network Fault Management	• GTR 8000 Base Radio • GCP 8000 Site Controller • GCM 8000 Comparator • Microwave Links

Table continued…

You can use this tool	To Diagnose
Unified Network Configurator (UNC)	• GCP 8000 Site Controller • GCM 8000 Comparator • GTR 8000 Base Radio • GBP 8000 Reference Distribution Module • Remote Site Access Router or Gateway • Subsystem • Channels • Remote Site
Traffic Monitoring Device	Ethernet LAN Switches (HP 3500)
ATR License Keys	

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Chapter 8

ASTRO 25 Trunked IP Simulcast Subsystem Maintenance

This chapter describes periodic maintenance procedures and restoration best practices relating to the IP simulcast subsystem.

8.1 Restoration Best Practices

When restoring a device as a result of a software upgrade or device failure, there is some level of risk in maintaining wide area trunking operation. It is generally a best practice to perform this type of maintenance during a scheduled maintenance window.

For example, when restoring a prime site switch (for example: replacing failed switch or during upgrade), there is a small risk of losing wide area trunking for a brief period. This could cause subscriber radios over a wide region to “scatter” to adjacent sites depending on the radio and system configuration. By restoring the switch during your organization agreed upon scheduled maintenance window, the number of subscribers impacted can be minimized.

8.2 Fan Grill Cleaning

NOTICE: If the station equipment is installed in a dusty environment, precautions must be taken to filter the air used for forced cooling of the station. Excessive dust drawn across and into the station circuit modules by the cooling fans adversely affects the heat dissipation and circuit operation. In such installation, ensure to clean or replace external filtering devices periodically.

If dust has accumulated on the fan grills, cleaning of the fan grills is recommended. When cleaning, ensure to prevent dust from being pulled into the modules. It is recommended that a damp cloth be used to wipe the front of the fan grills. When removing the power supply, make sure that the unit is turned off before proceeding.

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