SYSTEM RELEASE 5.2.2
INTELLIGENT MIDDLEWARE
ASTRO ® 25
OUTDOOR LOCATION SOLUTION

Feature Manual

SEPTEMBER 2018

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Document History

Version	Description	Date
MN003211A01-A	Original release of the ASTRO® 25 Outdoor Location Solution *Feature Manual* for IMW 5.2.	September 2016
MN003211A01-B	Minor updates in the "Location on Push To Talk - APX" section.	November 2016
MN003211A01-C	New section: Location on Receive – APX on page 77	September 2018

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About Outdoor Location Solution Feature Manual

The ASTRO® 25 Outdoor Location Solution is a resource tracking solution that uses Global Positioning System (GPS) satellites to provide operators with the ability to locate and track vehicles and personnel that operate outdoors.

What Is Covered In This Manual?

- Outdoor Location Solution – Overview on page 16 – provides an overview of the ASTRO® 25 Outdoor Location Solution for the ASTRO® 25 Trunking Integrated Voice & Data (IV&D), ASTRO® 25 Conventional IV&D, and ASTRO® 25 High Performance Data (HPD) systems.
- Outdoor Location Solution – Components on page 27 – describes the various components involved in the ASTRO® 25 Outdoor Location Solution that is offered on the ASTRO® 25 Trunking IV&D, ASTRO® 25 Conventional IV&D, and ASTRO® 25 HPD systems.
- Services Offered by the Outdoor Location Solution on page 44 – describes the services offered by the Location Service to the radio user and to the location application.
- Outdoor Location Solution – Operations Related to the XTS Portable Radios on page 52 – describes the operation of the XTS 5000 and XTS 2500 radios as part of the ASTRO® 25 Outdoor Location Solution including their Location and Presence Services.
- Outdoor Location Solution – Operations Related to the APX Series of Mobiles and Portables on page 65 – describes the operation of the APX radios as part of the ASTRO® 25 Outdoor Location Solution including their Location and Presence Services.
- Outdoor Location Solution – Operations Related to Mobile Radios with an External GPS Unit on page 83 – describes the operations related to mobile radios and one of the GPS units supported as part of the ASTRO® 25 Outdoor Location Solution.
- Outdoor Location Solution – Operations Related to the HPD 1000 Data Modem on page 102 – describes the operations related to the HPD 1000 Data Modem with integrated GPS as part of the ASTRO® 25 Outdoor Location Solution.
- Location Interface for Applications on page 115 – describes the protocol used for requesting location, setting digital outputs, reading digital inputs, and getting location updates.
- Outdoor Location Solution – Equipment Requirements on page 119 – describes the equipment required to enable the ASTRO® 25 Outdoor Location Solution on an ASTRO® 25 Trunking IV&D, ASTRO® 25 Conventional IV&D, and ASTRO® 25 HPD systems.
- Outdoor Location Solution – Maintenance and Troubleshooting on page 135 – provides maintenance and troubleshooting information for the ASTRO® 25 Outdoor Location Solution.

Helpful Background Information

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

Related Information

The following table lists related Motorola product documentation.

Documentation	Purpose
IMW Installation and Configuration webhelp	Explains how to install, configure, administer, and troubleshoot the Intelligent Middleware (IMW) system.
IMW Administrative Operation webhelp	Provides operation procedures for Intelligent Middleware (IMW). The list of procedures is designed to be used on demand, depending on your current needs and system requirements.
ASTRO® 25 Outdoor Location Solution *Device Installation and Configuration Guide*	Explains how to install and configure the ASTRO® 25 Outdoor Location Solution for ASTRO® 25 Integrated Voice and Data (IV&D), ASTRO® 25 Conventional IV&D, and ASTRO® 25 High Performance Data (HPD) systems including radio and GPS device configuration.
ASTRO® 25 Outdoor Location Solution *Location HPD Mobile Data Terminal SDK*	Explains how to use the Motorola Location HPD Mobile Data Terminal SDK to interface with an in-vehicle mapping application with the GPS from the HPD 1000 Data Modem.
ASTRO® 25 Outdoor Location Solution *Location Proxy User Guide*	Explains how to install and configure the ASTRO® 25 Location Proxy. The ASTRO® 25 Location Proxy is a component of the ASTRO® 25 Outdoor Location Solution. It is installed and runs on a Mobile Data Terminal (MDT), enabling communication between a GPS device that is connected to the MDT and the Location Service in the Customer Enterprise Network (CEN) over the ASTRO® 25 network.
Intelligent Middleware *Feature Manual*	Describes the Intelligent Middlewareplatform including an overview of the functions and capabilities, technical details of the implementation, and design considerations.
“High Performance Data” section of the ASTRO® 25 *Integrated Voice & Data (IV&D) System Planner*	Provides information about the High Performance Data (HPD) release introduced with ASTRO® 25 Trunked system release 6.7/7.0. See the HPD section of the appropriate System Planner for your system.

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Chapter 1

Outdoor Location Solution – Overview

This chapter provides an overview of the ASTRO® 25 Outdoor Location Solution and Intelligent Middleware Platform for the ASTRO® 25 Conventional or Trunking Integrated Voice and Data (IV&D) systems (including Enhanced Data), and for the ASTRO® 25 High Performance Data (HPD) system.

1.1 ASTRO 25 Outdoor Location Solution Supported Configurations

The ASTRO® 25 Outdoor Location Solution provides location data for both persons (using portables) and vehicles (using mobiles) over both the ASTRO® 25 Trunking or Conventional IV&D systems using VHF band, UHF range 1, UHF range 2, 800 MHz, and 700 MHz and over the HPD System.

Figure 1: ASTRO 25 Outdoor Location Solution Supported Configurations

The following figure shows the combination of radio, radio system, GPS receiver and available features.

			GPS Receiver	Transport System						Feature							
				ASTRO IV&D			HPD	Middleware/ VPN Solutions	MDT with the ASTRO25 Location Proxy **	LocalDisplay	Digital I/O	Emergency	Presence	Store & Forward	Location MDT SDK	Location on PTT	Location on Receive
				Conventional	Trunking	Enhanced Data											
Portables	XTS 5000	I	GPS RSM 1.0 or GPS RSM 2.0 (with or w/o ear-jack)	✓	✓	-	-	-	-	-	-	✓	✓	-	-	-	-
		II		✓	✓	-	-	-	-	✓	-	✓	✓	-	-	-	-
		III		✓	✓	-	-	-	-	✓	-	✓	✓	-	-	-	-
	XTS 2500	I		✓	✓	-	-	-	-	-	-	✓	✓	-	-	-	-
		II		✓	✓	-	-	-	-	✓	-	✓	✓	-	-	-	-
		III		✓	✓	-	-	-	-	✓	-	✓	✓	-	-	-	-
	APX series		Built-in	✓	✓	✓	-	-	-	✓	-		✓	-	-	✓	✓
Mobiles	APX series		Built-in	✓	✓	✓	-	-	-	✓	-	✓	✓	-	-	✓	✓
	APX series		Cellocator Olympic for ASTRO	✓	✓	✓	-	-	✓	-	✓*	✓	✓	✓*	-	✓	✓
	XTL 5000		Cellocator Olympic for ASTRO **or** Trimble Placer Gold APU **or** Trimble Placer Gold DRU Plus	✓	✓	-	-	-	✓	-	✓*	-	✓	✓*	-	-	-
	XTL 2500			✓	✓	-	-	-	✓	-	✓*	-	✓	✓*	-	-	-
	XTL 1500			✓	✓	-	-	-	✓	-	✓*	-	✓	✓*	-	-	-
	ASTRO Spectra Plus			✓	✓	-	-	-	✓	-	✓*	-	-	✓*	-	-	-
	HPD 1000		Built-in	-	-	-	✓	✓	✓	-	-	-	-	-	✓	-	-
	HPD 1000		Cellocator Olympic for ASTRO	-	-	-	✓	✓***	✓	-	✓*	-	-	✓*	-	-	-

IMPORTANT:

- (*) Digital I/O and Store and Forward capabilities are only available with the Cellocator Olympic for ASTRO.
- (**) The MDT with ASTRO® 25 Location Proxy configurations are needed for enabling an external GPS device including the Cellocator Olympic for ASTRO or Trimble GPS units connected to a Mobile Data Terminal that is in turn connected to an ASTRO® 25 mobile radio. For details, see the Outdoor Location Solution – Operations Related to Mobile Radios with an External GPS Unit on page 83 and the ASTRO® 25 Outdoor Location Solution *Location Proxy User Guide*.
- (***) Not system tested as part of the ASTRO® 25 Outdoor Location Solution release.

1.2
ASTRO 25 Outdoor Location Solution Description

The ASTRO® 25 Outdoor Location Solution is as a resource-tracking solution using Global Positioning System (GPS) satellites to enable operators to locate and track outdoor personnel and vehicles.

The solution uses the ASTRO® 25 system to transport location, presence, and telemetry data over the air to the Location Service. The IMW server routes the data to third-party mapping applications through the IMW Location Application Programming Interfaces (APIs), including the LRRP API, IMW REST & WebSocket APIs, and the 3GPP Parlay X Web services-based API.

The ASTRO® 25 Outdoor Location Solution includes the following components:

ASTRO® 25 Data Network

One or more of the following: ASTRO® 25 Conventional IV&D system, ASTRO® 25 Trunking with IV&D (with the Enhanced Data feature), ASTRO® 25 High Performance Data (HPD).
For location reporting, the use of the Integrated Voice and Data (IV&D) Enhanced Data is preferred when possible, due to the higher capacity it provides. Enhanced Data is only supported on ASTRO® 25 Trunked IV&D systems with GTR series site equipment and APX subscriber units.

Data Enabled ASTRO® 25 Portable Radios

One or more of the following - the APX portable radio with an internal GPS module, the XTS 5000/XTS 2500 portable radio connected to the GPS-enabled Remote Speaker Microphone (RSM). The ASTRO® 25 Outdoor Location Solution with UNS 5.0 supports versions 1.0 and 2.0 of the GPS RSM.

Data Enabled ASTRO® 25 Mobile Radios

The APX mobile radio with an internal GPS module or connected directly to the Cellocator Olympic for ASTRO GPS and Telemetry unit and the XTL 5000, XTL 2500, XTL 1500, or ASTRO® Spectra Plus™ radios connected directly to an external GPS unit. One of the following three GPS units may be used for the XTL and ASTRO® Spectra Plus™ radios: the Cellocator Olympic for ASTRO GPS and Telemetry unit, the Trimble Placer™ Gold APU, or the Trimble Placer™ Gold Dead Reckoning Unit (DRU) Plus.
Alternatively, the Trimble or Cellocator GPS units may be connected to a Mobile Data Terminal (MDT) that is connected to an ASTRO® 25 mobile radio. In this alternative configuration, the ASTRO® 25 Location Proxy must be installed and running on the MDT.

High Performance Data HPD 1000 Data Modem

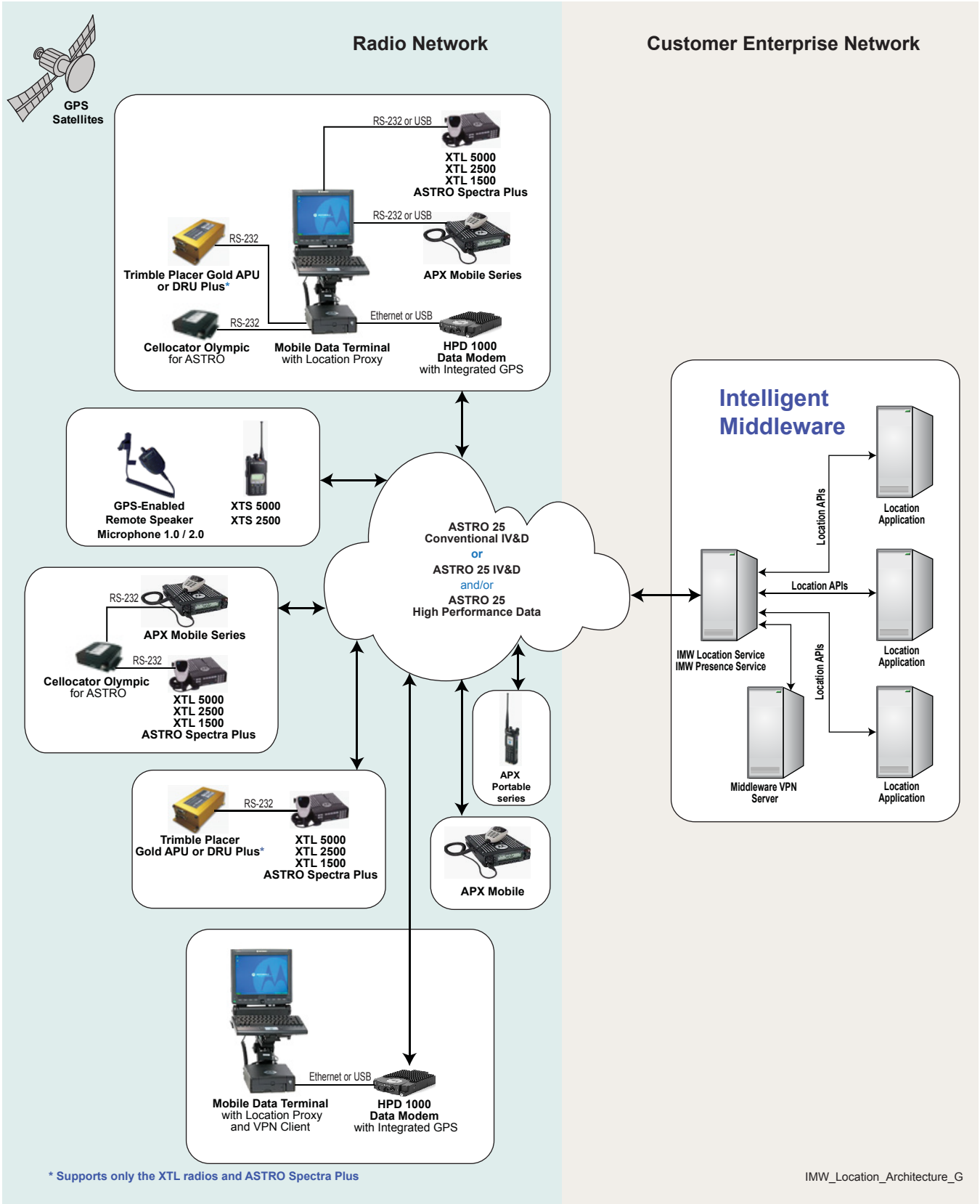
The HPD 1000 Data Modem with an integrated GPS module connected to a Mobile Data Terminal (MDT). Alternatively, the Cellocator Olympic for ASTRO GPS and Telemetry unit may be connected to an MDT that is connected to the HPD 1000 Data Modem to enable advanced capabilities such as telemetry.
Supported MDTs include the Motorola MW series of Mobile Workstation.

The ASTRO® 25 Outdoor Location Solution and IMW platform allow the radio user and third-party applications to determine the current location of portable or mobile radios. Location, telemetry, and presence (alone or combined with other information about the environment) enable powerful applications, which can be of great benefit.

1.3
ASTRO 25 Outdoor Location Solution High-Level View

The following figure shows a high-level view of the ASTRO® 25 Outdoor Location Solution.

Figure 2: ASTRO® 25 Outdoor Location Solution – High-Level View



NOTICE: When deploying the ASTRO® 25 Outdoor Location Solution, the IMW server contains both the presence and location services. These services are always deployed on the same physical server.

The Trimble Placer™ Gold and Cellocator Olympic for ASTRO GPS units can also be connected to a Mobile Data Terminal (MDT) that is connected to an ASTRO® 25 mobile radio listed below. In this configuration, the ASTRO® 25 Location Proxy must be installed and running on the MDT. The radios are:

- Trimble units- XTL or ASTRO® Spectra Plus™ mobile IV&D radios
- Cellocator units- APX, XTL, or ASTRO® Spectra Plus™ mobile IV&D radios or the HPD 1000 Data Modem.

1.4 Redundancy in ASTRO 25 Systems

Redundancy in ASTRO® 25 Systems deployments is based on the Active/Standby mode, with each IMW server residing in a separate CEN (Customer Enterprise Network). In this mode, only one of the two IMW server units is in an Active state and processing traffic. The Standby server becomes Active only when the Active server becomes unavailable. Presence Service and Location Service data is sent only to the Active IMW. The Active IMW pushes the Presence Service data to the Standby IMW periodically to keep the IMW pair synchronized.

Configuring an ASTRO® 25 Systems deployment with the IMW Redundancy feature requires that the two CENs the IMW is installed into share the network and L2 sub-network (the same IP addresses are valid in both CENs). This configuration is the same as other ASTRO® 25 L2 sub-network sharing in the ASTRO® 25 Core:

- Each IMW server is assigned a unique IP address to support inter-server synchronization
- A unique IMW Customer IP address is assigned to the Active IMW and configured in the ASTRO® 25 Systems Radios to enable the ASTRO® 25 Systems Radios to report their presence status to the Active IMW. After failover of the IMW pair the IMW Customer IP address is present on the new Active IMW Network Interface so that the ASTRO® 25 System Radios may still communicate with the IMW.

For additional information on configuring IMW Customer IP Address, see the “Configuring Redundant Server Settings for ASTRO 25 Systems” section in the Intelligent Middleware *Configuration Manager User Guide*.

1.5 ASTRO 25 Outdoor Location Solution Components

ASTRO® 25 Outdoor Location Solution consists of the following components:

- ASTRO® 25 Data Network
- Data Enabled ASTRO® 25 Radios
- GPS Devices
- Location Service
- ASTRO® 25 LRRP Application Programming Interface (API) and 3GPP Parlay X API
- Presence Service
- ASTRO® 25 Location HPD Mobile Data Terminal SDK
- ASTRO® 25 Location Proxy
- Middleware VPN Solutions

NOTICE: The ASTRO® 25 Outdoor Location Solution is intended for use only in outdoor locations and not in buildings or structures. In certain situations, due to the limitations of the GPS technology, a user can be outside and will not have GPS coverage. This is due to the limitation of the GPS technology itself. For example, GPS does not work well in buildings, tunnels, parking garages, and heavy tree coverage. The system provides the outdoor location of the following:

- All personnel carrying a GPS-enabled portable radio including the APX 7000 portable radio with an internal GPS module or an XTS portable equipped with a GPS RSM.
- An ASTRO® 25 mobile radio with an internal GPS module or connected to an external GPS device in an open sky (clear view of the sky with no obstructions) environment. For supported radios and external GPS devices, see the matrix in ASTRO 25 Outdoor Location Solution Supported Configurations on page 16.

1.5.1
ASTRO 25 Data Network

The ASTRO® 25 data networks include one of the following:

ASTRO® 25 Integrated Voice and Data (IV&D) System
The ASTRO® 25 Outdoor Location Solution is supported on the ASTRO® 25 IV&D system and uses the data pipeline (9.6 Kbps) for transferring location and telemetry data over-the-air interface. The solution is offered on the ASTRO® 25 Conventional 3.1 System with IV&D and/or the ASTRO® 25 Trunking IV&D System.

ASTRO® 25 Integrated Voice and Data (IV&D) System with Enhanced Data
Enhanced Data is supported on ASTRO® 25 Trunked IV&D systems with GTR series site equipment and APX subscriber units. For location reporting, the use of the Integrated Voice and Data (IV&D) Enhanced Data is preferred when possible due to the higher capacity it provides. The raw data rate for transferring location and telemetry data using Enhanced Data is 12 Kbps. However, thanks to the implementation of a reserved inbound channel which eliminates the collisions that exist on IV&D channels, the location throughput is improved ten times.

ASTRO® 25 High Performance Data (HPD) Network
The ASTRO® 25 Outdoor Location Solution is also supported on the HPD network using GPS coordinates from the HPD 1000 Data Modem or from an external GPS device. The solution uses the HPD pipeline (up to 96 Kbps) for transferring location and telemetry data over the air interface.

1.5.2
Data-Enabled ASTRO 25 Radios

The data-enabled ASTRO® 25 radios include the following:

ASTRO® 25 Portable Radios
The APX series of portable radios and the XTS 5000/XTS 2500 two-way portable radios act as both voice and data communications devices. These radios (when XTS radios are enabled with the GPS remote speaker microphone or when APX radios include an internal GPS module) are a virtual source of the GPS location information. The ASTRO® 25 portable radios use the Motorola Location Request/Response Protocol (LRRP) over User Datagram Protocol/Internet Protocol (UDP/IP) to communicate with the Location Service over-the-air interface on ASTRO® 25 Integrated Voice and Data (IV&D) system or ASTRO® 25 Conventional IV&D system. In ASTRO® 25 IV&D Trunking systems, APX devices can be used with the Enhanced Data feature.

ASTRO® 25 Mobile Radios
The APX and XTL families of mobile radios (XTL 5000, XTL 2500, and XTL 1500, and ASTRO® Spectra Plus™ radio) act as both voice and data communications devices. GPS is enabled on the APX radios with an internal GPS module or with the Cellocator Olympic for ASTRO GPS and Telemetry unit and on the XTL and ASTRO® Spectra Plus™ radios using an external GPS device

including the Cellocator Olympic for ASTRO GPS and Telemetry unit, Trimble Placer™ Gold APU and Trimble Placer™ Gold Dead Reckoning Unit (DRU) Plus. The external GPS devices used as part of the ASTRO® 25 Outdoor Location Solution use the ASTRO® 25 mobile radios to communicate with theLocation Service over-the-air interface on the ASTRO® 25 IV&D system. The APX internal GPS module uses the Motorola LRRP over UDP/IP to communicate with the Location Service over-the-air interface on the ASTRO® 25 IV&D system. In ASTRO® 25 IV&D Trunking systems, APX devices can be used with the Enhanced Data feature.

ASTRO® 25 High Performance Data (HPD) 1000 Data Modem

The HPD 1000 Data Modem is a mobile radio used with the ASTRO® 25 HPD network and includes an optional internal GPS module. The HPD 1000 Data Modem can operate standalone or connected to an MDT (such as the Motorola MW series of Mobile Workstation). When connected to an MDT, the location data from the HPD 1000 Data Modem can be sent on the over-the-air interface in an encrypted and compressed manner using a middleware VPN solution and the ASTRO® 25 Location Proxy. The HPD 1000 Data Modem with an internal GPS module uses the Motorola LRRP over UDP/IP to communicate with the Location Service over the air interface on the ASTRO® 25 HPD system. Alternatively, the Cellocator Olympic for ASTRO GPS and Telemetry unit can be connected to an MDT running the ASTRO® 25 Location Proxy that is, in turn, connected to the HPD 1000 Data Modem. In this configuration, the Cellocator Olympic for ASTRO uses the HPD 1000 Data Modem to communicate with the Location Service over-the-air interface on the ASTRO® 25 HPD system.

1.5.2.1

ASTRO Portable Radio Features and Services

The following table shows the supported features and services for the APX and XTS portable radios:

Table 1: Portable Radio Features and Services

Portable Radios	XTS 5000			XTS 2500			APX 7000		
	Model I	Model II	Model III	Model I	Model 1.5	Model II	Model III	Top Display	Dual Display
Radio User Features									
Position Updates to Radio User A portable radio user can initiate a position directly from the radio menu and display their current position	N/A	✓	✓	N/A	N/A	✓	✓	✓	✓
Location request Upon Radio Power On Upon power-on, the radio user's position information is delivered to a location application in the dispatch center, if requested.	✓	✓	✓	✓	✓	✓	✓	✓	✓
Emergency Alarm Location Request When the radio user equipped with a GPS RSM or built in GPS module pushes the	✓	✓	✓	✓	✓	✓	✓	✓	✓

Portable Radios	XTS 5000			XTS 2500			APX 7000		
	Model I	Model II	Model III	Model I	Model 1.5	Model II	Model III	Top Display	Dual Display
emergency alarm button either on the radio or on the GPS RSM, the system automatically sends the radio users location information along with the radio ID or alias									
Emergency Push-to-Talk (PTT) with GPS Location When a radio user equipped with a GPS RSM or built in GPS module presses the emergency push-to-talk (PTT) either on the radio or on the GPS RSM, the system automatically sends the radio users location information along with the radio ID or alias immediately to the operator.	✓	✓	✓	✓	✓	✓	✓	✓	✓
Services Provided to a Radio User									
Location Service On / Off Control	N/A	✓	✓	N/A	✓	✓	✓	✓	✓
Location Status Indication	N/A	✓	✓	N/A	✓	✓	✓	✓	✓
Location Display	N/A	✓	✓	N/A	✓	✓	✓	✓	✓

1.5.3 GPS Devices

The ASTRO® 25 Outdoor Location Solution supports the following GPS devices:

GPS Remote Speaker Microphone (RSM)

For the XTS portable radios, the GPS is integrated into the GPS Remote Speaker Microphone (RSM). The RSM communicates location information to the radio, which is displayed to the radio user and is sent to the dispatch operator through the Location Service. It also supports the location on emergency feature.

NOTICE: The ASTRO® 25 Outdoor Location Solution with IMW supports versions 1.0 and 2.0 of the GPS RSM.

Cellocator Olympic for ASTRO GPS and Telemetry Unit

For the XTL and ASTRO® Spectra Plus™ mobile radios, GPS is contained in an external device called the Cellocator Olympic for ASTRO. Supported APX family mobile radio models and the HPD 1000 Data Modem may also use the Cellocator Olympic for ASTRO as the GPS module. The Cellocator Olympic for ASTRO offers a 20 channel built-in GPS receiver, five discrete digital sensor inputs, including ignition on/off plus four variable inputs, an analog sensor input for vehicle battery

measurement, and remote operation of two discrete output sensors. In addition, the Cellocator Olympic for ASTRO generates location-based events and includes a buffering feature allowing it to buffer location reports for sending at a later time if the communication link is down. The Cellocator Olympic for ASTRO communicates to the dispatch center over the air interface by utilizing one of the ASTRO® 25 mobile radios on the ASTRO® 25 Trunking or Conventional IV&D systems or the ASTRO® 25 High Performance Data system. The Cellocator Olympic for ASTRO uses a proprietary binary protocol to report location and telemetry. For combinations of ASTRO® 25 radios and supported GPS devices, see ASTRO 25 Outdoor Location Solution Supported Configurations on page 16.

Trimble Placer™ Gold APU and Placer™ Gold DRU Plus

For the XTL and ASTRO® Spectra Plus™ mobile radios, the GPS is contained in external devices called the Trimble Placer™ Gold APU and/or Placer™ Gold DRU Plus. The Trimble Placer™ Gold APU and/or Placer™ Gold DRU Plus units offer a 12 channel “fast start” built-in GPS receiver. The Trimble units communicate to the dispatch center over the air interface by utilizing one of the ASTRO® 25 mobile radios on the ASTRO® 25 Trunking or Conventional IV&D systems. The Trimble Placer™ Gold units use Trimble protocol to report location. The Placer™ Gold DRU Plus can also be equipped with an optional internal module to provide dead reckoned position data while outside of GPS coverage. This is accomplished by using advanced gyroscopic technology in combination with connections to the vehicle speed sensor and vehicle direction signal (forward or reverse). For combinations of ASTRO® 25 radios and supported GPS devices, see ASTRO 25 Outdoor Location Solution Supported Configurations on page 16.

Internal GPS module

For the APX series of mobiles and portables and the HPD 1000 Data Modem, the GPS is integrated into the radio. The GPS information is sent to the dispatch operator through the Location Service. For supported APX radios, the location on emergency feature is supported and the GPS information is also displayed to the radio user. For details on supported radios, see ASTRO 25 Outdoor Location Solution Supported Configurations on page 16.

1.5.4
Intelligent Middleware Location Service

The Location Service resides on the IMW server within the Customer Enterprise Network (CEN) on a Windows-based server running the Microsoft Windows Server 2012 R2 (64 bit) operating system. The Location Service receives the location information from the GPS devices, which has traveled over the data network. The purpose of the Location Service is to act as a gateway and translate mobile device messages and transfer data to applications. The Location Service has the following functionality:

- Receives the disparate protocols of the GPS devices from Motorola and third-party radios, decompresses them, and translates them out into a unified protocol.
- Provides a single integration point for location, telemetry, and presence information for ASTRO® 25 networks, ASTRO® 25 devices and third-party devices through the IMW Parlay X APIs and the ASTRO® 25 LRRP API.
- Simplifies the integration process for application developers.
- Provides intelligent routing of messages by managing requests to the devices. The Location Service ensures that no messages are sent to absent devices and that multiple requests of the same type are not sent to the same device. By managing requests, the Location Service reduces traffic on the network.
- Manages the reporting of Location on Emergency messages and manages request IDs for LRRP-based devices.
- Ensures idle reporting so that devices are kept in contact with the location application for devices that do not use the Presence Service.

- Enables auto-request location reporting of new devices (APX series of mobiles and portables, XTS series portables, and the HPD 1000 Data Modem only) so that the developer does not have to manually enter that request at the mapping application.

1.5.5
IMW Application Programming Interfaces

The Intelligent Middleware API (including the 3GPP Parlay X API, IMW REST & WebSocket APIs, and the ASTRO® 25 LRRP API) allow a developer to integrate the Motorola solution with multiple mapping applications.

From the IMW server, the APIs provide data messages containing location, presence, and telemetry information in near real time to third-party applications. The IMW APIs provide a common integration point so that the application developer can integrate one time to one point on the ASTRO® 25 system and obtain all data available for the ASTRO® 25 Outdoor Location Solution: location, presence, and telemetry. Because the IMW APIs are backwards compatible, it translates into cost savings over the life of the system. The IMW also allows support for remote commands through a set of messages that can be sent to the GPS units. The ASTRO® 25 Location API uses Motorola LRRP over Transmission Control Protocol/Internet Protocol (TCP/IP) to communicate with third-party mapping applications. The IMW 3GPP Parlay X API and the IMW REST & WebSocket APIs use a Web services interface to communicate with third-party mapping applications.

1.5.6
Intelligent Middleware Presence Service

The Presence Service resides within the CEN cohabiting on the IMW server with the Location Service. The Presence Service provides the presence and absence information of radios that support the Presence Service (see ASTRO 25 Outdoor Location Solution Supported Configurations on page 16) to any compatible data application located in the CEN, such as the Location Service. The Presence Service interfaces with the radios using UDP/IP. The interface point for receiving the presence information is through the IMW Application Programming Interfaces (APIs).

1.5.7
ASTRO 25 Location HPD Mobile Data Terminal SDK

The ASTRO® 25 Location High Performance Data (HPD) Mobile Data Terminal Software Development Kit (SDK) is a tool (.NET library) used by developers that allows for in-vehicle mapping on the MDT on the HPD system. It allows an application on an MDT to access the GPS coordinates from the HPD 1000 Data Modem through a set of function calls and documentation to support those function calls. The following features are supported:

- Location on demand
- Periodic or distance-based location updates
- Stop Location Reporting

1.5.8
ASTRO 25 Location Proxy

The ASTRO® 25 Location Proxy is a component of the ASTRO® 25 Outdoor Location Solution. It is a Microsoft® Windows service software that is installed and runs on a Mobile Data Terminal (MDT) that is connected to an ASTRO® 25 mobile radio.

The main function of the ASTRO® 25 Location Proxy is to communicate with a GPS device that is connected to the MDT and with the Location Service in the CEN over the ASTRO® 25 IV&D and HPD networks. It also receives the commands that are sent from the Location Service over the ASTRO IV&D and HPD networks and routes them to the GPS device connected to the MDT.

The ASTRO® 25 Location Proxy is required to be used in either of two configurations:

External GPS Device <-> MDT <-> ASTRO® 25 Mobile Radio

When an external GPS device (see ASTRO 25 Outdoor Location Solution Supported Configurations on page 16) is connected to an MDT, which in turn is connected to an ASTRO® 25 Mobile Radio or an HPD 1000 Data Modem, the GPS coordinates are sent across the MDT by the ASTRO® 25 Location Proxy. The GPS coordinates are not made available by the ASTRO® 25 Location Proxy to the MDT for in-vehicle mapping at this time. In this configuration, the ASTRO® 25 Location Proxy is a required system component and must be installed and running on the MDT.

NOTICE: For information regarding the possibility to utilize GPS data from the various units locally for in-vehicle mapping, see the ASTRO® 25 Outdoor Location Solution *Device Installation and Configuration Guide*.

HPD 1000 Data Modem with Integrated GPS<-> MDT with Middleware Software

When the HPD 1000 Data Modem with Integrated GPS is connected to the MDT and uses a Middleware VPN Solution to send the location coordinates back to the dispatch center, the ASTRO® 25 Location Proxy is required on the MDT in order to properly route the Location coordinates across the MDT. In this configuration, the ASTRO® 25 Location Proxy must be installed and running on the MDT. The ASTRO® 25 Location Proxy also receives the commands that are sent from the Location Service over the ASTRO HPD network and the Middleware VPN Solution and routes them to the HPD 1000 Data Modem.

1.5.9
Middleware VPN Solutions

Middleware VPN Solutions are usually transport-independent solutions that maintain an encrypted data session while the client roams between subnets or networks. The client is able to maintain connectivity and access to an application host at the CEN (the Location Service in the CEN), without the need for manual intervention. Mobility is transparent to the user. IP addresses are assumed to be allocated statically. A Middleware VPN Solution is usually comprised of two components including the middleware VPN server in the CEN and middleware VPN client software installed on an MDT.

Chapter 2

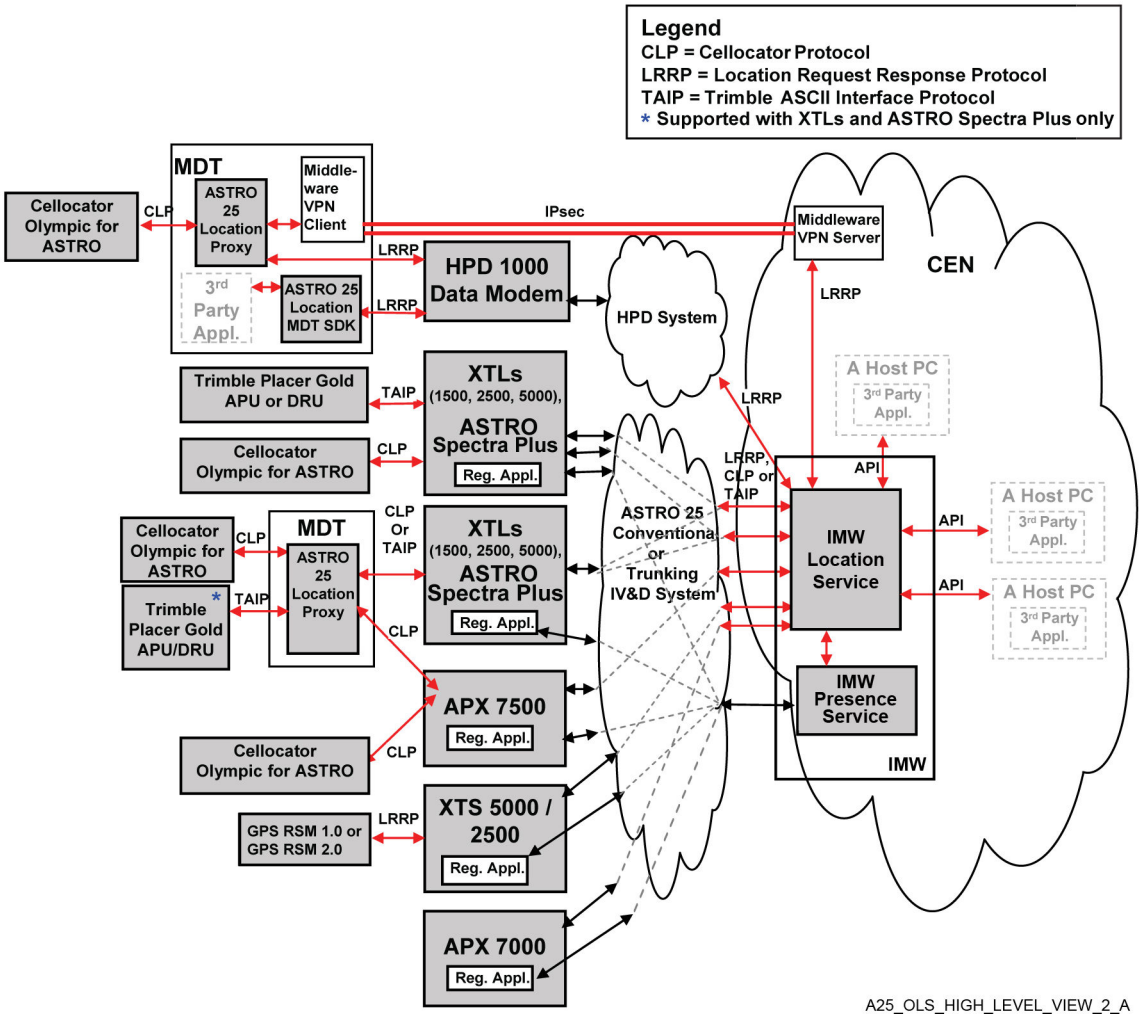
Outdoor Location Solution – Components

This chapter describes the various components involved in the ASTRO® 25 Outdoor Location Solution that is offered on ASTRO® 25 Integrated Voice and Data (IV&D) systems and ASTRO® 25 High Performance Data (HPD) systems.

2.1 Entities of the Location Services

The following figure shows a high-level architecture diagram for the Location Service and the associated Presence Service.

Figure 3: Architectural Diagram of ASTRO 25 Outdoor Location Services



NOTICE: The flow of data shown in the diagram is two way.

2.2 Components of the Location Service

2.2.1 Location Acquirers

The following sections detail how location is acquired for each of the supported devices of the ASTRO® 25 Outdoor Location Solution including:

- ASTRO XTS portable radios with the GPS Remote Speaker Microphone 1.0 and GPS Remote Speaker Microphone 2.0
- ASTRO APX radios with an internal GPS module
- Cellocator Olympic for ASTRO
- Trimble Placer™ Gold APU and Placer™ Gold DRU Plus
- HPD 1000 Data Modem with an internal GPS module

Location is acquired by using Coarse/Acquisition (C/A) code of the L1 carrier signal from at least three satellites for 2-D positioning (longitude and latitude) to four satellites for 3-D positioning (longitude, latitude, and altitude) of the GPS satellite navigation system. It is aimed to work in outdoor conditions, that is, the antenna of the GPS receiver has a line-of-sight view of the satellites.

NOTICE: GPS Satellites transmit two L-Band signals (L1 and L2). The carrier signal of L1 is 1575.42 MHz and is modulated with the following three data types:

- C/A (coarse acquisition or clear access) code
- P (precise or protected) code
- Navigation data message

The carrier signal of L2 is 1227.60 MHz and is modulated with the following two data types:

- P (precise or protected) code
- Navigation data message

2.2.1.1 Acquiring Location with the GPS RSM 1.0

A built-in antenna in the GPS RSM receives the GPS signals. The GPS RSM is an extension of the Smart RSM Platform, retaining its control functionalities and adding GPS Outdoor Location capability. It uses a SiRF StarII® chipset (GSP2e/LP 7455 series) as the GPS receiver. The GPS receiver searches the satellite's unique C/A code in the received signal by shifting and correlating the C/A code of a satellite with the received signal. This action is repeated for all the satellites until the receiver finds at least three or four satellites. The GPS receiver always operates in "autonomous mode". The "autonomous mode" means that there is no need to supply any assistance data from an external source to the GPS receiver.

To provide the peak current required by the GPS receiver, the GPS RSM has an internal rechargeable Li+ battery, which is charged from the XTS portable radio battery. The internal battery also performs a graceful shutdown of the GPS RSM when the XTS portable radio turns off and provides power to the Real Time Clock (RTC). To conserve the battery power and to obtain a good Time-To-First-Fix (TTFF), the SiRF StarII® chipset is used in the Advanced Power Management (APM) mode, which tries to minimize the duration for which the chipset is in location acquisition mode.

2.2.1.2
Acquiring Location with the GPS RSM 2.0

A built-in antenna in the GPS RSM receives the GPS signals. The GPS RSM is an extension of the Smart RSM Platform, retaining its control functionalities and adding GPS Outdoor Location capability. It uses a SiRF StarII® chipset (GSD4e series) as the GPS receiver. The GPS receiver searches the satellite's unique C/A code in the received signal by shifting and correlating the C/A code of a satellite with the received signal. This action is repeated for all the satellites until the receiver finds at least four satellites. The GPS receiver always operates in "autonomous mode". The "autonomous mode" means that there is no need to supply any assistance data from an external source to the GPS receiver.

To provide the current required by the GPS receiver, the GPS RSM utilizes power solely from the XTS portable radio battery, there is no battery inside the RSM. The GPS RSM also performs a graceful shutdown when the XTS portable radio turns off.

2.2.1.3
Acquiring Location with APX Series of Mobiles and Portables

The APX series of mobiles and portables use an internal SiRF GSCi5001 GPS receiver and support LRRP to provide location information both over the air to the CEN and to the radio user. The APX GPS module acquires location in a continuous mode. In this mode, if the radio can see three or more satellites, the GPS receiver will not be switched off even when there are no active requests for location data. Working in continuous mode reduces the Time To First Fix (TTFF) significantly.

NOTICE: The GPS receiver does not acquire location when the radio is switched off but the radio keeps the last location that was acquired successfully in a persistent memory.

2.2.1.4
Acquiring Location with the Cellocator Olympic for ASTRO

An external antenna connected to the Cellocator Olympic for ASTRO receives the GPS signals. It processes the received GPS signals and sends the location information to the Location Service using its own application layer protocol over UDP/IP. Cellocator Olympic for ASTRO also provides standard digital inputs / outputs that can be used to interface with a vehicle. For example, the digital inputs can be used to monitor the ignition, doors, or gun rack deployment, and the digital outputs, which are pulsed outputs, can be used for switching on/off the sirens, or lights. Cellocator Olympic for ASTRO can connect to any sensor that interfaces to the Cellocator specifications.

2.2.1.5
Acquiring Location with Trimble Placer™ Gold APU and Placer™ Gold DRU Plus

The Trimble Placer™ Gold APU and Placer™ Gold DRU Plus acquire location in a continuous mode. They provide a location update rate of one per second. Additionally, the Placer™ Gold DRU Plus model includes a dead reckoning sensor, which helps calculate location data when no GPS signal is available. The Placer™ Gold DRU Plus model is useful when intermittent loss of satellite signals is experienced.

2.2.1.6
Acquiring Location with the HPD 1000 Data Modem

The HPD 1000 Data Modem has a built-in GPS receiver (Phoenix GPS Acquisition module) with an external GPS antenna. It acquires location in a continuous mode, which means that the modem does not switch off its GPS receiver even when there are no requests for location data. This behavior reduces the Time to First Fix (TTFF) significantly.

NOTICE: The GPS receiver does not acquire location when the modem is switched off, but the modem keeps the GPS receiver on the battery backup to reduce the TTFF when the modem powers on.

2.2.2
GPS Operation and Specifications

The ASTRO® 25 Outdoor Location Solution uses GPS signals to determine the location of the Motorola devices. Each device acquires its location using non-assisted GPS, which means that to receive the most accurate location positioning from the GPS device, its GPS receiver must be in clear sight of at least five satellites.

Certain geographical conditions may cause a GPS receiver to gather inaccurate location positioning:

Obstructed Terrain
If the view of the sky is severely limited, signals can become degraded and the GPS receiver may not provide accurate location information. This situation can occur in deep canyons.

Urban Canyons
Large or tall buildings grouped closely together can cause multi-path and fading errors that may affect the ability for the GPS receiver to determine its location accurately.

The following sections detail the GPS operations and specifications for each of the GPS devices supported as part of the ASTRO® 25 Outdoor Location Solution.

2.2.2.1
XTS Portable Radios with GPS RSM v1.0

The GPS RSM interfaces with the XTS portable radios using a Universal (side) connector. Through this connector, an XTS portable radio provides power to the GPS RSM and communicates with it using two RS232 digital input/output lines.

The location data from the RSM is sent over a serial data line using the XCMP protocol to its XTS radio. If the Location Service of the radio is enabled, then the radio receives location requests from the Location Service and sends the location data as per the requests. It is possible for the radio user to temporarily disable the Location Service, and in that case, the location data is sent to the Location Service only in case of emergency. The supported models of the XTS radios with display also have menu options to display the location locally. The local display feature can be disabled using Customer Programming Software (CPS).

The application layer protocol between the XTS radios and the Location Service application is the LRRP in MBXML form. The XTS radios manage the requests from the Location Service. When the XTS radios need location data, they request and obtain the location from the GPS RSM. The location data from the GPS receiver in the RSM is sent over a serial data line between the RSM and the XTS radios. The XTS radios pack the location data into an appropriate “LRRP document” in MBXML form. The LRRP document in MBXML form is packed into UDP/IPv4 packets, which are sent over-the-air to the fixed end of the ASTRO® 25 Trunking or Conventional IV&D system as data PDUs. The ASTRO system provides the IPv4 packets to the Location Service through the CEN interface.

NOTICE: The XTS portable radios send the location updates only after the processing of an emergency is over (that is, after the emergency alarm and call ends or after the acknowledgment of the emergency alarm by the console). Since voice communication is important during an emergency, the radio does not entertain any new location request from a third-party application during an emergency.

2.2.2.1.1
GPS Specifications for the GPS RSM 1.0

Table 2: GPS RSM 1.0 Specifications

Attribute	Specification
Microphone	
Type	Omnidirectional
Sensitivity	-42 dBV typical
Speaker	
Diameter	45 mm
Output Power	0.5 W at rated audio
Output Level	90 dB SPL typical
Distortion (THD)	<5% at 1 kHz
RSM Body	
Dimensions	62 mm x 87.5 mm x 43 mm (2.4 in. x 3.4 in. x 1.6 in.) with Clothing Clip
Weight	270 grams
Case Material	Flame Resistant Polycarbonate
Operating Temperature	-30 °C to +60 °C
GPS Specifications	
Simultaneous Satellites	12
Sensitivity	-138 dBm (acquisition), -152 dBm (tracking)
Accuracy	15 m (40%) 25 m (95%)
Cold Start	< 90 seconds, typical
Warm Start	< 340 seconds, typical
Hot Start	2-4 seconds, typical
Mode of Operation	Autonomous (Non-Assisted) GPS

2.2.2.2
XTS Portable Radios with GPS RSM v2.0

The GPS RSM interfaces with the XTS radios using a Universal (side) connector. Through this connector, an XTS radio provides power to the GPS RSM and communicates with it using two RS232 digital input/output lines.

The location data from the RSM is sent over a serial data line using the XCMP protocol to its XTS radio. If the Location Service of the radio is enabled, then the radio receives location requests from the Location Service and sends the location data as per the requests. It is possible for the radio user to temporarily disable the Location Service, and in that case, the location data is sent to the Location Service only in case of **Emergency**. The supported models of the XTS radios with display also have menu options to display the location locally. The local display feature can be disabled using Customer Programming Software (CPS).

The application layer protocol between the XTS radios and the Location Service application is the LRRP in MBXML form. The XTS radios manage the requests from the Location Service. When the

XTS radios need location data, they request and obtain the location from the GPS RSM. The location data from the GPS receiver in the RSM is sent over a serial data line between the RSM and the XTS radios. The XTS radios pack the location data into an appropriate “LRRP document” in MBXML form. The LRRP document in MBXML form is packed into UDP/IPv4 packets, which are sent over-the-air to the fixed end of the ASTRO® 25 Trunking or Conventional IV&D system as data PDUs. The ASTRO system provides the IPv4 packets to the Location Service through the CEN interface.

NOTICE: The XTS radios send the location updates only after the processing of an emergency is over (that is, after the emergency alarm and call ends or after the acknowledgment of the emergency alarm by the console). Since voice communication is important during an emergency, the radio does not entertain any new location request from a third-party application during an emergency.

2.2.2.2.1 GPS Specifications for the GPS RSM 2.0

Table 3: GPS RSM 2.0 Specifications

Attribute	Specification
Microphone	
Type	Omnidirectional
Sensitivity	- 42dBV typical
Speaker	
Diameter	45 mm
Output Power	0.5 W at rated audio
Output Level	90dB SPL typical
Distortion (THD)	< 5% at 1kHz
RSM Body	
Dimensions	62 mm x 87.5 mm x 43 mm (2.4 in. x 3.4 in. x 1.6 in.) with Clothing Clip
Weight	242 grams
Case Material	Flame Resistant Polycarbonate
Operating Temperature	-30 °C to +60 °C
GPS Specifications	
Simultaneous Satellites	48
Sensitivity	-148 dBm (acquisition), -160 dBm (tracking)
Accuracy	5m (50%), 15m (95%)
Cold Start	< 35 seconds, typical with fully charged radio battery
Warm Start	< 35 seconds, typical with fully charged radio battery
Hot Start	3-5 seconds, typical with fully charged radio battery
Mode of Operation	Autonomous (Non-Assisted) GPS

2.2.2.3

APX Series of Mobiles and Portables

APX radios with enabled Location Service send location data in response to the location requests from the Location Service. It is possible for the radio user to temporarily disable the Location Service. In such scenarios, the location data is sent to the Location Service only in case of emergency. The APX radios with a display can also display the location locally. The local display feature can be disabled using Customer Programming Software (CPS).

The application layer protocol between the APX series of mobiles and portables and the Location Service application is the LRRP in MBXML form. The APX radios manage the requests from the Location Service. When the APX radios need location data, they request and obtain the location from the internal GPS receiver. The APX radios pack the location data into an appropriate “LRRP document” in MBXML form. The LRRP document in MBXML form is packed into UDP/IPv4 packets, which are sent over-the-air to the fixed end of the ASTRO® 25 Trunking or Conventional IV&D system as data PDUs. The ASTRO system provides the IPv4 packets to the Location Service through the CEN interface. The APX radios cache the last known valid GPS location. This location is kept in the radio even when power is cycled (turned off and on). If the APX radio is not able to obtain a new GPS fix when it is trying to service a request, the location data from the cache will be used along with the timestamp when it was obtained.

NOTICE: The location update is sent by the APX radios only after the processing of emergency is over (that is, after the emergency alarm and call ends or after the acknowledgment of the emergency alarm by the console). Since voice communication is important during an emergency, the radio does not entertain any new location request from a third-party application during an emergency.

2.2.2.3.1

GPS Specifications for the GPS Module in the APX Series of Mobiles and Portables

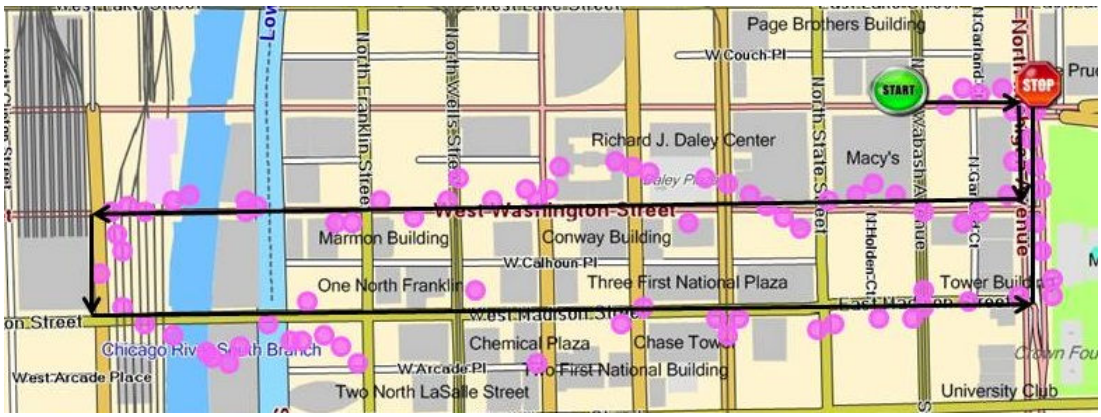
Table 4: GPS Specifications for the GPS Module in the APX Series of Mobiles and Portables

Attribute	Specification
Channels	12
Tracking Sensitivity	-151dBm (APX 7000) -153 dBm (APX 7500)
Accuracy*	<10 meters (95%)
Cold Start	<60 seconds (95%)
Hot Start	<10 seconds (95%)
Mode of Operation	Autonomous (Non-Assisted) GPS

NOTICE: * Accuracy specifications are for long-term tracking (95th percentile values > 5 satellites visible at a nominal -130 dBm signal strength).

With less than five satellite visibility, location accuracy decreases significantly, with measurements being within 100 meters of the actual APX device. The following figure shows typical location readings in an urban canyon setting with the APX device moving at walking speed along the path shown. Location discrepancies shown in the following figure reach up to 80 meters:

Figure 4: APX Radio GPS Location Tracking in an Urban Canyon



In order to obtain an initial GPS fix position, the radio must be located in an open sky, outdoor environment with no barriers that could affect the signal around you or above you. During this initial fix, the radio should **not** be worn on the body as this may affect the process of acquiring signal and/or add additional time to first fix.

2.2.2.4
Cellocator Olympic for ASTRO

The Cellocator Olympic for ASTRO is an integrated fleet management unit with location tracking capabilities. Its compact size makes it ideal for covert installation in the vehicle to avoid detection and tampering. The Cellocator Olympic for ASTRO uses the ASTRO® 25 mobile radios as a modem for IPv4 communication over-the-air on ASTRO® 25 Trunking or Conventional IV&D systems and the HPD 1000 Data Modem for IPv4 communication over-the-air on ASTRO® 25 High Performance Data systems.

The Cellocator Olympic for ASTRO communicates with the Location Service using a proprietary binary protocol over UDP/IP. For information on which model radios are supported with the Cellocator Olympic for ASTRO, see ASTRO 25 Outdoor Location Solution Supported Configurations on page 16.

The Cellocator Olympic for ASTRO can be connected directly to an ASTRO® 25 Mobile Radio. Alternatively, the Cellocator Olympic for ASTRO units can be connected and communicate with the Location Service through a Mobile Data Terminal (MDT) that is connected to an ASTRO® 25 mobile IV&D radio or HPD 1000 Data Modem. In this alternate configuration, the ASTRO® 25 Location Proxy must be installed and running on the MDT.

NOTICE: For the MDT configurations, the ASTRO Data Link Manager software must be installed and running on the MDT for the IV&D configurations and the ASTRO HPD Status Applet software must be installed and running on the MDT for HPD configurations.

2.2.2.4.1
Technical Specifications for Cellocator Olympic for ASTRO

Table 5: Technical Specifications for Cellocator Olympic for ASTRO

Attribute	Specification
GPS receiver	SiRF star III
Communication methods	UDP/IPv4/PPP/RS-232
Inputs	5 digital inputs – 1 dedicated for ignition, 4 variable for general purpose

Attribute	Specification
	1 analog input dedicated for battery measurement ranges between 0 V to 31 V
Outputs	2 open collector outputs
Operating voltage	9 V to 32 V
Power consumption	0.98 W in full operation, 0.327 W in hibernation
Dimensions	77.6mmx 106mmx 28.15mm(3.05 in. x 4.17 in. x 1.10 in.)
Weight	0.315 kg (0.69 lb)
Temperature range	-20 °C to 55 °C (-4 °F to 131 °F)

2.2.2.4.2

GPS Specifications for Cellocator Olympic for ASTRO

Table 6: GPS Specifications for Cellocator Olympic for ASTRO

Attribute	Specification
Channels	20
Sensitivity (Acquisition)	-130 dBm
Position accuracy	10 m at 2D RMS
Cold start	42 seconds (Signal Strength > 30 dB-Hz)
Warm start	35 seconds (Signal Strength > 30 dB-Hz)
Hot start	1 second (Signal Strength > 30 dB-Hz)
Mode of Operation	Autonomous (Non-Assisted) GPS
Reacquisition	0.1 second (typical)

NOTICE: Both dash mount and external mount GPS antennas are offered with the Cellocator Olympic for ASTRO as part of the ASTRO® 25 Outdoor location Solution.

2.2.2.4.3

Operational Specifications for Cellocator Olympic for ASTRO

The following table lists the power consumption of the Cellocator Olympic for ASTRO during various modes of operation:

Table 7: Cellocator Olympic for ASTRO – Power Consumption

Operation/Mode	Power Consumption
Normal (ignition on)	45 to 50 mA
Transmission and Reception	78 to 80 mA
Idle (ignition off)	15 to 20 mA
Full Operation	0.98 W
Hibernation	0.327 W
Olympic	19 mA

Operation/Mode	Power Consumption
GPS receiver	50 mA

The following table lists the technical parameters of the Cellocator Olympic for ASTRO:

Table 8: Cellocator Olympic for ASTRO – Technical Parameters

Parameter	MIN	TYPICAL	MAX	UNIT
IDLE Mode Current Consumption		15	20	mA
STANDBY Mode Current Consumption		45	50	mA
TX and RX Mode Current Consumption		78	80	mA
DC Supply to DC JACK	4.5	7.5	12	V
DC Supply to DB9-M pin 1 (Optional)	4.5	5.0	12	V
Operating Temperature	0	25	60	°C
Transmission Power (Output Power)		19.30		dBm
Frequency Band	2.4	2.4 GHz ISM Band	2.4835	GHz
Data Rate		723.1		Kbps
UART Speed	110	115200		bps
Sensitivity			-80	dBm

2.2.2.4.4
ASTRO Mobile Radios Supported with Cellocator Olympic for ASTRO

The location data (including sensor data) from the Cellocator Olympic for ASTRO is sent over a serial data line using the UDP/IP/PPP protocol to its APX 7500, HPD 1000 Data Modem, XTL family of mobile radios, and ASTRO® Spectra Plus™ radios. The radios behave as a conduit for data packets and do not look into the content of the packets.

2.2.2.5
Trimble Placer™ Gold APU and Placer™ Gold DRU Plus

The Trimble Placer™ Gold APU and Placer™ Gold DRU Plus are integrated fleet management units with location tracking capabilities. The Trimble units utilize the ASTRO® 25 mobile radios for IPv4 communication over-the-air on ASTRO® 25 Trunking or Conventional IV&D systems. The Trimble Placer™ Gold APU and Placer™ Gold DRU Plus communicate with the Location Service over UDP/IP (see ASTRO 25 Outdoor Location Solution Supported Configurations on page 16).

The Placer™ Gold DRU Plus can also be equipped with an optional internal module to provide dead reckoned position data while outside of GPS coverage. This is accomplished by using advanced gyroscopic technology in combination with connections to the vehicle speed sensor and vehicle direction signal (forward or reverse).

The Trimble Placer™ Gold APU and Placer™ Gold DRU Plus GPS unit can be connected directly to an ASTRO® 25 mobile radio. Alternatively, the Trimble units can be connected and communicate with the

Location Service through a Mobile Data Terminal (MDT) that is connected to an ASTRO® 25 mobile radio. In this alternate configuration, the ASTRO® 25 Location Proxy must be installed and running on the MDT.

NOTICE: For the MDT configurations, the ASTRO Data Link Manager software must be installed and running on the MDT as well.

2.2.2.5.1
Electrical Specifications for Trimble Placer™ Gold APU and Placer™ Gold DRU Plus

Table 9: Electrical Specifications for Trimble Placer™ Gold APU and Placer™ Gold DRU Plus

Attribute	Specification
Voltage	+8.5 to 32 V DC
Power Consumption	55 mA @ 13.8 V DC typical
Output Supply Voltage	5.0 V DC typical, 170 mA max on pin–9 of serial ports
Odometer Input	3.0 V DC minimum high (digital) 0.6 V DC maximum low (digital) +/- 1.0 V DC minimum (analog) fmax: 400 Hz
Reverse Input	4.1 V DC minimum high 3.2 V DC maximum low
Ignition Input	3.6 V DC minimum high 1.4 V DC maximum low 1 mA maximum off current

2.2.2.5.2
Physical Specifications for Trimble Placer™ Gold APU and Placer™ Gold DRU Plus

Table 10: Physical Specifications for Trimble Placer™ Gold APU and Placer™ Gold DRU Plus

Attribute	Specification
Size	79 mm W x 46 mm H x 152 mm D (3.1 in. x 1.8 in. x 6.0 in.)
Weight	312 g (11 oz)
Case	Sheet metal, gold anodized Extruded metal, gold anodized

2.2.2.5.3
GPS Specifications for Trimble Placer™ Gold APU and Placer™ Gold DRU Plus

Table 11: GPS Specifications for Trimble Placer™ Gold APU and Placer™ Gold DRU Plus

Attribute		Specification
General		L1 (1575.42 MHz) frequency, C/A Code, 12 Channel
Update Rate		NMEA @ 1 Hz; TAIP configurable (1 Hz maximum)
Accuracy:		
	Position:	2.5 m CEP (50%) w/o SA
	Velocity:	0.1 m/sec
	PPS:	± 500 ns
Acquisition:		
	Reacquisi-tion:	1 sec
	Hot Start:	15 sec (90%)
	Warm Start:	45 sec (90%)
	Cold Start:	140 sec (90%)
Tracking Sensitivity		(C/N). 30 dB min
Maximum Velocity		126 m/s

2.2.2.5.4
Gyro Specifications for the Trimble Placer™ Gold DRU Plus

Table 12: Gyro Specifications for the Trimble Placer™ Gold DRU Plus

Attribute	Specification
Startup Drift:	± 0.8 deg/s (1 s to 15 min)
Temperature Drift:	6 deg/s max
Temperature Drift Gradient:	± 1.0 (deg/s)/8°C

2.2.2.5.5
Environmental Specifications for Trimble Placer™ Gold APU and Placer™ Gold DRU Plus

Table 13: Environmental Specifications for Trimble Placer™ Gold APU and Placer™ Gold DRU Plus

Attribute	Specification
Operating Temperature:	–40 °C to +80 °C
Storage Temperature:	–55 °C to +85 °C
Humidity:	20–95% RH
Vibration:	< 3 G rms

Attribute	Specification
	NOTICE: MIL STD 810 F, –20°C to +70°C, Random Vibration 3 axis, 10 Hz to 500 Hz, 0.0005 to 0.005 G2/Hz
FCC Part 15 Class B	Radiated emission
ISO7637–2	Electrical transient conduction along supply lines

2.2.2.5.6
ASTRO Mobile Radios Supported With the Trimble Placer™ Gold APU) / DRU Plus

The location data from the Trimble Placer™ Gold units is sent over a serial data line using the UDP/IP/PPP protocol to the XTL radios, or ASTRO® Spectra Plus™ radios. The radios behave as a conduit for data packets and do not look into the content of the packets.

2.2.2.6
HPD 1000 Data Modem

The Motorola ASTRO® 25 High Performance Data (HPD) system is a data only radio system that delivers up to 96 Kbps of data. It operates in both 700 MHz and 800 MHz spectrum. It uses the standard 25 kHz channel allocations with a mobile coverage footprint similar to 800 MHz voice systems.

The High Performance Data (HPD) 1000 Data Modem is a mobile data modem for use on the High Performance Data system. It can be connected to a Mobile Data Terminal (MDT), thus enabling the MDT to use the HPD service. The HPD 1000 Data Modem is integrated with an internal GPS module.

The HPD 1000 Data Modem is supported on the ASTRO® 25 Outdoor Location Solution in multiple configurations. It can work standalone or be connected to an MDT such as the Motorola MW series of Mobile Workstations. In a standalone mode, the Location Service communicates directly with the HPD 1000 location module and enables third-party application to receive location through the Location APIs. When connected to an MDT installed with the ASTRO® 25 Location Proxy and a Middleware VPN Solution, the Location Service communicates with the HPD 1000 location module through the ASTRO® 25 Location Proxy. The ASTRO® 25 Location Proxy acts as a proxy service from the HPD 1000 to the Location Service and vice versa. This service combined with the usage of the Middleware VPN Solution networking services provides location information in an encrypted and compressed manner.

Alternatively, for enabling advanced location capabilities such as telemetry, the Cellocator Olympic for ASTRO can be connected to an MDT installed with the ASTRO® 25 Location Proxy that is in turn connected to the HPD 1000 data modem. In this configuration, the Cellocator is the source of the GPS data and it communicates with the Location Service through the MDT and ASTRO® 25 Location Proxy over the HPD network. The ASTRO® 25 Location Proxy acts as a proxy service from the Cellocator to the Location Service and the other way round.

2.2.2.6.1
GPS Specifications for HPD 1000 Data Modem

Table 14: GPS Specifications for HPD 1000 Data Modem

Attribute	Specification
General	L1 (1575.42 MHz) frequency, C/A Code, 12 Channel

Attribute		Specification
Update Rate		NMEA @ 1 Hz
Accuracy		
	Horizontal Position:	Autonomous < 2.5 m
	Velocity:	Speed < 1 m/s Heading < 0.1°
Acquisition:		
	Hot start:	Autonomous <5.5 s
	Warm start:	Autonomous <35 s
	Cold start:	Autonomous <45 s
Tracking Sensitivity		-157 dBm with external LNA -153 dBm with no external LNA
External reference clock		12-56 MHz
RTC input		32.768 kHz
Operating temperature		-40° to +85° C
Power	Continuous Autonomous operation:	63 mW
	Trickle Power:	42 mW
	Standby current:	5 µA

2.2.3
ASTRO Mobile Radios

The ASTRO® 25 mobile radios supported as part of the ASTRO® 25 Outdoor Location solution include the configurations detailed in ASTRO 25 Outdoor Location Solution Supported Configurations on page 16. Some configurations include radios with an internal GPS module. In these configurations, the radio serves as the source of the GPS data. Others configurations include an external device that enables GPS and is connected to a mobile radio directly or through an MDT. In these configurations, the mobile radio is used to send and receive GPS data over the ASTRO® 25 Trunking or Conventional IV&D systems or High Performance Data systems. The radios behave as a conduit for data packets and do not look into the content of the packets.

2.2.4
Intelligent Middleware Location Service in the CEN

The Location Service, located in the Customer Enterprise Network (CEN), communicates with:

- ASTRO® 25 IV&D and HPD radios
- the Cellocator Olympic for ASTRO
- Trimble Placer™ Gold APU and Placer™ Gold DRU Plus
- third-party P25 radios

The Location Service converts their proprietary location data to a unified protocol used by the third-party applications. The radios use the data services of an ASTRO® 25 IV&D and ASTRO® 25 HPD system to send the data packets to the Location Service.

The application layer protocols that the Location Service uses to communicate with the location devices are as follows:

- Motorola LRRP in binary format (MBXML) for ASTRO® 25 IV&D and HPD radios with an internal GPS module.
- Cellocator Ltd proprietary protocol for communicating with the Cellocator Olympic for ASTRO.
- Trimble TAIP protocol for communicating with the Trimble Placer™ Gold APU and Placer™ Gold DRU Plus units.
- P25 Location protocol for third-party radios and APX radios with an internal GPS module.

2.2.5
Third-Party Applications in the CEN

Location applications provide a user interface to display the location of a radio and to request the location of a radio. To obtain the location of a radio, an application can request a one time location query or send a request to receive periodic location reports via the IMW APIs. The location application is the final destination of the location data. A location application may display the location of a set of radios over a map.

2.2.6
API and Third-Party Applications

Third-party application use the Location APIs to receive location and telemetry data and to send commands to the end units. Applications also have the benefit of getting the presence information of the radios from the IMW through the 3GPP Parlay X, REST & WebSocket, and LRRP APIs. The following is a short description of this feature:

- When a third-party application uses the IMW API Services, it can receive the presence status of an ASTRO® 25 radio that has reported its presence to the Presence Service according to the permissions set up in the system.
- When a radio is powered on / off, the Location Service sends this information to the third-party applications through the Location Service APIs.

NOTICE: The Presence feature is only supported for mobile radios that support Presence Service (see ASTRO 25 Outdoor Location Solution Supported Configurations on page 16 for radio model information).

Note that the Location Service can support up to three applications that are connected through the ASTRO® 25 Location LRRP API simultaneously. This configuration allows you to utilize the Location Service for location enabling their applications such as mapping solutions, CAD applications and more. In addition, the Location Service includes a module that allows defining which application is allowed to view and which application is allowed to control each of the radios defined in the system.

2.3
Communication Protocols between the Components

The Location Service communicates with each of the location devices supported as part of the ASTRO® 25 Outdoor Location Solution using the protocols of the location device.

Communication Protocols

The protocols include:

- Motorola Location Request/Response Protocol (LRRP) in binary form (MBXML) to communicate with the ASTRO portable radios with the GPS RSM (v1.0 or v2.0).

- Motorola LRRP in binary form (MBXML) to communicate with the ASTRO APX radios with internal GPS module.
- Cellocator proprietary binary protocol to communicate with the Cellocator Olympic for ASTRO GPS units.
- Trimble TAIP protocol to communicate with the Trimble Placer™ Gold APU and Trimble Placer™ Gold DRU Plus units.
- Motorola Location Request/Response Protocol (LRRP) in binary form (MBXML) to communicate with the HPD 1000 Data Modem internal GPS module.
- P25 LRRP Location protocol with EXI compression to communicate with third-party radios and APX radios with an internal GPS module.

The location requests and responses are transported between the GPS devices and the Location Service using User Datagram Protocol/Internet Protocol version 4 (UDP/IPv4). The UDP/IPv4 messages from a radio are wrapped into an Association of Public-Safety Communications Officials (APCO) 25 Packet Data Unit (PDU) before sending over-the-air.

Depending upon the configuration of the ASTRO® 25 IV&D and ASTRO HPD system, these PDUs use unconfirmed/confirmed and/or protected data services to transport the UDP/IPv4 datagrams over-the-air.

The third-party applications in the Customer Enterprise Network (CEN) communicate with the Location Service using the Location Request/Response Protocol (LRRP) in Extensible Markup Language (XML) form for exchanging location-related requests and responses over TCP/IPv4. Alternatively, they can use the 3GPP Parlay X, or REST & WebSocket services interface.

A third-party in-vehicle mapping application in a Mobile Data Terminal (MDT) communicates with a connected HPD 1000 Data Modem with an internal GPS module through a set of Dynamic Link Libraries (DLL) provided by Motorola, the ASTRO® 25 Location High Performance Data (HPD) Mobile Data Terminal Software Development Kit (SDK). The DLL communicates with the HPD 1000 Data Modem using LRRP in binary form (MBXML) over UDP/IPv4.

Motorola LRRP vs P25 LRRP Considerations

Motorola LRRP protocol is intended for use with ASTRO® 25 radios working on the ASTRO® 25 networks. It provides support for both the Location and Presence Services.

The P25 LRRP Location protocol is intended for use in the following scenarios:

- For interoperability on another manufacturer's system: P25 LRRP can be used with Motorola radios working on a non-Motorola system. However, radios configured with P25 LRRP cannot communicate with the Presence Service.
- For third-party radios working on a Motorola network. In this scenario, the Presence Service is not supported either.

2.4 Components of the Presence Service

The Presence Service accepts presence information of radios (except the ASTRO® Spectra Plus™ and the HPD 1000 Data Modem), stores this information, and distributes it to the subscribing application. The intent of the Presence Service is to allow radios to announce their availability to an application in the CEN. The presence information of a radio is useful when an application must send a message (for example, a location request) to the radio when the radio powers on.

NOTICE: The Presence Service does not provide any information when a radio goes in or out of coverage. Also, the presence status of a radio may be wrong if the radio turns off in an unplanned way (for example due to battery failure). The Presence Service is not available for ASTRO® Spectra Plus™ radios and for the HPD 1000 Data Modem.

The ASTRO® Spectra Plus™ radios and HPD 1000 Data Modem do not support the Presence Service because they do not contain the Registration Application software, which is needed for a radio to send its presence/absence state to the Presence Notifier application.

An ASTRO® 25 Trunking or Conventional IV&D system with Presence Service enabled may be used by multiple data applications.

2.4.1
Registration Application in a Radio

On power-on, periodically, and on reentry to the radio data network, a Registration Application registers the radio to its Presence Service. It also de-registers the radio on power-off.

2.4.2
Presence Service in the CEN

The Location Service subscribes with the Presence Service to receive for the presence/absence events of radio of its interest. Upon a change in the status (that is, presence to absence or absence to presence) of any of these radios, the Presence Service sends a notification to the Location Service. With a notification, the Presence Service also sends the IPv4 address of the radio. This eliminates any need for the Location Service to manage the IPv4 address of the radio.

NOTICE: In the case of an ASTRO® 25 Trunking IV&D system, the IPv4 address to a radio is allocated dynamically.

The Presence Service is a logical entity, which is co-resident with other services on the IMW server.

NOTICE: The data service from the radio network to a radio may not be available during emergency, and therefore it is not possible to send a location request to a radio when it is in emergency mode.

Chapter 3

Services Offered by the Outdoor Location Solution

This chapter briefly describes the services offered by the Location Service to the radio user and to the location application.

3.1 Services Provided to a Radio User

The following services are available on supported models of the APX radios with an internal GPS module, and on supported models of the XTS portable radios with the GPS Remote Speaker Microphone:

Location service on/off control

Radio users may want to disable the Location Service either to conserve the battery power (for example, in urban canyons with an ongoing periodic location update) or when they are not interested in being tracked. This feature allows radio users to enable or disable the Location Service using a soft key. When disabled, the radio does not provide any Location Service except location to a third-party application in case of emergency.

NOTICE: It is possible to disable this feature (enable / disable of Location Service by a radio user) in the radio by programming the radio using the Customer Programming Software (CPS).

Location status indication

An icon is displayed on the radio to indicate that the Location Service is enabled. The absence of the icon indicates that the Location Service is disabled. The icon flashes during poor GPS signals, and it is continuously on when the GPS signal is detected.

Location display

On request from a radio user, the radio displays the current location coordinates (latitude and longitude) on its screen. If the received GPS signal is sufficient, then the radio updates the location periodically. The period is eight minutes for the XTS radios with the GPS Remote Speaker Microphone and 5 seconds for the APX radios. The Location Service does not provide a way for the radio user to trigger a location update to a third-party application. Unlike APX radios, an XTS radio does not store the last known location in the radio persistently.

Figure 5: Location Display Menu on an XTS Portable Radio

The following figure shows a location display menu on an XTS portable radio.

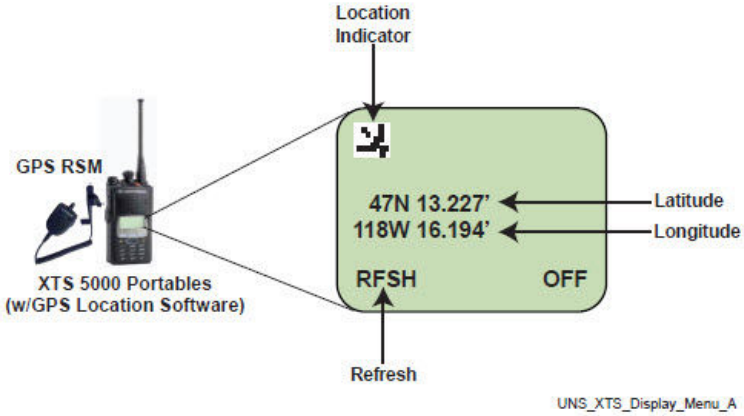


Figure 6: Location Display Menu on an APX 7000 Radio

The following figure shows a location display menu on an APX 7000 radio.

3.2 Services Provided to Third-Party Applications in the CEN

A third-party application is required to register with the Location Service for any of the services detailed in this section.

NOTICE: The Location Service supports up to three application registrations at a time.

The services offered to a third-party application include:

Single Location Updates

The third-party application wants to know the current location of a radio user. In this case, the application sends a request to the Location Service for a single location update. Single location updates can be used to track the location of radio users by third-party applications, but this use is inefficient for the air interface. Single location updates should be used as a one-time queries, not as periodic updates.

Periodic Location Updates

Location tracking allows a third-party application to obtain the location of the radio users periodically by sending a single location request containing the time or distance interval between two updates. The radio continues to send location reports at the specified time or distance interval until the third-party application cancels the request, which can be done at any time.

All the subscriber units supported as part of the ASTRO® 25 Outdoor Location Solution including the HPD 1000 Data Modem with integrated GPS, Cellocator Olympic for ASTRO, Trimble Placer™ Gold APU, and Trimble Placer™ Gold Dead Reckoning Unit (DRU) Plus store the requests and continue to process them even after a power cycle. Exceptions to this are the APX 7000 and the XTS portable radios and the APX 7500 mobile radio. These radios do not store requests persistently, and therefore a third-party application should send a fresh request when the radio is powered on.

The Location Service can be configured to automatically send requests with desired intervals to a radio that powers on. This prevents the need for the application to make such a request.

Location on events

A portable radio (that is APX 7000 and XTS portables) and a mobile radio send a location update after the emergency. The Cellocator Olympic for ASTRO sends unsolicited location updates in case of a telemetry event (that is, change in a digital input).

The APX series of mobiles and portables and the XTS series of portables send the location update only after the processing of emergency is over (that is, after the emergency alarm and call ends or after the acknowledgment of the emergency alarm by the console). Since voice communication is important during an emergency, the radio does not entertain any new location request from a third-party application during an emergency.

Location on Power-On

The Outdoor Location Solution does not provide automatic location updates on power on unless configured to do so. The Presence Service notifies registered third-party applications when a radio that supports Presence Services powers on, either through the IMW 3GPP Parlay X interface or through the ASTRO® 25 LRRP API according to the configuration set in Configuration Manager (see ASTRO 25 Outdoor Location Solution Supported Configurations on page 16 for radio model information). On notification, the third-party application should make an explicit request if it is interested in the location of the radio and if the Location Service was not configured to do so on its behalf.

Location on Push to Talk

The Location on Push to Talk (PTT) is a unique feature for APX trunking radios. It utilizes an embedded signaling mechanism to allow the currently transmitting subscriber to send location data during a group voice call. Other location reports, such as Periodic Location Updates or Location on events, can occur only when the subscriber is not participating in a voice call. These reports, if configured, are queued and sent after the call ends, provided they do not stay in the queue longer than their Queue Dwell Time. If a Periodic Location Update stays queued longer than its Queue Dwell Time, it is discarded and not sent after the voice call ends.

A single press of the PTT button generates one location report. The Location on PTT feature does not keep updating subscriber location during the group voice call. However, every new voice transmission sends a new location report. Thanks to this, the feature provides a more timely representation of the real-time position of the transmitting subscriber in situations that require a lot of quick voice calls, for example during a high-speed car chase scenario.

NOTICE:
The location updates in this solution are not encrypted - Motorola Solutions cannot guarantee the privacy of location information.

For information on feature requirements and operational overview, see Location on Push to Talk – APX on page 75

Location on Receive

The Location on Receive is a feature for APX trunking radios that allows subscribers to send their GPS location to a registered third-party application during voice and hangtime. The trunking RF site automatically initiates Location on Receive at the start of a TDMA call and schedules the subscriber to send in their location so that the received audio is not disturbed. Additionally, the Responder Alert uses Location on Receive to send Location with Critical Sensor Alert.

NOTICE:
The location updates in this solution are not encrypted - Motorola Solutions cannot guarantee the privacy of location information.

For information on feature requirements and operational overview, see Location on Receive – APX on page 77

Location Reporting

The Cellocator Olympic for ASTRO, Trimble Placer™ Gold APU, and Placer™ Gold DRU Plus units can be pre-configured to send unsolicited periodic location updates. This configuration is stored in the devices and is still active even after a power cycle. In this case, a third-party application is not required to send an explicit request for location updates. The HPD 1000 Data Modem also stores this configuration. However, it requires at least a single explicit request from an application through the IMW APIs to start sending location reports. The APX and XTS families of radios do not send location data on their own to a third-party application. They require an explicit request for location updates through the IMW APIs every time they are powered on, or alternatively, the location service can be configured to do so on behalf of the application. This is because these radios do not store requests persistently. When receiving a power on indication (presence) the application should send an explicit request for location updates through the IMW APIs to start location reporting.

Telemetry

The Cellocator Olympic for ASTRO provides the following input/output options:

- Five digital inputs that can be used to interface with sensors in a vehicle (for example, ignition, or door).
- Two digital outputs that can be used to interface with actuators in a vehicle (for example, control sirens, lights, or blinkers).
- One analog input that can be used for battery measurement.

Presence of a radio

The Location Service notifies the application when a radio that supports Presence Service powers on or powers off according to the configuration set in the Configuration Manager via the LRRP API. Alternatively presence information can be provided via the 3GPP Parlay X web services interface as well.

NOTICE: The Presence Service is not available for ASTRO® Spectra Plus™ radios and HPD 1000 Data Modems. As such, ASTRO® Spectra Plus™ radios and HPD 1000 Data Modems do not send presence and absence information to the location service when the radio powers on or powers off.

3.2.1
Periodic Reporting Ranges

IMW Location Service and APIs include a configuration parameter that enables setting the range of allowed values for the interval of a periodic location request. The allowed range is set per each device type.

Table 15: Periodic Reporting Ranges per Device Type

Network / Device Type	Default Range Minimum Value – Maximum Value
ASTRO Cellocator Network	30 seconds – 3.2 hours
ASTRO Trimble Network	30 seconds – 18 hours
ASTRO XTS Network	30 seconds – 24 hours
ASTRO APX Network	30 seconds – 24 hours

Network / Device Type	Default Range Minimum Value – Maximum Value
ASTRO High Performance Data (HPD) Network	10 seconds – 24 hours

The ranges per device type set the default and recommended validation range for each of the device types supported in the Location Service.

These ranges define the values a third-party application can send as the interval parameter when sending a Periodic Location Request through the Location LRRP or 3GPP APIs, assuming that it is allowed to control the radio configuration according to the configuration set in the Configuration Manager. Sending a request when the application is not permitted to do results in an "Operation not Permitted" error. If the third-party application sends an interval parameter that is not in the range for the device it will be automatically corrected by rounding it up or down to an allowed value and the application will be informed accordingly.

It is possible to change the default ranges to change the lower limitation. Changes to the default ranges must be performed by highly skilled personnel only, such as a system administrator, due to the impact they may have on the overall performance of the system. For additional information, see the *Configuration Manager User Guide*.

3.3 Services Provided to a Third-Party Application in an MDT

The ASTRO® 25 Outdoor Location solution enables receiving local GPS position updates on a Mobile Data Terminal (MDT) connected to the HPD 1000 Data Modem with an internal GPS module. This functionality is available using the ASTRO® 25 High Performance Data (HPD) Mobile Data Terminal Software Development Kit (SDK).

The HPD Mobile Data Terminal SDK is a tool used by application developers that allows in-vehicle mapping on an MDT. It is a tool that enables an application on the MDT to access the GPS coordinates from the HPD 1000 Data Modem, through a set of function calls and documentation to support those function calls. It also allows an application to configure the local reporting policy of the HPD 1000 Data Modem.

The HPD Mobile Data Terminal SDK acts as a router between the in-vehicle mapping application and the HPD 1000 Data Modem internal GPS.

The SDK is a compiled code library interface that provides function calls and asynchronic events for location services for use by in-vehicle mapping applications. The SDK exposes functions and events through an interface that can be used from a .NET environment or from a Visual Basic 6 and Visual C++ environments using a COM Wrapper.

The main services provided by the ASTRO® 25 HPD Mobile Data Terminal SDK to an in-vehicle mapping application include:

- Location on demand
- Periodic or distance-based location updates
- Stop location reporting

NOTICE: An MDT connected to an HPD 1000 Data Modem can receive local location updates through the ASTRO® 25 HPD Mobile Data Terminal SDK and also transmit location independently (through the MDT) to the CEN using the ASTRO® 25 Location Proxy and a Middleware VPN Solution.

3.4 Services Provided by the Location Service and APIs

The following sections briefly describe the services offered by the Location Service and APIs.

3.4.1
Location Service

The Location Service acts as a communication and business logic gateway to handle GPS and telemetry messages. It parses and processes them to transform them from their original protocol to a unified protocol: Motorola Location Request/Response Protocol (LRRP), the 3GPP Parlay X Protocol, or the Location REST protocol. The Location Service exposes a Location APIs to allow third-party mapping application or any other location-consuming back-office system to easily integrate to receive the location, presence, and telemetry information, and to send commands to the devices.

Explanation of data flow:

From the GPS devices to the third-party location application, the Location Service:

- Receives GPS and Telemetry Data from ASTRO® 25 and third-party devices.
- Communicates with the Presence Service for presence information.
- Processes the received data by decompressing the over-the-air protocols. It also translates disparate protocols into a unified protocol, thus providing a single integration point for application developers.
- Sends location, telemetry, and presence data to third-party applications through the IMW APIs, according to the configuration set in the Configuration Manager.

From the third-party location application to the GPS devices, the Location Service:

- Receives requests from location applications through the IMW APIs.
- Verifies that the application has the appropriate permissions to perform the operation according to the configuration set in the Configuration Manager.

  NOTICE: For multiple applications mode only.

- Translates the requests to the protocol of the device that it is communicating with.
- Provides intelligent routing of messages by managing requests to devices. This routing ensures, for example, that no messages are sent to absent devices, which reduces traffic on the network.
- Forwards the requests to the GPS devices.

3.4.2
IMW REST & WebSocket, 3GPP Parlay X, and LRRP APIs

The purpose of the ASTRO® 25 Location LRRP API, IMW REST & WebSocket APIs, and 3GPP Parlay X API is to allow third-party applications to obtain GPS, presence, and telemetry information from the GPS devices. The Location APIs also allow sending commands to the GPS devices.

The LRRP API is composed of data messages that are based on LRRP. LRRP is an XML-based protocol that defines a set of XML messages that allow the application to receive Location, Presence, and Telemetry reports from the devices and an additional set of messages that allow the application to send commands to the devices.

The 3GPP Parlay X-based web services API uses generally accepted SOAP-based web services technologies. It implements proprietary extensions to the 3GPP specification to provide telemetry data to subscribing applications. Additionally, new interfaces have been added to the Parlay X set of interfaces to change the reporting rate of a device from the mapping application, to subscribe for telemetry data and to monitor availability of the Location Service.

The REST & WebSocket APIs transfer presence and location data in the form of JavaScript Object Notation (JSON) documents, which is a lighter, simpler alternative to XML-based messages.

The IMW APIs include the following main messages or features:

- Third-party application registration to the API

NOTICE: Up to three application registrations at a time.

- Forwarding of the location reports from devices to third-party applications
- Over the air configuration of the location reporting policy for devices
- Querying instant location of a device
- Stop device location reporting
- Presence indication of ASTRO® 25 radios

NOTICE:

- The Location Service includes a module called the Configuration Manager that gives the flexibility to define which application is allowed to view and which application is allowed to control each of the GPS devices defined in the system.
- Changes made to the reporting policy of a device by the controlling application affect all applications that are configured to view the device.
- Multiple applications may have the option of querying the current location of a device.

Naming Conventions

Table 16: Triggers in Location APIs

Depending on the type of the Location API used, there are different terms for “Interval”, “Distance” and “Reporting Time Threshold”. The table presents the naming conventions for Location triggers across Location Application Programming Interfaces (APIs).

Configuration Manager	Parlay X	LRRP
Interval	Rate	interval
Distance	Distance	trg-distance
Reporting Time Threshold	MinimumInterval	interval

NOTICE: In LRRP, the meaning of “interval” depends on whether it is provided with or without a **trg-distance** parameter: If provided without a **trg-distance** parameter, then it is treated the same as the Parlay X Rate parameter; if provided with a **trg-distance** parameter, then it is treated the same as the Parlay X **MinimumInterval** parameter.

3.5 Constraints of the Location Services

The ASTRO® 25 Outdoor Location Solution is intended for use only in outdoor locations and not in buildings or structures. In specific situations, due to the limitations of the GPS technology, a user can be outside and will not have GPS coverage. This is due to the limitation of the GPS technology itself. For example, GPS does not work well in buildings, tunnels, parking garages, and heavy tree coverage. The system provides the outdoor location of the following (see ASTRO 25 Outdoor Location Solution Supported Configurations on page 16):

- All personnel carrying a GPS-enabled portable radio that is equipped with a GPS RSM.
- All personnel carrying a GPS-enabled portable radio that is equipped with an internal GPS Module.
- A mobile radio that is equipped with an internal GPS Module.
- An HPD 1000 Data Modem with internal GPS
- An ASTRO mobile IV&D or HPD radio that is GPS enabled with one of the external GPS units supported as part of the ASTRO® 25 Outdoor location Solution including the Cellocator Olympic for

ASTRO, Trimble Placer™ Gold APU or Placer™ Gold DRU Plus in an open sky (clear view of the sky with no obstructions) environment.

NOTICE: The Trimble Placer™ Gold DRU Plus unit provides dead reckoned position when no GPS coverage is available.

The acquisition of the location data is done by the GPS device. The acquisition depends on the ability of these devices to receive sufficient and proper signals from the GPS satellites.

Chapter 4

Outdoor Location Solution – Operations Related to the XTS Portable Radios

This chapter describes the operation of the XTS radios as part of the ASTRO® 25 Outdoor Location Solution including the Location and Presence Services.

4.1 Operational Overview of the Location Services of XTS Portable Radios

The Outdoor Location Solution provides the location information of XTS portable radios with a GPS RSM (see ASTRO 25 Outdoor Location Solution Supported Configurations on page 16 for radio model information). The location information is either an error status or consists of at least longitude, latitude, and Universal Time Coordinated (UTC) date and time of the fix. See Services Offered by the Outdoor Location Solution on page 44 for information about the services offered by the Location Service.

IMPORTANT: The Location Service supports GPS RSM v1.0 and v2.0. This includes allowing configuration of different reporting policies such as more frequent reporting intervals for the GPS RSM v2.0.

NOTICE:

- An XTS portable radio does not provide unsolicited location updates. A third-party application must send a location request to the Location Service, which in turn, sends the request to the portable radio. For a location update on emergency, the Location Service, on its own, sends a location request when the portable radio powers on. Alternatively, the Location Service can be configured to send a location request on behalf of the application.
- The portable radios do not store the location requests persistently and therefore an application should send a fresh location request to a portable radio, every time the radio powers on, if the Location Service is not programmed to do so on its behalf
- The portable radios do not support any digital input or output.
- The APX and XTS networks are not interchangeable in the Location Service.

4.1.1 Services Enable/Disable – XTS

There are two methods of enabling/disabling the Location Service of a radio:

Using Customer Programming Software (CPS)

The user can enable or disable the Location Service of a radio completely using the Customer Programming Software (CPS). If the user disables the Location Service using CPS, none of the services (shown in Services Offered by the Outdoor Location Solution on page 44) of the Location Service are available. This includes the location service to a local radio user and the location service to a third-party application. Therefore, when the location service is disabled through CPS, the local location data on the radio is not available, and the radio will not return any LRRP messages for a received location request.

NOTICE: When the location service is disabled through the CPS, the user cannot enable it on the radio and it can only be enabled through the CPS.

Using CPS, it is also possible to enable or disable the Presence Service of a radio (called **Automatic Registration Service** (ARS) in the CPS tool). The disabling of the Presence Service does not affect the display of the icon for GPS status or the location data to the radio user. However, no location updates are sent to the third-party application if it is using the presence information of a radio to send a location request to the radio.

Using the Radio

The radio user can disable and enable the Location Service. When the Location Service is disabled by the user, Location Data is not available to the radio user, including the icon for GPS Status. In addition, when the location service is disabled by the radio user, location data is sent to a third-party application only in the event of an emergency. For any other location request, the radio returns an LRRP message (result code = “NO PROVIDERS”). This feature of enabling and disabling by a radio user can itself be enabled or disabled by the CPS.

4.1.2 GPS Status to a Radio User

An icon is displayed on the radio to indicate that the Location Service is enabled. The absence of the icon indicates that the Location Service is disabled (either by CPS or by the radio user). The icon flashes during poor or no GPS signal, and it is continuously on when the GPS signal is detected.

4.1.3 Location Update to a Radio User – XTS

The radio displays a location menu when its user presses the Location soft key. If the GPS Remote Speaker Microphone (RSM) is not connected, then the radio generates a bad key tone; otherwise it generates a good key tone and displays the menu. On pressing the **Refresh** soft key, the radio requests the GPS RSM for a location update. If the GPS RSM has a location data that is less than two seconds old then it returns the location data; otherwise, it acquires fresh data. The following table shows this operation:

Table 17: State of Location Acquisition

State of Location Acquisition	First line of Display	Location Icon	Comments
Pending	“PLEASE WAIT ”	Flashing/Solid	The GPS RSM is acquiring the location.
Successful	“ ” (blank line)	Solid	The GPS RSM returns the location. The radio generates a good key tone.
Failed	“ NO SERVICE ” (temporary display)	Flashing	The GPS RSM returns an error. The radio generates a bad key tone.
Stored	“PREVIOUS LOC”	Flashing	The **Failed** state changes to **Stored** state after two seconds.

State of Location Acquisition	First line of Display	Location Icon	Comments
Off	“LOCATION OFF”	Off	The Location Service is disabled by the radio user.

The first line of display shows the state of location acquisition. The second line of display shows the latitude and the third line shows the longitude of the last known location.

The fourth line of the radio display shows a **Refresh** soft key. On pressing the **Refresh** soft key, the radio requests the GPS RSM to acquire a new location; otherwise, the radio requests a new location periodically and the location data is updated every up to eight minutes for GPS RSM v1.0. In the case of GPS RSM 2.0, the radio automatically requests the GPS RSM for a new location every 4 minutes for the Location Display of the radio. In the background, the GPS RSM 2.0 obtains location continuously.

4.1.4
Local GPS Position Update to a Radio User – XTS

Users of a supported GPS-enabled model of the XTS portable radios that are equipped with a GPS RSM can initiate a local GPS position update using the location menu on the radio, and the radio displays the user’s current GPS position (latitude and longitude). The location information is also updated automatically every eight minutes, if the received GPS signal is sufficient.

The local GPS position update feature is independent of the ASTRO® 25 network; therefore, it can be used in a standalone manner. This means it can be used on an ASTRO® 25 network without the Integrated Voice and Data (IV&D) feature, or even in a fire ground scenario where radios are used in a radio-to-radio manner and no network is used at all. Since these situations are not using a “data pipe”, the GPS location coordinates cannot be transmitted over-the-air to the dispatcher/operator. However, the GPS RSM can still receive latitude and longitude coordinates from the GPS satellites (assuming in line of sight of the satellites) and display them on the supported models of the XTS portable radios, enabling the radio user to verbally communicate the position over-the-air. When the user presses the Push-To-Talk (PTT) button, the radio exits the Location Display and returns to the **Home** menu to display its current operating channel and zone. The user may re-enter the Location display while the PTT is still pressed.

4.1.4.1
Operation – XTS

While in the **Location Display** menu, the radio user of a supported model of the XTS radios can press **Refresh** to obtain a new location. If the location is available, the radio user hears a good key tone and sees the new location (latitude/longitude) on the display. If no location is available, the radio user hears a bad key tone and “Previous Location” is shown along with the last latitude/longitude that was available.

Location Service on/off

The radio configuration can be programmed through the CPS to allow the radio user the ability to turn the Location Service functionality on/off through the radio menu display. If the radio user presses the **Emergency** button while the Location Service is turned off from the radio menu display, the radio user’s GPS location is sent back to the dispatcher. However, the dispatcher requests for location are not answered and an error message is received instead.

IMPORTANT: If the Location Service is disabled through the CPS, the radio does not return any LRRP messages for a received location request including errors. In addition, the dispatcher does not receive the radio user's location if the **Emergency** button is pressed.

Location status indicator

The indicator is an icon on the display that indicates the status of the location signal. The Location indicator is **off** when the Location Feature is disabled, flashing during no signal/acquiring signal, and continuously **on** when the signal is detected.

Location status indicator

If individuals who are out of coverage of the GPS signal initiate position updates, they are not able to obtain their current position information when initiating the update.

Location display

On request from a radio user, the radio displays the current location on its screen. The radio also automatically updates the location every eight minutes, if the received GPS signal is sufficient.

The Location Service does not provide a way for the radio user to trigger a location update to a third-party application. It also does not provide storage of previous locations in the radio.

4.1.5
Location Update to Third-Party Applications – XTS

A radio sends location updates to an application only on request from the application and according to the configuration set in the Configuration Manager. The request is made in three steps.

- A registered third-party application makes a request to the Location Service
- The Location Service validates that the application making the request is allowed to control the radio and sends an error if it is not.
- The Location Service makes a request to the XTS radio.

NOTICE: It is possible to configure the Location Service, on a per radio basis, to automatically send a periodic request for each XTS radio that was powered on.

The Location Service and the application use LRRP in XML form or the 3GPP Parlay X web services SOAP-based interface for exchanging location-related requests and responses, whereas the Location Service and the portable radio use LRRP in MBXML form for exchanging location-related requests and reports. The LRRP requests and responses are transported between a radio and the Location Service using User Datagram Protocol/Internet Protocol version 4 (UDP/IPv4). The UDP/IPv4 messages from a radio are wrapped into Association of Public-Safety Communications Officials (APCO) 25 Packet Data Unit (PDU) before sending over-the-air. Depending upon the configuration of the ASTRO® 25 IV&D system, these PDUs use unconfirmed/confirmed and/or protected data services to transport the UDP/IPv4 datagrams over-the-air. The location requests and responses are transported between the Location Service and an application using TCP/IPv4 for the LRRP API and using the web services SOAP-based interface for the 3GPP Parlay X API.

4.1.5.1
Single Location Update – XTS

A request for a single location update from a radio includes the following actions:

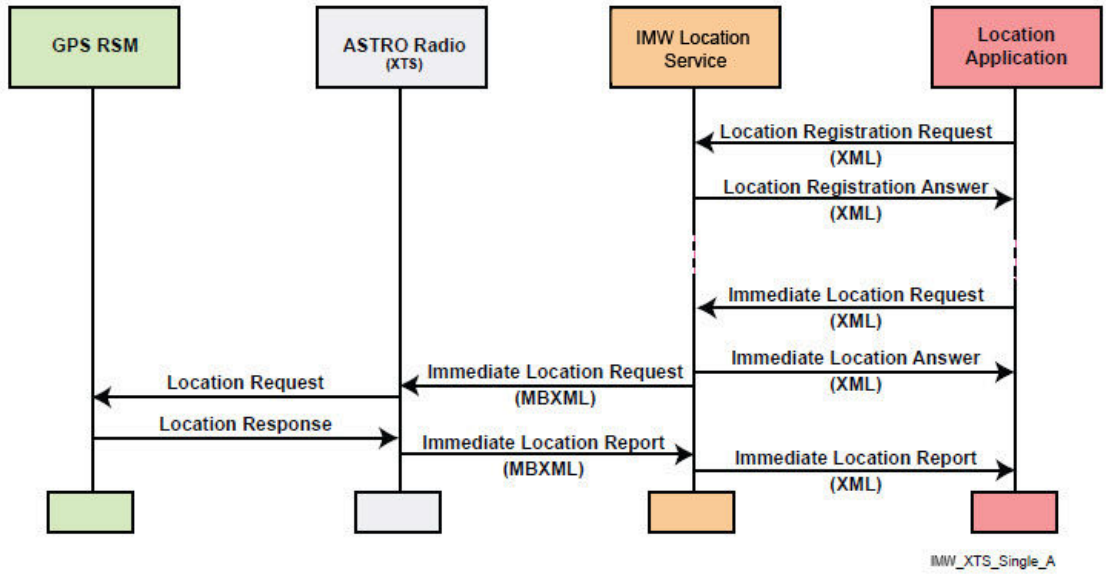
- A registered location application sends an Immediate Location Query to the Location Service .
- On receipt of a request for an immediate location update, the Location Service validates that the application is allowed to perform the operation it is trying to perform. If the application is not permitted to perform the operation an error is generated to the application; otherwise the Location Service sends an acknowledgment back to the third-party application.
- The Location Service sends an Immediate-Location-Request document of LRRP (in MBXML form) to the portable radio (XTS).
- The radio requests a location update from the GPS RSM.
  - If the GPS RSM has location data that is less than ten seconds old, it returns the location data immediately.

- If the location data is older than ten seconds, the GPS RSM starts a fresh acquisition and returns the location data after successful acquisition or the last known valid location data after a failed acquisition.
- If last known valid location information is not available (after power cycle), the GPS RSM returns an error.

• The Location Service forwards the report to the application(s) according to the configuration set in the Configuration Manager.

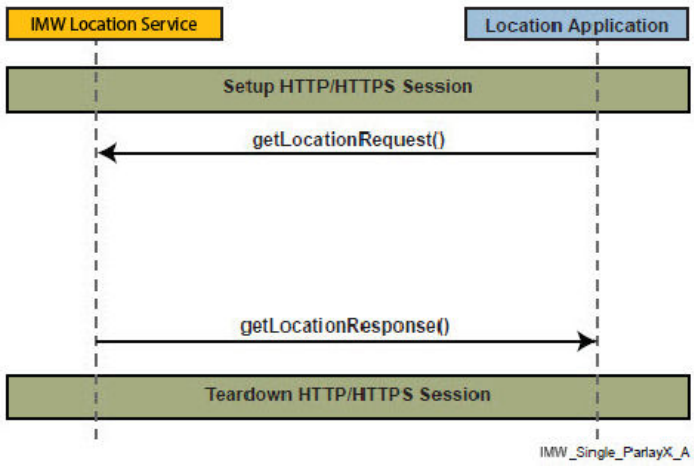
The following figures show a request for a single location update from a radio.

Figure 7: Single Location Request and Report using the LRRP Application Interface



Third-party location applications are not required to send a Location-Registration-Request for each immediate-location-request. This registration process detailed in this diagram (request and response) occurs once when a location application initially connects to the Location Service.

Figure 8: Single Location Request and Report using the Parlay X-Based Interface



NOTICE: The Parlay X-based interface only shows the unique messaging between the application and the IMW server. The messaging between the IMW server and the device are the same for both examples.

4.1.5.2

Periodic Location Update – XTS

A third-party application may use the periodic location update to track a radio. A periodic request saves the air interface bandwidth by sending one request for multiple location updates.

The process behind a request for periodic location updates from a radio includes the following:

- A third-party location application sends a Periodic Location Reporting Request with a **periodic-trigger** to the Location Service.
- On receipt of a request for periodic location updates, the Location Service validates that the application is allowed to perform the operation it is trying to perform. If the application is not permitted to perform the operation an error is generated to the application; otherwise the Location Service sends an acknowledgment back to the third-party application. After sending the acknowledgment, the Location Service sends a Triggered-Location-Request (in MBXML form) to the radio. The periodic trigger may contain a time interval, a distance interval, or both.
- The radio acknowledges with a Triggered-Location-Answer (in MBXML form).
- The radio requests the GPS RSM for a location update.
  - If the GPS RSM has location data that is less than ten seconds old, it returns the location data immediately.
  - If the location data is older than ten seconds, the GPS RSM starts a fresh acquisition and returns the location data after successful acquisition or the last known valid location data after a failed acquisition.
  - If last known valid location information is not available (after power cycle) the GPS RSM returns an error (no providers).
- The radio uses the Triggered-Location-Report document of LRRP to send the response to the Location Service, which forwards the report to the third-party applications according to the configuration set in the Configuration Manager module.

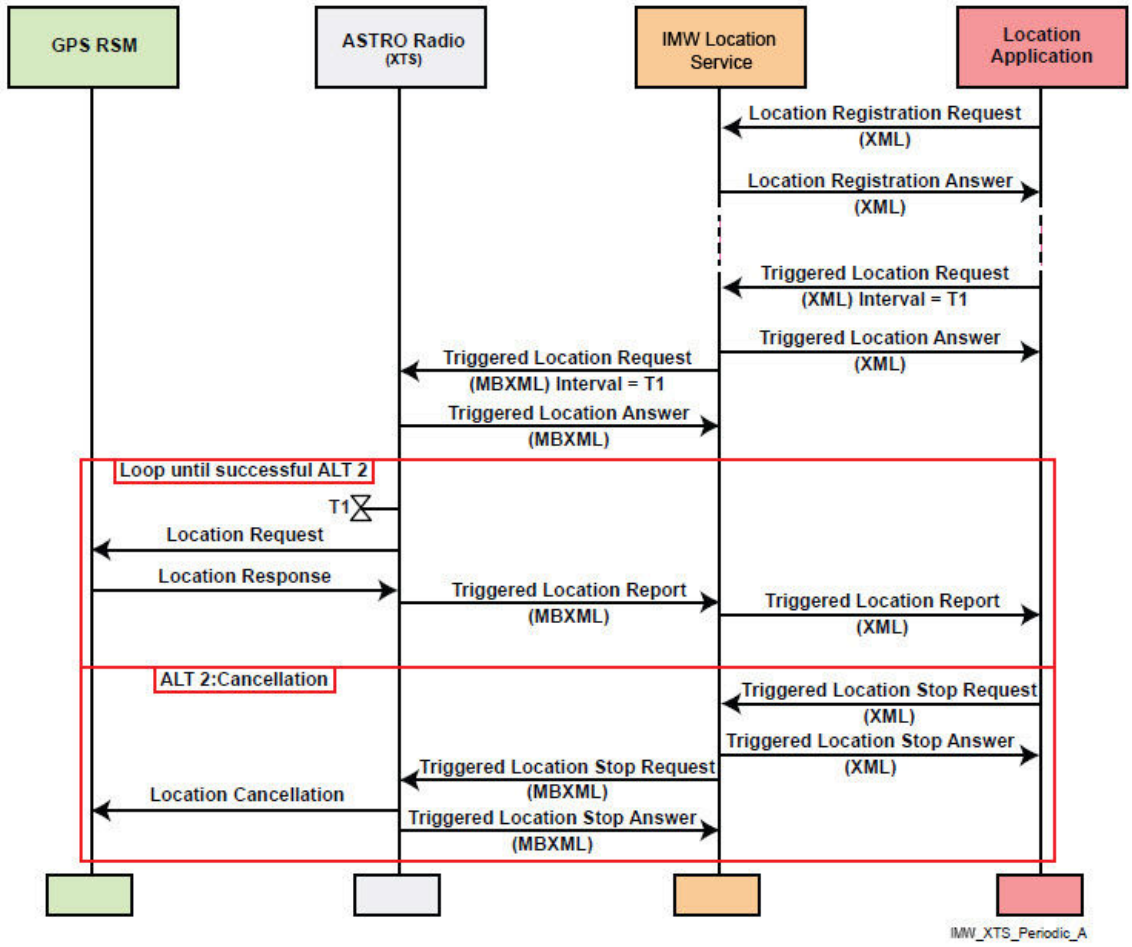
  NOTICE: Since it takes the GPS RSM time to acquire a new location fix, the time between reports may be inconsistent.
- If the periodic trigger has an interval, the radio repeats the previous steps after every expiry of the specified interval.
- If the periodic trigger has a distance, the GPS RSM acquires a new GPS fix every 10 seconds. The radio calculates the distance moved from the last reported position, and if it is more than the specified distance, the radio sends a response.
- If the periodic trigger has both interval and distance, the radio sends responses **only** when both conditions are met: the specified interval expires and the distance moved is more than the specified distance. If you want the radio to send a report when either condition is met (interval expiry or distance traveled), two separate periodic triggers need to be set.
- The periodic responses continue until the radio is powered off, the request is canceled by a third-party application, or the radio is switched to another radio network system.
- A request to stop periodic update can be made by the application to stop periodic reporting.

  NOTICE: If a request to stop the periodic update is sent to a radio (as a result of a new periodic request being made to the radio or as a result of a stop location reporting request to a radio) at a time when the radio is servicing the existing request, a result code 11 is generated as part of the first report being sent out from the radio. This result code is informational and does not indicate an operational error.
- The Location Service acknowledges the request to stop the periodic updates.

IMPORTANT: For the GPS RSM 1.0, it is recommended that to conserve the battery power of a radio and the channel capacity, a third-party application should ensure that the interval of the periodic request is not less than 240 seconds. If faster updates are required, then the location application should ensure that such updates are for short periods (approximately 30 minutes). In addition, a third-party application should ensure that a distance-based request is used for a limited period of time (approximately 30 minutes) due to power consumption considerations.

The following figures show the process behind a request for periodic location updates from a radio:

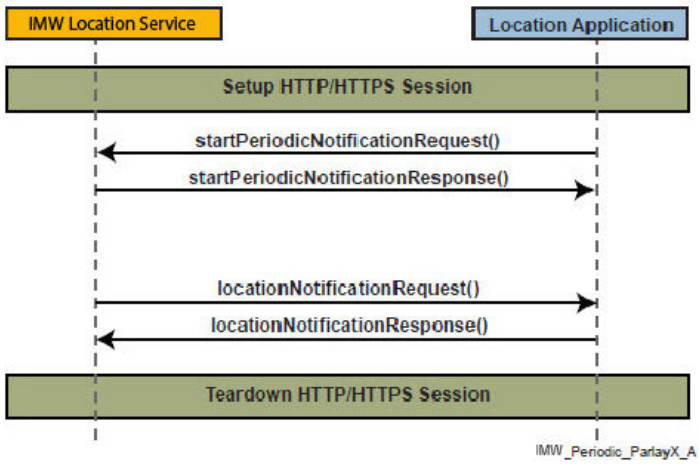
Figure 9: Periodic Location Request and Report using the LRRP Application Interface



- When using the LRRP API, the application can send one or two Triggered Location Requests where one can include distance and, optionally, interval and the second includes only interval. Each request is treated independently, that is, if the distance trigger is satisfied, then a location report is sent; if the second (interval only) trigger is satisfied, then a location report is sent.
  When two location requests are sent (distance and a separate interval), each request must be assigned a separate request ID by the requesting application. The request ID differentiates the requests for the same device. Failure to use unique request IDs will cause only the last trigger request received to be honored.
- Third-party location applications are not required to send a Location-Registration-Request for each triggered-location-request. This registration process shown in this diagram (request and response) occurs once when a location application initially connects to the Location Service.
- A radio does not keep the triggered location request in persistent memory, and therefore a third-party application must send a location request on power on of the radio.

- Altitude is not requested with a distance-based trigger. It may cause unexpected and frequent location updates since altitude causes 3-D distance calculation. If altitude is inaccurately determined due to poor satellite geometry, the distance calculated could change significantly even when the ground distance is small.

Figure 10: Periodic Location Request and Report using the Parlay X-Based Interface



NOTICE: The Parlay X-based interface only shows the unique messaging between the application and the IMW server. The messaging between the IMW server and the device are the same for both examples.

4.1.5.3
Location Update on Emergency – XTS

The Location Service provides the location of a portable radio (XTS) to registered third-party applications when the radio user triggers an emergency alarm, or an emergency alarm and call, according to the configuration set in the Configuration Manager module.

.The process behind an emergency location update from a radio includes the following actions:

- To obtain the location on emergency, the Location Service sends the Triggered-Location-Request document containing a Trg-condition with a trigger-code representing Emergency when the radio is powered on. The Presence Service notifies the Location Service when the radio is powered on. To receive presence notifications, the Location Service subscribes to receive the Presence Service for the radio.

  NOTICE: The Location Service performs the emergency location request internally. There is no need for an application to perform any additional actions.

- On receipt of the emergency request, the radio registers the interest of the Location Service.
- On occurrence of an emergency, the radio requests the GPS RSM for a location update.
  - If the GPS RSM has location data that is less than ten seconds old, it returns the location data immediately.
  - If the location data is older than ten seconds, the GPS RSM starts a fresh acquisition and returns the location data after successful acquisition or the last known valid location data after a failed acquisition.
  - If last known valid location information is not available (after power cycle) the GPS RSM returns an error (no providers).
- The radio waits for the end of any ongoing emergency processing (for example, after the emergency alarm and call is over or after the acknowledgment of emergency alarm by the console).
- The radio sends the location update (Triggered-Location-Report in MBXML) to the Location Service.

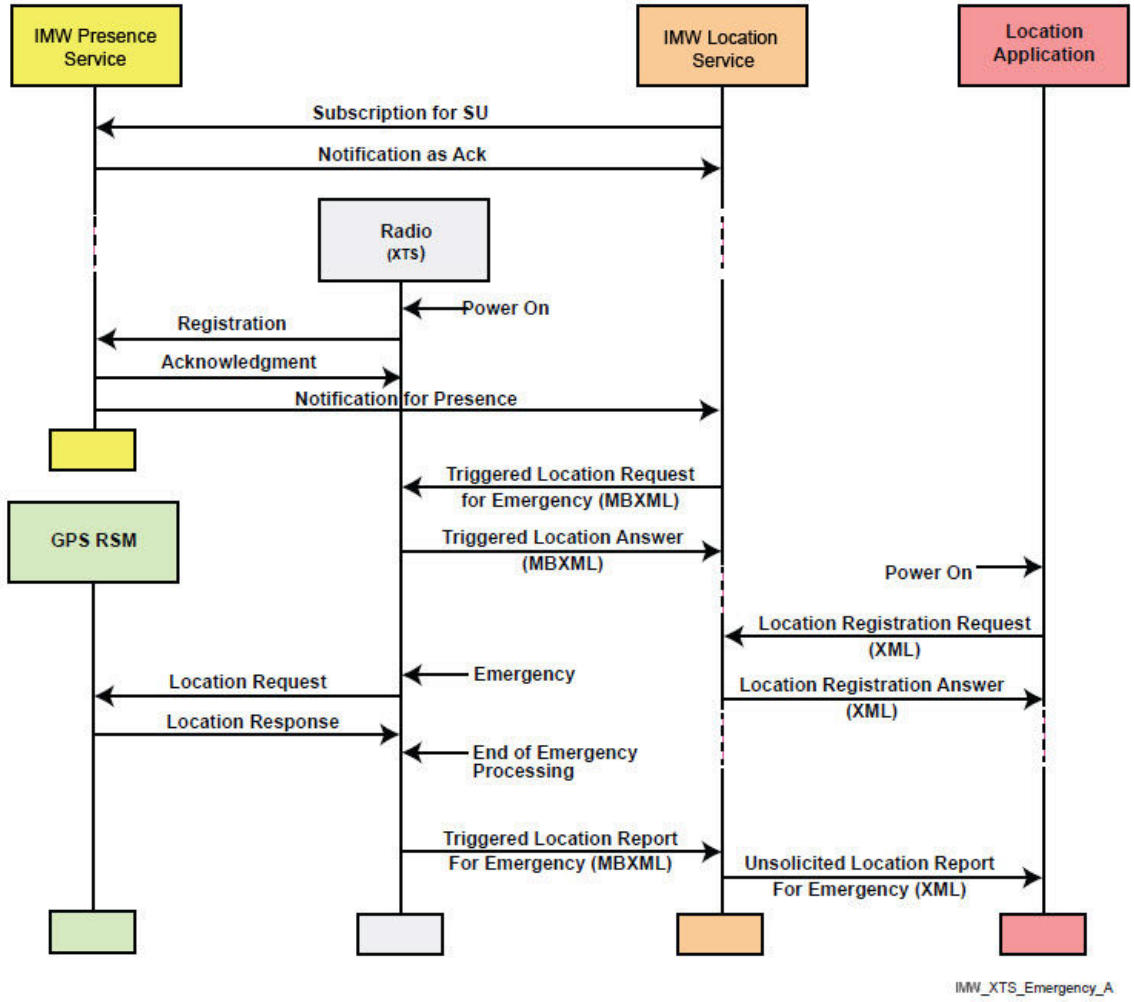
- The Location Service forwards the location information to the third-party application, according to the configuration set in the Configuration Manager module.

NOTICE: The XTS family of portable radios send the location update only after the processing of emergency is over (that is, after the emergency alarm and call ends or after the acknowledgment of the emergency alarm by the console). Since voice communication is important during an emergency, the radio does not entertain any new location requests from a third-party application during an emergency. The location requests are discarded by the ASTRO® 25 IV&D system, and an ICMP message is sent back.

The request for the location update in case of emergency is active until the radio is powered off or the radio is switched to another radio network system.

The following figure shows the process behind an emergency location request:

Figure 11: Emergency Location Request and Report



- For emergency, the application does not have to send any requests to the Location Service – it is handled by Location Service internally.
- This registration process shown in this diagram occurs once when a location application initially connects to the Location Service.

NOTICE: For the Parlay X-based interface, the Unsolicited-Location-Report for Emergency messages will be distributed in the same manner as a typical triggered location report notification

4.1.5.4
Location Update on Power-On – XTS

A radio does not provide an automatic location update on the power-on. The Presence Service notifies the Location Service when a radio powers on. On notification, the Location and Presence Services informs registered third-party applications, according to the configuration set in the Configuration Manager. An application that is receiving a presence indication should make an explicit request if it is interested in the location of the radio on the power on.

The user of the system has two options:

1. Configure the Location Service to automatically send a periodic request, with chosen interval, to each XTS radio that was powered on; this method is useful for a deployment that requires the radios to report at all times.
2. The API exposes the Presence Service, which notifies when a radio powers on. On notification, a third-party location application server should make an explicit request if it is interested in the location of the radio on the power on.

4.1.6
Location During Scan

The data services are not available when a radio is in Scan, and therefore the Location Service of a radio is not available during Scan.

4.2
Operational Overview of Presence Services of XTS Portable Radios

The IMW provides the presence/absence information of the radios (except the ASTRO® Spectra Plus™ and the HPD 1000 Data Modem with integrated GPS) to a registered third-party application. Presence Services accepts, stores, and distributes the presence information of radios to the Location Service for use in location applications. Presence Service receives a message when a radio is active on the system.

The Presence Service provides the following functionalities:

- Notifies the presence or absence of a radio to any data application such as the Location Service that has subscribed for that information.
  - The Presence Service receives registration/de-registration messages once the radio becomes active / inactive on the system. It also receives registration messages periodically, where the period is configurable in the Presence Service. The default is four hours, and the minimum is half an hour.
- Provides the attributes of a radio to any data application that has subscribed for that information. For example, the IP address of a radio (Internal Applications Only) or ID.
- Enables location applications to request the location of a radio on power-on through the IMW APIs.

The Presence Service has the following two components:

- **Registration Application** in the radio that sends its presence/absence state to the Presence Service.
- **Presence Service** that informs the application in the CEN about the presence/absence of selected radios.

The Presence Service communicates with the Registration Application in a radio using UDP/IP. The IPv4 address of the Presence Service is provisioned in the radio using Customer Programming Software (CPS). A radio registers itself only to the Presence Service, whose address is configured into the radio.

If the Presence Service is enabled in a radio, then on power on and periodically, the radio registers itself to its Presence Service. The radio also registers itself every time it reenters the radio data network (that is, the radio moves from a non-data capable channel to a data-capable channel). The radio de-registers itself on power-off. The Presence Service does not acknowledge the de-registration, but acknowledges the registration. The radio makes up to five attempts to register if it fails to receive an acknowledgment. If the radio is not able to register even after five attempts, then it keeps retrying after every 30 minutes.

On registration, the Presence Service changes the state of the radio to **present**. On de-registration by a radio and on failure to re-register after the specified period, the Presence Service changes the state of the radio to **absent**.

A registration is valid only for a specified period (default value is four hours) and the radio re-registers itself on expiry of the specified period.

NOTICE: The Presence Service stores the states of the radios in a persistent memory. On power-on, it uses the stored data to recover the states of the radios by querying all the radios whose registration is yet to expire. The Presence Service notifies the subscribing applications of the radios that failed to respond. The Presence Service cannot recover the state of a radio that was powered-on while the Presence Service was powered off. To overcome this problem, it is suggested that IMW server should be run on a PC with an Uninterruptible Power Supply (UPS). The details of a radio stay with the Presence Service forever. There is no way to remove a radio from the database of the Presence Service.

The Location Service subscribes to the Presence Service for the presence information of the radios of its interest. On receipt of a subscription, the Presence Service sends back an immediate response containing presence state, and if available, the IPv4 address of each radio listed in the subscription. The subscription is for a specified period and the Location Service can either renew the subscription or cancel the subscription within that period.

On change of the presence state of a radio, the Presence Service sends a notification to the Location Service for radios of its interest. The list of radios includes radios that the Location Service has subscribed to receive notifications for and that the subscription has not expired. The Location Service manages subscribing for presence notifications of radios of its interest internally. When a notification is received, the IMW Service sends the presence information to third-party applications via the IMW APIs in one of the two time frames:

1 When a third-party application registers to the IMW for service, it receives the current presence information of its relevant radios.

2 Whenever radios change their Presence state (such as connect or disconnect to the ASTRO network).

The Presence information is forwarded to the third-party applications via the IMW APIs.

4.3 Performance and Capacity – XTS Radios

The following sections provide information on the GPS performance considerations, enhancements, and radio battery life impact guidelines.

4.3.1 GPS Performance

The ASTRO®25 Outdoor Location Solution uses information from the GPS satellites orbiting the earth to determine the approximate geographical location of the radio, expressed as latitude and longitude. The availability and accuracy of this location information (and the amount of time that it takes to calculate it) vary depending on the environment in which the GPS feature is used.

For example, GPS location fixes are difficult to obtain indoors, in covered locations, between high buildings, or in situations where a clear broad view of the sky has not been established.

4.3.1.1
Performance Considerations

Since the GPS technology uses radio signals from earth-orbiting satellites to establish the location coordinates, maximizing the view of clear unobstructed sky is essential for optimum performance. If adequate signals from multiple satellites are not available, the GPS feature of the RSM does not work. Such situations include, but are not limited to:

- Underground locations
- Inside of buildings, trains, or other covered vehicles
- Under any other metal or concrete roof or structure
- Between tall buildings or under dense tree-cover
- In temperature extremes outside the operating limits of your RSM

Even when location information can be calculated in such situations, it may take longer to do so, and the location estimate may not be accurate. Therefore, in any emergency situation, verbally report the location to the dispatcher.

Even when adequate signals from multiple satellites are available, the GPS feature only provides an approximate location, within 25 meters 95% of the time in optimal GPS conditions for GPS RSM 1.0 and 15 meters 95% of the time for GPS RSM 2.0. The accuracy of the location information and the time it takes to obtain it varies depending upon circumstances, particularly the ability to receive signals from an adequate number of satellites. The accuracy of the information can be requested as part of the location response.

The satellites used by the GPS feature are controlled by the U.S. Government and are subject to changes implemented in accordance with the Department of Defense GPS User Policy and the Federal Radio Navigation Plan. These changes may affect the performance of the GPS feature on the RSM.

4.3.1.2
GPS Performance Enhancements for XTS 5000

Sometimes, the GPS feature of the RSM may be unable to complete a location calculation successfully. If this occurs, the GPS icon flashes, indicating that the RSM cannot see enough visible satellites. To maximize the ability of the RSM to determine a fix, use the following guidelines:

Stay in the open
The GPS feature works best when nothing is between the RSM and a large amount of open sky.

Wear the RSM outside all clothing
Keep it as high on the body as possible, ideally at the shoulder level.

NOTICE: For more information on the GPS RSM performance and specifications, see the *GPS RSM Spec Sheet*.

4.3.2
Optimal GPS RSM 1.0 Usage Guidelines

Motorola recommends the following usage guidelines for GPS Remote Speaker Microphone optimal performance:

- Motorola recommends that the GPS RSM battery is adequately charged. When the RSM battery is low, a unique tone is generated to indicate the low battery condition to the radio user, and all location reports to third-party applications include a “no providers” error without location information.

- Motorola recommends a minimum charge time of 8 hours or more in true indoor state to provide sufficient charge to the GPS RSM battery. To charge the GPS RSM battery, the RSM must be connected to the radio and the radio must be powered on.
- Motorola recommends a portable radio polling trigger rate of no more frequent than four minutes in regular operational mode.
- Motorola recommends avoiding using a distance-based system trigger for an extended period. If a distance trigger is required, the third-party application should ensure that it is used for a limited period (approximately 30 minutes) due to power consumption considerations.
- If the GPS RSM is shipped from one geographic location to another, it is recommended to perform a Forced Cold Start Procedure before providing GPS RSM to the end user. This procedure clears the GPS almanac* and ephemeris* (* satellite location information) and extends the initial GPS RSM Outdoor State search for 5 minutes to allow more time to reacquire satellites. The current almanac and ephemeris are collected automatically by the GPS RSM from the satellites during normal use at the new geographic location. For details on how to perform a Forced Cold Start Procedure, see the *GPS RSM User's Manual*.

NOTICE: A Forced Cold Start Procedure is performed in the factory before the RSM is shipped. This procedure should only be performed if the RSM has been operated in an initial geographic location and then shipped to a different location.

4.3.3
Optimal GPS RSM 2.0 Usage Guidelines

Motorola recommends the following usage guidelines for GPS Remote Speaker Microphone optimal performance:

- Motorola recommends that the radio battery be replaced with a charged battery when the radio low battery indicators starts flashing or the low battery tone is heard. This will ensure optimal GPS performance.
- Motorola recommends a portable radio polling trigger rate of no more frequent than 30 seconds in regular operational mode.
- Motorola recommends avoiding using a distance-based system trigger for an extended period. If a distance trigger is required, the third-party application should ensure that it is used for a limited period (approximately 30 minutes) due to power consumption considerations.

Chapter 5

Outdoor Location Solution – Operations Related to the APX Series of Mobiles and Portables

This chapter describes the operation of the APX series of mobiles and portables as part of the ASTRO® 25 Outdoor Location Solution including the Location and Presence Services.

5.1 Operational Overview of the Location Services – APX Series of Mobiles and Portables

The Outdoor Location Solution provides the location information of APX series of mobiles and portables with an internal GPS module. The location information is either an error status or consists of at least longitude, latitude, and Universal Time Coordinated (UTC) date and time of the fix. See Services Offered by the Outdoor Location Solution on page 44 for information about the services offered by the Location Service.

IMPORTANT: To achieve the best location reporting performance, IMW recommends using APX radios with ASTRO® 25 IV&D systems that employ the Enhanced Data feature. Enhanced Data is supported on ASTRO® 25 Trunked IV&D systems with GTR series site equipment.

NOTICE:
In a Cellocator and mobile APX radio configuration it is possible to utilize the advanced location and I/O functionality of the Cellocator GPS unit while at the same time utilizing the location on emergency feature of the APX radio. This functionality is available only from UNS 1.0 and onward.

For information regarding the operation of configurations that include the APX mobile radios with an external GPS device, such as the Cellocator Olympic for ASTRO, see Outdoor Location Solution – Operations Related to Mobile Radios with an External GPS Unit on page 83. In these configurations the APX radio acts as a data modem for sending data over the ASTRO® 25 IV&D network.

- The APX series of mobiles and portables does not provide unsolicited location updates. A third-party application must send a location request to the Location Service, which in turn, sends the request to the APX radio. Alternatively, the Location Service can be configured to send a request on behalf of the application according to the interval specified for the radio in the location service configuration. For the location update on emergency, the Location Service, on its own, sends a location request when the APX radio powers on.
- The APX radios do not store the location requests persistently and therefore an application should send a fresh location request to an APX radio, every time the radio powers on.
- The APX series of mobiles and portables do not support any digital input or output sensors at this time. If this functionality is needed it is possible to use the APX radio with the Cellocator Olympic for ASTRO GPS and Telemetry device, see Outdoor Location Solution – Operations Related to Mobile Radios with an External GPS Unit on page 83.
- The APX radios store the last valid GPS location that was successfully acquired in a location cache. This location is stored even when power is cycled in the radio. When GPS coverage is not available and the radio is not able to acquire a new location fix, it will transmit the last valid location

coordinates from the cache along with a timestamp indicating the time the location data was acquired.

- The APX and XTS networks are not interchangeable in the Location Service.

5.1.1
Services Enable/Disable – APX

There are two methods of enabling/disabling the Location Service of a radio:

Using Customer Programming Software (CPS)

The user can enable or disable the Location Service of a radio completely using the Customer Programming Software (CPS). If the user disables the Location Service using CPS, none of the services of the Location Service are available. This includes Location on Emergency, the location service to a local radio user and the location service to a third-party application. Therefore, when the location service is disabled through the CPS, the local location data on the radio is not available, and the radio will not return any LRRP messages for a received location request.

NOTICE: When the location service is disabled through the CPS, the user will not be able to enable it on the radio and it can only be enabled through the CPS.

Using CPS, it is also possible to enable or disable the Presence Service of a radio. The disabling of the Presence Service does not affect the display of the icon for GPS status or the location data to the radio user. However, no location updates are sent to the third-party application if it is using the presence information of a radio as a trigger to send a location request to the radio.

Using the Radio

The radio user can disable and enable the Location Service. When the Location Service is disabled by the user, Location Data is not available to the radio user, including the icon for GPS Status. In addition, when the location service is disabled by the radio user, location data is sent to a third-party application only in the event of an emergency. For any other location request, the radio returns an LRRP message (result code = “NO PROVIDERS”). This feature of enabling and disabling by a radio user can itself be enabled or disabled by the CPS.

5.1.2
GPS Status to a Radio User

An icon is displayed on the radio to indicate that the Location Service is enabled. The absence of the icon indicates that the Location Service is disabled (either by CPS or by the radio user). The icon flashes during poor or no GPS signal, and it is continuously on when the GPS signal is detected.

5.1.3
Location Update to a Radio User – APX

The radio displays a location menu when its user presses the Location soft key. On pressing the **Refresh** soft key, if the radio has a location data that is less than two seconds old then it returns the location data; otherwise, it acquires fresh data. The following table shows this operation:

Table 18: State of Location Acquisition

State of Location Acquisition	First line of Display	Location Icon	Comments
Pending	“PLEASE WAIT ”	Flashing/Solid	The APX radio is acquiring the location.
Successful	“ ” (blank line)	Solid	The APX radio returns the location. The radio

State of Location Acquisition	First line of Display	Location Icon	Comments
			generates a good key tone.
Failed	" NO SERVICE " (temporary display)	Flashing	The APX radio returns an error. The radio generates a bad key tone.
Stored	"PREVIOUS LOC"	Flashing	The **Failed** state changes to **Stored** state after two seconds.
Off	"LOCATION OFF"	Off	The Location Service is disabled by the radio user.

The first line of display shows the state of location acquisition. The second line of display shows the latitude and the third line shows the longitude of the last known location.

The fourth line of the radio display shows a **Refresh** soft key. On pressing the **Refresh** soft key, the radio tries to acquire a new location; otherwise, the radio tries to acquire a new location every 5 seconds.

5.1.4
Local GPS Position Update to a Radio User – APX

Users of a supported GPS-enabled model of the APX series of mobiles and portables that are equipped with an internal GPS module can initiate a local GPS position update using the location menu on the radio, and the radio displays the user's current GPS position (latitude and longitude). The location information is also updated periodically if the received GPS signal is sufficient.

The local GPS position update feature is independent of the ASTRO® 25 network; therefore, it can be used in a standalone manner. This means it can be used on an ASTRO® 25 network without the Integrated Voice and Data (IV&D) feature, or even in a fire ground scenario where radios are used in a radio-to-radio manner and no network is used at all. Since these situations are not using a "data pipe", the GPS location coordinates cannot be transmitted over-the-air to the dispatcher/operator. However, the APX radio can still receive latitude and longitude coordinates from the GPS satellites (assuming in line of sight of the satellites) and display them on the supported models of the APX radios (see ASTRO 25 Outdoor Location Solution Supported Configurations on page 16), enabling the radio user to verbally communicate the position over-the-air. When the user presses the Push-To-Talk (PTT) button, the radio exits the Location Display and returns to the **Home** menu to display its current operating channel and zone. The user may re-enter the Location display while the PTT is still pressed.

5.1.4.1
Operation – APX

While in the Location Display menu, the radio user of a supported model of the APX radios can press **Refresh** to obtain a new location. If the location is available, the radio user hears a good key tone and sees the new location (latitude/longitude) on the display. If no location is available, the radio user hears a bad key tone and "Previous Location" is shown along with the last latitude/longitude that was available.

Location Service on/off

The radio configuration can be programmed through the CPS to allow the radio user the ability to turn the Location Service functionality on/off through the radio menu display. If the radio user

presses the **Emergency** button while the Location Service is turned off from the radio menu display, the radio user's GPS location is sent back to the dispatcher. However, the dispatcher requests for location will not be answered and an error message will be received instead.

IMPORTANT: If the Location Service is disabled through the CPS, the radio does not return any LRRP messages for a received location request including errors. In addition, the dispatcher does not receive the radio user's location if the **Emergency** button is pressed.

Location status indicator

This is an icon on the display that indicates the status of the location signal. The Location indicator is off when the Location Feature is disabled, flashing during no signal/acquiring signal, and continuously on when the signal is detected.
If individuals who are out of coverage of the GPS signal initiate position updates, they will not be able to obtain their current position information.

Location display

On request from a radio user, the radio displays the current location on its screen. The radio also updates the location if the received GPS signal is sufficient every 5 seconds.
The Location Service does not provide a way for the radio user to trigger a location update to a third-party application.

5.1.5
Location Update to a Third-Party Application – APX

A radio sends location updates to an application only on request from the application.

The request is made in three steps.

- A registered third-party application makes a request to the Location Service.
- The Location Service validates if the application making the request is allowed to control the radio and sends an error if it is not.
- The Location Service makes a request to the APX radio.

NOTICE: It is possible to configure the Location Service to automatically send a periodic request for each APX radio that was powered on.

The Location Service and the application use either LRRP in XML form or the 3GPP Parlay X web services SOAP-based interface, for exchanging location-related requests and responses, whereas the Location Service and the APX radio use LRRP (in MBXML or EXI form) for exchanging location-related requests and reports. The LRRP requests and responses are transported between a radio and the Location Service using User Datagram Protocol/Internet Protocol version 4 (UDP/IPv4). The UDP/IPv4 messages from a radio are wrapped into Association of Public-Safety Communications Officials (APCO) 25 Packet Data Unit (PDU) before sending over-the-air. Depending on the configuration of the ASTRO® 25 IV&D system, these PDUs use unconfirmed/confirmed and/or protected data services to transport the UDP/IPv4 datagrams over-the-air. The LRRP requests and responses are transported between the Location Service and the application using TCP/IPv4. The 3GPP Parlay X requests and responses are transported between the Location Service and the application using a web services SOAP-based interface.

5.1.5.1
Single Location Update – APX

A request for a single location update from a radio includes the following actions:

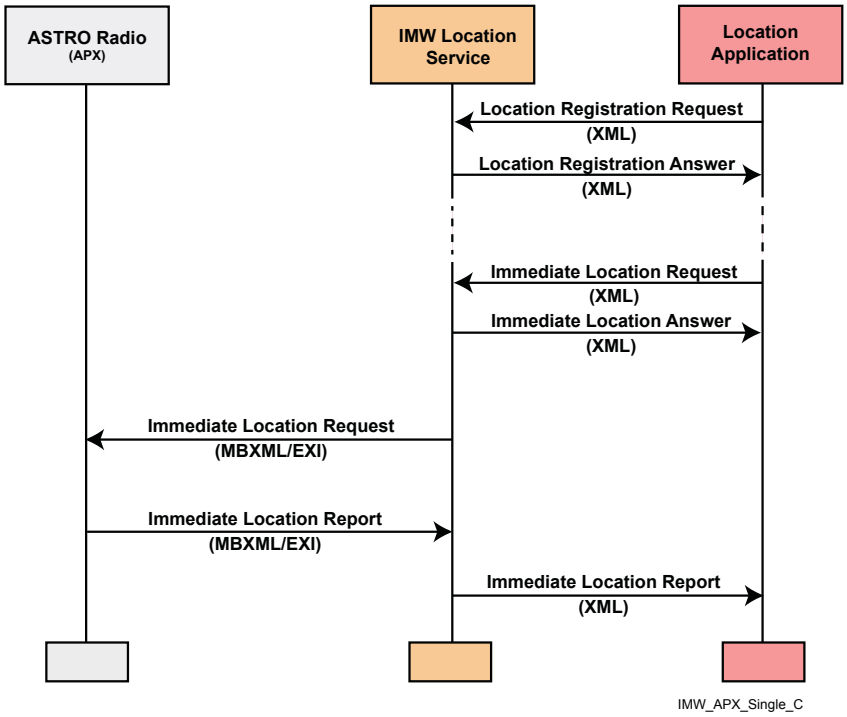
- A registered location application sends an Immediate Location Query to the Location Service directly via the LRRP API or via the IMW 3GPP Parlay X Interface.
- On receipt of a request for the immediate location update, the Location Service validates that the application is allowed to perform the operation it is trying to perform. If the application is not

permitted to perform the operation an error is generated to the application; otherwise the Location Service sends an acknowledgment back to the third-party application.

- The Location Service sends an Immediate-Location-Request document of LRRP (in MBXML or EXI form) to the APX radio.
- The radio initiates a location update as follows:
  - If the location cache has location data that is less than ten seconds old, it returns the location data immediately.
  - If the location cache data is older than ten seconds, the radio starts a fresh acquisition and returns the location data after successful acquisition or the last known valid location data after a failed acquisition.
  - If the last known valid location information is not available, the radio returns an error.
- The Location Service forwards the report to the application(s) according to the configuration set in the Configuration Manager and based on subscriptions from authorized applications.

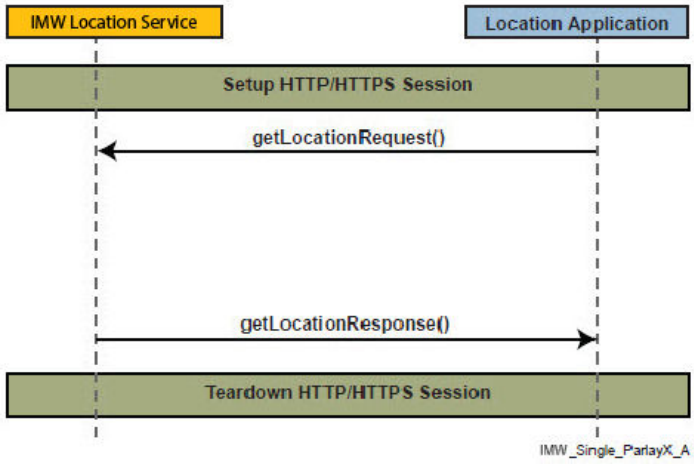
The following figures show a request for a single location update from a radio:

Figure 12: Single Location Request and Report using the LRRP Application Interface



Third-party location applications are not required to send a Location-Registration-Request for each immediate-location-request. This registration process shown in this image (request and response) occurs once when a location application initially connects to the Location Service.

Figure 13: Single Location Request and Report using the Parlay X-Based Interface



NOTICE: The Parlay X-based interface only shows the unique messaging between the application and the IMW server. The messaging between the IMW server and the device are the same for both examples.

5.1.5.2 Periodic Location Update – APX

A third-party application may use the periodic location update to track a radio. A periodic request saves the air interface bandwidth by sending one request for multiple location updates.

The process behind a request for periodic location updates from a radio includes the following actions:

- A third-party location application sends a Periodic Location Reporting Request with a **periodic-trigger** to the Location Service.
- On receipt of a request for periodic location updates, the Location Service validates that the application is allowed to perform the operation it is trying to perform. If the application is not permitted to perform the operation an error is generated to the application; otherwise the Location Service sends an acknowledgment back to the third-party application. After sending the acknowledgment, the Location Service sends a Triggered-Location-Request (in MBXML or EXI form) to the radio. The periodic trigger may contain a time interval, a distance interval, or both.
- The radio acknowledges with a Triggered-Location-Answer (in MBXML or EXI form).
- The radio initiates the procedure for a location update.
  - If the location cache has location data that is less than ten seconds old, it returns the location data immediately.
  - If the location cache data is older than ten seconds, the radio starts a fresh acquisition and returns the location data after successful acquisition or the last known valid location data after a failed acquisition.
  - If last known valid location information is not available the radio returns an error (no providers).
- The radio uses the Triggered-Location-Report document of LRRP to send the response to the Location Service, which forwards the report to the third-party applications, according to the configuration set in the Configuration Manager.

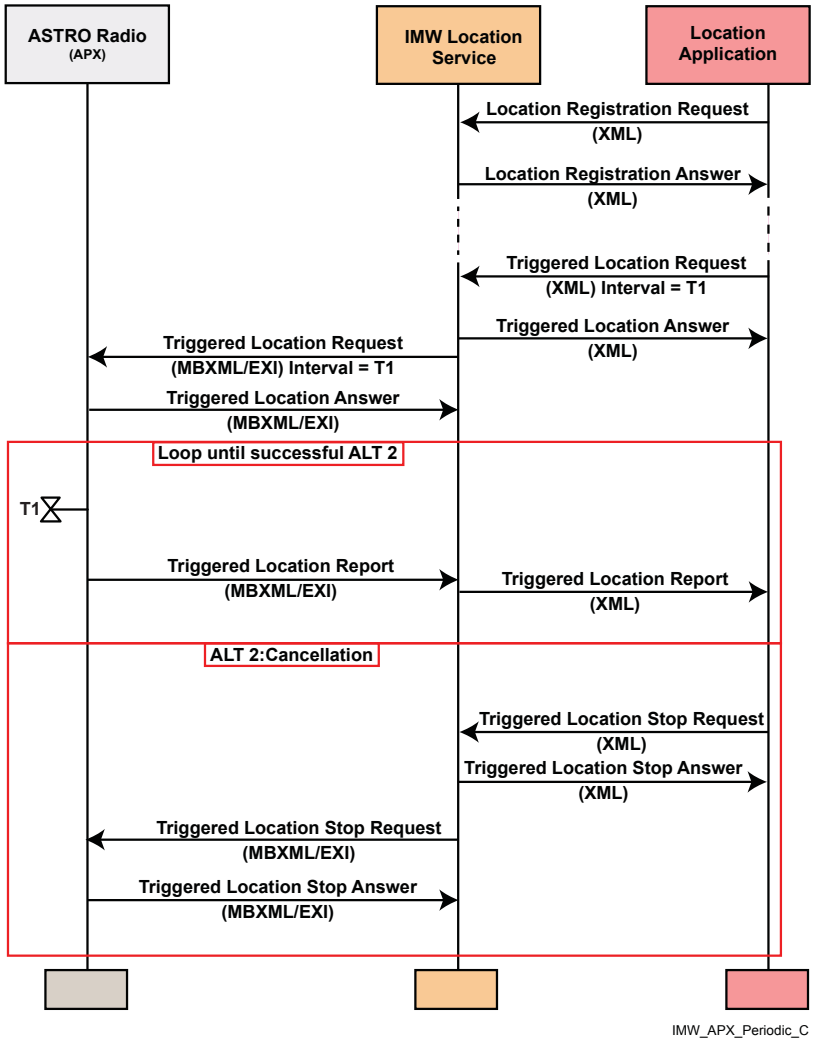
  NOTICE: Since the GPS module in the APX radios works in continuous mode – the GPS acquisition process takes considerably less time.
- If the periodic trigger has an interval, the radio repeats the previous steps after every expiry of the specified interval.

- If the periodic trigger has a distance, the radio acquires a new GPS fix every 2 seconds. The radio calculates the distance moved from the last reported position, and if it is more than the specified distance, the radio sends a response.
- If the periodic trigger has both interval and distance, the radio sends responses **only** when both conditions are met: the specified interval expires and the distance moved is more than the specified distance. If you want the radio to send a report when either condition is met (interval expiry or distance traveled), two separate periodic triggers need to be set.
- The periodic responses continue until the radio is powered off, the request is canceled by the third-party application, or the radio is switched to another radio network system.
- A request to stop the periodic update can be made by the application to stop periodic reporting.

  NOTICE: If a request to stop the periodic update is sent to a radio (as a result of a new periodic request being made to the radio or as a result of a stop location reporting request to a radio) at a time when the radio is servicing the existing request, a result code 11 is generated as part of the first report being sent out from the radio. This result code is informational and does not indicate an operational error.
- The Location Service acknowledges the request to stop the periodic updates.

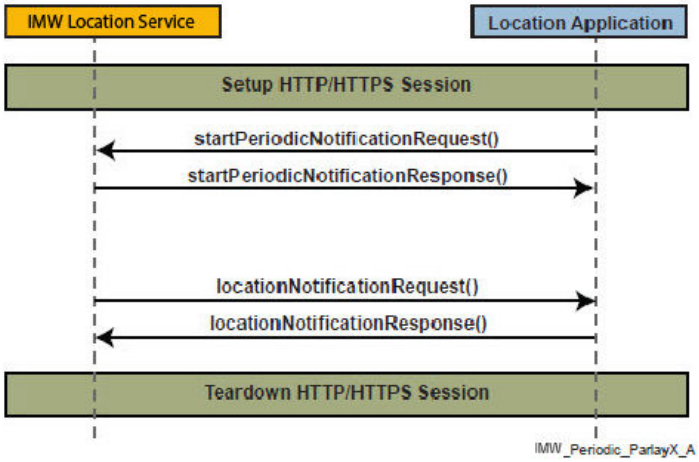
The following figures show the process behind a request for periodic location updates from a radio:

Figure 14: Periodic Location Request and Report using the LRRP Application Interface



- When using the LRRP API, the application can send one or two Triggered Location Requests where one can include distance and, optionally, interval and the second includes only interval. Each request is treated independently, that is, if the distance trigger is satisfied, then a location report is sent; if the second (interval only) trigger is satisfied, then a location report is sent.
  When two location requests are sent (distance and a separate interval), each request must be assigned a separate request ID by the requesting application. The request ID differentiates the requests for the same device. Failure to use unique request IDs will cause only the last trigger request received to be honored.
- Third-party location applications are not required to send a Location-Registration-Request for each triggered-location-request. This registration process shown in this diagram (request and response) occurs once when a location application initially connects to the Location Service.
- A radio does not keep the triggered location request in persistent memory, and therefore a third-party application must send a location request on power-on of the radio.
- Altitude is not requested with a distance-based trigger. It may cause unexpected and frequent location updates since altitude causes 3-D distance calculation. If altitude is inaccurately determined due to poor satellite geometry, the distance calculated could change significantly even when the ground distance is small.

Figure 15: Periodic Location Request and Report using the Parlay X-Based Interface



NOTICE: The Parlay X-based interface only shows the unique messaging between the application and the IMW server. The messaging between the IMW server and the device are the same for both examples.

5.1.5.3 Location Update on Emergency – APX

The Location Service provides the location of an APX radio to a registered third-party application when the radio user triggers an emergency alarm, or an emergency alarm and a call, according to the configuration set in the Configuration Manager.

The process behind an emergency location update from a radio includes the following actions:

- To obtain the location on emergency, the Location Service sends the Triggered-Location-Request document containing a Trg-condition with a trigger-code representing **Emergency** when the radio is powered on. The Location Service is notified by the Presence Service when the radio is powered on. To receive presence notifications, the Location Service subscribes to receive the Presence information for the radio from the Presence Service.

  NOTICE: The Location Service performs the emergency location request internally. There is no need for an application to perform any additional actions.

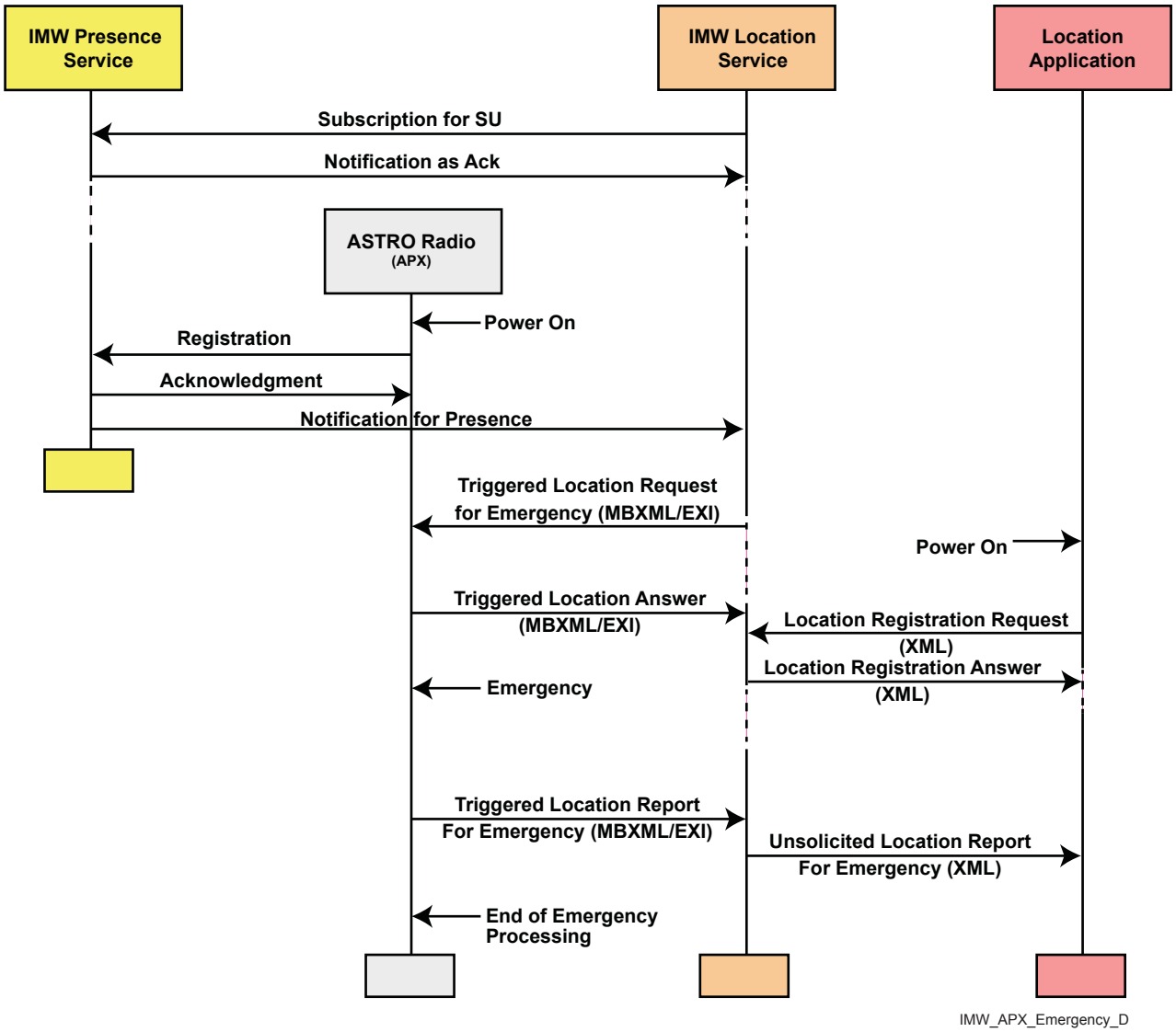
- On receipt of the emergency request, the radio registers the interest of the Location Service.
- On occurrence of an emergency, the radio initiates the process for a location update.
  - If the location cache has location data that is less than ten seconds old, it returns the location data immediately.
  - If the location data is older than ten seconds, radio starts a fresh acquisition and returns the location data after successful acquisition or the last known valid location data after a failed acquisition.
  - If the last known valid location information is not available, the radio returns an error (no providers).
- The radio waits for the end of any ongoing emergency processing (for example, after the emergency alarm and call is over or after the acknowledgment of emergency alarm by the console).
- The radio sends the location update (Triggered-Location-Report in MBXML or EXI form) to the Location Service periodically until the emergency is canceled on the radio.
- The Location Service forwards the location information to the third-party application, according to the configuration set in the Configuration Manager.

NOTICE: The location update is sent by APX radios only after the processing of emergency is over (that is, after the emergency alarm and call end or after the acknowledgment of the emergency alarm by the console). Since voice communication is important during an emergency, the radio does not entertain any new location requests from a third-party application during an emergency. The location requests are discarded by the ASTRO® 25 IV&D system, and an ICMP message is sent back.

The request for the location update in case of emergency is active until the radio is powered off or the radio is switched to another radio network system.

The following figure shows the process behind an emergency location request:

Figure 16: Emergency Location Request and Report



- For emergency, the application does not have to send any request to the Location Service – it is handled by Location Service internally.
- The third-party location application is not required to send a Location-Registration-Request for each request it is making. This registration process shown in this image (request and response) occurs once when a location application initially connects to the Location Service.

NOTICE: For the Parlay X-based interface, the Unsolicited-Location-Report for Emergency messages will be distributed in the same manner as a typical triggered location report notification.

5.1.5.4 Location Update on Power-On – APX

A radio does not provide an automatic location update on power-on. The Presence Service notifies the Location Service when a radio powers on. On notification, the Location and Presence Services inform registered third-party applications according to the configuration set in the Configuration Manager. An application that is receiving a presence indication should make an explicit request if it is interested in the location of the radio upon the power on.

The user of the system has two options:

1 Configure the Location Service to automatically send a periodic request with chosen interval to each APX radio that was powered on; this method is useful for a deployment that requires the radios to report at all times.

2 The IMW APIs expose the Presence Service, which provides a notification when a radio powers on. On notification, a third-party location application server should make an explicit request if it is interested in the location of the radio on power-on.

5.1.5.5

Location on Push to Talk – APX

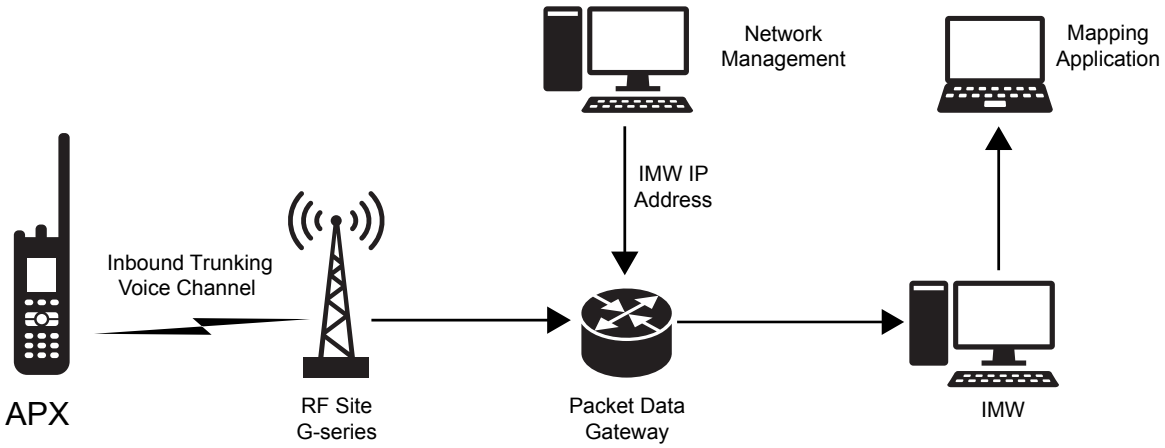
The Location Service provides a location report of an APX radio to a registered third-party application when the radio user presses the PTT button and begins a group voice call or responds during a group voice call.

NOTICE:
The location updates in this solution are not encrypted - Motorola Solutions cannot guarantee the privacy of location information.

Location on Push to Talk High-Level Overview

The diagram below represents the high-level overview of the Location on PTT reports. The subscriber sends its location to the RF Site during a P25 voice stream. The Site then creates a data message containing the location information, and forwards it to the Packet Data Gateway. The Packet Data Gateway adds the IMW IP address to the Location on PTT data message, and pushes it to the IMW server. The IMW Server then sends the information to the appropriate mapping application.

Figure 17: Location on Push to Talk Overview Diagram



Location on Push to Talk System Requirements

Ensure your system meets the following requirements before you enable the Location on Push to Talk feature:

- Infrastructure: A7.17 or later ASTRO® 25
- The device must be enabled for the Location Service in the IMW.
- The device must have GPS configured and enabled in CPS.

- The Network Time Protocol (NTP) system time in your site needs to be within 5 minutes of the actual GPS time, otherwise wrong location/time assignments may occur.
- The Location on PTT feature requires feature-specific licences. See the ASTRO® 25 *License Manager* manual for more information.

Location on Push to Talk Operational Requirements

The following requirements must be fulfilled for the Location on Push to Talk to generate location reports once the feature is enabled:

- The device must have GPS active and not disabled by the user.
- Data transmission at the site must be enabled for Location on PTT to send reports.
- The device must be in its home system, in a site capable of supporting Location on PTT. Roaming to sites that are not capable of supporting the Location on PTT feature stops the feature from sending location reports during a voice call.
- The device is context activated. The site is operating in wide area trunking.
- The last location obtained from GPS is less than the IMW configured max-info-age and less than 30 minutes.
  For max-info-age settings, see the Intelligent Middleware *Configuration Manager User Guide*.
- For best performance, limit the amount of reports from Location on Push to Talk, Periodic Location or Emergency Alarms to the standard budget of 2 million enhanced data messages per hour.
  In a system with the maximum active data user capacity of 48,000 subscribers, the Location on PTT reports will create about 100,000 data messages per hour from the Location on PTT reports alone. The remaining 1,900,000 data messages per hour can be used for other types of location reports. The P25 classic data message capacity will see no impact as a result of Location on PTT messages.

Location on Push to Talk Feature Considerations and Limitations

Before you start using the Location on Push to Talk, ensure you are familiar with the following aspects of the feature:

- The Location on PTT feature uses the voice channel to transmit the data message containing location information. So even though data-over-the air is not used, the feature requires the RF Site to have data enabled since the RF site transforms it into an infrastructure data message and sends to PDG.

  NOTICE: Location on PTT does not work with data sent using LTE.

- A single press of the PTT button generates one location report. The Location on PTT feature does not keep updating subscriber location while the subscriber is transmitting.
- A single Remote Monitor generates one location report using the Location on PTT feature. Restarting the Remote Monitor results in generating another location report. You can use this operation for precise vehicle tracking with Remote Monitor.
- The Location on Push to Talk feature sends the location report with a slight delay. Once a subscriber starts to transmit in a voice group call, the location information is displayed on the mapping application after 2 to 7 seconds, depending on the mapping application loading.

  NOTICE: A quick press and release of the PTT button it is not sufficient for creating a Location on Push to Talk report.

- The subscribers continue to transmit voice calls even if the Location on Push to Talk report is not sent.

- In systems with very heavy voice traffic, it may occur that a Location on Push to Talk report is followed by an outdated Periodic or Distance Location Report after the voice call ends. This can create a momentary discrepancy in the perceived and actual vehicle position.
- Even though the Location on Push to Talk feature uses a different mechanism than Periodic or Distance Location for reporting (no queue), it still uses the same GPS technology. If location is not available due to issues with the GPS module, the Location on Push to Talk reports are not generated.
- The following limitations apply to the Location on PTT reports:
  - Altitude unavailable
  - Time resolution: 15 seconds
  - Direction resolution: 45 degrees
  - Latitude and longitude resolution: 6 feet
  - Speed increments: minimum 4.5 mph, up to 134 mph

High-level Overview of Enabling Location on Push to Talk

Enabling the Location on Push to Talk feature requires changes to several elements of your system: the CPS, Configuration Manager, ASTRO Provisioning Manager, and the APX radio itself.

1. Enable the Location on PTT for the device using the Customer Programming Software (CPS). See the "APX Radio Configuration" section in the *ASTRO® 25 Outdoor Location Solution Device Installation and Configuration Guide* manual.
2. Enable the Location on PTT for the agency using the Configuration Manager on the IMW server. See the "Agency Parameters" section in the Intelligent Middleware *Configuration Manager User Guide*.
3. Update device provisioning in ASTRO Provisioning Manager. See the "Radio" section in the ASTRO® 25 *Provisioning Manager* manual.

5.1.5.6
Location on Receive – APX

The Location on Receive allows subscriber radio users to automatically send their GPS location data to a registered third-party application during voice and hangtime. Location is sent in the periodic voice gaps that are a part of the Time Division Multiple Access (TDMA) protocol. This feature is intended only for the subscribers receiving on a call (Location on Push to Talk enables obtaining location of the transmitting radio).

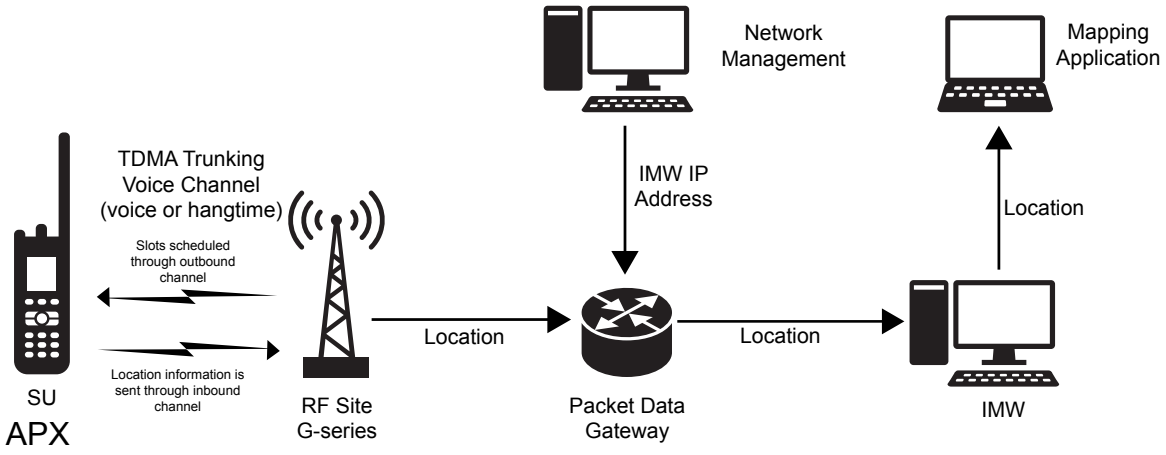
NOTICE:
The location updates in this solution are not encrypted - Motorola Solutions cannot guarantee the privacy of location information.

Location on Receive High-Level Overview

During a talkgroup call, the dispatchers receive updates on the location of the subscribers. Dispatchers not listening to a group call, but monitoring a subscriber in the group also can see the location updated.

Once the call starts, the Zone Controller (ZC) determines if the trunking talkgroup at the RF site can allow Location on Receive and provides a Location on Receive cadence that is tied to a talkgroup. To prevent data and audio loss and location collisions during voice and hangtime, the RF Site uses an outbound TDMA voice channel to schedule slots. Subscribers can then use the assigned slot to automatically send their location to the RF Site through an inbound TDMA voice channel. The Site creates a data message containing the location information, and forwards it to the Packet Data Gateway. The Packet Data Gateway adds the IMW IP address to the Location on Receive data

message, and pushes it to the IMW server. The IMW Server then sends the information to the appropriate mapping application.



NOTICE:
When a subscriber does not respond to a schedule, the RF Site makes four total attempts to get the location before pushing the subscriber to the next cadence.

Location on Receive feature supports the following types of calls:

- Talkgroup call
- Emergency call
- Supergroup call
- Patch call
- Dynamic regrouped call
- Multiselect (MSEL) call
- Announcement group call – excluding talkgroups associated with the announcement group
- Agency group call – excluding announcement groups associated with the agency group

Location on Receive System Requirements

Ensure your system meets the following requirements before you enable the Location on Receive feature:

- Infrastructure: A7.18 or later ASTRO® 25
- Site equipment: G-series A7.18. The trunking RF site must have data capability to create data location messages based on the location received in the TDMA slots.
- The device must be provisioned in ASTRO Provisioning Manager for Data on Receive. Set the IMW IP Address of the device and the Location Server Port that are also used by the Location on PTT feature. See the "Radio" section in the ASTRO® 25 *Provisioning Manager* manual.

  NOTICE: Do not provision non-Motorola devices, devices without upgraded software and radios that protect their location sent on the data channel.
- The device must be enabled for the Location Service in IMW 5.1 or later.
- The device must have GPS configured.

- The Packet Transmission HoldOff Time for the console must be at least 100 milliseconds to avoid potential audio loss in the receiving subscriber. See "Conventional System" section in the ASTRO® 25 *Provisioning Manager* manual.
- The Network Time Protocol (NTP) system time in your site must be within 5 minutes of the actual GPS time, otherwise wrong location/time assignments may occur.
- The Location on Receive feature reuses the licenses required for the Location on Push to Talk. See the ASTRO® 25 *License Manager* manual for more information.

Location on Receive Operational Requirements

The following requirements must be fulfilled for the Location on Receive to generate location reports once the feature is enabled:

- The device must have GPS active and not disabled by the user.
- Data transmission at the site must be enabled for Location on Receive to send reports.
- The device must be in its home system.
- The device is context activated. The site is operating in wide area trunking.
- The last location obtained from GPS is less than the IMW configured max-info-age and less than 30 minutes.
  For max-info-age settings, see the Intelligent Middleware *Configuration Manager User Guide*.
- For the best performance, each talkgroup has a cadence assigned that defines how often the RF site schedules a particular radio. The talkgroup cadence should range from 15 seconds to 6 minutes, assuming 14 calls per second.

Table 19: Talkgroup Cadence Capacity

Cadence	Number of supported subscribers
15 seconds	8K
30 seconds	15K
60 seconds	26K
145 seconds	48K maximum (context activations)

The default setting is 30 seconds with separate configuration for emergency and non-emergency calls.

Location on Receive Feature Considerations and Limitations

Before you start using the Location on Receive, ensure that you are familiar with the following aspects of the feature:

- The Location on Receive feature uses the TDMA voice channel to allow subscribers to transmit the location information. So even though data-over-the air is not used, the feature requires the RF Site to have data enabled since the RF site transforms it into an infrastructure data message and sends to PDG.

  NOTICE: Location on Receive does not work with data sent using LTE.

- Location reports are sent in scheduled time slots during voice or hangtime in a call. The Location on Receive feature keeps updating subscriber location according to the assigned cadence.
- The location updates in Location on Receive are not encrypted. If your configuration requires that the data encryption in the Customer Programming Software (CPS) is enabled, the devices will be

unable to send their location during voice and hangtime. See the *ASTRO® 25 Outdoor Location Solution Device Installation and Configuration Guide* manual.

- In systems with heavy voice traffic, it may occur that a Location on Receive report is followed by an outdated Periodic or Distance Location Report after the voice call ends. This can create a momentary discrepancy in the perceived and actual vehicle position.
- Even though the Location on Receive feature uses a different mechanism than Periodic or Distance Location for reporting (no queue), it still uses the same GPS technology. If location is not available due to issues with the GPS module, the Locations on Receive reports are not generated.
- The longer the voice is received and the more hangtime there is on a call, the more subscribers can have their location reported. A call with two 5-second PTT and 2 seconds of hangtime will allow 25 different subscriber locations per RF site. If there are three RF sites in a call, it will result in 75 different subscriber locations in 12 seconds. This example takes into account RF conditions, retries and RF site outbound loading.

  CAUTION: If you set the message trunking hangtime to zero, the performance of transmission trunked calls will be reduced and the alias of the transmitting subscriber will not be provided.
- Location on Receive with Critical Sensor Event provides a responder alert that is sent with the location.
- The following limitations apply to the Location on Receive reports:
  - Altitude unavailable
  - Direction resolution: 45 degrees
  - Latitude and longitude resolution: 6 feet
  - Speed increments: minimum 4.5 mph, up to 134 mph

5.1.6 Location During Scan

The data services are not available when a radio is in Scan, and therefore the Location Service of a radio is not available during Scan.

5.2 Operational Overview of Presence Services – APX Series of Mobiles and Portables

IMW provides the presence/absence information of the APX radios with integrated GPS to a registered third-party application. Presence Services accepts, stores, and distributes the presence information of radios to the Location Service for use in location applications. Presence Service receives a message when a radio is active on the system.

The Presence Service has the following functions:

- Notifies the presence or absence of a radio to any data application (or the Location Service) that has subscribed for that information.

  NOTICE: The Presence Service receives registration/de-registration messages once the radio becomes active / inactive on the system. It also receives registration messages periodically, where the period is configurable in the Presence Service. The default is four hours, and the minimum is half an hour.
- Provides the attributes of a radio to any data application that has subscribed for that information. For example, the IP address of a radio (Internal Applications Only) or ID.
- Enables a location application to request the location of a radio on power-on through the IMW APIs.

The Presence Service has the following two components:

- Registration Application in the radio that sends its presence/absence state to the Presence Service.
- Presence Service that informs the application in the CEN about the presence/absence of selected radios.

The Presence Service communicates with the Registration Application in a radio using UDP/IP. The IPv4 address of the Presence Service is provisioned in the radio using Customer Programming Software (CPS). A radio registers itself only to the Presence Service, whose address is configured into the radio.

If the Presence Service is enabled in a radio, then on power-on and periodically, the radio registers itself to its Presence Service. The radio also registers itself every time it reenters the radio data network (that is, the radio moves from a non-data capable channel to a data-capable channel). The radio de-registers itself on power-off. The Presence Service does not acknowledge the de-registration, but acknowledges the registration. The radio makes up to five attempts to register if it fails to receive an acknowledgment. If the radio is not able to register even after five attempts, then it keeps retrying after every 30 minutes.

On registration, the Presence Service changes the state of the radio to **present**. On de-registration by a radio and on failure to re-register after the specified period, the Presence Service changes the state of the radio as **absent**.

A registration is valid only for a specified period (default value is four hours) and the radio re-registers itself on expiry of the specified period.

NOTICE: The Presence Service stores the states of the radios in a persistent memory. On the power-on, it uses the stored data to recover the states of the radios by querying all the radios whose registration is yet to expire. The Presence Service notifies the subscribing applications of the radios that failed to respond. The Presence Service cannot recover the state of a radio that was powered on while the Presence Service was powered off. To overcome this problem, it is suggested that the IMW should be run on a PC with an Uninterruptible Power Supply (UPS). The details of a radio stay with the Presence Service forever. There is no way to remove a radio from the database of the Presence Notifier.

The Location Service subscribes to the Presence Service for the presence information of the radios of its interest. On receipt of a subscription, the Presence Service sends back an immediate response containing presence state, and if available, the IPv4 address of each radio listed in the subscription. The subscription is for a specified period and the location service can either renew the subscription or cancel the subscription within that period.

On change of the presence state of a radio, the Presence Service sends a notification to the location service for radios of its interest. The list of radios includes radios that the location service has subscribed to receive notifications for and that the subscription has not expired. The Location Service manages subscribing for presence notifications of radios of its interest internally. When a notification is received, the IMW Service sends the presence information to a third-party application, via the IMW APIs, in one of the two timeframes:

1. When a third-party application registers to the IMW for service, it receives the current presence information of its relevant radios.
2. Whenever radios change their Presence state (such as connect or disconnect to the ASTRO® 25 network) Location Service.

The presence information is forwarded to the third-party applications via the IMW APIs.

5.3
Performance and Capacity – APX Series of Mobiles and Portables

The following sections provide information on the GPS performance considerations, enhancements, and radio battery life impact guidelines.

5.3.1
GPS Performance

The ASTRO®25 Outdoor Location Solution uses information from the GPS satellites orbiting the earth to determine the approximate geographical location of the radio, expressed as latitude and longitude. The availability and accuracy of this location information (and the amount of time that it takes to calculate it) vary depending on the environment in which the GPS feature is used.

For example, GPS location fixes are difficult to obtain indoors, in covered locations, between high buildings, or in situations where a clear broad view of the sky has not been established.

5.3.1.1
Performance Considerations

GPS works best in an open sky (clear view of the sky with no obstructions) environment. Due to the limitations of the technology, there are certain situations which prevent GPS coverage. These situations include but are not limited to:

- Underground locations (tunnels, subways, and so on)
- Inside of buildings, elevators, parking garages, trains, other covered vehicles, and so on
- Under metal or concrete roof structures
- Urban canyons (between tall buildings or under dense tree coverage)

Due to the limitations mentioned above, GPS should only be utilized as a method to assist the user with location information but not as a means for mission critical communication. Therefore, in any emergency situation, the location should always be verbally reported to the dispatcher.

Even when adequate signals from multiple satellites are available, the GPS feature only provides an approximate location, within 10 meters 95% of the time with greater than 5 satellites visible at a nominal 130 dBm signal strength. The accuracy of the location information and the time it takes to obtain it varies depending upon circumstances, particularly the ability to receive signals from an adequate number of satellites. The accuracy of the information can be requested as part of the location response.

The satellites used by the GPS feature are controlled by the U.S. Government and are subject to changes implemented in accordance with the Department of Defense GPS User Policy and the Federal Radio Navigation Plan. These changes may affect the performance of the GPS feature on the APX Radio.

5.3.1.2
GPS Performance Enhancements for APX

Sometimes, the GPS feature of the APX radio may be unable to complete a location calculation successfully. If this occurs, the GPS icon flashes, indicating that the APX GPS module cannot see enough satellites. To maximize the ability of the APX GPS to determine a fix it is best to stay in the open. The GPS feature works best when nothing is between the APX radio and a large part of the open sky.

Chapter 6

Outdoor Location Solution – Operations Related to Mobile Radios with an External GPS Unit

This chapter provides an overview of the operations related to mobile radios and one of the GPS units supported as part of the ASTRO® 25 Outdoor Location Solution. It addresses all the configurations that utilize an external GPS connected to a mobile radio that are supported as part of the ASTRO® 25 Outdoor Location Solution. The supported external GPS units include the Cellocator Olympic for ASTRO, Trimble Placer Gold APU and Trimble Placer Gold Dead Reckoning Unit (DRU) Plus.

NOTICE: This chapter uses the term GPS unit when referring to behavior that is common for all three unit types. The GPS unit explicit name is used when specifying a feature or behavior that is unique for that GPS unit type.

6.1 Operational Overview of Location Services

The ASTRO® 25 Outdoor Location Solution provides the location information of a GPS device connected to one of the ASTRO® 25 mobile radios (XTL radios and ASTRO® Spectra Plus™) over the ASTRO Conventional and Trunking IV&D networks and the High Performance Data network (see ASTRO 25 Outdoor Location Solution Supported Configurations on page 16 for radio model information). The supported GPS devices and configurations include:

- Supported configurations with the Cellocator Olympic for ASTRO include:
  - Cellocator Olympic for ASTRO connected to an XTL mobile radios
  - Cellocator Olympic for ASTRO connected to a APX mobile radio
  - Cellocator Olympic for ASTRO connected to an ASTRO® Spectra Plus™ mobile radio
- Supported configurations with the Trimble Placer™ Gold APR / DRU Plus include:
  - Trimble Placer™ Gold APU / DRU Plus connected to an XTL mobile radios
  - Trimble Placer™ Gold APU / DRU Plus connected to an ASTRO® Spectra Plus™ mobile radio

NOTICE: Alternatively, these external GPS devices can be connected to a Mobile Data Terminal (MDT) which in turn is connected to the ASTRO® 25 mobile radio. In this alternate configuration, the ASTRO® 25 Location Proxy must be installed and running on the MDT. An additional supported configuration includes the Cellocator Olympic for ASTRO connected through an MDT running the ASTRO® 25 Location Proxy to an HPD 1000 Data Modem. This configuration is beneficial when advanced location features, such as telemetry, are required.

In a Cellocator APX configuration it is possible to utilize the advanced location and I/O functionality of the Cellocator GPS unit while at the same time utilizing the location on emergency feature of the APX radio. This functionality is available only from UNS 1.0 and onward.

All the supported GPS devices provide the location information according to one of the following pre-programmed reporting policies:

- Periodic time-based reports
- Distance-based reports

- Combination of both together

The report sent over-the-air contains the full location data and for the Cellocator Olympic for the ASTRO unit the data also includes the state of all the location unit sensors.

The Cellocator Olympic for ASTRO, Trimble Placer™ Gold APU, and Placer™ Gold DRU Plus send the location reports in a proprietary protocol. The Location Service translates this data and forwards it to third-party applications through the Location APIs according to the configuration set in the Configuration Manager.

All GPS device types send location reports in the following scenarios:

- As dictated by their reporting policy (by period/distance)
- As an answer to an Immediate location request
- Idle reporting – Both the Cellocator Olympic for ASTRO and the Trimble units have a mechanism that allows them to send out a periodic location report when the unit has not initiated a report based on its configured reporting policy. This mechanism is called “Idle reporting” and it allows the Location Service to stay current with the IP addresses of these units.

NOTICE: On an ASTRO® 25 Conventional IV&D Network and for devices that do not support the Presence Service, such as the ASTRO® Spectra Plus™ Radios and the HPD 1000 Data Modem, it is possible that there will be a timeframe in which the GPS device is not accessible for commands from the dispatch center due to IP addressing issues. This timeframe will not exceed the idle reporting time for that device type; therefore, the idle time should be configured accordingly. If the GPS unit is not accessible to receive the command a third-party application will be notified accordingly. This does not affect any location reports from the GPS device to the dispatch center.

In addition to the scenarios described above, the Cellocator Olympic for ASTRO supports sending location reports in the following scenario:

- As a trigger when a sensor is activated / deactivated. A sensor state change triggers a report including an indication that specifies the trigger reason in the message sent to the third-party applications (for example, opening or closing a door).

6.1.1
Radio Power On/Off

The XTL and APX mobile radios report their presence state (ON/OFF) to the Presence Service (see ASTRO 25 Outdoor Location Solution Supported Configurations on page 16 for radio model information). The Location Service interfaces with the Presence Service to receive notifications on the presence state of these radios.

When a radio is powered on or off, the Location Service receives notification about this radio and forwards this information to the third-party applications through the ASTRO® 25 Location LRRP API as an event message (Radio Present or Radio Absent) according to the configuration set in the UNS Web Location Administrative Client.

The ASTRO® Spectra Plus™ and HPD 1000 Data modem are exceptions; they do not report presence to the Presence Service. Therefore, the Location Service does not inform the third-party applications about these radios presence state.

NOTICE:

- When the radio is powered off or during a network coverage problem when the Cellocator Olympic for ASTRO cannot communicate with the Location Service, it stores the messages in a special buffer. This buffer can store up to 20 messages. Any messages generated when the 20 message buffer is full are inserted into the buffer and the oldest message in the buffer is discarded on a “first-in, first-out” basis. When communication is re-established, the Cellocator Olympic for ASTRO sends the buffered messages. (The Trimble Placer™ Gold APU and Placer™ Gold DRU Plus do not provide this feature.)
- The Cellocator Olympic for ASTRO (using the idle message configuration) and Trimble Placer™ Gold APU and Placer™ Gold DRU Plus must be provisioned to send location reports periodically when connected to an ASTRO® Spectra Plus™ mobile radio or the HPD 1000 Data Modem since they do not send an indication on power-on.

6.1.2
Cellocator Olympic for ASTRO and Trimble Units to ASTRO Radio Dial-Up

The Cellocator Olympic for ASTRO, Trimble Placer™ Gold APU, and Placer™ Gold DRU Plus communicate with the ASTRO® 25 mobile radio using a Point-to-Point Protocol (PPP) link. When the GPS units are turned on, they immediately try to establish a PPP link with the connected ASTRO® 25 radio. When the link is established, the GPS unit starts to send messages regularly over-the-air using UDP/IP to the Location Service. When the communication between the GPS unit and the radio is lost, the GPS unit tries to re-establish a PPP link.

NOTICE:

- The Cellocator Olympic for ASTRO tries to re-establish the PPP link after sending three keep alive echo messages that are not acknowledged by the radio. Each time the Cellocator Olympic for ASTRO establishes a dial-up to the radio, it sends a special “GPS Initialization” message to the Location Service that is forwarded to the third-party application through the LRRP API according to the configuration set in the Configuration Manager. The “GPS initialization” message includes location and telemetry data.
- When connected to an MDT and not directly to an ASTRO® 25 mobile radio, the Cellocator Olympic for ASTRO, the Trimble Placer™ Gold APU or Placer™ Gold DRU Plus do not try to establish a PPP link; instead they communicate with the MDT over an RS232 link. In this configuration, the PPP link to the radio is established by the ASTRO Data Link software running on the MDT for an IV&D configuration and by the HPD status Applet software for an HPD configuration.

6.1.3
Services Enable/Disable – External GPS

It is possible to enable/disable location service both locally on the GPS units as well as over-the-air through the API.

Enabling or disabling the location services locally on the device is done using the following methods:

- For the Cellocator Olympic for ASTRO, it is done using the Cellocator Programmer software, which communicates with the Cellocator Olympic for ASTRO directly over RS232. For information on using this software, see the ASTRO® 25 Outdoor Location Solution *Device Installation and Configuration Guide*.
- For the Trimble Placer™ Gold APU and Placer™ Gold DRU Plus, it is done using the HyperTerminal Software. The HyperTerminal software allows communicating with the unit directly over RS232 and is supplied as part of the Microsoft Windows operating system. For information on using this software, see the ASTRO® 25 Outdoor Location Solution *Device Installation and Configuration Guide*.

Disabling the location services over-the-air is done through the ASTRO® 25 LRRP API or through the IMW 3GPP Parlay X Interface. The third-party applications can send a dedicated API Stop Location Request message to the Location Service, assuming they have the proper rules set in the Configuration Manager. The Location Service forwards this request to the device, which stops reporting. To re-enable the location reports, the third-party applications must send a new periodic/distance-based request to the Cellocator Olympic for ASTRO, Trimble Placer™ Gold APU, or Placer™ Gold DRU Plus units through the APIs.

NOTICE:

- When the Location services are disabled on the Trimble Placer™ Gold APU and Placer™ Gold DRU Plus units, only idle (keep alive) messages are sent from the GPS unit. The Idle reports interval is configured in the Configuration Manager.
- When the Location services are disabled on the Cellocator Olympic for ASTRO, only idle (keep alive) and sensor event messages are sent from the GPS unit. The Idle reports are configured using the Cellocator Programmer software (idle transmission time).
- When the Location Services are stopped, the GPS units must be reprogrammed again to send location reports. Programming can be performed using the designated software for each unit type or over-the-air programming feature through the ASTRO® 25 Location API or through the IMW 3GPP Parlay X Interface. The designated software for each GPS unit type is the Cellocator Programmer for the Cellocator Olympic for ASTRO or HyperTerminal for Trimble Placer™ Gold APU and Placer™ Gold DRU Plus.
- When the location service is disabled on the GPS units, the third-party applications can still send an immediate location request, which allows the dispatcher to perform a one-time query on the GPS unit without re-enabling the location service.

6.1.4
Cellocator Olympic for ASTRO Local Storage

The Cellocator Olympic for ASTRO includes an additional storage feature that allows buffering of messages for sending at a later time. When communication with the Location Service is lost or cannot be established, the Cellocator Olympic for ASTRO stores the messages in a designated buffer. The buffer can hold up to 20 messages; any message generated when the 20 message buffer is full are inserted into the buffer and the oldest message in the buffer is discarded on a “first-in, first-out” basis. When communication is re-established the GPS unit sends the buffered messages.

Each message sent from a Cellocator Olympic for ASTRO waits for an acknowledgment from the Location Service. This acknowledgment time is a pre-programmed parameter, and if the message is not acknowledged within this time frame, it is re-sent to the Location Service.

6.1.5
Location Update to Third-Party Applications – External GPS

The Cellocator Olympic for ASTRO, Trimble Placer™ Gold APU and Placer™ Gold DRU Plus units acquire a new GPS position approximately every one second. This new position is stored in the unit and it is used whenever the unit sends a report.

IMPORTANT: When using the **External GPS Device <-> MDT <-> ASTRO® 25 Mobile Radio** configuration, the Mobile Data Terminal (MDT) power configuration is unique to each individual MDT. It is important to note that the location service will usually not be available in the following MDT power save modes:

- MDT is logged off.
- MDT is in a Standby mode.
- MDT is in a Hibernation mode.

To make sure the location service is available, configure the power save options according to the required functionality.

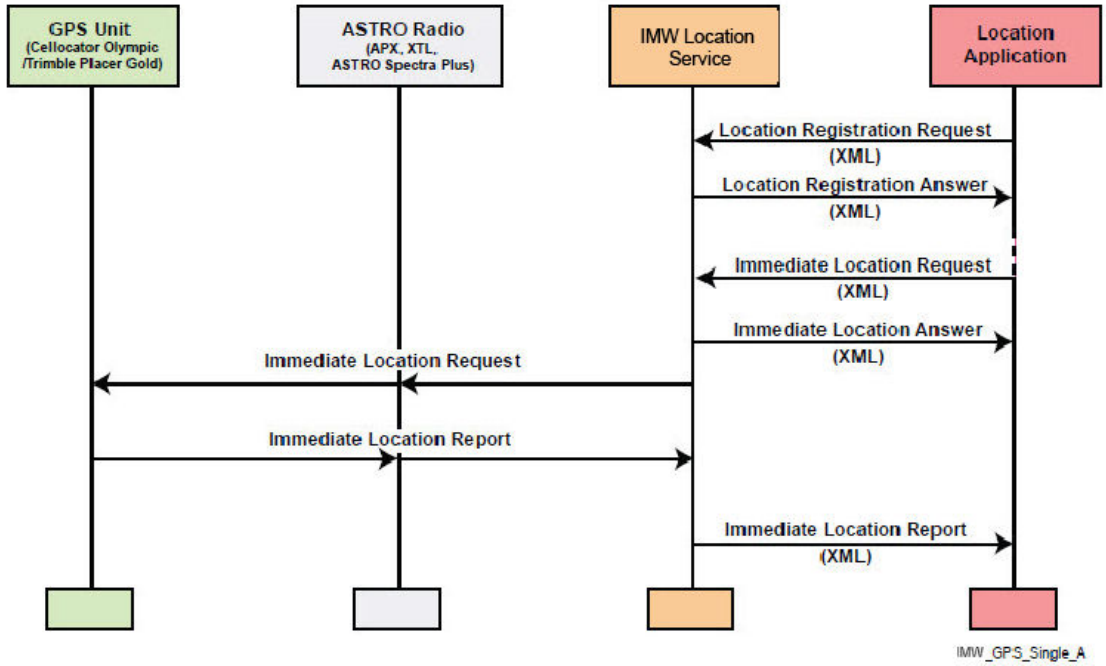
6.1.5.1
Single Location Update – External GPS

A request for a single location update from a GPS unit includes the following actions:

- A registered third-party application sends an Immediate Location Query to the Location Service directly via the LRRP API or via the IMW 3GPP Parlay X Interface.
- On receipt of the request, the Location Service validates that the application is allowed to perform the operation it is trying to perform. If the application is not permitted to perform the operation an error is generated to the application; otherwise the Location Service sends an acknowledgment back to the third-party application.
- The Location Service sends an Immediate-Location-Request (transformed to the GPS unit proprietary protocol) to the GPS unit through the ASTRO® 25 mobile radio.
- The GPS unit generates a location report with the updated GPS location, and sends it to the Location Service through the PPP link with the ASTRO® 25 radio.
- The Location Service transforms this location message to the API protocol and forwards it to the third-party applications through the API according to the configuration set in the Configuration Manager.

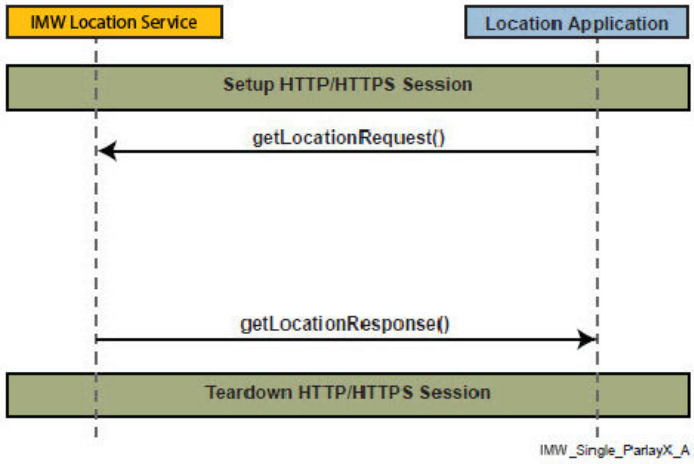
The following figures show a request for a single location update from a GPS unit:

Figure 18: Single Location Request and Report using the LRRP Application Interface



The third-party location application is not required to send a Location-Registration-Request for each immediate-location-request. The registration process shown in this figure (request and response) occurs once when a location application initially connects to the Location Service.

Figure 19: Single Location Request and Report using the Parlay X-Based Interface



NOTICE: The Parlay X-based interface only shows the unique messaging between the application and the IMW server. The messaging between the IMW server and the device are the same for both examples.

For combinations of ASTRO® 25 radio and GPS unit, see ASTRO 25 Outdoor Location Solution Supported Configurations on page 16.

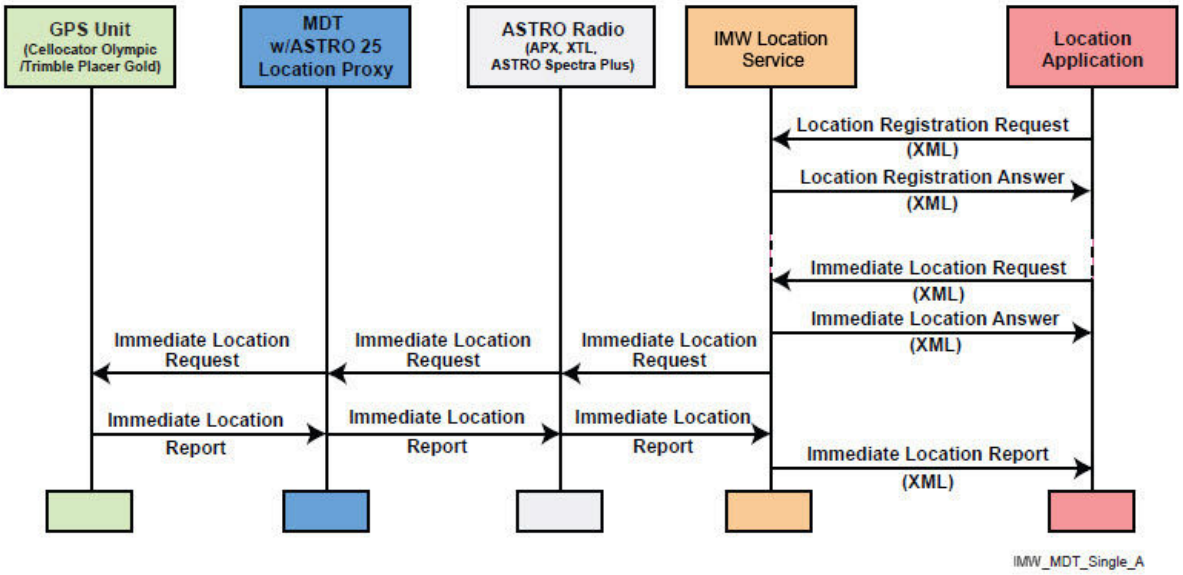
6.1.5.2
Single Location Update through an MDT

A request for a single location report from a GPS unit connected to an MDT includes the following actions:

- A registered third-party application sends an Immediate Location Query to the Location Service directly via the LRRP API or via the IMW 3GPP Parlay X Interface.
- On receipt of the request, the Location Service validates that the application is allowed to perform the operation it is trying to perform. If the application is not permitted to perform the operation an error is generated to the application; otherwise the Location Service sends an acknowledgment back to the third-party application.
- The Location Service sends an Immediate-Location-Request (transformed to the GPS unit proprietary protocol) to the MDT through the ASTRO® 25 mobile radio.
- The ASTRO® 25 Location Proxy receives the request and routes it to the GPS unit.
- The GPS unit generates a location report with the updated GPS location, and sends it to the ASTRO® 25 Location Proxy on the MDT.
- The ASTRO® 25 Location Proxy routes the location report to the Location Service through the PPP link with the ASTRO® 25 radio.
- The Location Service transforms this location message to the API protocol and forwards it to the third-party application through the API according to the configuration set in the Configuration Manager.

The following figure shows a request for a single location report from a GPS unit connected to an MDT:

Figure 20: Single Location Request via an MDT



The third-party location application is not required to send a Location-Registration-Request for each immediate-location-request. The registration process shown in this diagram (request and response) occurs once when a location application initially connects to the Location Service.

NOTICE: The same functionality exists on the Parlay X-based interface. The IMW server to application messaging is the same as what was shown in the previous example.

For supported combinations of ASTRO® 25 radio and GPS unit, see ASTRO 25 Outdoor Location Solution Supported Configurations on page 16.

6.1.5.3 Periodic Location Update – External GPS

A request for a periodic location report from a GPS unit includes the following actions:

- A registered third-party application sends a Periodic Location Reporting Request to the Location Service through the API. This request includes the new reporting interval.
- On receipt of the request, the Location Service validates that the application is allowed to perform the operation it is trying to perform. If the application is not permitted to perform the operation an error is generated to the application; otherwise the Location Service sends an acknowledgment back to the third-party application.
- The Location Service sends a Periodic-Location-Request, transformed to the GPS unit protocol, to the GPS unit itself, through the existing PPP link between the GPS unit and the ASTRO® 25 mobile radio.
- The GPS unit generates an acknowledgment message and sends it back to the Location Service through the same PPP link with the ASTRO® 25 radio.
- The GPS unit changes its settings and starts reporting location report messages (Triggered-Location-Report document of LRRP in MBXML) to the Location Service according to the new requested interval.
- The Location Service forwards the report to the application(s) according to the configuration set in the Configuration Manager.

IMPORTANT: The maximum supported value for the periodic reporting interval parameter for each of the GPS units is as follows:

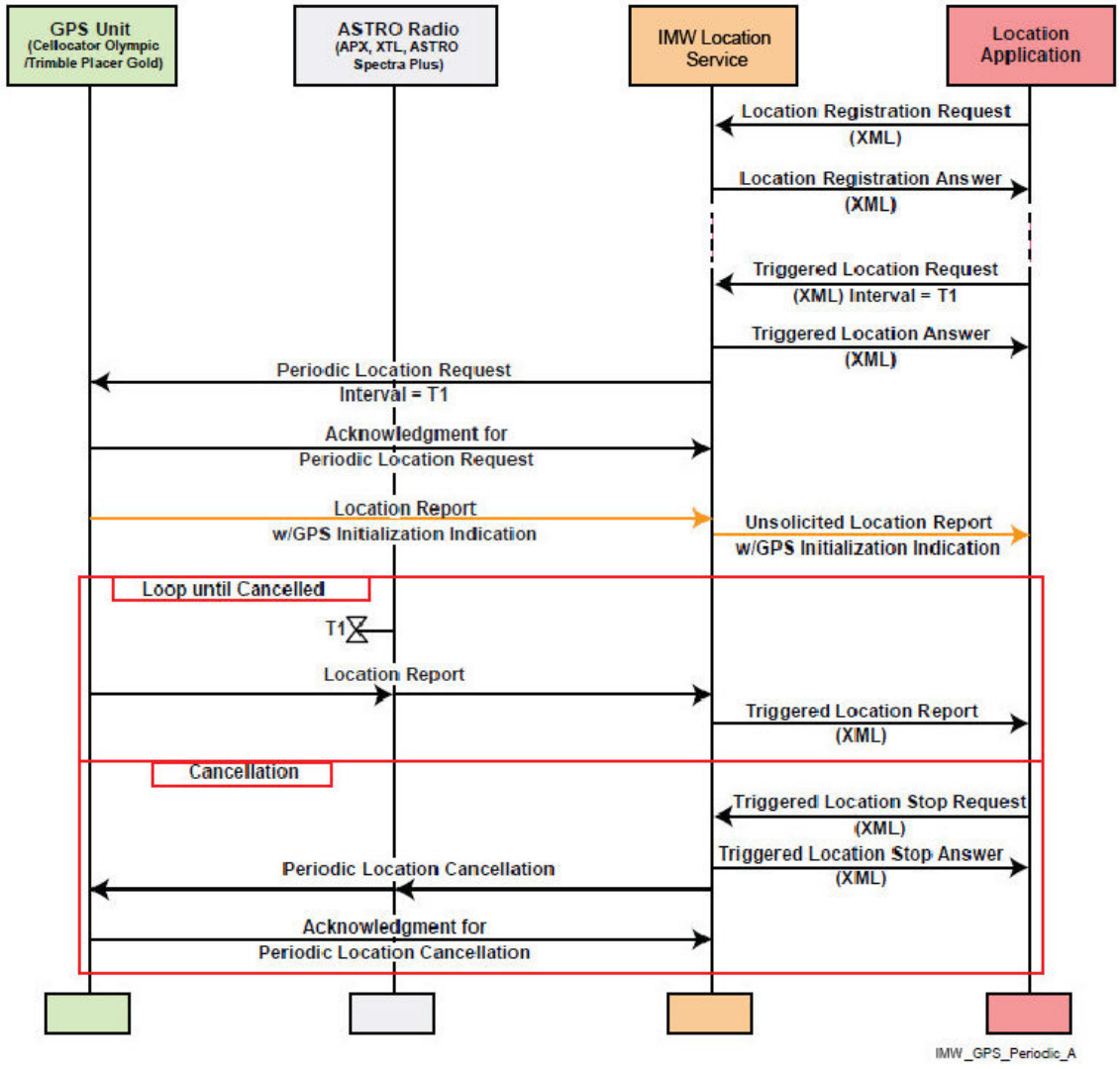
- For the Trimble Placer™ Gold APU or DRU Plus, the value is 18 hours.
- For the Cellocator Olympic for ASTRO, the value is 3.2 hours.

For both unit types, a value larger than the supported interval is rounded down to the maximum value. This limitation is true for requests sent by the third-party application through the APIs as well.

NOTICE: The Cellocator Olympic for ASTRO restarts after receiving a request to change its reporting settings and sending an acknowledgment message to the Location Service. After the restart is complete, the Cellocator Olympic for ASTRO first sends a “GPS Initialize” message and then sends location report messages according to the requested period.

The following figures show a request for a periodic location report from a GPS unit:

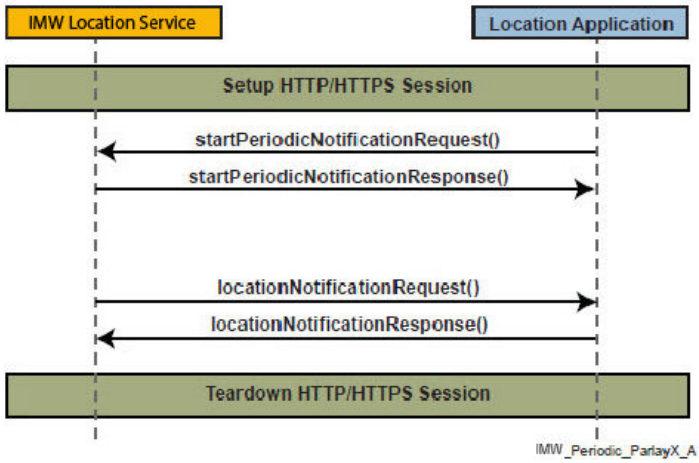
Figure 21: Periodic Location Request and Report using the LRRP Application Interface



- The Location Report with GPS initialization indication is unique to the Cellocator Olympic for ASTRO only (see the orange arrows).

- The third-party location application is not required to send a Location-Registration-Request for each Periodic-Location-Request. This registration process shown in this diagram (request and response) occurs once when a location application initially connects to the Location Service.
- The periodic location request can also be made with a distance as the trigger condition for generating a location report. The behavior for a distance request is identical to the time-based request.

Figure 22: Periodic Location Request and Report using the Parlay X-Based Interface



NOTICE: The Parlay X-based interface only shows the unique messaging between the application and the IMW server. The messaging between the IMW server and the device are the same for both examples.

For supported combinations of ASTRO® 25 radio and GPS unit, see ASTRO 25 Outdoor Location Solution Supported Configurations on page 16.

6.1.5.4
Periodic Location Update through an MDT

A request for a periodic location report from a GPS unit connected to an MDT includes the following actions:

- A registered third-party application sends a Periodic Location Reporting Request to the Location Service through the API. This request includes the new reporting interval.
- Upon receipt of the request, the Location Service validates that the application is allowed to perform the operation it is trying to perform. If the application is not permitted to perform the operation an error is generated to the application; otherwise the Location Service sends an acknowledgment back to the third-party application.
- The Location Service sends a Periodic-Location-Request, transformed to the GPS unit protocol, to the MDT through the existing PPP link between the MDT and the ASTRO® 25 mobile radio.
- The ASTRO® 25 Location Proxy receives the request and routes it to the GPS unit.
- The GPS unit generates an acknowledgment message and sends it back to the ASTRO® 25 Location Proxy on the MDT.
- The ASTRO® 25 Location Proxy routes the message to Location Service through the PPP link with the ASTRO® 25 radio.
- The GPS unit changes its settings and starts reporting location report messages (Triggered-Location-Report document of LRRP in MBXML) to the Location Service according to the new requested interval.

- The Location Service forwards the report to the application(s) according to the configuration set in the Configuration Manager.

IMPORTANT: The maximum supported value for the periodic reporting interval parameter for each of the GPS units is as follows:

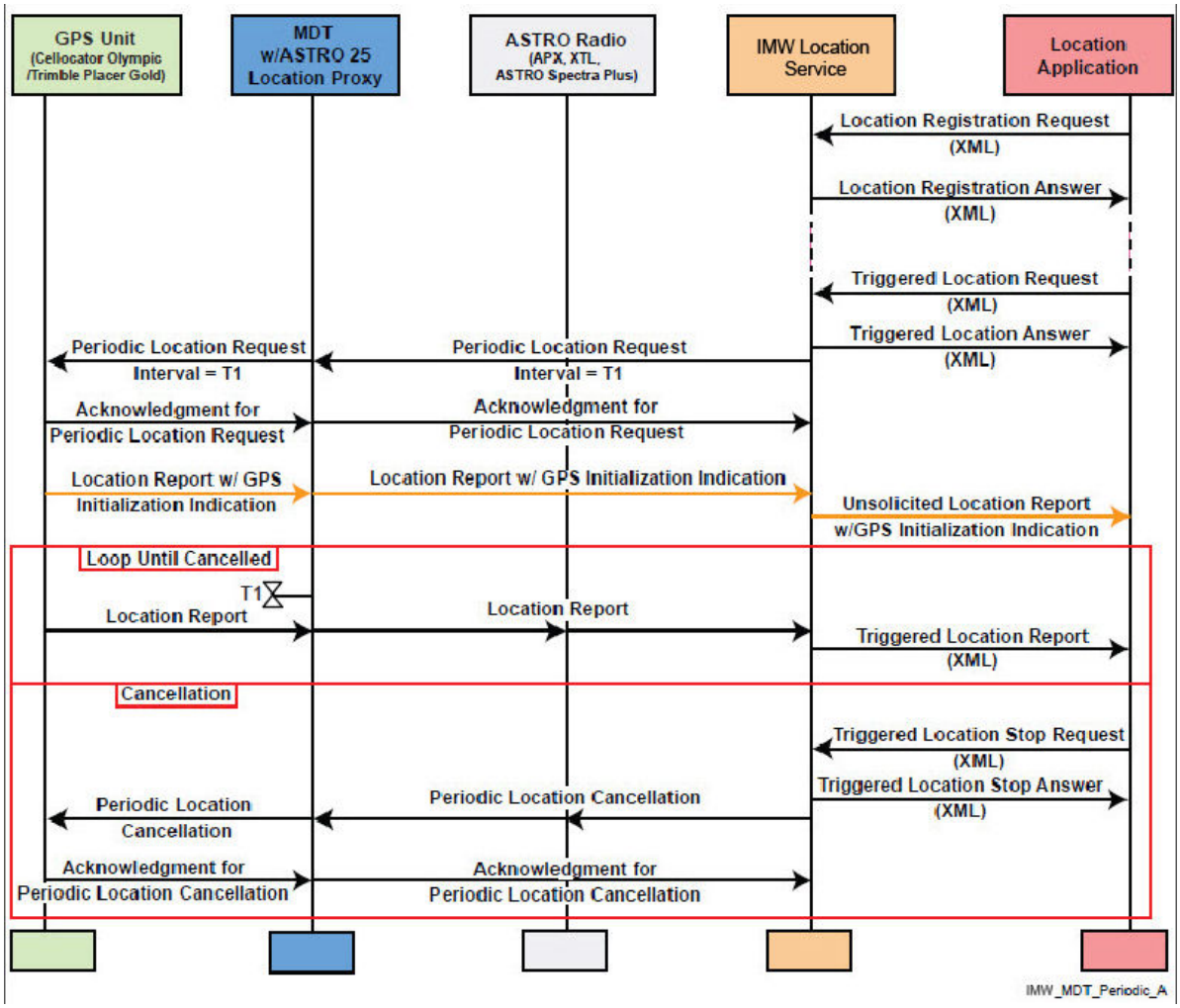
- For the Trimble Placer™ Gold APU or DRU Plus, the value is 18 hours.
- For the Cellocator Olympic for ASTRO, the value is 3.2 hours.

For both unit types, configuring a value larger than the supported interval will be rounded down to the maximum value detailed above. This limitation is true for requests sent by the third-party application through the APIs as well.

NOTICE: The Cellocator Olympic for ASTRO restarts after receiving a request to change its reporting settings and send an acknowledgment message to the Location Service. After the restart is complete, the Cellocator Olympic for ASTRO first sends a “GPS Initialize” message and then sends location report messages according to the requested period.

The following figure shows a request for a periodic location report from a GPS unit connected to an MDT:

Figure 23: Periodic Location Request through an MDT



- The Location Report with GPS initialization indication is unique to the Cellocator Olympic for ASTRO only (see the orange arrows).

- The third-party location application is not required to send a Location-Registration-Request for each Periodic-Location-Request. This registration process shown in this diagram (request and response) occurs once when a location application initially connects to the Location Service.
- The periodic location request can also be made with a distance as the trigger condition for generating a location report. The behavior for a distance request is identical to the time-based request.
- The same functionality exists on the Parlay X-based interface. The IMW server to application messaging is the same as what was shown in the previous example.

For supported combinations of ASTRO® 25 radio and GPS unit, see ASTRO 25 Outdoor Location Solution Supported Configurations on page 16.

6.1.5.5
Stop Location Request – External GPS

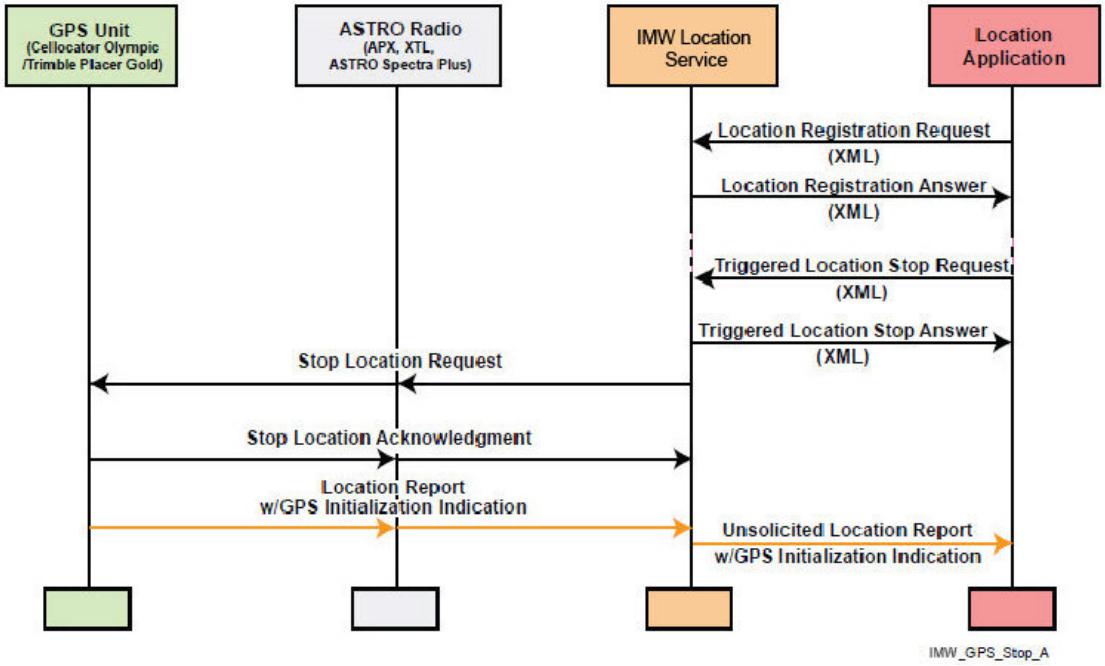
A request for a Stop Location Request from a GPS unit includes the following actions:

- A registered third-party application sends a Stop Location Reporting Request to the Location Service through the API.
- On receipt of the request, the Location Service validates that the application is allowed to perform the operation it is trying to perform. If the application is not permitted to perform the operation an error is generated to the application; otherwise the Location Service sends an acknowledgment back to the third-party application.
- The Location Service sends a Stop Location request, transformed to the GPS unit protocol, to the GPS unit itself, through the existing PPP link between the GPS unit and the ASTRO® 25 mobile radio. The Stop location request sent to the GPS unit includes two messages:
  1. Stop the periodic reports.
  2. Stop the distance reports.
- The GPS unit generates an acknowledgment message and sends it back to the Location Service through the same PPP link with the ASTRO® 25 radio.
- The GPS unit changes its settings and stops reporting location report messages according to the new requested policy.

NOTICE: The Cellocator Olympic for ASTRO restarts after receiving a request to change its reporting settings and sending an acknowledgment message to the Location Service. After the restart is complete, the Cellocator Olympic for ASTRO first sends a “GPS Initialize” message and then stops sending location report messages according to the requested policy.

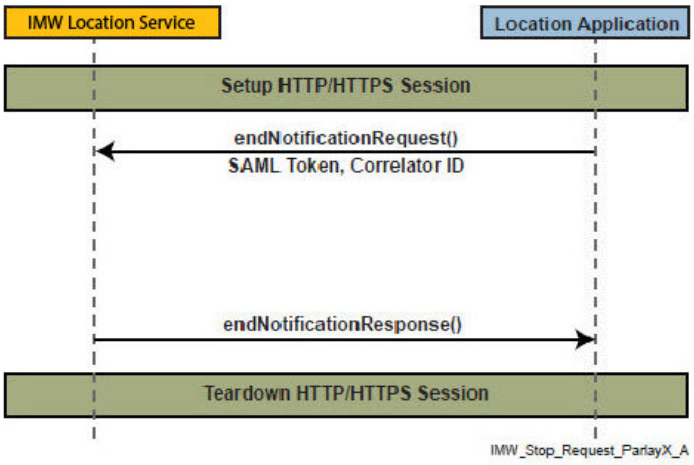
The following figures show a request for a Stop Location Request from a GPS unit:

Figure 24: Stop Location Request and Report using the LRRP Application Interface



- The Location Report with GPS initialization indication is unique to the Cellocator Olympic for ASTRO only (see the orange arrows).
- The third-party location application is not required to send a Location-Registration-Request for each triggered-location-stop-request. This registration process shown in this diagram (request and response) occurs once when a location application initially connects to the Location Service.

Figure 25: Stop Location Request for Parlay X-Based Interface



NOTICE: The Parlay X-based interface only shows the unique messaging between the application and the IMW server. The messaging between the IMW server and the device are the same for both examples.

For supported combinations of ASTRO® 25 radios and GPS units, see ASTRO 25 Outdoor Location Solution Supported Configurations on page 16.

6.1.5.6

Stop Location Request through an MDT

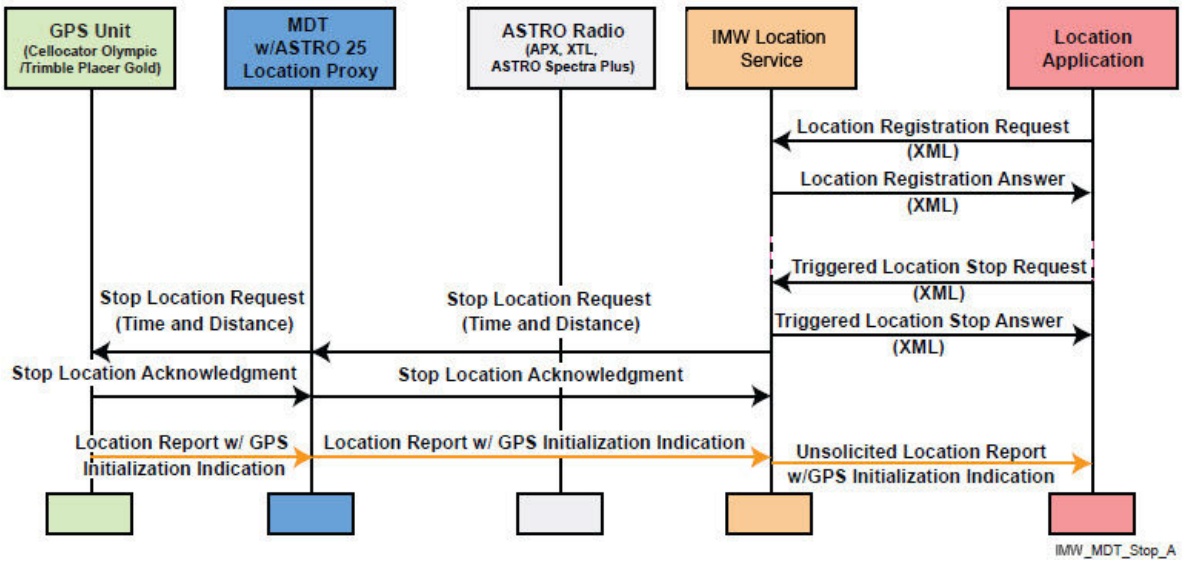
A Stop Location Request from a third-party application to a GPS device connected to an MDT includes the following actions:

- A registered third-party application sends a Stop Location Reporting Request to the Location Service through the API.
- Upon receipt of the request, the Location Service validates that the application is allowed to perform the operation it is trying to perform. If the application is not permitted to perform the operation an error is generated to the application; otherwise the Location Service sends an acknowledgment back to the third-party application.
- The Location Service sends a Stop Location request, transformed to the GPS unit protocol, to the MDT, through the existing PPP link between the MDT and the ASTRO® 25 mobile radio.
- The ASTRO® 25 Location Proxy routes the Stop location request to the GPS unit including two messages:
  - Stop the periodic reports.
  - Stop the distance reports.
- The GPS unit generates an acknowledgment message and sends it back to the MDT.
- The ASTRO® 25 Location Proxy on the MDT routes the acknowledgment message to the Location Service through the PPP link with the ASTRO® 25 radio.
- The GPS unit changes its settings and stops reporting location report messages according to the new requested policy.

NOTICE: The Cellocator Olympic for ASTRO restarts after receiving a request to change its reporting settings and sending an acknowledgment message to the Location Service. After the restart is complete, the Cellocator Olympic for ASTRO first sends a “GPS Initialize” message and then stops sending location report messages according to the requested policy.

The following figure shows a Stop Location Request from a third-party application to a GPS device connected to an MDT:

Figure 26: Stop Location Request through an MDT



The third-party location application is not required to send a Location-Registration-Request for each triggered-location-stop-request. This registration process shown in this diagram (request and response) occurs once when a location application initially connects to the Location Service.

NOTICE: The same functionality exists on the Parlay X-based interface. The IMW server to application messaging is the same as what was shown in the previous example.

For supported combinations of ASTRO® 25 radio and GPS unit, see ASTRO 25 Outdoor Location Solution Supported Configurations on page 16.

6.1.5.7 Location Update on Sensor Activation

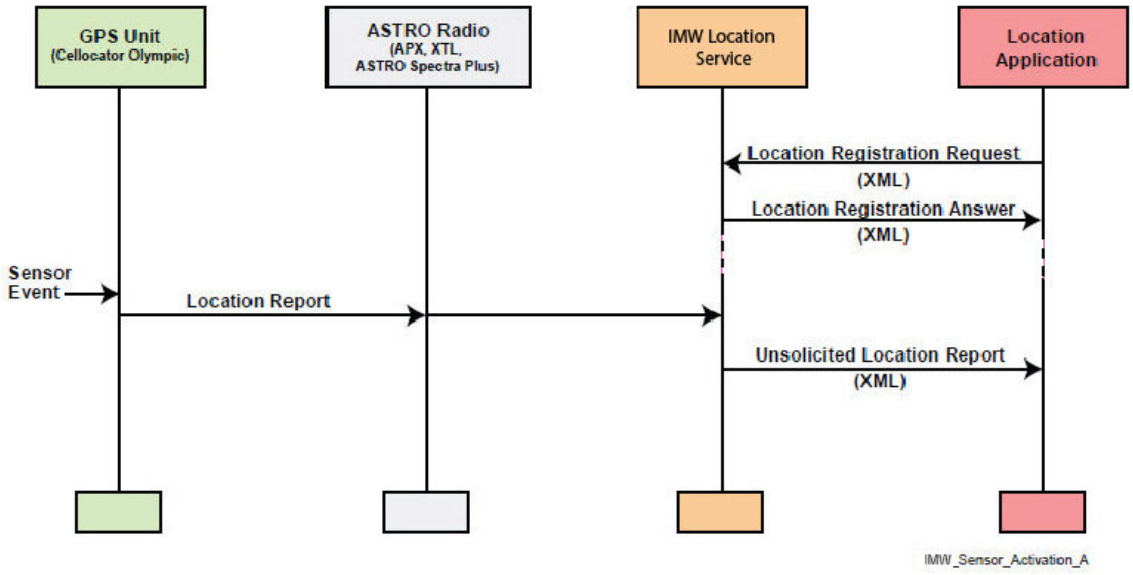
The sensor activation feature is supported by the Cellocator Olympic for ASTRO only.

A sensor activation report from a Cellocator Olympic for ASTRO includes the following actions:

- The driver activates a sensor in the vehicle.
- The Cellocator Olympic for ASTRO sends a location report indicating the sensor activation. The report includes all the sensors and their current state.
- The Location Service receives this report and forwards it through the API to the application(s) according to the configuration set in the Configuration Manager.

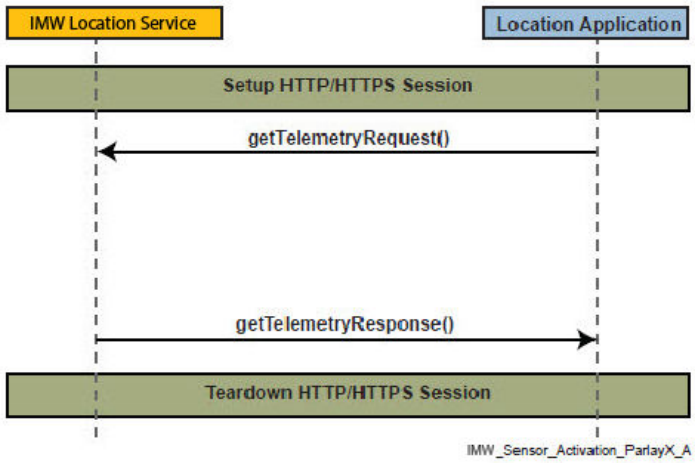
The following figures show a sensor activation report from a Cellocator Olympic for ASTRO:

Figure 27: Sensor Activation Event Report for LRRP interface



The third-party location application is not required to send a Location-Registration-Request for each unsolicited-location-report. The registration process shown in this diagram (request and response) occurs once when a location application initially connects to the Location Service.

Figure 28: Sensor Activation Event Report for Parlay X-Based Interface



NOTICE: The Parlay X-based interface only shows the unique messaging between the application and the IMW server. The messaging between the IMW server and the device are the same for both examples.

For supported combinations of ASTRO® 25 radio and GPS unit, see ASTRO 25 Outdoor Location Solution Supported Configurations on page 16.

6.1.5.8

Location Update on Sensor Activation through an MDT

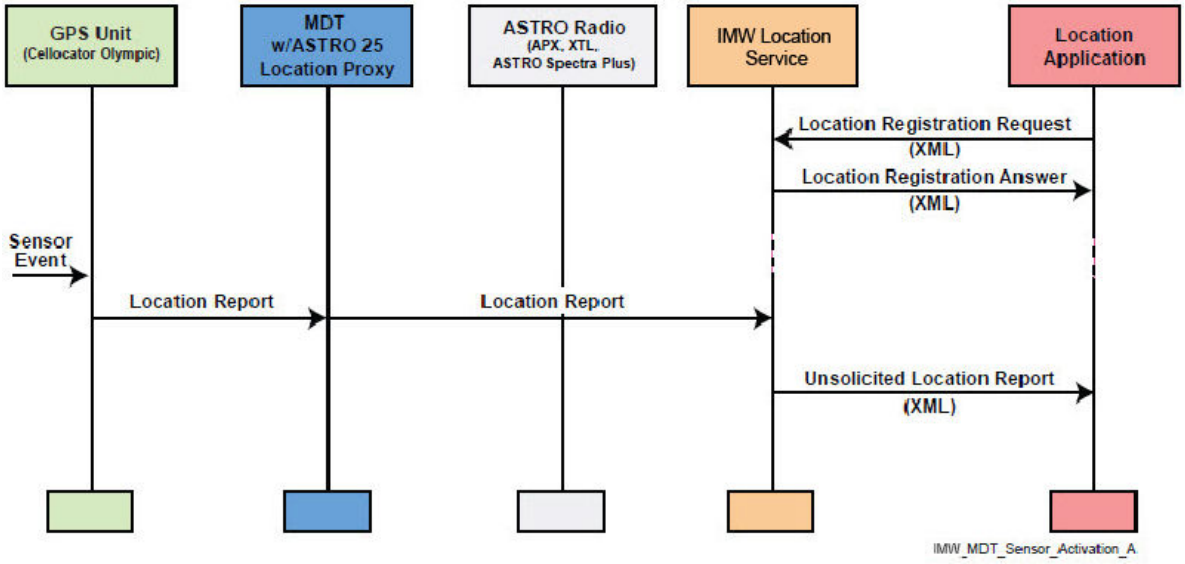
The sensor activation feature is supported by the Cellocator Olympic for ASTRO only.

A sensor activation report from a Cellocator Olympic for ASTRO through an MDT includes the following actions:

- The driver activates a sensor in the vehicle.
- The Cellocator Olympic for ASTRO sends a location report to the ASTRO® 25 Location Proxy on the MDT, indicating sensor activation. The report includes all the sensors and their current state.
- The ASTRO® 25 Location Proxy routes the message to Location Service through the PPP link with the ASTRO® 25 radio.
- The Location Service receives this report and forwards it through the API tot the application(s) according to the configuration set in the Configuration Manager.

The following figures show a sensor activation report from a Cellocator Olympic for ASTRO through an MDT:

Figure 29: Sensor Activation Event Report via an MDT



The third-party location application is not required to send a Location-Registration-Request for each Unsolicited-Location-Report. The registration process shown in this diagram (request and response) occurs once when a location application initially connects to the Location Service.

NOTICE:
The same functionality exists on the Parlay X-based interface. The IMW server to application messaging is the same as what was shown in the previous example.

For supported combinations of ASTRO® 25 radio and GPS unit, see ASTRO 25 Outdoor Location Solution Supported Configurations on page 16.

6.1.5.9
Location Update on Power-On – External GPS

It is recommended that in the initial periodic location reporting configuration of the Cellocator Olympic for ASTRO, Trimble Placer™ Gold APU, and Placer™ Gold DRU Plus units, the periodic reporting interval is set at 15 minutes if the periodic reporting is required. If the units are configured not to report at all, the Cellocator Olympic for ASTRO and Trimble Placer™ Gold still reports according to the idle transmission interval (default 1 hour). Idle Transmission reporting is used for reporting heartbeat location messages. These messages allow the Location Service to be updated with the latest IP information of the GPS unit.

The interval of periodic location reporting can be changed by the third-party location application by issuing periodic requests using the IMW APIs.

6.1.6
Telemetry Update to a Third-Party Application

The telemetry feature is supported by the Cellocator Olympic for ASTRO only.

6.1.6.1
Digital Output

The Cellocator Olympic for ASTRO has two digital outputs. These outputs can be used to operate or trigger a connected device from the dispatch center, for example a siren or a lamp.

Only a third-party application can send a digital output activation message to a Cellocator Olympic for ASTRO through the ASTRO® 25 Location API to turn on an output. This message is routed to the designated unit, and the device connected to the specific output is switched on for two seconds and then the signal is switched off.

NOTICE: Output activation is only supported via the ASTRO® 25 Location LRRP API and is not supported on the 3GPP Parlay X interface.

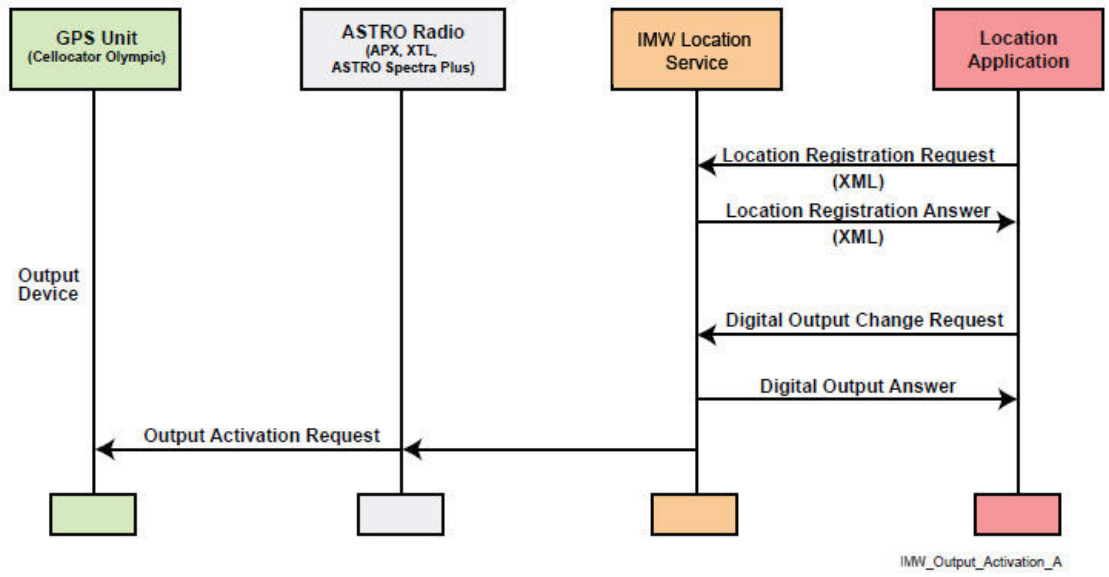
6.1.6.2 Digital Output Activation Update

An Output Activation Request from a third-party application to a device connected to a Cellocator Olympic for ASTRO output includes the following actions:

- A registered third-party application sends an Output-Activation-Request to the Location Service through the ASTRO® 25 Location LRRP API. This request includes the output name. On receipt of the request, the Location Service validates that the application is allowed to perform the operation it is trying to perform. If the application is not permitted to perform the operation an error is generated to the application; otherwise the Location Service sends an acknowledgment back to the third-party application. The acknowledgment uses a Digital-Output-Answer document (in XML form) with a result code of **Success**.
- The Location Service sends an Output-Activation-Request to the Cellocator Olympic for ASTRO through an existing PPP link between the Cellocator Olympic for ASTRO and the ASTRO® 25 radio.
- The Cellocator Olympic for ASTRO switches on the output by generating a signal pulse for two seconds.

The following figure shows an Output Activation Request from a third-party application to a device connected to a Cellocator Olympic for ASTRO output:

Figure 30: Output Activation Report



The third-party location application is not required to send a Location-Registration-Request for each digital-output-change-request. The registration process shown in this diagram (request and response) occurs once when a location application initially connects to the Location Service.

NOTICE: This capability does not exist on the Parlay X-based interface.

For supported combinations of ASTRO® 25 radio and GPS unit, see ASTRO 25 Outdoor Location Solution Supported Configurations on page 16.

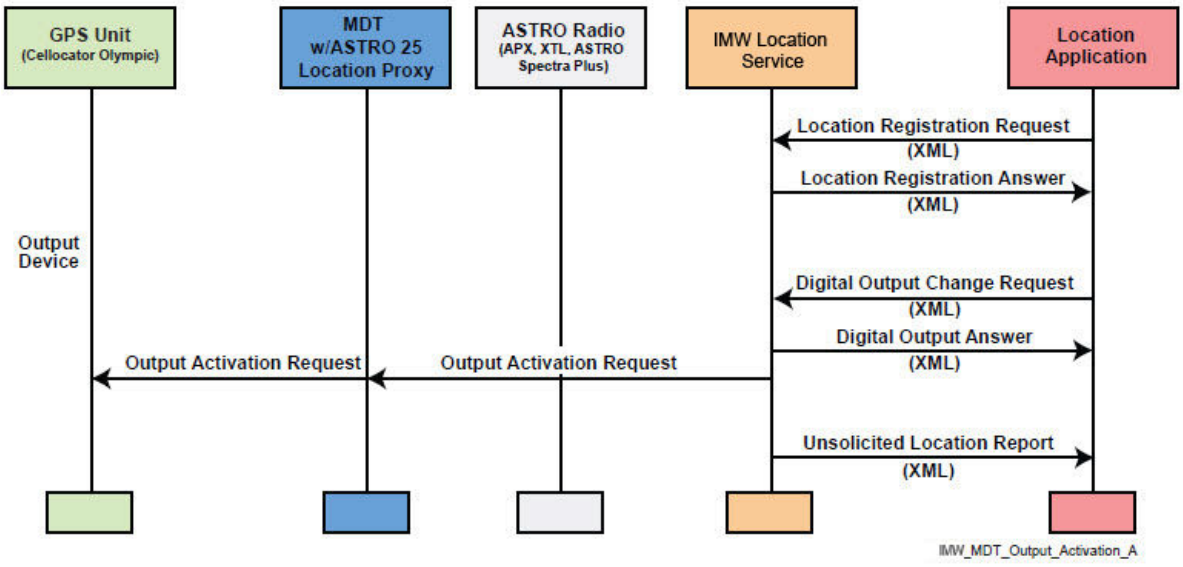
6.1.6.3
Digital Output Activation Update through MDT

An Output Activation Request from a third-party application to a device connected to a Cellocator Olympic for ASTRO output through an MDT includes the following actions:

- A registered third-party application sends an Output-Activation-Request to the Location Service through the ASTRO® 25 Location LRRP API. This request includes the output name.
- On receipt of the request, the Location Service validates that the application is allowed to perform the operation it is trying to perform. If the application is not permitted to perform the operation, an error is generated to the application; otherwise the Location Service sends an acknowledgment back to the third-party application. The acknowledgment uses a Digital-Output-Answer document (in XML form) with a result code of **Success**.
- The Location Service sends an Output-Activation-Request transformed to the Cellocator Olympic for ASTRO protocol to the MDT through the existing PPP link between the MDT and the ASTRO® 25 mobile radio.
- The ASTRO® 25 Location Proxy routes the Output-Activation-Request location request to the Cellocator Olympic for ASTRO.
- The Cellocator Olympic for ASTRO switches on the output by generating a signal pulse for two seconds.

The following figure shows an Output Activation Request from a third-party application to a device connected to a Cellocator Olympic for ASTRO output through an MDT:

Figure 31: Output Activation Report through an MDT



The third-party location application is not required to send a Location-Registration-Request for each Digital-Output-Change-request. The registration process shown in this diagram (request and response) occurs once when a location application initially connects to the Location Service.

NOTICE: This capability does not exist on the Parlay X-based interface.

For supported combinations of ASTRO® 25 radio and GPS unit, see ASTRO 25 Outdoor Location Solution Supported Configurations on page 16.

6.2 Performance and Capacity

The following sections provide information on the GPS performance considerations for the Cellocator Olympic for ASTRO and Trimble Placer™ Gold APU and Placer™ Gold DRU Plus.

6.2.1 GPS Performance

The ASTRO®25 Outdoor Location Solution uses information from the GPS satellites orbiting the earth to determine the approximate geographical location of the radio, expressed as latitude and longitude. The availability and accuracy of this location information (and the amount of time that it takes to calculate it) vary depending on the environment in which the GPS feature is used.

For example, GPS location fixes are difficult to obtain indoors, in covered locations, between high buildings, or in situations where a clear broad view of the sky has not been established.

6.2.1.1 Performance Considerations

Since GPS technology uses radio signals from earth-orbiting satellites to establish the location coordinates, maximizing the view of clear unobstructed sky is essential for optimum performance. If adequate signals from multiple satellites are not available, the GPS feature of the Cellocator Olympic for ASTRO and the Trimble Placer™ Gold APU and Placer™ Gold DRU Plus units does not work. Such situations include, but are not limited to:

- Underground locations
- Inside of buildings, trains, or other covered vehicles
- Under any other metal or concrete roof or structure
- Between tall buildings or under dense tree-cover
- In temperature extremes outside the operating limits of the Cellocator Olympic for ASTRO and the Trimble Placer™ Gold APU and Placer™ Gold DRU Plus units.

Even when location information can be calculated in such situations, it may take longer to do so, and the location estimate may not be as accurate. Therefore, in any emergency situation, the location should always be reported to the dispatcher.

Even when adequate signals from multiple satellites are available, the GPS feature only provides an approximate location, often within 20 to 100 meters from the actual location (but sometimes much farther from the actual location). The accuracy of the location information and the time it takes to obtain it varies depending on circumstances, particularly the ability to receive signals from an adequate number of satellites. The accuracy of the information is included as part of the location response.

The satellites used by the GPS feature are controlled by the U.S. Government and are subject to changes implemented in accordance with the Department of Defense GPS User Policy and the Federal Radio Navigation Plan. These changes may affect the performance of the GPS feature of the Cellocator Olympic for ASTRO, Trimble Placer™ Gold APU, and Placer™ Gold DRU Plus units.

6.2.1.2 GPS for Placer™ Gold DRU Plus

The Trimble Placer™ Gold DRU Plus GPS-based position information is augmented by Dead Reckoning (DR) to provide position information in areas where satellite signals are blocked by the surrounding buildings, structures, or terrain. The unit uses inputs from a heading sensor, pulses from an odometer and a signal from the backup light of the vehicle to calculate the current position of the vehicle when GPS is unavailable. The unit automatically switches back to a combination of DR and GPS when satellite signals are available.

Chapter 7

Outdoor Location Solution – Operations Related to the HPD 1000 Data Modem

This chapter provides an overview of the operations related to the HPD 1000 Data Modem with integrated GPS.

7.1 Operational Overview of the Location Services for HPD 1000 Data Modems

The ASTRO® 25 Outdoor Location release 2.0 and greater provides location information of an HPD 1000 Data Modem. The location information is either an error status or consists of at least longitude, latitude, and Universal Time Coordinated (UTC) date and time of the fix.

The HPD 1000 Data Modem can operate in two configurations; it can be connected to a Mobile Data Terminal (MDT) reporting location through a Middleware VPN Solution or it can operate standalone and report location independently. The Location Service supports both configurations for enabling location:

Direct HPD 1000

The Location Service communicates directly with the standalone HPD 1000 Data Modem over the High Performance Data network.

MDT Enabled HPD 1000

The Location Service communicates with the HPD 1000 Data Modem indirectly through the connected MDT (such as the Motorola MW series of Mobile Workstations). An additional Outdoor Location software component, the ASTRO® 25 Location Proxy, is installed on the MDT. The ASTRO® 25 Location Proxy acts as a proxy forwarding data from the HPD 1000 Data Modem to the Location Service and the other way round. The Location Service communicates with this proxy software over the Middleware VPN Network enabling the location data to be transmitted on an encrypted channel.

NOTICE:

- An HPD 1000 Data Modem does not provide unsolicited location updates. A third-party application must send a location request to the Location Service, which in turn, sends the request to the HPD 1000 Data Modem. The request message is routed directly to the HPD 1000 Data Modem or indirectly through the MDT depending if the HPD 1000 Data Modem is connected to an MDT or working standalone.
- The HPD 1000 Data Modem stores the location requests persistently when power is cycled (radio turned off and on). Therefore, the application is not required to send a fresh location request to an HPD 1000 Data Modem every time the radio powers on and the request remains active until it is explicitly stopped.
- The HPD 1000 Data Modem does not support any digital input or output. If this functionality is needed, see Outdoor Location Solution – Operations Related to Mobile Radios with an External GPS Unit on page 83 for a configuration that enables connecting the Cellocator Olympic for ASTRO GPS and Telemetry unit to an MDT connected to the HPD 1000 Data Modem. In this configuration, the ASTRO® 25 Location Proxy, must be installed and running on the MDT.
- The HPD 1000 Data Modem does not support an emergency feature.

7.2 Middleware VPN Solutions

Middleware VPN Solutions are Mobile Virtual Private Networks (VPN) that maintain secure connectivity while roaming between wireless networks and optimizes network performance. They keep applications open while roaming from one network to another. When coverage gaps occur, Middleware VPN Solutions keep applications running, and then reconnect them seamlessly and automatically.

Middleware VPN Solutions can typically provide the following features:

Best Network Selection
Provides the ability to send location back to the dispatch operator when out of range of the HPD network by choosing the best available network.

Data Encryption
Location Data is sent over-the-air in an encrypted manner to protect your data from unauthorized users.

Authentication
Only intended devices can transmit/receive location reports and commands.

7.3 Accessibility (IP Addressing)

The HPD 1000 Data Modem does not provide Presence Services for notification of presence and absence information including the ID and current IP address of a radio. For the system to always have current IP information of HPD 1000 Data Modems, it is configured as follows:

- HPD 1000 Data Modems in standalone configuration are configured with a heartbeat mechanism that triggers them to report every configurable period (default of 1 hour). This enables the Location Service in the CEN to keep track of the HPD 1000 Data Modems IP addresses.
- MDT Enabled HPD 1000 Data Modems: The MDT connected to the HPD 1000 Data Modem is configured with a static Home IP address in the middleware VPN domain. Access to the HPD 1000 and the connected MDT is obtained by configuring the static middleware VPN solution home IP address in the Location Service.

7.4 Local GPS Position Update to an HPD 1000 Data Modem User

The ASTRO® 25 Outdoor Location solution enables receiving local GPS position updates on an MDT connected to the HPD 1000 Data Modem. This functionality is available using the ASTRO® 25 Location High Performance Data (HPD) Mobile Data Terminal Software Development Kit (SDK).

The HPD Mobile Data Terminal SDK is a tool used by developers of in-vehicle mapping applications running on the MDT to easily access the GPS coordinates from the HPD 1000 Data Modem through a set of function calls, events, and documentation. It also allows an application to configure the local reporting policy of the HPD 1000 Data Modem.

The HPD Mobile Data Terminal SDK acts as a router between the in-vehicle mapping application and the HPD 1000 Data Modem internal GPS module.

The SDK is a compiled code library interface that provides function calls and asynchronous events for location services for use by in-vehicle mapping applications. The SDK exposes functions and events through an interface that can be used from a .NET environment or from a Visual Basic 6 and Visual C++ environments using a COM Wrapper.

NOTICE: An MDT connected to an HPD 1000 Data Modem can receive local location updates and also transmit location independently (through the MDT) to the CEN using a Middleware VPN Solution.

7.5 Location Update to a Third-Party Application – HPD

The HPD 1000 Data Modem can be deployed standalone (only the modem without a connected MDT) or connected to an MDT installed with a Middleware VPN Solution client and the ASTRO® 25 Location Proxy. The Location Service communicates either directly with the HPD 1000 Data Modem GPS module or indirectly through the MDT accordingly.

The HPD 1000 Data Modem does not provide unsolicited location updates to an application. It provides location updates only upon the request from the application.

A location request is made in two steps:

1. A registered third-party application makes a request to the Location Service.
2. The Location Service makes a request to the HPD 1000 Data Modem (directly or through the MDT and Middleware VPN Solution according to the deployed configuration).

NOTICE: It is possible to configure the Location Service to automatically send a periodic request with a selected time interval to each HPD 1000 Data Modem during its initialization process in the Location Service (for the HPD 1000 standalone configuration only).

The Location Service and the third-party applications use LRRP in XML form or the 3GPP Parlay X web services SOAP-based interface for exchanging location-related requests and responses, whereas the Location Service and the HPD 1000 Data Modems use LRRP in MBXML form for exchanging location-related requests and reports. The LRRP requests and responses are transported between an HPD 1000 Data Modem and the Location Service using User Datagram Protocol/Internet Protocol version 4 (UDP/IPv4). The UDP/IPv4 messages from a radio are wrapped into Association of Public-Safety Communications Officials (APCO) 25 Packet Data Unit (PDU) before sending over-the-air. Depending on the configuration of the ASTRO® 25 High Performance Data system, these PDUs use unconfirmed/confirmed and/or protected data services to transport the UDP/IPv4 datagrams over-the-air. The LRRP requests and responses are transported between the Location Service and an application using TCP/IPv4 and the 3GPP Parlay X requests and responses are transported between the Location Service and an application using a web services SOAP-based interface.

7.5.1

Single Location Update – HPD

A request for a single location update from an HPD 1000 Data Modem includes the following actions:

- A registered third-party location application sends an Immediate Location Query to the Location Service directly through the LRRP API or through the IMW 3GPP Parlay X interface.
- On receipt of a request for an immediate location update, the Location Service validates that the application is allowed to perform the operation it is trying to perform. If the application is not permitted to perform the operation an error is generated to the application; otherwise the Location Service sends an acknowledgment back to the third-party application.
- The Location Service sends an Immediate-Location-Request document of LRRP (in MBXML form) to the HPD 1000 Data Modem (directly in HPD Direct mode or through the MDT, Middleware VPN Solution, and the ASTRO® 25 Location Proxy in the MDT Enabled mode).
- The HPD 1000 Data Modem uses the Immediate-Location-Report document of LRRP (in MBXML form) to send the response to the Location Service, which forwards the report to the third-party applications according to the configuration set in the Configuration Manager.

NOTICE: In the MDT Enabled mode, the ASTRO® 25 Location Proxy receives requests and routes them to the HPD 1000 Data Modem. The ASTRO® 25 Location Proxy also receives the reports from the HPD 1000 Data Modem and routes them through the Middleware VPN Solution client to the Location Service.

The following figures show a request for a single location update from an HPD 1000 Data Modem:

Figure 32: Single Location Request – HPD 1000 Data Modem Standalone for LRRP-Based Interface

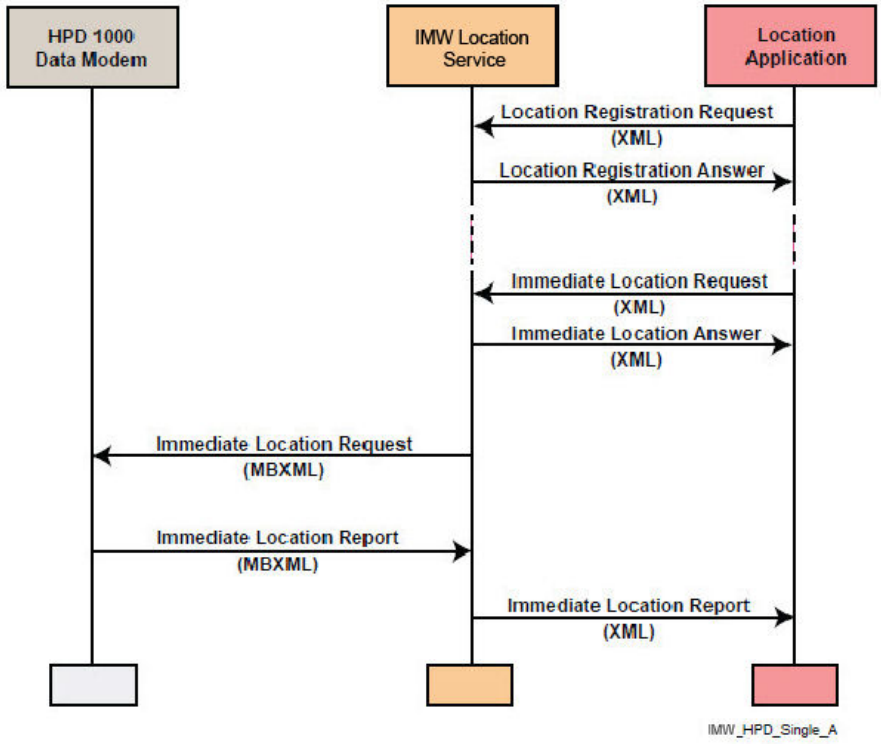
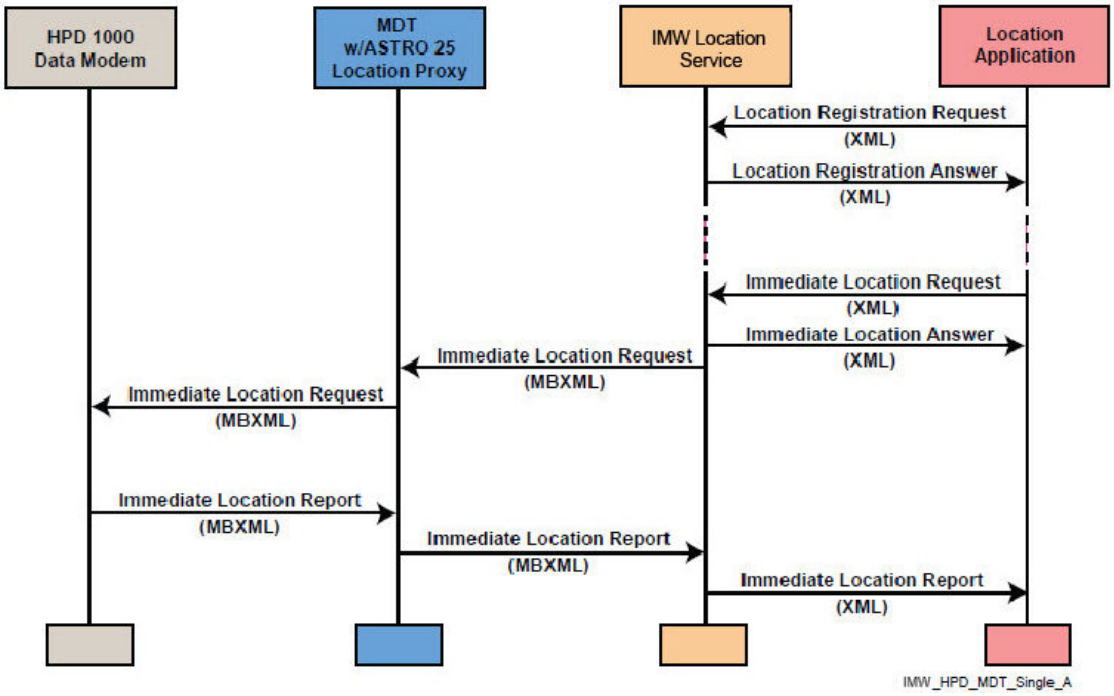
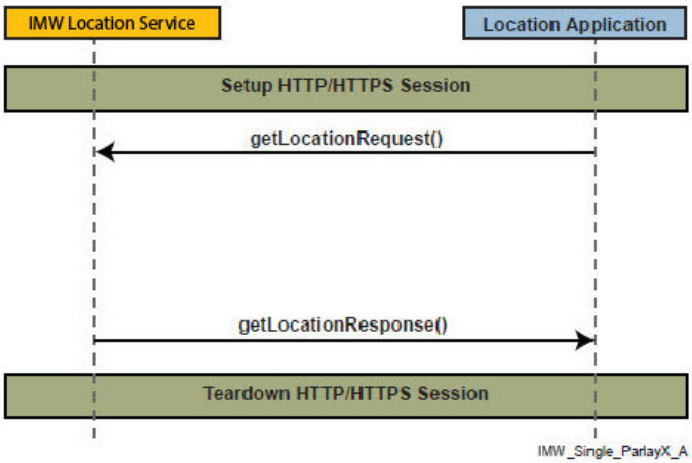


Figure 33: Single Location Request – HPD 1000 Data Modem MDT Enabled



The third-party location application is not required to send a Location-Registration-Request for each immediate-location-request. The registration process shown in this diagram (request and response) occurs once when a location application initially connects to the Location Service through the LRRP interface. For the 3GPP Parlay X interface a full authentication and authorization interface is available.

Figure 34: Single Location Request-HPD 1000 Data Modem Standalone / MDT for Parlay X-Based Interface



NOTICE: The Parlay X-based interface only shows the unique messaging between the application and the IMW server. The messaging between the IMW server and the device are the same as shown for previous examples.

7.5.2
Periodic Location Update – HPD

A third-party application may use the periodic location update to track an HPD 1000 Data Modem. A periodic request saves the air interface bandwidth by sending one request for multiple location updates. The periodic trigger may contain a time interval or a distance interval. The HPD 1000 Data Modem can entertain one time-based and one distance-based request from the Location Service at once.

A request for a distance-based periodic location update from an HPD 1000 Data Modem includes the following actions:

- A registered location application sends a Periodic Location Reporting Request with a periodic-trigger to the Location Service directly via the LRRP API or via the IMW 3GPP Parlay X interface.
- On receipt of a request for periodic location updates, the Location Service validates that the application is allowed to perform the operation it is trying to perform. If the application is not permitted to perform the operation, an error is generated to the application; otherwise the Location Service sends an acknowledgment back to the third-party application.
- The Location Service sends a Triggered-Location-Request document of LRRP (in MBXML form) to the HPD 1000 Data Modem (directly in HPD standalone configuration or through the MDT, Middleware VPN Solution, and the ASTRO® 25 Location Proxy in the MDT Enabled mode).
- The HPD 1000 Data Modem uses the Triggered-Location-Report document of LRRP (in MBXML form) to send the response to the Location Service, which forwards the report to the third-party applications according to the configuration set in the Configuration Manager.
- The HPD 1000 Data Modem continues to generate Triggered-Location-Reports after every expiry of the specified interval or if the required distance has been traveled. The periodic responses continue until the third-party application cancels the request.

NOTICE: In the MDT Enabled mode, the ASTRO® 25 Location Proxy receives requests and routes them to the HPD 1000 Data Modem. The ASTRO® 25 Location Proxy also receives the reports from the HPD 1000 Data Modem and routes them through the Middleware VPN Solution to the Location Service.

The following figures show a request for a distance-based periodic location update from an HPD 1000 Data Modem:

Figure 35: Time-Based Periodic Location Request – HPD 1000 Data Modem Standalone Using the LRRP Application Interface

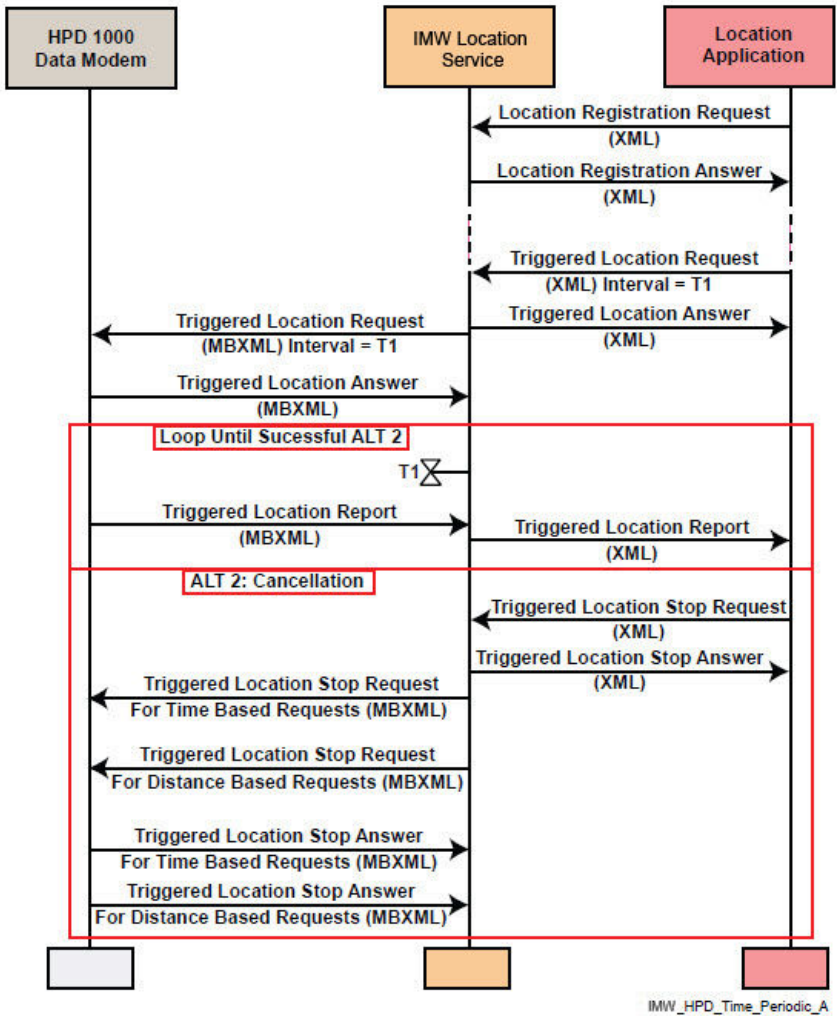
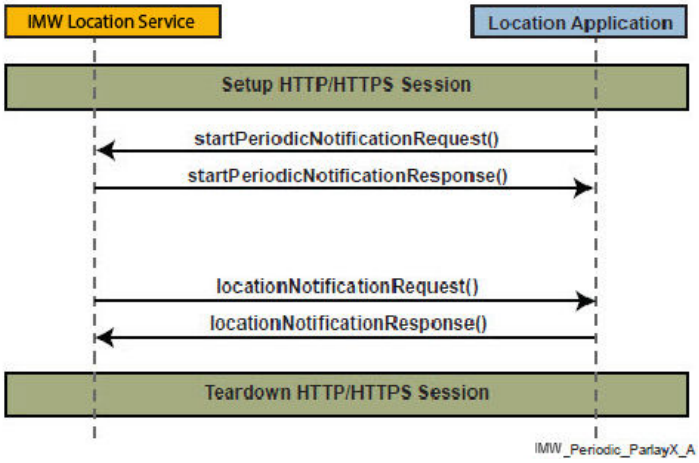


Figure 36: Time-Based Periodic Location Request - HPD 1000 Data Modem Standalone Using the Parlay X-Based Interface



NOTICE: The Parlay X-based interface only shows the unique messaging between the application and the IMW server. The messaging between the IMW server and the device are the same for both examples.

Figure 37: Time-Based Periodic Location Request – HPD 1000 Data Modem MDT Enabled

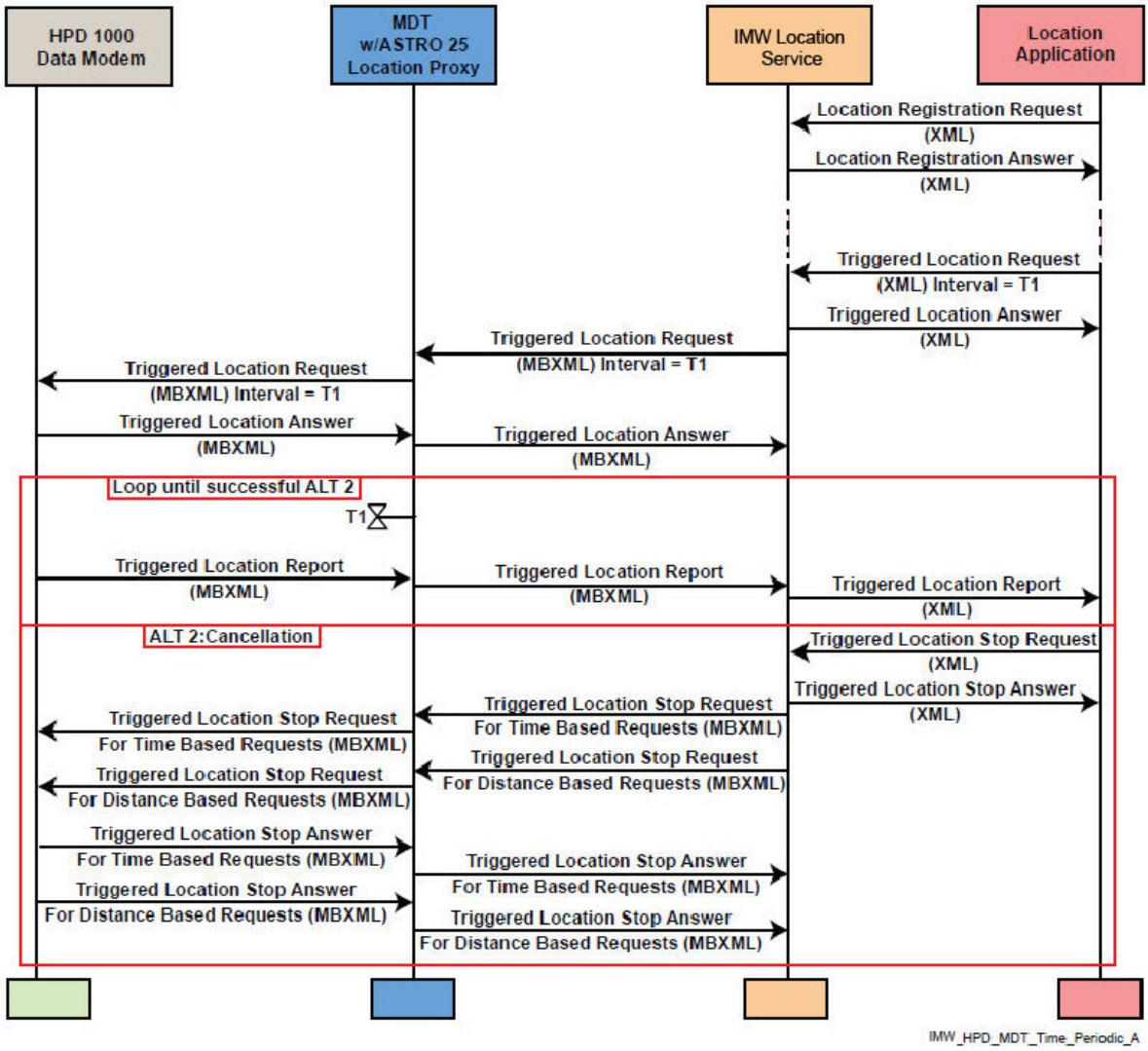


Figure 38: Distance-Based Periodic Location Request – HPD 1000 Data Modem Standalone

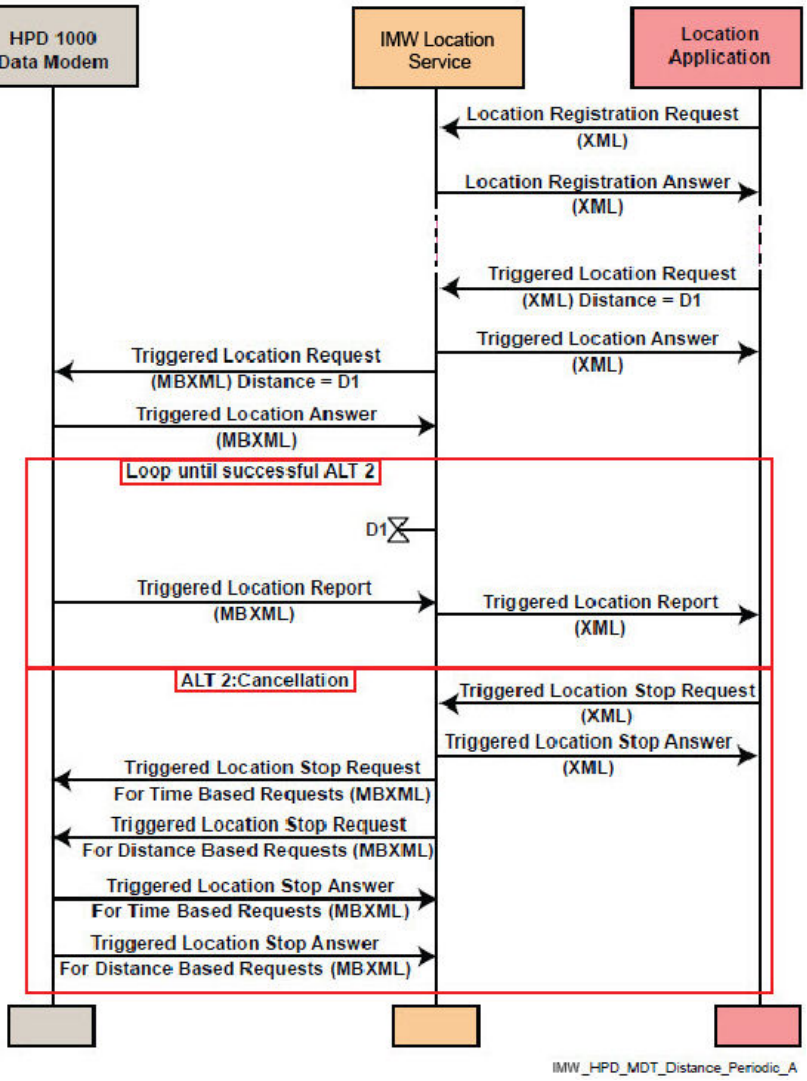
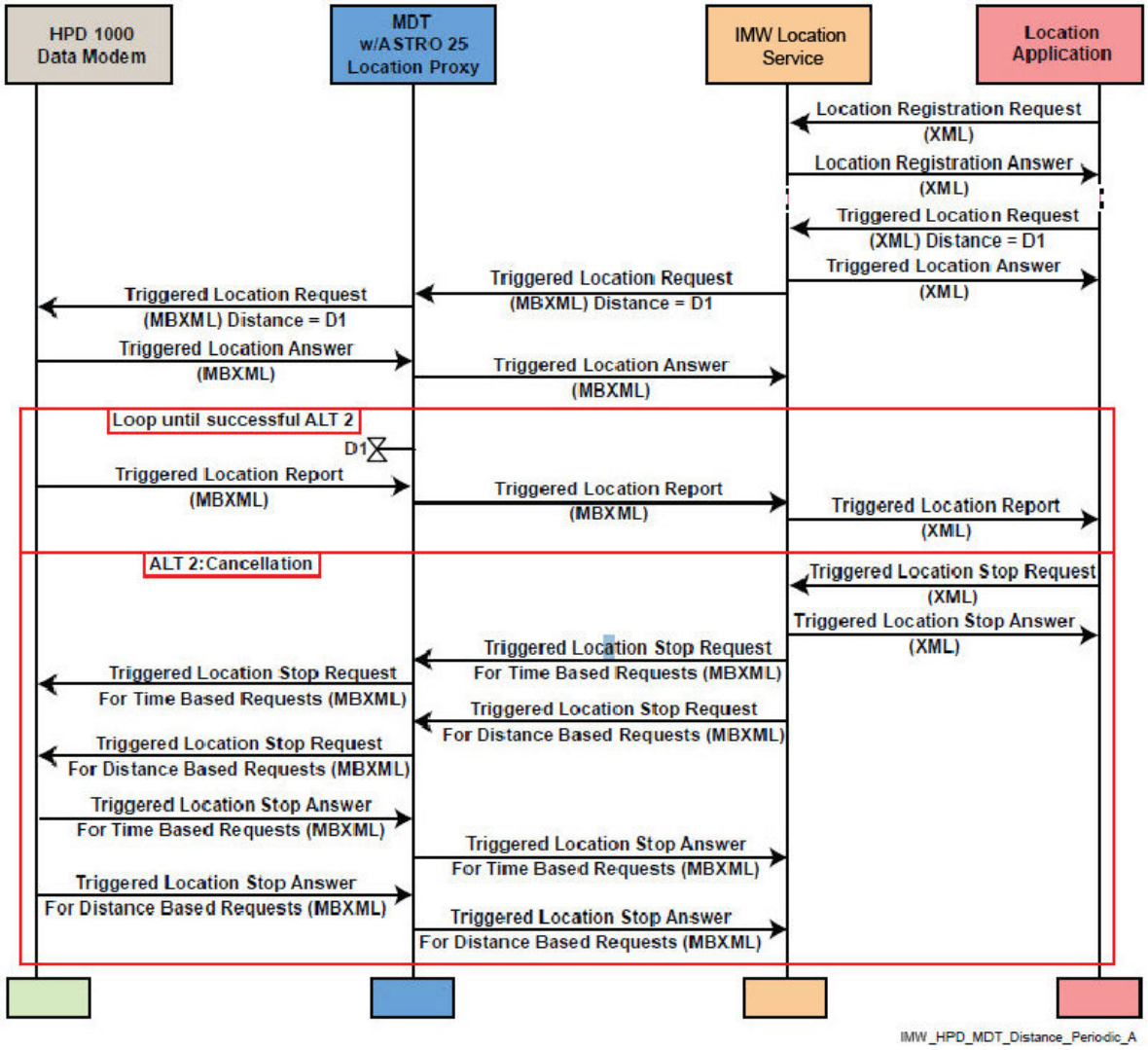


Figure 39: Distance-Based Periodic Location Request – HPD 1000 Data Modem MDT Enabled



The third-party location application is not required to send a Location-Registration-Request for each triggered-location-request. The registration process detailed in Figure 35: Time-Based Periodic Location Request – HPD 1000 Data Modem Standalone Using the LRRP Application Interface on page 108 through Figure 39: Distance-Based Periodic Location Request – HPD 1000 Data Modem MDT Enabled on page 111 (request and response) occurs once when a location application initially connects to the Location Service.

NOTICE: The same sequence diagrams are not repeated for the Parlay X-based interface but the messaging between the device and IMW server is the same in all cases, regardless of application interface used.

7.5.3
Stop Location Updates – HPD

A third-party application may request to stop periodic location updates from the HPD 1000 Data Modem. Canceling periodic location updates from the HPD 1000 Data Modem cancels both time-based and distance-based requests sent previously to the data modem.

A request for a Stop Location Updates from an HPD 1000 Data Modem includes the following actions:

- A registered location application sends a stop periodic location updates request to the Location Service directly via the LRRP API or via the IMW 3GPP Parlay X interface.
- On receipt of a Stop Location updates request, the Location Service validates that the application is allowed to perform the operation it is trying to perform. If the application is not permitted to perform the operation, an error is generated to the application; otherwise the Location Service sends an acknowledgment back to the third-party application.
- The Location Service sends a Triggered-Location-Stop-Request document of LRRP (in MBXML form) to the HPD 1000 Data Modem (directly in HPD Direct mode or through the MDT, Middleware VPN Solution, and the ASTRO® 25 Location Proxy in MDT Enabled mode). One request is sent for time-based reporting and one for distance-based reporting.
- The HPD 1000 Data Modem uses the Triggered-Location-Stop-Answer document of LRRP (in MBXML form) to send a response for each of the stop requests to the Location Service.

NOTICE: In the MDT Enabled mode, the ASTRO® 25 Location Proxy receives requests and routes them to the HPD 1000 Data Modem. The ASTRO® 25 Location Proxy also receives the reports from the HPD 1000 Data Modem and routes them through the Middleware VPN Solution to the Location Service.

The following figures show a request for a Stop Location Updates from an HPD 1000 Data Modem:

Figure 40: Stop Location Updates - HPD 1000 Data Modem Standalone Using the LRRP Application Interface

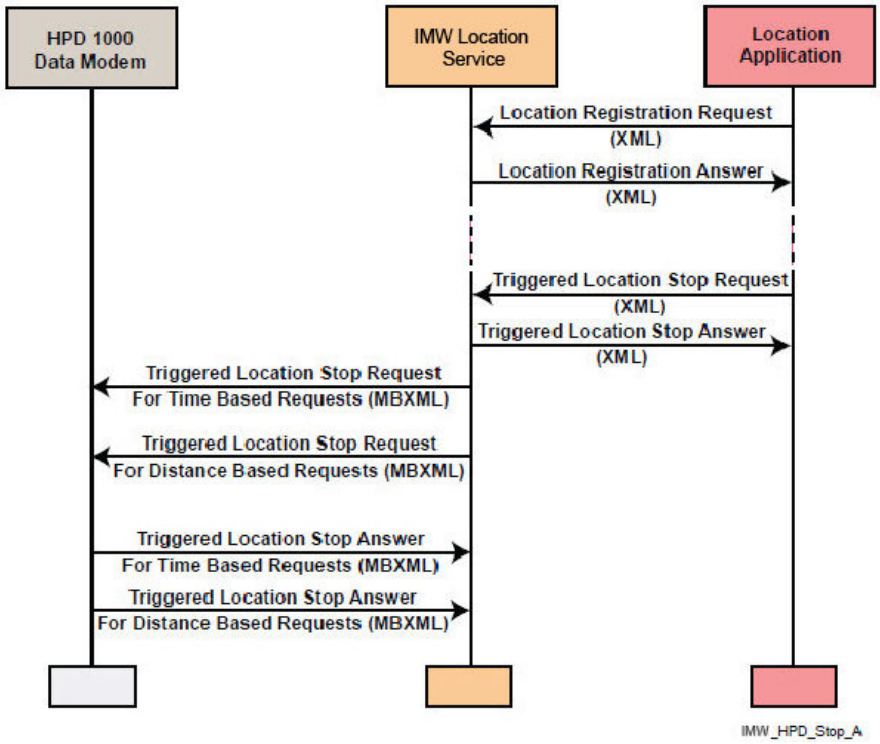
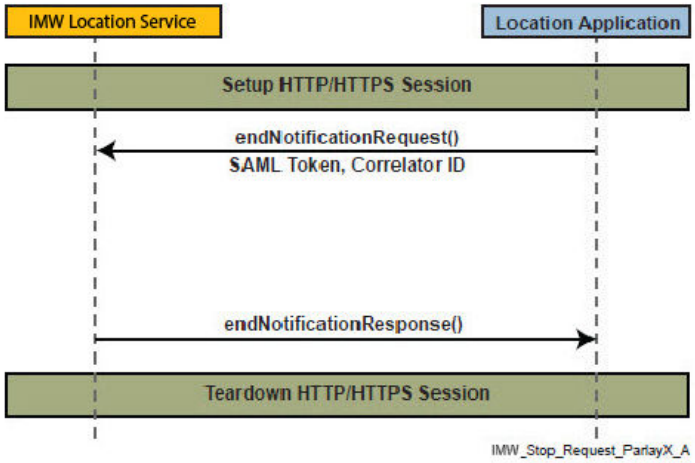
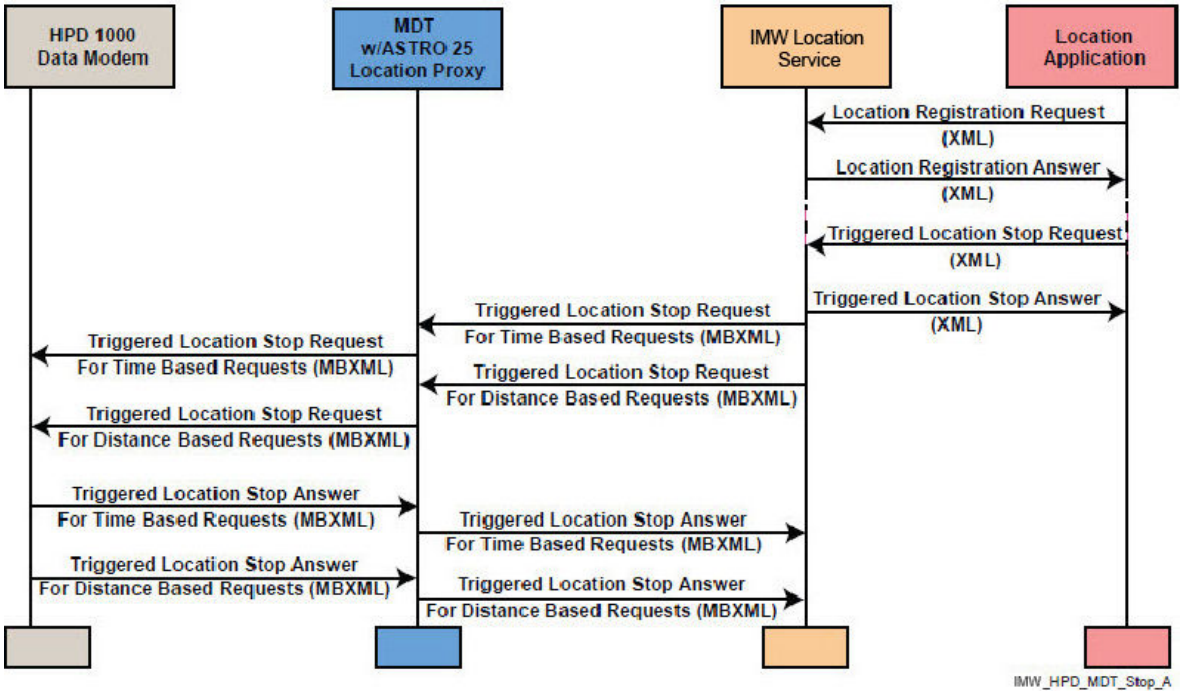


Figure 41: Stop Location Updates- HPD 1000 Data Modem Standalone using the Parlay X-Based Interface



NOTICE: The Parlay X-based interface only shows the unique messaging between the application and the IMW server. The messaging between the IMW server and the device are the same for both examples.

Figure 42: Stop Location Updates – HPD 1000 Data Modem MDT Enabled



The third-party location application is not required to send a Location-Registration-Request for each triggered-location-stop-request. The registration process detailed in Figure 40: Stop Location Updates - HPD 1000 Data Modem Standalone Using the LRRP Application Interface on page 112 and Figure 42: Stop Location Updates – HPD 1000 Data Modem MDT Enabled on page 113 (request and response) occurs once when a location application initially connects to the Location Service.

NOTICE: The same messaging can be observed between the device and the IMW server for the Parlay X-based interface.

7.6 Performance and Capacity

The ASTRO® 25 Outdoor Location Solution uses information from the GPS satellites orbiting the earth to determine the approximate geographical location of the radio, expressed as latitude and longitude. The availability and accuracy of this location information (and the amount of time that it takes to calculate it) vary depending on the environment in which the GPS feature is used. For example, GPS location fixes are difficult to obtain indoors, in covered locations, between high buildings, or in situations where a clear broad view of the sky has not been established.

7.6.1 Performance Considerations

Since GPS technology uses radio signals from earth-orbiting satellites to establish the location coordinates, maximizing the view of clear unobstructed sky is essential for optimum performance. If adequate signals from multiple satellites are not available, the GPS feature of the HPD 1000 Data Modem does not work. Such situations include, but are not limited to:

- Underground locations
- Inside of buildings, trains, or other covered vehicles
- Under any other metal or concrete roof or structure
- Between tall buildings or under dense tree-cover
- In temperature extremes outside the operating limits of the HPD 1000

Even when location information can be calculated in such situations, it may take longer to do so, and the location estimate may not be as accurate. Even when adequate signals from multiple satellites are available, the GPS feature only provides an approximate location, often within 20 meters to 100 meters from the actual location (but sometimes much farther from the actual location). The accuracy of the location information and the time that it takes to obtain it vary depending on circumstances, particularly the ability to receive signals from an adequate number of satellites. The accuracy of the information can be requested as part of the location response.

The satellites used by the GPS feature are controlled by the U.S. Government and are subject to changes implemented in accordance with the Department of Defense GPS User Policy and the Federal Radio Navigation Plan. These changes may affect the performance of the GPS feature of the HPD 1000 DataModem.

Chapter 8

Location Interface for Applications

Location applications receive the location information of a radio and telemetry information of a vehicle from the Location Service according to the configuration set in the Configuration Manager. The protocol used for requesting location, setting digital outputs, reading digital or analog inputs, and obtaining location updates is either an extended version of the Motorola Location Request/Response Protocol (LRRP) transported using Transmission Control Protocol/Internet Protocol version 4 (TCP/IPv4) or the 3GPP Parlay X web services SOAP-based interface.

8.1 Protocol Support

LRRP is a Motorola developed and supported protocol that provides an interface for the third-party location applications. The 3GPP Parlay X web services SOAP-based interface is a generally accepted standard interface with an addition of proprietary extensions to allow for Motorola Solutions value-added differentiation. The REST & WebSocket APIs transfer presence and location data in the form of JavaScript Object Notation (JSON) documents. The IMW APIs provide an interface for the third-party location applications to:

- Register with the Location Service.
- Verify the version number of the protocol supported by the Location Service.
- Request the location of a radio.
- Receive the location of a radio.
- Set the digital output associated with a mobile radio (for mobile radios connected to the Cellocator Olympic for ASTRO).
- Obtain the status of digital inputs associated with a mobile radio (for mobile radios connected to the Cellocator Olympic for ASTRO).
- Obtain the status of the analog input associated with a mobile radio (for mobile radios connected to the Cellocator Olympic for ASTRO).
- Receive the presence/absence status of a radio (excluding the HPD 1000 Data Modem configurations and the ASTRO® Spectra Plus™ radios).

The IMW APIs allow the ASTRO® 25 Outdoor Location Solution to operate on ASTRO® 25 Trunking IV&D, Conventional IV&D, and High Performance Data networks and interface with a location application without the need for modification.

NOTICE: Each IMW API provides different capabilities.

8.2 LRRP Messages Summary

This section summarizes the LRRP messages and explains the purpose of each of them. In addition, the names of the XML documents are provided for the following messages:

Request
From the third-party application to the Location Service.

Acknowledgments
From the Location Service to the third-party application.

Response

From the Location Service to the third-party application.

NOTICE:

- Only configured applications (up to three) are able to register with the Location Service.
- API functionality is based on the application configuration in the Configuration Manager.

Table 20: Summary of the LRRP Messages

Purpose	Name of XML Documents for:			Comments
	Request: From the Third-Party Application to the Location Service	Acknowledgments: From the Location Service to the Third-Party Application	Response: From the Location Service to the Third-Party Application	
Verification of the Version number of “Extended LRRP” of the Location Service by application.	Location- Protocol- Request	—	Location- Protocol- Report	To remain compatible with future versions, an application should verify the version of the LRRP of the Location Service.
Registration of an application by the Location Service	Location-Registration- Request	—	Location- Registration- Answer	An application must register with the Location Service before using any services (except protocol verification).
Location and Sensor Info/Ping	Immediate- Location- Request	Immediate- Location- Answer	Immediate- Location- Report	The Location Service returns an immediate acknowledgment. The radio returns one location and sensor information through the Location Service.
Location and Sensor Info/ Tracking Start	Triggered- Location- Request	Triggered- Location- Answer	Triggered- Location- Report	The Application specifies the interval between location reports in the request. The Location Service returns an immediate Acknowledgment. The radio returns location and sensor information periodically through the Location Service.
Location and Sensor Info/ Tracking Stop	Triggered- Location- Stop-Request	Triggered- Location- Stop- Answer	—	This is used by an application to stop the periodic location report. The Location Service returns only an immediate Acknowledgment
Location and Sensor Info/ Unsolicited	—	—	Unsolicited- Location- Report	This is used by the Location Service to send location info in case of a telemetry event, an emergen-

Purpose	Name of XML Documents for:			Comments
	Request: From the Third-Party Application to the Location Service	Acknowledgments: From the Location Service to the Third-Party Application	Response: From the Location Service to the Third-Party Application	
				cy event. It is also used to send location info due to pre-configuration of a Cellocator Olympic for ASTRO.
Presence Info	—	—	Unsolicited- Location- Report	When a radio powers on or off, the Location Service informs the application of the presence or absence of the radio.
Telemetry command	Digital- Output- Change- Request	Digital- Output- Answer	—	This is used by the application to control a digital output of a Cellocator Olympic for ASTRO.

NOTICE: It is recommended that a third-party applications should verify the protocol version number of the LRRP implementation in the Location Service. The location applications must register with the Location Service before using any services (except protocol verification).

8.3 3GPP Parlay X Messages Summary

This section summarizes the Parlay X-based messages and explains the purpose of each of them. In addition, the names of the web service messages are provided for the following:

Request
From the third-party application to the IMW.

Acknowledgments
From the IMW to the third-party application.

Response
From the IMW to the third-party application.

Table 21: Summary of the 3GPP Parlay X Messages

Purpose	Name of Web Service Interface			Comments
	Request: From the Third-Party Application to the IMW	Acknowledgments: From the IMW to the Third-Party Application	Response: From the IMW to the Third-Party Application	
Location and Sensor Info/Ping -Individual device	getLocation	getLocationResponse		The IMW returns an acknowledgement containing the location and telemetry information of a radio.
Location and Sensor Info/Ping	getTelemtry	getLocationForGroupResponse		The IMW returns an acknowledgement containing

Purpose	Name of Web Service Interface			Comments
	Request: From the Third-Party Application to the IMW	Acknowledgments: From the IMW to the Third-Party Application	Response: From the IMW to the Third-Party Application	
- Group of devices				the location and telemetry information for a group of radios.
Sensor Info/Ping -Individual device	getTelemetryForGroup	getTelemetryResponse		The IMW returns an acknowledgement containing the telemetry information of a radio.
Sensor Info/Ping - Group of devices	startPeriodicNotification	getTelemetryForGroupResponse		The IMW returns an acknowledgement containing the telemetry information for a group of radios.
"Location and Sensor Info/ Tracking Start"	startPeriodicNotification	startPeriodicNotificationResponse	locationNotification	The application requests periodic location and sensor information for one ore more devices. The IMW returns an immediat acknowledgement. The radio returns location and sensor information periodically through the IMW.
Location and Sensor Info Rate Modification	setTerminalNotification	setTerminalNotificationResponse	locationNotification	The application modifes the interval between reports for a device. The IMW returns an immedatie acknwoledgement.
"Location and Sensor Info/ Tracking Stop"	endNotification	endNotificationReponse		"This is used by an application to stop the periodic location report. The IMW returns only an immediate acknowledgement."
Application Keep-alive Start	startHeartbeatsRequest	startHeartbeatsResponse	heartbeatRequest	Allows the application to request Heartbeats from the Location Service to ensure the application link remains active.
Application Keep-alive Stop	stopHeartbeatsRequest	stopHeartbeatsResponse		This is used by an application to stop the periodic Heartbeat procedure. The IMW returns only an immediate acknowledge.

Chapter 9

Outdoor Location Solution – Equipment Requirements

This chapter describes the equipment required to enable the ASTRO® 25 Outdoor Location Solution on an ASTRO®25 Trunking IV&D system, Conventional IV&D system, or ASTRO® 25 High Performance Data (HPD) system.

9.1 XTS Radios Requirements

The following sections describe the requirements for the XTS portable radios.

9.1.1 GPS Remote Speaker Microphone

The GPS Remote Speaker Microphone (GPS RSM) contains a GPS receiver. It communicates the location information to the radio, which displays that information to the radio user and sends it to the dispatch operator when requested.

Figure 43: GPS Remote Speaker Microphone

The GPS RSM provides the following features:

- Integrated GPS receiver
- Submersible (only when used with the ruggedized XTS 5000 Models I and III)
- RSM Volume Control
- 16-Position Channel Control
- Emergency Button (orange)
- Programmable Side Button

- PTT Switch

The following GPS Remote Speaker Microphone types are supported:

Table 22: Outdoor Location Solution Supported GPS Remote Speaker Microphones

Speaker Microphone	Part Number
GPS Remote Speaker Microphone	HMN4080
GPS Remote Speaker Microphone with Earjack	HMN4084
GPS R2 SMART/SUBM Remote Speaker Microphone	HMN4106
GPS R2 SMART/NON-SUBM Remote Speaker Microphone	HMN4107

9.1.2
GPS RSM Battery Information

The GPS RSM contains a Li-Ion battery, which is continuously charged from the radio's battery. The typical impact on the radio battery life is 12%. Under normal usage, the GPS RSM battery remains charged continuously. If the GPS RSM battery does become low, the GPS RSM emits an audible tone until the battery is completely discharged. Once the GPS RSM battery becomes low, the GPS RSM cannot provide location information.

The GPS RSM low battery tone repeats every 30 seconds while the GPS RSM battery is low. The tone cannot be turned off, but the radio user can prevent further drain-off of the battery by disabling the Location Service with the on/off soft button in the location menu (if this feature is enabled by the CPS).

To recharge the GPS RSM battery, the GPS RSM must be connected to the radio, and the radio must be powered on.

NOTICE: Reporting of location updates over-the-air further impacts radio battery life, and is dependent on the system configuration.

9.1.3
GPS-Enabled XTS Portable Radios

Supported models of the XTS portable radios offer GPS capability and a ruggedized version that operates on an ASTRO® 25 IV&D system.

The GPS enabled ASTRO® 25 XTS portable radios act as both voice communications devices and data communications devices and require the GPS RSM. The XTS portable radios are the virtual source of the location information. They contain the Motorola Location Request/Response Protocol (LRRP) software.

9.1.3.1
Required Software

The following table lists the required software to use the GPS-enabled XTS portables for ASTRO®25 IV&D operation.

Table 23: Required Software to Use the XTS Portables for ASTRO 25 IV&D Operation

System	Radio Firmware	GPS RSM Firmware	CPS Version
Conventional	R06.01.00 or later	R01.00.08 or later	R09.00.00

System	Radio Firmware	GPS RSM Firmware	CPS Version
Trunking	R07.00.00 or later	R01.00.08 or later	R09.00.00

9.1.3.2
Radio Options – XTS

The following XTS 5000 radio options are required to enable the ASTRO® 25 Outdoor Location Solution on the ASTRO® 25 Conventional IV&D system:

- ASTRO CAI Operational Mode Software – Q806
- System Enhancement Software – H35 (H37 or H38 in Conventional mode only)
- GPS Remote Speaker Microphone – HMN4080 / HMN4084 Remote Speaker Microphone with Earjack.

  Or

  GPS R2 SMART/SUBM Remote Speaker Microphone HMN4106 / GPS R2 SMART/NON-SUBM Remote Speaker Microphone HMN4107

The following XTS 2500 radio options are required to enable the ASTRO® 25 Outdoor Location Solution on the ASTRO® 25 Conventional IV&D systems:

- Software P25 Conventional – Q811
- Radio Packet Data and RS 232 Packet Interface – Q947
- GPS Remote Speaker Microphone – HMN4080 / HMN4084 Remote Speaker Microphone with Earjack.

  Or

  GPS R2 SMART/SUBM Remote Speaker Microphone HMN4106 / GPS R2 SMART/NON-SUBM Remote Speaker Microphone HMN4107

The following XTS 5000 radio options are required to enable the ASTRO® 25 Outdoor Location Service on the ASTRO® 25 Trunking IV&D systems:

- ASTRO CAI Operational Mode Software – Q806
- SmartZone System Software – H38
- Project 25 9600 Baud Trunking Software – Q361
- GPS Remote Speaker Microphone – HMN4080 / HMN4084 Remote Speaker Microphone with Earjack.

  Or

  GPS R2 SMART/SUBM Remote Speaker Microphone HMN4106 / GPS R2 SMART/NON-SUBM Remote Speaker Microphone HMN4107

The following XTS 2500 radio options are required to enable the ASTRO® 25 Outdoor Location Service on the ASTRO® 25 Trunking IV&D systems:

- Software Trunking 9600 – Q574
- Radio Packet Data and RS 232 Packet Interface – Q947
- GPS Remote Speaker Microphone – HMN4080 or HMN4084 Remote Speaker Microphone with Earjack.

  Or

  GPS R2 SMART/SUBM Remote Speaker Microphone HMN4106 / GPS R2 SMART/NON-SUBM Remote Speaker Microphone HMN4107

9.1.4
Relative Radio Receive Sensitivity

The relative radiated receive sensitivity test measures the radio sensitivity on all channels across all radio frequency bands.

The following are the radio frequencies:

- VHF: 165.8875 MHz
- UHF1/UHF2:
  - 405.5000 MHz
  - 442.3625 MHz
  - 479.2250 MHz
  - 479.2375 MHz
  - 516.0875 MHz

The above UHF1/UHF2 radio frequencies showed a degraded performance when used with the GPS RSM.

9.2
APX Series of Mobiles and Portables Requirements

The following sections describe the requirements for the APX series of mobiles and portables with internal GPS.

9.2.1
APX 7000 Battery Information

The APX 7000 contains a Li-Ion battery. The typical impact on the radio battery life is 12%. Under normal usage, the APX 7000 radio battery remains charged continuously.

9.2.2
GPS-Enabled APX Series of Mobiles and Portables

Supported models of the APX series of mobiles and portables offer GPS capability and a ruggedized version that operates on an ASTRO® 25 IV&D system.

The GPS enabled ASTRO® 25 APX series of mobiles and portables act as both voice communications devices and data communications devices. The APX series of mobiles and portables are the virtual source of the location information. They contain the Motorola Location Request/Response Protocol (LRRP) software.

9.2.2.1
Required Software

All released software versions of the APX series of mobiles and portables for ASTRO® 25 IV&D operation support GPS as shown in the following table:

Table 24: Required Software to Use the APX Series of Mobiles and Portables for ASTRO 25 IV&D Operation

Radio	System	Radio Firmware	CPS Version
APX 7000 / 7500	Conventional IV&D	R01.00.00 or later	R01.00.01 or later
APX 7000 / 7500	Trunking IV&D	R01.00.00 or later	R01.00.01 or later

9.2.2.2
Radio Options – APX

The following APX series of mobiles and portables options are required to enable the ASTRO® 25 Outdoor Location Solution on the ASTRO® 25 Conventional and ASTRO® 25 Trunking IV&D system:

- Q947-RADIO PACKET DATA
- For the APX 7000 Portable:
  - QA00782 - ENABLE INTERNAL GPS OPERATION
- For the APX 7500 Mobile:
  - GA00229 - GPS ACTIVATION
  - GA00226 - GPS ANTENNA

Figure 44: APX 7000 Portable Radios

9.3
Location and Presence Requirements

The Location Service provides ASTRO® 25 Outdoor Location Services to third-party applications in the CEN. The Location Service resides within the CEN on the following platforms:

- HP Proliant DL380 Gen8 Server
- Microsoft Windows Server 2012 R2 (64 bit) Operating System

The Presence Service cohabitates with the Location Service on the IMW server and provides the presence and absence information of radios to the Location Service.

9.3.1
Location Service and API Configuration Parameters

For information on Location Service configuration parameters, see *Configuration Manager User Guide*.

NOTICE: API configuration parameters include parameters that can be modified such as the Listen Port, which states the port that a third-party application should connect to in order to receive API messages from the Location Service.

9.3.2
Presence Service Configuration Parameters

For information on Presence Service configuration parameters, see *Configuration Manager User Guide*.

9.3.3
Presence Service Capacity

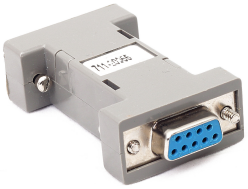
See the Intelligent Middleware *Feature Manual*.

9.4
Cellocator Olympic for ASTRO Requirements

The following table lists the name, description, part number, and picture of the modules available as Field Replaceable Units (FRUs) and Field Replaceable Entities (FREs) for the Cellocator Olympic for ASTRO. For information on the GPS Unit installation and configuration, see the ASTRO® 25 Outdoor Location Solution *Device Installation and Configuration Guide*.

Table 25: Components Available as FRUs and FREs

Name	Description	Part Number	Picture / Note
CELLOCATOR OLYMPIC FOR ASTRO Dash Mount GPS Kit	Cellocator Olympic GPS kit including a GPS unit, Vehicle Harness and internal mount GPS antenna	HKCN4001B	N/A
CELLOCATOR OLYMPIC FOR ASTRO External Mount GPS Kit	Cellocator Olympic GPS kit including a GPS unit, Vehicle Harness and external mount GPS antenna	HKLN4474A	N/A
Cellocator Olympic for ASTRO GPS and Telemetry Unit	Compact Olympic unit, including the GPS receiver	HKUN4091B	 ph_UNS_Cellocator_GPS_Unit

Name	Description	Part Number	Picture / Note
Cellocator Vehicle Harness	The full wiring harness for vehicle installation	HKLN4352A	 ph_UNS_Vehicle_Harness
Programming Cross Plug	The Cellocator Programming Cross Plug (HKLN4353A) connects to a computer that is used for programming the GPS Unit during the installation in a vehicle. To order a replacement, you need to order the Cellocator Programming Kit that includes the cross plug and Programming S/W CD.	HK1613B - Cellocator Programming Kit	 ph_UNS_Programming_Cross_Plug
Cellocator Dash Mount GPS Antenna	An Internal Mount integrated GPS antenna and receiver	HKLN4351A	 ph_UNS_Cellocator_GPS_Antenna_2

Name	Description	Part Number	Picture / Note
Cellocator External Mount GPS Antenna	An External Mount integrated GPS antenna and receiver	HKAN4001A	 ph_UNS_Cellocator_GPS_Antenna_1

9.4.1
Cellocator Olympic for ASTRO Interfaces

The following sections provides information on how the Cellocator Olympic for ASTRO interfaces with vehicles, GPS signals, radios, and the Location Service.

9.4.1.1
Interfaces with the Vehicle

The Cellocator Olympic for ASTRO dash includes a vehicle harness that provides the necessary connectivity options for installing in a vehicle.

For information on Cellocator Olympic for ASTRO installation and configuration parameters, see the ASTRO® 25 Outdoor Location Solution *Device Installation and Configuration Guide*.

9.4.1.1.1
Digital Inputs and Outputs

The Cellocator Olympic for ASTRO includes five digital inputs (one dedicated for ignition), two digital outputs, and one analog input dedicated for vehicle battery voltage measurement.

For information on Cellocator Olympic for ASTRO installation and configuration parameters, see the ASTRO® 25 Outdoor Location Solution *Device Installation and Configuration Guide*.

9.4.1.2
Interface with GPS Signals

The GPS-based location is acquired every one second and the mode of acquisition is non-assisted.

The Cellocator Olympic for ASTRO SiRF star III module is a GPS receiver (also referred to as a smart antenna), which contains both the GPS receiver and the GPS antenna. The SiRF Star III has an interface allowing the GPS Unit to turn the GPS on/off. The GPS off condition ensures low current consumption (less than 0.1 mA) and also verifies that the fast location acquisition is turned on. See GPS Specifications for Cellocator Olympic for ASTRO on page 35 for the GPS Specifications for Cellocator Olympic for ASTRO.

For information on the Cellocator Olympic for ASTRO installation and configuration parameters, see the ASTRO® 25 Outdoor Location Solution *Device Installation and Configuration Guide*.

9.4.1.3
Cellocator Olympic for ASTRO Configurations

The Cellocator Olympic for ASTRO can be used with the ASTRO® 25 Outdoor Location Solution in either of two configurations:

Cellocator Olympic for ASTRO GPS Unit <-> ASTRO® 25 Mobile Radio

When a Cellocator Olympic for ASTRO is connected directly to an ASTRO® 25 mobile radio, the GPS coordinates are sent directly from the Cellocator Olympic for ASTRO to the CEN through the mobile radio.

Cellocator Olympic for ASTRO GPS Unit <-> MDT <-> ASTRO® 25 Mobile Radio

When a Cellocator Olympic for ASTRO GPS unit is connected to an MDT which in turn is connected to an ASTRO® 25 mobile radio, the GPS coordinates are sent across the MDT by the ASTRO® 25 Location Proxy. In this alternate configuration, the ASTRO® 25 Location Proxy is a required system component and must be installed and running on the MDT.

9.4.1.4
Interfaces with Radios

The Cellocator Olympic for ASTRO connects (using a standard RS232 interface) to the ASTRO® 25 mobile radios using Point-to-Point Protocol (PPP). On the startup, the Cellocator Olympic for ASTRO establishes a PPP connection to the modem of the Mobile radio. This connection is monitored using PPP echo and response every four seconds. The GPS Unit tries to re-dial to the modem if three consecutive echoes are not replied.

9.4.1.5
Interfaces with an MDT

The Cellocator Olympic for ASTRO communicates with the ASTRO® 25 Location Proxy on the Mobile Data Terminal (MDT) using the RS232 interface. In this configuration, the ASTRO® 25 Data Link Manager connects (using an RS232 or USB interface) to the ASTRO® 25 IV&D mobile radios using the PPP protocol for IV&D and the ASTRO® 25 HPD Status Applet connects (using a USB or ethernet interface) to the HPD 1000 Data Modem using the PPP protocol for HPD.

9.4.1.6
Interface with the Location Service

The Cellocator Olympic for ASTRO is equipped with a buffer for 20 messages, which is used during communication failures. When a message is sent and an acknowledgment is not received within the acknowledgment time-out (32 seconds), the GPS unit sends a message. When the buffer is full, the oldest message is overwritten with a new message.

After the communication link is restored, the GPS unit sends the buffered messages in a sequence. The first message in-line (oldest in the buffer) is sent and the next message is sent only after an acknowledgment is received for the first message.

9.4.1.6.1
Anti Flooding

The Cellocator Olympic for ASTRO includes a feature that ensures less traffic on the network, in case that the Location Service is not able to receive its data. If a GPS initialized or a unit connected message is not acknowledged, the GPS unit tries (up to 16 times) to send the message to the Location Service with a wait of period between each try. If this is not successful, the unit will try to re-dial the PPP connection with the radio. This whole process is repeated 5 times and it takes 41 minutes (16*32*5) in total. If the unit is not successful in communicating with the Location Service in the CEN, it will not try to send additional messages, for a defined timeframe, to prevent unnecessary traffic over the network.

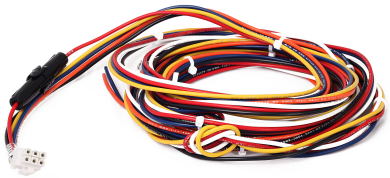
9.4.2
Cellocator Olympic for ASTRO Configuration Parameters

For information on Cellocator Olympic for ASTRO installation and configuration parameters, see the ASTRO® 25 Outdoor Location Solution *Device Installation and Configuration Guide*.

9.5
Trimble Placer™ Gold APU and Placer™ Gold DRU Plus Requirements

The following table lists the name, description, part number, and picture of the modules available as Field Replaceable Units (FRUs) and Field Replaceable Entities (FREs) for the Trimble Placer™ Gold APU and Trimble Placer™ Gold Dead Reckoning Unit (DRU) Plus units.

Table 26: Modules Available as FRUs and FREs

Name	Description	Motorola Part Number	Picture / Note
Trimble Placer™ Gold APU GPS Receiver	Trimble Placer™ Gold APU GPS Unit (Ships standard with the power cable.)	DDN9440	N/A
Trimble Placer™ Gold DRU Plus GPS Receiver	Trimble Placer™ Gold APU GPS Unit equipped with an internal module to provide dead reckoned position while outside of GPS coverage. (Ships standard with the power cable.)	DDN9439	 ph_UNS_Trimble_Placer_Gold
GPS Antenna Bundle for Trimble Placer™ Gold unit	GPS Antenna Bundle for Trimble Placer™ Gold unit	DDN9474	N/A
Main Power and Ignition Cable for Trimble Placer™ Gold unit	Main Power and Ignition Cable for Trimble Placer™ Gold unit	Included as part of DDN9440/ DDN9439	 ph_UNS_Trimble_Ignition_Cable

Name	Description	Motorola Part Number	Picture / Note
9 Pin Male Male Serial RS232 Gender Changer Adapter	9 Pin Male Male Serial RS232 Gender Changer Adapter	DSFA440R2	 ph_UNS_Gender_Changer For the **Trimble Unit <-> ASTRO® 25 Mobile Radio**, one is required per each Trimble GPS unit.
Serial I/O Cable DB9	Serial I/O Cable DB9	DS36084	For the **Trimble Unit <-> ASTRO® 25 Mobile Radio** configuration, for example, order 5% of the total number of Trimble GPS units ordered. For the **Trimble Unit <-> MDT <-> ASTRO® 25 Radio** configuration, one is required per each Trimble GPS unit.

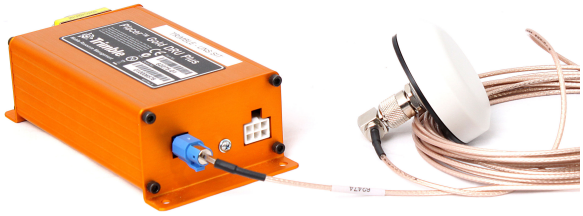
9.5.1
Trimble Placer™ Gold APU and Placer™ Gold DRU Interfaces

The following section provide information on how the Trimble Placer™ Gold APU and Placer™ Gold DRU Plus interface with GPS signals, radios, and the Location Service.

9.5.1.1
Interface with GPS Signals

The following figure shows the Trimble Placer™ Gold DRU Plus unit and the Trimble Placer™ Gold External Mount GPS antenna. The GPS-based location is acquired every one second and the mode of acquisition is non-assisted.

Figure 45: Placer™ Gold DRU Plus Unit with External Mount GPS Antenna



ph_UNS_Trimble_Placer_Gold_wGPS_Antenna

The Trimble Placer™ Gold DRU Plus GPS-based position information is augmented by dead reckoning (DR) to provide position information in areas where satellite signals are blocked by the surrounding buildings, structures, or terrain. The unit uses inputs from a heading sensor, pulses from an odometer, and a signal from the backup light of the vehicle to calculate the current position of the vehicle when

the GPS is unavailable. The unit automatically switches back to a combination of DR and GPS when satellite signals are available.

For complete specification information on the Trimble Placer™ Gold APU or Placer™ Gold DRU Plus, see Trimble Placer Gold APU and Placer Gold DRU Interfaces on page 129.

9.5.1.2
Trimble Placer™ Gold Configurations

The Trimble Placer™ Gold units can be used with the ASTRO® 25 Outdoor Location Solution in either of two configurations:

Trimble Placer™ Gold GPS Unit <-> ASTRO® 25 Mobile Radio
When a Trimble Placer™ Gold APU or Trimble Placer™ Gold DRU Plus GPS unit is connected directly to an ASTRO® 25 Mobile Radio, the GPS coordinates are sent directly from the Trimble unit to the CEN through the mobile radio.

Trimble Placer™ Gold GPS Unit <-> MDT <-> ASTRO® 25 Mobile Radio
When a Trimble Placer™ Gold APU or Trimble Placer™ Gold DRU Plus GPS unit is connected to an MDT which in turn is connected to an ASTRO® 25 mobile radio, the GPS coordinates are sent across the MDT by the ASTRO® 25 Location Proxy. The GPS coordinates are not made available to the MDT for in-vehicle mapping in this configuration at this time. In this alternate configuration, the ASTRO® 25 Location Proxy is a required system component and must be installed and running on the MDT.

9.5.1.3
Interfaces with Radios

The Trimble Placer™ Gold APU and Placer™ Gold DRU Plus units connect (using standard RS-232 interface) to the ASTRO® 25 mobile radios using the PPP protocol. On the startup, the Trimble Placer™ Gold APU and DRU Plus units establish a PPP connection to the modem of the Mobile radio. This connection is monitored using PPP echo and response. The GPS Unit tries to re-dial to the modem if three consecutive echoes are not replied.

9.5.1.4
Interfaces with an MDT

The Trimble Placer™ Gold APU and Placer™ Gold DRU Plus units communicate with the ASTRO® 25 Location Proxy on the Mobile Data Terminal (MDT) using the RS232 interface. In this configuration, the ASTRO® 25 Data Link Manager connects (using an RS232 or USB interface) to the ASTRO® 25 mobile radios using the PPP protocol.

9.5.2
Trimble Placer™ Gold APU and Placer™ Gold DRU Configuration Parameters

For information on the Trimble Placer™ Gold APU and Placer™ Gold DRU Plus installation and configuration, see the ASTRO® 25 Outdoor Location Solution *Device Installation and Configuration Guide*.

9.6 Mobile Radio Requirements

The following table lists the minimum options that should be available on the mobile radios:

Table 27: Minimum Options on the Mobile Radios

Mobile Radios	Options	Radio Firmware Versions	CPS Versions
XTL 5000/XTL 2500 and ASTRO Spectra Plus (Trunking)	G806 (same as Q806) G51 (same as H38) G173 (same as Q173) G361 (same as Q361) W947 (same as Q947)	Host: R09.00.00 DSP: R09.00.00	R09.00.00
XTL 5000/XTL 2500 and ASTRO Spectra Plus (Conventional)	G806 (same as Q806) G48 (same as H35) G50 (same as H37) G51 (same as H38) W947 (same as Q947)	Host: R09.00.00 DSP: R09.00.00	R09.00.00
XTL 1500 (Trunking)	G966 (same as H38)	Host: R09.00.00 DSP: R09.00.00	R09.00.00
XTL 1500 (Conventional)	G964 (same as H35) G965 (same as H37) G966 (same as H38)	Host: R09.00.00 DSP: R09.00.00	R09.00.00

9.6.1 XTL Mobile Radios Equipment

The following figures show the XTL 5000, XTL 2500, and XTL 1500 radios.

Figure 46: XTL 2500 Radio

Figure 47: XTL 1500 Radio

9.6.2
ASTRO Spectra Plus Equipment

The following figure shows the ASTRO® Spectra Plus™ radio.

Figure 48: ASTRO Spectra Plus Radio

9.7 HPD 1000 Data Modem Requirements

The following table lists the name, description, part number, and picture of the modules available as Field Replaceable Units (FRUs) and Field Replaceable Entities (FREs) for the HPD 1000 Data Modem with integrated GPS and associated parts:

Table 28: Modules Available as FRUs and FREs

Name	Description	Motorola Part Number	Picture
HPD 1000 Data Modem	HPD 1000 Data Modem	M26UGA9PW1_N	
HPD 1000 Data Cable	Data Cable for connectivity to the Mobile Data device	Ethernet: G651 / G652 USB: G308 / G309 / G654	—
HPD 1000 GPS Operation	HPD 1000 GPS module	G440	—
HPD 1000 GPS antenna	HPD 1000 GPS antenna (Includes the antenna and cable).	G619	—

NOTICE: For additional information regarding MDT products such as the Motorola MW series of Mobile Workstations, see the Motorola MW documentation.

9.8 Part Numbers

The following table lists the part numbers and versions of the ASTRO® 25 Outdoor Location Solution system components:

NOTICE: For complete IMW ordering instructions including required components and options, see the IMW ordering guide or ECAT price page.

Table 29: Outdoor Location Solution System Components – Part Numbers and Versions

Components	Part Number/Version
GPS RSM	HMN4080
RSM with Earjack	HMN4084
GPS Remote Speaker Microphone (RSM) User Guide	6881109C03
GPS R2 SMART/SUBM Remote Speaker Microphone	HMN4106
GPS R2 SMART/NON-SUBM Remote Speaker Microphone	HMN4107
XTS 5000/XTS 2500 GPS Enabled Portable Radio Models I, II, III, and Firmware version for ASTRO® 25 Conventional IV&D	R06.01.00 or later
XTS 5000 GPS Enabled Portable Radio Models I, II, III, and Firmware version for ASTRO® 25 Trunking IV&D	R07.00.00 or later

Components	Part Number/Version
XTS 5000/XTS 2500 Customer Programming Software version for ASTRO Conventional IV&D or ASTRO® 25 Trunking IV&D	R09.00.00 or later
XTL 5000/XTL 2500/XTL 1500/ASTRO Spectra Plus Mobile Radios Firmware version for ASTRO® 25 Trunking or Conventional IV&D	R09.00.00 or later
XTL 5000/XTL 2500/XTL 1500/ASTRO Spectra Plus Customer Programming Software version for ASTRO® 25 Trunking or Conventional IV&D	R09.00.00 or later
APX 7000 Portable Radio Firmware version for ASTRO® 25 Trunking or Conventional IV&D	01.00.00
APX 7500 Mobile Radio Firmware version for ASTRO® 25 Trunking or Conventional IV&D	02.00.00 or 05.00.00 when used with the Cellocator
APX 7000/APX 7500 Customer Programming Software version for ASTRO Conventional IV&D or ASTRO Trunking IV&D	01.00.00 or later
Unified Network Services	SQM01SUM0257A / 3.0
ASTRO® 25 Location HPD Mobile Data Terminal SDK	DVN1422
ASTRO® 25 Location Proxy	DVN1423
Cellocator Olympic for ASTRO GPS and Telemetry	See Cellocator Olympic for ASTRO Requirements on page 124.

Chapter 10

Outdoor Location Solution – Maintenance and Troubleshooting

This chapter provides customer service information to help troubleshoot maintenance issues.

10.1 Customer Service Information

If you have read this document and made every effort to resolve installation or operation issues yourself and still require help, please contact the Motorola System Support Center (SSC) using the following contact information:

Technical Support:

- North America: 800-221-7144
- International: 302-444-9800

10.1.1 Obtaining Support

Motorola provides technical support services for your system and recommends that you coordinate warranty and repair activities through Motorola SSC. When you consult the Motorola SSC, you increase the likelihood that the problems are rectified in a timely fashion and that the warranty requirements are satisfied. Check your contract for the specific warranty and service information.

10.1.2 System Information

To be provided with the best possible opportunity for support, collect the following system information and have it available when obtaining support:

- Location of the system
- Date the system was put into service
- Software or firmware version information for components of your system
- Serial number(s) of the device(s) or component(s) requiring support
- A written description of the symptom or observation of the problem:
  - When did it first appear?
  - Can it be reproduced?
  - What is the step-by-step procedure to cause it?
- Troubleshooting log files
- Do other circumstances contribute to the problem? For example, changes in weather or other conditions?
- Maintenance action preceding the problem:
  - Upgrade of software or equipment
  - Change in the hardware or software configuration

- Software reload – from backup or from CD-ROM (note the version and date)

10.1.2.1
Return Material Request

After collecting system information, contact Motorola SSC for assistance or to obtain a Return Material Authorization (RMA) number for faulty Field Replaceable Entities (FREs).

Technical Support:

- North America: 800-221-7144
- International: 302-444-9800

10.1.2.2
Returning FREs

Return faulty FREs to Motorola for repair. When you return an assembly for service, follow these best practices:

- Place any assembly containing CMOS devices in a static-proof bag or container for shipment.
- Obtain a return authorization (RA) number from Motorola SSC.
- Include the warranty, model, kit numbers, and serial numbers on the job ticket, as necessary.
- If the warranty is out of date, you must have a purchase order.
- Print the return address clearly in block letters.
- Provide a phone number where your repair technician can be reached.
- Include the contact person's name for return.
- Pack the assembly tightly and securely, preferably in its original shipping container.