

The background of the slide is a low-angle photograph of a radio tower against a clear blue sky. The tower is a complex lattice of metal with several large satellite dishes or antennas attached. To the left of the tower, there are three concentric white arcs representing radio waves. The image is framed by large, semi-transparent geometric shapes in shades of blue and grey.

**NEXT GENERATION
OFF-NETWORK COMMUNICATIONS**

FirstNet
Request for Information

1. INTRODUCTION

The FirstNet Authority recently issued a Request for Information (RFI) entitled Next Generation Off-Network Communications (the full RFI can be viewed at [➔](#)). The RFI asked the question... “What happens when the FirstNet is unavailable?” The following is Skymira’s answer and solutions to this question.

Skymira provides solutions that push communication capabilities out to the edge allowing businesses, government agencies, and NGOs (Non Government Organizations) to have real-time communications anytime, anywhere.

Founded in 1998, Skymira provides cutting-edge communication technology tailored and reliable systems with incredible resilience and coverage that meet workflow and budget requirements.

Skymira’s inclusive portfolio of hardware, software, and services are integrated to provide turn-key solutions for:

- Push-to-talk hardware and services over LTE, FirstNet, Satellite, and WiFi
- Satellite voice & broadband IP connectivity
- LTE / FirstNet hardware and services
- Radio over IP (RoIP) hardware and integration services
- Land mobile radio interoperability
- Situational awareness software
- GPS tracking
- Sensors and other IoT integration services
- Ruggedized GoKITS

2. TECHNOLOGY OVERVIEW

The hardware and associated services discussed in this document are COTS available and are currently deployed with many federal departments and agencies and private businesses and NGOs including:

- Federal law enforcement agencies
- Disaster recovery agencies
- Transportation companies
- Utilities
- Oil and Gas companies
- Fixed sites businesses
- Manufacturing

The technology is network agnostic and provides seamless routing for:

- Global over the horizon PTT
- LMR interoperability
- GPS tracking of vehicles, mobile / portable P25 radios, smartphones, and personal satellite trackers
- Enterprise data
- Video streaming
- Smartphone, dialup voice, text messaging, email, application data
- Multi-bearer redundancy
- AES-256 Encryption

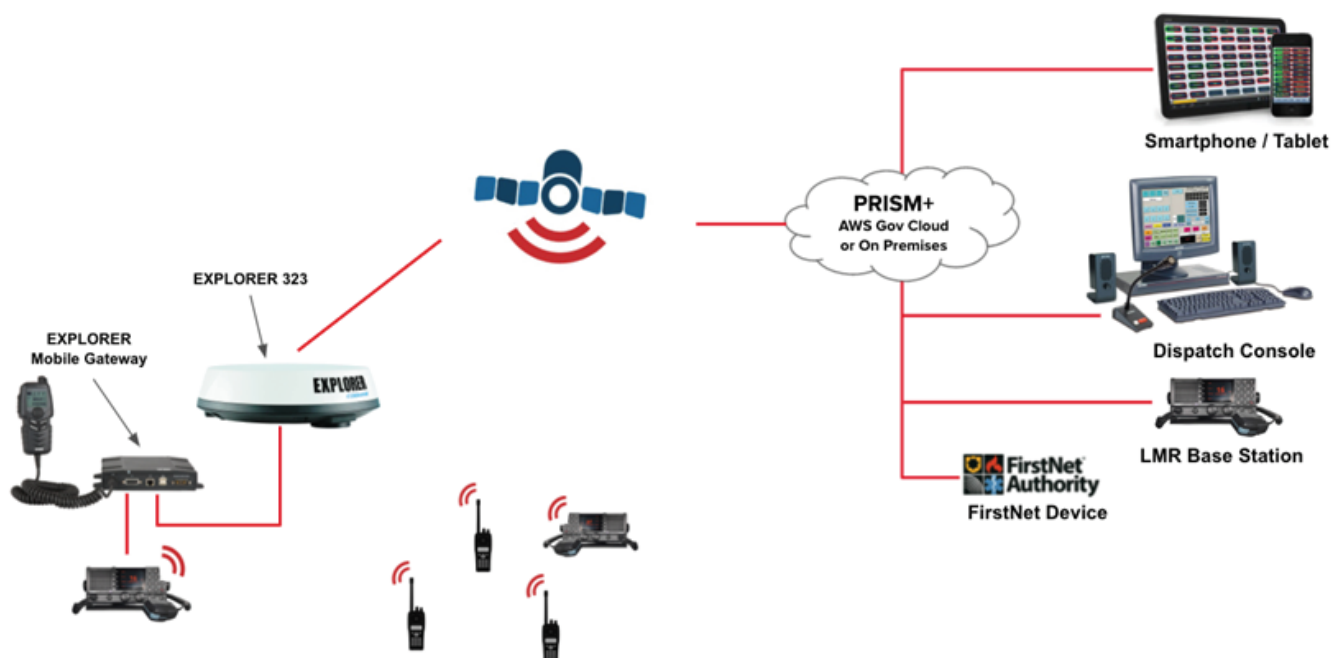
The following overviews of Skymira's top system components provide insight into some of the communication setups possible with Skymira's next generation RoIP (radio over IP) solutions.

2.1 PRISM+

Private Routing and IP System Management (PRISM+) is a hybrid communications system leveraging LTE and satellite connectivity to increase resilience and coverage. It is a user-friendly voice and data solution turning LMR, LTE / FirstNet, and Satellite networks into one unified network.

Skymira hosts the North American instance of PRISM+ in the AWS Government Cloud. On-premises installations are also an option.

In the diagram below, LMRs do not have network coverage. The LMRs are communicating device to device on a simplex tactical channel. A donor radio on the same simplex tactical channel is connected to the EXPLORER Mobile Gateway via LMR 4-wire E&M cable with patch switch. When the patch switch is “on” the PTT audio on the simplex tactical channel is transmitted over the satellite network and received on the PRISM+ server. The PRISM+ server then routes the audio to other connected devices and applications. This includes other FirstNet devices that do have network coverage.



2.2 EXPLORER MOBILE GATEWAY

The EXPLORER Mobile Gateway is an AES-256 encrypted IP-based radio and data communications device that supports Satellite/LTE/LAN bearers to provide automatic switching between available networks in any situation.



An example of a common configuration: an EXPLORER Mobile Gateway is connected to a FirstNet certified LTE modem and an EXPLORER 323 BGAN satellite terminal. The EXPLORER Mobile Gateway simultaneously connects to and monitors both FirstNet and satellite networks. In this example, the FirstNet modem is prioritized 1st and the EXPLORER 323 is prioritized 2nd. If the FirstNet network connection is lost for any reason, the EXPLORER Mobile Gateway automatically switches to the satellite network without user action. Once connection to the FirstNet network is restored, the EXPLORER Mobile Gateway automatically switches back.

The following are configured on PRISM+ and automatically downloaded to EXPLORER Mobile Gateways in the field without user action:

- Bearers (e.g., modems)
- Talk Groups (1-to-many and 1-to-1 private)
- LMR E&M profiles (including gain adjustments and active low/high)
- GPS and RSSI reporting intervals

The EXPLORER Mobile Gateway (above) is compatible with any IP network with bandwidth greater than 10kbps (Satellite, LTE, LAN).

2.3 SATELLITE NETWORK & HARDWARE

Operational requirements play a significant role in selecting the best satellite network, hardware, and services. Examples of factors to consider include:

- Hardware that is portable or suitable for vehicle installation or fixed site installation
- Require connectivity moving or stationary
- Services required (voice, data, GPS data, video streaming, etc)
- Geography and topography
- Minimum IP bandwidth
- Security

Following are details regarding the satellite network and various component hardware used in SkyMira's interoperable communication systems.

2.3.1 INMARSAT BGAN NETWORK




Inmarsat's BGAN satellite network provides near global coverage with a constellation of geo-stationary satellites.

Supported services include:

- Voice (PTT and dialup)
- IP connectivity (web surfing, email, text messaging, 3rd party applications, video streaming)
- GPS Tracking and other IoT data applications
- Video Streaming

2.3.2 COBHAM EXPLORER BGAN TERMINALS

Skymira uses the following Cobham BGAN terminals for various applications and workflow situations:

TERMINAL	SUITABLE FOR	BANDWIDTH	SERVICES
 EXPLORER 323	Mobile Portable	200 kbps	<ul style="list-style-type: none"> - Voice (PTT & Dialup) - Email & TXT MSG - 3rd Party Applications - M2M Data - Video Streaming
 EXPLORER 325	Mobile	464 kbps	<ul style="list-style-type: none"> - Voice (PTT & Dialup) - Web Surfing - Email & TXT MSG - 3rd Party Applications - Video Streaming
 EXPLORER 540	Fixed Site Portable	464 kbps	<ul style="list-style-type: none"> - Voice (PTT & Dialup) - Web Surfing - Email & TXT MSG - 3rd Party Applications - M2M Data - Video Streaming

2.3.2.1 COBHAM EXPLORER 323 AND 325

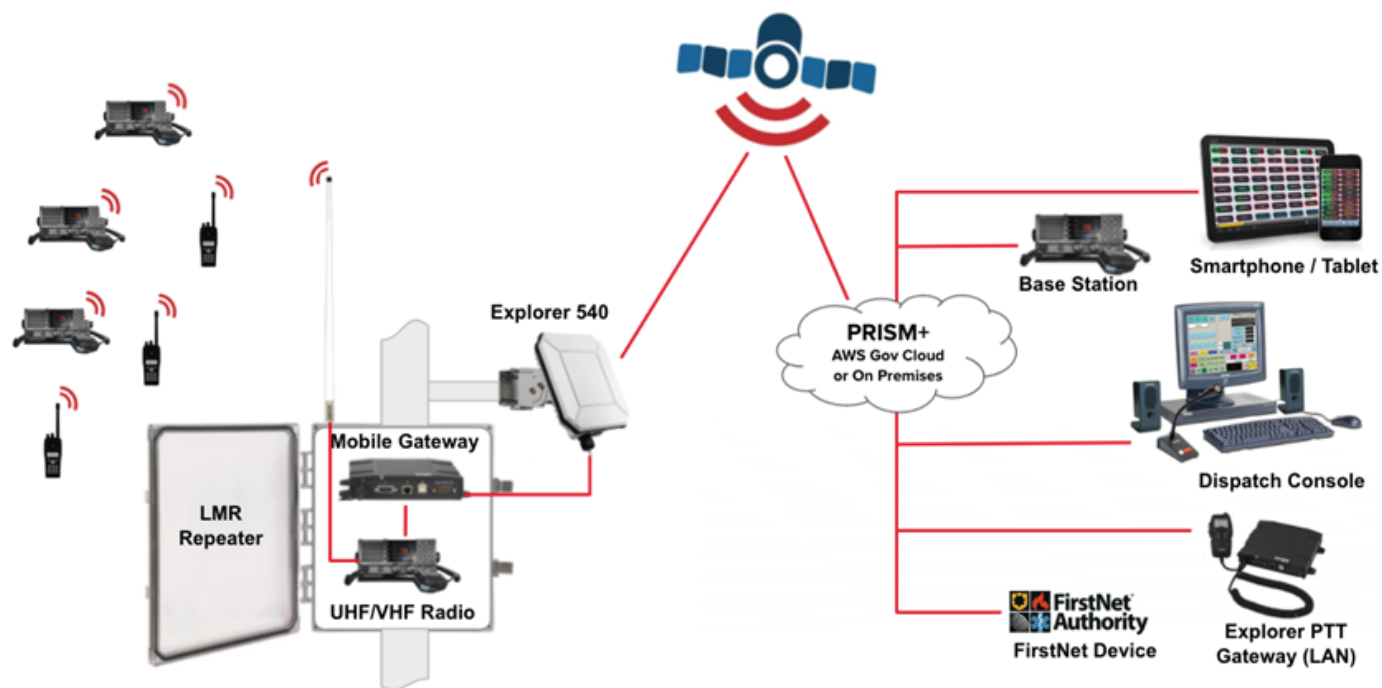
A new class of BGAN mobile terminal, the EXPLORER 323 is well suited for vehicle installation for mobile communications on-the-go or in a ruggedized Skymira GoKIT for portable use. The Explorer 323 is the first mobile BGAN terminal without moving parts.

For applications requiring higher bandwidth, the EXPLORER 325 is a gyro-stabilized terminal providing bandwidth for a moving vehicle up to 464 kbps.



2.3.2.2 Cobham Explorer 540

EXPLORER 540 is a stationary pole mounted BGAN terminal ideal for fixed site use cases that include an LMR repeater, an IP Network Access Point, or M2M / Sensor applications.



2.3.2.3 Cobham Explorerconnect Smartphone App

Compatible with iOS and Android, the EXPLORER Connect Smartphone app enables phone calls when LTE / FirstNet are unavailable.

2.4 LMR INTEROPERABILITY

The EXPLORER Mobile Gateway includes a 4-wire E&M interface. Skymira manufactures 4-wire E&M cables compatible with all major LMR brands and models. Skymira's 4-wire E&M cables include a connector for external speakers and a patch switch that enables the user to toggle on/off LMR audio over the satellite network.

The following links offer two video demonstrations of LMR interoperability using the EXPLORER Mobile Gateway.

- [Motorola Demonstration](#) P25 APCO, MOTOTRBO and WAVE over satellite.
- [BK/KNG Demonstration](#) showing mobile and portable over satellite.

2.5 SKYMIRA GOKIT

Skymira's ruggedized GoKITS are ideal where portability is required. The GoKITS can be deployed in minutes and powered via vehicle cigarette lighter plug or battery power.

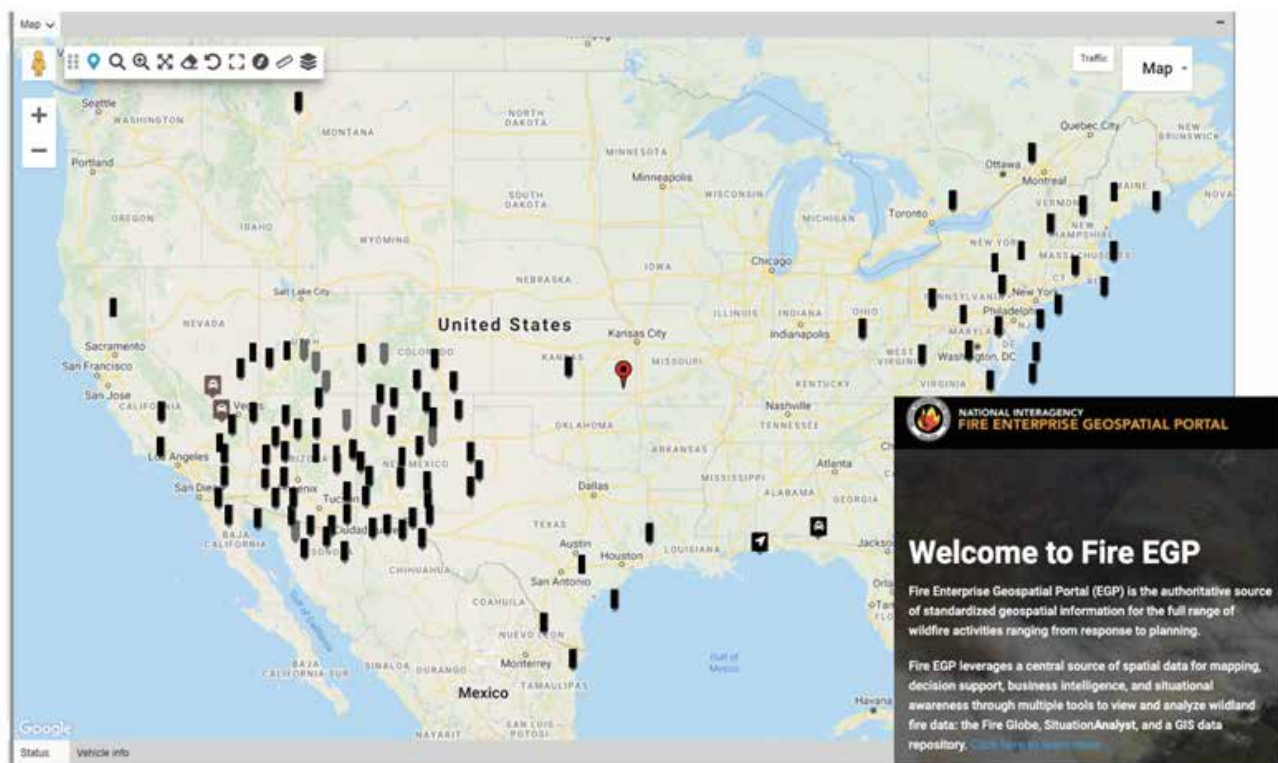
The Skymira GoKIT includes an EXPLORER Mobile Gateway, EXPLORER 323 BGAN terminal and installed 4-wire E&M connected Motorola APX 7500 mobile radio.



2.6 SKYMIRA GPS TRACKING PLATFORM

Skymira's GPS Tracking platform supports numerous GPS tracking devices including the EXPLORER Mobile Gateway, Sierra Wireless, Cradlepoint, Garmin InReach, MSAT-G2 and Iridium devices. The platform includes a full featured GPS portal viewable on laptops, tablets, and smartphones.

The platform is also capable of sending / receiving GPS data to 3rd party situational awareness platforms. The following is a simulation of a vehicle tracking screen in the GPS tracking platform. The data can be shared with platforms such as NIFC's Fire Enterprise GeoSpatial Portal (EGP).



2.6.1 P25 DATA OVER SATELLITE

P25 data enabled LMRs will transmit P25 data (Subscriber ID, GPS, Man Down) over the satellite network via EXPLORER Mobile Gateway. This data will be available for consumption on dispatch consoles and other situational awareness platforms.

3. FUNCTIONAL & OPERATIONAL SCENARIOS

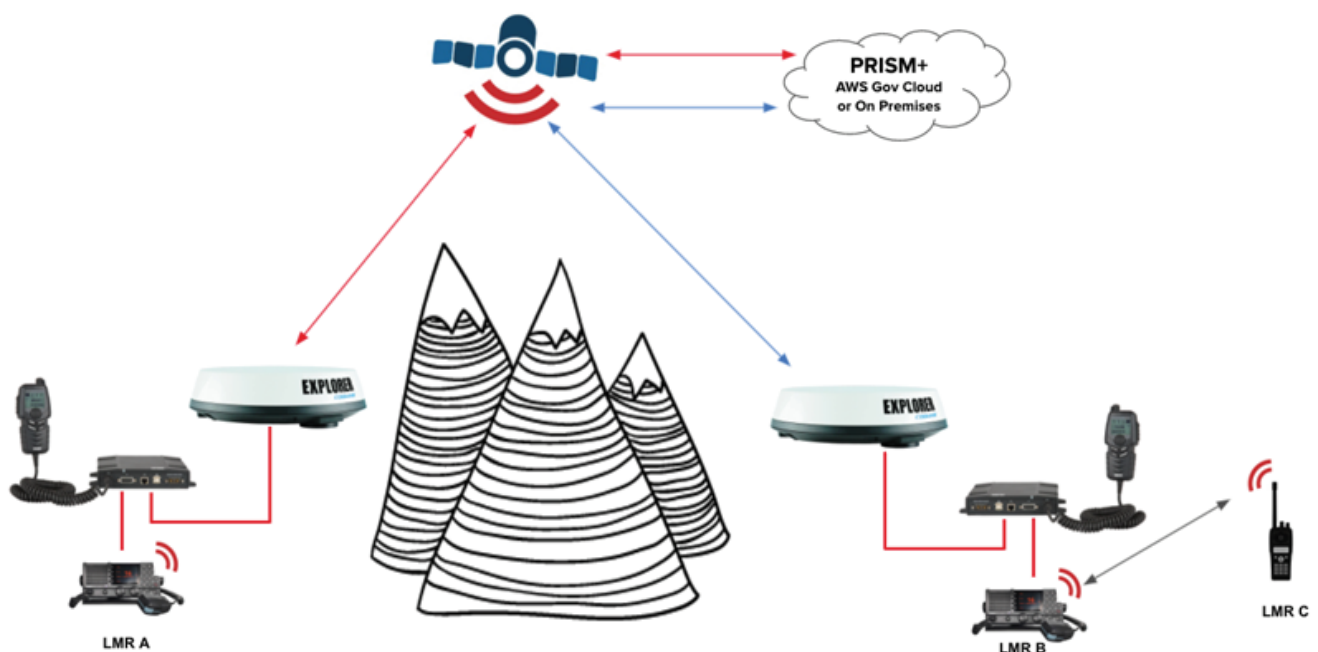
3.1 DEVICE TO DEVICE

Two or more EXPLORER Mobile Gateways equipped with EXPLORER BGAN Terminal and FirstNet approved LTE modem are able to communicate at any time regardless of FirstNet availability. A configuration is available to allow a user to select satellite network or FirstNet network.

In addition, when an LMR is interfaced to EXPLORER Mobile Gateway, the user has the option to toggle on/off the patch switch.

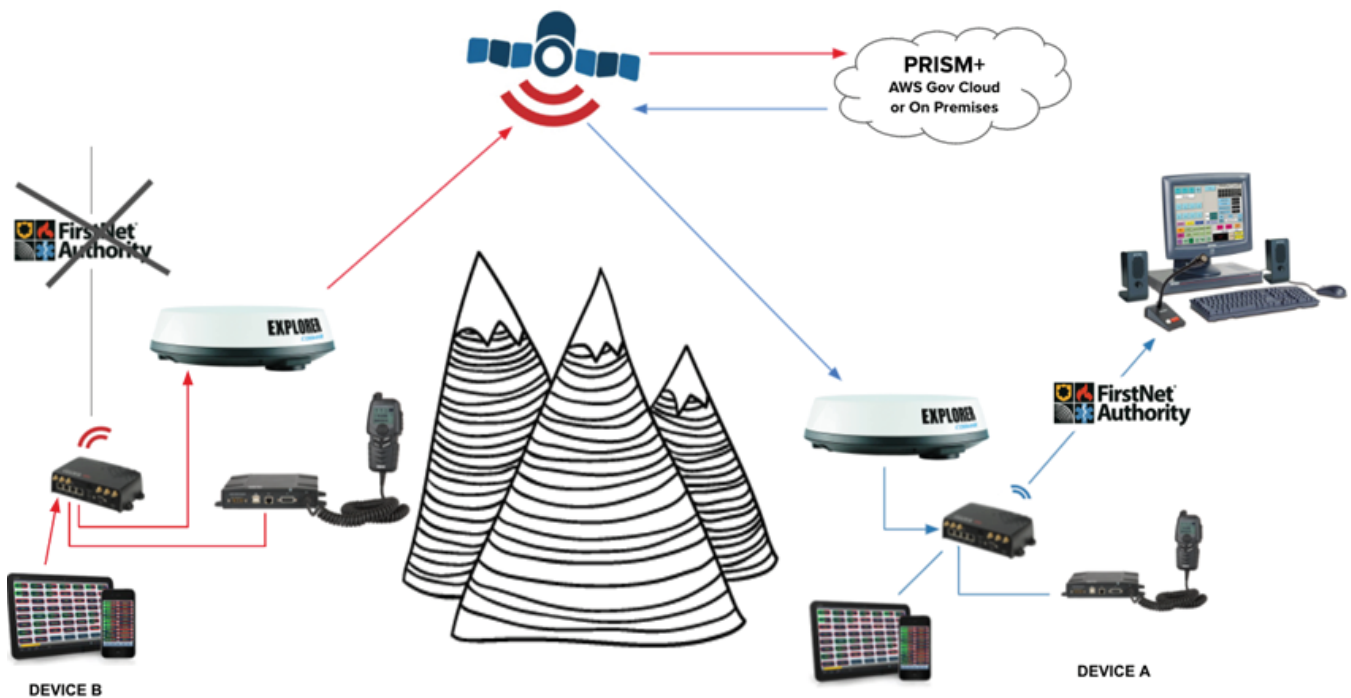
3.2 DEVICE RELAY

Devices A and B are each connected to EXPLORER Mobile Gateways. Also connected to Mobile Gateways A and B are mobile radios via 4-wire E&M. Device C is an LMR and can PTT with B via simplex tactical channel.



3.3 NETWORK RELAY

In the configuration diagrammed below, Device B does not have access to the FirstNet Network. Device A does have access to FirstNet. Device B sends a situational report over the satellite network to the dispatcher. Device A receives the data over satellite network and re-routes the data via the FirstNet approved LTE modem over the FirstNet Network to the dispatch console. Device B is fully functional and unaware Device A is assisting.



3.4 DATA SERVICE

The configuration diagrammed in section 3.3 Network Relay will also support sharing pictures, video, telemetry including location, sensor data or IoT data to other devices that lack Macro Network coverage.

4. DETAILED QUESTIONS

4.1 Question:

Please describe your proposed technology and/or solution and directly address each of the scenarios described in the section above.

Answer: The foundation of each solution is PRISM+ (Private Routing and IP System Management) technology. PRISM+ is a hybrid communications system leveraging LTE and satellite connectivity to increase resilience and coverage. This user-friendly voice and data solution turns LMR, LTE / FirstNet, and Satellite networks into one unified network.

PRISM+ is extremely flexible in its configuration allowing agencies to use currently deployed LMRs, smartphone apps, IoT sensors, etc. even when and where FirstNet is unavailable.

Scenario: Device to Device - Two or more EXPLORER Mobile Gateways equipped with EXPLORER 323 BGAN terminals can PTT, pass data, and share GPS locations regardless of FirstNet availability. If LMRs are added, then more users can utilize that same population of EXPLORER Mobile Gateways / EXPLORER 323 BGAN terminals.

Scenario: Device to Relay - EXPLORER Mobile Gateways can function as relays / repeaters for LMRs, Mobile Data Terminals, sensors, smartphone applications etc. See section 3.2 for an LMR example.

Scenario: Network Relay - The EXPLORER Mobile Gateways does not have to rely on a terrestrial IP or RF network. EXPLORER Mobile Gateways can relay voice and data from a location without FirstNet connectivity to a location that does have FirstNet connectivity thereby connecting OFF-NET devices to ON-NET devices. Using satellite IP networks removes distance as a barrier to the relay. See section 3.3 for a Mobile Data Terminal example.

Scenario: Data Services - Cobham's full line of BGAN terminals offer a range of bandwidth and services that support sharing pictures, video, telemetry including location, sensor data and Internet of Things (IoT) data. Based on the type of data most frequently shared, users can choose a solution that best meets their requirements.

4.2 Question:

What is the Technical Readiness Level (TRL) of the components of your technology/solution using the definitions in APPENDIX C – Technology Readiness Level Definitions.

Answer: All hardware and software described in this document are Technical Readiness Level 9 (actual system proven through successful mission operations), except P25 data over satellite (section 2.6.1) which is Technical Readiness Level 6 (system/subsystem model or prototype demonstration in a relevant environment).

The hardware and associated software are COTS available and currently operationally deployed by many Federal Departments and Agencies, businesses, and NGOs.

4.3 Question:

Can users choose to employ your off-network solution regardless of their Macro Network coverage?

Answer: Yes, there are numerous configurations that meet this requirement.

4.4 Question:

What is the anticipated transmit power, receive power, and associated link budget/margin for various ranges and various sets of obstruction e.g., buildings, foliage, indoor, etc.?

Answer: Transmit power, receive power, and associated link budget/margin vary based on type of terminal selected. The BGAN terminals discussed in this document all operate on L-Band which is very tolerant of foliage, weather, and movement (communication on-the-go).

4.5 Question:

Which frequency bands are utilized and how is interference with cellular macro coverage managed?

Answer: The BGAN terminals discussed in this document all operate on L-Band. Interference with cellular macro coverage is not an issue.

4.6 Question:

For relays included in your solution, please discuss:

A. How public safety operationalizes the use of relays.

B. Additional latency or other performance challenges.

C. Whether the relays are part of the handheld or body worn equipment or are separate devices.

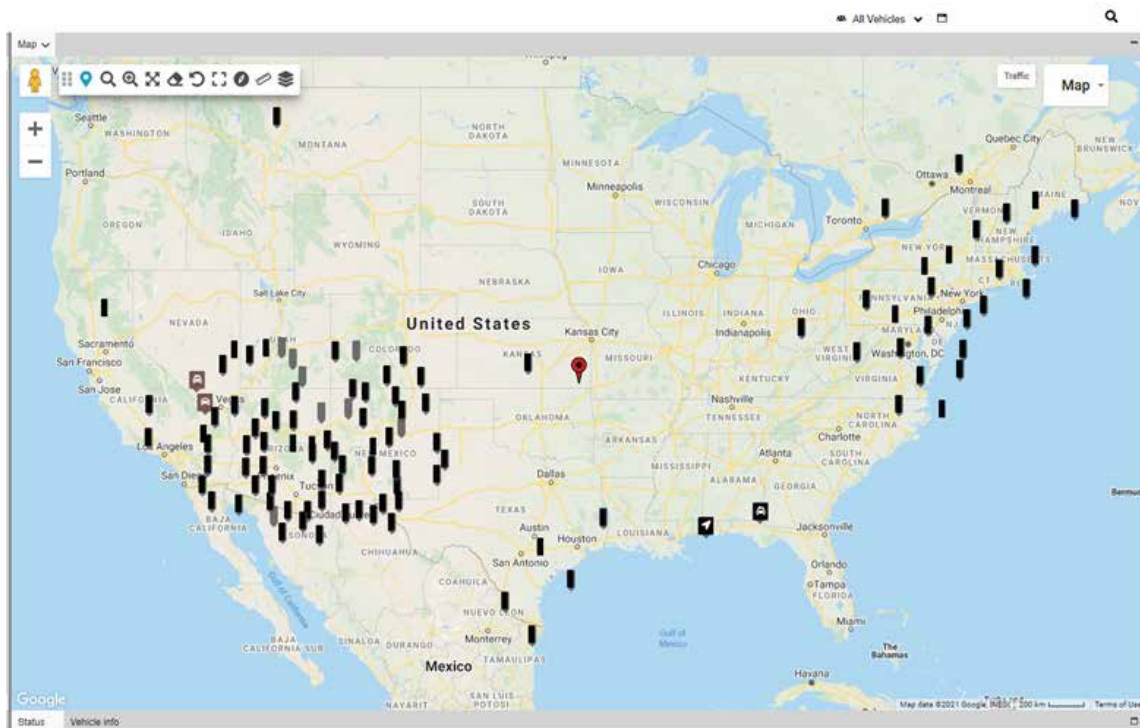
Answer

A: A federal law enforcement agency's current deployment is a good example of operationalizing a relay. Agency trucks are equipped with EXPLORER Mobile Gateways / EXPLORER 323 BGAN terminals and APX 7500 / 8500 mobile radios connected to Mobile Gateway via 4-wire E&M cable with patch switch. The dispatch center located in Phoenix, AZ has a Mobile Gateway connected to a Motorola MCC7500 console via 4-wire E&M cable.

When the Ranger dismounts from the vehicle, their portable and mobile radios are on a simplex tactical channel. The E&M cable patch switch is "on". The Ranger now has PTT communication from the portable radio back to Phoenix Dispatch from any distance within range of the mobile.

In some scenarios, the Ranger PTTs with local 911 dispatch. When the Macro (LMR) Network is within range, the patch switch will be "off" so local 911 dispatch traffic is not transmitted back to Phoenix dispatch.

Vehicles deployed along the east coast, throughout New England and the Southwest and a few on the gulf are all seamlessly dispatched from the Phoenix dispatch center.



B: Latency over the satellite network discussed in this document is on par with LTE networks. It should be noted that this technology is not intended to replace LMRs but rather to improve reliability by enabling communication when the FirstNet or RF Network is unavailable. For those instances where a tactical operation is underway, it is expected that all personnel onsite will have LMRs utilizing a tactical channel thus providing minimal latency between onsite personnel.

C: In most scenarios, the relay itself (i.e. Explorer Mobile Gateway) will be installed in a vehicle or ruggedized Skymira GoKIT. Onsite personnel will continue to use their handheld portable LMRs, smartphones or MDTs.

4.7 Question: **What international or national standards are followed if any?**

Answer: All devices discussed in this document are in compliance with all FCC regulations.

4.8 Question: **Describe how your solution securely identifies nearby devices for use in any relay activity as well as communication with other users.**

Answer: Voice and data between EXPLORER Mobile Gateway and PRISM+ is AES-256 encrypted. Security on devices connected to the EXPLORER Mobile Gateway may vary (i.e. P25 for LMR vs smartphone or MDT app security).

4.9 Question: **Is your solution capable of integration to current or future Mission Critical Services defined by 3GPP? If so, please explain details and user experience expectations.**

Answer: The Cobham PRISM+ PTT service is designed in compliance with MCP-TT-to-P25 requirements specified in 3GPP TS 22.179. These PRISM+ PTT features provide seamless interworking with MCPTT systems that are in compliance with 3GPP TS22.179.

PRISM+ is interoperable with MCPTT in compliance with Section 6.18 of 3GPP TS 22.179 and the following sub-sections, 6.18.1 Non-3GPP access, 6.18.2 Interworking between MCPTT systems, 6.18.3 Interworking with non-LTE PTT systems, 6.18.3.2 Project 25.

4.10 Question:

Are devices other than standard “smartphones” required?

Answer: Yes, the PRISM+ gateway and satellite terminals which are discussed in this document.

4.11 Question:

What form factor does your solution employ, e.g., specialized device, accessory or add-on to commercial cell phone, separate device paired with smartphone or radio, etc.?

Answer: Separate device paired with smartphone, LMRs, MDTs, etc.

4.12 Question:

Are there unique operational considerations of your solution including UI, how worn on body, health & safety, e.g., SAR requirements, etc.?

Answer: The BGAN terminal must have a view of the sky if the satellite network is to be used when FirstNet is unavailable. If another IP network is to be used then no special consideration is required.

4.13 Question:

Are “talk-group” communications possible when off-network?

Answer: Yes, talk-group(s) can be used when off-network. Talk-groups are configured on PRISM+ and automatically pushed to EXPLORER Mobile Gateways in real time without user action. Talk-groups can be 1-to-many or 1-to-1 private.

4.14 Question:

Are there unique or extensive cost considerations?

Answer: Yes, unique in a positive way. Historically, satellite communications have been difficult to budget because of variable cost. The satellite PTT services described in this document are now available as a flat rate, unlimited PTT service.

4.15 Question:

Is there, or do you anticipate, a robust supply chain for the components of your solution?

Answer: Yes, a robust supply chain is in place for all components discussed in this document.

4.16 Question:

Is there an expectation regarding intellectual property rights (IPR), licensing considerations or other financial considerations for use of your technology and/or solutions or any of its components?

Answer: All hardware and services discussed in this document utilize standard industry licensing.

5. USE CASES

5.1 SCENARIO A HURRICANE DISASTER RELIEF

After a recent hurricane swept through the Florida Keys leveling everything in its path – including cellular and RF towers – traditional communications were cut off for a week. The command post had fixed-site satellite repeaters, but relief workers and damage assessors on location were out of network. This meant that the fastest way to get information to headquarters was by vehicle – travelling over washed out and otherwise damaged roads –which took hours or days. If the responders, assessors, and others with boots on the ground were equipped with mobile RoIP gateways or portable Skymira GoKITS, they would have voice, data and video connection with the command post and others on the ground so that everyone would have real-time data to make efficient decisions and provide timely medical assistance and other aid.

5.2 SCENARIO B WILDLAND FIRE

Wildland fires are often fought in undeveloped areas with little to no infrastructure. Because of this, firefighters are often out of network – greatly increasing risks and making efficient communication via traditional networks virtually impossible. The Explorer Mobile Gateway becomes a virtual satellite radio repeater allowing firefighters to communicate locally and with dispatch on the field without the need to return to the vehicle. It further minimizes risks by broadcasting GPS tracking information for vehicles and individuals for safety and to comply with the Dingell Act.

5.3 SCENARIO C TRANSPORTATION

Whenever there is increased physical distance between parties, traditional PTT connections suffer. Increased distance is the norm, however, for transportation operatives where vehicles such as trucks or barges are often away from the dispatch center. Vehicle-based mobile RoIP gateways eliminate this strain allowing vehicle operators to stay in touch with dispatch and each other wherever they go.

