FIRST RESPONDER'S GUIDE TO SATELLITE COMMUNICATIONS

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Via Satellite

FIRST RESPONDER'S GUIDE TO SATELLITE COMMUNICATIONS

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VIA SATELLITE WELCOME LETTER

Via Satellite

Hello and welcome to our updated 2018 First Responders Guide to Satellite Communications, a vital guide to all of those who have to respond to extreme weather like hurricanes, earthquakes and tropical storms, to name a few. It is an interesting time to be producing such a guide for a number of reasons. There is little doubt that climate change is a reality, and we are seeing a fairly consistent number of natural disasters in all parts of the world. Natural disasters lead to loss of life, loss of infrastructure and the task of a rebuild, both in the short term and the long term. Satellite communications has always, and will continue to provide a vital role in all aspects of this rebuild. What has changed over the last few years is that the technology has gotten better, cheaper and more efficient than what has previously seen before. More effective technology in the immediate aftermath saves lives, both of people caught up in the tragedy as well as people such as medics, firefighters etc. Satellite technology can and does make a huge difference. It probably makes more of a difference than many of us realize.

So, why do we need this guide? The fact is satellite technology is more complex than ever before with satellites operating at different orbits, and different capabilities now being offered. For first responders, having a knowledge of the solutions available and how they can be deployed is vital. With the satellite industry developing at a faster pace than ever before, people involved in first response efforts need to have an understanding of the changing nature of satellite technology and how it can help them with their efforts. It really could make the difference between life and death. The importance of communications in these situations cannot be understated. This guide could actually make a difference and that is a pretty compelling reason for us to put it together.

No-one wants to see natural disasters but they are now a fact of life. And while there are always likely to be life changing and often horrific consequences, at least with better technology we can save lives and provide the communications on the ground that will give people hope for the future.

This guide will provide you all you need to know about the satellite industry and how its technology can make a difference to first response efforts.

Mark Holmes
Editorial Director
Via Satellite

SATELLITE INDUSTRY ASSOCIATION WELCOME LETTER

In the weeks following Hurricane Maria, a lengthy queue formed at Derkes Pharmacy, in Guayama Puerto Rico, a town of 45,000 people an hour's drive from San Juan. The wait was not for medicine, but for access to the town's only working phone — a satellite phone. It allowed for communication to the outside world while 1,500 of the 1,600 cell towers on the island were destroyed.

Hurricanes Harvey, Irma, and Maria wreaked havoc on U.S. infrastructure in 2017; the lack of operable, terrestrial communications infrastructure resulting from these disasters severely impeded command and control functions, situational awareness, and therefore, the disaster relief and recovery efforts of first responders. When the telephone and broadcast networks went down, satellites remained on the job. Satellites connected emergency personnel and other first responders. Satellites reunited families. Satellites reconnected communities. Satellites enabled the heroes on the ground to save lives and made the difference when it mattered most. In many of the affected areas, satellites provided the only source of communications in the hours, days, and weeks following these events. Satellites provided the basic "operability" that terrestrial networks could not provide following those disasters.

The Satellite Industry Association (SIA) and its member companies thank you for reading the updated 2018 First Responder's Guide to Satellite Communications. We hope the information in this guide provides users in public safety, homeland security, and emergency preparedness with the fundamental information needed to effectively incorporate satellite communications into the preparations for the next natural or man-made disaster.

Tom Stroup
President
Satellite Industry Association

SIA is a U.S.-based trade association providing worldwide representation of the leading satellite operators, service providers, manufacturers, launch services providers, and ground equipment suppliers. SIA is the unified voice of the U.S. satellite industry on policy, regulatory, and legislative issues affecting the satellite business.
Additional information can be found at www.sia.org.

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I. WHY SATELLITE

A. WHY CONSIDER SATELLITE-BASED WIRELESS?

In the face of natural or man-made disasters when everything used to communicate in "normal" conditions has disappeared, satellite-based wireless networks provide highly robust, mission-critical connectivity for responders. Satellites provide communications load sharing and supplemental capacity for large command-level sites, as well as essential connectivity for small teams and individuals at the forefront of a response. Satellite-based wireless excels in providing redundant and resilient connectivity in ***any*** situation.

B. WHAT'S NEW?

Satellite-based networks have evolved in many ways over the past few years. They now blend with terrestrial network elements including two-way radio and 3G/4G/LTE/B14. Field elements come in a wide variety of mission configurations that meet every possible scenario for the response and recovery situations faced on a daily basis, as well as under exceptional circumstances.

While single-line satellite telephones continue to be a backpack essential for responders jumping into an area with impaired communications, satellite broadband units of nearly the same size now offer advanced enterprise level communication with the same ease of transport into any disaster.

New generations of satellite platforms in Low-Earth-Orbit (LEO), Middle-Earth-Orbit (MEO) and Geosynchronous Earth Orbit (GEO) have made wireless communications through towers up in the sky an entirely new ballgame. Broadband data capabilities in portable and mobile terminals that can be hand carried or easily placed onto vehicles now reach multi-megabit speeds. Emergency Operation Centers (EOCs) and field command locations can now obtain up to 200 megabit speeds using the newest innovation, High Throughput Satellites (HTS), recently placed into orbit above North America. Advanced satellite infrastructure and new constellations enables data-centric applications such as wide-area two-way radio, broadband data and video, that heretofore could only be achieved with extensive terrestrial-based infrastructure, or earlier generation massive satellite terminals.

C. BENEFITS OF SATELLITE

- **Truly Ubiquitous Coverage:** Satellite constellations and their integrated network backbones now cover 100% of planet Earth! All weather capabilities, coupled with unique networking attributes means responders need not worry about connectivity challenges, whatever locale they might be dropped into.

- **Instant Infrastructure:** Satellite-based wireless services enable instantaneous connectivity when there is little or no available terrestrial infrastructure due to event-related damage, or when response missions take you to locations where terrestrial backbones simply do not exist.

- **Secure Infrastructure:** Satellite-based wireless networks offer the same secure communications as terrestrial-based systems through the use of both hardware and encryption applications. Like terrestrial networks, satellite system network security ranges from very simple to extremely sophisticated, and can be implemented based on an agency's applications and cybersecurity requirements.

- **Backup Infrastructure:** Satellite-based wireless has the capacity to provide large bandwidth data pipes to aid in restoration of damaged or destroyed infrastructure, as well as create resilient communications within affected areas for longer-term recovery operations after a disaster or other extraordinary event.

- **Temporary Network Solutions:** The 2017 hurricane season presented some especially challenging communication situations for responders, some of which have continued well into 2018. In most cases satellite-based connectivity solutions provided the mission-critical connectivity to coordinate operations and render essential aid. This attribute is a key tenet of satellite-based wireless communications. The same satellites used in news gathering, homeland security and the military, enables response and recovery activities to flow with efficiency and resiliency for responders in the face of the destruction into which they have ventured.

- **Rapid Provisioning of Services:** Terrestrial networks supporting responders are ready when events take place through advance preparation and planning. Satellite networks are no different. Pre-planning is key! Satellite-based wireless solutions can be set up very quickly, especially when fail-over has already been established in conjunction with existing terrestrial-based communications networks. Creating resilience within existing agency networks through satellite means that services can be recovered and reconfigured quickly when events strike, sometimes with zero intervention.

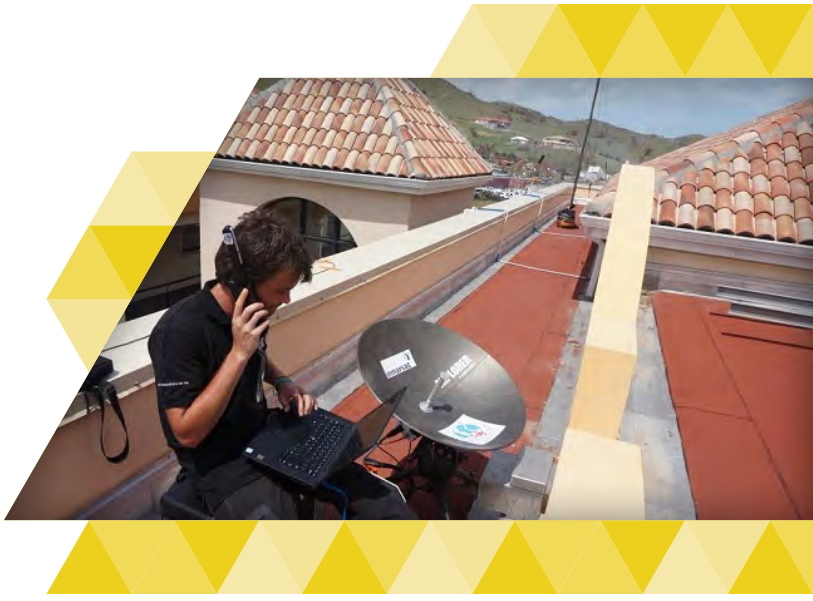
In addition, when traditional terrestrial networks disappear, responders can achieve a high level of voice, data and video communication instantaneously, in any affected area, with satellite-based wireless solutions.

II. SATELLITE CAPABILITIES

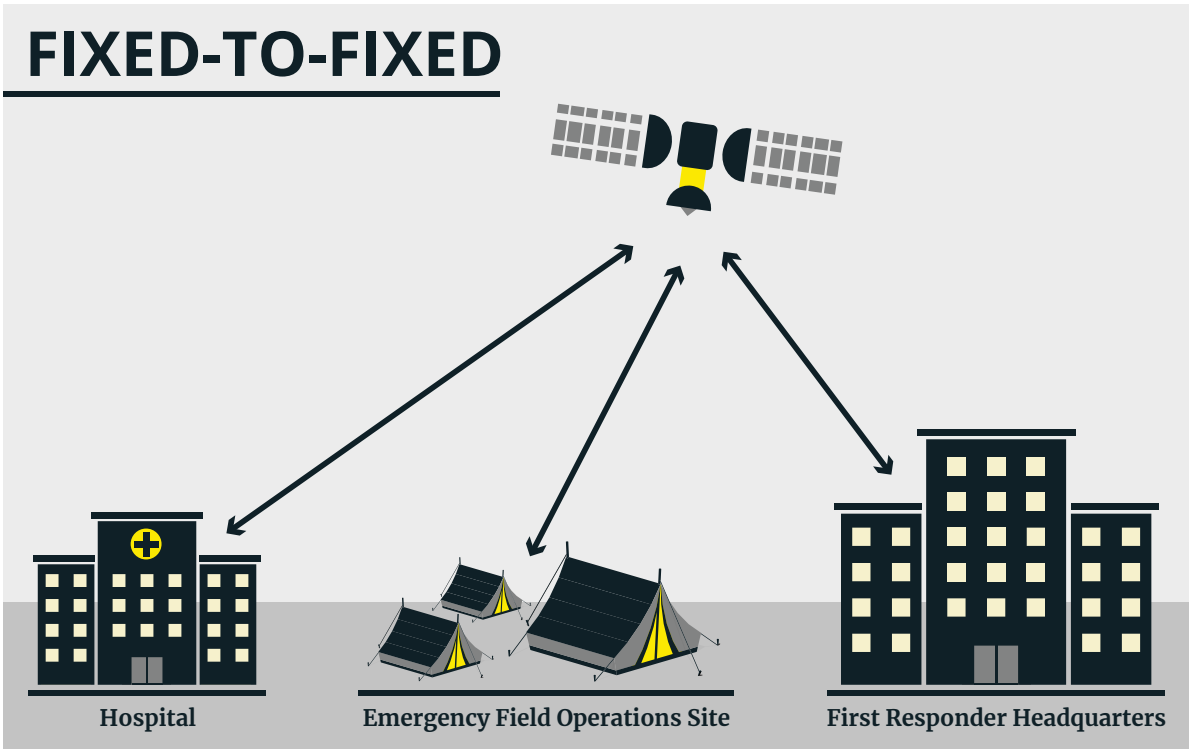
Satellite-based wireless communications routinely work in remote locales lacking terrestrial infrastructure (e.g. mining, offshore oil platforms). This same functionality excels in situations where normal terrestrial systems become impaired or overloaded due to some extraordinary event. First responders who integrate satellite into their mission toolkit will be able to act quickly in preparation for and recovery from any emergency.

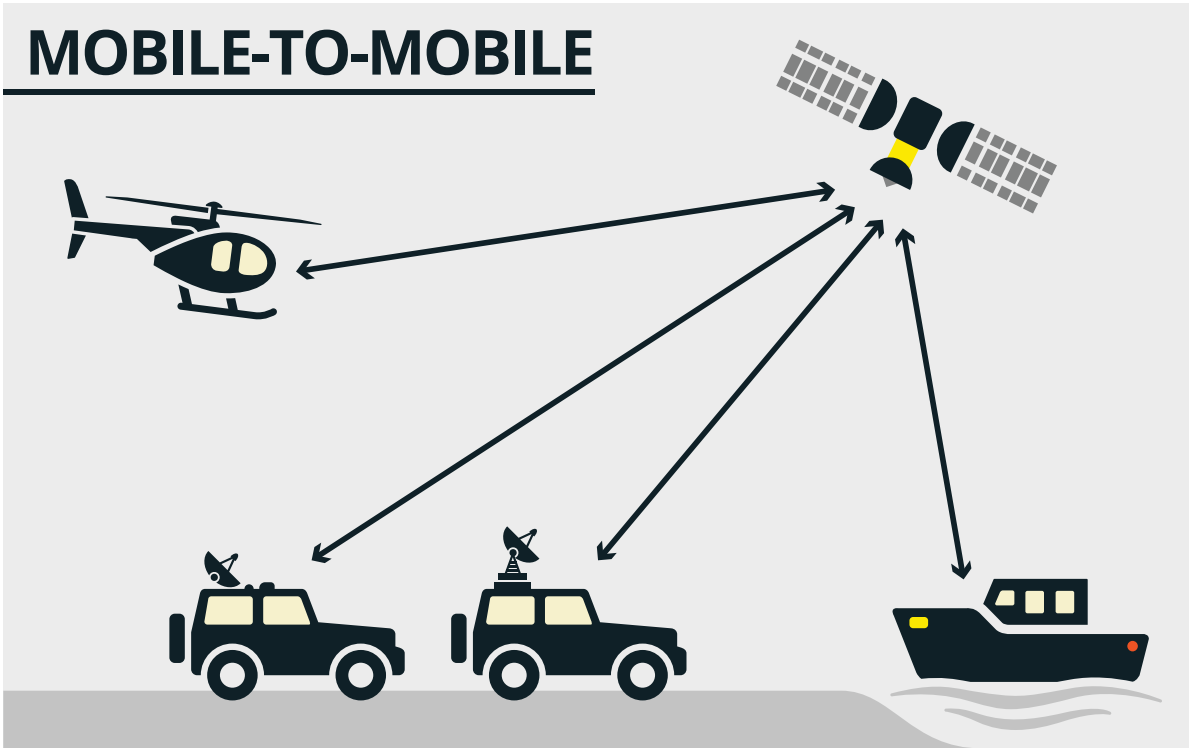
More than simply a communications gap filler, satellite-based wireless creates a solid foundation for a successful response. A few examples of this mission-critical assistance includes:

- Gain critical visibility into weather patterns and response area conditions before, during and after an incident;
- Interconnecting widely dispersed, incident-specific, responder two-way radio networks;
- Providing mission-critical interoperability between disparate radio systems and data networks of various responding agencies;
- Provide shared information and situational video from and across an entire disaster area, regardless of size, in coordination with all responding agencies;
- Direct, receive and use video and sensor information from advanced Unmanned Aerial Vehicle (UAV) platforms;
- Providing voice and data network connectivity for the "last mile" when traditional terrestrial-based networks have become impaired, or are simply not available where response is required; and
- Providing mobile wideband and narrow-band communication tools to enable agile voice, two-way radio, data and video communications for remote responders.



III. HOW IT WORKS





INMARSAT GX TYPE-APPROVED TERMINAL

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ONE FAST SOLUTION.

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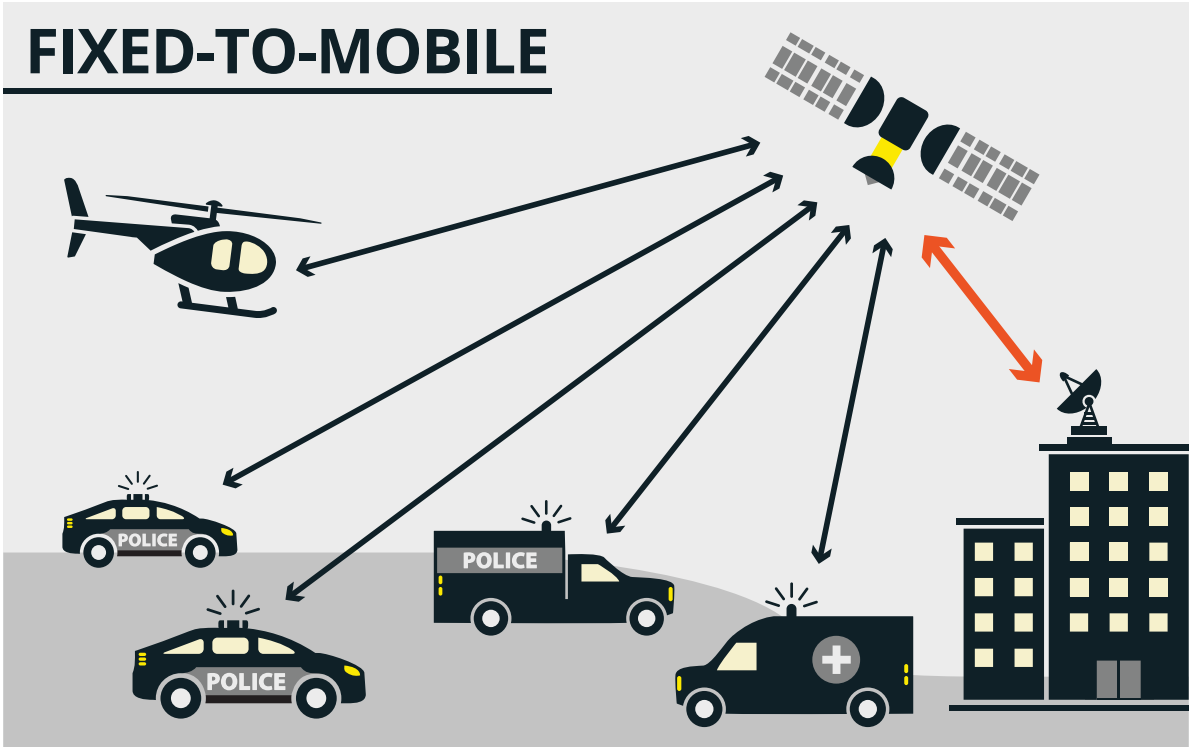
SENSOR SYSTEMS


FIXED-TO-MOBILE
POLICE
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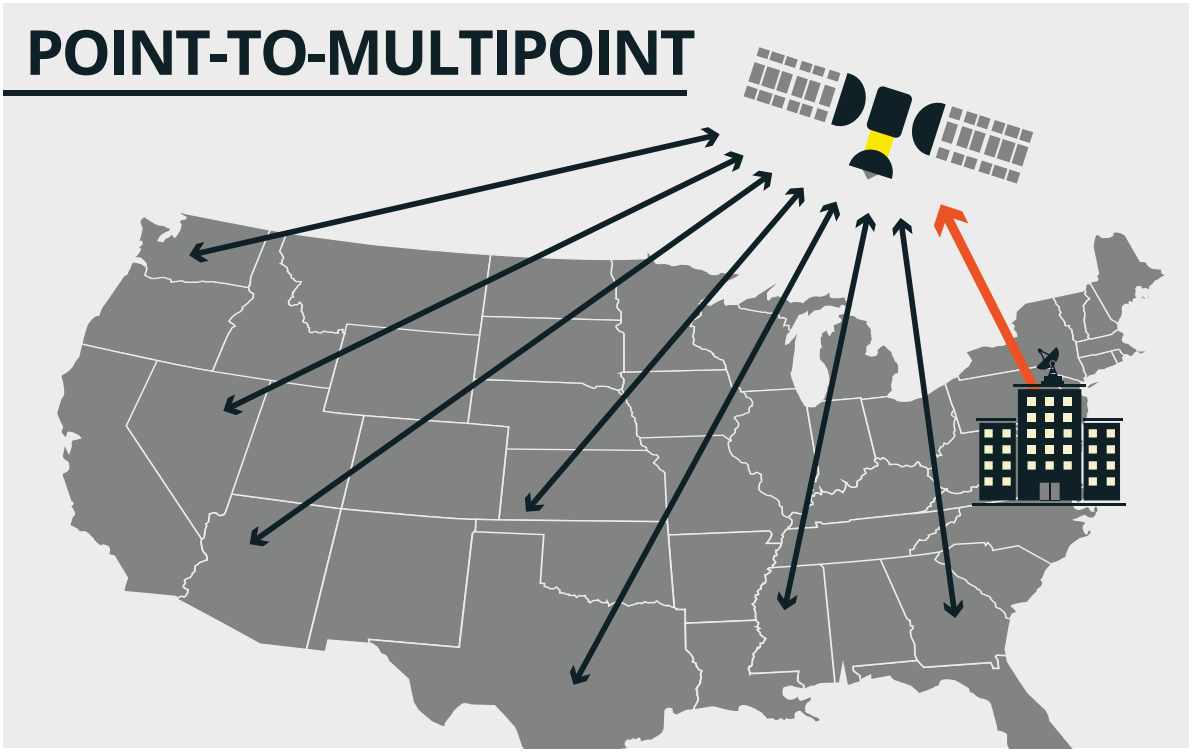
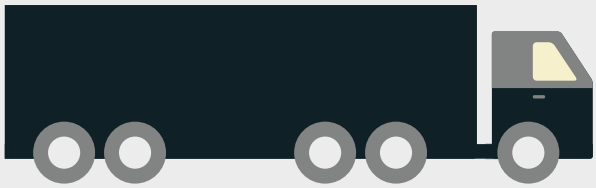

POINT-TO-MULTIPOINT

INTEROPERABILITY

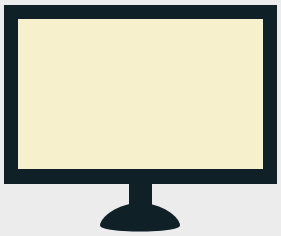
Satellite communications can interconnect with any other communications solution via generic crossbanding equipment.

Cell Tower

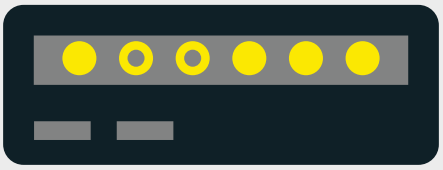


Asset Tracking

Wi-Fi or WiMAX HotSpot



Live Video/ Situation Awareness



Generic Crossbanding Equipment

2-Way Radio

Satellite Phone

VOIP Desk Phone

Wireless Internet

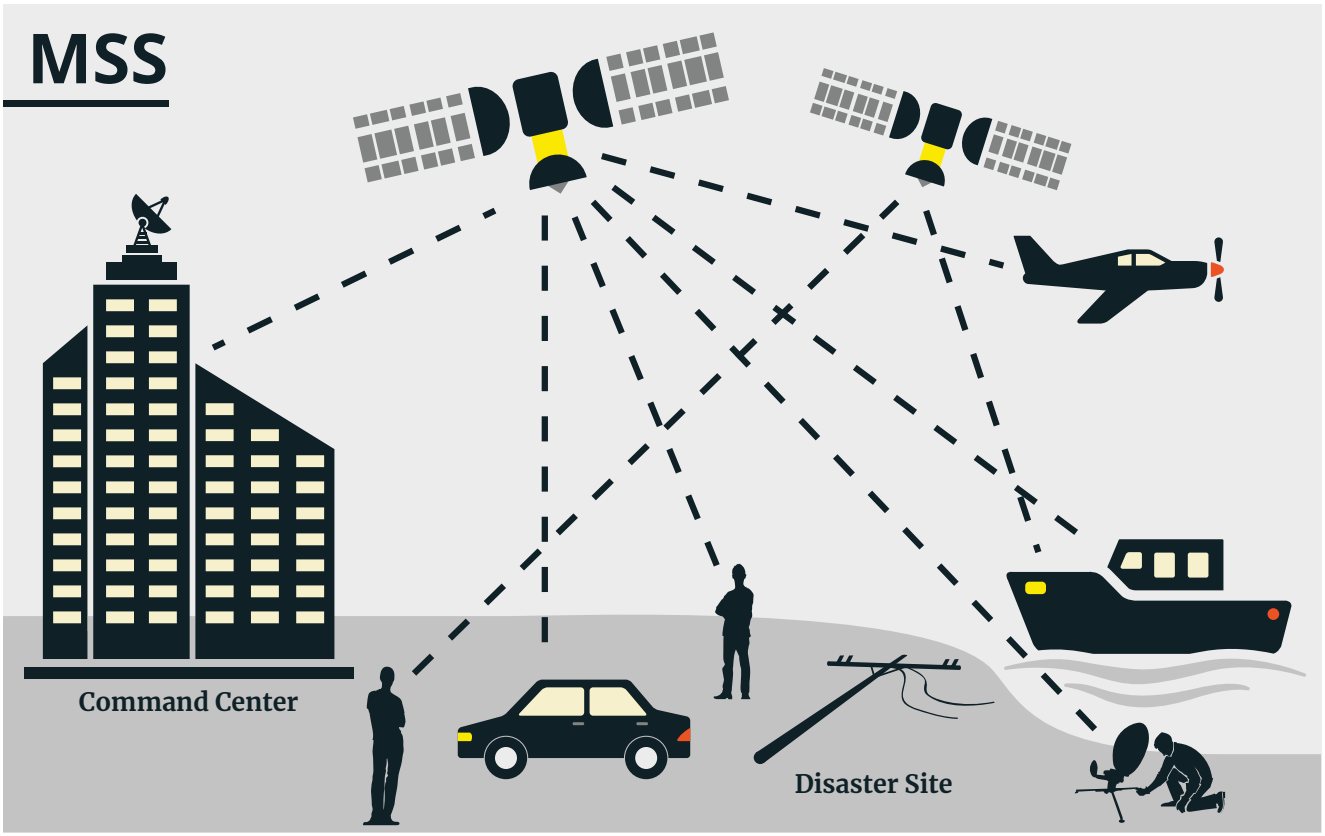
A. MOBILE SATELLITE SERVICES (MSS)

Mobile Satellite Services (MSS) are solutions that comprise networks of special communications satellites feeding handsets, lightweight portable and mobile terminals. MSS offers unprecedented capabilities in a fashion one could only dream about a few short years ago.

Typically used "on-the-move" or "on-the-pause" by field forces, MSS terminals can be mounted on ships, airplanes, vehicles, and carried by individuals. Satellite-based asset tags little larger than a deck of cards can keep track of critical response assets and relief materials.

MSS devices are essential for individuals and small teams at the forefront of any response. Today's MSS terminals possess native capabilities that not only include voice, two-way Push to Talk (PTT), video, data services and Wi-Fi, but also integrate terrestrial wireless (LMR/3G/4G/LTE/B14) and satellite technologies into fully interoperable elements.

In today's Bring Your Own Device (BYOD) world, responder provided laptops, tablets and smartphones equipped with Wi-Fi become extensions of MSS terminals out in the field. Mobile satellite network providers now offer enhanced services that blur the lines between terrestrial and satellite backbones, making it easier for responders to use the devices they are familiar with truly anywhere.



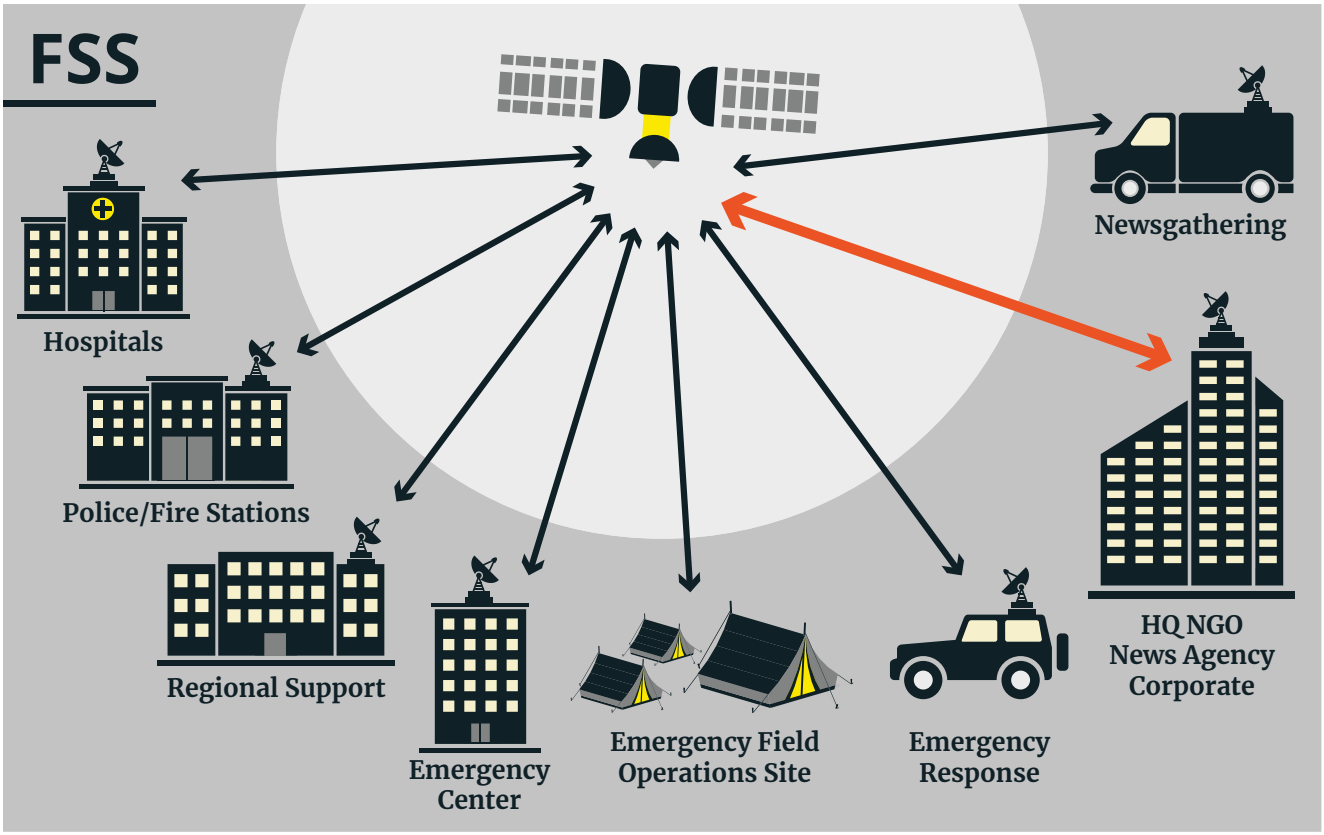
MSS Applications

- Mobile voice, data and video communications
- Enterprise-level push-to-talk radio
- Communications on the move
- Location-based technologies for response asset and field team coordination
- Responder tracking, status and alerting
- Remote monitoring
- Event reporting
- SMS messaging

B. FIXED SATELLITE SERVICES (FSS)

Fixed Satellite Service (FSS) typically refers to wide-band, higher data rate satellite services such as those used by fixed location EOCs, large command vehicles or responders who broadcast video on the move through UAVs or from units at a disaster scene. These operations rely on advance capability enterprise-level terminals to communicate via satellites.

Today's FSS are no longer limited to "fixed" locations, communicating across a multitude of Connectivity-on-the-move (COTM), Connectivity-on-the-Halt (COTH), and UAV platforms — pushing large amounts of incident data, situational video, and command level information for response and recovery operations. This class of service rides the latest advancements in satellite-based communication backbones, including High Throughput Satellites (HTS) with up to 200 megabits of service. FSS terminals now have a level of portability that allows the highest level of service in the most remote or communications-impaired locations. FSS network topology can be set-up to provide point-to-multi-point broadcast, point-to-point two-way mesh connectivity, even field-to-hub stand-alone connectivity.



FSS Applications

- Two-way radio network backbones
- Cellular restoration
- Emergency phone bank
- UAV operations
- Command and control situational video
- Voice Over IP (VOIP)
- Broadband internet access
- Telemedicine
- Video conferencing

C. VSAT FSS & MSS Networks

Very Small Aperture Terminals (VSATs) take many forms. For responders, regardless of terminal type or network operator, it means data and video transfers at broadband speeds (typically more than 400 Kbps). Antenna and terminal sizes vary based on the individual installation on both MSS and FSS networks. Functionality across VSAT networks take many forms:

- Fixed sites at EOCs, government facilities, hospitals or public safety access points, for failover and resiliency;
- Responders operating smaller vehicles (SUVs, pick-ups) as "first-on-scene" with COTM or COTH back-packable portable satellite terminals;
- Command-level vehicles (COTH) with multi-megabit capabilities to support a force-level response out in the field;
- Auto-deploy portable VSAT trailers with radio towers, repeaters and power generation; and
- Portable modular VSAT kits with stand-alone electronics and gensets for instant infrastructure when other elements are impractical to deploy in a timely manner.

In all the above installations, antenna sizes can range from 10-inch mobile broadband to 2-meter auto-deploy and fixed antenna elements.

Fixed sites have antennas that are designed to maintain communications resiliency whatever is thrown at the location by Mother Nature, with available specialty systems certified to operate in 200 mph sustained winds.

Command-level, trailer and portable systems can be on the air in as little as five minutes with the touch of a single button to make systems operational.

Satellite network providers can provide levels of service to support and sustain missions from response through recovery and restoration. Many carriers provide dial-up voice, two-way radio, video services, private network data and internet access.

If your agency needs an alternate location to maintain fail-over infrastructure, many satellite operators have co-location data centers at teleports to host this functionality. Thus, the VSAT services can carry radio, voice, data and video even if the agency location is impaired or destroyed.

- **IOT VSAT:** With sensors of all nature providing data from points in the field as part of the Internet of Things (IOT), inexpensive micro-VSATs are increasingly deployed at much slower speeds for transmission of critical data, such as water-level sensors on waterways or wind speeds at critical infrastructure sites. The information provided from these sites can be critical to situational awareness, and help shape the response strategy.

D. FIRST RESPONDERS SATELLITE-BASED WIRELESS APPLICATIONS

The line between types of MSS/FSS services and the terminals used to receive them has blurred to the point where single-function equipment has all but disappeared. In 2018, while some satellite telephone handsets and asset tags still operate on proprietary standards, the majority of satellite-based wireless systems are now IP-centric. This is the thread of commonality that ties all response elements and satellite-based wireless together. Your computers, smartphones and tablets are all IP-centric. In an IP-centric world any function that uses bits and bytes, from video streaming and internet access to simple messaging, will operate through a wide variety of terminals, across LEO-, MEO- and GEO-based satellite network backbones, with plug-and-play simplicity.

This is positive news for first responders. There are now more ways than ever to extend what is used in everyday operations through advanced satellite-based wireless backbones. You don't have to be a satellite expert to use a smartphone to get to your applications or use two-way radio to talk back to your dispatch, even if you're responding thousands of miles away from home base.

Here is a run-down on some of the service categories and functionality that are enabled today via satellite-based wireless backbones. Some services and functions are value-add and specific to certain satellite carriers:

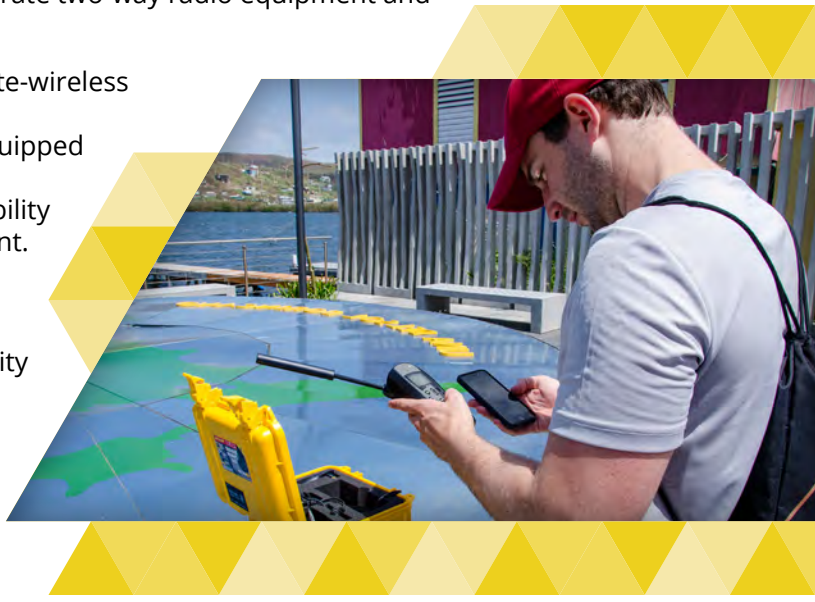
- **Dial-Up Voice:** This functionality is still an essential element in any response. From individual to enterprise, systems scale according to your plans, resources, and the size of the actual emergency. You can use satellite telephone handsets, with a monthly access charge for standby service, and pay by the minute when used, which usually doesn't matter in an emergency. If you have telephone service across VSAT systems, you can get multiple lines with "in-office" functionality, usually at a fixed cost per-line, with 10-digit telephone numbers, and no per-minute charges.

- **Two-Way Radio:** There are proprietary satellite-based two-way radio networks that require specific terminals, and then there are standards-based two-way networks that flow across MSS/FSS satellite and terrestrial networks in tandem. In both cases these two-way products can function on a stand-alone basis if nothing else is available in a disaster. Two-way radio networks that traverse satellite and terrestrial networks in tandem provide 100% coverage across North America and beyond.

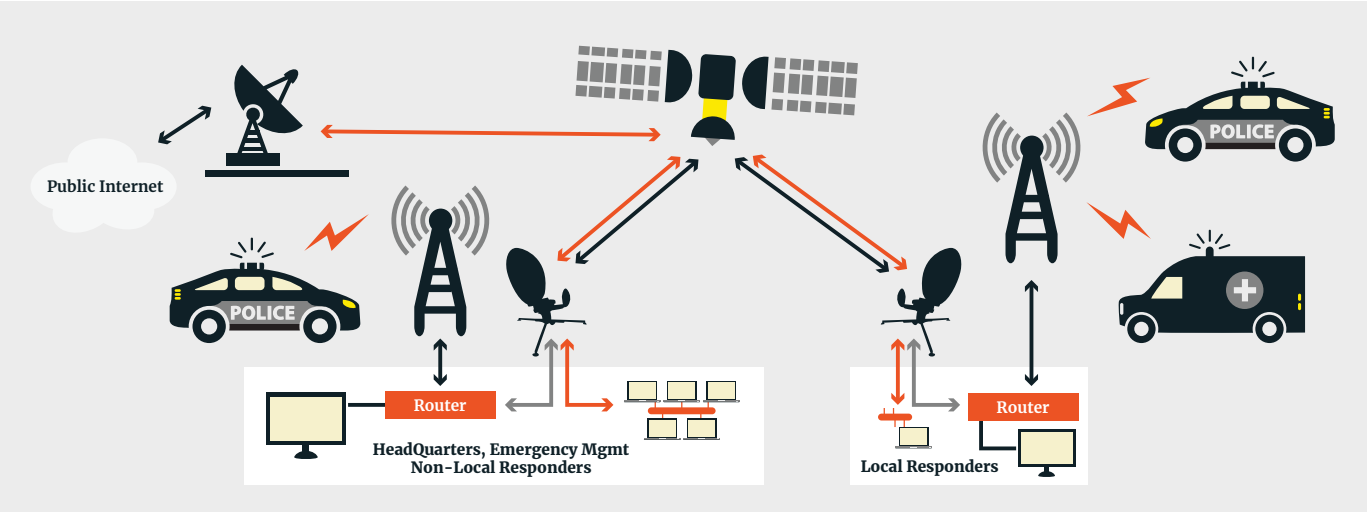
  A key element of satellite-based two-way radio is the ability to have infinite interoperability through the joining together, at a network level, of disparate two-way radio equipment and network backbones.

  Two-way radio repeaters can be added to remote satellite-wireless terminals to create a tactical operating area, enabling collaborative communication among dozens of radio-equipped responders. In this scenario, a single-repeater-equipped satellite MSS/FSS terminal can treble the response capability of a field force using an agency's existing radio equipment.

  Costs for use of these networks is usually fixed per month, with a range of pricing that depends on the number of carriers subscribed and requested functionality (channels, number of units, etc.).



▸ **Interoperability:** This is where advanced satellite-based wireless backbones and their network services excel. Disparate radio, data and video systems can cross-band and join any network together to achieve collaborative functionality and information sharing on any operation. As an example, a mobile responder can be on-scene operating on a hybrid LTE/mobile satellite network, sending situational video and essential data to a higher command at a fixed or field location. It does not matter which satellite or terrestrial network is being used, as-long-as you have worked with your carrier to set up an interoperable path to join the elements together. Some of this can be done on the fly in the field, but preparation and advance set-up can save valuable time in response situations. Interoperable functionality can be achieved without having to own or maintain expensive crossbanding equipment.

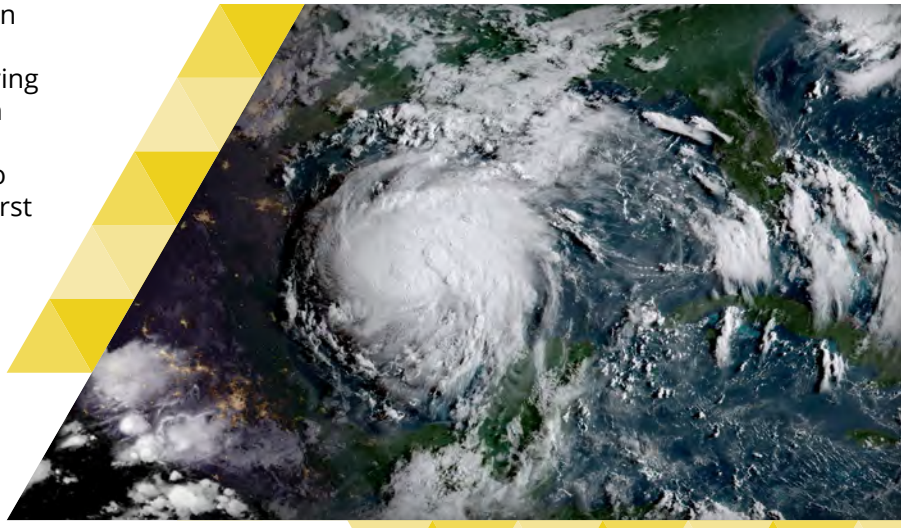


▸ **Broadband Mobile Data:** Private network data or internet access is provided for multiple users on both MSS and FSS network backbones. This is done at broadband speeds on all FSS and the majority of MSS networks. MSS continues to break the lower speed barriers with new constellations of LEO and MEO satellites. This continues the convergence of MSS and FSS network functionality.

▸ **Satellite Wi-Fi:** Satellite-wireless hotspot capabilities exist in nearly every MSS and FSS terminal, enabling multiple users to use the broadband data and collaborate remotely, as if they were together at home in their office. In this scenario, there need not be people physically tethered to the network. Responders can send email and text messages, interact with social media, and transmit pictures and video from the field using their own devices. They can also make and receive phone calls and operate two-way radios completely independent of terrestrial networks.

▸ **Response Asset Tracking and Management:** GPS-driven satellite-based asset tags are a new essential element for response and recovery operations. What could be described as mobile IOT is the capability these small size inexpensive tags bring to the response. With thousands of items to keep track of, from mobile equipment like gensets and tractors to pallets of response goods (food, water, shelters), asset tags bring order to logistics staging and mission deployment. They speed time to delivery and maintain operational control in otherwise chaotic situations.

▸ **Situational Video:** A picture is worth a thousand words certainly applies in pretty much every response situation. First responders initially arriving on-scene can relay video via satellite (typically MSS) showing the state of events. These actions assist incident commanders in sending the proper resources to save life and property, something critically essential in the early hours of any response.



▶ **Earth Observation Sciences:** Earth observation technologies play a critical role in supporting first responders through the assessment and monitoring of natural hazards. In the wake of disasters, Earth observation capabilities, derived from space and surface networks, have provided effective tools to map damages and proven essential in directing first responder resources and their ongoing activities.

At the heart of Earth observation is fleets of sophisticated GEO satellites operated by agencies such as NOAA and DOD, as well as private players, that capture vivid, granular images of hurricanes, cyclones and other rogue weather patterns, and send the information to terrestrial technology systems that can provide much-needed analytics for first responders.

a. **Pre-Response:** Having access to visuals and information about the movement and severity of hurricanes, storms and other natural disasters allows first responders to take actions when time is of the essence — such as declaring a state of emergency. The sooner first responders have information about an impending disaster, the more quickly they can act on it — planning life-savings evacuations and redirecting resources as needed.

b. **During and After Response Commences:** Earth observation technologies speed up the pace of coordinating post-disaster relief. Specifically, "before" and "after" imaging from satellite companies can aid first responders in quickly locating the areas most affected by disaster, such as areas of flooding or structures that have suffered critical infrastructure damage. Such imaging can also be leveraged to search for navigable roads or prioritizing response and recovery.

▶ **UAV Beyond Line of Sight (BLOS) Operations:** Closer to earth observation and communications restoral capability now exists via satellite in BLOS operations for UAVs. Whether monitoring gases and lava from a volcano, or looking for lost hikers in the wilderness, UAVs take response to an entirely new level. Once out of sight they need to be positively controlled. Satellite-based wireless does the job here, relaying visual and sensor data back to responders on the ground, providing a tactical level of Earth observation that directly assists their operations. The next generation of UAV payloads will include LTE and two-way radio repeater nodes, with mission ability to maintain constant air cover over any affected area.

▶ **Service Restoration:** VSAT networks provide day-to-day routine carriage of telecommunications, financial, energy distribution and television programming for government, enterprise and consumers across North America. These same systems are called into play during disasters and extraordinary planned events, to supplement and restore the Public Switched Telephone Network (PSTN), two-way radio networks and provide internet and video services.

Satellite-based wireless services provide high-speed broadband connectivity that is totally independent of terrestrial-based networks in any affected area. They can be the primary fail-over and restoration element for agencies whose communications have become impaired when disaster strikes and places them at ground zero. Put into place in advance, they also create an element of resiliency that can eliminate the service restoration aspect in the first place.

IV. CONCLUSION

You might be closer to using today's satellite-based wireless communications than you realize. Perhaps your agency already has some satellite equipment on command vehicles, sitting in a closet, or installed in your operations centers. These might be able to be upgraded to function with advanced services beyond simple internet access at very little, if any cost. New satellite systems you might acquire for EOCs, command vehicles and remote field locations have the capability to handle the majority of advanced functions described in this handbook right out of the box.

As illustrated in this first responder's handbook, satellite-based wireless communications are more than just an option in response and recovery planning. Collectively the equipment and services form a group of essential elements worthy of consideration by each and every first responder organization. Please take the time to reach out to the carriers listed in this guide. They stand ready to assist in planning, then partnering with you in the implementation process when the time to respond arrives.

V. SATELLITE SOLUTIONS PROVIDERS

Cinetcomm
- 702-342-5590 - 24x7
- https://cinetcomm.com

Solutions: Defi – All Hazards/ Hurricane-Proof Instructure, TotalConnex Network Solution for responders, MSS & VSAT Network Services for responders, and disaster management teleport and co-location services.

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- https://www.eutelsat.com

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- https://www.globalstar.com/corporate/home

Solutions: High-quality, cost-effective satellite voice and data communications.

Hughes
- 301-428-5500
- www.Hughes.com

Solutions: Broadband satellite networks, backup services and other managed network services.

iDirect
- 703-648-8000
- www.idirect.net

Solutions: IP-based satellite communications; high-throughput satellites and other services.

Inmarsat
- GlobalCustomerSupport@inmarsat.com
- www.Inmarsat.com

Solutions: Mobile Satellite Services (MSS); Broadband Global Area Network (BGAN).

Intelsat
- 703-270-4200
- www.intelsatgeneral.com

Solutions: Ground infrastructure, mobile and fixed satellite systems, technical expertise and secure communications network solutions.

Iridium
- 480-752-5155
- www.Iridium.com

Solutions: Satellite phones, MSS solutions and other satellite communications technologies.

Kymeta Corporation
- 425-896-3700
- http://kymetacorp.com

Solutions: Flat-paneled, electronically steered antennas and other solutions.

LeoSat Enterprises
- info@leosat.com
- http://leosat.com

Solutions: Low-Earth Orbit (LEO) communications satellites.

Marshall Communications
- 571-223-2010
- www.marshallcomm.com

Solutions: Secure content delivery, mobile VSAT, and custom turnkey communications solutions.

On Call Communications
- sales@occsat.com
- http://www.occsat.com

Solutions: Satellite communications systems that enable voice, data and video services for first responders and disaster management.

OneWeb
- contact@oneweb.net
- http://www.oneweb.world

Solutions: High-performance satellites that enable instantly deployable connectivity or long-term broadband access solutions.

SES
- +352 710 725 1 (Luxembourg)
- www.ses.com

Solutions: High-definition video conferencing, streaming, GSM backhaul, cloud-based services and high-speed broadband.

Spire
- https://spire.com/contact/customer-portal/
- https://spire.com

Solutions: Critical weather data and forecasting technology.

Xtar
- info@xtar.com
- www.xtar.com

Solutions: Fixed and COTM X-band communications services.

VI. FREQUENTLY ASKED QUESTIONS:

Q: What is a communications satellite?

A: A communications satellite is a device used to receive and transmit radio signals space. The satellite has communications equipment including receive and transmit antennas, power, and electronic components which enable it to receive a signal from a satellite terminal/user and then transmit that same signal to another satellite terminal/user.

Q: What can I use satellite-based wireless services for?

A: Anything that uses an IP-centric or serial connection to operate equipment, provide video, voice, broadband data and global location services.

Q: What is a satellite terminal?

A: A satellite terminal is anything you use to receive or transmit a signal via a satellite, such as a satellite phone, satellite radio, satellite dish/antenna, or VSAT.

Q: What is a satellite gateway?

A: A satellite gateway (also referred to as a teleport or hub) is the ground station that houses the network equipment connecting remote field terminals back to agency networks, the internet, telephone and video networks.

Q: Do satellite phones work just like cell/wireless phones?

A: Satellite phones offer many of the same characteristics as cellular phones including a similar user interface and design. Satellite phones are slightly larger in size than cellular phones because the antenna required to communicate on the satellite frequencies must be larger than a cellular phone antenna. Another fundamental difference between traditional wireless phones and satellite phones is that when the phone is in satellite mode, it must be within line-of-sight of the satellite in order to complete calls (i.e. you need to have a clear view of the sky). Therefore, a traditional satellite phone cannot be used indoors, unless equipped with an external antenna on the building. Some dual-mode satellite phones will work indoors in cellular mode when the user is within a cellular-serviced area.

Q: How secure is satellite?

A: Satellite is secure as any IP connection. In circumstances where high security is required, commercial off-the-shelf security hardware and encryption applications can be applied to secure the network. Security protocols operating on an agency's network today can also be used in the satellite-based wireless environment.

Q: Are satellite services and equipment reliable?

A: Yes. Satellite-based wireless services and terminal equipment are reliable. Reliability is a critical factor to consider when using satellite for response recovery operations because it is often the only wireless network with coverage in affected areas.

Q: Aren't satellite communications cost-prohibitive for anyone except DoD?

A: Satellite-based wireless communications is a sound economical option for any federal, state, or local first responder. Whether VSAT or MSS, various types of equipment and service plans can be tailored from occasional to full-time use at competitive rates.

Q: Why are satellites an essential component in all critical telecom network planning?

A: Satellite-based wireless systems enable rapid deployment and/or restoration and truly mobile communications. First responders should incorporate satellite services and networks as a redundancy requirement in their own agency communications network or architecture. Satellite systems should be emphasized and included in the early planning of these initiatives to ensure there is a back-up communications solution when the terrestrial network is damaged or destroyed. Without a satellite component to any future emergency response communications network, the emergency communications network will be rendered useless for first responders when the terrestrial network next sustains damage or becomes overloaded.

Q: How do Earth observation technologies impact the decision-making process?

A: Earth observation technologies support first responders by providing real-time data insights into the development and activities of natural hazards. This information helps first responders plan evacuations and other activities to dispatch resources, save lives, and improve recovery efforts.

VII. GLOSSARY

- **Antenna:** A device for transmitting and receiving signals. An antenna is part of satellite terminal, either attached or remote from the equipment Earth Station.
  - **Parabolic Antenna:** The most frequently found satellite antenna dish. It takes its name from the shape of the dish described mathematically as a parabola. The function of the parabolic shape is to focus the satellite signal hitting the surface of the dish into a single focal point to "feed" the satellite equipment
  - **Flat-Panel Antenna:** Antennas that are flat and spread out, as opposed to their parabolic dish counterparts. They include phased-array antennas and electronically steered antennas used by the military and commercial satellite providers to transmit and receive communications signals.
- **Backhaul:** A terrestrial communications channel linking an earth station antenna to a local switching network, agency location or population center.
- **Bandwidth:** A measure of spectrum (frequency) use or capacity. For instance, a voice transmission by telephone requires a bandwidth of about 3,000 cycles per second (3KHz).
- **Channel:** A frequency band in which a specific broadcast signal is transmitted. Channel frequencies are specified in the United States by the Federal Communications Commission (FCC).
- **Downlink:** The link from the satellite down to the Earth Station.
- **Earth Observation:** The process of gathering information about planet Earth, including weather and environmental conditions, for planning, rescue and recovery purposes.
- **Earth Station:** The buildings, hardware, software and antennas used to communicate with a satellite.
- **Footprint:** The area of the Earth's surface from which an Earth station can transmit to or receive from a particular satellite.
- **Frequency bands:** Internationally, frequencies are divided into well-defined bands. For satellites, the relevant bands are:
  - **C-Band:** Transmissions are less affected by atmospheric conditions such as snow and rain. However, C-band transmissions have low power, so Earth Stations must be rather large to compensate dish size. Applications include public switched networks and internet trunking.
  - **Ka-Band:** Has a higher power than Ku-band allowing for smaller dishes to be used and therefore, used for high-bandwidth interactive services such as high-speed internet, videoconferencing and multimedia applications. Ka-band transmissions are more sensitive to poor weather conditions than Ku-band.
  - **Ku-Band:** Has higher power than C-band allowing for smaller dishes to be used. However, the higher frequency of Ku-band makes it more susceptible to adverse weather conditions than C-band. Applications include Very Small Aperture Terminals (VSAT), rural telephony, satellite news gathering, videoconferencing and multimedia.
  - **L-Band:** Used for Mobile Satellite Services (MSS) and offers good penetration through adverse weather conditions and foliage.
  - **X-Band:** The X-band frequency enables high power operations with very small terminals. Applications include Communications on the Move (COTM), manpacks, emergency communications and airborne and shipboard platforms. X-band is also less vulnerable to rain fade and adjacent satellite side lobe interference than other frequencies.

- **GHz:** Gigahertz. One Gigahertz is equivalent of 1 billion Hertz, or 1 billion cycles per second. Used to measure frequency and bandwidth.
- **High Throughput Satellite:** an advanced FSS satellite that has many times the throughput of earlier generation orbital wireless platforms.
- **Hub:** The master station at either a teleport or client location through which all transmissions, to, from and between terminals flow.
- **Kbps:** Kilobits per second. Refers to transmission speed of 1,000 bits per second.
- **kHz:** KiloHertz. One KiloHertz is the equivalent of 1,000 Hertz, or 1,000 cycles per second. Used to measure frequency and bandwidth.
- **LAN:** Local Area Network. A geographically localized network.
- **MHz:** MegaHertz. One MegaHertz is equivalent of 1 million Hertz, or 1 million cycles per second. Used to measure frequency and bandwidth.
- **Orbit:** A regular, repeating path that one satellite in space takes around another one. All orbits are elliptical, which means they are an ellipse, similar to an oval.
  - **GEO:** an orbit located 35,786 kilometers (22,236 miles) above the Earth's equator, which follows the direction of the Earth's rotation. Weather satellites are often placed in GEO.
  - **Low Earth Orbit (LEO):** an orbit with an altitude of 2,000 km (1,200 mi) or less — the first 100 to 200 miles (161 to 322 km). The International Space Station is in LEO, as it is easiest orbit to get to and stay in. While there is potentially more crowding of satellites in this orbit, latency is less of a concern than higher-altitude orbits.
  - **Middle Earth Orbit (MEO):** an orbit within the range of a few hundred miles to a few thousand miles above the Earth's surface.
- **Spot beam:** A satellite beam with concentrated geographic coverage.
- **Terminal:** One of the communications stations that receives, processes, and transmits signals between itself and a satellite.
- **Transponder:** A device located on board the satellite which receives signals uplinked from an earth station and transmits them back to Earth on a different frequency.
- **Uplink:** The link from the Earth station up to the satellite.
- **VSAT:** Very small aperture terminal. Refers to small Earth stations, with antennas usually in the 1.2 to 2.4 meter range. Small aperture terminals under 0.5 meter are sometimes referred to Ultra Small Aperture Terminals (USAT's)
- **WiMAX:** a wireless communications technology that provides high-throughput broadband connections for considerably longer distances than that offered via Wi-Fi (Wireless Fidelity) or LAN (Local Area Network).

Via Satellite