System Assessment and Validation for Emergency Responders (SAVER)

Satellite Mobile Phones Market Survey Report

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FOREWORD

The U.S. Department of Homeland Security (DHS) established the System Assessment and Validation for Emergency Responders (SAVER) Program to assist emergency responders making procurement decisions. Located within the Science and Technology Directorate (S&T) of DHS, the SAVER Program conducts objective assessments and validations on commercially available equipment and systems, and develops knowledge products that provide relevant equipment information to the emergency responder community. The SAVER Program mission includes:

- Conducting impartial, practitioner-relevant, operationally oriented assessments and validations of emergency response equipment

- Providing information, in the form of knowledge products, that enables decision-makers and responders to better select, procure, use, and maintain emergency response equipment.

SAVER Program knowledge products provide information on equipment that falls under the categories listed in the DHS Authorized Equipment List (AEL), focusing primarily on two main questions for the responder community: "What equipment is available?" and "How does it perform?" These knowledge products are shared nationally with the responder community, providing a life- and cost-saving asset to DHS, as well as to Federal, state, and local responders.

The SAVER Program is managed and executed by the National Urban Security Technology Laboratory (NUSTL). NUSTL is responsible for all SAVER activities, including selecting and prioritizing program topics, developing SAVER knowledge products, coordinating with other organizations, and ensuring flexibility and responsiveness to first responder requirements. NUSTL provides expertise and analysis on a wide range of key subject areas, including chemical, biological, radiological, nuclear, and explosive weapons detection; emergency response and recovery; and related equipment, instrumentation, and technologies. For this report, NUSTL conducted a market survey of commercially available satellite mobile phones. Satellite mobile phones fall under AEL reference number 06CC-03-SATM titled Satellite Mobile Phone.

Visit the SAVER website (http://www.dhs.gov/science-and-technology/first-responders) for more information on the SAVER Program or to view additional reports on satellite mobile phones or other technologies.

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1. INTRODUCTION

Satellite mobile phones utilize satellites to communicate with landline, cellular, or other satellite phones in most regions of the world. Responders use satellite mobile phones for emergency communications in order to coordinate response and recovery efforts in remote areas, where there are no landline or cellular telephone networks, or in areas where existing networks are damaged or overloaded during a natural disaster (e.g., severe weather or earthquake) or a man-made incident, including potential chemical, biological, radiological, nuclear, or explosive events. Satellite mobile phones can help maintain command and control functions during an emergency when existing communications networks are not functioning. These phones are designed to be relatively rugged and simple to operate, but are more expensive than cell phones to buy and use. To provide emergency responders with information on satellite mobile phones, the System Assessment and Validation for Emergency Responders (SAVER) Program conducted a market survey.

This market survey report is based on information gathered between June and August 2015 from Internet searches, product literature obtained from manufacturer/vendor websites, and responses to a government-issued Request for Information posted on the Federal Business Opportunities website (https://www.fbo.gov).

For inclusion in this report, satellite mobile phones had to meet the following criteria:

- Commercial off-the-shelf product

- Handheld

- Can communicate with satellite phone systems and transmit the information signals, from voice or Short Message Service (SMS) text, to a receiving mobile phone

- Can operate on internal battery power

- Primarily for use by emergency responders.

Due diligence was performed to develop a report that is representative of products in the marketplace.

2. SATELLITE MOBILE PHONES OVERVIEW

Satellite mobile phones are handheld and use satellites to communicate with landline, cellular, and other satellite phone systems. Generally, the satellite receives an information signal, by voice or text, from the sending phone (source) and transmits the signal to the satellite phone (receiver) or the satellite phone user (source) generates an information signal (voice or text) and the satellite relays this signal to a ground station for transmission to the receiver.
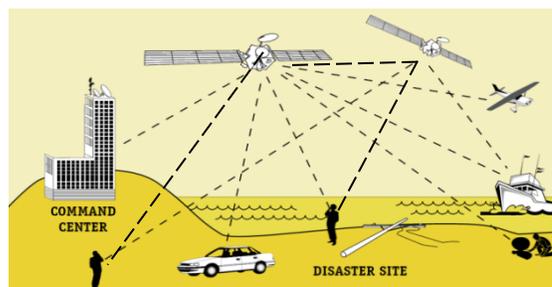
Figure 2-1. Satellite Communications

Photo courtesy of Satellite Industry Association

An omnidirectional or directional antenna in the satellite mobile phone is used for both transmitting and receiving signals. Satellite phones generally require line-of-sight with the sky to receive a signal for service. Obstructions, such as trees, buildings, hills, and mountains, can block the phone's information signal. As a result, satellite phones do not work well indoors, although operation may still be possible if the phone is positioned near a window. Satellite mobile phones can provide communications to ships, vehicles, planes, other ground-based phones, and command centers (Figure 2-1). Current generation satellite phone systems can be powered on quickly and locate the satellite signals using built-in Global Positioning System (GPS) technologies.

2.1   Current Satellite Mobile Phone Technologies

Satellite mobile phones use geosynchronous equatorial orbit (GEO) or low earth orbit (LEO) satellites. GEO satellites orbit approximately 36,000 kilometers (22,400 miles) above the earth's equator. At this altitude the satellite matches the earth's period of rotation and remains in a fixed position over the earth. Therefore, phone antennas can be directed towards the GEO satellite and remain on track without re-orientation. GEO satellites can provide near-continuous global coverage with only a few satellites in orbit. However, they have an approximate latitude limitation of above 82 degrees north of the equator to below 82 degrees south of the equator. Also, GEO satellite phone systems may introduce a noticeable voice delay (latency) during phone calls or while using data services, due to the long distance that is required for signal transmission. In comparison to GEO satellites, LEO satellites orbit the earth at significantly lower altitudes, generally between 500 kilometers (310 miles) and 1,500 kilometers (930 miles). Since a satellite in LEO is not geosynchronous, it moves with respect to the ground, and a larger network of satellites is required to provide continuous coverage. A data signal from a LEO satellite has a narrower bandwidth as the satellites move in and out of the range of the transmitting phone and each other. LEO satellites have a short dwell time over any particular point on the earth since LEO satellites orbit the Earth. Even given these limitations, LEO satellites need less powerful amplifiers for successful transmission and provide no perceptible data or voice latency because they are closer to the earth's surface than GEO satellites. Yet, in both cases, the transmitting phone must have line-of-sight to a satellite at all times.

The four largest companies that operate satellite networks for telephone communications are Iridium, Globalstar, Inmarsat, and Thuraya. Thuraya's satellite phone system utilizes a single GEO satellite and provides coverage for areas within Europe, Africa, and the Middle East, but not North America and South America. Therefore, Thuraya's satellite phone system is not further included in this Market survey report because it does not serve the Western Hemisphere.
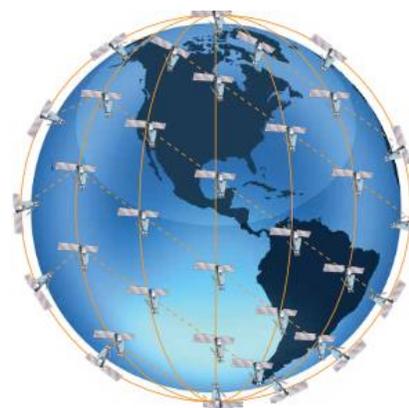
Figure 2-2. Iridium Global Satellite Network

Photo courtesy of Satcom Direct, Inc.

Iridium's global satellite network is comprised of 66 cross-linked LEO satellites (Figure 2-2). There are 11 satellites in each of the 6 orbital planes and their orbits "crisscross" roughly over the north and south poles. A second-generation Iridium network, called NEXT, planned for 2017, is expected to provide expanded services for the growing communications demand

In 2007, Globalstar launched the final 8 first-generation LEO satellites into space, bringing their first-generation total to 48 satellites. Between 2010 and 2013, Globalstar launched 24 second-generation LEO satellites in an effort to restore their system to full commercial operability.

Inmarsat operates a satellite phone system that uses 11 GEO satellites including Inmarsat-4 satellites and their most recent launch of next-generation Inmarsat-5 satellites that were deployed from 2013 to 2015.

2.2   Applications and Phone Selection Guidelines

Satellite mobile phones are more frequently being used by emergency responders as a reliable alternative to land-based communications systems that may be unavailable or unreliable during natural or man-made disasters. Satellite networks are rarely, if ever, out of service. Emergency response organizations use handheld satellite mobile phones primarily for voice communications; however, satellite mobile phones may be also equipped with e-mail, SMS, GPS, and Internet capabilities. Some satellite mobile phones with Bluetooth and Wi-Fi allow for the use of a remote headset and a wireless computer connection for data access. Most modern satellite mobile phones are designed so that it is easy to send and receive e-mails and post to social media from any Wi-Fi enabled device. Newer models have become smaller and lighter and have functionality similar to that of modern cellular phones. The satellite phone companies provide services with different technologies, geographic coverage, audio quality, and reliability.

The following criteria should be considered when selecting a satellite mobile phone:

- Geographic coverage requirements (e.g., global or regional)
- GEO or LEO satellite network of use (e.g., advantages/disadvantages of GEO and LEO)
- Cost of handset
- Economics of use (e.g., usage fees, types of contracts, in-network and out-of-network call charges)
- Handset design (e.g., ease of use, antennas, displays, buttons)
- Battery life (e.g., talking time vs. standby time)
- Data capabilities and features (e.g., e-mail, SMS, GPS, Internet, phone tracking, Wi-Fi, Bluetooth)
- Data speed (e.g., speed of accessing or downloading data)
- Ruggedness (e.g., IK or IP ratings for degree of protection and resistance)
- Compliance with military specifications and guidance.

A comprehensive review of satellite communication technology for disaster response is given in the reference listed in Section 6.

2.3   Standards

Some satellite mobile phones are manufactured in accordance with standards such as European standard EN 62262/International Electrochemical Commission 62262 (IEC 62262), European standard EN 60529/International Electrochemical Commission 60529 (IEC 60529), and the U.S. Department of Defense MIL-STD-810F.

EN 62262/IEC 62262-2002 relates to IK ratings, which specify the degree of protection against mechanical impacts provided by enclosures for electronic equipment. There are 10 IK ratings ranging from IK00 (not protected) to IK10 (highest impact resistance). For example, a phone with an IK04 rating can withstand an impact of up to 0.5 joules (i.e., equivalent to the impact of a 0.25 kilogram mass dropped from 200 millimeters above the impacted surface).

EN 60529/IEC 60529-2004 defines ingress protection (IP) ratings for electronic devices. An IP rating gives the degree of protection provided against water and solid objects (dust). An IP rating is a two-digit number in which the first digit, which ranges from 0 to 6, indicates the degree of resistance to the entry of dust and other solids. The second digit, which ranges from 0 to 8, indicates the degree of resistance to the entry of water. For both digits, higher numbers indicate a greater degree of resistance to substances like dirt, dust, and oil, in addition to splashing water. For example, IP54 is characterized as protection from dirt, dust, oil, other non-corrosive material, and splashing water. IP65 indicates a higher degree of resistance from dirt, dust, oil, and other non-corrosive material, in addition to protection from splashing water up to water projected by a nozzle against the enclosure from any direction.

MIL-STD-810F standard uses a series of test methods for determining the ability of an instrument to operate under various types of environmental conditions, such as exposure to rain, sand, dust, vibration, or shock. The guidance and test methods of MIL-STD-810F include:

- Defining environmental stress sequences, durations, and levels of equipment life cycles
- Developing analysis and testing criteria tailored to the equipment and its environmental life cycle to meet user and interoperability needs
- Evaluating equipment's performance when exposed to a life cycle of environmental stresses
- Identifying deficiencies, shortcomings, and defects in equipment design, materials, manufacturing processes, packaging techniques, and maintenance methods
- Demonstrating compliance with contractual requirements.

Purchasers may wish to discuss with the satellite mobile phone vendor how compliance to these standards was established, for example, if the product was tested by the manufacturer/provider or by an independent testing agency.

3.   PRODUCT DATA

This section provides information on six satellite mobile phones that range in price from $500 to $1,695. These prices are for the phones only and do not include the operating costs (i.e., monthly phone service plans or prepaid phone plans), call charges (i.e., per minute charge for incoming and outgoing calls), and other usage fees (i.e., fee for sending and receiving SMS messages, activation fee, fee for downloading data), which may vary considerably among the

different satellite networks. Generally, the monthly service phone plans are typically designed for users who will be regularly using the satellite phones. The prepaid phone plans, when available, have an expiration date, but no activation fee and no regular monthly charge, and potentially represent a good choice for users who know the number of minutes they will be using and need to purchase over a specific time period. Selection of the right phone plan will confer considerable savings on overall annual operational costs. Table 3-1 summarizes product features and specifications. Sections 3.1 through 3.6 describe each product in more detail. The information obtained has not been confirmed by the SAVER Program.

The product characteristics listed in Table 3-1 are defined as follows in column order:

Provider	The name of the satellite communications phone company that operates the satellite network service.
Satellite Type	Whether the satellite network uses GEO or LEO satellites.
Product	Name/model number of the specific satellite mobile phone product.
Vendor(s)	Distributor for the listed product.
Dimensions	The satellite mobile phone's length, width, and height, rounded to the nearest 0.1 inch (in).
Weight	The satellite mobile phone's weight without battery in ounces (oz).
Water-resistant	Whether or not the product is resistant to water.
Temperature Range	Satellite mobile phone's operating temperature range in degrees Fahrenheit (^{o}F).
Battery Life	Indicates the typical talking and standby times, in hours, when powered by standard battery (hrs).
GPS	Whether or not the product includes a GPS.
Data Upload	Indicates means of uploading data to a laptop.
Data Speed	Indicates the speed of accessing uncompressed data (kbps).
Standards	Indicates standards that the product meets.
Emergency Services	The availability of emergency services, such as an "SOS" tracking button.
GSA	Whether or not the product is available on the General Services Administration (GSA) schedule.
Price	Indicates the company's suggested price for one mobile phone, as quoted by the satellite communications companies or vendors, in U.S. dollars. The prices for any accessories are not included.

3.1   Globalstar: GSP-1700

The GSP-1700 satellite mobile phone can transmit data at speeds of 9.6 kbps and 28 kbps for uncompressed and compressed data, respectively. The USB port speed is up to 38.4 kbps. The phone receives texts and e-mails using SMS and stores up to 91 messages with 35 characters or less per message. The phone is compact enough to be carried in a pocket, and, with a weight of 7.1 ounces, is the lightest of the phones surveyed. The phone has a lighted keypad and a backlit liquid-crystal display (LCD) that allows 4 lines of 12 characters each. There are volume, signal, and battery-strength indicators. The GSP-1700 has a user-configurable call timer to help manage costs and a keypad lock for security. There is also a 99-entry internal address book with the ability to hide numbers in secret memory. The phone is available in three colors: copper, silver, and red. The lithium-ion (Li-ion) battery provides 4 hours of talk time or 36 hours of standby time. The phone can be used over a temperature range between -4°F and 131°F. The GSP-1700 can be integrated with a portable docking kit for installing a speakerphone and an additional external antenna for outdoor mounting. Calls using the external antenna can be placed from inside a building, vehicle, or vessel. The phone is not GPS enabled.

GSP-1700

Photo courtesy of Globalstar

3.2   Inmarsat: IsatPhone Pro

The IsatPhone Pro satellite mobile phone from Inmarsat has clear voice quality and is designed to operate in diverse weather conditions. It is a low-cost phone that can be used to make calls anywhere around the globe except from the polar regions above and below 82 degrees latitude. The phone comes equipped with voicemail, text and e-mail messaging, and GPS. Voice calls are made via a global network built for Inmarsat's satellite communications, and there are no roaming charges for incoming calls and receiving voicemails. The phone is available in two colors: blue and grey. The phone battery allows 8 hours of talk time or 100 hours of standby time. IsatPhone Pro can be used over a temperature range between -4°F and 131°F and a humidity range between 0 and 95 percent. The IsatPhone Pro has an IP54 rating for dust and water resistance.

IsatPhone Pro

Photo courtesy of Inmarsat

3.3   Inmarsat: IsatPhone 2

The IsatPhone 2 satellite mobile phone has added features and is designed differently from its predecessor, the IsatPhone Pro. The IsatPhone 2 is equipped with a scratch-resistant display screen. The display screen is larger and transreflective, improving the user's ability to read the screen under bright illumination, such as daylight. The IsatPhone 2 is available in the color black and weighs 11.2 ounces, which is heavier than the IsatPhone Pro. The IsatPhone 2 has a

rugged design that can be used in extreme weather conditions, including desert sandstorms and monsoon rains. The phone functions in both high-heat and ice-cold conditions. The operating temperature range is between -4ºF and 131ºF, and the humidity tolerance is between 0 and 95 percent. Similar to the IsatPhone Pro, the battery life is 8 hours when used for talk time. The IsatPhone 2 has a longer battery life when used for standby, lasting 160 hours, 60 hours longer than the IsatPhone Pro. In the event of an emergency, the phone is equipped with a programmable assistance feature, commonly referred to as an "SOS" tracking button. The tracking button will supply the phone's GPS position and send a text to a pre-set emergency number using the satellite. The phone is operable while wearing gloves. The IsatPhone 2 stores messages if there are incoming calls and the antenna is folded. The antenna must be unfolded in order to answer incoming calls. The IsatPhone 2 is rated IP65, indicating protection from dust particles and low pressure jets of water from all directions.

IsatPhone 2

Photo courtesy of Inmarsat

The Inmarsat phones can connect to a Broadband Global Area Network (BGAN) portable device that enables users to access the Internet with speeds up to 492 kbps and send e-mails and talk on the phone simultaneously. BGAN connects to Inmarsat-4 satellites and provides clear voice quality during calls with other Inmarsat phone devices.

3.4   Iridium: 9505A

The Iridium 9505A satellite mobile phone is an early model from a series of Iridium satellite phones. The phone operates in temperatures ranging between 14ºF and 131ºF and has a relative humidity range between 25 and 75 percent. Power is provided by a Li-ion battery that weighs 66 grams for a standard battery and 98 grams for a high-capacity battery. The standard battery lasts for 2 hours of talk time and 20 hours of standby time, while the high-capacity battery, which requires about 3 hours in recharging, allows 3 hours of talk time and 30 hours of standby time. The user interface is equipped with an illuminated graphic display screen and a keypad, and 21 language choices are supported for accessing the commands and prompts. The phone is easy to use for international calling. There is an indicator for missed calls. The internal phonebook stores up to 100 address entries. The phone is not GPS enabled.

9505A

Photo courtesy of Iridium

The 9505A was replaced by a newer model, the Iridium 9555. The 9505A is now manufactured in lesser quantities, but is still available for purchase.

3.5　　Iridium: 9555

The 9555 satellite mobile phone is approximately 30 percent smaller in size than the 9505A model. Its lightweight and compact design allows the phone to be comfortably carried inside a pocket. A different type of battery is used for 9555 than for the 9505A model, and the standard battery lasts for 3 hours of talk time and 30 hours of standby time. The high-capacity battery has 6.5 hours of talk time and up to 43 hours of standby time. The battery can be recharged in approximately 4 hours. The 9555 has updated features including an integrated speakerphone, two-way SMS and short e-mail messaging, an upgraded mini-USB data port, and an antenna that is more sensitive in design than the previous 9505A model. The two-way SMS feature allows the user to receive and send numerous SMS texts while engaging in multiple text conversations. The user interface has a brighter display screen than 9505A and users can set audible ring and alert tones. Other enhancements include a quicker connection to voicemail and added mailbox storage for voice and text messages. The phone is also water, shock, and dust resistant according to the manufacturer.

9555

Photo courtesy of Iridium

3.6　　Iridium: 9575 Extreme

The Iridium 9575 Extreme satellite mobile phone is the newest model in a series of Iridium satellite mobile phones. It is a small, lightweight design and works in all types of weather conditions. The 9575 Extreme is the first model of satellite mobile phone to meet the U.S. Department of Defense Military Standard, MIL-STD 810F, for resistance to dust, shock, vibration, and blowing rain. The phone has an IP65 rating and provides global coverage that includes the poles. The phone's internal GPS and one-touch emergency "SOS" button provide first responders with accurate location information, which is critical for response during emergencies. The fully integrated GPS online tracking is programmable to notify emergency responders about the exact location of the mobile phone. The phone is built to be dust proof, shock resistant, and water-jet resistant and has an illuminated weather-resistant keypad. The Iridium 9575 Extreme phone is enhanced with a quick-connect to Iridium voicemail, two-way SMS and short e-mail, pre-programmable international access codes, and a 100-entry internal phonebook that has storage capacity for multiple phone numbers, addresses, and other notes. The integrated speakerphone is equipped with a wind-resistant microphone and an internal mailbox for storing voice and text messages. The 9575 Extreme is supported by Google Maps which shares visual coordinates for phone location tracking among various users. For security purposes, users can lock the keypad using a PIN. The device has a mini-USB data port and a 200-character illuminated graphic display screen.

9575 Extreme

Photo courtesy of Iridium

4.   VENDOR CONTACT INFORMATION

The information on satellite mobile phones included in this market survey report was obtained from the following vendors listed in Table 4-1.

Table 4-1. Vendor Contact Information

Vendor	Product	Provider	Address	Contact Information
E&E Enterprises Global, Inc.	9575 Extreme	Iridium	101 Research Drive Hampton, VA 23666	www.eeenterprisesinc.com (757) 265-9750
Ground Control, Inc.	IsatPhone Pro, IsatPhone 2, 9575 Extreme	Inmarsat, Iridium	3100 El Camino Real Atascadero, CA 93422	www.groundcontrol.com 805-783-4600 Ext. 101
Knight Sky	9575 Extreme	Iridium	5123 Pegasus Court, Suite X Frederick, MA 20878	www.Knight-Sky.com 240-422-8742
Inmarsat Government	IsatPhone 2, 9555, 9575 Extreme	Inmarsat, Iridium	11600 Sunrise Valley Drive Reston, VA 20191	www.inmarsatgov.com 703-621-6447
In The Zone Communications	GSP-1700	Globalstar	210 Zeta Street Ravenna, OH 44266	www.itzcomm.com 330-297-6977
Roadpost	9575 Extreme	Iridium	7a Taymall Avenue Toronto, Ontario M8Z3Y8 Canada	www.roadpost.com 416- 253-6990 Ext. 252
Satcom Direct Communications	IsatPhone Pro, 9555, 9575 Extreme	Inmarsat, Iridium	201 North Union Street, Suite 300 Alexandria, VA 22314	www.satcomdirect.com 703-209-0014
Whenever Communications LLC	9505A, 9575 Extreme	Iridium	2100 19th Street Sarasota, FL 34234	www.satellitephonestore.com 941-955-1020

Information in the table is based on data gathered from vendors and their websites between June and August 2015.

5. SUMMARY

This report provides an overview of commercially available satellite mobile phone technology and applications, use considerations, specifications, and features of six satellite mobile phone models produced by three satellite phone providers. Considerations for selecting satellite mobile phones include ease of use, how fast the mobile phone can locate and connect to a satellite (if available), from what locations the user will need to send and receive phone calls, price, and other characteristics. Iridium and Globalstar provide a wide global coverage using LEO satellites. Inmarsat uses GEO satellites that provide global coverage except in the polar regions above and below 82 degrees latitude, regardless of longitude. Inmarsat BGAN provides high bandwidth and speed of accessing the Internet and enables users to send e-mails and talk simultaneously on the Inmarsat phone. Some of the satellite mobile phones surveyed replicate similar functionality to that of modern cellular phones, including GPS, in addition to Bluetooth and Wi-Fi capabilities necessary for accessing data. Weights of the satellite mobile phones range between 7.1 and 13.2 ounces. Overall operational costs will vary based on the selection of satellite phone providers (i.e., Globalstar, Inmarsat, or Iridium) and type of phone plan (i.e., monthly service phone plan or prepaid phone plan) the user enrolls in.

Careful assessment of the features, phone plan options, capabilities, and limitations of various commercially available satellite mobile phone products will allow agencies to acquire the equipment best suited for their particular needs. Phone specifications and phone plans may change with time; therefore, agencies should contact vendors and providers to obtain the most up-to-date information before making a purchase decision. The products generally come with a warranty of 1 year from the date of shipment.

6. REFERENCES AND RESOURCES

A Review of Satellite Communications and Complementary Approaches to Support Distributed Disaster Response. First Responder Group. U.S. Department of Homeland Security, Science and Technology, prepared by Massachusetts Institute of Technology, Lincoln Laboratory, December 2013.
http://www.firstresponder.gov/TechnologyDocuments/A%20Review%20of%20Satellite%20Communications%201-15-14.pdf