System Assessment and Validation for Emergency Responders (SAVER)

Portable Cellular Systems Application Note

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SAVER
System Assessment and Validation for Emergency Responders

Prepared by Space and Naval Warfare Systems Center Atlantic

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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; and
- 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 supported by a network of Technical Agents who perform assessment and validation activities. As a SAVER Program Technical Agent, the Space and Naval Warfare Systems Center (SPAWARSYSCEN) Atlantic has been tasked to provide expertise and analysis on key subject areas, including communications, sensors, security, weapon detection, and surveillance, among others. In support of this tasking SPAWARSYSCEN Atlantic developed this report to provide emergency responders with information on commercially available portable cellular systems, which fall under AEL reference number 06CC-01-CELL titled Phone, Cellular.

Visit the SAVER website on First Responder.gov (http://www.firstresponder.gov/SAVER) for more information on the SAVER Program or to view additional reports on portable cellular systems or other technologies.

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1. INTRODUCTION

The ability to communicate, especially in an emergency situation, is an essential requirement. Modern mobile communication technologies have greatly improved the capability to meet this requirement. In fact, today's communication systems readily offer the ability to transfer not only voice information, but also photographic, video, and a variety of other data (e.g., GPS).

At the core of these systems is the personal cellular (cell) phone. These devices have benefited from the rapid and dramatic development in technology over the past decade. The advent of the smartphone has resulted in lightweight portable devices capable of a wide variety of data communication tasks. Furthermore, the network infrastructure needed to reliably transfer vast amounts of data has also evolved. For example, the state-of-the-art mobile communication network commonly known as 4G, or fourth generation, is described in the SAVER *LTE for Mobile Phones TechNote* available on the SAVER website on FirstResponder.gov (http://www.firstresponder.gov/SAVER).

Unfortunately, communication systems are susceptible to disruption or loss of service. Whether such interruption is due to being at a remote or isolated location, attending a crowded event that overloads the capacity of the communication service, or the occurrence of a disaster, loss of communication is a critical issue for emergency responders.

Three broad categories of portable cellular systems are cellular-on-wheels (COW), cellular-on-light-truck (COLT), and man-portable systems. A COW system is a complete communication system designed and built onto a dedicated mobile platform, such as a trailer, and is available from several manufacturers, vendors, and system integrators. Likewise, several companies offer COLT systems that are complete communication systems installed onto a dedicated vehicle. As its name implies, the third category refers to complete portable cellular systems that are transportable by an individual.

This application note reviews these three categories of portable cellular systems. First, a background presentation is provided on the necessary equipment and interconnections needed to make a portable cellular system operational. Next, each type of portable cellular system is discussed in detail with an emphasis on system performance capabilities. Finally, selection criteria issues and considerations are presented to assist in the decision-making process for procurement of a portable cellular system.

2. PORTABLE CELLULAR SYSTEMS OVERVIEW

2.1 Connection to the Telephone Network

In order to use cell phones in an area with limited or no service coverage, a cellular network must first be established. The portable cellular system acts like a stationary cell tower providing a cellular communication link to the mobile devices within range of its broadcast antenna. Most portable cellular systems will then allow communication between mobile devices within range of the portable cellular system. Knowing the communication protocol capabilities of the portable cellular system is important. Only portable cellular devices designed with the same communication protocol will operate within the cellular network established by the portable cellular system. Communication protocols are further discussed in section 2.2.

The publicly switched telephone network (PSTN) contains all of the telephones, equipment, and networks that comprise public telecommunications worldwide. To reach other telephone users, a connection must be made to the PSTN (Figure 2-1). This connection is typically achieved either through an Internet local area network (LAN) or a satellite link commonly known as the backhaul connection. Once the portable cellular system establishes the communication link with the PSTN, mobile devices within its range are capable of sending and receiving voice and data throughout the PSTN as if they were connected to a stationary cell tower.

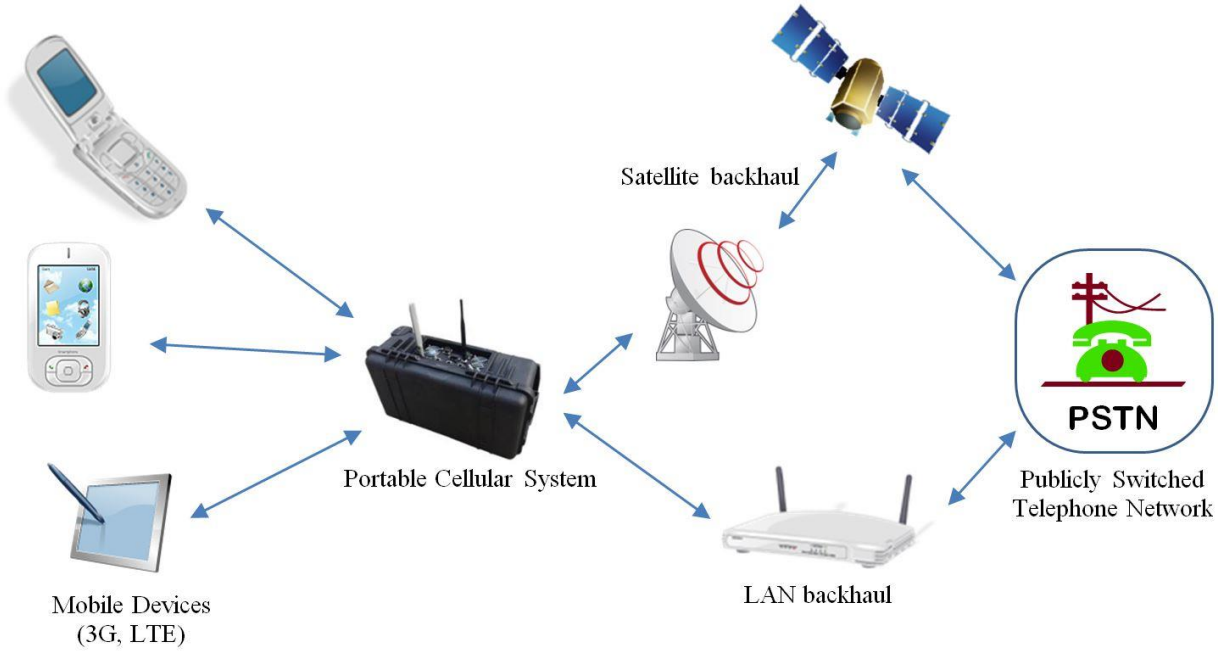

Figure 2-1. Portable Cellular Network Connection Illustration

Image courtesy of Space and Naval Warfare Systems Center Atlantic

2.2 Communications Protocols

As with normal cellular systems, portable systems operate using one or more wireless communication standard protocols. The specific type of communication standard will determine which handheld devices can be used in conjunction with the portable system. All current protocol standards used by modern cellular phones are based on digital communication techniques, but they have transitioned from standards designed primarily for voice communication to ones optimized for transmitting data.

Early digital systems in the United States, known as 2G systems, were based on standard communication protocols such as Global System for Mobile Communications (GSM), Code Division Multiple Access (CDMA), and Time Division Multiple Access (TDMA). These systems were designed primarily for voice communications and have relatively slow rates for data transfer. As the desire for data transmissions increased, the next generation or 3G systems were introduced. 3G systems primarily use either the Wideband Code Division Multiple Access (WCDMA), which is also known as the Universal Mobile Telecommunications System (UMTS), or the CDMA 1x protocol standard and provide faster data transfer rates than 2G systems. Modern 4G systems, or LTE systems, are even faster than 3G networks and are designed

primarily for data communication. Thus, all information transferred within a 4G network, including voice, is transmitted in data format. Due to the similarity of how Internet communication operates, data-based transmission technology is quite mature and these solutions tend to be more compact and feature-rich.

2.3 The Backhaul Connection

The backhaul communication link to the PSTN is typically established by the portable cellular system. Most portable cellular systems use either a LAN or satellite backhaul connection. LAN is useful when the portable cellular system is located in a non-remote area and the communication service problem is primarily due to the limitations of service network capacity. For connection to a LAN backhaul, access to a high-speed Internet connection is required.

A satellite backhaul is required in remote locations or when native cell-phone service coverage is not available. For this backhaul link, a separate satellite terminal is required for use with the portable cellular system. Most portable cellular systems use the Broadband Global Area Network (BGAN) for satellite backhaul. This network is provided by Inmarsat, a British company, and the satellite terminals must be designed for use on the BGAN network. One advantage of these terminals is that they are very small and portable, about the size of a small notebook computer. However, one drawback with satellite backhaul is a communication latency of up to 1.5 seconds in each transmission due to the large distance the signal has to travel.

2.4 Power Source

All portable cellular systems require a power source to operate. Some systems are capable of functioning with typical alternating current (AC) voltage (e.g., a standard 120 volt outlet). For wheeled systems, an electric generator is commonly an integral part of the complete setup. Some systems feature a battery powered configuration, although the duration of operation on battery can vary significantly from one system to another. Alternately, transportable, renewable energy sources (e.g., solar panels) may be used as a power source for the communication system.

3. CELLULAR-ON-WHEELS SYSTEMS

Cellular-on-wheels (COW) systems are trailer-mounted transportable solutions that come in various sizes and have a wide range of features. An example COW system is shown in Figure 3-1, with a unit having both a satellite and tower antenna. Depending upon the platform size, onboard electrical power generation may not be included in the system. Thus, some COW systems require external electrical power service.

Many COW system vendors give purchasers the option to integrate their choice of communication equipment onto the trailer frame. For the technically savvy purchaser, this option provides greater ability to manage overall system cost by performing the role of system integrator; however, most vendors will provide this service if desired.

Figure 3-1. COW System with Both Satellite and Tower Antenna Backhaul

Image courtesy of FEMA

4. CELLULAR-ON-LIGHT-TRUCK SYSTEMS

Consisting of a complete cellular system installed on a light-duty service truck, cellular-on-light-truck (COLT) systems provide a self-contained total communications solution. An example of a COLT system is shown in Figure 4-1, with a truck carrying a satellite backhaul. In most cases, these systems have a self-contained electric generator capable of providing cellular and ancillary vehicle services without using the truck engine as a power source. Furthermore, most will have a vehicle electric service connection available to power system components from an external utility source.

Figure 4-1. COLT System with Satellite Backhaul

Image courtesy of FEMA

The amount of configuration options available varies widely among vendors, with some providing completely customized solutions. Thus, each aspect of the portable cellular system presented can be uniquely chosen to provide optimal mission-specific performance. Other vendors provide standardized platforms with fewer system choices, which are likely suitable for most application scenarios. The COLT is typically designed to accommodate one or more communication system operators during the stationed deployment.

5. MAN-PORTABLE CELLULAR SYSTEMS

Consisting of a complete cellular setup in a packaged case, man-portable systems offer a unique cellular solution that is especially suitable for remote access locations that are not accessible by vehicles. These systems are designed to be transported by an individual and typically weigh less than 50 pounds, depending on configuration options. An example system, the EXPLORER Mobile Net available from SiRRAN Communications and their distributors, is shown in Figure 5-1.

Figure 5-1. Man-Portable Cellular System

Image courtesy of 4K Solutions, LLC

Several issues need to be considered when choosing a man-portable cellular system. First, the range of communication reception needs to be examined. Since these are extremely compact solutions, their antenna backhaul connections are usually small. This impacts the service performance and may require positioning the base station in an obstacle-free locale. With proper placement, mobile device users may anticipate connectivity to distances of approximately five miles from the man-portable cellular system. An additional consideration for reception is the anticipated number of simultaneous users who will access the system. This quantity should be a factor in determining the configuration setup of a particular portable cellular system.

These systems are often designed to consume power from a battery pack, although alternate power sources may also be available. As a result, while on battery power alone, the usable service time is limited and may last only a couple of hours. The actual amount of usable service time depends on specific installation scenario factors such as the number of users and the amount of communication traffic.

6. COMMON APPLICATIONS

Three broad categories exist that illustrate the need of portable cellular systems for emergency responders.

6.1 Public Events

Public events such as inaugurations, sporting or concert events, and rallies commonly result in scenarios in which the local cell service network becomes overloaded. In these situations, many users will be simultaneously seeking network access beyond the inherent capabilities, which results in dropped calls, intermittent service access, or even complete loss of service. However, such events are commonly known about in advance. Thus, providing emergency agencies time to implement a portable COW or COLT communication setup as a response solution.

6.2 Natural Disasters

Natural disasters such as severe storms, earthquakes, and tornados may result in damage to the existing cell service infrastructure. Additionally, during these times of crisis, the volume of cell users typically increases, which can overload the service network. Obviously, the combination of these two phenomena results in a worst case scenario. Sometimes emergency agencies have

advanced warning of these events and may be able to position a COW or COLT solution to be prepared for the anticipated loss of service.

6.3 Remote Locations

Scenarios such as search and rescue operations and event and disaster responses sometimes take place in remote locations without normal cell service coverage. Again, agencies may have advanced notification that would facilitate the COW or COLT approach; however, the man-portable systems are more readily deployable in rapid response situations and are often the only practical solution for extremely remote activities.

7. CONCLUSION

Many portable cellular systems are available for temporary use for emergency responders. Several questions that need to be evaluated in determining a solution are:

- Does the system have onboard electric power generation?
- How many users can simultaneously access the network?
- What is the typical range of service?
- What cellular network protocols are served?
- What is the process to add mobile devices to the network?
- What additional equipment will be needed?
- Are there size and weight considerations?

Due to the tremendous flexibility in the marketplace, a custom portable cellular system should be readily available. Furthermore, for situations where a planned response is possible, portable cellular systems can be rented in lieu of purchase.