A Disaster-Recovery Plan For Local Municipalities Using Currently Available Communication Satellite Facilities and Services

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I. Introduction

In times of emergency, communications systems can mean the difference between life and death. No one knows this better than state and local governments, police, fire and emergency departments. Each of these entities currently uses a variety of communications systems—wireline and wireless—to ensure that its employees are kept informed, can communicate with each other, with other entities (other emergency response departments, hospitals, etc.), and with the public. Over the years these systems have become increasingly sophisticated and useful. However, no system is invulnerable to catastrophic failure or the stress of widespread response to disasters such as occurred on September 11, 2001. The tragic events of that day have led to a renewed interest in analyzing the existing emergency and local government response mechanisms and evaluating what measures can be taken to provide additional safeguards and backup communications in the event of future disasters.

In future situations, as on September 11, 2001, the communications networks can themselves suffer damage, resulting in reduced or unavailable service, and the networks can be overloaded as both government and disaster personnel and the average citizen seeks to stay informed and communicate with family members.

This paper focuses on the role of satellite communications in providing ancillary communications to entities involved in safeguarding the public. It provides background on the current role and capabilities of certain types of satellite communications systems

and specific recommendations which can be utilized by local entities in utilizing existing satellite communications networks to add redundancy and backup to their communications systems.

II. How Satellite Systems were Used on September 11, 2001

On September 11, 2001 the entire communications network of the United States was severely tested. Police, fire, local government and emergency personnel responding to the disasters in New York City and Washington, D.C. required immediately available and highly functional communications systems to address the unfolding crisis. Beyond the use of communications by emergency response personnel, local, state and national governments needed to stay informed, communicate and have the capability of communicating with the general population. And, on the individual level, millions of Americans and those abroad were attempting to communicate with each other and to have access to information on the situation at hand.

While there were huge demands on the communications systems, critical infrastructure was damaged or destroyed, particularly in the World Trade Center attack. For instance, the main switching line for Verizon Communications was destroyed in the collapse of a nearby building and the backup phone system at NYC police headquarters was impaired because it was on the same electrical grid as the Twin Towers. Some firefighters engaged in rescue efforts in the towers didn't hear the order to evacuate on their handheld radios. A repeater used to boost the signal of the mobile phones went down with the towers.

Many communities throughout the U.S., and particularly in Washington and Philadelphia, suffered from the lack of an evacuation plan which should have been communicated to the people in those locations who made their own decisions and headed for home, creating traffic gridlock and severely taxing public transportation systems. In the review by many municipalities of the events of September 11, some have implemented new procedures which can serve as simple emergency alert systems. The role of satellite communications on September 11, 2001 was generally invisible to the observer. The most visible role was the case of satellite mobile communications service providing much needed on-the-ground backup to emergency mobile communications and jammed local cellular networks. The Globalstar, Iridium and Inmarsat networks were all put to use in this situation. Globalstar USA donated the use of over 100 Globalstar phones in New York City with unlimited airtime. In other locations, including Washington, other Globalstar dealers provided mobile and fixed phones within hours of the attack. Iridium also made its phones and airtime available during the crisis.

In addition, satellite communications were a critical component of keeping people informed of the unfolding events. Satellites are the main workhorses of transmitting broadcast communications to cable headends where the programming is then made available throughout the United States. They also form a significant part of the infrastructure for gathering on-the-spot news coverage and enabling that coverage to be

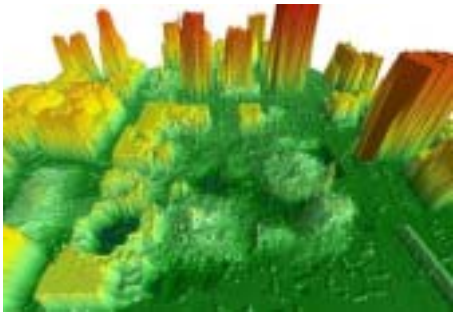
transmitted on a real-time basis to the network or local station where it is then broadcast over the airwaves (terrestrially) or uplinked to a satellite for distribution to cable systems.

In fact, in New York City, people who did not have cable television, and received programming solely through over-the-air reception, were limited to one network, CBS. This was because CBS, unlike the other major networks, has a diversity antenna on top of the Empire State Building. In the case of cable subscribers, the loss of the antennas on the World Trade Center did not impact their ability to stay informed by all the networks.

Satellites also play a significant role in transmitting Internet content throughout the United States and internationally. The Internet became a key component of communications as well as obtaining data, especially among individual citizens, on September 11, 2001. While the Internet slowed on that day, it proved itself as a critical element of the communications infrastructure.

Another component of communications related to the tragedy of September 11, 2001 that has been less observed, is the continued functioning and reliability of commercial communications systems involved in banking, retail sales, business and other networks. Despite the crisis situation and the overwhelming demands placed on the system, business continued to function amazingly well. Satellites provide data network services throughout the United States and in many instances, are immune from the jammed situation of the public communications networks.

Remote Sensing satellites also provided a view of the destruction which was used to aid rescue efforts.



The ability of America to keep on functioning on September 11, 2001 and afterwards is a tribute to the strength of America and Americans and in no small way, a tribute to the extensive and redundant communications system we enjoy.

III. What Communications Must be Maintained During an Emergency Including One Where Telecom Infrastructure Has Been Damaged

In addressing the needs to improve the communications capabilities of governmental and the emergency response community, it is useful to recall the main requirements of that community. These can be summed up as follows:

- ability to communicate within the local emergency response community (police, fire, rescue, local government, hospitals)

- ability to communicate with state and federal government and emergency management officials

- ability to receive broadcasts (radio and television) in order to stay informed

- ability to communicate with the local population (via Internet, radio and television)

- ability to communicate with private entities which will be needed to provide equipment and services during an emergency

IV. A Short Review of How Satellite Communications Are Used Today

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Today, satellite communications are used in a variety of ways that relate to disaster and emergency communications.

Transmission of Broadcasting

Probably the most extensive use of satellites today in the United States is to provide point-to-multipoint (one to many) broadcast communications such as television, radio, and provision of programming to television stations and cable TV systems. Broadcasters take advantage of the fact that the same amount of satellite resources are used to send a signal to one receiver or to a million receivers. Broadcast networks such as CBS, NBC, ABC, as well as cable programming providers such as HBO, distribute their programs to their affiliates or head-ends using satellite resources. Similarly, satellites are used to provide programming direct to the home via systems such as DirecTV, Dish Network, XM Satellite Radio and Sirius.

In a disaster scenario, direct satellite broadcast may be the only way, other than short wave radio, to receive news broadcasts at the disaster scene. News sources can be of considerable value in such times for keeping rescue workers and aid organizations informed on weather information, pertinent news and the overall progress of the rescue operations.

Satellite Newsgathering and Deployable Antennas

Satellites are also used for services known as “satellite newsgathering” in which trucks, vans and “flyaway” satellite terminals are located on the scene of the breaking news and used to transmit live programming to broadcast network headquarters and also to television stations throughout the US. An entire industry has built up to provide these specialized trucks and vans to provide this programming.

Some of these vehicles have been adapted for emergency communications purposes. For example, the Federal Emergency Management Agency has a number of such vehicles that are equipped with telephone equipment. These vehicles can access Ku-band satellites for quick connectivity that provides up to 48 lines for either telephones or data.

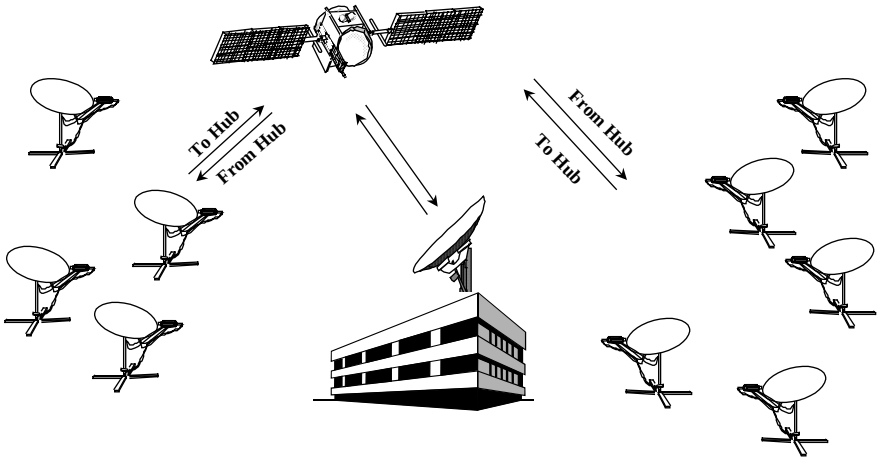
Following September 11, FEMA drove these vehicles into the disaster area and used them to provide scores of emergency telephone channels via satellite, as well as to use them for live coverage of press conferences.

A picture of one of these vehicles is shown below:

VSAT Networks

Another type of satellite communications which is readily adaptable to disaster communications consists of a network of Very Small Aperture Terminals, or VSATS, connected in a "star" or "hub and spoke" topology in which all VSATS talk to a central hub terminal. This hub has the dual function of maintaining network control and acting as the central communications interconnect point for all the VSATS in the network. This type network topology is particularly well adaptable to situations where the hub can be interconnected to terrestrial telephone or data networks at a major switching center. A diagram of such a network is shown on the next page.

Interactive Star Network



Some states already utilize VSAT networks as a part of their emergency communications systems. For example, the State of Florida recently contracted with Hughes Network Systems to upgrade and expand the state's emergency communications network. The upgraded network will allow the Florida Division of Emergency Management to transmit critical data and audio information throughout the state faster and more reliably. The previous system required emergency warnings to be delivered to one county at a time. With the new system, messages can now be distributed simultaneously to all stations within a matter of seconds. The system will encompass 127 remote sites throughout Florida's 67 counties.

Point-to-Point Systems as Backup to Terrestrial Infrastructure

Other uses of satellite communications in a disaster scenario can involve "point to point" satellite circuits which involve a small to medium sized satellite terminal (dish) at each end connected through the satellite. Uses for these satellite connections include:

- Provide internet connections to disaster areas, bypassing failed terrestrial connections
- Support paging networks
- Provide critical telemedicine links for situations where medical expertise is not available at the disaster scene
- Provide for video and audio conferences to bring in experts located off site
- Bypass overloaded, damaged or failed terrestrial communications facilities

Mobile Satellite Systems as Backup to Terrestrial Wireless

Mobile satellite communications also can provide a useful adjunct to terrestrial networks, particularly in disasters. Because of the focus on terrestrial mobile communications, including dispatch, paging and two-way voice, including networks dedicated to the government and emergency community, the ability of satellites to provide mobile communications has been largely overlooked. Despite the high-profile financial failures of Globalstar and Iridium, these systems nonetheless are functioning today and provide both satellite-only communications and satellite/cellular communications. These systems function as follows:

(1) satellite-only situation: caller places call which is transmitted directly to the satellite. The call then is downlinked to a gateway earth station (in the U.S. Iridium's gateway is in Arizona and Globalstar's is in California). The call is then routed from the gateway to the destination which could be another mobile satellite phone, a fixed wireline phone or a cellphone.

(2) satellite/cellular situation: caller places call and the call is routed over the terrestrial network if one is available. If terrestrial network is not available, call follows path described above.

Below is a picture of a Globalstar tri-mode phone (terrestrial TDMA, terrestrial CDMA and satellite):

The benefit of such systems for back-up communications is that they can function when existing infrastructure is damaged or overloaded. In addition to providing connectivity, the phones usually have position-locating capability, through GPS capabilities in the handset, or other techniques. Position-location can be especially helpful to assist emergency personnel in locating the user of the MSS phone.

Another system which provides mobile satellite communications is INMARSAT. provide service to mobile handsets, it does provide communications two and from portable handsets and provides higher bandwidth communications through computer laptops connected with an antenna. Inmarsat has been used to provide video and voice communications from remote locations, including news broadcasts by journalists in hard-to-reach locations such as Afghanistan. Inmarsat is implementing a more powerful, higher data rate system over the next two or three years which will provide

communications to handsets as well. Currently, Inmarsat systems are primarily used on vessels and airplanes. On ships and planes, Inmarsat has provided communications for years and has been a critical adjunct to dedicated maritime and aeronautical emergency communications systems.

Iridium, which provides services directly to the U.S. Department of Defense under a long-term contract, played a critical role in the evacuation of Ronald S. Shemenski from the South Pole during May, 2001. Four Iridium phones were rushed to the rescue team for the hazardous rescue of Shemenski who was diagnosed (by satellite) as having a potentially life-threatening case of pancreatitis.

Another rescue was made possible by satellite phone on October 30, 2002 when the yacht Ocean Wolf had an explosion in its engine compartment when 420 miles from the nearest land. The two-person crew used its Comsat-C service (which uses the Inmarsat system) to contact the Southbury, Connecticut Inmarsat earth station. The staff at the earth station determined the location of ships in the area and polled them to determine which could respond to the emergency. Within three hours two ships moved to rescue the crew. The U.S. Coast Guard acknowledged the valuable assistance of this system in providing critical communications in search and rescue efforts undertaken by the Coast Guard.

Global Positioning Systems, or GPS, receivers are also valuable at disaster sites to be able to pinpoint exact locations and provide navigation information.

V. A Basic Set of Satellite Equipment and Services to Provide Communications Back-up

Governmental, law enforcement and safety agencies can utilize existing satellite networks with proven technology as part of ensuring redundancy in their telecom networks. Local jurisdictions should evaluate the benefits of using satellite communications networks for the following purposes.

Obtaining News and Weather Information

Perhaps the easiest and lowest cost satellite communications capability to implement for news and weather information would be a Digital Audio Radio Service (DARS) receiver such as for XM Radio or Sirius. These receivers can be mounted in vehicles or be portable, and can be brought into the scene and receive news broadcasts directly from the satellite. The receivers are in the range of $300-500 and service costs $9.95 per month. In a disaster situation where local broadcasts were unavailable, this type of backup could be useful. Similarly, DBS systems such as DirecTV and EchoStar could also be used to provide a satellite-based ancillary to terrestrial broadcast systems. DBS receivers are available for $200-500 and service is approximately $50 per month.

Backup Communications Network and Intra or Inter-Organization Communications

VSAT installations can also provide intra-organization and inter-organization communications and access to other communications networks when local infrastructure has been damaged or overloaded. These systems have the additional advantage of reducing the burden on the remaining (overloaded) telecommunications infrastructure in the disaster area by "leapfrogging" the local switches and interconnect facilities to distant hub equipment.

One such case in point that occurred following the September 11 disaster involves the New York State Insurance Fund, NYSIF, located in lower Manhattan with over 1000 employees. Having lost all their data service and much of their telephone service on September 11, NYSIF was able to restore service only by physically running fiber cable through the streets. They have since purchased and installed 1.8 m antennas at their Manhattan and Albany locations and have a 1 Megabit per second connection standing by at all times if service is disrupted.

Similarly, a truck mounted mesh- type VSAT system was brought into the Manhattan disaster site to allow American Red Cross workers to access telephone service and get broadband communications and computer data in areas where no other facilities were available. This system utilized a technique known as "Demand Assigned Multiple Access" or "DAMA" which acts like a PBX in the satellite to concentrate telephone trunks and maximize capacity while minimizing satellite costs.

A wide variety of disaster recovery communications are available today. From truck mounted VSATs, to permanently installed antennas or even "flyaway" terminals, the options are many and varied. Considerations regarding the appropriate disaster recovery network design include:

- Permanently mounted or transportable antennas and terminals
- Network topology: "star" (hub and spoke) network versus a "mesh" network design in which terminals can call each other directly (without going through a hub)
- Fixed assignment of resources or demand (DAMA) assignment
- Type of communications (voice, data, and video) and bandwidth required
- Time delay required to activate the network following the disaster
- Capital cost, operating cost and cost when system is not in use
- User-friendliness and ability to be operated by non-technical personnel
- Amount of privacy required/ need for encryption of circuits

The tradeoffs are usually complicated enough to justify the use of an engineering consultant who is not associated with any particular vendor of equipment or satellite time. This way the recovery network can be optimized to meet the needs of the particular user seeking this type of backup capability.

Backup to Mobile Communications Systems

A relatively low-cost and easy way to acquire backup capability for voice (primarily) and data communications would be to purchase or lease several MSS handsets and subscribe to service which is billed a monthly minimum basis or on a per-minute use basis. For some rural communities, terrestrial cellular may not be available so local entities are limited on a regular basis to their dedicated mobile systems. In such cases, satellite mobile systems could provide a useful complement to the government and emergency communications systems rather than just as a backup for use in case of disaster.

Mobile satellite terminals and service can be acquired generally through third-party suppliers. Some of the suppliers are:

Supplier	***Website***	***Equipment/Service Offered***	***Price Range***
Globalstar	www.globalstar.com	Globalstar phones and services	Refers to distributors
Iridium	www.iridium.com	Iridium phones and services	Refers to distributors
Inmarsat	www.inmarsat.com	Inmarsat terminals and services	Generally available through distributors
Globalstar USA	www.globalstarusa.com	Globalstar phones and service	Varies
Roadpost	www.roadpost.com		Terminal Service: $1 to $1.50 per minute
Stratos	www.stratos.ca	Inmarsat primarily	Inmarsat terminal prices range from $2,000 to much higher; service cost is based on bandwidth and time use
OSS	www.oss-sat.com	Inmarsat M4, Inmarsat-B (battery operated); Globalstar phones	
GPSPhones	www.gpsphones.com	Inmarsat Mini-M and M4; Globalstar, Iridium	Used Globalstar phones: $345; Used Iridium phones: $395
Rent Express	www.rentexpress.com	Iridium	Iridium phone: $1,495; rentals at $49 per week
Telenor	www.telenor-usa.com	Various networks	

An important point with any communications system, and particularly mobile communications, is to ensure that the personnel who would use the terminals are trained in their use, and ideally would use the terminals occasionally to maintain familiarity with them. The terminals must be kept charged and easily accessible to emergency personnel.

VI. Conclusion

This paper has provided an overview of the role satellite communications can play in the provision of emergency communications, in particular, as backup to critical infrastructure which can be damaged or overloaded in disaster situations. Local governments, police, fire and emergency organizations should consider implementing mobile and fixed satellite systems to be available as a complement to other communications infrastructure.