

**Government Use of Commercial Satellite Systems for Disaster Response
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ABSTRACT

Commercial satellite communications services are undergoing major changes. Service is now available all over the world and the user terminals are becoming smaller and lighter – the capabilities offered in the terminals of the early 1980's that weighed several hundred pounds are now available in nearly pocket sized terminals that weigh approximately one pound. The new terminals also boast omni-directional antennas making them easier to use. Some new mobile satellite systems are already providing service, while many more are under development or being deployed.

Advances in commercial mobile communications technology, the increasing demand for communications access from remote areas, and economic constraints have led many Federal agencies to consider commercial satellite services in lieu of private systems to satisfy some of their communications needs. Agencies must consider several factors when determining if a particular service offering is appropriate for disaster response communications. Among these are the communications requirements that can and cannot be satisfied with the service, the reliability and cost effectiveness of the service, and the congestion users are likely to experience with the service. However, for some requirements, commercial satellite communications show a great deal of promise and benefit for disaster response communications.

INTRODUCTION

Based on Presidential mandate under Executive Order (E.O.) 12472, the National Communications System (NCS) was established. The NCS consists of 23 member organizations, including the Department of Defense (DOD), and is tasked with ensuring the availability of a viable national security and emergency preparedness (NS/EP) telecommunications infrastructure capable of satisfying priority telecommunications requirements through the use of commercial, government, and privately owned telecommunications resources in support of the President and Federal departments, agencies, and other entities. NS/EP telecommunications must be assured in all environments including disaster response and wartime.

Additionally, National Security Decision Directive 97 tasked the NCS to investigate the use of commercial satellite systems to fulfill NS/EP requirements, and direction to implement a nationwide priority system was received in a White House memo on January 11, 1995. Upon this direction, the NCS established the Wireless Priority Services (WPS) Program to provide for NS/EP requirements using commercial wireless systems.

**WIRELESS PRIORITY SERVICES
REQUIREMENTS**

There are 6 baseline NS/EP functional requirements identified in a January 1991 White House memo to the NCS: voice band service, interoperability, survivability and durability,

international interface, nationwide coverage, and intra or interagency emergency operation. These requirements are used to measure the suitability of satellite service offerings for NS/EP missions.

DISASTER RECOVERY NEEDS

The joint NCS/Federal Emergency Management Agency (FEMA)-coordinated disaster area architecture effort seeks to improve communications capabilities to support disaster response and recovery. Coordination during disaster recovery is required among Emergency Support Functions (ESFs) (e.g., Fire Fighting, Health and Medical, Urban Search and Rescue), ESF Headquarters, FEMA field offices, state/local entities, and other Government organizations and private industry. Figure 1 illustrates the ESFs and their interfaces to the Disaster Field Office (DFO).

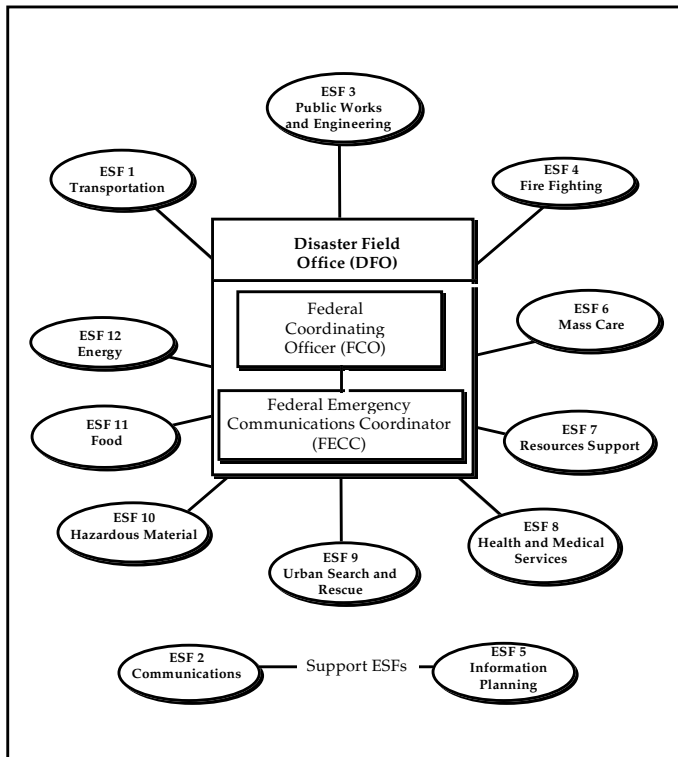


Figure 1. ESF Interfaces

There are significant challenges in providing NS/EP user communications in a disaster area. Public switched network (PSN) traffic increases

exponentially and often saturates or overwhelms the local infrastructure, resulting in severe network congestion and an inability to complete calls. This is particularly challenging in wireless systems because call volume is limited by the number of radio channels available in an area. Further, the infrastructure can also be damaged or rendered partially inoperative. In these cases, a means of circumventing the local infrastructure is useful, and satellite services can provide this capability. These services augment local two-way private radio systems by providing a capability to communicate over very long distances with limited or no dependence on the PSN.

PAST AND PRESENT DISASTER RESPONSE USES OF SATELLITE SERVICES

The NS/EP community has included commercial satellite services as part of its suite of communications capabilities for several years. The Office of the Manager, NCS (OMNCS) has included satellite terminals approximately the size of a laptop computer in a deployable communication package called the emergency response flyaway kit (ERFAK). These terminals, using AMSC and INMARSAT service, provide voice and data communications up to 4.8 kbps. The service is offered via geosynchronous satellites, and use of these terminals requires pointing of a flattop patch array antenna integrated into the terminal.

These technologies have proven themselves useful in circumstances where other wireless means of communication were unavailable, whether due to congestion in systems, damage to system assets, or lack of RF coverage. However, their size, bulk, and pointing requirements limited their use. Newer technologies incorporate improvements that will make satellite services more useful to NS/EP users. Table 1 includes physical specifications on AMSC and INMARSAT GEO satellite terminals used in support of various disaster recovery efforts.

Table 1
GEO Satellite Terminal Characteristics

Terminal	Size	Weight	Data Rates	Talk Time
INMARSAT: Inmarsat mini-M	1.6 x 9.5 x 8.3 in.	6 lbs.	4.8/2.4 kbps (voice/data)	150 min (battery)
AMSC: Mitsubishi ST 251	2 x 11 x 8.3 in.	6 lbs.	2.4/4.8 kbps (voice/data)	60 min. (battery)

**NEW SATELLITE SERVICES IN THE
DISASTER RESPONSE MISSION**

Mobile satellite service (MSS) offerings from Iridium, Globalstar, ICO, and others promise enhanced mobility and longer talk times than previous satellite service offerings. Because these services rely on satellites in low earth orbit (LEO) or medium earth orbit (MEO), they are able to use lower powered terminals and incorporate omni-directional antennas.

The omni-directional antennas used in the LEO and MEO terminals enable users to communicate on the move provided that there is an unobstructed view of the satellite. Changes in position do not require a re-pointing of antennas, making the process of communicating on the move easier and nearly as familiar as talking on a cellular phone.

Lower power requirements translate into longer talk time for users and smaller battery packs. Combining the integrated omni-directional antennas and smaller batteries enables production of terminal handsets only slightly larger than standard cellular phones. The small size contributes to making use of the phone while on the move easier — users can communicate and inspect a disaster area simultaneously without stopping to set up communications as they would need to with larger terminals. At the time of submission of this paper, only Iridium service is available. Official reports from Globalstar and ICO indicate that service will be available in November 1999 and July 2000 respectively.

**RISKS ASSOCIATED WITH USE OF
COMMERCIAL MOBILE SATELLITE
SERVICES**

Commercial MSS offerings contain risks for NS/EP users similar to the use of terrestrial-based commercial mobile radio services (CMRS). As presently configured, the systems provide the same priority to all customers calls. Should congestion occur in these systems following a disaster with far reaching geographic effects, it is uncertain that NS/EP users would be able to use the service to communicate. Similar experiences with cellular service indicate that there is a surge in service demand several times engineered load. While the capacity of a spot beam from a satellite is many times that of a typical terrestrial cell, the area covered is also many times larger. Thus, the degree of risk posed by congestion is dependent on the geographic impact of a given disaster event.

Commercial satellite systems also depend on the signaling and authentication systems based on the ground to establish and bill for calls. Damage to these assets could result in the service becoming unavailable for large groups of users. There are also risks associated with call security in commercial systems. This issue is being investigated in most commercial satellite systems.

**COSTS FOR USE OF COMPETING
COMMERCIAL SERVICES**

Service costs include 3 main categories: terminal equipment cost, monthly subscription fees, and airtime charges. Cost information is provided for 5 services, 3 of which were in operation as of submission of this paper. Terminal costs for operational systems are roughly the same, but terminal costs for developing systems are projected lower. Airtime costs for all services are comparable. Table 2 contains summary information on the costs associated with service from AMSC, INMARSAT, Iridium, Globalstar, and ICO.

**Table 2
Service Costs**

Service Provider	Terminal Cost	Monthly Fee	Airtime Cost
AMSC	\$3500	Waived for Government	\$2.50/min
INMARSAT	\$4000 –\$5000	Waived for Government	\$3.00 – \$4.50/min
Iridium	\$3000	\$75 – \$80	\$2.00 – \$4.00/min
Globalstar ¹	\$1000	Not determined	\$1.50 – \$3.00/min
ICO ¹	\$1000	Not determined	\$1.00 – \$2.00/min

¹ Globalstar and ICO were not in service at the time of this report, and all costs are based on company estimates

REFERENCES

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<http://www.skycell.com/>

<http://www.globalstar.com/tech/tech.htm>

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OMNCS CPAS Technical Alternatives Report, September 30, 1997

**POTENTIAL TECHNICAL
IMPROVEMENTS FOR THE DISASTER
RESPONSE COMMUNITY**

A number of technical improvements to MSS would greatly aid NS/EP users, including data rate increases, longer battery life, priority access and egress, and security features. Improved battery life, security, and priority features are viable candidates for enhancing systems currently being deployed. These improvements will enhance the appeal of MSS offerings to the NS/EP user community. Because of the limitations of the satellites in current systems, higher data rates will likely be reserved as a candidate for improvement in the next generation of MSS to be available in 7 – 10 years.

SUMMARY

A substantial number of the communications needs of an NS/EP user can be satisfied with MSS offerings. These services can potentially provide communications from anywhere on earth. Improvements to system operation, including the addition of priority access features, is desirable and achievable in the current generation of systems. The OMNCS continues to work with representatives from the satellite industry to make these services a reality for the NS/EP user.