Space Data®

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SPACE DATA

NEAR SPACE COMMUNICATIONS SYSTEM FOR EMERGENCY RESPONSE

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Introduction

Space Data Corporation (SDC) offers a unique solution to the problems first responders and other emergency personnel face in the aftermath of a natural disaster or terrorist strike. This inexpensive, commercial off-the-shelf near space communications system provides coverage across wide areas and in difficult terrain, capabilities that previously could only be delivered by satellite communications. Of particular note, SDC's technology could provide communications coverage for first responders within 30 minutes of a catastrophe with no reliance on terrestrial infrastructure.

In 2005, SDC began demonstrating its voice technology, dubbed the StarFighter™ Repeater System and based on its SkySite® technology, with the U.S. Air Force. The system allows end-users to continue using their existing military portable radios while increasing the range at which they can communicate by more than an order of magnitude. Following many successful USAF demonstrations, Space Data was awarded a $49M contract to deploy this capability to the warfighter. This paper describe options several options for extending StarFighter™ technology to other frequency ranges in support of first responders and public safety personnel.

Technology Overview

Space Data Corporation has developed and deployed a balloon-borne wireless network that enables the delivery of wireless services in geographic areas that are not served or are poorly served by existing wireless technologies and service providers. Space Data's SkySite® network uses a balloon-borne lift method that has proven reliable for more than half a century. Every day for more than 60 years, at nearly one thousand sites worldwide, governments have launched weather balloons to gather atmospheric data for weather forecasts. These balloon launches are performed reliably on a coordinated basis in all weather conditions. Space Data has developed the expertise to adapt this field-proven concept for commercial and government applications.

As part of its ongoing engineering and manufacturing efforts Space Data has produced a SkySite® Platform which weighs less than six pounds, and incorporates the functions of balloon control, telemetry relay and wireless messaging. This development effort reflects SDC's expertise in RF engineering and miniaturization, environmental protection against the effects of temperature and pressure at various altitudes, and experience in power management. In addition, SDC has developed the capability to design and manufacture its own synthetic latex balloons, allowing the company to respond to different environmental and operational requirements in short order. The Federal Aviation Administration has approved the use of SkySite® Platforms and has determined that their small size presents no danger to aircraft and their launching requires no preflight coordination. Space Data currently operates a wireless data network in the Permian Basin area of Texas and Oklahoma. This 24/7 network, in commercial operation since April 2004, provides highly reliable data service to the oil and gas industry in areas that traditional wireless networks cannot serve. In over 13,000 flights and over 175,000 flight hours of experience, Space Data has developed its operational expertise in launching and managing a persistent network of balloon-borne transceivers.

Figure 1. Launch of a typical payload

The Space Data commercial data network comprises 11 launch sites, three remote ground station (RGS) installations and a Network Operations Center (NOC). The launch sites and ground stations are located in and around the commercial network coverage area, while the NOC is housed at Space Data's corporate facility in Chandler, AZ. Commercial network operations continue 24 hours a day, 7 days a week, with network reliability at 99% or greater.

On a daily basis, between 10 and 15 flights are launched to cover the commercial coverage area. These payloads are launched by local contract employees, then controlled during their 12 to 18 hour mission through the Chandler, Arizona NOC. At end of mission the payloads are released from the balloon so they can safely parachute to the ground. Once on the ground, they report their location back to the NOC through the wireless network and are then are recovered to be refurbished and flown again.

StarFighter™ Repeater System

Space Data Corporation was contracted by the Air Force Space Battlelab (AFSB) to demonstrate the ability of a balloon-borne repeater to extend radio communications beyond line of sight (BLOS). Initial proof-of-concept flights with commercial radio repeaters were accomplished in March 2005, proving that radio repeaters in near space could extend the range of standard hand-held radios from a typical 10 miles to over 400 miles.

Following the initial work with the AFSB, Space Data was invited to participate in the 2006 Joint Expeditionary Force Experiment (JEFX-2006). This exercise, sponsored by the Chief of Staff of the Air Force, showcases new technology that can be rapidly deployed to help the warfighter. As part of its effort under the JEFX contract, Space Data modified its existing SkySite Platform technology to produce the StarFighter™ Repeater System. Each StarFighter payload is a single unit that integrates in-house designed radio repeaters, command and control and power supply into a six-pound package. The StarFighter is a low-cost system that allows for rapid deployment in support of a wide range of operations. Figure 1 shows the launch of a typical payload.

The system is designed to be launched from a single vehicle by a two-man team, and controlled via a ground station contained in that vehicle. The lifting gas used in the system is hydrogen or helium, readily available from a variety of sources.

The StarFighter™ Repeater System was tested extensively in the military UHF bands for both voice and data transmissions. Voice testing incorporated analog and digital transmission methods, and the digital voice tests used both encrypted and unencrypted links. These tests supported ground-based users with military portable radios such as the PRC-148 and PRC-117. During a September 2007 Air Force Research Laboratory demonstration, a StarFighter™ payload floating around 79,000 feet above eastern New Mexico enabled communications between participants across the state; results are shown in Figure 2. Both voice and data communications were conducted via the StarFighter™ balloon-borne platform during the demonstration, using Thales PRC-148/MBITRs for voice, and ViaSat VDC-600 Data Controllers interfaced to the Thales MBITR for data exchange.

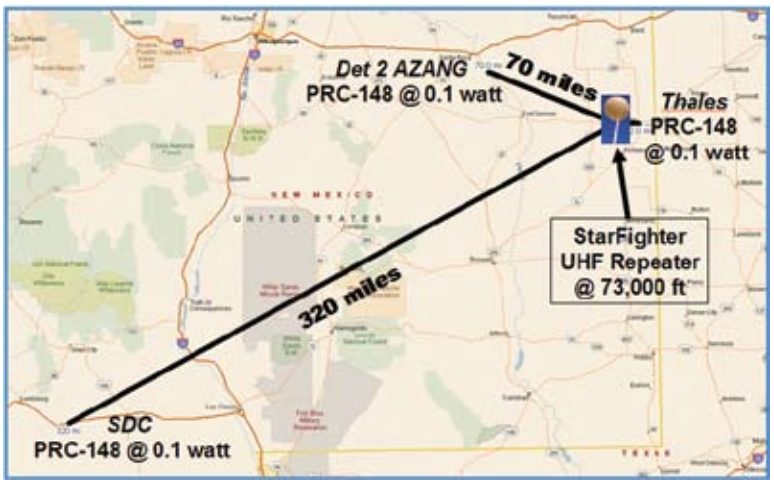


Figure 2. Communications through a StarFighter payload on 19 September 2007.

In August 2006, SDC was awarded a $49M Air Force contract to deploy its relatively inexpensive, highly effective and reliable solution to fill the void. Based on its commercial SkySite® technology, SDC's solution permits the use of DoD's existing inventory of tactical radios while extending their coverage across an entire theater for both ground-to-ground and ground-to-air communications—it is a virtual dedicated tactical communications satellite system.

The StarFighter™ Repeater System currently operates as an FM repeater in the range 225 MHz to 375 MHz. It can be adapted to operate in other frequency bands or modulation schemes, as required by the end-user. Regardless of configuration, the StarFighter™ Platform turns a standard portable radio into a wide-area communications device, producing effects that mirror satellite communications at a fraction of the program complexity and cost.

Deployment to Support Emergency Response

Emergency response communications are characterized by two major problems. First, terrestrial communications networks/infrastructure typically sustain damage from natural disasters or other catastrophic events, which render them ineffective or inoperable for days after the incident. Second, personnel responding to incidents are drawn from multiple agencies, and often have communications equipment that is incompatible with other groups. Space Data's SkySite® Voice Repeater System can restore wide area communications, and provide interoperability between radio equipment using different frequencies and/or modulation schemes.

Voice Repeater — Wide Area Communications

The SkySite® Voice Repeater System is ideally suited to provide wide-area communications support immediately after a natural disaster or terrorist attack. The system offers rapid deployment, and minimal personnel and logistics requirements.

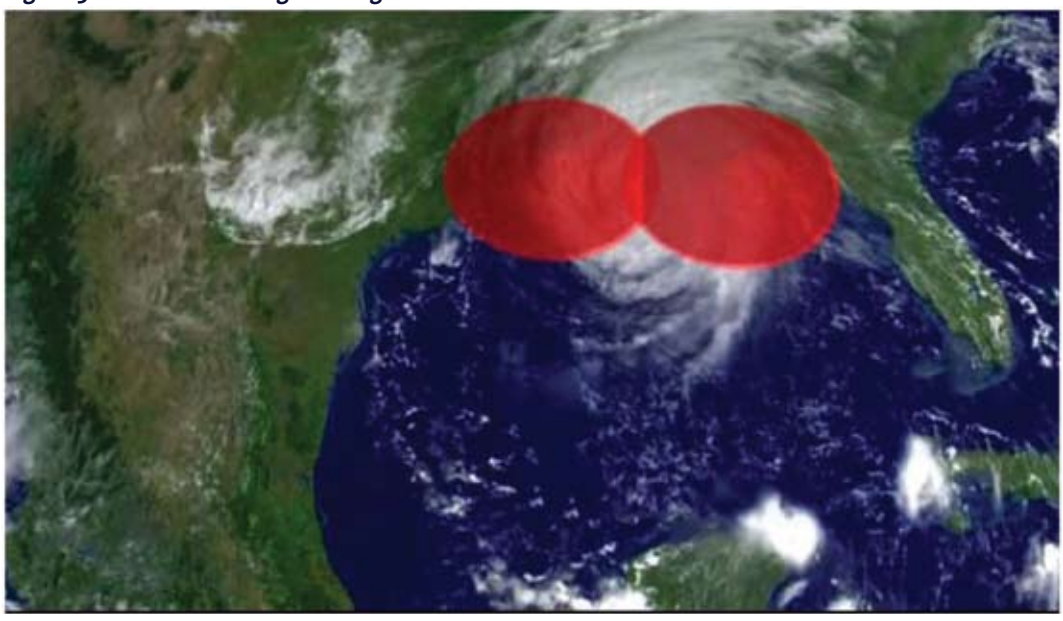
The SkySite® System, comprising payloads, command and control equipment and associated hardware can be deployed by air or ground transportation on short notice. A standard pallet could contain enough equipment for a week of 24/7 coverage. Equipment for one day of 24 hour coverage is easily transported in carry-on luggage. With its wide coverage area and operating altitude above terrestrial weather, the SkySite® Repeater can be launched outside the affected area, even before a predicted incident, providing communications support before, during and after any disaster. Figure 3 shows an example of coverage that could have been provided during Hurricane Katrina.

As successfully demonstrated with the Air Force, a two-person team can launch and control a payload. In the case of first responders using the system following an attack or natural tragedy, payloads, associated hardware and helium and /or hydrogen tanks could be stored at selected locations (e.g. fire or police stations) for immediate access in an emergency.

Using Hurricane Katrina as an example, payloads could have been launched from the Florida Panhandle to provide 24/7 coverage. Once the system is deployed first responders would be able to access these wide-area channels using the mobile radios that they currently carry. The channels provided by the system could be used for extended coverage on emergency calls, communications from the field to headquarters, or any other function currently provided by the existing radio infrastructure.

In June 2007, the StarFighter™ Repeater system was used by Air National Guard teams from California, Arizona and Hawaii in support of a simulated earthquake emergency centered at Hilo, Hawaii. With launches from the island of Hawaii, communications coverage was demonstrated across the entire state.

Figure 3. Potential Coverage During Hurricane



Frequency Management & Interference Mitigation

Our payloads provide a large coverage footprint when operating at high altitude, which is generally a benefit when coordinating first responder efforts across a wide area. However, we recognize that large footprints can be a detriment, particularly in scenarios when frequency reuse over broad geographic areas is a necessity. Space Data has a number of solutions for addressing this issue.

The most reliable approach to interference mitigation, while maintaining the generally advantageous large footprint provided with the StarFighter payload or other near space platform, is to use dedicated frequencies for such emergency applications. One particular set of frequencies was identified by the FCC, in cooperation with NTIA, in FCC Public Notice DA 01-1621, dated 13 July 2001. Further detail on the use of these frequencies is contained in the NTIA Manual of Regulations and Procedures for Federal Frequency Management in its January 2006 revision. At this writing, it appears formal implementation of this concept was never completed, but the concept bears reexamination by the Government in light of remaining reuse issues.

The frequencies set aside in DA 01-1621 were intended for intermittent interoperability between Federal and non-Federal public safety entities, a common requirement in responding to emergencies and disasters that extend beyond a localized area. More importantly, these are frequencies over which the Federal Government maintains direct control and can, therefore, facilitate their use in emergency response situations. In particular, the interoperability frequencies support ten repeater pairs each in both the 162-174 MHz (VHF) and 410-420 MHz (UHF) ranges. A survey of modern synthesized VHF or UHF public safety radios indicates their ability to handle both standard state and local public safety frequencies and these Federal frequency allocations in a single unit without modification. As a key part of implementing the interoperability concept outlined in DA 01-1621, these ten repeater frequency pairs, as well as the ten simplex frequencies for each band, would be programmed into every public safety radio. In that way, there is no need to reprogram radios once a crisis situation arises.

To further support broad emergency response and interoperability requirements, it is suggested that this issue be further addressed by regional, local, and organizational frequency coordinating bodies to set aside additional nationwide or regional broad-area frequencies under their control. Again, pre-planning for crises in the form of programming radios in advance for these special purpose frequencies is paramount.

An alternative to these Federally-controlled frequencies would be the use of nationwide allocations such as those owned by Space Data in the Narrowband Personal Communications System (NPCS) 900 MHz bands. Commercially available Specialized Mobile Radio (SMR) portable and mobile units have been used in demonstrating this capability. This approach may be best considered as a temporary capability instead of a long-term answer since public safety personnel are not keen on carrying another radio, preferring to have additional capabilities on their existing radios. However, it is certainly a viable, immediately available capability that can provide instant communications during or post disaster. This approach seems entirely appropriate pending any revisions to the interoperability concept proposed in DA 01-1621.

Another approach to interference mitigation is to provide a more concentrated / confined radio footprint from the near space platform. This can be accomplished with more directional antennas and such antennas reduce power requirements for the payload and user radios. The downside of this approach, of course, is that the broad footprint available with a more omnidirectional antenna is sacrificed. The ability to communicate with and coordinate first responders, for example, offering assistance from well outside the affected area is a significant advantage. By limiting the footprint size, this capability is lost or less effective.

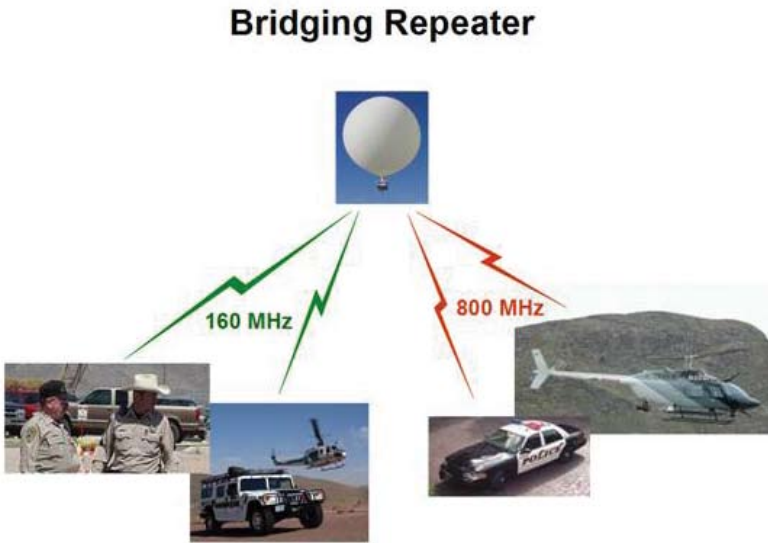
The bottom line is, Space Data SkySite® technologies can be adapted to the particular need or interest of first responders.

Bridging Repeater

A conventional repeater re-broadcasts transmissions on a single network, allowing police officers to talk with other police officers, border patrol agents to talk to other border patrol agents, and so on. One of the major problems with disaster response is that different emergency response groups need to interact and coordinate their recovery and relief efforts; however, their respective radio equipment isn't compatible. A paramedic and a National Guardsman could be 100 yards away from each other, yet unable to communicate. Another type of StarFighter Repeater offers a fix to the problem—the 'Bridging Repeater'.

The Bridging Repeater carries two or more radio transceivers to "bridge" radio communications networks, thus offering interoperability. With this payload in the air, different groups on the ground could tune to one of their existing radio channels and have their communications re-broadcast on the other network. This enables police to talk to firefighters, FBI to talk to local law enforcement, or the National Guard to talk to the Border Patrol.

This "Bridging Repeater" concept was demonstrated in 2005 in conjunction with the AFSB. In those demonstrations, the payload could link an FM network at one frequency to an AM network at another frequency.



Cellular Voice

Space Data is developing a cellular voice payload to provide iDEN service, supporting in particular the Sprint-Nextel wireless network, to an area approximately 150 miles in diameter. Launched and controlled in the same manner as the StarFighter payload, the iDEN payload will provide subscribers the same text messaging and voice services that they currently enjoy on terrestrial networks, without requiring new cellular handsets.

In a crisis, these wireless capabilities can provide not only first responders but also affected citizens a means to summon help and get word out to others. The short message services supported by the voice protocols are ideal for post-disaster communications when capacity efficiency is critical. Imagine citizens injured during Hurricane Katrina or trapped inside a residence following the storm being able to send text messages of their status and location - information needed to save lives.

SDC's upcoming iDEN trials in Texas represent the commercial capability planned for broad deployment in 2008. Additionally, SDC has development efforts underway for other standard voice protocols such as the widely used CDMA.

Wireless Data

SDC also has the capability to deploy for emergency services a wireless data system similar to the one that it operates commercially in Texas and Oklahoma. This system could provide first responders and other emergency personnel with GPS-based tracking services, text messaging and secure remote database access across the entire area of operations. SDC can provide the wireless network, end-user devices to support the applications mentioned above, and any software engineering services required to allow wireless access to networked databases.

Summary

Hurricane Katrina is a lasting example of how the lack of critical communications networks, rendered inoperative by the storm hampered rescue and recovery efforts. Space Data's voice and data capabilities could make an immeasurable difference in such natural disasters and other emergencies such as terrorist-induced situations. Space Data technology is equally suited to events like those of 9/11 where the impact is immediately felt. The responsive nature of balloon-borne platforms means broad area communications coverage can be restored in a matter of minutes, not hours or days.

Balloon-borne voice and data capabilities can be crucial when most or all existing infrastructure has been damaged or destroyed. With a cache of SkySite Platforms or StarFighter repeaters in the hands of emergency services and first responders, an immediate task following a terrorist incident can be to launch communications payloads that will support the many services required to address extreme emergency incidents in a coordinated fashion. Whether responding to a terrorist attack or a Category 5 hurricane, Space Data's responsive balloon-borne communications system is ideally suited to assist affected zones, while providing an unmatched ability to centrally coordinate the agencies involved.

Long-range, reliable communications are critical to relief efforts that follow catastrophic events. By extending the range of existing radios, the SkySite® Voice Repeater System from Space Data Corporation increases the safety and efficiency of personnel in the field in a reliable, cost-effective manner. The SkySite® Repeater System is built upon the commercial-off-the-shelf technology developed by Space Data for their commercial network and military applications, and proven through thousands of flights across the south-central United States and customer demonstrations. Current capabilities include a voice repeater, capable of single network and bridging functions, and a wireless data payload that can support messaging, data and tracking services. The company also has an iDEN-based cellular voice payload in development that will provide voice and text messaging services in the near future.