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SATCOM 101

An Introduction to Satellite Communications Networks

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In recent years, the need for reliable emergency communications has taken center stage in the wake of some of the nation's most tragic events, including Hurricane Katrina and the terrorist attacks of September 11, 2001. These two events in particular demonstrated that relying on land-based communications networks, be they wired or wireless, can leave emergency services agencies without the capability to relay important safety and rescue information between emergency responders. Access to a robust satellite communications network can alleviate land-based communications failures and ensure reliability in emergency situations, as well as through other more routine applications.

High-profile events like hurricanes or terrorist attacks are not the only emergency situations that can disrupt standard communications networks. A major, prolonged electricity blackout, for instance, can be equally disruptive, putting people and property at risk, especially if the outage occurs in rural or isolated areas. When emergency responders are called to remote locations, for example to battle wildfires in forest locations outside of populated areas, satellites can play a vital role in relaying containment strategies and ensuring that those fighting the blazes can reach out for assistance if necessary.

For some, satellites are not just about emergency communications, but also provide the ability to stay in touch and to meet business objectives. Satellites play a vital role in keeping remote operations like offshore drilling connected to office headquarters, and aid in simply keeping track of a company's inventory at any given point in a supply chain.

This booklet provides a top-level look—in plain language—at the basic types of satellite networks, and provides some real-world examples of how satellite communications are used to meet specific communications needs.

Key Types of Satellites

Satellite communications networks can leverage a variety of in-orbit assets. Depending on the communications needs, certain networks offer advantages when compared to other available options. The following provides an overview of the different types of communications satellites commonly used.

LOW-EARTH ORBIT SATELLITES

Unlike geostationary (GEO) satellites, low-earth orbit (LEO) satellites do not remain in a relatively fixed location. LEO satellites move around the Earth in an orbit less than 2,000 kilometers above the surface. It typically takes between 90 minutes and two hours for an LEO to complete its orbit. LEO satellites have many functions, including communications—typically performed in constellations such as Iridium and Orbcomm—or navigation, such as GPS. However, another very common application of LEO satellites is Earth observation. These satellites are not deployed as constellations, but rather in unique configurations depending on the type of observations to be performed. This provides a person who is located almost anywhere in the world with access to voice and data communications, although there are LEO constellations that focus their communications activities to specific regions. Unlike geostationary satellites, voice communications via an LEO satellite constellation are less prone to the effects of transmission delays. LEOs are also an efficient means of transmitting small amounts of data, such as location and alphanumeric messages.

90–120 minutes
for complete orbit

GEOSTATIONARY SATELLITES

GEO satellites, as they are commonly referred to, sit roughly at the same place along the Earth's equator but at an orbital height of about 35,786 miles. A GEO satellite can cover about one-third of the Earth's surface but because of its location, cannot see either the North Pole or the South Pole. Signals for this satellite are received from the ground on an uplink frequency unique to the satellite terminal. These signals are rebroadcast as a downlink frequency and are transmitted across the satellite's footprint. Transponders are the onboard electronics that accomplish this task. A GEO satellite can carry more than 30 transponders, each one dedicated to sending and receiving unique signals without interfering with other transponders on the satellite. Depending on the age of the satellite, they can be combined with other transponders to increase a customer's communications bandwidth.

GEO satellites are ideal for certain high-volume communications. Television is the most common application. GEO satellites are also commonly used in business for activities such as completing credit card transactions and tracking inventory through a corporate supply chain. GEO satellites can also be used for telephone communications and are ideal when a telephone hub is set up at a single, stationary uplink point on the ground, although voice communications do suffer from hundreds of milliseconds of delay when calls are conducted.

Basic Types of Satellite-Based Services

SATELLITE PHONES

In the hands of general users, satellite phones offer a user experience similar to what a wireless phone provides. The key application for satellite phones is voice service, particularly where standard land line and wireless infrastructures do not exist. These phones also provide emergency services in areas hit by catastrophic events where the local infrastructure may be damaged or destroyed. Satellite phones are generally operated via LEOs and can offer short message service (SMS) capabilities, which provide limited data capabilities that can be useful for inventory tracking services. However, satellite phones have some limitations. They are typically sold using a subscription model, which makes them vulnerable to unexpected latency and even loss of service in times of extremely high network demand. Also, limitations on bandwidth prevent the use of satellite phones for robust video and data applications such as emergency command and control or continuity of operations.

INTERNET VIA SATELLITE

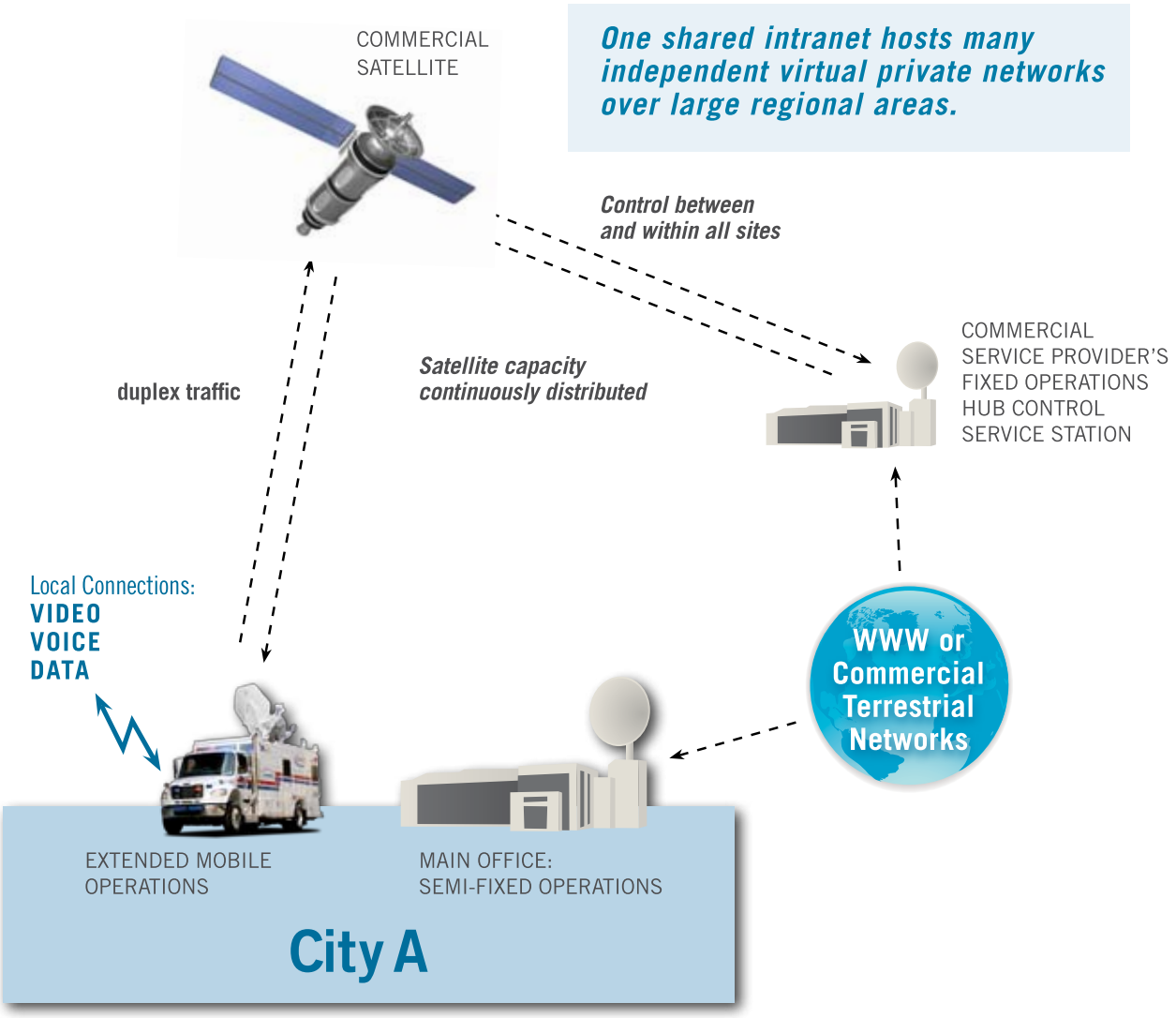
Small terminals provide basic Internet connectivity, allowing for remote access to information. However, throughput on such terminals can be limited and generally does not support advanced applications such as Voice over Internet Protocol (VoIP) or enterprise applications.

Iridium Phone

INMARSAT Suitcase

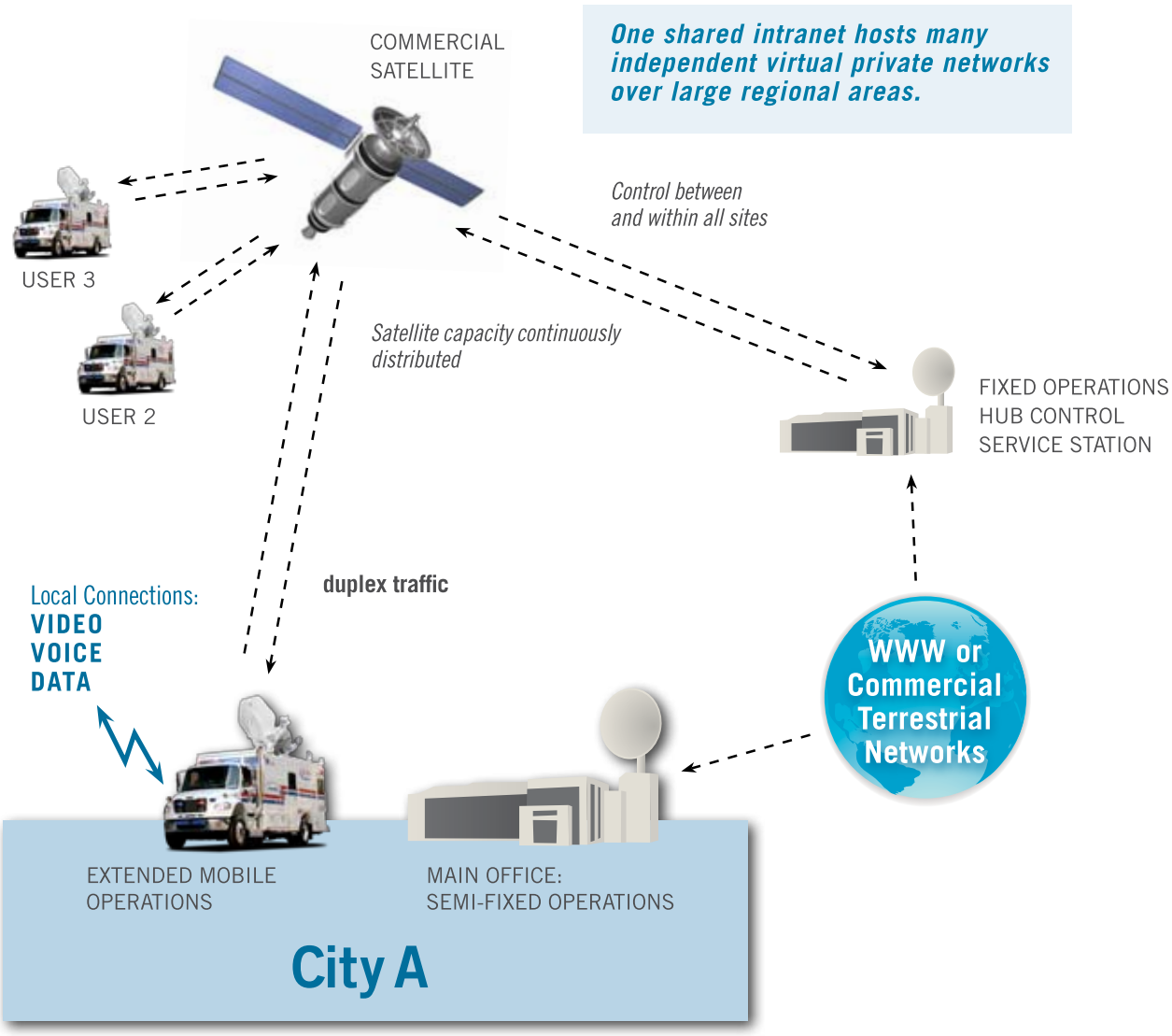
LEASED SINGLE CHANNEL PER CARRIER (SCPC)

SCPC services are offered by external service providers and supply a point-to-point link between a remote site and a central hub. Users get the benefit of dedicated bandwidth, which allows the remote location to access enterprise applications. However, connections like this typically are not scalable and require connectivity between the service provider and the enterprise network. These services can also be provided between two user-defined locations, but the same limitations listed earlier apply. These connections are also very expensive because the links are typically subscribed to by the user for months or years at a time.



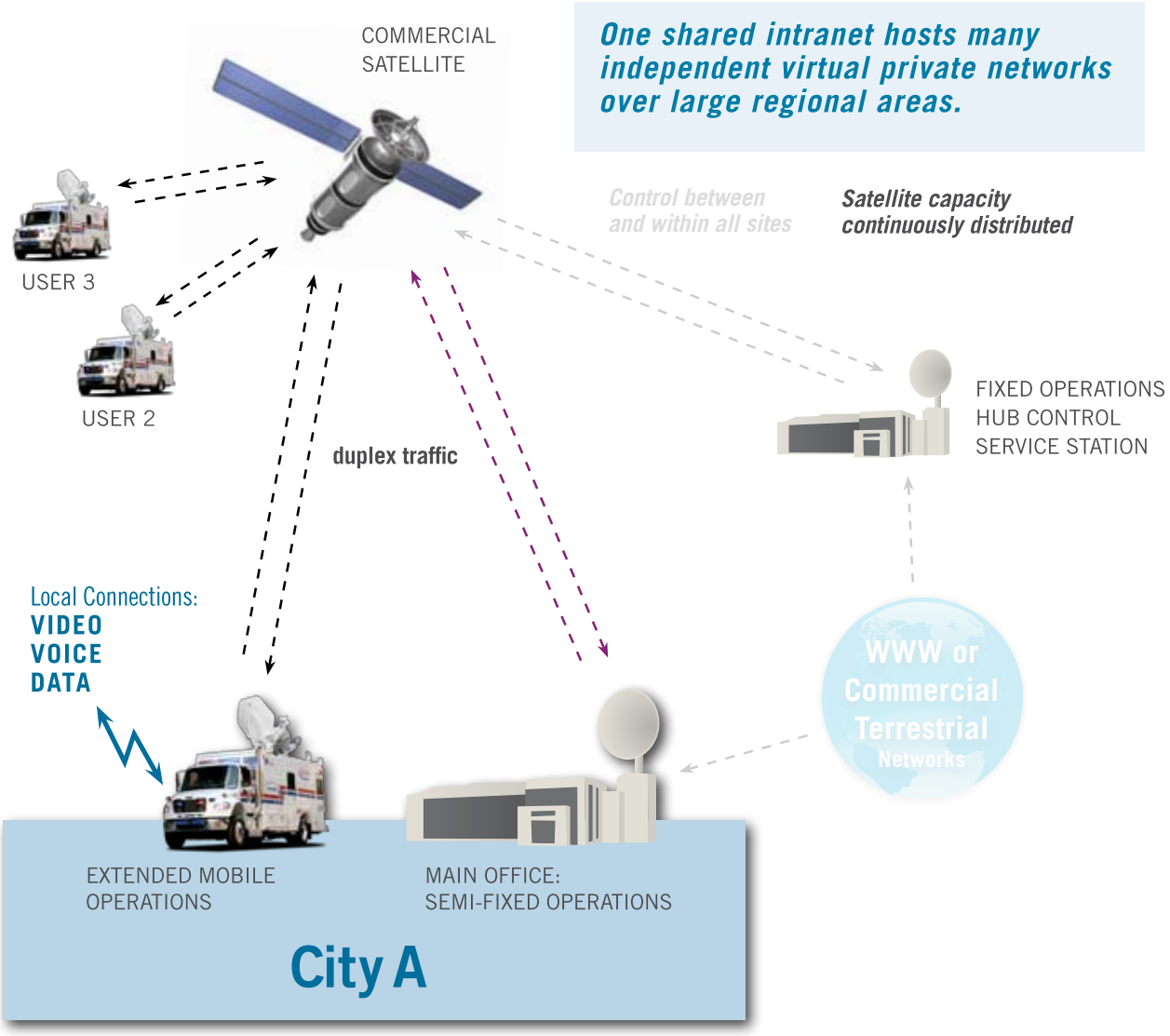
LEASED TIME DIVISION MULTIPLE ACCESS (TDMA)

TDMA services are also offered by external service providers and supply a broader range of connectivity options, as users are not limited to a single location and the services are scalable to meet bandwidth requirements depending on the field location. TDMA services still require connectivity between the provider and the enterprise network, and there is also a risk that the network could get bogged down as multiple users contend for bandwidth use.



DEDICATED SELF-MANAGED NETWORKS

Companies that want to make their own capital investments can purchase satellite hubs and deploy their own SCPC or TDMA networks. This gives the purchasing company complete control over the bandwidth and does not require connecting the network to outside parties. Increasingly, jurisdictions and organizations concerned with access to dedicated network capacity for voice, video, and data applications are turning to self-managed networks. Today there are a host of engineering, operations, and maintenance service providers to help deploy and make the best use of dedicated satellite solutions.



Enhance Your Capacity for Communications

Several options exist for satellite communications to meet specific needs and ensure reliable communications. Television, credit card transactions, inventory tracking, phone service, and emergency response services all benefit from satellite communication. From disaster recovery to GPS tracking for snow removal, military operations to point-of-sale or commerce-related transactions, and tolled highways to news gathering and maritime cargo tracking, satellite technology makes it possible to reliably manage the flow of essential information. Whether meeting business objectives or relaying safety information to emergency responders, satellite technology enhances an organization's communications capacity.

DISASTER RECOVERY

The preceding application is only one example of the larger application of disaster recovery. Similar concepts can be adapted to provide communication services in areas affected by natural disasters like tornadoes or floods. In such situations, remote, mobile satellite links can be deployed to provide the communications backbone for responders. These links can also serve as a way to upload video, allowing government agencies to survey the situation and inform the public of any impending risks.

Disaster recovery efforts can benefit from other forms of satellite technology. For example, a municipality can use GPS tracking to manage the location of its snow removal fleet. Routing vehicles can be handled more efficiently when a central station knows where its vehicles are and, more importantly, where they have been. This can make for more efficient deployment and usage of vehicles to make sure the key roads are clear in case it becomes necessary to deploy other emergency equipment.

EMERGENCY MANAGEMENT

When facing crisis situations, a key factor in determining the success of emergency response is time. For a large-scale crisis, getting a communications network up in a short amount of time could help set the tone for all of the activities to follow.

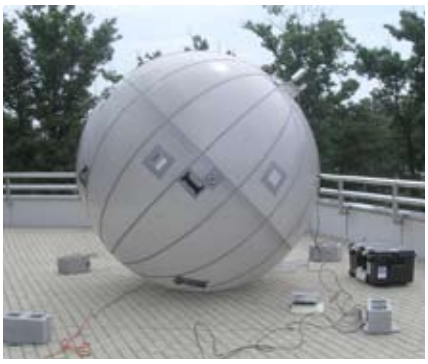
To be successful in such situations, the City of Chicago has implemented the Unified Command Vehicle (UCV) project to develop and deliver a system capable of extending core command, control, and communications via satellite to any location. Designed for Chicago's Office of Emergency Management and Communications (OEMC), the system features four components: a large, self-propelled vehicle that contains all of the necessary technology to support emergency management communications; connectivity to a large Ku-band satellite hub; a high-capacity Ku-band satellite link that connects the vehicle with the satellite hub; and a high-performance IP standards-based network that connects people and applications residing in the vehicle to people and applications in the OEMC and other locations.

The vehicle is a self-contained unit capable of autonomous operations for as long as several days using onboard power generation. It carries with it a 1.5 meter Ku-band satellite and can operate at duplex satellite data rates of up to 45 mpbs. The solution features a backup satellite link to ensure that communication lines remain open, and also uses wireless connectivity to augment its capabilities, including high-speed cellular data networks via Verizon and Sprint.

Commercial Infrastructure—The Economic Model				
TYPE	Cell	Satellite Phones	Internet via Satellite	Dedicated Satellite Networks
PROVIDER	All	Iridium, INMARSAT	HughesNet, Skyframes	IntelSat, SES Americom
SERVICE	Voice	Voice	Basic Internet Services	Full Network Services
ECONOMICS	800–2200% oversubscribed	Up to 1700% oversubscribed	400–600% oversubscribed	Fully dedicated
BEST USE FOR		Small/Localized Events		Catastrophic/Widespread Events

INSTANT SATELLITE COMMUNICATIONS NETWORKS FOR FRONT-LINE OPERATIONS

For military operations, GATR Technologies developed an inflatable satellite solution that can be dropped to any ground location and set up within an hour to provide quick access to satellite networks, especially when soldiers, news gatherers, emergency responders, and others arrive on the ground and at the scene. The components are compact enough to be transported by the usual military and mobile transport methods. They are also sturdy enough to be dropped from high altitudes using only a parachute to help slow the descent and ensure safe and secure ground arrival.



For those who do not need satellite equipment airlifted to a remote location but do require connectivity in an emergency situation, the GATR equipment carrying cases are small enough to be carried as checked baggage on commercial aircraft. The equipment footprint is well-suited for storage in pre-deployment emergency caches that can be deployed as needed.

Once the components are on the ground, including the inflatable VSAT antenna, battery pack, satellite modem, and necessary communications devices such as laptops or phones, ground forces can connect back to a central command center via a Ku-band GEO satellite. The connections are completely self-sufficient and can be used in ever-expanding network-centric activities. Plus, the kits are plug-and-play for scalability, which makes it easy to add users onto the network.

VIDEO BROADCAST

Historically, one of the primary reasons for the proliferation of satellite technology is the distribution of video. Satellites are the most efficient way to distribute information from a single point to multiple points. And in the case of video distribution, receivers can range well into the millions without impacting the quality of the signal received, barring a specific attempt to interfere with the signal.

From a consumer perspective, the most common application within video broadcasting is direct broadcast satellite (DBS) services. Offered by DIRECTV and the Dish Network, DBS services are viable competitors for cable and fiber optic infrastructure, with millions of subscribers in the U.S. For people in certain parts of the world, namely in rural areas where terrestrial land line infrastructure may not be developed, DBS may be the only option. Many DBS companies also work with partners to offer Internet services, bringing two-way data services along with one-way video reception services.

While DBS may be the most visible application on the consumer end, satellites also play a key role in the news-gathering realm. Satellite technology allows journalists around the world to bring images to the masses from on-the-spot events. Much like the way a disaster recovery team uses satellites to send video to a central office to aid in the coordination of response teams, journalists can provide video footage of the latest unfolding event to major networks for distribution to worldwide consumers.

For some events, satellite technology is brought in under a planned deployment. Events like the Super Bowl use satellite technology to ensure that viewers around the world are able to experience all aspects of the game, and that sports journalists can file on-the-scene reports prior to and during the event. Satellite service providers also deploy services at events for smaller groups who may not have the in-house technology to access big events, allowing them to have people physically on-site to report from an event.

MARITIME

For passengers of military and luxury maritime vehicles, satellites play a vital communications role. Satellites enable Internet connections that allow travelers to keep in touch with loved ones back home. Cruise ship providers can use satellites to offer a variety of services, such as downloading content from major newspapers around the world for distribution amongst the passengers. Satellites also play a vital role in providing voice services, as terrestrial wireless services most likely cannot reach out into the open waters.

Data can be used in the shipping industry as well, providing similar types of applications and combining with services such as those noted in the inventory tracking section to help cargo fleets effectively and efficiently track the parcels within their care.

Maritime applications do not necessarily have to be mobile. These applications can be adapted and integrated into areas such as offshore oil drilling platforms in order to provide workers with connectivity to the mainland and provide companies with information regarding the status of the drilling operation.

REMOTE WORK SITE LOCATIONS

Applications in this domain can be as simple as enabling an individual to work from an area that lacks the terrestrial infrastructure needed to support connectivity, to remote construction sites where more activity needs to be actively monitored on a day-to-day basis. In these situations, satellites can be used to monitor the location and status of construction vehicles and enable remote crews to remain in contact with a central office for project status updates.

MOBILE CONNECTIVITY

Outside of the luxury maritime community, satellite connections are used on stationary remote links to connect to central hubs. But there is active development to make certain that connections at remote sites are truly mobile. Not surprisingly, the most common stationary application, DBS, is the most advanced when it comes to mobility. Several companies have developed receivers that can be mounted onto vehicles such as RVs to allow users to receive satellite television services regardless of their location, even when they are traveling.

Mobile Internet via satellite is also under development. This has generated some interest, particularly in the airline industry—both for use on large commercial jetliners as well as smaller private flights—to offer as a value-added service to passengers. Thus far, mobile Internet via satellite has picked up slowly, particularly on the commercial side. The struggling state of the airline industry also plays a role in the adoption of the technology. On the video side, however, one airline has built a successful model for bringing satellite TV broadcasts to its passengers.

As emerging technology continually redefines the boundaries of communications, mobile connectivity continues to gain prominence as an integral element of modern communications. The crossover of cellular phones, PDAs, and other portable devices from the business world to everyday life has solidified the importance of reliable mobile connectivity.

INVENTORY TRACKING

While emergency response applications enjoy a higher profile, particularly in the face of natural or man-made disasters, satellite technology can be just as useful in conducting everyday business.

Inventory tracking, specifically when conducted across international borders where consistent wireless technology may be unavailable, is one example of how satellite technology can facilitate business processes. In these situations, a solution built around low-earth orbit satellites can provide an efficient means to track cargo as it moves through a supply chain from the warehouse to its destination.

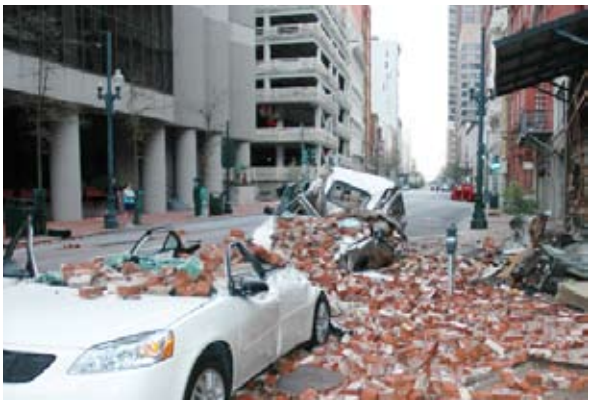
Cargo can be outfitted with transmitters that relay information—such as container breaches, location information, and other relevant data—back to central offices using the integrity of the cargo containers themselves and GPS data.

POINT-OF-SALE AND OTHER COMMERCE-RELATED TRANSACTIONS

Very Small Aperture Terminal (VSAT) services are the foremost application for point-of-sale transactions. This involves the use of satellite communications, predominantly at gas stations and banking institutions, for account verification and transaction processing. Satellites are much easier to deploy and depending on the location, they can be much faster and more efficient than running land lines or relying on wireless infrastructure to establish a secure connection. Satellites can even allow for remote ATM services at major gatherings, such as concerts held in isolated areas, and can enable credit card transactions for vendors where the infrastructure may not otherwise support it. Other emerging areas include the use of satellites to more accurately charge motorists for using toll roads. Ongoing experiments seeking to understand the benefits of using GPS data instead of toll plazas to determine vehicles' usage of toll roads aim to improve traffic flow and accurately collect revenue from motorists.

CONTINUITY OF OPERATIONS AND BUSINESS RESILIENCY

In the event of disruptive incidents or major disasters, terrestrial communications alone will not sustain the flow of information. However, core operational and customer-facing processes can be maintained by satellite communications, which facilitate continuity of operations and business resiliency. Communication capabilities can be designed for consistency with an organization's operations to back up critical communications infrastructure and provide access to other data and systems required to conduct essential functions. This technology helps ensure remote connection capabilities for employees in geographically dispersed locations and provides survivable voice communications and hot lines for the entire organization.



In heavily populated areas—and especially in austere environments—construction costs for installing terrestrial links sometimes far exceed the cost of satellite communications. A good example of the benefits of satellite communication is new, major construction. In a new area, it usually takes months before the telephone communications services are in place, but satellite service works well in providing quick setup and assured continuity of service.

Satellite communications provide extensive options for business continuity. In a distributed work environment where a data center is split among three geographic areas—depending on the size of an operation with remote capability—an office can be created anywhere. In the event of a disruption, satellite services provide the kind of flexibility that allows an unconventional location to function as the center of an organization's operations. Terrestrial infrastructure cannot offer that kind of support.

The trend toward employing satellite communications is growing more prevalent. Investments are currently focused on alternate data centers, but as satellite communications awareness grows, more organizations are realizing that they have the option to build small satellite hubs or set themselves up for managed satellite services. Such services can be used to reconstitute corporate network services anywhere, and to create kits that can be deployed in trucks or in a series of transit cases. With a data center built into a truck, for example, organizations do not have to plan for 100 percent of potential emergencies. Instead, they can engage in general deployment planning and then adapt to any unique emergency situation.

SCADA AND OTHER ENVIRONMENTAL MONITORING

Many industries use Supervisory Control and Data Acquisition systems (SCADA) to manage information flow. SCADA systems are commonly found in oil and gas pipeline systems but can also be found in water management, manufacturing, electric power distribution, and other systems. The purpose of a SCADA system is to monitor the system in real time. In the case of an oil or gas pipeline that may stretch hundreds or even thousands of miles—and possibly through locations without the appropriate terrestrial communications infrastructure—satellites can play a vital role in allowing an enterprise to manage the oil flow and detect problems before they become major catastrophes. In this example, the SCADA system collects the appropriate performance data and relays it via satellite to the central computer system for the necessary analysis. Real-time SCADA information can also help companies demonstrate compliance with applicable regulations.

Transporting SCADA information is not the only way that companies can engage in environmental monitoring. Imaging satellites can provide companies with detailed information that may not otherwise be available. Imaging satellite data combined with SCADA information can offer an even clearer picture for managers, especially in the event of an emergency. The only drawback is that imaging data, if not properly scheduled, may not be able to provide potentially needed real-time data. However, that does not necessarily diminish the usefulness of combining the data.

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