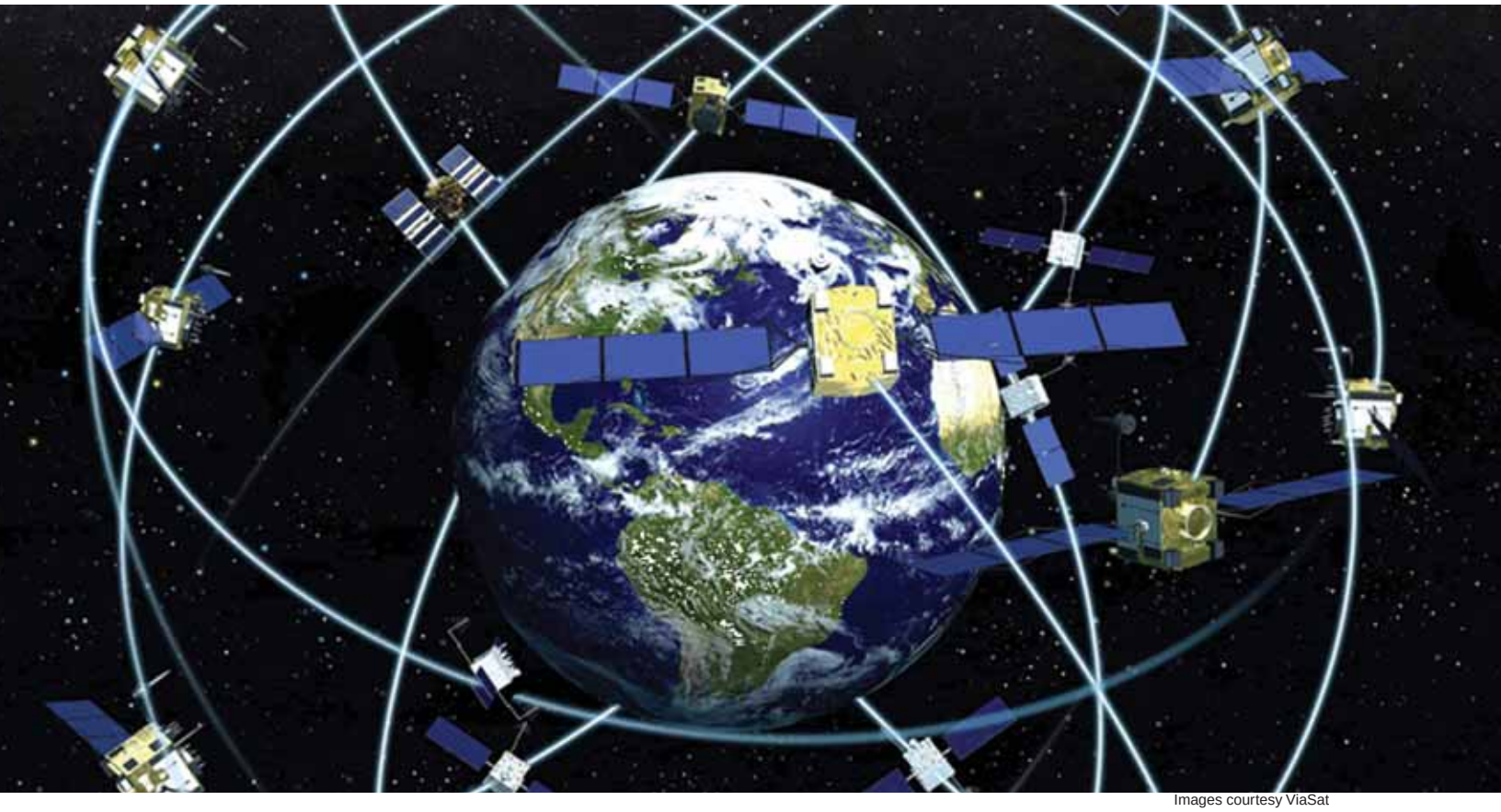

Images courtesy ViaSat

Weaving Satellite into Public-Safety Networks

A new report will investigate technology to seamlessly integrate satellite networks with public-safety communications.

By Bob Schutz

In the United States, more than 55,000 separate public-safety agencies operate fragile communications networks. All but a few rely on terrestrial narrowband voice services based on analog radios. Despite significant effort by designers, manufacturers and operators, there continues to be a large base of incompatible systems with varying capabilities.

In the past, communications professionals provided interagency cooperation by mandates to agencies, requiring the purchase of specific equipment from specific suppliers. This model provided a level of interoperability but at significant cost of system infrastructure deployment. It also limited the ability of agencies to purchase communications equipment that met the unique challenges of their tactical-mission requirements.

In recent years, new policies and technology promise to support new levels of interoperability to strengthen the communications fabric between agencies. Policy promoting open standard waveforms, such as Project 25 (P25) and TETRA, for distribution of services as well as use of spectrum, and standardization of terminal provisioning and network access opened the market for interoperability between suppliers of equipment. Software-defined radio (SDR) technology makes the development of fully adaptive handheld, mobile and fixed-site platforms capable of hosting multiple waveforms over multiple frequency bands possible.

Collaboration that occurs in international trade associations supported by both industry and the user community is an important driver in technological advancements. The Wireless Innovation Forum is an association that continues to be at the center of development of technology and architectures for adaptive communications in both the public-safety and tactical-radio markets. Membership in the forum includes all major public-safety industry players, as well as strong support from the user community and government agencies. Originally responsible for the development of SDR technology, the forum is now developing standards and architectures based on cognitive radio

ViaSat-1 is a geosynchronous satellite that represents advancements in satellite technology designed to deliver 100 Gbps of broadcast and IP-based services in the continental U.S.

technology and information processing architectures (IPA) that promise to eliminate traditional barriers to interoperability and delivery of mission-critical services.

Satellite for Public Safety

Satellite communications plays an increasingly important role in supporting emergency response teams. The global nature of man-made and natural disasters, as well as mobility requirements of rapidly deployed equipment and personnel, further stresses the traditional public-safety, terrestrial communications fabric. Satellite communications is an efficient and reliable means to provide connectivity for first responders across wide geographic regions. Satellite infrastructure is also independent of terrestrial infrastructure and less likely to be damaged or disrupted in the local vicinity of a disaster, making it often the only uncompromised communications system available when a major disaster occurs.

Damage to terrestrial infrastructure during Hurricane Katrina and the Indian Ocean and Haiti earthquakes are just a few examples of why public-safety agencies need immediate access to rapidly deployable satellite communications. It isn't enough to replace terrestrial communications with satellite communications. To be effective, satellite communications must provide seamless terrestrial interoperability of services needed by first responders.

Public-safety agencies that integrated satellite communications into their infrastructure had to understand the unique capabilities and limitations of the systems. A basic understanding of the physics that govern satellite communications is helpful in understanding how to effectively evaluate the trade space when considering satellite communications in public-safety applications. Although there are a dozen or so dominate physical characteristics of satellite communications systems, two key characteristics determine the performance of these systems:

Orbital Dynamics. Individual satellites or a constellation of satellites can be placed in a number of orbital locations. Geosynchronous Earth Orbit (GEO) satellites are located (parked) in a specific location about 22,341 statute miles over a fixed spot above the equator. Because of the distance needed for link closure, communications with GEO satellites require more power and larger antennas than other types of satellites. On the other hand, because GEO satellites are in fixed locations, low-cost earth terminals can be deployed. Low Earth Orbit (LEO) satellites are located in orbital paths, often just a few hundred statute miles above the earth. LEO satellites aren't located over a fixed earth location above the earth but rotate around the earth every 100 minutes or so. Link closure to LEO satellites requires less power and antenna size, but in some cases, require tracking antennas that are more expensive then the antennas needed with GEO satellites.

Frequency of Operation. As with terrestrial communications, the uplink and downlink frequencies of satellite data links determine key performance parameters. The lower the frequency of operation, the better the ability of the waveform to penetrate urban jungles and inside buildings. The higher the frequency of operation, the more transponder bandwidth available for users; however, the data link is more sensitive to atmospheric conditions such as rain fade and smoke. A number of important GEO and LEO satellite constellations provide L-band services for public-safety applications capable of both narrowband and wideband operation up to 450 Megabits per second (Mbps) of data bandwidth. Ka-band GEO systems that are being launched will provide as much as 100 Gigabits per second (Gbps) over the continental United States.

Satellite communications has matured to the point that key providers of services for public-safety applications focus on service delivery rather than just delivery of infrastructure. This is eliminating many of the barriers smaller agencies and regional authorities have in making satellite communications a key component of their public-safety communications fabric.

Hybrid Architecture Project

In June, the Wireless Innovation Forum approved a project for the satellite communications special interest group (SATCOM-SIG) to investigate user requirements and define hybrid SATCOM reference architecture. The SATCOM-SIG is under the forum's user requirement committee that acts as the primary interface for requirements between wireless stakeholders in the end-user community and suppliers. The project's primary purpose is to support users who require advanced communications systems capable of concurrent, assured connectivity between terrestrial line-of-site (LOS) and satellite beyond-line-of site (BLOS) networks for support of emergency services in response to disasters.

The user requirements committee works through special interest groups to validate concepts and requirements against technology readiness and standardization to document domain-specific requirements, use cases and

The goal is to allow end users to send and receive communications over multiple data links concurrently.

business models that will drive the activities of the regulatory and technical committees. The committee also supports member organizations in identifying new opportunities for next-generation products and services in each defined market domain. All major suppliers of public-safety systems are forum members.

The hybrid reference architecture being developed by the SATCOM-SIG is a highly configurable platform architecture capable of running multiple satellite and terrestrial waveforms. The focus is to identify the wireless technology innovations necessary to integrate satellite systems seamlessly into public-safety communications to allow emergency personnel to exchange knowledge over any satellite or terrestrial data link. The goal is to allow end users to send and receive communications over multiple data links concurrently.

Platform architectures run waveforms and manage network connectivity as multithreaded applications rather than as dedicated radio functions seen in radio architecture. This allows platforms to run waveforms concurrently, as well as user applications that provide important data processing functions such as data fusion for situational awareness, movement tracking system (MTS) broadcast, auto-location in GPS-denied environments, machine-to-machine (M2M), context sensitive information delivery and a wide range of user applications.

The forum's SATCOM-SIG is conducting a literature survey to identify state-of-the-art product offerings in combined LOS/BLOS-capable systems for public-safety markets. This effort is expected to be completed in December. At the forum's SDR 2010 conference in Washington in December, a user survey will be taken to identify specific use cases and operational requirements for satellite communications used by public-safety and emergency response teams. The results of the survey will help define architectural requirements for development of the hybrid reference architecture and support gap analysis to identify wireless innovations needed to implement the target architecture. Forum members will have access to the SATCOM-SIG results to support development of standards and architectures to build the next generation of hybrid platforms.

The results of the project will also be published and made available to international first responder and public-safety organizations. The SATCOM-SIG reference architecture will be one of several architectures that will be part of the forum's roadmap committee project, which will define and publish the forum's "top 10 most wanted wireless innovations" list as the foundation of the next generation of wireless devices.

If realized, these technical, business or regulatory innovations will address various shortcomings in existing wireless communications from different wireless industry stakeholders, including users, radio or platform manufacturers, software and hardware component providers, operators and service providers, and spectrum regulators. The innovations don't necessarily result in patents or intellectual property, but they serve to help guide the community in addressing emerging wireless communications requirements through improved performance of deliverables, reduced total life cost of ownership, and the responsive and rapid deployment of standardized products, technologies and services.

Information Processing Architecture

The forum's published information processing architecture (IPA) report addresses technology and requirements driving the next generation of communications devices. The domain of cognitive radios is rapidly evolving from radios that are aware of their RF environment and capable of modifying their signal-in-space operational characteristic to a policy-based platform capable of responding to external environmental characteristics, as well as internal user contextual information processing requirements.

IPA is a platform focused on the delivery of more than just data. IPA is based on the progression from data to information to knowledge. A key element in this progression is the understanding that full communications occurs only when data is exchanged, processed into information and placed in context so it's understood by the receiver and imparts knowledge.

Author Robert McCloskey clearly articulated the problem with communications when he said, "I know that you believe you understand what you think I said, but I'm not sure you realize that what you heard is not what I meant." At the end of the day, information must be understood in the correct context to impart knowledge to the end user. ■

Bob Schutz is the vice president of engineering for Datron World Communications. He is a member of the board of directors of the Wireless Innovation Forum and chairman of the forum's satellite communications special interest group (SATCOM-SIG). E-mail comments to bschutz@dtwc.com.