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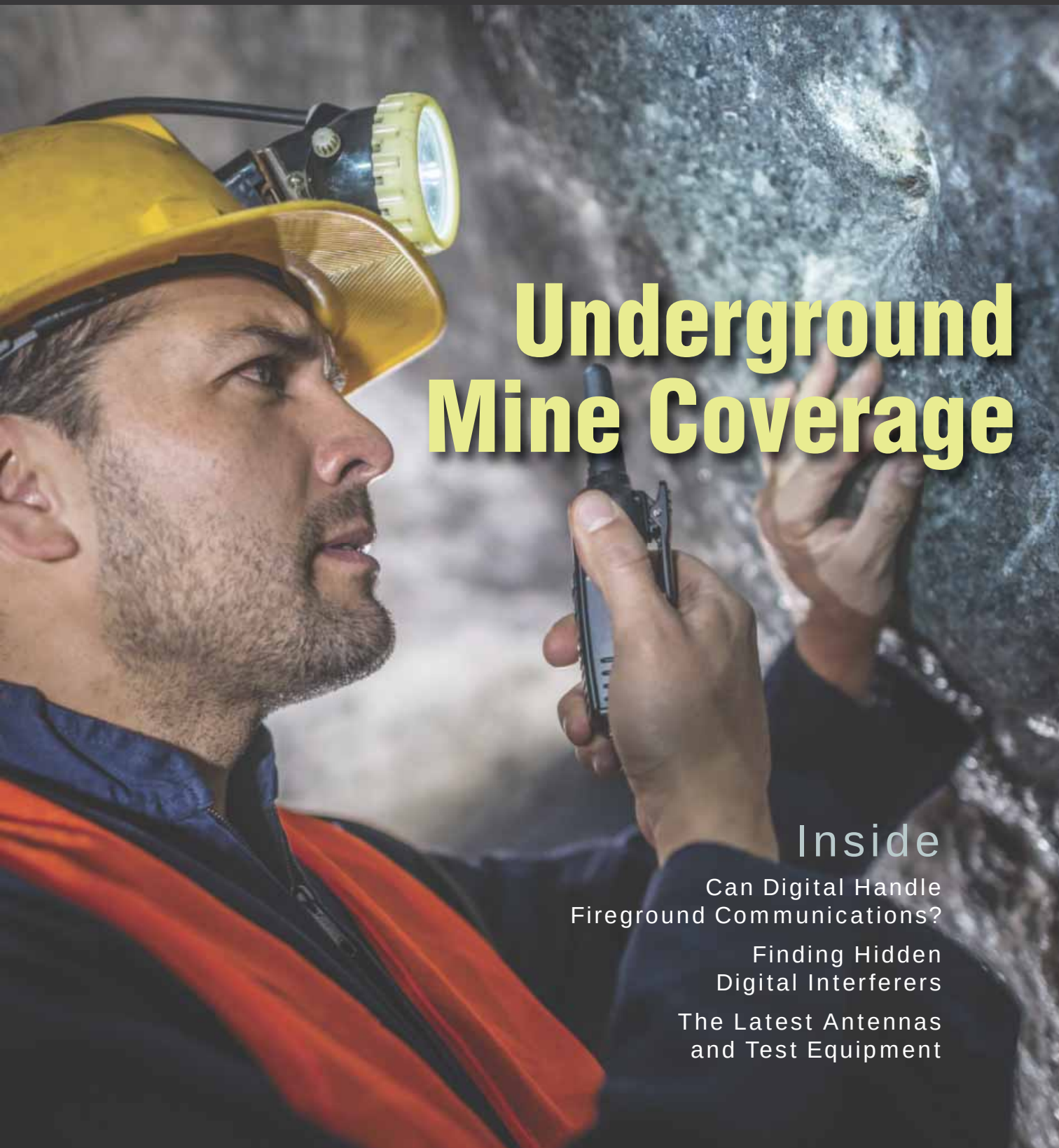

Underground Mine Coverage

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Can Digital Handle Fireground Communications?

Finding Hidden Digital Interferers

The Latest Antennas and Test Equipment

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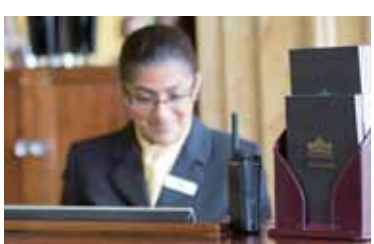

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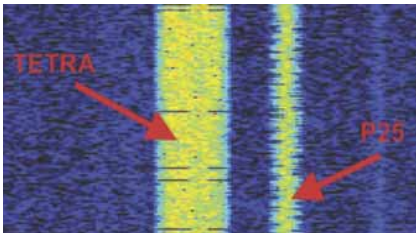

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Photo courtesy Airbus

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Connecting Networks Across Borders

For years, many different technologies have comprised the professional mobile radio (PMR) industry. Different users have different needs for coverage, spectrum, functionality and reliability, and various technologies have evolved to fill those needs. Each mission-critical communications user is different, and that is what makes our industry unique and unable to rely solely on commercial mobile operator networks.

The various technologies bring challenges when users with two different types of networks need to communicate. Interoperability for disaster relief operations has been a problem for decades.

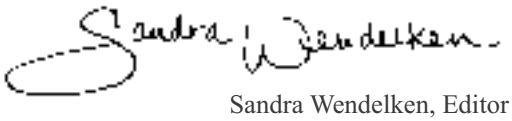
The global Tampere Convention, concluded in 1998 and in effect in 2005, is a multilateral treaty governing the provision and availability of communications equipment during disaster relief operations, particularly for transporting radio and related equipment over international boundaries. The Second Global Forum on Emergency Telecommunications: Saving Lives (GET-2016), held in January, continued the work of the Tampere Convention. (See Page 12.)

In Europe, the Inter System Interoperability for TETRA-TETRAPOL Networks (ISITEP) project is an effort to create a pan-European framework for integration of different public protection and disaster relief (PPDR) organizations' merging communications technology, operational procedures and a legal framework. A consortium of companies is conducting five trials with different groups of European users to test various operational scenarios.

Gateways that connect different TETRA networks or a TETRA network with a Tetrapol network play a large part in the trials. Gateways will also likely be key in helping TETRA and private or commercial Long Term Evolution (LTE) networks connect at some point as well.

Along with technology, common procedures and legal agreements are a big part of interoperability efforts, especially when connecting networks in different countries. Funding, of course, plays a role as well. Interoperability will continue to be a challenge as it has been for many years but recent efforts are addressing the various issues. Let us know if you have overcome an interoperability hurdle and how.

We value your opinions! Please email your feedback to me at swendelken@RRMediaGroup.com.



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RadioResource INTERNATIONAL

RadioResource International delivers wireless voice and data information for mobile and remote mission-critical operations for professionals who reside or do business outside the United States and Canada. The magazine covers private and trunked mobile radio, wireless data, location technologies, public safety communications, microwave radio, satellite, paging/messaging, remote monitoring, and other wireless applications. Editorial content is international in scope and encompasses emerging technologies, industry reports and trends, innovative applications, product information and comparisons, news, standards, and troubleshooting tips.

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Nordic Countries Emphasize Importance of 700 MHz Dedicated PPDR Spectrum

The owners of the public-safety radio networks in Sweden, Norway and Finland emphasized the importance of dedicated frequencies in the 700 MHz band for emergency communications in a joint white paper. Broadband is the key word in the white paper signed by the Swedish Civil Contingencies Agency, Finnish State Security Networks and the Norwegian Directorate for Emergency Communication.

The three Nordic countries' operational personnel in public protection and disaster relief (PPDR) organizations use TETRA technology for their emergency communications systems — respectively Rakel in Sweden, VIRVE in Finland and Nødnett in Norway. The Radio Spectrum Committee (RSC) works to ensure harmonized conditions across Europe for the availability and efficient use of radio spectrum.

TETRA radio systems operate in the 380 – 400 MHz range. They are excellent for voice communications, have extensive coverage and security, and operate independent of commercial mobile networks. However, the frequencies are insufficient to meet PPDR organizations' increased need for secure and robust broadband data.

Photo courtesy Airbus

The 700 MHz band will eventually be allocated for broadband communications in the Nordic countries. The three Nordic public-safety network owners recommend that part of the 700 MHz frequency band should be dedicated for use by PPDR organizations. Without dedicated frequencies, the next-generation emergency communications systems must be built exclusively on commercial operators' networks. It is unclear whether commercial networks can offer functionality and sufficient technical quality, robustness and security for PPDR use. In addition, there is no guarantee that commercial operators will be willing to meet the needs of PPDR.

"Dedicated networks will undoubtedly provide the best security and data safety and greater possibilities for sending large volumes of important and mission-critical data," a statement from the groups said. "The 700 MHz band is pointed to as the only realistic alternative to achieve a harmonized solution for future emergency communication systems in Europe. This band is well suited for achieving high percentage area coverage and good indoor coverage without having to invest in unrealistic, extensive and expensive infrastructures."

The white paper said a harmonized approach is important if radio equipment is to operate across national borders. Norwegian and Swedish officials said the two countries' TETRA networks will be interconnected this year. The paper also underlines that a larger market also provides better conditions for further development of services and functionality. Even if the PPDR community requires specialized handsets, the key components should be the same to avoid becoming a niche market. The United States, Canada and France selected the 700 MHz frequency band and Long Term Evolution (LTE) technology for PPDR broadband networks, the paper said.

ASIA

GLENSIDE, Australia — Beach Energy, Australia's largest onshore oil producer, selected **Nokia Networks** equipment for a private Long Term Evolution (LTE) network

As part of the project, Nokia Networks provided base stations and small cell solutions that provide capacity for managing data/voice traffic generated at indoor and outdoor hot spots. Nokia Networks' LTE base stations can each replace multiple Wi-Fi access points, providing cost efficiency.

"The new LTE network allows our staff to access key systems, facilities and production information throughout our western Cooper Basin field area, reducing requirements for travel between sites, making operations more efficient, saving money and significantly enhancing safety," said Neil Gibbins, acting CEO at Beach Energy. "Beach is proud to be an early adopter of technologies within the oil and gas industry. With Nokia Networks and Challenge Networks, we have become one of the pioneers in adopting LTE as the communications backbone of our remote operations and are pleased that it will deliver ongoing value and enable us to lead the way in low-cost oil production within the Cooper Basin."

Nokia Networks estimates that the global market for LTE public-safety networks will exceed 2 billion euros by 2019 (US$2.2 billion) Last year, the company announced it was re-entering the public-safety communications market to offer LTE products.

SINGAPORE — A report from Frost & Sullivan found that the Asia-Pacific market for industrial control systems (ICS) security reached revenues of US$162.9 million in 2014. The report, titled "Asia-Pacific Industrial Control Systems Security Market," estimated that the market will reach revenues of US$1.8 billion by 2019.

"In recent years, industrial control systems used in the automation of industrial plants were increasingly connected to the Internet for its benefits. However, cybersecurity was not part of

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Perry Pushes Amateur Radio for Youth Around the World

Carole Perry is an advocate for teaching students about the benefits of amateur radio. The American retired middle school teacher is expanding her U.S.-based efforts globally.

Perry spoke in 2014 at the world's second-largest amateur radio convention in Friedrichshafen, Germany. She described how she taught amateur radio for 30 years in middle schools in New York and how others could use similar curriculum to recruit amateur radio operators. Perry and her counterpart in Germany set up a one-year exchange program that allowed three young ham operators to receive technical magazines from each country. U.S. kids received the German version of *CQ* magazine and German kids received U.S. *CQ* and *QST*, the monthly magazine of the Amateur Radio Relay League (ARRL).

Carole Perry

"The idea was for them to get on the radio and communicate with each other," Perry said.

Last year at the Dayton Ham Convention in Dayton, Ohio, USA, Perry conducted a session with young presenters, as she has for 28 years. She had eight young U.S. presenters in the session, in addition to a 16-year-old ham from India. Tom Jose was escorted by the Indian National Amateur Radio organization during his 38-hour trip to speak at the youth forum.

"He was extremely personable and spoke so beautifully," she said. "His resume is long. He helps during weather-related disasters in India."

After his presentation, one of the members of the Radio Club of America (RCA) Youth Activities Committee who had donated to other young presenters, gave Jose a US$100 bill, she said. He also received a JVCKENWOOD handheld radio.

U.S. astronaut Mike Fincke came to Dayton to present and speak during a luncheon. The eight young licensed hams from the audience, along with Jose, were invited to attend. The Indian escort invited Perry to India to visit schools and see how they are teaching amateur radio, and she hopes to visit this year or next.

Perry has another connection to India through Yamini Sadineni, a young Indian woman who she met in mid-2014 at ARRL's centennial celebration. "She and I are in communication," Perry said. "Yamini and Tom are very interested in radio communications during weather disasters. She is from the same area of India as Tom."

In another positive move for females in amateur radio, the first licensed female Palestinian contacted Perry and asked for suggestions for recruiting. They are in communication.

In October, the RCA Youth Activities Committee, which Perry chairs, made a substantial donation to a group of ham radio operators who went to Cuba to introduce amateur radio at several venues, including to an elementary school.

Perry feels strongly that youth education about amateur radio can bring help during international and other disasters and can boost global harmony.

"The ripple effect for the past 40 years or so that I've experienced with young people is amazing, along with their networking and communicating worldwide," she said.

the original design process, which made the systems vulnerable to cyber threats," said Charles Lim, senior industry analyst for Frost & Sullivan's digital transformation and cybersecurity practice. "Therefore, it is vital that the industry understands the threats pertaining to operational technology and ensures that the right cybersecurity solutions are in place to address this."

The report noted that several energy plants in the region have begun looking at complying with ICS guidelines such as the North American Reliability Corp.'s Critical Infrastructure Protection (NERC-CIP) or National Institute of Standards and Technology (NIST) standards to combat cyber threats.

Additionally, governments in the region have begun to mandate or recommend cybersecurity measures for critical infrastructure. For example, the Japanese government recently established the National Center of Incident Readiness and Strategy for Cybersecurity (NISC), which created the Capability for Engineering of Protection, Technical Operation, Analysis and Response (CEPTOAR) Council to facilitate information sharing among critical infrastructure verticals in the country.

INTERNATIONAL

PARIS — The French stock market authority, Autorité des Marchés Financiers (AMF), published interim results of the initial offer period of **Nokia**'s public exchange offer for **Alcatel-Lucent** securities in France and in the United States.

Following settlement of the offer, Nokia would hold 91.25 percent of the share capital and at least 91.17 percent of the voting rights of Alcatel-Lucent.

The companies will begin to progress their integration plans, and 14 January was the first day operating as a combined group. Nokia announced plans to buy Alcatel-Lucent last year.

"We are delighted that the offer has been successful, and that Alcatel-Lucent's investors share our confidence in the future of the combined company," said Rajeev Suri, president and CEO of Nokia. "We will move quickly to combine the two companies and execute our integration plans. As of 14 January, Nokia and Alcatel-Lucent will offer a combined end-to-end portfolio of the scope and scale to meet the needs of our global customers. We will have unparalleled research and development (R&D) and innovation capabilities, which we will use to lead the world in creating next-generation technology and services."

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Emergency Volunteer Network, Fund for Response Established at GET-2016

Two new global initiatives, the International Telecommunication Union (ITU) Network of Volunteers for Emergency Telecommunications and the Global Emergency Fund for Rapid Response, launched at the Second Global Forum on Emergency Telecommunications: Saving Lives (GET-2016) in Kuwait City 26 – 28 January.

More than 500 participants from 70 countries attended the ITU event that underscored the importance of information communication technology (ICT) in disaster early warning and response. The event discussed trends and emerging technological innovations, financing mechanisms, country case studies, challenges in deploying ICTs in disaster zones, climate change issues and the role of the private sector and other nonstate stakeholders. It also featured a series of exhibits with solutions for the most effective use of ICT in emergencies.

"This was a very successful event," said ITU Secretary-General Houlin Zhao. "Nearly every day, a disaster strikes somewhere in the world. The high number of participants reflects the common will to join forces to help reduce the impact of disasters."

The adopted outcomes of GET-2016 provide strategic guidance to the national and international communities and will result in increased knowledge of the role different entities could play in giving telecommunications/ICT a central role in disaster mitigation and management.

"At this forum, we have adopted practical strategies to strengthen the world's response in emergencies," said GET-2016 Chairman Salim Alozainah, who is also chairman and CEO of the Communication and Information Technology Regulatory Authority (CITRA).

Siaosi Sovaleni, deputy prime minister of Tonga, said "all participants at the forum agreed that ICT is a key tool for disaster management. They further stressed the need for a multistakeholder approach and showed unwavering support to the initiatives launched by ITU, as they will greatly help countries to enhance their capacity and provide accessible resources to mitigate the impact of natural disasters and save lives."

MANILA, Philippines — More than 300 military and civilian communications specialists from 21 Indo-Asia-Pacific nations came together for the United States Pacific Command (USPACOM) program known as PACIFIC ENDEAVOR from 31 August to 11 September. The annual humanitarian and disaster relief event is the culmination of 12 months of planning workshops and is designed to strengthen relationships with allies and partners by testing the communications response to a natural disaster.

The 2015 event was based on the crisis response to a fictitious 7.2 magnitude earthquake in the Philippines capital of Manila. The goal of this year's interoperability assessment event included radio testing focusing on HF automatic link establishment (ALE) and RF over IP. Sixteen nations volunteered to bring equipment and participate in the assessments.

Initially, interoperability assessment was stalled because of interoperability issues with HF data. With each of the participating nations supplying their own equipment, multiple data waveforms were unable to interoperate.

John Rosica, president of NVIS Communications, the Barrett Communications system integrator for the U.S. market, attended the event as a U.S. Army Military Auxiliary Radio System (MARS) member and was called on to assist the interoperability assessments to overcome the HF data issues. By selecting a single data environment, multiple data waveforms could operate over HF.

A new pre-event has been scheduled where attending nations and vendors will come to a planning session in advance to increase knowledge and architecture methods of interoperability prior to PACIFIC ENDEAVOR 2016. This would be similar to other training exercises that friendly nations' militaries conduct to facilitate full interoperability.

GENEVA — Global imports of information and communications technology (ICT) goods increased by only 1 percent in 2014, the latest year for which figures are available, the lowest rate of growth compared with the preceding five years, newly released United Nations Conference on Trade and Development (UNCTAD) data show.

Global imports of communications equipment and electronic components were the only two subsectors that increased slightly in 2014 — up 3 percent and 2 percent respectively — compared with the previous year.

Developing countries, and those countries changing from a centrally planned economy to a market economy, accounted for more than half (57 percent) of total global imports, which reached a value of US$2.1 trillion.

In 2014, Chinese exports and imports of ICT goods came to a halt after many years of growth. Among the top 10 importers of ICT goods, China and Singapore were the only economies with declining rates in 2014, down 4 percent and 3 percent respectively. By contrast, imports grew strongly in the Republic of Korea (up 11 percent), Hong Kong, China (up 9 percent), and Germany (up 8 percent). On the export side, there was zero growth for ICT goods from China, but Taiwan Province of China and Hong Kong, China, maintained positive and significant growth rates.

Economies with the largest declines of ICT goods imports in 2014 included Ukraine (down 34 percent), Argentina (down 23 percent), Paraguay (down 18 percent), Belarus (down 18 percent), Chile (down 17 percent), Kazakhstan (down 15 percent) and Hungary (down 13 percent).

The largest increases in ICT goods exports were for the Russian Federation

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(up 80 percent), the Philippines (up 40 percent), Latvia (up 30 percent), South Africa (up 25 percent), Poland (up 21 percent), Finland (up 13 percent) and Australia (up 12 percent).

In total, ICT goods accounted for 12 percent of world merchandise imports in 2014. That proportion ranged between 44 percent for Hong Kong; around 20 to 24 percent in China, Malaysia, the Philippines and Singapore; and less than 1 percent in Afghanistan and Mauritania.

A complete dataset for 2000 – 2014 on trade in ICT goods can be accessed free at http://stats.unctad.org/ict3ict4. Data for 123 economies are available, including by trading partner and by type of good traded.

AUSTIN, Texas, USA — The Project 25 (P25) Technology Interest Group (PTIG) released a standards update report from the October meetings. At the meetings, several revisions were released, including one that aims to improve data peripheral interoperability. Work on P25 integration with broadband was put on hold.

A revision of the Radio Management Protocols Standard was approved for publication. The standard was clarified to prevent interoperability issues as an increasing number of vendors are offering P25 data peripherals.

In addition, a revision of the OTAR Interoperability Tests Standard was approved for publication. This revision is a complete rewrite of the tests and test methods in the previous document and is based on the recent revisions to the over-the-air reprogramming (OTAR) messages and procedures standard.

A revision of the Data Overview and Specification was approved for publication. The revision aligns the overview with the recent revisions to several other P25 data documents. A revision of the Block Encryption Protocol Standard, which provides minor editorial clarifications to the previous version, was approved for publication.

New work includes additions to the Trunking Inter RF Subsystem Interface (ISSI) Messages and Procedures Standard. The additions will add individual and group regrouping capability associated with console "patch" type operations.

Work on public-safety requirements for broadband data/professional mobile radio (PMR) interoperability, in conjunction with the Alliance for Telecommunications Industry Solutions (ATIS), is on hold pending advancement of the Third Generation Partnership Project (3GPP) mission-critical services architecture. This is the beginning of work to create the requirements for interworking of broadband and existing P25 and other PMR systems. A new ATIS ad hoc group began an effort to gather interworking requirements and scenarios for broadband mission-critical services and PMR technologies such as analog FM, P25 and TETRA.

LONDON — Improvements for portable professional mobile radio (PMR) accessories include increasingly longer battery life, faster charging batteries and better sound in speaker microphones. These improvements and increased demand have led to a market estimated to be worth US$1.3 billion in 2014 and is forecast at a 2.1 percent compound annual growth rate (CAGR) to US$1.5 billion in 2019.

During recent years manufacturers have focused on products that take advantage of Bluetooth Smart technology to provide wireless functionality. Bluetooth Smart, also called Bluetooth low energy (LE), is applied to products such as headsets in the PMR market. In heavy industrial applications where there are large machines with many moving parts, wireless connections between certain accessories and the terminals mean that there is one less cord that can get caught in the machinery. By using a wireless connection between a headset and the terminal, the radio no longer needs to be holstered on the hip and can be in a backpack or placed in another location out of the user's way.

While there has been increased interest in Bluetooth Smart, adoption by end users has been slow. Users still believe that Bluetooth drains battery relatively quickly. However, the technology, released in 2010, has considerably reduced power consumption. In addition, many users have limited budgets for accessories, and Bluetooth Smart products are inherently more expensive than other accessories.

Finally, many PMR manufacturers are making the Bluetooth LE in their radios proprietary so only they can provide Bluetooth accessories for those products. This has limited competition in the market for Bluetooth-capable accessories.

While these can be substantial issues for manufacturers to overcome, the PMR industry must better educate users on the advantages of Bluetooth Smart accessories. Dedicated accessory manufacturers also must partner with PMR manufacturers to produce Bluetooth Smart products. IHS forecasts that Bluetooth Smart will become an important technology for headsets and other accessories during the next few years.

CHICAGO, United States — Motorola Solutions invested in two technology companies. **Nubo Software**, a virtual mobile infrastructure (VMI) provider, completed a $7 million Series A financing round led by Magma Venture Partners along with Motorola Solutions Venture Capital. VMI allows businesses to deliver corporate and consumer mobile apps as a display from a remote server, ensuring zero data is stored on employee devices.

Motorola Solutions also made an undisclosed strategic investment in **BlueLine Grid**. The company provides an encrypted suite of messaging, location, conferencing, virtual command and file-sharing tools for public and private security officials.

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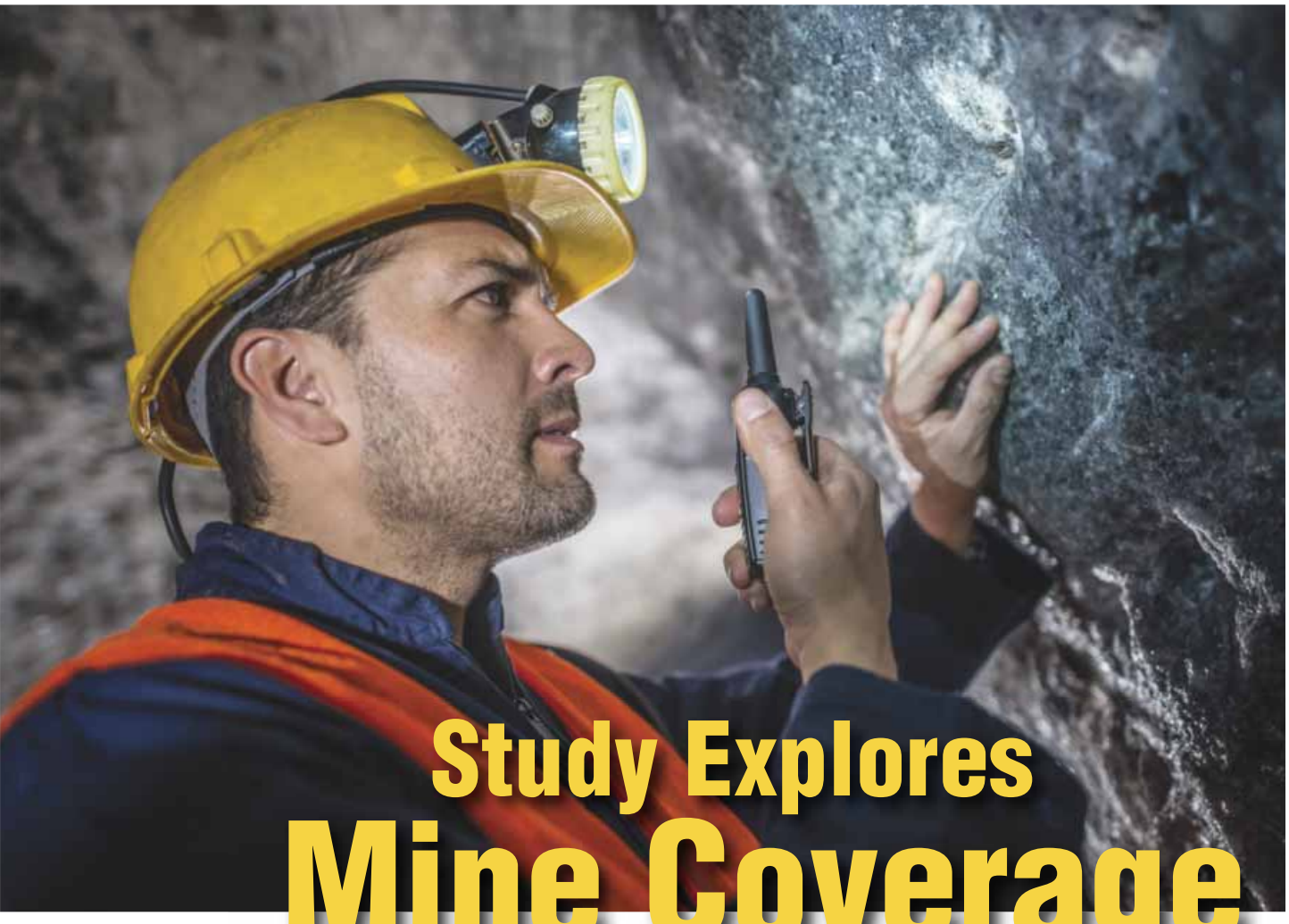

Study Explores Mine Coverage

An underground gold mine in Brazil conducted a wireless site engineering study (SES) to validate the best wireless solution for its needs.

By Ron White

Extreme conditions create extreme challenges. When an underground gold mining site in central Brazil was having issues successfully deploying a wireless network, the mining company realized it needed to explore alternatives and asked a partner to conduct a wireless site engineering study (SES). The results of the study allowed the mining company to create a future plan for an end-to-end wireless communications network throughout the mine.

Site Challenges

An underground mining site presents significant challenges to the successful deployment of a wireless network, and the Brazilian gold mine is no exception. The mine comprises an extensive tunnel system — 160 kilometers of underground tunnels in total. Multiple levels, each connected to its neighbor by tight spiraling ramps, limit the distance wireless signals can travel. Workers follow the ore at an angle, with the levels sitting on top of one another. A shaft runs all the way down and serves as the ore's pathway to the surface.

Two-way radio voice systems provide communications across the majority of the site; however, there are no IP or data radios to direct communications out of the tunnels.

Technology in each mine shaft includes a hybrid radiating cable for voice and an Ethernet switch connected to the fiber. The shaft intersects the mine level in certain places, and in those places, a fiber-connected switch enables the systems to communicate with the network. At each level, fiber from one of the vertical shafts feeds an Ethernet switch. Systems on each

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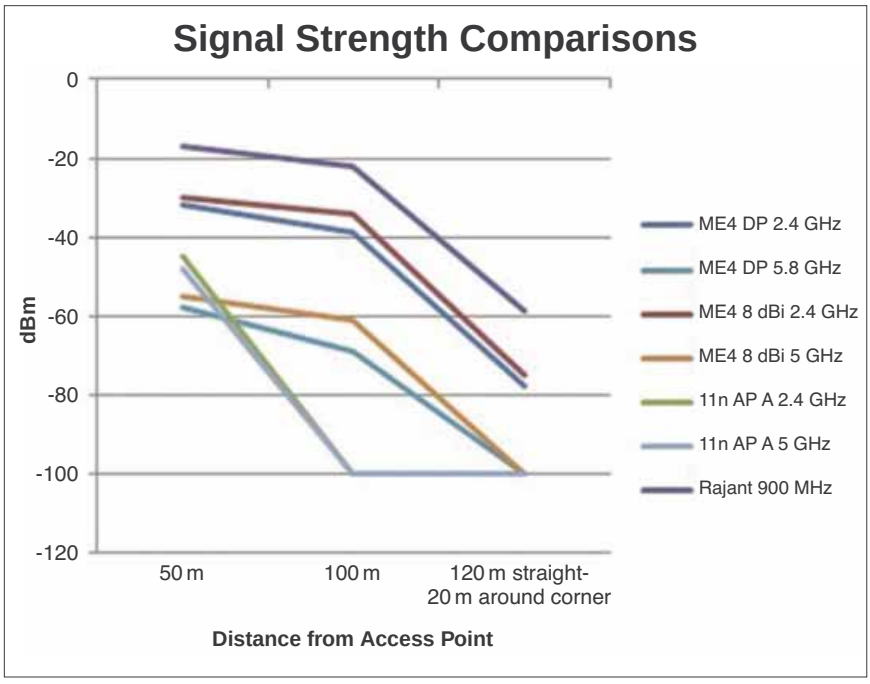

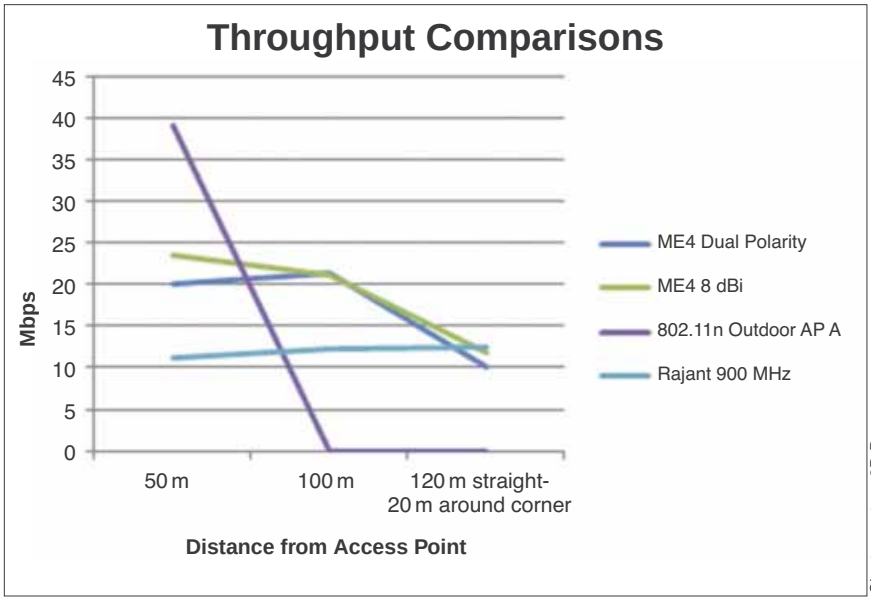

Charts courtesy 3D-P

level can connect to the core network through these switches, but not wirelessly.

Establishing and maintaining communications in the active stope is especially problematic. While connectivity and throughput demands are high, no wired infrastructure exists there. Throughout the various mine levels, there are limited, if any, power sources, as well as a lack of Ethernet, except in the shafts. This lack of power further impairs wireless implementation.

Study Goals

A wireless communications network is important so the mine can pull data from equipment applications. For example, a proximity application can improve safety and productivity by keeping the mine workers informed about where equipment and operators are at all times. The objective of the SES was to find the best option for future implementation of an end-to-end wireless communications network that would supply application connectivity throughout the mine, including coverage in the active stope area.

A wireless network not only would need to deliver reliable, high-throughput application connectivity, but also provide scalability for adding future applications such as autonomous mining, as well as connectivity to support dispatch and onboard machine health systems, access to business systems, asset tracking, wireless and wired VoIP systems and, where appropriate, IP cameras.

Preliminary discussions and analysis by the mining company and its partner in the study, 3D-P, focused on a series of possible wireless solutions. The companies narrowed the list to two solutions that had the potential to meet the mine's requirements.

The SES tested a kinetic mesh network and an 802.11n outdoor mesh wireless solution and compared them to determine:

- Performance characteristics of the solutions
- Performance characteristics of the 900 MHz and 2.4 and 5.8 GHz radio frequencies in an underground mining environment
- Best practices for mobile and infrastructure antennas
- RF noise and interference, particularly possible self-interference
- Availability and best practices for backhaul throughout the mine
- Tactics and best practices for extending wireless coverage into the stope area

Test Methodology

The SES process included a tour of the mine with visits to an active stope and other areas, including active workshop areas, so that 3D-P had a full understanding of the challenges of the mine's layout.

3D-P learned that there are few areas of straight, line-of-sight visibility throughout the mine. Certain areas have minor bends and turns, while others have steep turns of more than 90 degrees. The limited

width of the tunnels is an additional challenge to RF propagation because of severe Fresnel zone infringement.

The companies created two test environments to test the impact of the spiral design in a wireless environment — one on-site at the mine and another at a nonworking mine of similar design in the United States. In the on-site test, an infrastructure radio was set up at one end and tested against different radios and antennas to monitor throughput and signal strength. The throughput and signal strength tests continued around the spiral to measure how far the signals would go without faltering.

Tests were conducted on the 2.4 and 5 GHz frequencies to determine latency, noise, throughput and signal strength differences with changes in distance and varying degrees of signal blockage.

Four Tests

Test One. Two kinetic mesh wireless nodes were configured with both 2.4 and 5 GHz radio transceivers. The first node was equipped with a dual-polarity directional antenna and deployed at test location one as a fixed access point. The second node was equipped with a low-gain antenna and used on a mobile vehicle.

The throughput and signal strength tests continued around the spiral to measure how far the signals would go without faltering.

The wireless node was allowed to select the best transceiver for each throughput test, using its own networking software, and data was collected on the mobile device at locations two, three and four.

Test Two. The antennas were changed to 8 decibels isotropic (dBi) directional antennas at both ends of the kinetic mesh network link. The test results showed significant but not overwhelming noise and retries on both frequencies with throughput of about 22 Megabits per second (Mbps) through the straight areas of the tunnel.

As expected, there was complete line-of-sight loss around the corner at location four, with throughput at that location dropping to about 12 Mbps over the 2.4 GHz frequency. The 5 GHz signal was too weak to reliably measure at location four.

Test Three. In the next test, the wireless nodes were replaced with 802.11n radios. The radios also operated in both the 2.4 and 5 GHz frequencies, and 8 dBi antennas were used on both the mobile vehicle and

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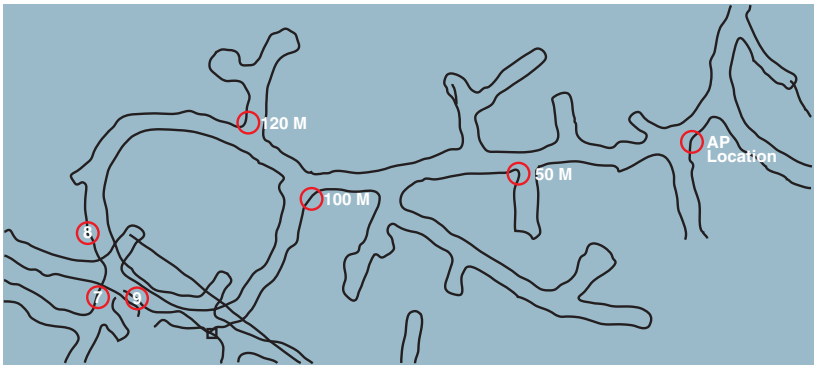
Test Locations



fixed access point (AP). The radios were configured with identical channelization and power settings as the wireless nodes.

The AC power requirements for the 802.11n radios and the power challenges at location one prevented deployment of the 802.11n AP at that location. As a result, the AP was moved to location two.

While the throughput between the fixed AP at location two and the mobile AP at location three reached a high of 39 Mbps, no 100-meter test could be performed between location one and location three because of the power situation.

At location four, the 802.11n radios completely lost connection, negating any advantage gained by the higher line-of-sight throughput.

Test Four. For test four, a 900 MHz node was configured with an 11 dBi antenna at both ends of the link. As expected, throughput between locations two and three was about half the 12 Mbps throughput of the wireless node tests because of the 802.11g device's limited throughput capabilities. The signal strength of the 900 MHz node was approximately 15 decibel-milliwatts (dBm) higher than that of the 802.11n devices, partially because of the 6 dBi addition of gain in the 900 MHz antennas tested. Attenuation around the corner to location five was nearly the same as test one with 12 Mbps throughput maintained.

Nonworking Mine Tests. The tests performed at the nonworking mine used a radiating cable, a 2.4 and 5 GHz wireless node, and two 5 GHz antennas on the spiral to measure how far the signals would travel. These tests indicated that the kinetic mesh network could maintain connectivity all around the spiral, up to a distance of 500 meters. Bandwidth was not lost with the dual-transceiver devices because network traffic traveled efficiently without signal interruption.

Results

Based on the results of the four tests, 3D-P recommended Rajant's kinetic mesh network. 3D-P designed a future plan for the mine that involves placing multiple nodes at each level, connecting them to the existing Ethernet switch, and allowing them to mesh between each other on each level. At each spiraling ramp, coaxial radiating cable connects a radio at the top of the ramp with another at the bottom. In this manner, a single mesh network between the mine's two levels is established, with the added benefit that clients on the ramp maintain 100 percent coverage.

These tests indicated that the kinetic mesh network was able to maintain connectivity all around the spiral, up to a distance of 500 meters.

The radios on each level would be deployed so that several layers of redundancy are maintained among all nodes. The average designed distance between each mesh node in the mine is 400 meters. If one node fails, the mesh can bypass that unit and establish a connection with the next radio along the tunnel. The second level of redundancy is the connection between the levels through the spiraling ramp, allowing traffic access to the level through the second path.

The multiradio meshing functionality of the kinetic mesh solution, along with the network's own software algorithm, prevents throughput loss across multiple hops of a mesh, with no loss of throughput demonstrated out to 10 hops. This capability allows the underground design to give both the high redundancy and high throughput capability the mine requires for its communications.

To address the stope issue, 3D-P employees recommended that wireless nodes be placed on all vehicles in the area. As personnel work, the nodes maintain communications with the rest of the kinetic mesh network. 3D-P also recommended a portable, battery-powered node to extend coverage into highly demanding coverage situations.

Going wireless underground was not easy, but a high-bandwidth, low-latency kinetic mesh network was able to reliably perform to the mine's specifications despite the extreme conditions and challenges of the environment. ■

Ron White is chief technology officer (CTO) at 3D-P, a privately held company enabling communications technologies for the mining sector. Email comments to ronwhite@3d-p.com.

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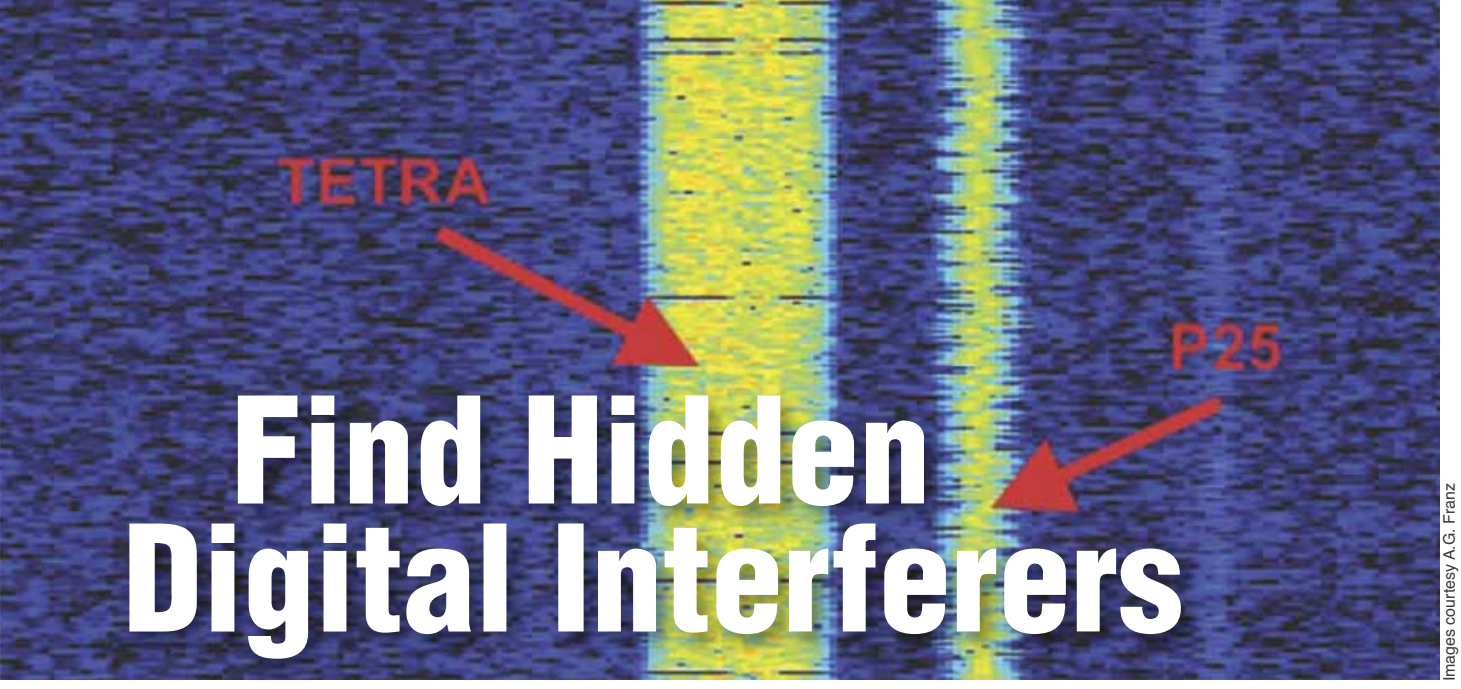

Find Hidden Digital Interferers

Images courtesy A.G. Franz

Detecting a signal under a signal is difficult, but high-resolution spectrograms in a new class of handheld devices help identify an interfering signal. **By Holger Schwarz and Andrea Franz**

Undisturbed transmission of RF signals is the key to clear and concise communications, especially in mission-critical applications. An interferer, intentional or unintentional, is an unwanted RF source preventing failure-free communications. When analog modulation was still common, detecting interferers was possible just through demodulation and listening.

Now, listening alone is not enough because of digital channel modulation. Interferers can hide underneath those signals, and they are impossible to detect using a standard test tool, but powerful enough to prevent reliable communications. Assuring secure communications in real-world situations requires handheld field-ready tools. This article describes how to detect a signal under a signal for the first time in a handheld device using a high-resolution spectrogram with a resolution down to 1 microsecond per scan. This capability has not been available until now in this class of instruments and offers the possibility to visualize and identify an interfering signal in the field.

Many digital signals use short time slots for synchronization. During those time slots, the unmodulated carrier is switched on but modulation is off, such that an interfering signal hiding underneath the desired signal can be detected. Unfortunately, this time period is only several microseconds long so a traditional spectrum analyzer or receiver isn't capable of making the event visible. For a better understanding of the requirements for a spectrum analyzer, we first review current common analyzer methodologies used.

The FFT Analyzer

Conventional spectrum analyzers are tuned to a single frequency at any given time — a drawback. Anything occurring outside the bandwidth captured at the time can't be detected. The FFT analyzer gets around this problem by calculating the spectrum of the signal from the time response using fast Fourier transformation (FFT) for all captured frequencies simultaneously. With sufficient computing power, this real-time analysis can be done without gaps.

However, the frequency range of a pure FFT analyzer is quite narrow. The limit is set by the technology — the possible sampling rate and computing power of the digital signal processor (DSP). Modern technology allows analysis of signal frequencies up to a few tens of megahertz with portable devices. Laboratory instruments have a wider range, but still cannot reach the frequencies in the gigahertz range necessary for RF analysis.

Combined Analog and Digital Techniques

An initial analog preprocessing stage is needed in digital analyzers for frequencies into the gigahertz range. A superhet receiver converts the high-frequency signal to a suitable lower frequency range, similar to a conventional receiver. Analog-to-digital conversion and computer processing in the DSP take place only after this stage.

In contrast to a conventional receiver, it is important to capture as wide a channel bandwidth (CBW) as possible so one FFT can be used to analyze a broad range. The superhet receiver then stays tuned to a single frequency in zero span mode, and the device provides all the advantages of an FFT analyzer, such as parallel calculation of all spectral components and real-time capability.

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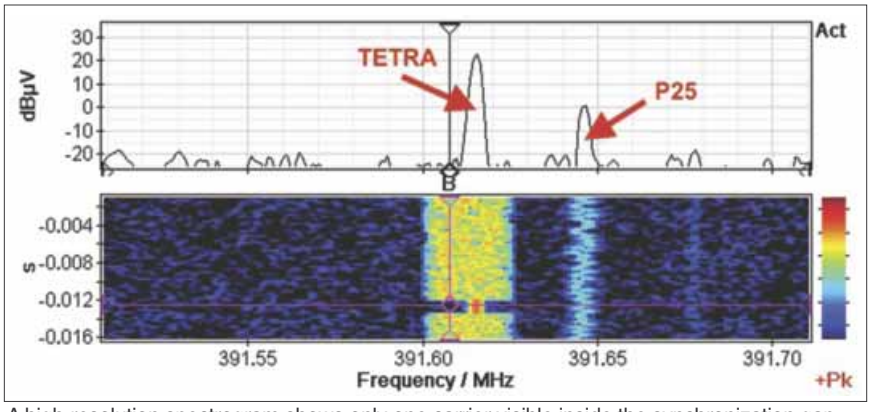


A high-resolution spectrogram shows only one carrier visible inside the synchronization gap.

Hidden Signal Interference

One of the toughest applications for a spectrum analyzer or receiver is detection and classification of in-band interference — signals that are hidden beneath the desired signal. In interference finding, a classic tool is the spectrogram, which displays the spectra against a time and a frequency axis. Each line in the display represents a spectrum, with the amplitude values shown on a continuous color scale.

The quantity of data becomes a problem when recording spectra at microsecond intervals: Within one second, 1 million spectra have to be captured, processed, evaluated and displayed. There are several solutions:

Solution 1: Spectrogram with data compression. The advantage of spectrogram analysis is that the signals are captured in real time, so no time-related events are missed. However, a continuous spectrogram with microsecond resolution would be too much to deal with, both technically and from a human point of view. Assuming the display can show a maximum of 500 lines and the results are produced every microsecond, it would only be possible to show a time range of 500 microseconds, after which the display would have to be refreshed. Thus, the display would refresh 2,000 times a second — technically impossible and absolutely useless for the viewer. For this reason, real-time spectrum analyzers often compress the spectra by combining several hundred or thousand, reducing the data from the microsecond range to a few milliseconds to be able to display the results. This allows for a good overview, but makes precise time assignment impossible.

Solution 2: Snapshot spectrogram without compression. When classifying interference, it is often a question of whether the signal needs to be observed for a number of seconds. It is usually enough to record a frame — frame length of a digital signal — in real time and capture this as a set of data. Spectra with different resolutions, or time characteristics, or persistence spectra, can be calculated from the stored data. The original data set is retained regardless of the settings chosen for testing, such as frequency resolution, time period or time resolution.

Equipment and Standards

We use the portable Narda Interference and Direction Analyzer IDA2 to demonstrate the detection of an interferer underneath a regular RF signal. When operating as a receiver, the analyzer offers an unusually large CBW for a portable device as it has a maximum of 32 megahertz. As a spectrum analyzer, it provides resolution bandwidth (RBW) settings from 10 hertz up to 20 megahertz, more than most portable devices. It is thus well equipped to meet the demands of Long Term Evolution (LTE) and its 20-megahertz channel bandwidth.

The unit is also tuned to a fixed frequency (zero span) in I/Q analyzer mode. A demodulator separates the digitized signal data into its real (in-phase) and imaginary (quadrature) components. Up to 250,000 I/Q data pairs can be stored in the memory for subsequent analysis and generation of time responses, spectrograms or persistence spectra. This allows an extremely high degree of time resolution. Time responses can be resolved as fine as 31.25 nanoseconds, and spectrograms down to 1 microsecond.

Data recording is continuous during the measurement time, making it possible to display and analyze the time correlation between signals. The analyzer is equipped with trigger functions for capturing infrequent events to allow recording of the event, its history (trigger delay) and consequences.

We use the TETRA digital standard as a practical measurement example; however, the results are equally applicable for other deployed RF systems. TETRA is used throughout the world for mission-critical and public-safety communications. As a potential interfering signal, we selected a Project 25 (P25) radio channel. P25 is a digital standard used for public-safety professional mobile radio (PMR) systems in North America.

The Conventional Spectrogram

A normal spectrogram is a good way to get an overview of what is happening within a frequency band. The example shows a capture of part of the trunked radio downlink band at 400 MHz. It shows the typical image of a TETRA signal with a transmission bandwidth of 25 kilohertz in the middle of the screen. The P25 on-air signal is first at 391.645 MHz, just next to the TETRA signal. If the P25 signal frequency is then shifted such that the P25 signal moves into (beneath) the TETRA signal, it can hardly be seen in the conventional spectrogram. A conventional spectrogram with a time resolution in the millisecond range is clearly not sufficient in this situation. This is where the IQ analyzer mode with its high-resolution spectrogram view is required.

The High-Res Spectrogram

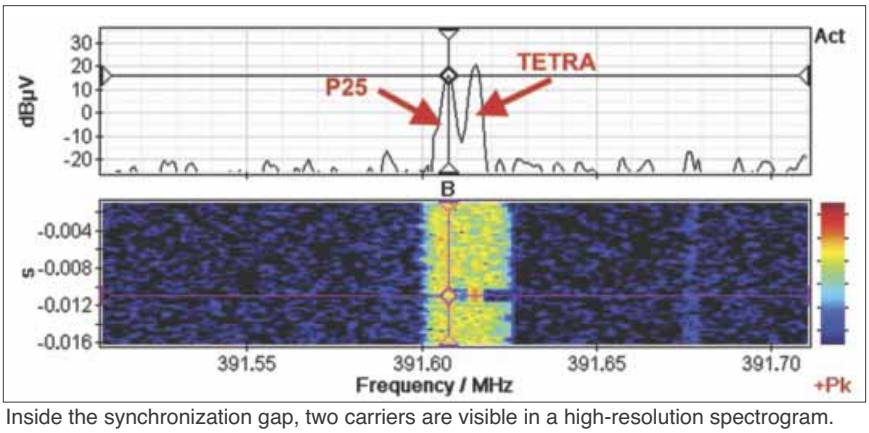
The high-resolution spectrogram can provide a time resolution down to

1 microsecond. In the example on Page 24, the portable analyzer recorded a real-time I/Q stream of length 1 second and generated spectra spaced 128 microseconds apart in time. This means the device has 7,805 complete spectra stored in memory.

The resolution is already sufficient for this application. The time slots of no-modulation (carrier only) can easily be identified. The P25 signal is at 391.645 MHz. Using the marker, it is possible to depict the spectrum during the synchronization gap and thus identify the interferer's exact frequency, the first step to finding and eliminating the emitter.

At first, the P25 signal is at the correct frequency. However, if the frequency of the P25 signal is shifted into the band occupied by the TETRA signal, the left part of the synchronization gap is filled up with the P25 signal, shown above.

Portable spectrum analyzers help ensure reliable mission-critical communications in the increasingly crowded RF spectrum landscape. The quick visualization of very short-time interferers (signals beneath signals) using a high-resolution spectrogram with its much smaller time intervals is the mandatory first step for a successful search and removal of interfering or hostile emitters. ■



Inside the synchronization gap, two carriers are visible in a high-resolution spectrogram.

Holger Schwarz is manager of international sales and marketing at Narda Safety Test Solutions in Germany. He has more than 25 years of experience in engineering and sales of spectrum analyzer and electromagnetic field (EMF) equipment.

Andrea Franz is partner at A.G. Franz, a small business distributing specialty RF equipment in North America. She has more than 25 years of experience in engineering and program management in the telecommunications and satellite industry. Email feedback to editor@RRMediaGroup.com.

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APCO's Spectrum Management Division has been the leading certified public safety frequency coordinator in the United States since the inception of coordination committees in 1986. Professional staff are available to assist with frequency coordination, interference resolution, licensing applications, management, and engineering challenges to ensure mission critical communications operate effectively.

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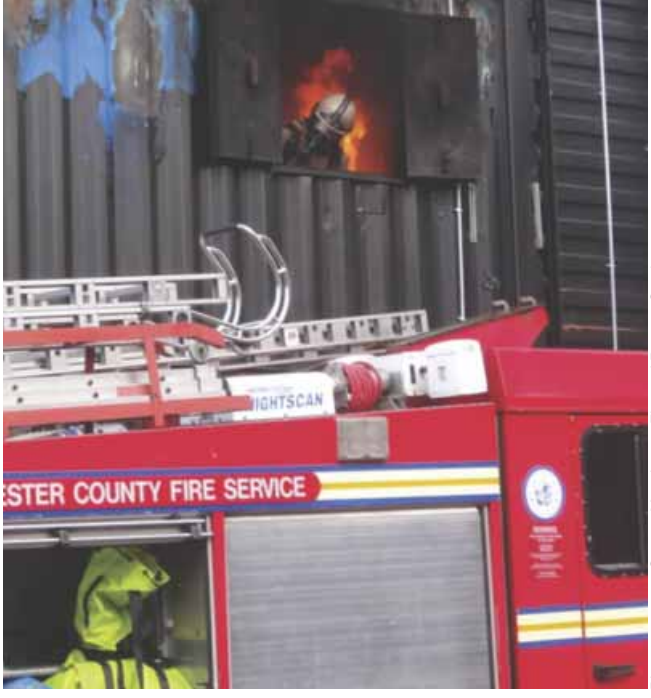

Photos courtesy Greater Manchester Fire and Rescue Service

A London-area fire agency upgraded its analog fireground network to a Digital Mobile Radio (DMR) system after extensive testing.

By *RadioResource International* Staff

Most public-safety agencies in England use a nationwide TETRA network run by Airwave Services for secure communications, however, many fire agencies need separate networks for fireground communications. Greater Manchester Fire and Rescue Service (GMFRS), the second-largest fire service in England, selected a Digital Mobile Radio (DMR) network for its fireground communications.

GMFRS protects more than 2.6 million people across a 1,300-square-kilometer area and employs 1,200 firefighters across 42 fire stations. In April 2014, it became one of four fire services to fall under the responsibility of North West Fire Control and now collaborates with its neighboring services in Cumbria, Lancashire and Cheshire.

The GMFRS fireground staff had used analog radios for seven years for fireground communications.

"The fireground network is completely separate from Airwave, and it's designed that way," said Mark Scoales, GMFRS information communications technology (ICT) senior radio/voice communications analyst. "We are users of Airwave, but this is a separate network."

The U.K. has several national UHF fire frequencies that allow fire agencies to communicate with other fire agencies. In addition, the country's flexible duty system allows uniformed operational managers to work a 24/7, 365-days-a-year rotation system made up of managerial hours, as well as operational cover for incidents and on-call hours, where officers continue to provide operational cover from their homes throughout the night and during holidays.

Analog Upgrade

GMFRS' analog radios had reached the end of life, and communications were unclear, especially when used in breathing apparatus (BA), high-rise buildings and tactical ventilation scenarios. With high fault and failure rates, GMFRS faced spiralling costs and lengthy lead times for repairs. Concerns about ineffective fireground communications, which could result in firefighter injury and risks to the public and property, increased.

Operational teams on site at an emergency must be able to communicate clearly with the flexible-duty officers managing the incident from the command support unit or command unit, and vice versa. Background noise in these situations can be extreme. With sirens blaring, engines roaring and equipment running, sound levels regularly exceed 85 A-weighted decibels (dBA).

Officers identified a full set of technical requirements for the replacement of the analog fireground radios and ancillary equipment. They highlighted the previous poor and unreliable communications with BA wearers and firefighters operating noisy equipment, such as positive pressure ventilation (PPV) fans and ultra high pressure

GMFRS firefighters tested equipment in realistic scenarios at its dry rig training center.

(UHP) lances. The requirements also included the need for radios suitable for use in potentially explosive and hazardous environments and hands-free communications for the increased efficiency of all teams.

DMR Tests

U.K. supplier Radiocoms Systems recommended Motorola Solutions' MOTOTRBO radios, based on the DMR standard, with Motorola audio accessories to help suppress ambient noise, amplify loudness and improve voice intelligibility. GMFRS wanted to test the MOTOTRBO equipment at its dry rig training center. The firefighters adapted tests to properly assess the real problems and challenges they face.

During several months in 2014, the fire service conducted the tests in conjunction with Motorola Solutions because it was important for the supplier to understand the situations that fire crews are under daily, said Scoales. "We put vendor employees in so they would understand the situations, and they found it extremely difficult," he said. "One employee got lost in a room and panicked. The tests show you the conditions that the fire crews are in at all times."

The agency trialed several devices, including noise-canceling microphones, for functionality, durability and high-quality radio during a three-month period. Similar to most governmental agencies, GMFRS purchases are scrutinized so Scoales needed to ensure comprehensive tests to find the right solution.

"We tested many different scenarios with more than 105 users to get a real balanced opinion on what these radios could do," he said.

After various tests it became clear that the DMR radios were the best devices to meet all of GMFRS' requirements. The radio audio was good but the noise-canceling microphones improved the audio even with communications from officers wearing BAs. Firefighters can now clearly hear instructions through the noise-canceling earpiece. GMFRS tested a noise-canceling remote speaker microphone (RSM) next to a fire engine with its siren running. None of the communications from the analog radio test could be recorded, but the audio from the digital radio was clear.

New Equipment

The GMFRS firefighting teams use the DMR radios in every situation they are called to, including fires, floods and road accidents. The radios usually operate on the six Home Office-approved fire service channels: two for general fireground, two for incident command and two for BA. The service can use other channels for a widespread incident when GMFRS officials work alongside other agencies. The

"We tested many different scenarios with more than 105 users to get a real balanced opinion on what these radios could do."

— Mark Scoales, GMFRS

radios natively operate in digital mode; however, all channels are also available in analog mode for compatibility with other services that have not yet migrated.

The flexible-duty officers use portable two-way radios with full keypads and increased operational functionality, such as a private calling and transmit interrupt function, which allows an officer to interrupt all communications on the fireground. A portable with five programmable buttons is more suited to the firefighters, who need an easy-to-operate radio in emergency situations.

Every firefighter is now equipped with a radio, which had not previously been the case. The radios are certified for use in potentially explosive atmospheres (ATEX) and are kept on the command unit and command support unit vehicles in case the teams are called out to an incident involving hazardous materials, such as gas or petrochemicals.

BA crews wear the external noise-canceling microphone attached at chest level. In tests, this delivered 30 percent clearer communications than the alternative solution — a microphone from another supplier integrated into the breathing apparatus. And officers operating PPV fans or UHP lances use the noise-canceling earpiece. To keep their hands free to carry out their tasks, all crews wear the radios on their belts.

During a small incident, the service deploys firefighters on a LAN with the DMR radios working back to back with nothing else. For large incidents, GMFRS adds up to 12 fixed repeaters on the site for wider coverage. The repeaters are strategically placed across three command vehicles based at the Hyde, Rochdale and Atherton fire stations, which geographically offer the best coverage across the region. The fire service also has other repeaters throughout the area in hotels, shopping centers and sports stadiums, for example, and will request access to those networks if needed.

The new radios ensure future-proof efficient cross-border communications

with the other fire services in the northwest. A SmartPTT application allows officers to locate and communicate with all of the fire crew. A five-year service agreement ensures that all GMFRS radios are insured, even against accidental damage, with any damaged radios being replaced within three business days. Scoales said faults have dramatically decreased compared with the analog equipment.

Challenges and Solutions

Several teething issues were encountered when implementing the new radio system, according to a September 2015 GMFRS report. While most users saw a significant improvement, a number of issues were raised, such as:

1. Radio feedback when several users were next to each other with the volume on the higher setting;

2. The audio levels experienced with general fireground operations were high, and as such, clarity couldn't be achieved on some occasions;

3. Cross-border communications with neighboring fire services was affected because of differing radio configurations; and

4. BA users found that communications was poor. Messages could be heard/understood by the wearers inside a building; however, messages sent by the wearers could not be understood because of distortion.

To investigate and address these points, a Focus Improvement Group, which included a variety of operational staff and key stakeholders, was established. Testing of all equipment took place and solutions to the first three issues were addressed. These have since received positive feedback from stakeholders at several operational debriefs, the report said.

To address the fourth issue on BAs, Motorola Solutions produced a new RSM that connects to any BA mask. Extensive tests have been undertaken and recorded for training purposes. The tests identified several areas of improvement to the communications while in BA, including the following actions:

1. The RSM will be used;

2. BA radios will be set to a fixed operating channel;

3. Updates to training notes and standard operating procedures; and

4. An operations alert to all staff.

"The MOTOTRBO radios offer mission-critical clear communications, decisively also for BA wearers and officers operating PPV fans and UHP lances," said Scoales. "The radios offer improved functionality, flexibility and coverage. The robustness of the radios, the excellent noise-canceling accessories, the long-life batteries and the service element, all also contributed to our decision to deploy MOTOTRBO. Our firefighters' feedback has been exceptional. They now know that their messages will be heard clearly, first time." ■

RadioResource International editorial staff compiled this article. Email comments to editor@RRMediaGroup.com.

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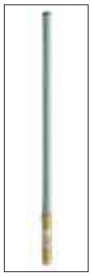
ANTENNAS

Barrett Communications

The Barrett 2019 HF automatic tuning mobile whip antenna offers continuous coverage in the 2 – 30 MHz band, rapid tuning and low power consumption. The antenna provides field-proven reliability in harsh environments and is fully compatible with automatic link establishment (ALE) operation, tracking using an onboard GPS option and data transmission when used with high duty-cycle applications, such as the Barrett 2020 email, fax and data system. The Barrett 2018 mobile magnetic loop HF antenna is a near vertical incidence skywave (NVIS) antenna and is more efficient than traditional whip type antennas, providing performance up to 4 decibels (dB) and continuous communications coverage up to 1,000 kilometers, company officials said.

www.barrettcommunications.com.au

Bird Technologies



Bird Technologies' high-performance base station antennas are designed to complement the company's wide bandwidth multicoupling systems covering the 380 – 512, 746 – 896 and 896 – 941 MHz frequency ranges. Through a true corporate-feed design, equal in-phase power is distributed to each radiating element to ensure excellent vertical pattern control and shaping, low loss and beam tilt that does not vary over the operating bandwidth of the antenna, company officials said.

www.birdrf.com

Codan Radio Communications

The 3040 automatic whip antenna is a low-profile, high-performance mobile antenna for Codan's HF radios. Fast tuning, a compact form factor and rugged construction combine to provide a state-of-the-art mobile antenna tuner product, company officials said. The antenna is built to withstand severe conditions often experienced in mobile HF radio deployments. Internal electronics are protected by a lightweight composite shroud and vibration-absorbing mount to provide a product that is fully waterproof and Mil-Std-810F compliant for temperature, immersion, vibration and dust ingress.

www.codanradio.com

Comprod Communications

The F-3749 tri-band antenna provides long-lasting reliability and performance for in-building applications and public transport vehicles. The antenna allows coverage for more than three frequencies and comes in a variety of configurations, designs and specifications. Fire-retardant 6200 Kydex radomes meet recommended fire safety practices for smoke emission and flammability as tested under ASTM E-662 and ASTM E-162.

www.comprodcom.com

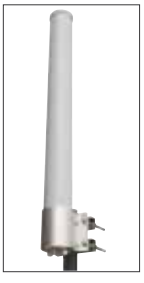
dbSpectra

A new UHF dual omnidirectional antenna from dbSpectra is passive intermodulation (PIM) certified and features 45 decibels (dB) of isolation between antenna sections for maximum versatility and protection from interference, company officials said. The antenna operates in the 450 – 470 MHz frequency range, provides 6 decibels related to the dipole (dBd) of gain per antenna, and leverages the company's 7.6-centimeter omni platform, all with an optimized elevation pattern and low-PIM performance. The antenna is the first in a new line of antennas targeted for the UHF frequency band suitable for demanding environments, including mission-critical applications.

www.dbspectra.com

L-Com

The HyperGain HG2458-DPU series includes 802.11ac four-by-four multiple input multiple output (MIMO) outdoor omnidirectional, dual-polarized/dual-frequency antennas. The antennas are professional high-gain, dual-band base station antennas designed and optimized for 2.4 and 5 GHz frequencies. The antennas are suited for multipoint applications where long range and wide coverage is desired. The series offers 360-degree omnidirectional antennas with patent-pending technology. The antennas are available in 6, 9 and 11 decibels-isotropic (dBi) versions off the shelf.



www.l-com.com

Linx Technologies

The WRT series includes compact and tamper-resistant antennas designed for applications where the physical security of the antenna is important, such as vending machines and traffic equipment. The antenna mounts through a hole in the product case and is secured with a nut or threaded fastener. Available in 418, 433, 868 and 916 MHz and 2.45 GHz versions, the antennas attach to a 216-millimeter RG174 cable with an SMA or FCC Part 15-compliant RP-SMA connector on the other end. The 868 and 916 MHz and 2.4 GHz models are also available with a 1.32-millimeter cable and U.FL/MHF compatible connector.

www.linxtechnologies.com

MicroMagic

The UHF unit gain fiberglass antenna with a mast mount features a frequency range of 400 – 470 MHz and a gain factor of 5 decibels (dB). The antenna offers bandwidth of 5 megahertz, omni radiation pattern, vertical polarization and series-fed mounting array. The antenna operates in temperatures from -40 to +80 degrees Celsius and comes with an N-female connector.

www.micromagic2way.com

MiMOMax Wireless

The MiMOMax 900 MHz compact panel antenna comes in two sizes — 10 and 12.5 decibels isotropic (dBi). Both antennas operate in the 906 – 960 MHz frequency range. The antennas are highly versatile base station antennas that perform well in various weather conditions, including heat, humidity, ice, snow and strong wind, company officials said.

www.mimomax.com

Mobile Mark

The LTB series blade-style antenna combines two cellular or Long Term Evolution (LTE) elements and one GPS element in a slim, compact radome. The cellular elements cover 694 – 960 MHz and 1.71 – 2.7 GHz frequencies. The antenna's slim profile measures 19 by 3.8 by 10 centimeters. The product is designed to mount on utility cabinets or National Electrical Manufacturers Association (NEMA) boxes but can be mounted in any setting where a slim profile is desired. The antenna is ground-plane independent and designed to perform on either a fiberglass or metal box. The antenna can be attached to the box through a single mounting hole that accommodates all three cable connections.

www.mobilemark.com

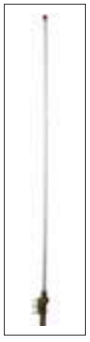
Panorama Antennas

The TRNM[G] range offers two-by-two multiple input multiple output (MIMO) coverage across the 698 – 960 MHz and 1.71 – 6 GHz bands with optional active GPS at 26 decibels (dB) low-noise amplifier (LNA). Designed to meet applicable industry standards, the products are ideal for providing high-speed data on trains, trams, buses and

light rail vehicles. Because the products combine MIMO cellular and GPS functions inside a single housing, only one antenna is required for several functions, making installation, maintenance and decommission quick and easy, company officials said. Housed in a high-impact, flame-retardant Lexan housing, the series is fully weatherproof, ensuring uncompromised performance, company officials said.
www.panorama-antennas.com

Procom

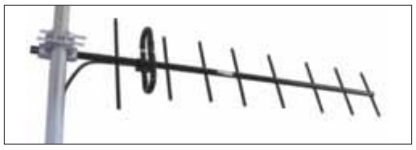
The CXL 900-3LW is a 3 decibels related to the diploe (dBd),



vertically polarized, omnidirectional rod-type base station and marine antenna, covering the 900 MHz band in three models. The antenna is vibration-proof, lightweight, slim and corrosion resistant. The broadbanded antenna element is sealed in a high-quality, conical glass fiber tube with a low wind load, ensuring performance is not disturbed by corrosive environments. The product comes with a sturdy LW mast mount — a lightweight, multipurpose, epoxy-coated mounting bracket made of noncorrosive aluminum. The antenna supports a large bandwidth with respect to standing wave ratio (SWR) and gain.
www.procom.dk

Radial Firm

The Y9-T antenna operates as a part of communications systems in regions with challenging climates. An all-welded design makes it invulnerable to icing and strong wind, while a polymeric



coating protects it from hostile environments. The company's D1 VHF antenna is a folded Pistolcors dipole configuration that provides wideband functionality and relatively low susceptibility to technical interference. Collapsible construction allows easy mounting and dismounting, and the welded dipole eliminates intermodulation. The emitting unit directional pattern can be slightly corrected by changing the distance to the mast. An all-metal construction provides reliable lightning protection.
www.radial.ru

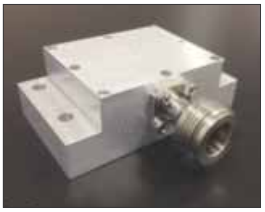
Radio Frequency Systems (RFS)

RF X-TREME base station antennas provide high-performance, triple-band capability in a compact dual-band package without

compromising electrical performance. Enhancements provide greater flexibility for cell site optimization with increased tilt range, improved sector power ratio (SPR) and simplified installation. The series allows a higher percentage of energy to be broadcast or received within the 65-degree beamwidth and a higher electrical tilt range in the low band. RFS offers optional integrated bias tees, eliminating the need for Antenna Interface Standards Group (AISG) cables from tower-mounted amplifiers (TMA).
www.rfsworld.com

Response Microwave

Response Microwave's compact termination is for use in high-power automatic test equipment (ATE) or production appli-



cations. The RMTE.12000Nf100 provides DC – 12 GHz coverage with maximum VSWR of 1.20:1 over the band. The 100 watt (W) average power is handled via a small package measuring 5.8 by 3.3 by 2 centimeters. Units are standard with N female connectors but TNC options are also available. The unit's housings are made from clear iridite aluminum with stainless/passivate connectors.
www.responsemicrowave.com

RFI

RFI's range of broadband panel antennas are ideal for coverage in corridor and sectorized applications. The antennas are avail-

able in two high-gain versions — 8 and 14 decibels isotropic — with a 500-watt (W) power handling capability, 65-degree beamwidth and a passive intermodulation (PIM) rating of -150 decibels relative to carrier (dBc). The antennas suit rigorous base station requirements and are fully enclosed to aid installation, provide waterproofing and resist bird attacks. The antennas offer full band coverage over the 380 – 430 MHz band with future capability in the 330 – 380 MHz band, company officials said.
www.rfiwireless.com.au

Royal Communications International

The CWA-125 is a small footprint, 125-watt (W), long-range antenna that improves communications for HF/single side band (SSB)

1.6 – 30 MHz links. Assembly and installation of the antenna is simple and can be done with two people in as little as 20 minutes, company official said. Designed to be mounted to a pole or U-bolt to a wall, the product's total installed height is 3.7 meters and includes four 1.8-meter loaded whip antennas. The antenna has been installed and tested in many adverse environments with excellent results for medium and long-range communications, company officials said.
www.royal-communications.com

STI-CO Industries

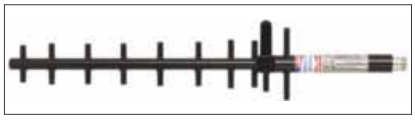
STI-CO's steel tactical ground plane kit deploys in minutes and

improves field communications, eliminating performance degradation because of lack of appropriate ground plane, company official said. The product is designed to work with existing magnets or NMO antennas covering UHF, VHF and 3G/4G networks. The tactical ground plane is tough, durable and corrosion resistant, with aluminum tripod and custom STORM case options. The product is made in the United States.

www.sti-co.com

Telewave

Telewave's ANT2045Y12-WR and ANT2400Y12-WR yagi antennas cover 1.92 – 2.17 and 2.4 – 2.5 GHz respectively. Measuring 46 – 61 centimeters long, the lightweight antennas are ideal for handheld use with portable analyzers or as a wireless donor link. Each antenna provides 14 decibels isotropic (dBi) gain with a typical 30 decibels (dB) front-to-back ratio, and is completely coated for full environmental protection. An N-female or 7-16 DIN connector is permanently mounted in the end of the boom. Several types of optional mounting hardware are available, including a rotatable universal mount for precise positioning on a variety of supports.



www.telewave.com

Webb Industries

Webb Industries provides bespoke solutions for industrial applications, including extra-rugged whip antennas with a strengthened attachment between the whip and the spring, popular in industrial and agricultural applications. Robust, short, helical-type antennas are used mainly in mining and cash-in-transit industries. Very low profile (VLP) Iridium antennas from 3 millimeters (mm) thick are used in the tracker industry. The company offers 2.4 GHz, wideband cellular and 900 MHz industrial, scientific and medical (ISM) antennas in a 3-mm format.

www.webb.co.za

Westell Technologies

The ClearLink passive intermodulation (PIM)-certified multiband directional antenna has PIM specification of -153 decibels relative to carrier (dBc). The multiband design has an indoor and outdoor weather-resistant radome and covers frequency ranges

of 698 – 960 MHz and 1.71 – 2.69 GHz. The antenna is suitable for cellular and Long Term Evolution (LTE) in-building applications. With a VSWR rating of less than or equal to 2-to-1 in the 698 – 806 MHz band and less than or equal to 1.8-to-1 in the 806 – 960 MHz and 1.71 – 2.7 GHz frequencies, the antenna is suitable for any in-building network.

www.westell.com

TEST EQUIPMENT

AaroniaUSA

The Spectran HF6000 series of professional-level RF spectrum analyzers features superior sensitivity and resolution specifications and is ideal for precompliance testing, field interference tracking (DF), research and development, radiated and conductive exposure and limits testing, and general RF spectrum analysis. The HF 60105 analyzer has a frequency range of 1 MHz to 9.4 GHz, with a 9 kHz option. The analyzer has a peak power detector of 10 GHz, with a level minimum of -120 decibel-milliwatts (dbm) and a level maximum of 20 dbm. An internal 15 decibel (db) pre-amplifier, 1.8-meter USB cable, rubber rod omnidirectional antenna, software and documentation are included.

www.aaroniausa.com

Bird Technologies

The SignalHawk cable and antenna analyzer brings a modular approach to RF spectrum analysis. The product has the same spectrum analyzer functionality as the company's handheld models and rack-mount products but is configured as a stand-alone unit. Weighing only 1.6 kilograms, the analyzer is a lightweight solution in a small 19-by-17.8-by-7.6 centimeter package. No special connectors are required to connect the analyzer to a computer because it communicates directly through a standard USB port.

www.birdrf.com

Cobham AvComm

With its hybrid portable design and large color touchscreen display, the 8800S provides laboratory-grade measurements in a portable test solution. RF power measurements range from -140 decibel-milliwatts (dBm) to 500 watts (W). Providing both digital radio test capabilities, VSWR and distance-to-fault (DTF) cable and antenna tests, the system is ideal for testing Project 25 (P25), P25 Phase 2, Digital Mobile Radio (DMR), digital Private Mobile Radio (dPMR) and NXDN LMR systems. Weighing only 7.7 kilograms with more than 2.5 hours of internal battery and a 30 G shock rating, the product provides critical test functions without compromising portability, company officials said.

www.aeroflex.com

Davicom, div. of Comlab

Davicom's intelligent site monitoring solutions remotely monitor and control transmitter sites and unattended studios via Simple Network Management Protocol (SNMP), Modbus and general-purpose input/output (GPIO), allowing reduced operating costs and downtime. Immediate access to real-time site information, such as transmitter status, RF power, antenna VSWR, audio/video levels, mains power presence, temperature, tower lighting, fire alarm and building security status, are easily accessible. The units provide automation with decision-making features and commands that go beyond conventional telemetry systems.

www.davicom.com

Doppler Systems

DDF7000 series radio direction finders operate from 100 MHz to 1 GHz, enabling operators to find interference sources, stuck transmitters and nefarious jammers. Doppler Systems incorporated nearly 35 years of experience into the design and manufacture of the series, including fixed site and mobile systems. The included TargetTrack software provides a map-based display of the measured bearings, as well as a prediction of the location of the transmission source. Multiple direction finders can be networked to provide instantaneous measurement of the transmitter location.

www.dopsys.com

Freedom Communication Technologies

The R8000C is a portable LMR test set with complete benchtop functionality. Servicing Project 25 (P25) Phases 1 and 2, Digital Mobile Radio (DMR), NXDN, TETRA and digital Private Mobile Radio (dPMR), the product also has complete analog radio test capability available at any price. Because the test set is a software-defined instrument, options can be quickly added in the field. The 6.35-kilogram product operates to 3 GHz and has industry-leading spectral purity, company officials said. AutoTune options allow operators to automatically test and align radios to manufacturer specifications as quickly as 10 minutes.

www.freedomcte.com

Keysight Technologies

The N9914A FieldFox handheld RF analyzer delivers precise

microwave measurements in a portable package that match benchtop results up to 50 GHz. The standard model includes

cable and antenna analyzer functions, while expanded capabilities include optional vector network analyzer (VNA), spectrum analyzer, built-in power meter and vector voltmeter capabilities. Distance-to-fault (DTF) and time domain reflectometry (TDR) are measured in the same sweep. The product simultaneously measures all four S-parameters, makes accurate spectrum analyzer measurements (±0.5 decibels) without warmup and is lightweight at 3 kilograms.

www.keysight.com

Multiple Access Communications (MAC)

The CRIBS RF walk-test and drive-test survey system is used

in Europe, the Middle East and Asia for TETRA transportation systems. The product's sampling technique simultaneously monitors all channels of interest. Positional information is provided by GPS input or during walk testing by manually inputing waypoints via the provided tablet PC onto an imported floor layout drawing. Processing on the fly provides the surveyor with information that can be analyzed in situ. The turnkey solution includes a CatchAll measurement receiver and capture and analysis software.

www.macltd.com

Narda Safety Test Solutions

Using Interference and Direction Analyzer (IDA) 2's high-resolution spectrogram display mode, the type of signal or finger-

print can be identified. The instrument writes the spectra line by line, with levels indicated by different colors, allowing time and spectral relationships to be seen immediately. With time resolution as fine as 1 microsecond (µs), for example, Long Term Evolution (LTE) frame structures can be displayed, with any underlying dissimilar signals being immediately apparent because of their different frequency and time characteristics. The frequency and time signatures 2/4 allow conclusions about the type of source to be drawn and mutual interference detected in multi-use frequency ranges such as the industrial, scientific and medical (ISM) bands.

www.narda-sts.com

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Optoelectronics

The CD100 is a frequency counter/subaudible tone decoder with a frequency range of 10 MHz to 1 GHz. The product captures signals from two-way radios and instantly displays the frequency along with the CTCSS, DCS, DTMF and logic trunked radio (LTR). Ideal for frequency and tone coordination during emergency situations, setting up radios in the shop or at remote sites, the product reduces the need for a service monitor at the job site. The battery-operated, handheld unit is simple to use even for nontechnical personnel.

www.optoelectronics.com

Praxsym

Model 310-010108-014 is a wideband, portable continuous wave (CW) test source capable of transmitting test signals on two channels simultaneously. Each channel contains a scanning function, allowing the user to enter up to four output variations (level and frequency) and scan through them at a desired rate. The output from each channel can be adjusted between -10 and 12 decibel-milliwatts (dBm) in 0.1 decibel (dB) steps, while providing frequencies in the 698 – 960 MHz and 1.71 – 2.17, 2.305 – 2.36 and 2.495 – 2.69 GHz bands. The internal rechargeable batteries allow for between six and eight hours of continuous operation.

www.praxsym.com

Signal Hound

The BB60C is a broadband real-time spectrum analyzer and RF recorder that captures RF events as short as 1 microsecond (µs). With accurate operation from 9 kHz to 6 GHz over its entire temperature range of -40 to 65 degrees Celsius, the analyzer is well suited for capturing intermittent events in addition to performing complex and remote functions. As a spectrum analyzer, a proprietary application programming interface (API) can perform up to 1.2 million fast Fourier transform (FFT) spectrum or 320 million FFT points every second, delivering real-time spectrum data to the company's Spike software or third-party software applications.

www.signalhound.com

Spectracom

Spectracom's Path Align-R test set for microwave antenna alignment is a high-performance, complete test solution designed to quickly and accurately optimize the transmission path between two microwave antenna sites. The product provides precise alignment results in about 20 minutes and directly drives the site's antennas, allowing the optimization process to be done without on-site radios, complex test equipment, ground technicians, on-site AC power, cellphones or two-way radios. Proof of alignment is provided with recorded and documented records.

www.spectracomcorp.com

Sunsight Instruments

Antenna Alignment Tools (AAT) ensure RF antennas are installed to accurate RF design position in azimuth, tilt, roll and height. The protected information is recorded in a report along with precise antenna GPS position coordinates for operator records. Durable and versatile, the tool saves labor hours and commissioning timelines with quick path alignment using a patented auto-alignment kit. Units automatically calculate values based on accurate coordinates and height, which are sent to the opposite side's unit. The product aligns links in minutes instead of hours or days without power, signal or frequency requirements and can be completed with or without installed radios.

www.sunsight.com

Survey Technologies Inc. (STI)

To simplify Project 25 (P25) network testing, Survey Technologies Inc. created the best server quality measurement (BSQM) capability, which enables entire P25 networks to be performance tested dynamically in a single drive test. All network frequencies are scanned, and then test mobiles are tuned to the best frequencies where quality and performance measurements are rapidly conducted. Meanwhile, the scanner re-tests all network frequencies for the strongest signals at the next location, retuning the test mobiles again for rapid quality tests. In this way, drive testers can quality test entire P25 wireless networks in one drive study.

www.surveytech.com

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Radio Accessories

DMR Radio

Hytera Mobilfunk introduced the PD415 radio that supports both conventional Digital Mobile Radio (DMR) and analog and comes with an RF identification (RFID) reader.

Other features include mixed channel operation, an open application programming interface (API) for RFID-based third-party developments, support for pre-programmed text message transmission and TDMA direct mode. Users can integrate the radio into the Hytera Patrol System, which monitors the position of security personnel in real time on a digital map. The patrol system comes with management software, RFID identity cards and check points.

www.hytera-mobilfunk.com

ATEX dPMR Radio

Icom UK's IC-F3202DEX ATEX digital radio satisfies the International Electrotechnical

Commission's (IEC) Ex/ATEX intrinsically safe specifications and supports conventional digital Private Mobile Radio (dPMR) operation and dPMR mode 2 multisite radio systems. The radio can also be used as an analog ATEX system and has built-in five-tone CTCSS and digital tone code squelch (DTCS) signaling capability for analog mode group communications and selective calling, company officials said. Lone-worker and man-down functions automatically send an alert when a worker gets in trouble. The product has IP67 water and dust protection and can withstand submersion in up to 1 meter of water for 30 minutes.

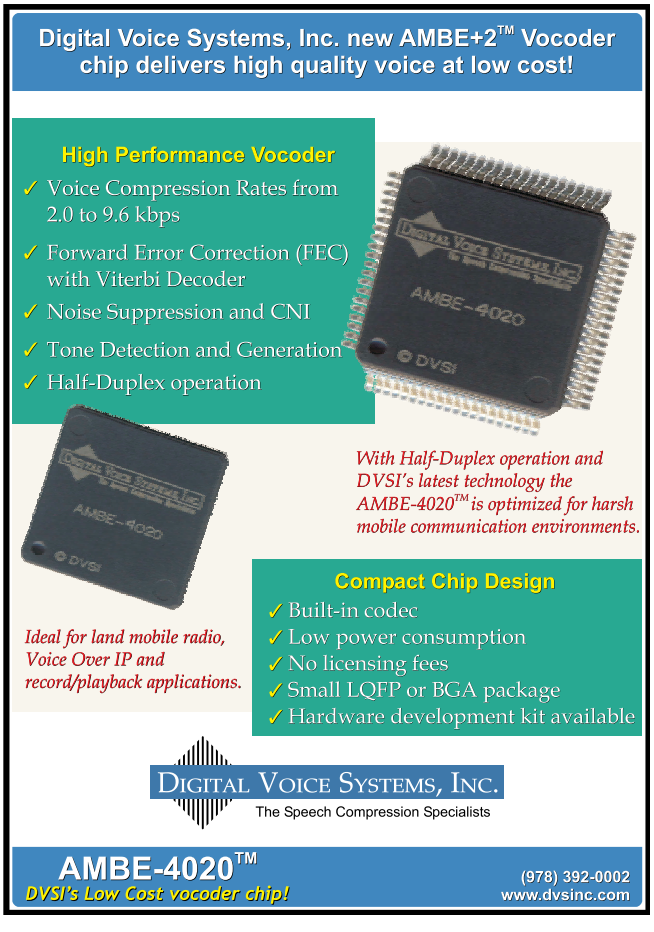
www.icomuk.co.uk

Portable Radio and RSM

Sepura's SC20 series of portable radios, including the SC2020 and SC2040, cover the 380 – 430 and 403 – 470 MHz bands and have a class 3 TETRA engine and receiver that exceeds European Telecommunications Standards Institute (ETSI) standards. Other features include audio capability of 2 watts (W) and waterporting technology for audio clarity even in heavy rain. IP66, 67 and 68 ratings make the radio dustproof, submersible up to 2 meters for an hour and resistant to jets of water, company officials said.

The company also introduced the sRSM all-weather remote speaker microphone (RSM) that has IP67 environmental protection and waterporting technology for clear audio, even in continuous, heavy rain. The product works with the company's STP and SC20 series radios and can be used with gloved hands or in poor light, company officials said.

www.sepura.com



Tactical Radio and Trunking System

Motorola Solutions launched the SRX 2200 combat radio in Latin America and the Caribbean. The unit offers tactical security functions including individual location information (ILI), text messaging between radios, tactical over-the-air rekeying (OTAR) and radio inhibit to remotely disable radios. Over-the-air programming (OTAP) allows users to change any programming parameters on the device and can enable or disable a radio. Other features include an IP67 rating for dust and water protection, a multiunit charger that can charge at high temperatures and Project 25 (P25) compliance.

The MOTOTRBO Capacity Max trunking system is scalable from small, single-site systems to large, complex projects with up to 3,000 users. The system uses a standard IP network with a centralized server that helps reduce costs, company officials said. Advanced Encryption Standard (AES) encryption is incorporated, and the product supports the company's MOTOTRBO application developer program, allowing for access to a variety of in-house and third-party applications.

www.motorolasolutions.com

Covert DMR Radio

Excera launched a Digital Mobile Radio (DMR) covert radio that complies with DMR Tier 2 conventional and Tier 3 trunking and Professional Digital Trunking (PDT) standards. The radio has a thin, rugged body with IP67 protection and 256-bit Advanced Encryption Standard (AES) digital encryption. Other features include full-duplex communications and a large, high-definition (HD) LCD.

www.excera.com.cn

DMR SCADA Portfolio

Simoco announced its Pulse portfolio, which allows organizations to control smart grids and networks across vast operational areas, company officials said. The products allow users to quickly deploy supervisory control and data acquisition (SCADA) telemetry applications over Digital Mobile Radio (DMR) Tier 3 trunked networks. The Pulse AIR and AIR Pro data modems interface with any remote transmitter unit (RTU) that uses standard telemetry protocols and transport data back to SCADA master controls over licensed VHF or UHF channels. The Pulse ELITE integrated RTU is for in-field deployments; has digital and analog outputs; and collects data and status information from equipment such as actuators, meters, switchgear and programmable logic controllers (PLCs). Gateway products enable SCADA master controls to interface with digital radio infrastructure, making it transparent to the SCADA application.

www.simoco.com

DMR Base Station

Tait Communications introduced the TB7300 base station/repeater that operates in Digital Mobile Radio (DMR) Tiers 2 and 3 and analog modes and provides a software flexible migration path between platforms, company officials said. The product provides remote network management and monitoring, Simple Network Management Protocol (SNMP) capability and IP-linked nodes for multisite network capability. The base station provides output of 50 watts (W) with a 100 percent duty cycle and typical input power of 13.8 volts direct current (VDC). The product is compatible with the company's TaitEnable application suite and its DMR Access and Express solutions.

www.taitradio.com

P25 Repeater

Codan Radio Communications announced the Stratus Fixed Site Project 25 (P25) repeater that allows organizations to use publicly available 3G/Long Term Evolution (LTE) cellular networks for backhaul of P25 radio traffic into dispatch. The repeater, which can replace costly leased links and T1 connections, can connect up to four Codan base stations and/or repeaters over a single cellular link, company officials said. The product is interoperable with all P25-compliant subscriber units and consoles.

www.codanradio.com

PTT Application

The Tactilon Suite TSA application from **Airbus Defence and Space** allows smartphones to connect and communicate with TETRA radios or smart devices. The application gives smartphones push to talk (PTT) and other TETRA capabilities and runs on any standard 3G, 4G or Wi-Fi network. The application provides group and individual calling, group scanning, and status and short data messages.

www.airbusdefenceandspace.com

Wireless Intercom System

McMurdo introduced the SABRE CommLink wireless intercom system that provides secure digital communications, no-loss voice activation and dual-band VHF/UHF support. Multiple preprogrammed groups allow simultaneous communications within operational teams. An integrated, self-adapting noise-canceling microphone provides clear audio quality in challenging environments, company officials said. The device has multiple operational modes including headset, walkie-talkie and peer to peer (P2P). The product is IP68 rated, has integrated GPS and automatic identification system (AIS) that allow ground asset tracking, and has a

10-kilometer intercom range.
www.mcmurdogroup.com

Firefighter Headsets

Imtradex introduced the FireTalk EN443 and S EN443 helmet sets that fit most helmets and ensure smooth communications in intense heat. The helmet sets consist of a waterproof and noise-canceling electret gooseneck microphone, splash-proof housing and transmit buttons. The helmet sets weigh less than 200 grams and can either be screwed on or flexibly reconnected.

www.imtradex.com

Industrial Headset

Sensear announced the SM1R industrial headset that uses the company's SENS technology and a noise-canceling boom microphone to allow users in high-noise environments to communicate either face to face or on two-way radios while maintaining 360-degree audible awareness. The headset supports radios from Motorola Solutions, JVCKENWOOD, Harris, Hytera Communications, Icom, Vertex Standard and Tait Communications. The product is powered by the user's radio.

www.sensear.com

Vocoder Chip

Digital Voice Systems Inc. (DVSI) announced the AMBE-4020 FD full-duplex vocoder chip that offers data and forward error correction (FEC) rates from 2 – 9.6 kilobits per second (kbps). The chip provides low-power operation of less than 29 milliwatts (mW) for encoder, less than 20 mW for decoder, less than 38 mW for full duplex and less than 20 microwatts (µW) for sleep mode. Other features include push-to-talk (PTT) signaling, automatic voice/silence detection (VAD), adaptive comfort noise insertion (CNI), DTMF, low power modes, and call progress tone detection and regeneration. A built-in 16-bit analog-to-digital converter (ADC) and 12-bit digital-to-analog converter (DAC) reduce additional hardware requirements, company officials said.

www.dvsinc.com

DMR Chipset

CML Microcircuits released a Digital Mobile Radio (DMR) chipset that includes a low-power RF direct conversion receiver (DCRx) integrated circuit (IC) and professional mobile radio (PMR) common platform processor with the DMR air interface

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and coding embedded within a Function Image. The Function Image implements most of the DMR air interface protocol including the physical layer 1 and data link layer 2 and complies with the European Telecommunications Standards Institute's (ETSI) TS 102 361 DMR standard. The processor includes an embedded audio codec that supports both software and hardware implementations of the AMBE+2 vocoder. The IC connects directly to the processor, and the Function Image automatically sets up and manages the RF section. The chipset occupies a small printed circuit board (PCB) footprint.

www.cmlmicro.com

TETRA Repeater and ATEX Antennas

The CBBR-400 from **antennaPRO** is a band-selective repeater for 400 MHz TETRA systems in areas that cannot be covered economically by base stations. Users can set the repeater locally or remotely using remote control software. The product has maximum output power of 21 decibel-milliwatts (dBm) and 40 – 70 decibels (dB) of gain.

The company also introduced the CXL 150-3LW-Ex and CXL 2400-3LW-Ex ATEX-certified omnidirectional base station antennas that cover the 146 – 175 MHz and 2.2 – 2.7 GHz bands. The antennas are vertically polarized; have 3 decibels-dipole (dBd) gain; and are specified for use in gas groups IIA, IIB and IIC in zone 2. A broad-banded antenna element is sealed in a glass-fiber tube with a low wind load. All metal parts are direct current (DC) grounded.

www.procom.uk.com

Microwave Router

Aviat Networks' CTR 8380 outdoor microwave router combines microwave, IP and multiprotocol label switching (MPLS) capabilities into one device. The device eliminates the need for shelters or cabinets and is suitable for rooftop locations and all-outdoor macrocell and small cell connectivity, company officials said. The product extends IP/MPLS to the cell site, improving network scalability and enabling IP-based virtual private network (VPN) services, company officials said.

www.aviatnetworks.com

GSM-R Tester

Cobham Wireless introduced the 2201R railway communications tester that connects directly to GSM-R devices and provides fast and accurate RF measurements for voice, data and short message service (SMS) operations. The device can simulate group calls at various priority levels to verify the performance of cab and mobile radios and optical and acoustical alarms. The three test modes are manual; autotest, which allows testing without a PC; and remote control, which uses the company's 7310 Lector or Scriptor products to perform tests remotely. The device has optional battery operation with up to 2.5 hours of life and weighs 6.2 kilograms.

www.cobham.com/wireless

Vehicle Mount Antenna

The Panther GPSMB501 GPS/multiband vehicle-mount antenna from **Pulse Electronics** features five connectors that support two multiple input multiple output (MIMO) cellular, two dual-band MIMO WLAN and one global navigation satellite system (GNSS) options. The antenna delivers 40 decibel (dB) isolation across Wi-Fi-to-Wi-Fi ports and more than 15 dB across Long Term Evolution (LTE)-to-LTE ports. The product has a VSWR of less than 1.5:1 in LTE bands and 1.4:1 in Wi-Fi bands. A GPS low-noise amplifier (LNA) enhances isolation and provides out-of-band rejection of more than 55 dB in the 1.71 and 2.17 GHz frequency bands and more than 75 dB in the 824 and 960 MHz bands.

www.pulseelectronics.com

FPC Antennas

Antenova introduced three flexible printed circuit (FPC) board antennas that are 0.15 millimeters thick and weigh less than 0.5 grams. The dual-band Dromus and Amoris Wi-Fi antennas operate in the 2.4 – 2.5 and 4.9 – 5.9 GHz spectrum bands and are suitable for network devices, wearable technology, access points and portable electronics. The Montana antenna operates in the 863 – 870 and 902 – 928 MHz industrial, scientific, and medical (ISM) bands and is suitable for use in industry, remote sensors, smart metering, monitoring equipment, security, medical devices and lighting.

www.antenova.com

Radio Test Reference

Keysight Technologies announced a PXI open radio test reference solution and radio test audio library that allow engineers to evaluate and integrate core test measurement capabilities into validation, production or depot test systems, company officials said. The reference solution supports traditional digital and analog radio standards, as well as standards-based signal creation and analysis for Long Term Evolution (LTE). The reference solution can also generate and analyze custom waveforms and supports advanced capabilities such as spurious emission measurements up to 27 GHz. The products can be used with Keysight's signal analyzers, vector signal analyzers and X-Series applications.

www.keysight.com

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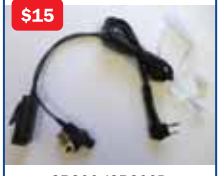
$29 PMLN5811	$25 PMLN4216G	$19 PMLN4553A	$15  CP200/CP200D	$19 XPR 6550/7550/3500	$39 PMK4016A

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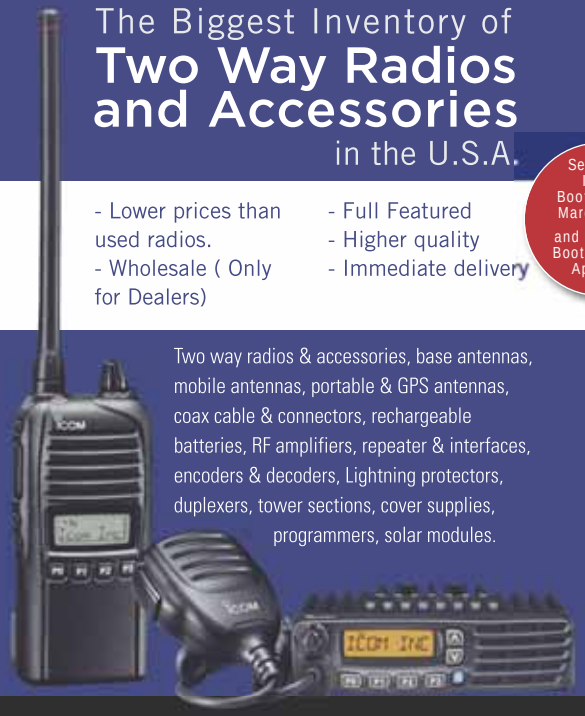

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2. Which of the following best describes your organization?
❑ A Mobile Communications Dealer/Reseller
❑ B Distributor, Agent, Importer, Exporter, Rep
❑ C Commercial Trunked Radio and Other Wireless Service Providers
❑ D Government/Public Safety/Military
❑ E Business/Industrial/Transportation User
❑ F Communications Manufacturer/OEM/Software Developer
❑ G Engineering and Consulting Firm
❑ Z Other—please specify _____

3. What is your function?
❑ A Corporate/Senior Management
❑ B Operations/Administration Management
❑ C Technical/Engineering Management
❑ D Sales/Marketing
❑ Z Others Allied to the Field—please specify _____

4. Do you recommend, specify or purchase mobile communications equipment or services?
❑ A Yes ❑ B No

5. Is there any servicing of mobile communications equipment at your location?
❑ A Yes ❑ B No

6. In what areas of the world do you do business? (mark all that apply)
❑ A Western Europe
❑ B Eastern Europe
❑ C Middle East
❑ D Asia
❑ E Australia/New Zealand
❑ F Africa
❑ G Mexico/Central and South America
❑ H United States/Canada

7. What wireless technologies does your organization plan to use/buy over the next 2 years? (check all that apply)
❑ A Conventional Two-Way
❑ B Cellular/Personal Communications
❑ C Paging/Messaging
❑ D Mobile Data
❑ E SCADA/Telemetry
❑ F Microwave radio
❑ G Trunking
❑ H Location Technologies
❑ I Tone Signaling (ANI, Encryption, etc.)
❑ J Interconnect
❑ K Satellite
❑ L CAD
❑ M Wireless Broadband
❑ Z Other _____

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21 – 25 March: International Wireless Communications Expo (IWCE), Las Vegas. Penton Media: www.iwceexpo.com

22 – 23 March: British APCO (B-APCO) Exhibition and Conference, Telford, United Kingdom. British Association of Public-Safety Communications Officers (BAPCO): www.bapco-show.co.uk

22 – 23 March: SafeRail and PTC World Congress, Washington, D.C. Global Transport Forum: www.saferailcongress.com

23 – 24 March: Microwave & RF, Paris. Bureau International de Relations Publiques: www.microwave-rf.com

6 – 7 April: LTE Latin America, Rio de Janeiro. Informa Telecoms & Media: http://latam.lteconference.com

6 – 8 April: EENA Conference, Prague. European Emergency Number Association (EENA): www.eena.org

14 – 15 April: Comms Connect, Wellington, New Zealand. Westwick-Farrow Media: www.comms-connect.co.nz

19 – 20 April: SmartRail Europe, Amsterdam. Global Transport Forum: www.smartraileurope.com

26 – 28 April: Dynamic Spectrum Alliance Global Summit, Bogota, Colombia. Dynamic Spectrum Alliance (DSA): www.dynamicspectrumalliance.org/global-summit

9 – 11 May: LTE MENA, Dubai, United Arab Emirates. Informa Telecoms & Media: http://mena.lteconference.com

31 May – 2 June: Critical Communications World, Amsterdam. TETRA + Critical Communications Association (TCCA) and Informa Telecoms & Media: www.criticalcommunicationsworld.com

31 May – 3 June: CommunicAsia, Singapore. Singapore Exhibition Services: www.communicasia.com

7 – 9 June: Critical Communications Expo (CCExpo) and General Police Equipment Exhibition and Conference (GPEC), Leipzig, Germany. Exhibition and Marketing Wehrstedt: www.police-exhibition.eu

22 – 23 June: Comms Connect, Sydney. Westwick-Farrow Media: http://sydney.comms-connect.com.au

28 – 30 June: 5G World Summit, London. Informa Telecoms & Media: www.5Gworldevent.com

14 – 17 August: APCO Conference & Expo, Orlando, Florida, USA. Association of Public-Safety Communications Officials (APCO) International: www.apco2016.org

14 – 16 September: VSAT, London. Informa Telecoms & Media: http://vsatevent.com

21 – 22 September: Emergency Services Show, Birmingham, United Kingdom. Broden Media: www.emergencyuk.com

26 – 28 September: LTE Asia, Singapore. Informa Telecoms & Media: http://asia.lteconference.com

4 – 6 October: LTE Voice Summit, London. Informa Telecoms & Media: http://voice.lteconference.com.

7 – 8 November: Critical Communications Middle East, Dubai, United Arab Emirates. TETRA + Critical Communications Association (TCCA) and Informa Telecoms & Media: www.criticalcommunications-me.com

15 – 17 November: LTE Africa, Cape Town, South Africa. Informa Telecoms & Media: http://africa.lteconference.com

22 – 24 November: PMR Expo, Cologne, Germany. Bundesverband Professioneller Mobilfunk: www.pmrexpo.de

23 – 24 November: Comms Connect, Melbourne, Australia. Westwick-Farrow Media: http://melbourne.comms-connect.com.au

30 November – 1 December: U.K. Security Expo 2016, London. U.K. Security Expo: www.uksecurityexpo.com

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South Korea Plans Nationwide LTE Network to Boost Interoperability

By Sandra Wendelken, Editor

Seoul, South Korea

South Korean mission-critical organizations operate their own voice-oriented networks on a variety of frequency bands and technologies. VHF networks comprise about 40.1 percent of the mission-critical communications market, and TETRA networks comprise about 38.3 percent of the market. Nearly 15 percent of the market includes UHF networks, with iDEN at 5.1 percent and WiMAX systems at 1.6 percent.

The country includes about 330 police, fire, EMS, coast guard, military, local administration office, electricity and gas organizations comprising about 200,000 total users.

"The Sewol ferry disaster brought attention to the urgent need for establishing a nationwide public-safety broadband network for sharing information and communicating among public-safety agencies," said Dujeong Choi, general manager, public safety communication team, South Korea's Telecommunications Technology Association (TTA).

On 16 April, 2014, the Sewol ferry capsized off the South Korean coast while carrying 476 people. There were 172 survivors. Response efforts were hindered by a lack of interoperability from responding agencies.

In July 2014, the South Korean government adopted plans to build a broadband network dedicated to public safety using Long Term Evolution (LTE) technology to be deployed nationwide by 2017. The plan calls for 20 megahertz of dedicated spectrum in band 28 at 700 MHz.

The goal of the project is to build an integrated network that supports various multimedia services and coincides with the evolution of technology trends, Choi said. In principle, the network will be used for voice and data. There are multiple solutions being considered as an interim solution to substitute mission-critical voice services before the mission-critical push-to-talk (PTT) standard is finalized.

The network will be rolled out in phases, focusing on the rural provinces first. Phase one will be established in the Gangwon Province, which is where the 2018 Winter Olympics, Pyeongchang, will be held. The network will then be extended from rural to urban. Phase two will cover other provinces, and phase three will cover metropolitan cities. Rural areas will get the network first because unlike the urban areas that already have unified LMR networks based on TETRA technology, the rural areas do not currently have a unified network.

In October 2015, South Korea selected two commercial carriers for its public-safety LTE pilot in three areas of the country. KT won the tender to deploy the main LTE network including the evolved packet core (EPC) and operations center, said Choi. KT, which won the Lot 1 contract in the tender against SK Telecom (SKT), will deploy the network in Pyeongchang.

SKT won the bidding for Lot 2 of the pilot, which includes the city of Gangneung, as well as Jungsun. Two operators — SKT and LG U+ — also bid for Lot 2.

Public Procurement Service (PPS), the national department for public procurement, ran the selection process for both lots. PPS issued the request for proposals (RFP), and bidding companies submitted proposals including price.

KT is South Korea's second-largest commercial wireless operator by subscriber numbers, and SKT has the largest number of wireless subscribers in the country.

South Korea's Ministry of Public Safety and Security plans to continue the pilot with the selected operators through the end of May 2016, Choi said. The US$40 million pilot network, pushed back from its original schedule earlier this year, will include 205 base stations and 2,496 handsets.

Users on the pilot network include four organizations — police, fire, coast guard and the local administration office. The pilot will offer testing and validation of the planned nationwide public-safety LTE network. There will be a separate RFP for the full nationwide network deployment. ■

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