chapter 4 Fixed wireless access

Three initials are currently dominating discussions within many parts of the wireless communications industry: I.o.T. Given the oft quoted figures from Cisco, Ericsson *et al*, the world will see billions of connected devices as part of the Internet of Things over the coming years, and the entire IoT ecosystem is expected to expand rapidly.

However, according to a report published by consultancy firm Arthur D. Little (ADL) earlier this year,[1] while mainstream IoT deployment is already prevalent across many vertical industries, its increased penetration across use cases poses "unique" challenges for ICT policy-makers and regulators beyond traditional telecoms-focused regulatory topics such as spectrum, numbering and roaming.

"The complexity and scale of the IoT brings increased focus on elements such as the safety of various stakeholders, new business models, data security and privacy," stated the report. "Given the potential benefits of the IoT, growth can be accelerated, and some of the pitfalls are avoided at the same time by effectively involving other national departments and ministries in addition to telecom regulators."

ADL believes IoT use cases blur traditional industry-specific boundaries and challenge governance of industry verticals by respective sector authorities. It added that IoT success is dependent on collection and use of data to provide customised solutions, and that this poses a "significant threat" to consumers' data privacy and security. "So there is an emerging trend to develop regulations which are case specific, as we have seen in the cases of drones and consumer data privacy protection," says the firm.

The report went on to point out that these regulations are being developed independently. It said that so far, only New York state in the US has issued a comprehensive IoT policy which not only covers data privacy and security, but also plans to make information about IoT infrastructure public and share such infrastructure through public-private partnerships.

As a result, ADL said investors into the IoT ecosystem are looking for clarity on what is regulated or unregulated and permitted or prohibited. It reckons this situation makes it even more critical that policy-makers have holistic views for better management of the IoT ecosystem, and that ICT regulators are better placed to coordinate this cross-sector effort.

Wi-Fi

The level of industry confidence in Wi-Fi investment is at its highest-ever, according to the Wireless Broadband Alliance (WBA).

In its industry report for 2017 published last December,[2] the alliance found that more than 80 per cent of those surveyed felt as, or more, confident than they did a year ago as the wireless industry becomes crucial to delivering high quality, high speed, low latency connectivity. And when looking at unlicensed spectrum more broadly, 47 per cent said that they felt more confident.

The WBA said its report (which was compiled by Maravedis) comes at a significant time for the wireless ecosystem. It said there is a growing consensus that the success of 5G, unlike previous generations of standards, will rely on the convergence of multiple radio access technologies (RATs) in unlicensed, shared and licensed spectrum, with Wi-Fi playing the central role. According to the alliance, developments in the latest Wi-Fi standards, including 802.11ax, will improve Wi-Fi performance and capabilities to support 5G use cases – including high-density networks, extreme Mobile Broadband (eMBB), and aggregation of multiple frequencies, amongst others.

As industry attention moves toward monetising Wi-Fi, WBA's study also highlighted the drivers of additional traffic over the network, as well as use cases with initial revenue potential in different verticals.

In the 2017 survey, respondents said that the applications most important to monetisation strategies for 2018 included location-based services (37.5 per cent), roaming (33 per cent), and marketing analytics (almost 33 per cent).

According to the WBA, the three Wi-Fi use cases tipped to drive near term revenue potential include: extending internet access and media to a full smart home; richer and more efficient enterprise services driven by cloud managed networks and security; and expansion of the Wi-Fi roaming model.

"As Wi-Fi continues to evolve, enabled by new technologies, it has the ability to support new connected services and use cases in the 5G era across all segments including, carriers and service providers, connected cities, and enterprise and hospitality ecosystems", said WBA CEO Shrikant Shenwai. "This report shows that confidence in Wi-Fi is at its highest level ever, as the industry starts to recognise the central role the technology will play in next-generation wireless networks.".

Shenwai concluded that, further extended by 802.11ax, Wi-Fi will remain "incredibly important" to support a range of use cases and industries. But he also warned that ensuring interoperability with other technologies will be the key. ■

[1] *With the Internet of Things (IoT) everywhere, can regulation be far behind?*, Jan 2018, http://www.adlittle.com/en/insights/viewpoints/internet-things-iot-every-where-can-regulation-be-far-behind

[2] WBA *Annual Industry Report* 2017/18, https://www.wballiance.com/resource/wba-annual-industry-report-201718/

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RAJANT

Africa's IoT ambitions

From having very little network connectivity just a few years ago, Rwanda now has ambitions to become a smart city blueprint for other African nations to follow. In May 2017, the country's government launched a flagship IoT project in Kigali which features technology supplied by **Inmarsat** and **Nokia**. Inmarsat deployed low-power WAN infrastructure around the capital using the LoRaWAN protocol to connect sensors and devices. The IoT network went live at the beginning of May was expected to remain active for an initial period of a year. It was developed with Actility, the France-based M2M and IoT specialist which is now backed by Inmarsat as an investor.

The network is providing city-wide coverage enabling a variety of organisations to develop and deploy IoT applications on a large scale, as well as allowing entrepreneurs to easily connect their front-end IoT devices through a middleware layer.

To demonstrate the IoT's transformative potential, Inmarsat planned to work with Jersey Telecom and other partners to deploy a number of proof of concepts and technology validations around Kigali. These included a smart bus equipped with satellite internet to provide ubiquitous connectivity for remote communities. The bus will also be LoRaWAN-enabled to provide real-time data acquisition in the communities that it services.

Other planned demos included a precision farming initiative intended to increase crop yield and better manage water resources, and environmental monitoring systems that will feature sensors installed in buildings to gauge air quality.

Inmarsat also began a range of initiatives designed to educate and empower the next generation of students and entrepreneurs in Africa. It launched a *Smart Cities Education* programme in Rwanda and planned to replicate it in other countries on the continent in an effort to accelerate the deployment of IoT and smart city solutions. The programme includes a three-month student internship, as well as an IoT boot camp for students and entrepreneurs.

Engineers setting up Kigalis' smart city LoRaWAN network.

Rosine Mwiseneza, the winner of Rwanda's 2016 'Ms Geek' competition, has developed an IoT-based agricultural irrigation solution.

As part of the initiative, Inmarsat is also working with Rosine Mwiseneza, the 2016 winner of Rwanda's 'Ms Geek' competition which is designed to inspire female university students to employ technology to overcome local issues. Inmarsat collaborated with Mwiseneza and her team to implement a prototype IoT-based agricultural irrigation solution for potential commercialisation. Their aim was to create a scalable solution that can be used across Rwanda as well as Africa and the rest of the world via Inmarsat's global networks.

Separately, Nokia was chosen by local Rwandan company SRG as part of its collaboration with the government's smart city rollout. SRG is using a variety of products from the Finnish vendor including a mission-critical access network, IP and *Cloud Core* networks, as well as its *Impact Platform* with associated IoT applications.

Speaking at the *Transform Africa Summit* held in Kigali in May, Rwanda's youth and ICT minister Jean Philbert Nsengimana, said: "Through this project, we will not only improve people's day to day lives with improved services and security, but [also] anticipate long-term, positive socio-economic benefits."

Nsengimana claimed Rwanda was now a "pioneer" in deploying a smart city solution in Africa, and that the government's vision is to position the country as a technology hub. He added that the plan was to share Rwanda's experience with other nations on the continent.

Elsewhere in Africa, the IoT will help deliver clean energy to millions of people living in off-grid communities following a partnership between **Aeris** and **BBOXX**. US-based M2M specialist Aeris offers IoT connectivity in East and Central Africa, while UK company BBOXX designs, manufactures, distributes and finances plug and play solar systems. Its core products are a range of solar battery boxes that allow users to power small appliances, from lights and mobile phones to TVs and computers.

The collaboration between the two aims to ensure that the battery boxes have reliable IoT connectivity and can be remotely monitored. BBOXX has installed Aeris' global SIM at the point of manufacture, thereby reducing both supply-chain costs and deployment time. BBOXX said that by utilising Aeris' single global access point name, its solar system can also be deployed anywhere in the world on a simple plug-and-play basis, removing the necessity to configure local network settings.

Aeris is also providing its *AerPort* connectivity management platform for IoT devices. This

BBOXX's solar 'battery boxes' can power domestic appliances such as TVs.

JANUARY/FEBRUARY 2017

The Nigerian Communications Commission has told local operators it will re-plan the 23GHz microwave frequency band. Following industry consultation, it has decided to re-channelise the 23GHz band from its original 7MHz plan to 28MHz in accordance with recommendation ITU-R.F. 637-4. The new plan will take effect from 30 May 2017. All affected operators will be given two years to migrate from 7MHz to 28MHz channel spacing in the 23GHz band. New assignments on the band will now be based on the 28MHz plan, and channel aggregation will no longer be permitted.

MARCH/APRIL

Mobile operator InterCEL + is building a major wireless network that will distribute high-capacity broadband from the *ACE* submarine cable system to major urban and business regions in Guinea. The company is using a point-to-multipoint microwave system and has already established phase one in Conakry. It has rolled out a network that supports 600Mbps across many parts of the capital, and is said to be offering businesses up to a ten-fold increase in bandwidth compared to the legacy WiMAX links they had previously been limited to.

MAY/JUNE

Windhoek's Police Department has replaced its Wi-Fi network with a wireless video surveillance system based on broadband access equipment from RADWIN. Namibia aims to be the safest African country by 2020. As part of that ambition, RADWIN's point-to-point and point-to-multipoint systems have been installed in dozens of crime hotspots throughout Windhoek. The systems are said to transmit high-quality video from the cameras directly to police headquarters, enabling on-the-spot detection and response to events.

gives BBOXX real-time access to data usage, as well as alert and device-connectivity management over each SIM's lifecycle. BBOXX added that Aeris' global support of major mobile standards such as GSM, CDMA and LTE, means that it will be able to deploy its devices across the world as it looks to expand.

In South Africa, **SqwidNet** teamed up with Johannesburg-based **Adroit Technologies** to boost the Industrial IoT. The partnership is enabling IIoT application and service providers to use Adroit's cloud-based SCADA and industrial-automation platforms via SqwidNet's network which is licensed to use Sigfox technology in South Africa.

SqwidNet launched in November 2016 and is a wholly owned subsidiary of open-access fibre connectivity provider DFA. The company's network is already said to cover all of South Africa's eight major metro zones and 64 per cent of the national population. The firm planned to cover the entire country with its network by 2018.

Meanwhile, Adroit Technologies MD Dave Wibberley said: "We see Sigfox technology as much more compelling from a scalability, simplicity, cost, and ease-of-integration perspective than traditional telemetry options."

He continued by saying that SqwidNet's technical experts have helped Adroit to build interfaces to the Sigfox back-end. A number of trials based on data from sensors and connected devices on the SqwidNet network had also been developed. "We have successfully completed several proofs of concept for use cases such as water quality readings, automated meter readings for both water and electricity, and manhole tip sensor readings."

France-based Sigfox is a global provider of IoT connectivity and currently has deployments in around 45 countries. In 2017, Adroit began the process of becoming a certified Sigfox partner for devices and for its SCADA platform.

In late September, **Vodacom** proclaimed that the Internet of Things was no longer hype as its IoT division had now passed the three million connections milestone. According to the company, it was averaging 55,000 new IoT connections per month in South Africa.

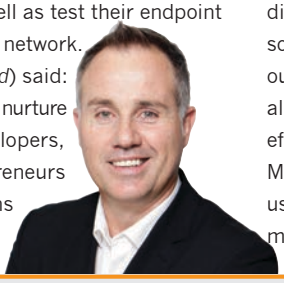
"It's worth noting that it took us eight years to get to two million connections and it took us only one year to get to three million," said Deon Liebenberg, managing executive for Vodacom IoT. "The rate of IoT adoption is picking up speed locally, and with the commercial rollout of NarrowBand-IoT, this is only going to accelerate even faster. The Internet of Things is no longer hype – it's real and it's becoming more and more a part of our daily lives."

In February, Vodacom's parent company, Vodafone, said that it had become the first global IoT mobile provider to exceed 50 million connections, demonstrating growth of around one million new connections a month. It said performance was particularly strong in the automotive, healthcare and utilities sectors.

Earlier in the same month, Vodacom announced that it had successfully completed the launch of Africa's first live NB-IoT site, in partnership with **Huawei**. The live site, which is on the roof of Vodacom's data centre in Johannesburg, was the company's first step towards the development of a smart campus which will monitor and meter utilities on the network. The operator said collection of this data will reduce the risks of water losses, mitigating both environmental sustainability and cost risks.

The live site was followed with Vodacom opening a new lab at its campus in June. The facility aims to commercialise M2M and IoT systems using narrowband low power. It has been designed to provide a controlled test environment and framework for customers and specialists to come up with hardware and applications as well as test their endpoint devices on the NB-IoT network.

Liebenberg (*pictured*) said: "Our ultimate goal is to nurture an ecosystem of developers, engineers and entrepreneurs for NB-IoT applications on the continent."



Expanding connectivity

Software giant **Microsoft** has been increasingly making its presence felt across the continent in recent years and continued to do so in 2017.

In January, we reported that the company had teamed up with Nominet to help ISPs across Africa leverage unused broadcast frequencies and deliver low-cost broadband access using TV white space (TVWS) spectrum. As the available set of TVWS frequencies varies, Nominet has developed a geo-location database that tells devices which frequencies they can use in a particular area, at what power, and for how long. The database allows wireless devices to access TVWS frequencies, and was also the first to receive regulatory approval for use in the UK.

As part of its *Affordable Access* initiative, Microsoft is working with public and private sector partners around the world to develop technologies and business models that will make it easier for billions more people to affordably get online. In Africa, the company has been involved with broadband connectivity programmes in Kenya, Botswana, Malawi, Ghana, amongst others.

To support its goals, Microsoft is now using Nominet's TVWS database across its *Azure* cloud platform to enable the deployment of low-cost terrestrial wireless broadband internet to communities across the continent.

It is also leveraging Nominet's dynamic spectrum management technology. This has been designed to support two-way communications at relatively high data rates over long distances, and delivers connectivity to large open areas where it would be difficult to deploy fixed infrastructure.

Speaking at the time, Nominet's R&D director Adam Leach said: "Spectrum is a scarce and valuable resource, and demand can outstrip supply. Dynamic spectrum sharing allows the available spectrum to be used more efficiently than any existing static techniques. Maximising the efficiency of the spectrum usage lowers the barriers to access, enabling more users and devices to get connected."

JULY/AUGUST

Liquid Telecom has introduced a new roaming hub that enables operators and ISPs to access its pan-continental network of public Wi-Fi hotspots for the first time. The company says the *Africa Wi-Fi Hub* will allow customers of its wholesale clients to connect to hundreds of locations across Kenya, Rwanda, Uganda, Zambia and Zimbabwe, with additional markets to be rolled out soon. Partners can connect via peering points in Eastern and Southern Africa, with the option to connect to hundreds of locations in one country, or join a global network of public Wi-Fi hotspots.

SEPTEMBER/OCTOBER

ATM Mobilis (formerly Algeria Telecom Mobile) will provide customers with access to PCCW Global's international connectivity, as well as a portfolio of managed services and UCaaS (unified communications-as-a-service) products. In 2016, ATM signed a high capacity IPX interconnect agreement with PCCW. This has now been extended to cover services beyond traditional voice, and the two partners have also extended their combined MPLS network coverage.

NOVEMBER/DECEMBER

Microsoft and Orange Business Services will deliver large-scale, end-to-end IoT solutions that boost the digital processes of companies in the manufacturing sector. The *Microsoft Azure* IoT suite now supports Orange Business Services' IoT *Datavenue* service which is said to offer a comprehensive set of solutions and services to securely manage IoT projects and their integration with information systems. Orange Business Services says the software environment provided by Microsoft will allow for the use of advanced solutions such as the *Cortana Intelligence Suite*, *Power BI*, and the *Xamarin* app to ensure a "flawless" mobile user experience.

In Africa, Microsoft has been supporting TVWS projects in Botswana, Ghana, Kenya, Malawi, amongst others.

UK-based Nominet is a global internet company. Since 1996, it has managed and run domain names that end in .uk and is now said to be one of the world's largest country code registries.

In another agreement signed under its *Affordable Access* initiative, Microsoft also teamed up with ISP Brightwave to bring Wi-Fi and broadband access based on TVWS technology to schools and clinics in South Africa. At the end of July, the two partners announced that more than 213,000 students at 609 primary and secondary schools in the OR Tambo district will gain network access. They also planned to extend connectivity to several healthcare clinics in the municipality of King Sabata Dalindyebo in the Eastern Cape.

The deployment is co-funded by Microsoft and the Universal Service and Access Agency of South Africa. Lumko Mtimde, the agency's CEO, said: "This initiative will provide many entrepreneurs within underserved communities and rural areas with the tools they need to create businesses, address community problems and also help close the local skills gap."

Under the agreement, Brightwave is also able to leverage the Microsoft partnership to sell internet access, devices, as well as cloud-based services such as *Office 365* to government offices, small businesses and consumers.

Brightwave CEO Charles Mwaura said: "Our new partnership with Microsoft enables Brightwave to offer an integrated services value proposition that will power e-learning, e-health, e-government and e-commerce in rural and underserved communities in South Africa."

Brightwave is a certified black-owned enterprise that builds infrastructure to enable the delivery of high speed, affordable broadband access and services for the majority. For instance, in the under-served community of Soweto, the ISP is said to have successfully deployed and commercialised the largest Wi-Fi network through offering data bundles at a tenth of market prices by leveraging an ad-driven 'freemium' model.

Enterprise connectivity Wi-Fi

Microsoft was also busy building partnerships to push the greater usage of enterprise services on the continent. In May, the company unveiled plans to deliver its complete range of cloud services for the first time from data centres in Africa. The company will offer products such as *Azure*, *Office 365* and *Dynamics 365* from its own facilities in Johannesburg and Cape Town with initial availability anticipated in 2018.

According to Microsoft, many companies in Africa currently rely on cloud services delivered from outside of the continent. It claimed its investment will provide highly available, scalable, and secure cloud services across the continent with the option of data residency in South Africa.

Speaking at the time, Scott Guthrie, EVP, cloud and enterprise group, Microsoft Corp, said: "With cloud services ranging from intelligent collaboration to predictive analytics, the *Microsoft Cloud* delivered from Africa will enable developers to build new and innovative apps, customers to transform their businesses, and governments to better serve the needs of their citizens."

The company said that it had so far helped to bring 728,000 SMEs online across the continent and supported them to transform and modernise their businesses. It added that more than 500,000 firms are now utilising its cloud services, with 17,000 using the *4Afrika* hub to promote and grow their businesses. Furthermore, it said that the *Microsoft Cloud* is also helping Africans build job skills, with 775,000 trained on subjects ranging from digital literacy to software development.

Microsoft believes businesses across the continent have traditionally been slower adopters of cloud services, particularly in areas with limited ICT infrastructure. In March, it joined forces with **Liquid Telecom** to further accelerate the use of such services. By combining Liquid's fibre network reach (*see p.108*) with Microsoft's business solutions, the companies said they will bring the cloud closer to the end user. They reckoned this will enhance business potential and enable startups and home-grown operations to be more productive and efficient.

"Cloud computing is still gaining momentum on the continent but we believe it has the potential to transform the way businesses of all sizes operate," said Ben Roberts, group CTO, Liquid Telecom. "Through better connectivity, faster internet and secure cloud offerings, businesses will have the platforms and tools they need to grow and succeed. We have the infrastructure to enable locally and regionally hosted cloud solutions keeping African data in Africa."

Part of the project is *Business in a Box*, a cloud-based toolkit of relevant applications, cloud services and connectivity for SMBs.

As well as the delivery of cloud services, Microsoft and Liquid are also focusing on SMB development and the enablement of a TVWS technology and partner ecosystem to provide further connectivity across Africa.

Dr. Omar Elloumi, Technical plenary chair, oneM2M

The year ahead: CSPs must adopt an open standards approach if they are to make the most of the revenue opportunities presented by IoT applications that use LPWA networks. A common IoT service layer will result in increased cost-effectiveness, improved scalability, and greater confidence that today's IoT deployments will be future-proof.

While the latest figures from Analysys Mason[3] suggest there could be 3.4bn LPWA connections by 2025, the forecasted revenue per connected device is relatively low unless CSP strategies to tap into the larger revenue opportunity provided through application enablement become mainstream. With the recent ramp-up of LPWA deployments worldwide, we have seen an increasing number of CSPs adhering to the oneM2M value proposition, but they will need to expedite their strategies to improve the value they are seeing from the IoT.

Open standards for the IoT were developed after enterprises that deployed the early wave of IoT connections found themselves restricted by a vertical approach to platform management. Working in this way restricted the applications' scalability, limited cost-effectiveness and stifled interest from device manufacturers and app developers, who found themselves repeating efforts to integrate different connections and device management protocols.

The need for interoperability is what drives oneM2M's architecture, which allows CSPs to break down the silos that inhibit growth and creates a single, horizontal platform for data sharing between applications. This not only delivers opex savings from not having to manage multiple horizontal silos, but also opens up new service innovation opportunities. LPWA provides the means to deliver the IoT and a standards-based, horizontal approach makes it a stronger business case.

The above is based on information first published in the whitepaper 'Boost LPWA Revenue Through oneM2M', December 2017. For the full article, visit: https://tinyurl.com/y7nlguz4

[3] *Preparing for LPWA: How operators are maximising their chance of success,* Michele Mackenzie, Analysys Mason, September 2017.

In a separate deal, **Liquid** and **GlobalReach Technology** launched a new managed service to help businesses in Africa that want enterprise-grade Wi-Fi without the worries of procuring and managing a WLAN. In January, the two firms claimed users ranging from the smallest cafés to the largest shopping malls and hotels will be able to offer Wi-Fi securely to customers without having to incur high installation costs.

According to Liquid, the partnership with UK-based GlobalReach brings the "power and scale" of a global Wi-Fi enabler into its core network and data centres, allowing its customers to benefit from the latest Wi-Fi technology deployed in-country.

The service combines connectivity from Liquid, hardware from Ruckus Wireless (which has since been acquired by the ARRIS Group), and GlobalReach's cloud-based platform which provides authentication, authorisation and accounting. It enables businesses offering Wi-Fi to their guests to connect and engage with them through customisable and branded captive portals, and tap into new commercial opportunities. The platform is also said to offer "comprehensive" analytics of user demographics and engagement. This will allow businesses to better understand customer behaviour, and tailor their services accordingly.

Liquid's existing managed Wi-Fi customers, along with its public Wi-Fi networks, were migrated to the new GlobalReach platform over the months that followed. The new service can be bought for a fixed monthly fee and is now available in Zimbabwe, Zambia, Rwanda, Uganda, DRC and Kenya, with Tanzania and South Africa to follow.

Software specialist **D2L** said its cloud-based learning platform, *Brightspace*, is enhancing education for more people across the EMEA region, including South Africa where **AFRICOLLEGES International** (ACI) is now using the system.

ACI is an online college addressing the agricultural education gap. It introduced *Brightspace* to provide students with affordable, accessible and industry-relevant course content. "For the very first time, *Brightspace* will give our students here on the continent the opportunity to study from anywhere, at any time, whether it's on their mobile, desktop or tablet," said ACI founder and CEO Howard Blight. "This provides a dynamic learning environment without the added costs of being 'on campus.' It will enable ACI to accommodate those students that may not have the financial resources associated with traditional learning models."

Canada-based D2L says *Brightspace* was created for the digital learner and helps schools and institutions deliver personalised learning in a classroom or anywhere online. The platform is claimed to make designing courses, creating content and grading assignments easier, and also features analytics that track and deliver insights into the performance of departments, teaching programmes or individuals. ■

Chris Mason, Director of sales & marketing, EMEA, Rajant Corporation

According to Chris Mason, US-headquartered Rajant has a "solid" position in Africa, with both deployments of its technology and the size of the networks in operational sites growing.

"Mining has always been at the forefront of our work in the continent. However, as we continue to expand globally, our partners and customers from different verticals across the region are realising the benefits that *Kinetic Mesh* can bring to their organisation."

Rajant claims its *Kinetic Mesh* technology provides fully mobile wireless broadband connectivity that is "simple, instantaneous, and failproof in any application". The system uses a combination of the company's *BreadCrumb* wireless network nodes and *InstaMesh* networking software. The firm says these nodes have been designed to communicate with any Wi-Fi or Ethernet-connected device to deliver low-latency, high-throughput data, voice and video applications across the meshed, self-healing network.

"Rajant enables companies and organisations to build private wireless networks that support the IIoT [Industrial Internet of Things]," said Mason. "We refer to those networks as 'Living Networks' because they thrive in dynamic network environments where everything in the network can move and evolve as connectivity demands change. With our *Kinetic Mesh* technology, network infrastructures can be built with the ruggedness, mobility, and autonomous application support required in today's demanding business environments.

He continued by saying that security, port terminals, petrochemicals, and municipalities are a few of the verticals that the company is continuing to branch into in the African market.

"A recent and particularly notable deployment has involved the ability to deploy our *Kinetic Mesh* networks to a mining operation in South Africa. We are hoping to publicise more on this activity soon. But in summary, this network is supporting an autonomous drilling rig and mine-wide monitoring made possible due to the high-bandwidth support and, more importantly, low latency that the network can deliver. As a result, operations are improved and safety measures have been put in place."

When asked how Rajant has seen the wireless communications market adapt and evolve on the continent over the last year, Mason said the telecoms boom continued in 2017. "In Ghana for example, the value of products and services produced by the ICT sector surged 239 per cent since 2012 according to data compiled by Bloomberg.[4] This impressive explosive growth marked the sector as one of the fastest of any in the country.

"2017 also saw a key trend in fleet automation and optimisation in the mining industry. Deloitte reported an estimate in its annual trend report that said approximately 35 per cent of current mining positions in South Africa will be completely automated by 2037.[5]

"With this emergence of the Internet of Things and the rise of autonomous equipment such as self-driving technology in mines, increase in production along with reduced cost in fuel and maintenance is rife in the industry. To sustain this powerful production, operators must ensure that they have a fully supported network infrastructure capable of supporting the increasing demands for mobility and autonomy within the mine environment."

So what does Mason see as the challenges for Africa over 2018 and beyond?

"The exploitation of data from within organisations' operations is extending from consumer and enterprise into industrial environments. The IIoT is extending into every industry and further underlining the requirement for all assets, devices and people to be connected.

"Added to the escalating population growth, operators must consider environmental and economical challenges when working to provide the best technology. Whether it's a mine, an oil rig or a CCTV implementation, telecom operators must adapt their approach on a situation-by-situation basis, to ensure the best connection for their operation. In mining, even brief periods of operational downtime can cause significant loss of revenue in short order, and thus the need for iron-clad network infrastructure is critical to ensuring that autonomous vehicles and industrial robots operate flawlessly.

"The potential for significant growth of technology adoption across the continent is immense. As we now look to connect anything and everything, a 'Network of Things' in all environments of diverse moving assets and next-generation applications is imperative. Today's expansive industrial operations require robust connectivity everywhere. People and assets must be able to take robust connectivity with them wherever they go, and that's where we come in.

So what are Rajant's hopes and plans for the continent over the coming months? "While we have a growing number of deployments and testing in Botswana, Zambia and Lesotho, our

[4] https://www.bloomberg.com/view/articles/2017-11-13/african-economic-growth-rides-on-wireless-rails

[5] https://www2.deloitte.com/content/dam/Deloitte/global/Documents/Energy-and-Resources/gx-er-tracking-the-trends-2017.pdf

aspirations for growth are already extending into other African countries such as Namibia, Kenya and Tanzania. We are also exploring opportunities in North Africa and French-speaking countries on the continent.

"As digital transformation takes hold across the world, Rajant has ambitions for companies across several verticals in Africa to reap the benefits of *Kinetic Mesh*. Of course, for us to continue to grow and expand in the region, we need to secure partners which relate to the geographies and markets identified.

"As previously mentioned, mining is a big focus for us in Africa, and we are always aiming to help more firms in this sector with their connectivity efforts. In a critical industry like this, where short periods of operational downtime can cause millions of dollars in losses, operators must be empowered to continuously monitor, manage and control their fleets of high-value equipment, vehicles and personnel wherever they roam. *Kinetic Mesh* networks, which have already been proven to stand up to the extremes of mine environments across the continent, effectively connect sprawling open pit and underground mining operations.

"*Kinetic Mesh* networks have been implemented in some of the largest mining operations around the world to reliably cover people and assets across all remote operations. And there is no clear sign of any slowing down, with 69 per cent of mining companies looking at remote operation and monitoring centres, 29 per cent at robotics, and 27 per cent at unmanned drones, globally.

Kamal Mokrani, Global vice president, InfiNet Wireless

In the 2017 edition, Kamal Mokrani said that Libya[6] had been a good market for InfiNet Wireless until the whole country was turned upside down by the unrest and political turmoil that began in 2011. But at the time, he also said that there were signs that the country was being re-built. Catching up with Mokrani once again at AfricaCom in November 2017, we asked if that had lead to the firm returning to Libya for new business.

"We are still active there – it's not yet at the stage where it is stable enough, but it has grown in leaps and bounds from last year. There is some kind of government that did not exist in 2017 (at least a recognised government), so things are moving. What we are seeing today is a lot of entrepreneurs, for example, who are starting things on a regional basis. A lot of Libyan business people had escaped to Southern Europe or to Dubai but now they are coming back with their money and they are investing. In fact, just in GITEX in Dubai three weeks ago, I met separately with two guys who were in the telecoms business before and now want to go back to Libya and want to setup nationwide ISPs.

"And the oil and gas sector is slowly coming back – foreign operators like Total and Schlumberger are now going back to Libya and they need all the connectivity that was there before it had been destroyed. They have also discovered some oil offshore which, for them, is easier to drill rather than on land. So we are providing connectivity to a number of rigs that have been setup in the past 12 months."

Mokrani mentions oil but the last few years have certainly been tough for countries such as Angola and Nigeria whose economies are fuelled by the stuff. Has that had any impact on InfiNet's business in Africa?

"Oil and gas has never been our main focus in terms of market sector so it perhaps only has a tiny impact on us. Our biggest sectors are ISPs and homeland security/video surveillance. Take Egypt for example, which was our biggest country in Africa last year. They created a safe city programme to attract tourists back so we're working a lot with law enforcement agencies and the army to secure the tourist sites, Sharm El Sheikh, Hurghada, Cairo, Alexandria, Luxor, etc.

"The tourists are coming back but slowly and a lot slower than the Egyptian authorities want. The Russians and Germans are coming back, but the British are still hesitating. It takes time. Tunisia is still suffering from the terrorist attack of three or four years ago. It will be forgotten, eventually, if nothing else happens. Turkey is having a similar problem now as well, as did Malaysia seven or eight years ago, but now people go to Malaysia without thinking."

Do such security threats mean more business for specialist vendors such as InfiNet Wireless? "A problem for some is an opportunity for others, so unfortunately and fortunately that is true. I know Colombia is outside your remit but we see that is coming back very quickly; the government has signed an agreement with the rebels, the drug lords are handing in their weapons, and the authorities are re-building the country."

On the subject of Latin America, it sometimes seems as if that region is almost the 'new Africa' as many wireless communications specialist seem to have switched their focus to the developing markets on that side of the Atlantic. Is that at the expense of Africa?

"I recruited a team of five people in Latin America to cover Brazil, Colombia and Argentina, and we already had a presence in Mexico. We are not re-focusing. We are just addressing another market; as one market goes down another comes up. Take Saudi Arabia, for example. For the past five years, that was traditionally our best market but right now I could not tell you what's going to happen there in the next few months because of what's going on [refers to the high profile anti-corruption arrests that had taken place at the time, and the changes being brought in by the new regime]. But because we are spread across the world, if one market goes down another comes up and it has little impact on our business."

At this point, Mokrani is keen to point out that Africa is certainly not a market that is going down, and that it remains an exciting and vibrant region for InfiNet. "I would not be here if I didn't feel that there was a big chunk for us to address. We have partners here, and we're putting more efforts into raising brand awareness even further with dozens of meetings planned for the weeks to come. They will include a mix of people such as ISPs, operators wanting to do backhauling, enterprises such as banks wanting to link up different branches to headquarters, or manufacturing facilities wanting to link up their different locations together, etc."

When asked about what trends he has observed over the last year, Mokrani said that in South Africa he is seeing more ISPs interested in what InfiNet offers because they have invested quite heavily in, for example, WiMAX, which is becoming fairly obsolete now. "So they want to secure the next generation and this is where we come in. WiMAX did what it did, when it had to do it, but manufacturers have stopped investing in that technology. There are alternatives, such as LTE as well as our solutions, that can plug the gap.

"Earlier, I was sitting in some separate meetings with ISPs from Congo, DRC and Somalia that are more interested in video surveillance. They want to secure their mining sites or the hotels or airports, for example. So I am seeing a mix of different things. I would say that in Africa, the two main areas of interest right now are definitely ISPs at number one, while number two is video surveillance."

In terms of building infrastructure, Africa is no longer, in the main, a greenfield site. Earlier, Mokrani spoke about replacing WiMAX in some situations so in general would he define the market as one where users are upgrading rather than building new networks?

"It really is a mix. As I said in Libya you are getting some entrepreneurs who are starting from scratch, and then at the other extreme you have operators like Vodacom who have approached us to help them migrate their existing infrastructure into platforms that are more carrier grade and offer higher capacity, better QoS, etc.

"So you get a bit of both. But I would say that maybe 70 per cent of what we are seeing today is more replacing existing platforms. Everybody talks about the IoT, 5G, etc. They want to be ready with the higher capacity pipes as and

[6] African Wireless Communications Yearbook 2017, p53.

when that happens. The big operators such as MTN, Vodacom, Orange, Liquid Telecom and a few others are talking to us about that and thinking along that direction. But you can't talk about Africa as if it was a single market. Ghana and South Africa for me are far more advanced, for example, than other countries so you see different trends in different markets."

But from general perspective, 2017 was certainly a good year for InfiNet. "Traditionally, we have been very strong in the CIS, Russian-speaking countries and that still remains important as we have a strong installed base there. The second region for us was the Middle East, but now I can see a shift where Africa and Latin America are becoming more important than that region for us. From a dollar figure we are still growing in the CIS, but we are growing faster in Africa and certainly in Latin America.

"As you know, the fixed infrastructure is almost non-existent in certain countries so you have no option but to go wireless. But we do not promise to fix all problems because we cannot, and if I was an operator, I would need a mix of different technologies to provide the whole thing."

In the 2017 interview, Mokrani mentioned the *XG 1000* radio that InfiNet had just launched at the time. The company has since launched a version that is claimed to deliver up to 1Gbps of data over 80km to 100km and also offers extra frequencies. So what hopes does he have for the future?

"Maybe I didn't mention it much last year but the *XG* was our first foray into a fully SDR-based approach. So we can do many more different things using the same hardware, whether it is changing frequencies, increasing capacities, offering different types of QoS, etc. We are therefore definitely fully engaged with the software-defined radio route and our next generation, which we are aiming for release around mid-2018, will take the current product into a full SDR. That is the only way to go and it is the reality. 5G is our driver here. We need to be super-flexible when 5G is fully ratified and fully deployed, and you cannot be flexible if you have fixed hardware that you cannot change."

Dan Zajicek, CEO, Gilat Telecom

In 2017, Gilat Satcom changed its name to Gilat Telecom as part of an effort to highlight the fact that it offers more that just satellite communications. Speaking last year, Dan Zajicek said that the change supported the firm's strategy of long-term investment in African fibre as well as satellite networks. Gilat is a shareholder in the *West Africa Cable System* (*WACS*) and also in WIOCC which owns the *Eastern Africa Submarine Cable System* (*EASsy*). The company also continues to provide space segments over numerous satellites including Intelsat, Telesat, Hellas Sat, ABS, SES, and others. It operates three international teleports in the Middle East and Europe, as well as 16 hubs/PoPs, of which 14 are in Africa and two are in Europe.

According to Zajicek, 2017 was the year that the cloud became a hot topic in Africa with Microsoft becoming the first of the major cloud providers to actively target the continent with its *Azure*, *Office 365* and *Dynamics 365* products being offered from multiple data centres.

"An increase in the number of data centres in Africa combined with ever-improving connectivity infrastructure is increasing confidence in cloud. A flash poll on the ConnectingAfrica.com website, operated by the organisers of the annual AfricaCom conference, asked the question: "*How important are cloud services to African enterprises in 2017?* The answers are both very interesting and encouraging to cloud service providers."

Citing the survey results, Zajicek said 41 per cent of all enterprises reported that cloud services are "very important". Sixteen per cent said that they were only important to large enterprises, while 10 per cent believe they are only of "limited importance". Meanwhile, 30 per cent stated that such services are not yet important but may become so later in 2018 or beyond, and three per cent didn't know.

However, while the popularity of cloud services continues to grow and data centres and connectivity infrastructures are improved, Zajicek said Africa's protection policies are still unclear, and that security fears along with the high cost of bandwidth are limiting market growth. "Still yet, there is general mistrust of the global technology providers in Africa, and an understandable desire to work with companies that are on the ground and present in [the region].

"We have found that all of these concerns can be addressed. Indeed, security is one of the first interests of African customers when they approach us. Companies understand the tremendous risks that exist to their data and they want to ensure that they are protected properly – and able to quickly restore their data when they need it."

Zajicek went on to state that the issue of latency is also being resolved by establishing data centres in Africa's capital cities. "This way, the delay is just of a few minutes as opposed to a much longer one when the cloud services exist out of Africa."

He added that the company sees opportunities for smaller providers to differentiate themselves by offering a fully managed platform that combines cloud services with the provision of a fast and reliable broadband service, allied to a genuine interest in helping their customers succeed. "As both knowledge and interest in cloud services continue to grow and as more companies learn to ask the right questions they need to provide to technology providers, there's no doubt in my mind that in 2018 we will see widespread adoption of cloud services across Africa."

"There is general mistrust of the global technology providers in Africa, and a desire to work with companies on the ground."

Chris Meering, Vice chair of marcom, oneM2M

OneM2M's aim is to develop technical specifications that address the need for a common M2M service layer. It says this can then be readily embedded within various hardware and software, and relied upon to connect the myriad of devices in the field with M2M application servers worldwide.

The organisation currently has around 200 members and partners. One of its critical objectives is to attract and actively involve organisations from M2M-related business domains such as telematics and intelligent transportation, healthcare, utilities, industrial automation, smart homes, etc.

As well as being an 'IoT evangelist' at HPE (Hewlett Packard Enterprise), Chris Meering also works as oneM2m's vice chair of marketing and communications. He believes that – whether it's from an increasing proliferation of smartphones, demand for new bandwidth-hungry services or an explosion of low bandwidth IoT-connected devices – countries everywhere have one thing in common: a growing requirement for connecting people and things.

"For CSPs, this equates to increasing pressure and a need to rethink their infrastructures, with no such thing as a one-size-fits-all approach. This is especially true as the global rollout of the IoT, which is determined to bring convenience and simplicity to everyday life, continues.

"In many areas, fibre is too expensive or impossible to install due to the challenging terrain and economic conditions. As such, new cost-effective solutions which overcome these physical and economic challenges is required – with fixed wireless access being one of the frontrunners for high bandwidth services. New innovations in this area mean it can bring levels of performance and gigabit internet

speeds to rival the best fibre connections. "When it comes to connecting battery-powered devices that require infrequent transfer of small data payloads (such as smart meters), LPWA (low power wide area) networks will play a particularly important role."

According to Meering, matching the right connectivity option to the use case is key to ensuring customer satisfaction and driving economic value. However, when it comes to the IoT, he said CSPs must look beyond basic connectivity to ensure return on investment.

"Connectivity revenue is a relatively small component of the IoT value chain, with the bulk of this expected to come from applications. But there's no need for CSPs to be restricted to pure connectivity. By pioneering a standards-based horizontal approach to IoT deployments – such as that provided by oneM2M – they can avoid growth-inhibitive silos, re-use sensor data in multiple applications, and deploy devices for more than one purpose.

"This approach boosts connectivity volumes, attracting device and application providers onto networks and creating partnerships within a vibrant ecosystem. Ultimately, this enables entry into the applications space and movement up the value chain – whatever the connectivity type."

Mahmoud El-Banna, Global IoT solution management leader, Nokia

The term smart city is not a new one and, while some examples already exist on the African continent, it is not as widespread as it should be, according to Mahmoud El-Banna. He said urbanisation, economic, social and environmental sustainability requirements are putting increasing pressure on cities' infrastructure, and believes this requires a paradigm shift to urban centres operational and management models by adopting new and smart technologies to create sustainable living environment for their citizens.

"Cities across the globe are facing persistent challenges in different sectors in terms of energy consumption, environmental sustainability, citizen safety, traffic management, vulnerability to disasters, changing climate conditions and many more. These challenges are accelerating the need of new business models for cities management to improve the quality of life inside the city.

"Cities looking to thrive in the future are encouraged to invest in a 'Six 6s' smart city model – this creates smart, safe and sustainable applications enabled by a shared, scalable and secured ICT infrastructure.

"The challenges translate into various opportunities for cities to embrace new technologies and improve efficiency of urban operations. The IoT, which aims at connecting everything around us towards the journey to a programmable world, is on the high rise and at the heart of future proof smart cities. IoT will be the technology of choice to enable unlimited possibilities for smart city applications and use cases.

"Smart city IoT applications will have various requirements with direct implications on the ICT infrastructure. These requirements will vary in terms of data volume, throughput, number of devices and the latency pattern for transferring the data.

"This in return mandates the need to have a robust and flexible infrastructure to support a wide range of use cases that would be implemented as part of a smart city. The adequate infrastructure would be composed of a massive scale broadband access technologies layer supported by an agile networking gear and topped by a city management platform to manage all aspects of the city. Across all these horizontal layers, security is vertically positioned to secure the data across the entire ICT infrastructure.

"Optimal smart city implementation will truly benefit from the Six 6s. By sharing network infrastructure, applications and data over a single IP infrastructure, cities can minimise cost and provide residents with ubiquitous and real-time access to applications anytime and anywhere.

"Cyber security and data privacy also remain ultimate priorities. Endpoint data protection, device management, authentication, authorisation, traffic profiling and encryption must be key points on both governments' and citizens' checklists. On the scalability aspect, while the initial uptake of smart cities initiatives might start small, they can grow fast and cities must ensure that their ICT infrastructure anticipates this growth.

"To ensure smart city initiative success, applications must satisfy the smartness, safety and sustainability angles.

"Smart applications aim at improving the quality of success, bolster innovation and drive social and economic development, but also make the cities more attractive places to live, visit and do business. Safety comes through providing applications that prevent or minimise the risks of adverse events, such as crime, accidents and natural disasters.

"Sustainability applies to minimising the environmental impact of the municipality's operations and the activities of its businesses and citizens, while ensuring that cities select the right business model to fund, invest and cost-efficiently manage innovations."

Mak Rahnama, Senior technology analyst, GlobalData

// Telcos in sub-Saharan Africa, which have traditionally focused on voice and data connectivity, are increasingly looking to expand their enterprise services portfolio and transition towards offering IT services. Data centres are a key pillar for them to provide colocation, managed platforms, cloud services, amongst others.

"The key drivers in the adoption of data centre services in the region include increasing fixed broadband coverage and a growing number of submarine cables providing improved wholesale and international connectivity. This has led to the data centre competitive landscape developing significantly over the past few years, as in addition to telcos and dedicated providers, governments are also launching data centres and selling these services to enterprises.

"However, enterprises have limited familiarity with data centre services, making it a key barrier to adoption. Telcos need to address this in their go-to-market strategies by launching targeted awareness campaigns to inform and educate the market about such services.

"One commercial strategy deployed by providers of data centre services in sub-Saharan Africa involves using the technical features of their facilities as the main way to differentiate service offerings. These include access to a reliable power supply, a feature that is particularly important in a region plagued by unreliable national electricity grids.

"Investment in data centres allows a telco to strategically position itself to cater to the demand for IT services from the enterprise segment. It expands the operator's revenue stream to beyond just connectivity services. Failing to capitalise on the opportunity for data centres would mean telcos risk missing out on a key revenue opportunity, and an important component in their enterprise services portfolio."

The above article by Mak Rahnama first appeared in the Jan-Feb 2017 issue of Southern African Wireless Communications magazine.

"Enterprises have limited familiarity with data centre services, making it a key barrier to adoption. Telcos need to address this in their strategies."

Eckart Zollner, New business development, Jasco Group

Listed on the Johannesburg stock exchange, Jasco is a South African technology specialist that works across telecoms, IT, energy and industry. As well as having multiple offices throughout South Africa, the group has an office in Kenya to service East Africa as well as one in Dubai to service the Middle East and Northern Africa region. It also trades in many sub-Saharan African countries with a special focus on the Southern African Development Community.

Eckart Zollner said: "We are able to provide active and passive infrastructure elements as well as network services from the planning and design phase, the deployment and commissioning phase right through and including the operational and ongoing support services.

In South Africa, Zollner said the firm has seen "good growth" in demand for its solutions from neighbouring countries and is currently servicing numerous opportunities across its solution portfolio. It is now concentrating its attentions on the eastern side of the continent. "Following our entry into East Africa through the Jasco Kenya office in 2016, we have now focused on growing our client base in East Africa and to maximise opportunities through regional expansion with customers in the area. We have started building capacity in the region for additional solutions as offered across the Jasco group.

"Areas of uptake and growth include enhancement of contact centres, provision of hosted solutions, and automation. Jasco is currently assisting customers to improve their businesses and services to their customers through the establishment of multi-channel contact centres, automation of functions and implementation of transactional recording.

"Wireless networks are an essential platform for provision of new services and solutions in Africa, and will contribute directly to improving economic development in its countries. We have the knowledge and skills to bring additional services, such as electronic security, IoT deployments and value added virtualised data platforms, to these markets.

"To drive down costs and increase provision and uptake of services, regulators and telecoms incumbents in Africa are supporting the establishment of carrier-neutral data centres and infrastructure sharing models. This is a major area of opportunity for Jasco with its ability to provide wireless and managed services, as well as to implement wireless infrastructure. There are already a number of data centre players in African markets, and we are able to provide hosted, storage and recovery services out of these centres."

Zollner continued by saying that Africa's wireless communications market has followed the trend of shifting from voice to data services. However, he added that large parts of the population remain underserviced by the latest generation 4G LTE standard. "A number of smaller networks have been licensed and are challenging incumbent operators, but network rollout remains slow due to the lack of funding. Effective 4G LTE broadband services require a cost effective and affordable fibre backhaul solution, and these are often still lacking in the geographic areas, due to a lack of competition and open regulation.

"Where networks are rolled out, we are able to offer core network components, offering service providers hosted and as-a-service solutions. This model not only lowers the cost of services to service providers' customers, but will also enable those service providers to scale quickly as demand grows."

When it comes to identifying the challenges in Africa for the foreseeable future, Zollner said the biggest one will be the build-out of wireless infrastructure to reach the unconnected population living outside the metropolitan areas. He believes infrastructure sharing will be key to achieve this. "Because backhaul for optic fibre and satellite networks is very expensive, these networks must be built on the concept of infrastructure sharing. Governments, regulators, incumbents and industry must work together to achieve this – it's the only way forward to deliver effective economic growth.

"A lot of socio-economic progress can be made once communication networks and underlying platforms are rolled out. This will facilitate the growth of e-commerce and e-health, and extend the reach of education and government infrastructure. Africa already has the vision – smart cities are being planned and piloted in numerous countries. We expect to see a lot of localised innovation across these areas as metro platforms expand into un- and underserved areas to achieve critical mass.

"We also expect to see transformative growth as Africa steps up its capabilities in key areas. Tourism is a useful example: potential holidaymakers expect to access information about countries online to make their decisions and book their vacations. They don't just want websites and reservation capabilities, they want to be able to see hotspots using live webcams. Once the telecoms and digital infrastructure and platforms are in place, Africa can reach deeper into the global tourism market.

"Jasco is able to offer full turnkey solutions for wireless infrastructure and services deployment, from the planning and design phase to deployment and commissioning, operational and ongoing support services. Our model is to work in these emerging markets with local partners, leveraging a programme of knowledge and skills transfer to increase penetration of wireless services into relevant markets."

Nick Ehrke, Sales director, Southern Africa, RADWIN

In the 2017 edition of the Yearbook, Nick Ehrke said RADWIN saw expansion across all of its segments during 2016.[7] So how did the last 12 months pan out for the company? "We continue to see growth across all of our sectors, including the mining sector. Our ongoing success in this sector in Africa is due to the fact that mines run in mission critical environments with regards to internal data and security. This requires the reliability and assured availability that the RADWIN networks have been able to provide."

Ehrke also pointed out that the company had been involved in a number of projects to replace obsolete WiMAX networks in 3.5GHz spectrum and to address the enterprise market which fixed LTE is unable to do. While further details about this were not provided, he said: "Our operator customers are expanding their networks rapidly in order to replace the LMDS [local multipoint distribution service] networks as carriers come under increasing pressure to reduce cost. The issue of availability has become a key factor in the competitive market place."

One thing he notes about the way the continent's market is now developing is what he describes as an "unfolding maturity".

"Traditional mobile markets have come under increasing pressure to be more cost effective particularly with the cloud facilities developing and evolving. Services have been focused on higher margin enterprise business.

"In this environment, connectivity availability is critical and continues to drive demand for RADWIN products. Our outlook is positive. Investment in Africa is changing, business and retail are becoming more digital; the continent's economies are diversifying rapidly and we believe the prospects for growth are good. However, the usual proviso of political and economic uncertainly is something we continue to monitor."

To prepare itself for the opportunities ahead, the company recently launched two new products, the *DuoJet* and the *Smart-Node*, which Ehrke claims will give users a "competitive advantage". And in terms of the year ahead, he said RADWIN's plan is to continue to listen to its customer's needs, and design and develop products that give customers "cutting edge" technology. ■

[7] African Wireless Communications Yearbook 2017, p55.