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SAIEE THE OFFICIAL PUBLICATION OF THE SOUTH AFRICAN INSTITUTE OF ELECTRICAL ENGINEERS | OCTOBER 2017

SA Energy Storage 2017

Venue

Emperors Palace, Ekurhuleni, South Africa

Dates

28, 29 and 30 November 2017

Theme

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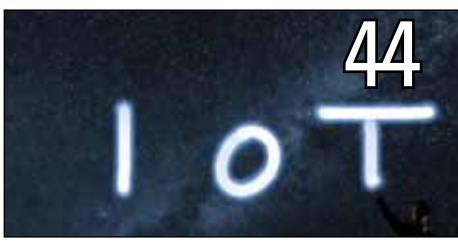

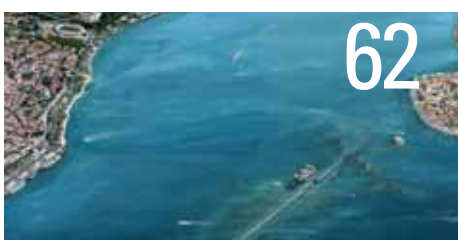

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Dear Reader,

We have entered the 'silly' season, with year-end functions and parties filling our diaries! It is because of this that I chose this issue features Communication.

Without communication the world would be a very quiet place - which might not be a bad idea - but alas - we are currently living within the fourth industrial revolution - where communication is imperative. Unfortunately, we are all so involved with our communication devices, that we forget to look up at the person next to you - and smell the roses.

Our first feature is a paper written by SAIEE Member, Pascal Motoasele on "Feasibility of using Wi-Fi for underground mine communications. He compares various Wi-Fi variants and vendors.

Read more on page 22.

On page 36, all the way submitted from Iran, is a paper on electronic communications - a case study on the design and simulation of a triple polar band pass filter with defected ground structure.

Our last feature article is posing the question: "What does cloud integration mean?" Read it on page 44.

Page 46 list the new membership fees for 2018. Please familiarise yourself with the fees and pay yours in time, to qualify for the discount.

We have a lovely article written by Dudley Basson on Astronomy - "Communicating with ET" - read it on page 48.

Herewith the October issue, enjoy the read!

Earn CPD Credits

Visit www.saiee.org.za to answer the questions related to these articles to earn your CPD points.

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JACOB MACHINJIKE
2017 SAIEE PRESIDENT

Communication is an essential human need, and arguably a basic human right. As such, social media platforms such as Facebook, Twitter and WhatsApp have become entrenched in our everyday life, as they enable us to keep in touch and easily communicate with our network of people.

"The fast changes in communication technologies require new skill sets and regulations."

In some countries in Africa, mobile money subscriptions are reported to be in excess of 40 million people accounting for an equivalent of over R130 billion worth of transactions. The enabler for these services has been advances in telecommunications technologies and availability of bandwidth. Indeed, the introduction of 3G networks in 1998 provided for higher data rates and better mobile internet connectivity. It also introduced applications not previously available to mobile phone users, such as location-based services, GPS, mobile TV, videoconferencing, social media and internet of things. Telecommunications is also an understated prerequisite in enabling the monitoring and control of critical infrastructure and services, in areas such as electrical power system, rail, freight, military, and travel, amongst others.

Telecommunications technologies and infrastructure are at the centre of economic growth and development. Studies have indicated a strong correlation between having Internet access and Gross Domestic Product (GDP) growth. In South Africa, the Square Kilometre Array (SKA) project has contributed to the development of parts of the Northern Cape Province. The Square Kilometre Array (SKA) radio telescope project is co-located in Australia and in Africa. In Africa the SKA will be built in South Africa and eight other African Countries. This is the largest radio telescope ever built, and will produce science that changes our understanding of the universe.

The traditional Telecommunications industry has seen many changes in recent years, particularly with the mainstream introduction of the Internet Protocol (IP) and Over the Top (OTT) networks. These have subsequently led to unified communications and greater collaboration, together with integration of traditional Information Technology (IT) services, to create the now called Information and Communications Technology (ICT).

In Power Utilities and Systems, mission critical services over packet networks require cyber security to be at the centre of every design. Security management systems are critical to facilitate centralized management of security policies, and to enable utilities to react as fast as possible in the likely events of cyber-attacks. Some utilities have developed proprietary solutions with algorithms to detect cyber-attacks before they even happen. These cognitive systems provide the security management centre with dashboards showing potential cyber-attacks, and targeted network locations in real-time.

The fast changes in communication technologies require new skill sets and regulations. Human capital development programmes need to be enhanced, and well directed to support professionals working with the technologies. We live in exciting times for communications.

J Machinjike | SAIEE President 2017
Pr. Eng | FSAIEE

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2017 SAIEE Smart Grid Conference

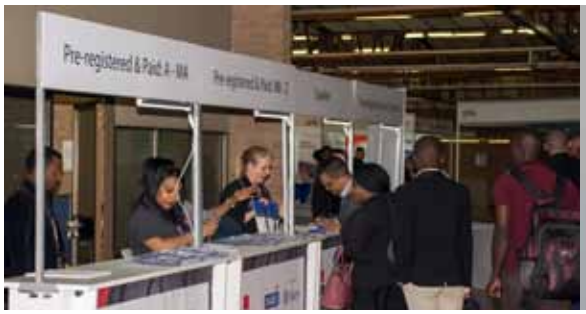
From left: Stan Bridgens (SAIEE CEO), Nico de Jager (MMC, Environmental & Infrastructure Services), Reji Kumar Pillai (President, India Smart Grid Forum), George Debbo (Chairman, Organising Committee) and Jacob Machinjike (SAIEE President).

In his opening address at the SAIEE's Smart Grid Conference recently, the president of the South African Institute of Electrical Engineers (SAIEE), Jacob Machinjike, said that a smart grid infrastructure would provide unique opportunities for improved electricity services which would benefit people in Africa.

The conference, which was held at the Eskom Convention Centre in Midrand recently, heard that since the continent has wonderful wind and solar energy resources, these should be harnessed and fed into a smart grid which would efficiently control and regulate the inherently varying supply of electricity.

Machinjike said that the development of a smart grid, which will enable the integration of renewable energy sources into micro- and mini-grids, will also require new skills which industry will have to provide and which may require some changes at tertiary education level.

In his presentation, Nico de Jager, a councillor from the Johannesburg City Council, said that a smart grid would be of benefit to City Power as the utility focuses on the growth and extension of its electrification programme. Johannesburg, he said, which covers an area of over



Delegate Registration Desk

Exhibitor: Siswe

Exhibitor: DFA

Exhibitor: Old Mutual

From left: Prof Valerie Anne Lencznar (MD, Think Smartgrids) with Stan Bridgens (CEO, SAIEE)

From left: Chris Yelland (MD, EE Publishers), Reji Kumar Pillai (President, India Smart Grid Forum) and Roger Lily (Journalist, EE Publishers).

Delegates seen at the various networking events

1600 km2, contributes 16% of South Africa's gross domestic product (GDP) and 40% of Gauteng's economic activity. There are 181 informal settlements within the city's limits, he said, many of which still lack electrical power and other basic infrastructure.

Currently, the city's peak demand of 4 GW is met by electricity generated by the Kelvin Power Station, Eskom, and some diesel and methane powered generators. Diesel, together with some methane from the city's refuse sites, is used to generate 170 MW, he said.

The city has a growth and development strategy, de Jager said, to make energy reliable and affordable by 2040. Part of the programme is the reduction of harmful greenhouse gases which come from energy generation and vehicular transport. To achieve this, the city will make use of more renewable energy. By making use of a mix of generating technologies, the

Delegates attending the conference.

Exhibitor: Schneider Electric

WATTSUP

2017 SAIEE Smart Grid Conference cont.

Jacob Machinjike
SAIEE President

Nico de Jager
MMC, Environmental & Infrastructure Services

Reji Kumar Pillai
President
Indian Smartgrid Forum

city plans to reduce the cost of electricity to consumers.

Eskom is, and will remain, the city's largest supplier of electricity, he said. However, some residents, who have installed – or will install – rooftop PV systems, are likely to generate more electricity than they need. A smart grid would enable them to supply the surplus to the city, de Jager said.

City power's smart grid programme will allow the network to change from having a hierarchical structure to a more interconnected one, where energy and data moves bi-directionally. The objective of the programme is to improve customer satisfaction by improved billing, condition monitoring, demand-side management and outage management, he said.

According to de Jager, the city is highly reliant on accurate billing because 60% of the city's income comes from electricity sales, along with water and refuse removal services.

Reji Kumar Pillai, the president of the Indian Smartgrid Forum, said in his keynote address, that just as progress in technology over the last 25 years has changed the way people do things, so too we must expect things to change in the energy sector.

He said that smart metering, which is a vital component in a smart grid network, is difficult and expensive for a municipal utility to manage and should be outsourced to a specialist company which is paid a fixed fee per meter it manages.

Energy storage, another important part of any renewable energy-based network, has developed significantly in recent years and will continue to do so, Pillai said. Citing an example of a flywheel storage system which provides power for four hours in California, and the dramatic decrease in the price of Li-ion batteries, he said that recent developments in various mechanical and chemical storage systems have extended storage capacities and reduced the cost per MW stored.

These developments make the variable output from wind- and solar-powered generators more useful in off-grid applications, and less disruptive to grid-based networks.

Solid state distribution transformers and other technological advances in electrical equipment, will continue to improve power quality while reducing capital and maintenance expenditure – resulting in more reliable and less expensive electricity to power homes and businesses across the city, he said.

Written by: Roger Lily

2017 SAIEE Smart Grid Conference

From left: Dr Willie de Beer (Independent Energy Sector Consultant), Amelia Mtshali (SAIEE Council Member) and Stan Bridgens (SAIEE CEO) enjoying a well-earned break at the close of the 2017 Smart Grid Conference.

One of the pertinent aspects of the SAIEE Smart Grid (SG) Conference was seeking synergy among the competing and varied technologies necessary in order to create a holistic and complete smart grid system.

Dr Willie de Beer's contribution to the panel discussion on synergy, pointed out that what was more important at this stage, was the seeking of synergy between and among the many players in the SG arena.

"To create a complete SG-system took careful medium to long term planning and required a large financial commitment. It was therefore unlikely that any one player had all the skills and financial muscle to go it alone" he said.

In his view it is vital to seek synergy and develop a coordinated effort where players share the available resources - as opposed to protecting their turf.
This sharing of the development of systems, standards, tariffs and the regulatory framework is perhaps the key to an accelerated and advantageous positioning of South Africa in taking the big step in the new SG arena.

It is obvious that the traditional supply authority in Local Government and National Suppliers of energy are set to have their turf aggressively invaded in the future.

Energy for all - and by all - is around the corner. Willie de Beer's caution to look for collaboration is well placed and should be taken very seriously by all decision makers!

Fluke 709/709H Precision Current Loop Calibrator with HART communication

Fluke, represented locally by The Comtest Group, has on offer the Fluke 709 and 709H mA loop calibrators, specifically designed to save time and produce high-quality results. These calibrators are built around a user-friendly interface with a Quick-Set rotary encoder knob. This tool reduces the time it takes to measure, or source, current and power up a loop. The protective holster easily fits into a technician's hand and the large backlit display is easy to read, even in dark, cramped worked areas.

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WATTSUP

Growthpoint powers innovation with its NWU Solar Car team sponsorship

Pushing the boundaries of what is possible for alternative energy and engineering, Growthpoint Properties has announced that it is sponsoring the North West University's Solar Car challenge team.

With its sponsorship, Growthpoint is helping to the give the team its day in the sun at the Bridgestone World Solar Challenge, which takes place from 8 to 15 October in Australia. The gruelling journey starts in Darwin and follows the Stuart Highway to Port Augusta followed by Highway 1 to Adelaide about 3,000km away.

NWU Solar has already set the bar high with its solar car challenge achievements. It was co-winner of its very first outing at the 2012 Sasol Solar Challenge, an honour it shared with Tokai University, which is consistently ranked as one of the top three teams in the world.

The team has gone on to break various records. In 2015, at the previous biennial Bridgestone World Challenge, NWU Solar debuted to become the first team from Africa to cross the finish line. It took 11th place in an overall field of 29, beating some world-renowned universities in the process including MIT and Cambridge. It holds the record for the furthest distance travelled by a South African team in a single day (611.9km), as well as the furthest distance completed by a South African team (3,524.9km).

The faculty recently launched Naledi, the 2017 iteration of the solar car that will be competing in Bridgestone World Solar Challenge. Naledi, meaning 'star', boasts a brand new design with the body based on the world-class JS3 Jonker Sailplane that also has its roots at the NWU Faculty of Engineering. The team from NWU will also be using solar tracking technology to soak up sun rays, keeping its panels at an optimal angle to the sun at all times. The body shape with the use of solar tracking makes Naledi one of the unique vehicles in the competition.

With its impressive track record, the NWU Solar team has a lot to live up to, but it has already proven that it relishes a challenge. Van Antwerpen says: "We wish the NWU Solar team everything of the best for the upcoming Bridgestone World Solar Challenge. True to the name of their car (and its power source), we believe that they are stars who will continue to shine in this global challenge."

Van Antwerpen highlights that the NWU Faculty of Engineering has also proven courageous in what it takes on, and this is a quality that Growthpoint values, encourages and invests in.

Its sponsorship of the NWU Solar car challenge team is just one of the ways the Growthpoint invests in sustainability and innovation at university level in South Africa. Growthpoint also founded the Greenovate Awards programme with the Green Building Council South Africa (GBCSA), which sets university students of the built environment and engineering on a quest to find more sustainable ways of living.

From left: Mr Francis Brochon (FTE President), Her Excellency Malika Berak (Ambassador of France in Tanzania), Mr Edouard Heripret (General Manager Schneider Electric East Africa), Mr Micheal Ramser (VP Strategic Marketing and Sponsorships) and Mr Jean Pierre Acquadro (ADEI President).

Schneider Electric Foundation inaugurate the KITEC solar power plants and laboratory

The Kilimanjaro International Institute for Telecommunications, Electronics and Computers (KIITEC) has officially opened its 30KW solar power plant and solar laboratory at its training centre in Moshono, Arusha, Tanzania.

It was officially opened by Her Excellency Malika Berak, Ambassador of France in Tanzania, the event brings together the partners that have supported KIITEC for many years. These are: Schneider Electric East Africa, the Schneider Electric Foundation, ADEI, EDF Help and the Foundation for Technical Education (FTE).

Attending the event are Mr Edouard Heripret (General Manager Schneider Electric East Africa), Mr Francis Brochon (FTE President), Mr Jean Pierre Acquadro (ADEI President) and Mr Daniel Mtana (KIITEC Director of studies). In addition, volunteers from Schneider Electric teachers attended the celebration.

The opening also featured two conferences – one on 'Micro Grid market model: a way for Africa' and the 'Internet of things (IoT), impact in industrial and photovoltaic applications'.

"The opening of this solar power plant speaks to the accomplishment of our vision to become the centre of training excellence for renewable energy, particularly solar photovoltaic systems in East Africa," says Mtana. *"Committed to true hands-on experience, KIITEC has now invested heavily in photovoltaic solutions and strives to be recognised as the premier provider of quality technical education in a student-centred community. The group is firmly committed to facilitating energy access for unprivileged populations through renewable energy, particularly solar technologies. We are proud to conclude this latest partnership with KIITEC, one of our oldest partners in Africa, to help train young Tanzanians for energy and electricity jobs."*

The SAIEE WCC Dinner & Dance Celebrations

From left: Joyce Mtimkulu (Chairperson, SAIEE Western Cape Centre), TC Madikane (Immediate Past President), Mrs Mahle Madikane and Mr Zach Vanto.

The SAIEE Western Cape Centre (WCC) held its annual Dinner & Dance event, which was attended by members based in the Western Cape. Mr TC Madikane, SAIEE Immediate President, and his beautiful wife, Mahle were amongst the invited guests. This auspicious event took place at the Lagoon Beach Hotel in Milnerton, with a magnificent sea view. *"I would like to thank the Western Cape Centre Committee for their unwavering support and hard work for making this year's event one never to forget"* said Joyce Mtimkulu, Chairperson, WCC.

WATTSUP

Mitigate summer lightning strike risk and tick insurance compliance boxes for your thatched roof

It is no longer necessary to install a 30-metre long mast as the only option for lightning protection for residential or commercial thatched roof structures. This is thanks to DEHN's external protection system for installation on thatched buildings, the High Voltage resistant Insulated (HVI) lightning protection system, which is compact and more aesthetically pleasing then the traditional 30 metre mast.

Kirk Risch, Sales and Marketing Director at DEHN Africa, an expert in surge and lightning protection, notes that with DEHN Africa's alternative lightning protection option, the vulnerability of a thatched roof to lightning strikes is substantially mitigated, without the need to erect the typical mast that we are so used to seeing in South Africa.

He says, *"Thatched roofs are very popular in South Africa and are to be found in rural communities, many urban developments, both commercial and residential, as well as in game lodges. They are regarded as being aesthetically pleasing, especially where there is a desire to make the structures 'blend' into the environment."*

"Of course, thatched roofs are also known to be far more susceptible to catching alight as a result of a lightning strike than any other roof type, as outlined by the South African National Standard, SANS 10313. Many local areas are prone to high incidents of lightning strikes, including Gauteng as well as the northern regions and some coastal areas of the country, and so this makes a thatched roof even more susceptible to this danger. In addition to considerations around the protection of human life, this increased fire risk also has implications for the insurance industry."

Infrastructure bottleneck weakens consulting engineering sector

The third South African Institution of Civil Engineering (SAICE) Infrastructure Report Card (IRC) gives South Africa's state-owned infrastructure an overall grade of D+.

According to the SAICE IRC, South Africa has achieved remarkable strides in the past twenty years. It has provided water to approximately 11 million citizens at a pace unrivalled in history, as well as electricity and sanitation, for which government deserves recognition.

However, maintenance of existing infrastructure and provision of new infrastructure require regular investment by Government to ensure continued growth in service delivery.

The damning report cautions that efficient maintenance of infrastructure is critical. If infrastructure is mismanaged through a lack of maintenance, the functional life-span will decline. Roads will deteriorate and the cost of repair can be up to six times more expensive. The lives of people in smaller towns are negatively impacted when, for example, water purification works and sewage plants are in disrepair, as residents are without access to clean water and proper sanitation and are then exposed to health risks.

The report reveals that there is a clear link between well-maintained public infrastructure and the social and economic health of a country.

Consulting Engineers South Africa (CESA) welcomes the diagnostic IRC but is concerned about the current under-maintained infrastructure as reported.

CESA regards infrastructure development as being key to service delivery, as well as an employment enabler and a catalyst for economic growth and transformation of the historically disadvantaged individuals, who were excluded from meaningful participation in the country's economy.

Parnis Completes E-Houses For African Mine

An established track record for quality manufacture resulted in Parnis Manufacturing securing a contract to fabricate modular electrical houses (E-House) destined for a mine in Africa.

The continued trend to make use of E-Houses has seen a marked increase in the demand for a company that can manufacture these structures to the necessary quality standards. This is according to Gary Colegate, General Manager at Parnis Manufacturing, who says that the latest unit was shipped to the customer at the beginning of the third quarter this year.

Contracts for E-Houses are typically secured by either EPCM contractors or electrical OEM (Original Equipment Manufacturer) companies, and most have neither the facilities nor the capability to undertake such large fabrication work.

Parnis Manufacturing operates a comprehensively equipped manufacturing plant south of Johannesburg and has the ability to tackle a wide range of engineering projects. Colegate says that most E-Houses comprise a base frame upon which insulated panels are installed to form the basis of the wall and roof structure. The interior is then populated with the requisite electrical equipment and auxiliary systems which include HVAC, fire detection and suppression, furniture and fixtures, and gas systems as well as all cabling reticulation.

"Because E-Houses are custom built for individual customer requirements, it is essential that close communication between all parties is maintained, and this includes the dovetailing of all activities within our facility to ensure that the installation of electrical and other systems can be completed in line with the construction programme," Colegate says.

The E-Houses in question are intended to serve not only as an electrical control room, but also include office space and toilet.

First Solar Powered Coffee Trailer For Cape Town

More than three million South Africans aged between 15 and 24 are neither employed nor pursuing higher education.

Energetics SA, the renewable energy arm of CHS Eco Technologies, which was established by Leon Badenhorst in 2005, has just launched a Non-Profit Organisation, Cups for Life, an empowerment programme for dynamic, mostly young, South Africans. The programme aims to identify, train and empower potential entrepreneurs who cannot find work or who struggle to get into the employment market.

The programme will also assist in additional job creation as it requires about ten workers to create a trailer from start to finish. Marlene Robson, CEO of Energetics SA, says, *"Cups for Life calls on South Africans to support this worthy cause. Wherever you spot this bright yellow trailer, buy a cup of superior quality coffee, and know you are supporting someone who is taking responsibility for his or her future and is willing to work hard for it."*

She adds, *"Statistics South Africa has released figures that paint a bleak picture for young South Africans. Their Quarterly Labour Force Survey Q2: 2017 reveals that young people aged 15-24 remain vulnerable in the labour market with an unemployment rate of almost 56% and absorption rate of 12%. Among those in this age group, 32,2% are not in employment, education or training. This is approximately 3,3 million young people aged 15-24 who are idle."*

According to Statistics SA's second quarter unemployment numbers, the country has shed 113 000 jobs over that period.

WATTSUP

Vacuum trucks supplied for power-station cleaning contract

Mpumalanga Renovating Maintenance Services (MRMS), a leading cleaning and maintenance specialist servicing the local industrial cleaning, civil, and general construction sectors, has standardised on rental machines from Goscor Cleaning Equipment (GCE) to ensure it receives the lowest total cost of ownership.

When MRMS secured a three-year civil site-maintenance contract at Kusile power station in 2010, it purchased its first cleaning machine from GCE, part of the Goscor Group. Following a second cleaning contract at Arnot power station, MRMS decided to rent all its cleaning equipment on a long-term rental basis, GCE GM Greg Venter reveals.

In August 2013, MRMS Director F.J. Steyn discovered the Highpoint Vacuum HPVR 1000 cleaning truck showcased by GCE at Bauma, ideal for cleaning operations at power stations and other industrial sites. As a result, MRMS acquired its first vacuum truck.

"The way the vacuum truck is put together is of a world-class standard. Apart from the fact that I could not import a truck at the same price nor of the same quality, I would face an impossible lead time of 12 months," Steyn explains. In addition, the Highpoint Vacuum HPVR 1000 is simple and easy to operate.

MRMS ordered another two HPVR1000 wet and dry vacuum trucks and received delivery of these vehicles during early 2016 for cleaning operations at Matla, Kusile, and Arnot power stations and other industrial sites.

Quality machines and customer service is of the utmost importance to MRMS. *"We expect the same level of quality from our service providers, and we deal with only the best,"* Steyn asserts. *"GCE is far superior compared to any of its closest rivals, while its service is on par."*

Regular service and maintenance of the machines is key in keeping operational costs and downtime to a minimum. Highpoint is responsible for service and maintenance on the vacuum component of the trucks, which are serviced at a truck centre.

MRMS also secured a maintenance contract with GCE, which ensures more output from its cleaning machines in the long run, resulting in maximum availability and ultimately the lowest total cost of ownership.

"In the event of a breakdown, GCE ensures that the machine is replaced or repaired within 24 hours. I can count on GCE for zero downtime because, irrespective of the hour, it goes out of its way to assist us. With well-trained operators, these durable machines can last at least a decade. My oldest machines look like they are only a year old. The all-round quality I receive from GCE enables me to fulfil all of my customers' expectations," Steyn concludes.

Jacob Machinjike (SAIEE President) and Prof Nelwamondo with a few of the Western Cape Centre Delegates.

2017 BP Lecture kicks off

The 66th Bernard Price Memorial Lecture, in conjunction with the WITS university kciked off at the Western Cape Centre. This year's presenter, Prof Fulufhelo Nelwamondo, addressed the delegates with "Redressing structural and systemic bias in Modern-day automated solutions". Prof Nelwamondo is an electrical engineer by training, and has a Bachelor of Science and a PhD in Electrical Engineering, in Computational Intelligence, both from Wits. He is a registered Professional Engineer, a Member of the SAIEE, and a senior member of the IEEE.

Next generation of temperature controllers embrace the era of AI

Omron is introducing their E5_D series - the next generation of controllers built on the successful E5_C platform. It is designed to achieve optimal and automatic temperature control without human intervention.

Omron's E5_C series substantially raised the bar for temperature control in the past five years thanks to its user-friendliness, high precision and highly reliable control. Now, the E5_D series - the next generation of controllers built on the successful E5_C platform - is designed to achieve optimal and automatic temperature control without human intervention. In fact, from now on all typical adjustments made in the field by experts are automated using Artificial Intelligence (A.I.). The E5_D is based on the E5_C platform so the basic features are the same (50msec control period, universal inputs measurements Thermocouples/ Pt100/linear, and more) but with a draw-out structure to make maintenance even easier.

SAIEE Staff Achieves

At the October SAIEE Council Meeting, President Jacob Machinjike handed out Long Service Awards to a few of the SAIEE Staff. From left: Alice Makhado, Dudu Madondo, Celeste Pretorius and Roberto Benetis.

From left: Jacob Machinjike (SAIEE President), Dr Albert Lysko (Chairman: IEEE South Africa Section) and Stan Bridgens (SAIEE CEO).

IEEE/SAIEE signs MOU

At the recent Council Meeting, the Chairman of the IEEE South Africa Section, Dr Albert Lysko signed a Memorandum of Understanding (MoU) with SAIEE President Jacob Machinjike and Stan Bridgens, CEO.

This MoU was signed to encourage the exchange and dissemination of technical information, and to promote understanding and cooperation among the members of the South African Institute of Electrical Engineers (SAIEE) and The Institute of Electrical and Electronics Engineers, Incorporated (IEEE).

Minister Kubayi's Renewable Energy Plan: Does it signify progress or regression?

BY | SIYABONGA MBANJWA | REGIONAL MD | SENER SA

The energy industry breathed a huge sigh of relief recently when Energy Minister Mmamoloko Kubayi announced that power purchase agreements (PPAs) for renewable energy from bid windows 3.5 and 4 will be signed by the end of October 2017.

The industry's sense of euphoria is understandable, given that the renewable energy sector has been plagued by a dearth of positive news and lengthy delays in signing the outstanding PPAs, which slammed the brakes on the roll-out of South Africa's Renewable Energy Power Producer Procurement Programme (REIPPPP).

For a long time, these delays had led to a thick, dark cloud of uncertainty over the REIPPPP. This was weighing heavily on independent power producers (IPPs), investors, manufacturers, suppliers, and other role players in our industry's value chain, who were beginning to lose faith in the programme.

While the announcement by Minister Kubayi sends a positive signal, it is premature to conclude that we have turned a corner and that the future direction of the REIPPPP has been crystallised. The minister has made it clear that state-owned electricity supplier Eskom is sitting with excess generation capacity that is projected to last until 2021.

She has also acknowledged that the majority of the projects in bid window 3.5 and 4 will be commissioned closer to 2021 therefore these projects will not further increase the overcapacity. The minister also informed the market that all future programmes related to the REIPPPP will be put on hold until the Integrated Resource Plan (IRP) is updated in early 2018.

A careful analysis of the statement indicates that the government has removed uncertainty for projects related to bid window 3.5 and 4 but, beyond this window, huge uncertainty over the REIPPPP still remains.

The moratorium on future renewable projects has left bid window 4.5 in limbo, despite Eskom previously indicating that this bid window will go ahead. The DoE received bids for window 4.5 in November 2015, but since then the industry has been waiting for preferred bidders to be announced. The uncertainty over the REIPPPP is further complicated by the DoE's intention to renegotiate a tariff cap of 77c per kilowatt hour with preferred bidders in bid windows 3.5 and 4.

We sympathise with the fact that the government needs assistance from the industry to reduce costs associated with the programme. However, it is concerning that the minister has placed the 77c/kwh tariff cap as a condition for signing PPAs without investigating the implications for individual renewable energy projects.

For instance, some projects will be able to accommodate the tariff cap and remain economically viable, while others -- particularly those that use technologies such as biomass and concentrated solar power (CSP) -- will be affected negatively, as the proposed cap is too low and commercially unworkable for these technologies. It also assumes that the value that each technology provides is the same.

This cap is significantly out of touch with tariffs that are currently being achieved all over the world for some technologies. The one-size-fits-all approach to the tariff cap needs to be handled with care, as it may cause more harm than good and slow down the pace of innovation, research and development in the renewable energy sector, which is at a nascent stage of development in South Africa.

We are hopeful that in the course of consultations with the minister and the DoE, the position on the tariff cap will be reconsidered. It may displace technologies that could contribute a great deal to generating reliable and dispatchable renewable energy.

The moratorium and the proposed tariff cap have introduced some level of complexity to the debate on how best to proceed with the REIPPPP. It becomes imperative that the updated IRP removes uncertainty that may hamper progress.

Unfortunately, if prolonged, the lack of policy clarity will stifle future investments and employment creation in the sector. As a result, socio-economic and enterprise development projects will suffer in rural communities that host the renewable energy projects. This will be an unnecessary price to pay given our country's need to stimulate economic growth and reduce inequality.

We are hopeful that the government will consider all inputs made by the public and the renewable energy industry and that our country will remain committed to renewables being part of a balanced energy mix.

A move in a tangent direction would be contrary to our country's commitment to significantly slashing greenhouse gas emissions by 2025 in order to mitigate the negative impact on climate change. Our commitment to the Paris Agreement, which was recently re-confirmed by President Jacob Zuma at the United Nations in the past few days, would also lose credibility.

South Africa is the 12th largest emitter of carbon dioxide (CO2) in the world and is responsible for nearly half of Africa's CO2 emissions. Our energy sector accounts for 69% of that, largely due to our reliance on coal-generated power.

Having said this, we believe that the renewable energy programme is not at risk of being scrapped outright, but it will probably proceed at a slower pace with more emphasis on obtaining the lowest tariffs from IPPs and using the sector to drive radical economic transformation.

Siyabonga Mbanjwa is the Regional Managing Director of SENER Southern Africa, a global engineering & technology group operating in the Power, Oil & Gas sector.

Future Proofing ICT Strategies

As both local and global markets face constant and intricate business changes, relevant, reliable and secure Information Communication Technology (ICT) has become not only a dire need, but also a prerequisite for success. To deliver an effective ICT strategy, one must take a view to the future and consider what the business requirements will be next month, next year or in the next decade.

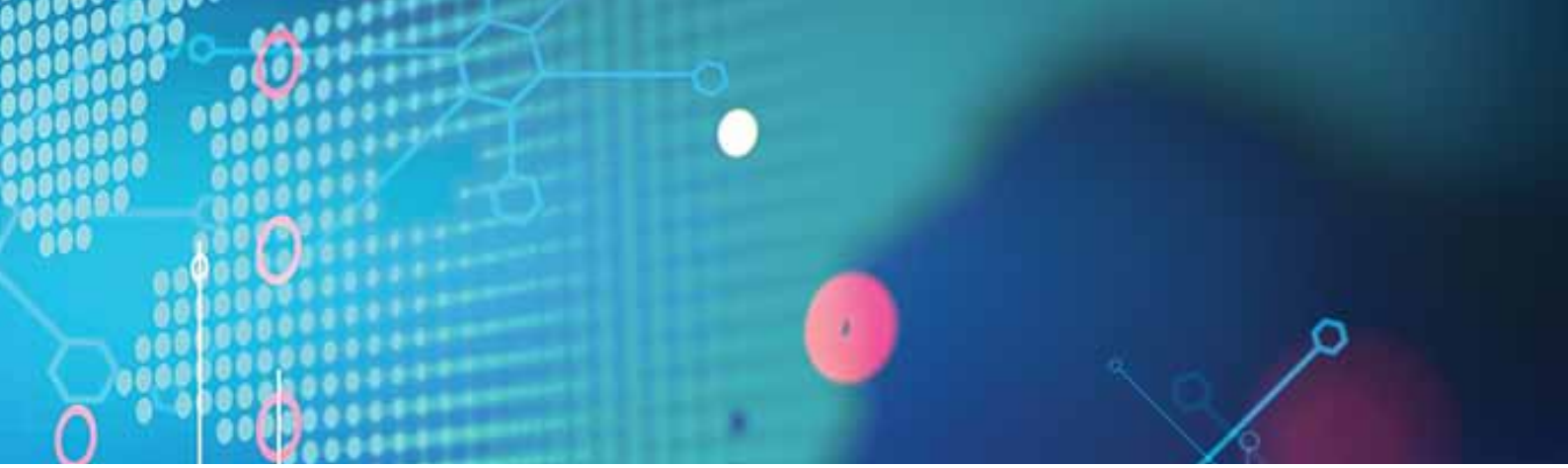
Without this forward-thinking focus, the strategy will remain reactive and the benefits of proactivity will never be enjoyed.

At Infoprotect's recent Future Proofing Your ICT Strategy event, held in August at the Focus Rooms in Sunninghill, CEO Brad Fraser confirmed that an effective strategy requires a holistic approach. *"There are four ICT pillars that businesses must consider to ensure that their strategies can grow with the business,"* confirms Fraser. *"These are: security with data loss protection; data back-up; WiFi infrastructure with guest analytics; and connectivity management with failover."*

The event featured interactive discussions with Infoprotect's technology partners, detailing how best to address current and future business needs associated with these four pillars.

For security strategies to be successful in a Cloud enabled world, these must be scalable across the board, regardless of the size of an organisation. According to Jon Hamlet, Symantec Country Manager, strategies should incorporate an open, integrated cyber-security platform. *"Cloud adoption is driving change, and increasing the speed at which information is being shared: information which must be secured. The key is to gauge your visibility, what you don't know is what you don't know."* Hamlet believes that a realistic organisational view is essential to meeting the security needs presented by private, public, hybrid and multi-Cloud scenarios.

To achieve effective data back-up solutions, Veritas suggests considering the truth in the information. *"There are various elements to consider,"* said Julie Noizeux Veritas Distribution Success Manager (South Africa). *"In a multi-Cloud environment, businesses must consider which data necessitates long-term retention, software defined storage and compliance with POPI and the GDPR. The key question is, do you know what you're storing? Dark data assessments provide valuable insight into unstructured data, what it is and where it's being stored."* In the digital age users want access to services, data and information on demand wherever they are. According to Wayne D'Sa, Managing Director at Cipherwave, data centres rely heavily on internet connectivity. *"If we consider the current ICT buzzwords - IoT, Big Data, Cloud computing, unified communications – they all have one common requirement, connectivity. Whether the*



business is collecting information from IoT to optimise operations, or developing large server farms to collect Big Data; connectivity is a key enabler for any company's Cloud, IoT, Big Data or Unified Communication strategy."

This necessitates a reliable WiFi infrastructure, which is not only always connected, but also offers in-depth insights into customer behaviour, staff performance and market intricacies. Mark Esslemont, Channel Manager Sub Sahara at HPE Aruba, confirmed that the right technology creates this infrastructure, offering capabilities limited only by the imagination. *"Consider downloading an app when purchasing a rugby ticket, which not only directs you to the stadium, but shows you where your specific parking bay is situated. It'll show you to your seats, allow you to order drinks and food, indicate which restrooms have a vacancy and offer instant replays."* Sound futuristic? This technology has already been implemented at the Levi's Stadium in San Francisco – all it requires is the right infrastructure.

WiFi guest analytics are moving beyond visually attractive dashboards that offer mere insights into data. *"Analytics are evolving,"* stated Dean Horsten, Sales Engineer at Skyfii. *"The key is to build campaigns that can not only analyse the data, but trigger automatic action if a particular event occurs – such as vouchers, push notifications, or corrective action. With fully location aware software, for example, a university could track whether or not a student is attending lectures. If he misses a week of class, we could send him a voucher for a free burger at the canteen if he attends two classes."*

To achieve all of the above, a constant connection is required. For a constant connection, a reliable failover is essential. According to Hubert Da Costa, Vice President, EMEA at Cradlepoint, ensuring a constant connection requires looking forward to what the future of connectivity holds. *"It's time to start imagining what a 5G world would look like in the endeavour to connect people, places and things securely,"* confirmed Da Costa. *"This may be built on the backbone of LTE, but 5G is a reality that will surface around 2020. It'll offer greater communication in all verticals, interactive fitting room mirrors, virtual tours of hotel rooms, heat mapping, beacons, driverless cars, predictive maintenance and an overall improvement on 4G performance."*

In retail, FMCG and fast food in particular, data insights, protection and connectivity are essential to success. According to the Technology Manager at Nando's South Africa, Stephen Brookstein, being offline meant Nando's would lose revenue, and this became the driving force behind how the company viewed its future. *"We required ICT infrastructure that could run a scalable, sustainable, great business, while delivering a continuously enhanced and seamless experience for both customers and staff."*

Through Infoprotect and its partners, Nando's achieved a unified and stable communications platform across the entire estate with a centrally managed 3G failover position. *"We're able to manage the traffic on the lines to prioritise the important data and have increased uptime to almost 99%."* With dual sims for multiple coverage, Infoprotect deployed more than 300 Cradlepoint routers across Nando's stores in only 12 weeks. Connectivity is consistently managed and monitored by Infoprotect's support team. *"This allows for software to be centrally deployed while providing enhanced network security and laying the platform for the roadmap ahead,"* said Brookstein.

Change is constant, and if businesses do not evolve to match these changes, they will be left behind. *"If two companies are selling the same product in the same area, why does one company succeed when the other doesn't?"* asked Gavin Sharples, keynote speaker at the event. *"There is one common denominator to success and it's this; 'chinking' - change, innovation and creativity. There's something to be said for experience, but do you really have 40 years of learning, growing, and changing experience? Or do you have one year's experience that you've repeated 39 times? Change is going to happen whether you like it or not, so you're either changing or you're dying."* wn

Underground Wi-Fi communications

Communications in underground mines is necessary to achieve coordinated work. There is no problem while members of the work crew are within range of each other's voices; but immediately upon entering a portal to the underground, the work crew is separated from the surface workers and from a safety perspective, the Law calls for reliable communications.

BY | PASCAL MOTSOASELE | PRENG | SMSAIEE

This article explores the maturity of existing Wi-Fi technology standards to meet the communication requirements of underground mines (UGM).

Recently, South Africa has seen a proliferation of Wi-Fi communications, especially in metropolitan areas. What was the domain of cellular communications, is now enabled through either free, or affordable Wi-Fi from the municipality. The question is, however, can the world leverage Wi-Fi technology for underground mine communications?

UNDERGROUND MINE (UGM) OPERATIONS

According to [1], the main operations of underground mining can be summed up as:

- Ground Control – Scaling, shot-creting, bolting, meshing, etc.
- Mine exploration – Core drilling, etc.
- Excavation – Blast-hole drilling, explosive charging, raise boring, continuous mining, mucking, etc.
- Materials handling – Loading, hauling, conveying, hoisting, etc.
- Service – Maintenance, ventilation, drainage, illuminations, etc.

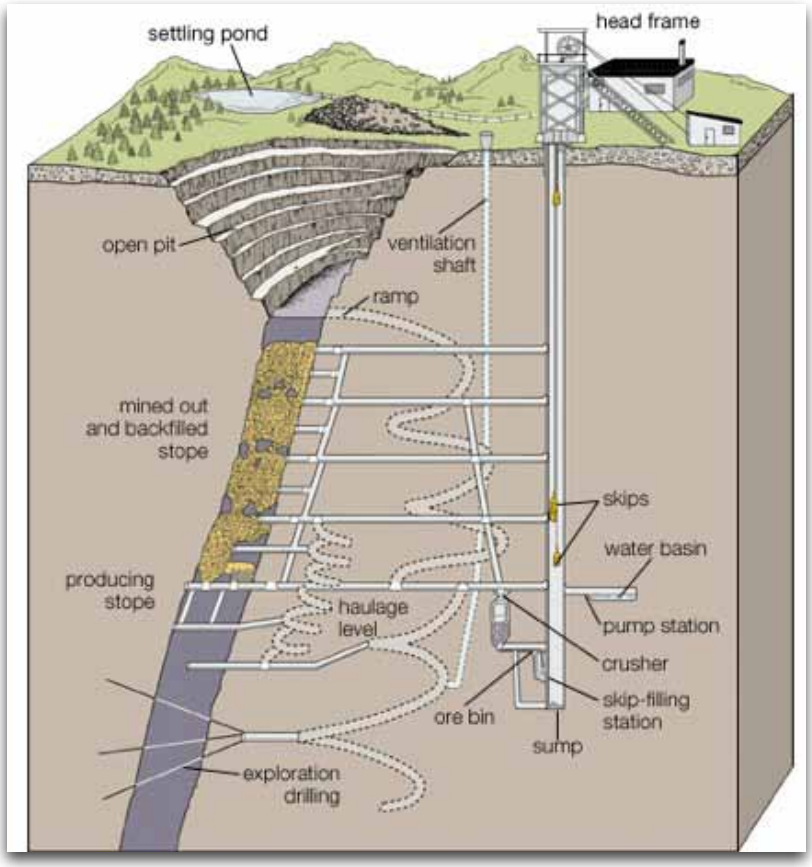


Figure 1: Cross-sectional view of underground mining operations

Wi-Fi for mines

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Figure 1 gives a fairly accurate representation of underground mining operations.

COMMUNICATIONS REQUIREMENTS FOR UNDERGROUND MINING

In underground mining, communications is crucial from both a safety and productivity point of view:

- Underground mining is intrinsically a dangerous career choice. Miners work hundreds of metres underground, beneath millions of tons of rock. They are surrounded by HV electric lines, darkness, dust, heat and underground gases that are dangerous to humans. Therefore, for emergency services, a reliable and effective communication system is an essential requisite for the safety of the workers.
- Additionally, proper and reliable communications not only reduces machine breakdown times, but also helps in the immediate passing of messages from underground working areas to the surface, for a speedy resumption of operational challenges when required.

COMMUNICATION SYSTEMS IN UNDERGROUND MINES

Communications systems in underground mines have traditionally been based on copper wireline technologies. The challenge is that wireline communications cannot withstand disaster conditions such as rock falls, earthquakes, fire outbreaks, explosions, power outage, etc. where miners could be trapped, and are in inaccessible areas of the shaft.

This had prompted additional systems that are based on radio technology. The challenge with the use of radio technology underground is that propagation of radio waves is negatively impacted by the small mine tunnels, and performance deteriorates quickly. In addition, prior to the introduction of computers into mines, two-way voice communications was the primary requirement for a communication system.

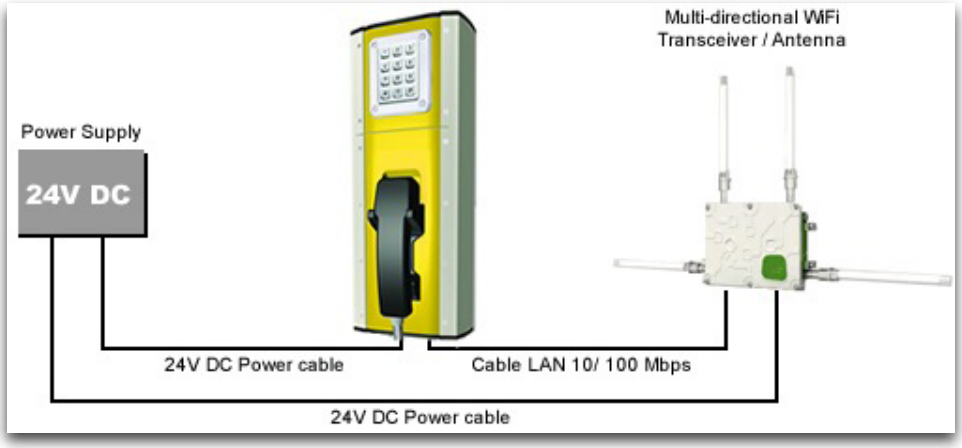

Figure 2: A Wireless Emergency Telephone system [source: www.norphonic.com]

Nowadays, data communications is of utmost importance, as it is used for process control, ventilation on demand, blasting systems, seismic activity monitoring, tagging, emails, Internet and a number of other applications [2]. Thus, a state-of-the-art radio-based communications system will have to meet, at minimum, the following new age requirements for UGM communications:

- Services requirements
- Range capability
- Mobility
- Service availability and resilience

The above requirements will be addressed below in relation to capabilities of existing Wi-Fi specifications, in correlation to the specifications as detailed in the Mine Health and Safety Act 74 of 2008 (MHSA) [3], [4].

SERVICES REQUIREMENTS

According to [3], the information to be transferred within UGM operations includes data, voice, and video information.

a) **Voice:** There is no specification of the codec being used but the assumption (which I base on [4]) is that some form of packetised voice processing would be used, and the connection would be two-way. Voice over Internet Protocol (VoIP) capacity should be derived, assuming a 12.2 kbit/s codec with a 50 % activity factor, such that the percentage of users in outage is less than 2 % for a given bandwidth (based on choice of technology, this type of outage can be brought to near 0% [8]).

b) **Data:** is a generic term for information being transferred from machine to machine, and can include information being displayed to a person for interpretation and further action.

c) **Video:** in cases where there is an outage and the situation in the mine needs to be displayed to the surface, video might be desirable. Video could be still pictures or motion pictures.

Figure 2 gives an example of a Wi-Fi based emergency telephone solution.

RANGE CAPABILITY

Propagation characteristics of Wi-Fi through underground mines are not well documented. In [8] the author explores the expected range in a theoretical deployment, to gain a perspective regarding the most applicable UGM communications network segment to which Wi-Fi could be best suited.

When comparing range predictions for possible UGM wireless systems, however, it is important to take into account both the bandwidth and frequency of operation, modulation scheme, system gains and the margins assumed for fading, penetration loss, and interference, etc. The margins, together with the system gain, determine the link budgets used to predict the range. It is also important to indicate the path loss model used, and the type environment assumed (rock and concrete in this case), tunnel Line of Sight (LoS) or non-LoS, Point-to-Point (PtP) or Point to multipoint (PMP), etc., since these factors will also influence the range prediction.

Note that the greatest range achievable by a specific technology typically requires transmission at the maximum Effective Isotropic Radiated Power (EIRP) permitted in the frequency band of operation, and assumes the most robust modulation index. The latter point is important to note because the Wi-Fi technology variants are designed to comply with the legal specifications, irrespective of the fact that the technology would in this case be used underground.

In some cases there may also be factors other than path loss, and the link budget that places limits on the range. These factors may be latency-dependent features, or other mechanisms built into the standard designed to optimise performance over a limited range of path lengths.

MOBILITY

Some UGM applications might require relative movement between a transmitter and receiver during the operation of the radio link. The inability of the radio link to operate successfully in situations of movement is due to many factors, such as Doppler shift.

A solution to this is to deploy a series of Access Points (APs) or Wi-Fi mesh nodes, propagating the signal from one to the other, down the length of the mine shaft ,and wirelessly connecting computers and miners to the network. These APs may be placed along the shaft entries, travel ways, beltways and in air-way intakes and returns.

SERVICE AVAILABILITY AND RESILIENCE

The Code of Practise (COP) as detailed in the Mine Health and Safety Act (MHSA) [3] dictates that an adequate communications system must enable effective communications to deal with an emergency. The Wi-Fi solution will therefore need to comply with this requirement.

CHARACTERISTICS OF WI-FI STANDARDS

The IEEE Std 802.11™-2014 standard are a group of evolving specifications defined by the Institute of Electrical and Electronic Engineers (IEEE).

Commonly referred to as Wireless Local Area Networks (WLANs) or Wi-Fi, the 802.11 standards define an over-the-air interface between a wireless client and a base station access point or between two or more wireless clients.

WI-FI NETWORK TOPOLOGY

Wi-Fi consists of a set of Access Points (APs) and clients as presented in Figure 3. Each AP, and the clients associated to it, form a Basic Service Set (BSS). Multiple BSS can be connected via a Distribution System (DS), and they are usually connected to the Internet [4].

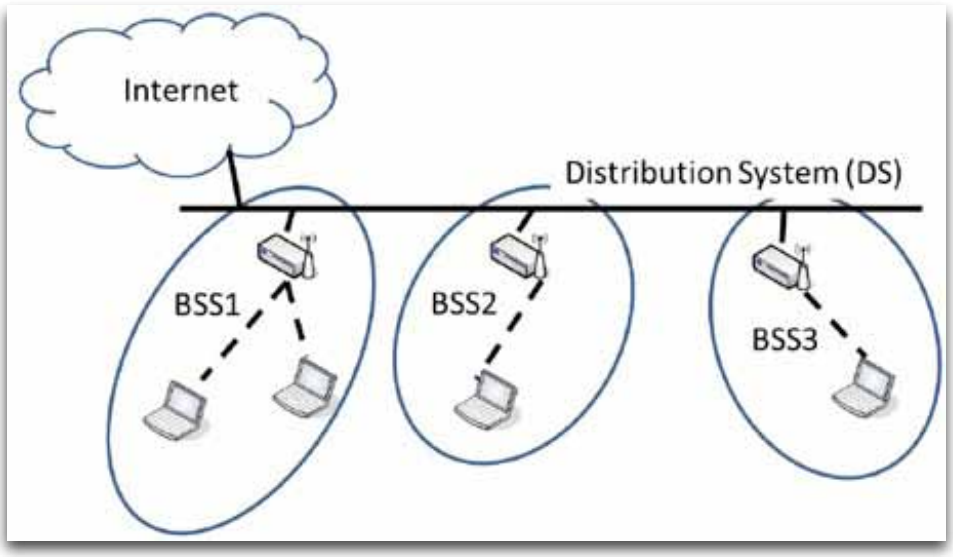

Figure 3: Topology of an IEEE 802.11 Wireless Local Area Network

Wi-Fi for mines

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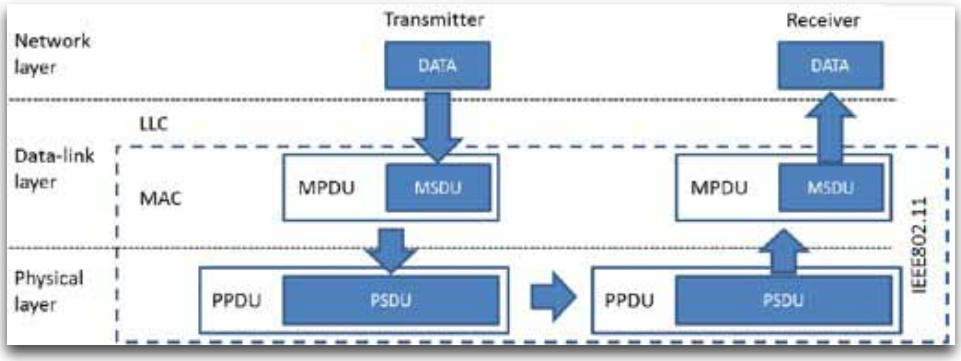

Figure 4: Simplified view of OSI model and packet encapsulation.

The modern IEEE 802.11 WLANs operate in the 2.4 GHz and 5 GHz frequency bands. The basic channel is 20 MHz wide, but 802.11n and 802.11ac allow usage of wider channels, by bonding several channels together. The number of available 20 MHz channels in the 2.4 GHz and 5 GHz frequency bands are 11-13 and 19-25 respectively, depending on the regulatory domain. All devices that are within the transmission range and share the same, or overlapping channel, also share the channel transmission capacity.

IEEE 802.11 specifies operations in two layers of the Open Systems Interconnection (OSI) model, namely in the data-link and physical layers as presented in Figure 4.

The data-link layer contains the Medium Access Control (MAC) protocol, which is responsible for controlling transmissions in the BSS. The physical layers, as responsible for modulating and transmitting data. Each transmitted data packet goes through each layer, and is encapsulated with the layer specific framing. Finally, the corresponding layer in the receiver decodes the frame. The framing in each layer is needed for the operation of the layer, but this overhead decreases the effective capacity of the network [4].

WI-FI MAC OPERATION

The 802.11 MAC protocol uses a Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) method [4] illustrated in Figure 5. The basic principle in channel access is that, before sending, each station must listen to the channel, and send only when the channel is sensed free. Detection of collisions is difficult in a wireless environment, and the following additional method is used to avoid collisions.

When the channel is sensed as 'free' and available, first the station waits for the duration of an InterFrame Space (IFS).

The time between the IFS and the next transmitted frame is called a contention window, which is divided into transmission slots. After the IFS period has passed, the station starts a backoff counter. The initial value for this counter is selected randomly between zero and contention window minus one slots.

When the counter reaches zero and the channel is still idle, the station starts transmitting. If another station starts to transmit before that, the counter is stopped; and the counting continues when the channel has been idle again for longer than the IFS. When the counter reaches zero, the transmission can start.

In the MAC layer the transmitted data packet is called a MAC Protocol Data Unit (MPDU). It starts with the MAC header, followed by a MAC Service Data Unit (MSDU), which is the actual payload data of the packet. The payload is followed by a Frame Check Sequence (FCS), which is used for detecting transmission errors in the packet. Each correctly transmitted packet is acknowledged with an ACK packet, and retransmitted if no ACK packet is received. Each transmitted MAC layer packet is wrapped inside a physical layer packet. [4]

Several additional methods are used to avoid collisions. These are a dynamically changing contention window, as well as Request to Send (RTS), Clear to Send (CTS) packets [5]. RTS and CTS packets are omitted from the figure for simplicity.

The channel access method described above enables controlled usage of the transmission channel simultaneously by several stations. However, as shown in the figure, it also requires a considerable overhead before

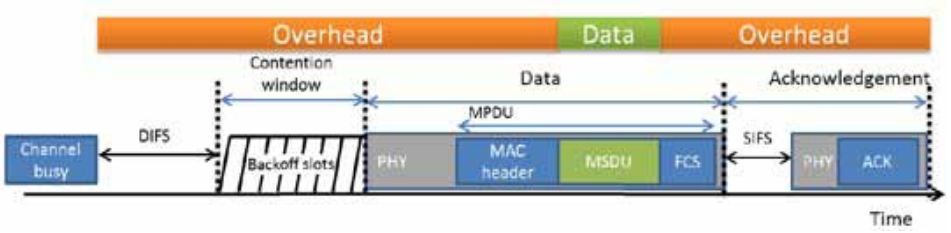

Figure 5: CSMA/CA access cycle

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Wi-Fi for mines

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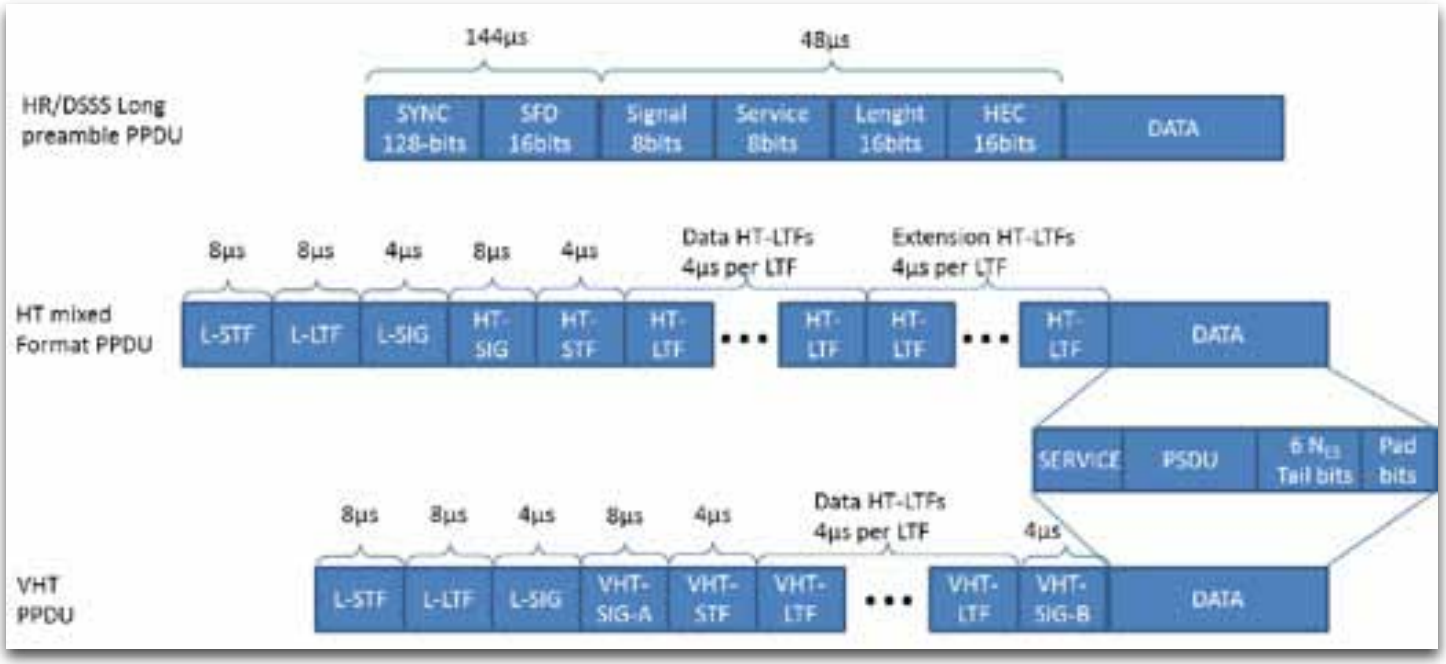


Figure 6: Example physical layer frame formats with 802.11b, n and ac. [source: EKAHU]

each sent frame, and this causes problems, especially with high loads and small packet sizes [6]. Distributed channel access also makes capacity estimation very difficult.

Packet aggregation was introduced with 802.11n to reduce overhead in the MAC layer [7]. It allows transmission of several network layer packets in a single MAC layer packet. Packet aggregation increases packet delay, because the transmitter must wait until all packets are collected before a MAC frame can be transmitted. Thus, the method has its limits with delay sensitive applications, such as voice and video.

WI-FI PHYSICAL LAYER

The IEEE 802.11 standard defines several physical layers. The latest new physical layer is nicknamed Wi-Fi HaLow and it is defined in the IEEE 802.11ah standard amendment [IEEE Std 802.11™-2016]. This Physical Layer is a re-use of the one first introduced by the VHT (Very High Throughput) Physical Layer as defined in IEEE 802.11ac. The physical layer packet starts with a preamble, which is different for each physical layer. The preamble is needed to synchronise transmission and control physical layer operation.

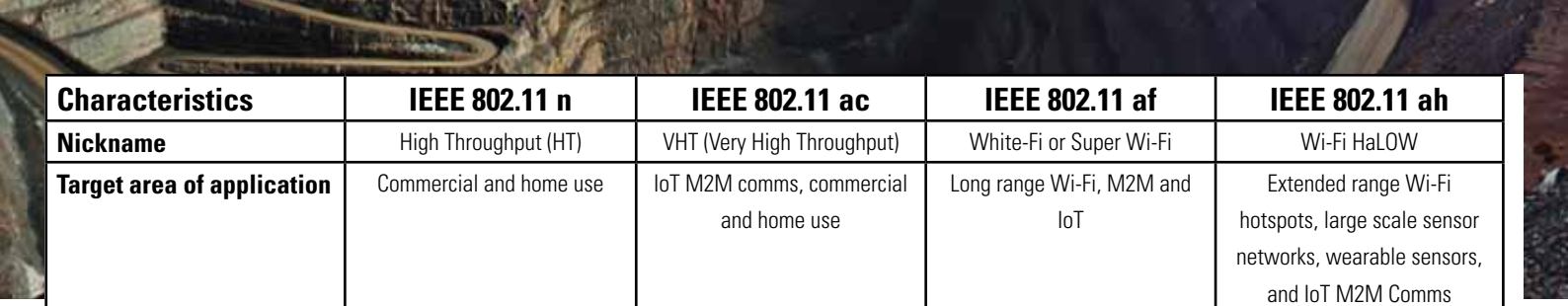
Figure 6 shows examples of the physical layer frame formats for High Rate / Direct Sequence Spread Spectrum (HR/DSSS) defined in 802.11b, High Throughput (HT) mixed format defined in 802.11n and VHT format, defined in 802.11ac. As can be seen in the picture, the overhead required in the preamble has decreased from 192 µs to a minimum of 40 µs.

After the physical layer preamble, the data itself is transmitted using a selected Modulation and Coding Scheme (MCS). Each physical layer defines a set of possible MCSs, depending on the quality of the signal between the transmitter and receiver. The MCSs differ on the amount of error coding and density of data. This makes different MCSs suitable for different signal conditions.

COMPARISON OF WI-FI VARIANTS

In the latest physical layers (802.11n, 802.11ac, 802.11af and 802.11ah), data is transmitted using several possible channel bandwidths. The normal channel bandwidth in 802.11 WLANs is 20 MHz, whereas the 802.11n supports a 40 MHz bandwidth and the 802.11ac can also utilise 80 MHz and 160 MHz bandwidths.

This allows transmission of much more data during the same time period. By contrast, the 802.11af and 802.11ah support much lower bandwidths as a trade-off for greater coverage distances. Table 1 gives a comparison of the five latest IEEE 802.11 standards.



Characteristics	IEEE 802.11 n	IEEE 802.11 ac	IEEE 802.11 af	IEEE 802.11 ah
Nickname	High Throughput (HT)	VHT (Very High Throughput)	White-Fi or Super Wi-Fi	Wi-Fi HaLOW
Target area of application	Commercial and home use	IoT M2M comms, commercial and home use	Long range Wi-Fi, M2M and IoT	Extended range Wi-Fi hotspots, large scale sensor networks, wearable sensors, and IoT M2M Comms
Date of ratification	Oct-09	Dec-13	Feb-14	Sep-16
Frequency of operation in ITU Region 1	2412 - 2472 MHz ISM band, and 5180 - 5825 MHz ISM	5725 - 5875 MHz ISM band	470 to 790 MHz VHF/UHF TV White Spaces (TVWS) spectrum	863 - 868 MHz ISM band
Channel Bandwidth	20 MHz in 2.4GHz range, 40 MHz in 5GHz range	20, 40, 80, 160, and 80+80 MHz	6, 7, 8 MHz channels (Broadcast TV)	1 MHz for long range low data rate applications; 2, 4, 8 and 16 MHz for high data rate applications
Coding / Modulation schemes	BPSK, QPSK, 16-QAM, and 64-QAM	BPSK, QPSK, 16-QAM, 64-QAM and 256-QAM	BPSK, QPSK, 16-QAM, 64-QAM and 256-QAM	BPSK, QPSK, 16-QAM,64-QAM and 256-QAM
PHY Signal encoding	Direct Sequencing Spread Spectrum/Complementary Code Keying (DSSS/CCK), OFDM (Orthogonal Frequency Division Multiplex)	OFDM, DSSS/CCK	Single Channel (SC), OFDM	SC, OFDM
Forward Error Correction (FEC) coding	coding rate is ⅚	Convolutional or low-density parity-check (LDPC) with a coding rate of ½,⅔ ,¾, or ⅚	Convolutional or low-density parity-check (LDPC) with a coding rate of ½,⅔ ,¾, or ⅚	Convolutional or LDPC with a coding rate of ½, ⅔ ,¾, or ⅚
Packet size	Up to 7.991 Bytes without aggregation 65,535 Bytes with aggregation	1,048,575 Bytes with aggregation	Up to 7.991 Bytes without aggregation 65,535 Bytes with aggregation	Up to 7.991 Bytes without aggregation 65,535 Bytes with aggregation
Data rate per spatial stream	54 Mbit/s over 20MHz channel, and 150 MHz over 40 MHz channel (using 3 spatial streams)	866.7 Mbit/s using 8 spatial streams over 40MHz channel and 256-QAM	26.7 Mbit/s for 6 and 7 MHz channels, and 35.6 Mbit/s for 8 MHz channels	150kbit/s in 1-, 2-, 4-, 8-, and 16-MHz bandwidth (up to 40 Mbit/s maximum)
Maximum data rate	600 Mbit/s (450 Mbit/s on a three-antenna configuration at 40MHz)	6.934 Gbit/s using 160MHz	426.7 Mbit/s for 6 and 7 MHz channels and 568.9 Mbit/s for 8 MHz channels	600 Mbit/s
Antenna technology	MIMO, up to 4 antennae (spatial streams), but most existing products use a maximum of 2 or 3 antennae	MIMO, up to 8 antennae (spatial streams), but most existing products use 3 spatial streams	MIMO, up to 4 antennae (spatial streams)	MIMO, up to 16 spatial streams
MIMO capability	Single user MIMO: All streams are used to communicate between the access point and a single device	Multi-user MIMO: different streams can be directed to different users, allowing access point communications to multiple users simultaneously	Space-Time Block Code (STBC) or MU-MIMO	Downlink Multi-user MIMO (DL MU-MIMO)
Topology	Mesh, Star, Tree	Mesh, Star, Tree	Mesh, Star, Tree	Mesh, Star, Tree
End node transmit power	1mW - 0.1W	1mW - 0.1W	1mW - 4W	1mW - 1W
Devices per Access Point	30 - 40, for optimal performance	90 - 100, optimally	(not yet quantified)	8191
LoS Range (with 3 antennae)	250 metres	250m	> 1km outdoor	1km outdoor

Table 1: IEEE 802.11 Wi-Fi variants

Wi-Fi for mines

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UGM WI-FI DEPLOYMENT PROPOSAL

Mines continuously operate 24/7, so a reliable failsafe network between the underground and surface control centre is crucial to not only reduce costly downtime, but also ensure that information can be readily accessed in real time, to guarantee efficient operations both normally, and especially during emergencies.

To meet these requirements, a literature search has revealed that there are several vendors that have implemented a Wi-Fi based solution in underground mines. They claim that their mine-specific solutions meet the voice, data, video and even location (tagging) requirements.

The Wi-Fi vendors for UGM communications provide equipment such as 2-way radios, VoIP phones, APs and RF tracking tags that work over their network.

UNDERGROUND NETWORK INFRASTRUCTURE

Underground mines include tunnels of various lengths, with wired and wireless networking devices connecting them to the backbone. A flexibly extensible architecture is required to make the network expand to fill the mine's ever-changing layout.

Some vendors offer a communication system based on Ethernet standards, integrated into a redundant optic fibre backbone, with WLAN support to deliver network connectivity to all layers and subsections of the underground mines. Figure 8 gives a depiction of their underground network infrastructure.

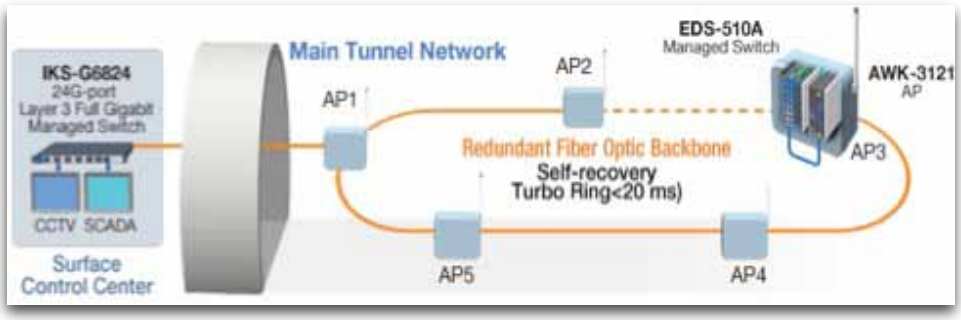

Figure 7: An example of Moxa's UGM network infrastructure offering [source: 9]

Figure 8: Example of real-time location tracking [source: 9]

Figure 9: Example of VoIP communications using a Wi-Fi phone [source: 9]

WI-FI TRACKING AND COMMUNICATION SYSTEMS

Figure 8 shows an example where the AP is used as a tag reader, used for location tracking; and Figure 9 shows an example where the network is used for making Wi-Fi voice calls.

REMOTE CONTROL, MONITORING AND VIDEO APPLICATIONS VIA WIRELESS ROAMING

As mining operations dig deeper, the remote control and monitoring of underground mobile machines -- now unmanned, to remove workers from mining

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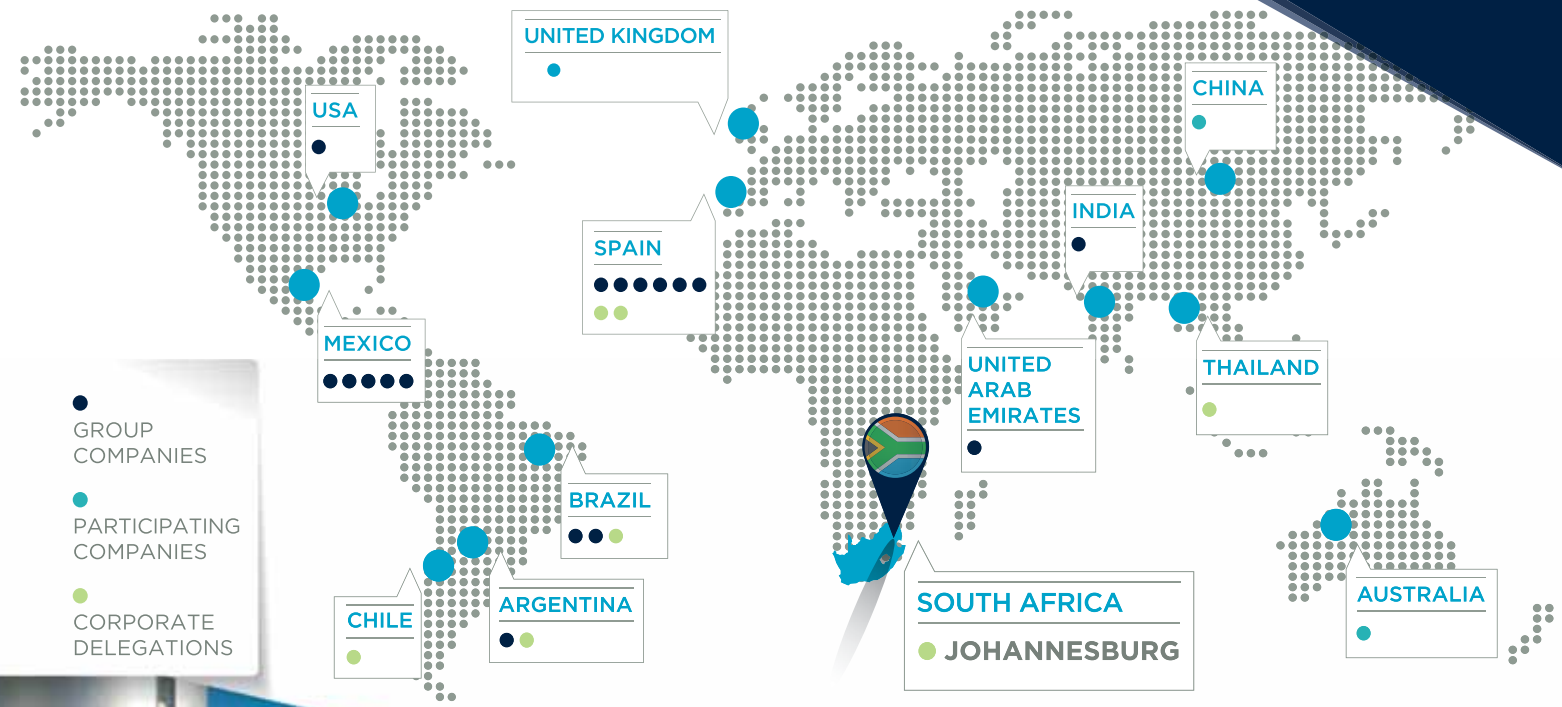

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Wi-Fi for mines

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Figure 10: Example of remote control & monitoring of underground mobile machines [source: 9]

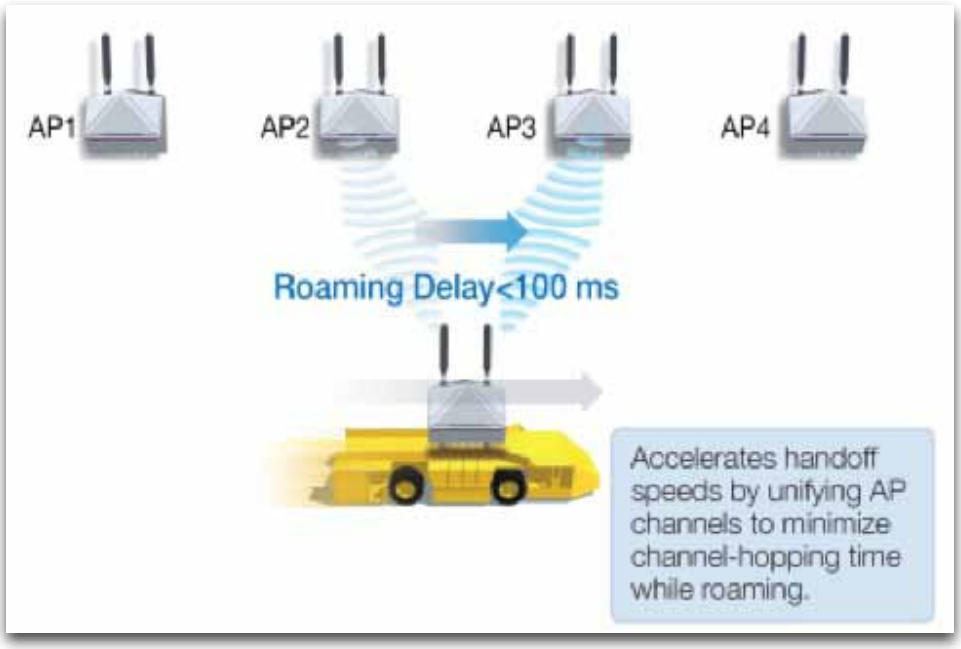

Figure 11: Example illustrating turbo roaming [source: 9]

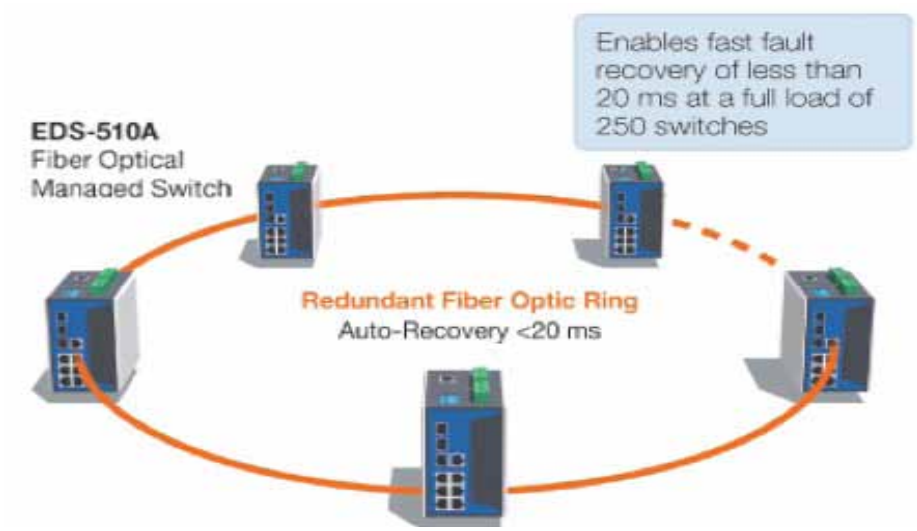

Figure 12: Example illustrating ring redundancy [source: 9]

hazards - becomes increasingly important. Communication between machine networks and the surface control room can be realised via Wi-Fi. APs can be installed at fixed locations to provide saturated links for mobile machines. IP cameras, installed on each end of the shuttle cars, can be used for remote machine supervision. An example of this setup is shown in Figure10.

MEETING LATENCY REQUIREMENTS

When mobile machinery operates underground, it seldom moves within the sole coverage of a single AP. As soon as the client (machine) loses the link to an AP, it starts searching for another AP to resume its connection. This handover may take up to several seconds, and would be entirely inadequate for mining machinery controlled remotely via video and Wi-Fi. Handover latency of milliseconds can be achieved by employing roaming technology. Figure 11 depicts this setup.

NETWORK REDUNDANCY

Mines operate around the clock, and breakdowns or network failures must not affect productivity. Network redundancy is therefore vital to guarantee connectivity is always safe and stable, even when failures occur. All mining information can be transmitted from the surface control room to underground locations via a fail-safe, redundant fibre optic ring that has built-in auto-recovery, as depicted in Figure 12. Alternatively, the use of long range Wi-Fi (e.g. 802.11af and 802.11ah) may eliminate the need for the fibre optic backhaul.

VENDORS OF UGM WI-FI SOLUTIONS

As stated in 5 above, there are several vendors that have offered working Wi-Fi solutions in UGM environments. The

following are examples of offerings from a few companies.

BECKER ELECTRONICS

In 2009, Becker Electronics induced its in-house-manufactured industrialised Wrap 200 Wi-Fi underground systems to its range of products [10]. The first client installation was done in September 2009 at mining giant BHP Billiton. The system has been tested and implemented in mines in the US, Australia and South Africa, while, in Europe, mines in Russia, Germany and Poland are using the product.

Becker's Wi-Fi systems use leaky feeder communication system cables, which act as antennae to allow for extended communication coverage underground. They also have a mine evacuation signalling system, where radio frequency identification tags are situated in miners' helmets.

The control room is then able to alert people underground in the case of an emergency, as well as to locate miners. The company has also developed a hand-held Wi-Fi device, similar to a personal digital assistant (PDA), which is equipped with voice recognition capability. People can phone from hot spots underground to the outside world, and one could even phone from underground to a different country, if needed.

Underground machinery can also be controlled by the Wi-Fi systems. A version of a supervisory control and data acquisition (SCADA) system can be activated on a PDA, which can control equipment, as well as locate miners. The company is able to include a computer system, Wi-Fi access points and all additional systems into one hybrid system, which effectively connects all devices, and affords continued voice or digital signals anywhere underground.

MINELERT

Minelert is a communications service provider in rugged mining environments. To date they have provided more than 100 km of continuous Wi-Fi coverage underground in one of South Africa's deepest mines [11].

Their solution is a modular application suite specifically developed for underground, surface and open pit mining operations, which provides for mission-critical, and real-time mobile voice communications, real-time production information, critical alarms and real-time monitoring of personnel and assets over a digital network.

Mining giants Ashanti Gold and Harmony Gold have implemented Minelert's Wi-Fi solutions in several of their mine shafts:

(a) Mponeng Shaft
- Infrastructure: Blown Fibre Optic Ethernet Backbone (± 40km)
- Wi-Fi IEEE 802.11 (45km continues coverage)
- Mobile Handsets : VoWiFi
- Fixed/Vehicle IP Phones
- IP PA System
- Alarm & Messaging
- Material Car Monitoring (1000)
- Lost Persons Detection (8000)

(b) Tao Tona Shaft
- Infrastructure: Fibre Optic Ethernet Backbone
- Wi-Fi IEEE 802.11 (Strategic Areas)
- Mobile Handsets: VoWiFi
- Material Car Monitoring (1000)

(c) Moab Khotsong Shaft
- Infrastructure: Blown Fibre Optic Ethernet Backbone (± 30km)
- Wi-Fi IEEE 802.11 (40km continues coverage)
- Mobile Handsets: VoWiFi
- Material Car Monitoring (1000)
- Lost Persons Detection (7400)

(d) Doornkop Shaft
- Wi-Fi IEEE 802.11 (7km continues coverage)
- Mobile Handsets: VoWiFi
- Alarm & Messaging
- Material Car Monitoring (1000)

(e) Bathopele Shaft
- Infrastructure: Fibre Optics Installation
- Infrastructure, Supply & Support: Hirschmann Switches (Underground)
- Wi-Fi (Continues Coverage to the face – MODA)
- VoWiFi – Tested
- Current Project: Supply and Install 80 equipped network enclosures & 30km single mode Fibre Optic cable.

MOXA

Moxa offers a mine-specific communication system based on Ethernet standards, integrated into a redundant optic fibre backbone, with WLAN support to deliver network connectivity to all layers and subsections of underground mines [12]. Access points are installed at fixed underground locations to provide saturated links for mobile machines.

Two IP cameras, installed on each end of the shuttle cars, are used for remote machine supervision. The WLAN offers stable, wide bandwidth to eliminate latency in live video streams. To maintain steady connectivity, as shuttle cars move from

Wi-Fi for mines

continues from page 33

one AP to another, handoff times must be kept under milliseconds so that video streams remain unbroken, with no delays. Moxa has developed its proprietary Turbo Roaming™ technology, to hasten roaming handoff speeds by unifying AP channels.

Using this fast, reliable roaming technology, handover latency of milliseconds can be achieved, achieving handoffs that are unnoticeable, even in sensitive video applications.

Designed for maximum reliability, Moxa's fibre optic switches are built with their proprietary Turbo Ring™ auto-recovery technology. All mining information can be transmitted from the surface control room to underground locations via a fail-safe, redundant optic fibre ring.

The single RF module AWK-3121 accommodates one optic fibre port, giving it up to 80 km reception range, as well as optimised bandwidth and robust immunity to noise. wn

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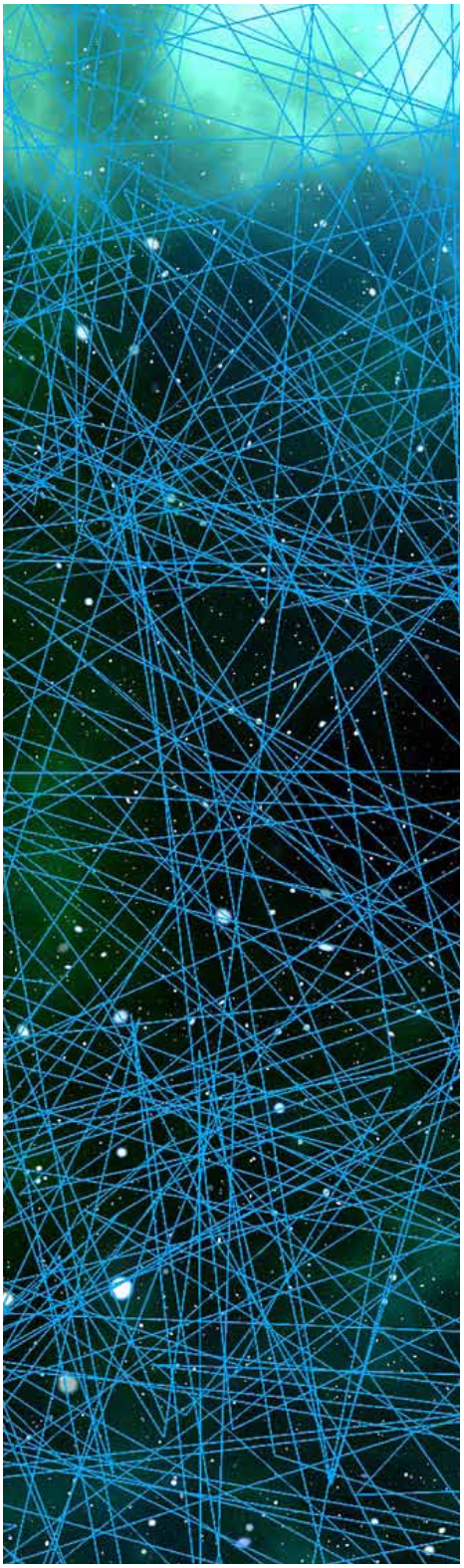

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The

In this paper, a new method for designing a three-polar bandpass filter (with three elements) on a microstrip line, with a Defected Ground Structure (DGS) is presented. The structure of the defected ground appears on the surface of the earth, with paired feed lines. This structure improves the filter performance in both of the Pass band and non-pass band.

BY | F S SORKH ABADI & A ROOHAVAR

Initially the traditional band-pass filter was designed and the results presented. Unwanted performance in its bandwidth was observed. In order to achieve the best performance, a three-polar structure was designed, and by varying the size of the defected ground structure, unwanted signals in the band-pass part have been significantly eliminated.

The proposed schemes were simulated with High Frequency Structure Simulator (HFSS) software. The simulated results for the proposed defected earth structure

Design and Simulation of a triple polar band-pass filter

are as follows: The centre frequency of this design is equal to 2 GHz, and its working bandwidth is 300 MHz. In addition, insertion loss values are less than 0.4dB, while the return loss is equal to 12 dB. Eventually, disintegration in the passband is better than 25dB.

Filters have always been an integral part of telecommunication circuits. Because of the important role of filters in telecommunication devices, and the regular replacement of these components, there is always a need for research to improve the important parameters of the filters.

Some of these parameters include the sharpness of the filter around the cut-off frequencies, the reduction of filter losses in the acceptance band (pass band), the reduction of the physical size of the filters, the ease of construction, and low cost. [1-2].

Triple Polar Band design

continues from page 37

Filters play an important role in many microwave/RF applications. Filters should either separate or combine different frequencies. The creation of applications such as wireless communication, to challenge microwave/RF filters is needed more than ever, with the requirement for higher performance, smaller size, lighter weight and lower cost. Depending on the requirements and characteristics of the microwave/RF, they can be designed as a cumulative element, or circuits with distributed elements. They may be found in various line structures such as waveguides, coaxial lines, and micro-strips [3-4]. Computer-aided design tools such as Full-wave Electromagnetic Simulators (FWES) have been used to alter the design of the filter.

Many micro-strip filters have emerged with advanced filtering features. The application of the micro-strip band-pass filter is therefore as follows:

1. The output of an oscillator is used to pass only the desired frequency band.
2. At the input of a receiver and amplifier, only the desired frequency band is allowed to pass.

In recent years, many studies have been done on DGS structures. Defected ground structures or DGS are a relatively new field in filter research and broadband antennas. In 1999, for the first time, the DGS were proposed by Park. That initial idea was based on Frequency Prohibited Band structures (PBG) [5]. Frequency-Prohibited Band structures are intermittent structures that prevent the release of a particular frequency band (in the visible light region). Recently, interest in the use of ground structures in the design of flat microwave circuits and microstrip antennas has been created. DGS structures have many uses, of which some are: reducing the back lobe of some antennas; removing couplings between elements of an array; designing a higher-level of filters, and adding or reducing the higher harmonics in antennas and filters respectively, Among many other applications are improving Cross-polarization in antennas and improvement of micro-strip filter parameters. It is also imperative to optimize the important parameters of the filters, such as the sharpness of the performance curve around the cut-off frequencies; reducing internal losses; decreasing the reel in the passband, and reducing their size [6-9].

In a paper [10], the effect of filter function with DGS element has been studied, and its various geometric structures have been investigated. Also, in [11], two sets of Quasi Elliptic (QE) filters are well designed. In another paper [12], a filter with a Hyperpin defected ground structure with a sharp screw is presented.

Due to the importance of the micro-strip band-pass filter with the defected ground plane therefore, the purpose of designing a filter is to improve parameters and reduce power consumption. The structure is configured as follows: In the second section, a traditional micro-strip band-pass filter is simulated. In the third section, the ineffectiveness of the conventional microsphere filter is described first, and the band-pass filter is designed and simulated with the structure of the defected ground plate.

PROPOSED MICRO-STRIP FILTER

In many applications, it is important to minimize the size and weight of the filters. It seems that the use of flat filters is appropriate with PCB technology (if not limited)[13]. The groove on the strip creates a defect on the circuit, which can be used to design a variety of filters, dividers, amplifiers, etc. by creating resonance properties. In the micro-strip structure with a grooved strip, there is no cavity on the ground plane. This type of structure is created by removing the metal in a special pattern on the microstrip line. This created groove, such as structures with a defected ground plate, are known as DGS.

It causes the deleted band in the frequency response of the circuit, which is also called a banned frequency band [14]. This type of structure has beneficial properties in the design of high-frequency circuits and millimeter wave fields. Unlike DGS circuits, due to the lack of any gap in the ground plane, as well as in terms of interference and hearing, the gap of the ground performs very well.

Figures 1 and 2, respectively, show the proposed structure of the microstrip cross-pass filter in two-dimensional and three-dimensional form. The circuit at the bottom of an RF4 bed is carved with a dielectric constant of 4.3 and a thickness of 1.58 mm.

The band-pass filter consists of three N-paired lines and three N-feeding lines. The overall response of the band-pass filter is determined by the connections (pairs) between resonators. The coupling coefficient is therefore related to the distance between resonators. The coupling factor can be changed by changing the distance between resonators.

To achieve the desirable coupling coefficient, the size of the arms of the desired design is explained in Table 1.

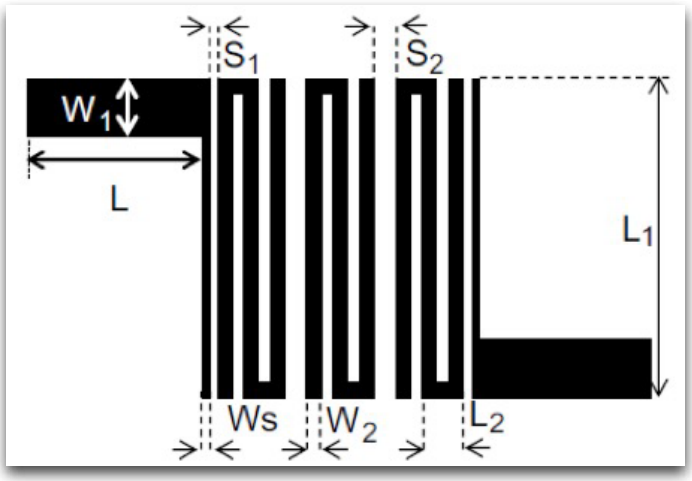


Figure 1: Two-dimensional design of three-polar band-pass filter

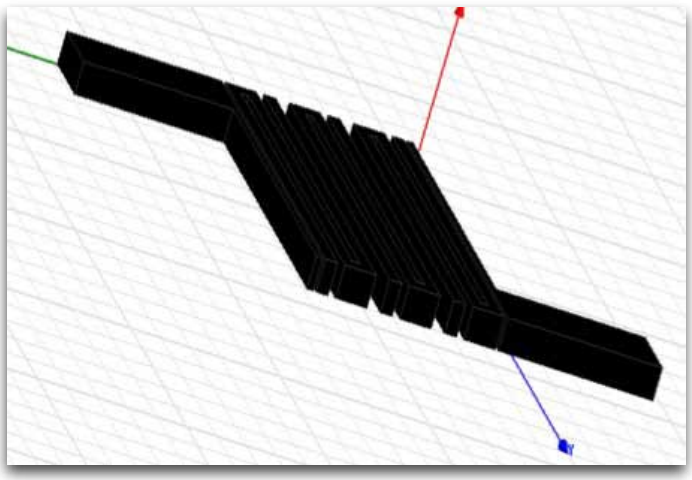


Figure 2: Three-dimensional image/design of three-polar band-pass filter

NAME	MILLIMETER	NAME	MILLIMETER
W1	3.1	L2	1.2
W2	0.8	L	0.2
Ws	0.4	S1	0.9
L1	18	S2	10

Table 1: The size of the proposed layout lines

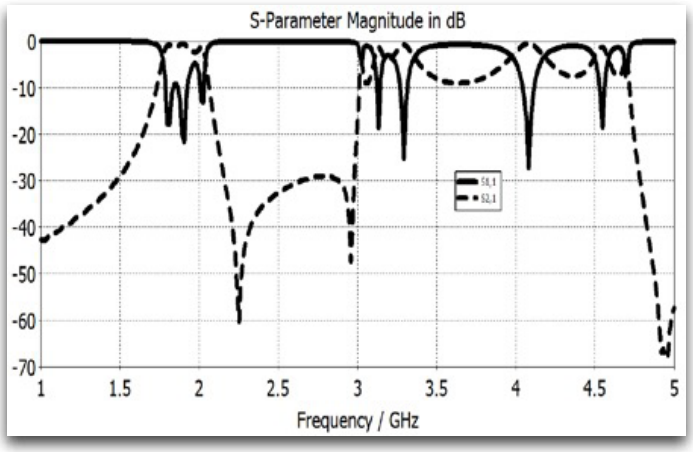


Figure 3: Output of three-polar band-pass filter

Classical characteristics of high level response at the high-frequency edge that is clearly visible is distributed in the filter. To remove it, this can only be done by adding a resonant DGS element at the desired bandwidth. In Fig. 3, the response of the domain S of the parameter is shown. We therefore have:

- $S_{1,1}$ = Return Loss
- $S_{2,1}$ = Insertion Loss

PROPOSED MICRO-STRIP FILTER WITH DEFECTED GROUND STRUCTURE (DGS)

Simple microspheres have a symmetrical non-pass band, and in order to improve the performance of non-passive bands, one can use the elements of a defected ground structure, which, as a result, does not require a more complex design and the design is simple.

The base element of the defected earth structure is a resonance gap, or a gap in the ground metal. This gap is placed directly under a transmission line, and also aligned to the line for effective connection to the line. The unwanted response can be eliminated using a defected ground unit. When two similar defected grounds are introduced at both ends of the feed lines, these unwanted bands are suppressed with a better damping[15].

As a result, the two similar defected ground cells are incorporated on the ground in two input and output feed lines. These feed lines are for the n straight pair lines of band-pass filters. The integrated structure in Figures 4 and 5 is shown in two-dimensional and three-dimensional form, respectively, in which

Triple Polar Band design

continues from page 39

the defected ground unit have been placed at a distance d from the edge of the feeding lines.

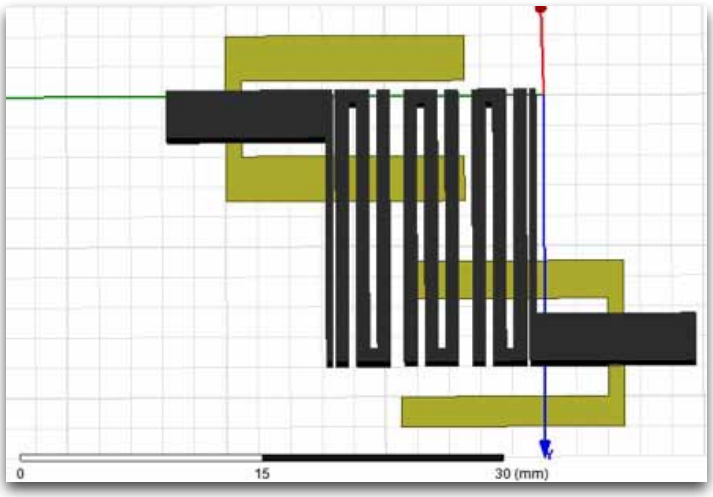


Figure 4: Three-polar band-pass filter with two defected ground units

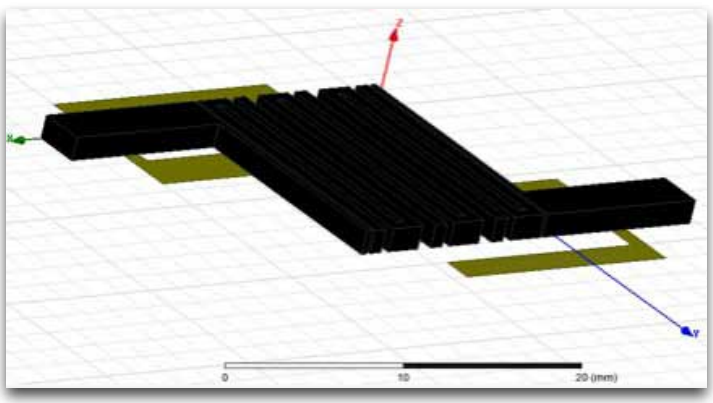


Figure 5: Three-dimensional band-pass filter structure with DGS structure

In order to increase the rejection of the unwanted responses of the proposed filter, we need to check the effect of the defected developed land sizes. Then, the one-dimensional dimension of the defected ground is changed, and other dimensions are kept constant. The S parameter response with these changes will show the best lengths. To obtain the best structure by changing the size of defected ground gap (see Fig. 6), the output results are reported.

The number of variables is five (a, b, c, g, d). By changing each one, the S parameter response can be measured, and the best answer

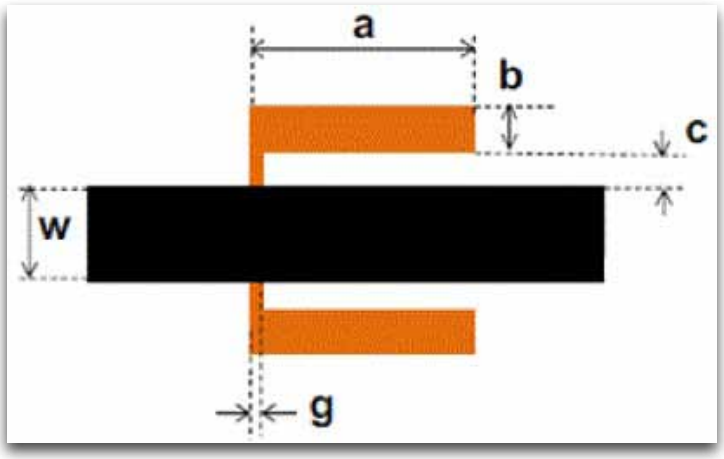


Figure 6: The structure of designed defected ground

chosen among them. By changing one of the five parameters, and keeping the rest of the dimensions, the response of each S parameter is obtained and the best dimensions for the desired parameter are considered the best answer. The best dimensions are therefore selected according to the analysis of each single S parameter response as follows:

- a= 9mm
- b= 2mm
- c= 0.4mm
- g= 0.2mm
- d= 5.5mm

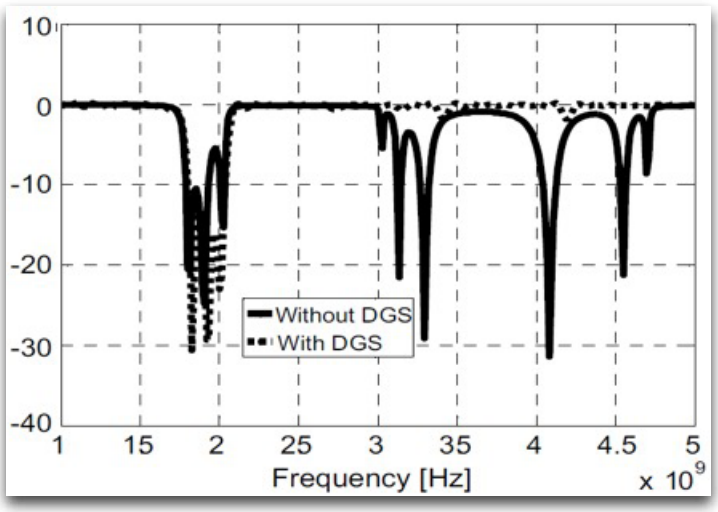
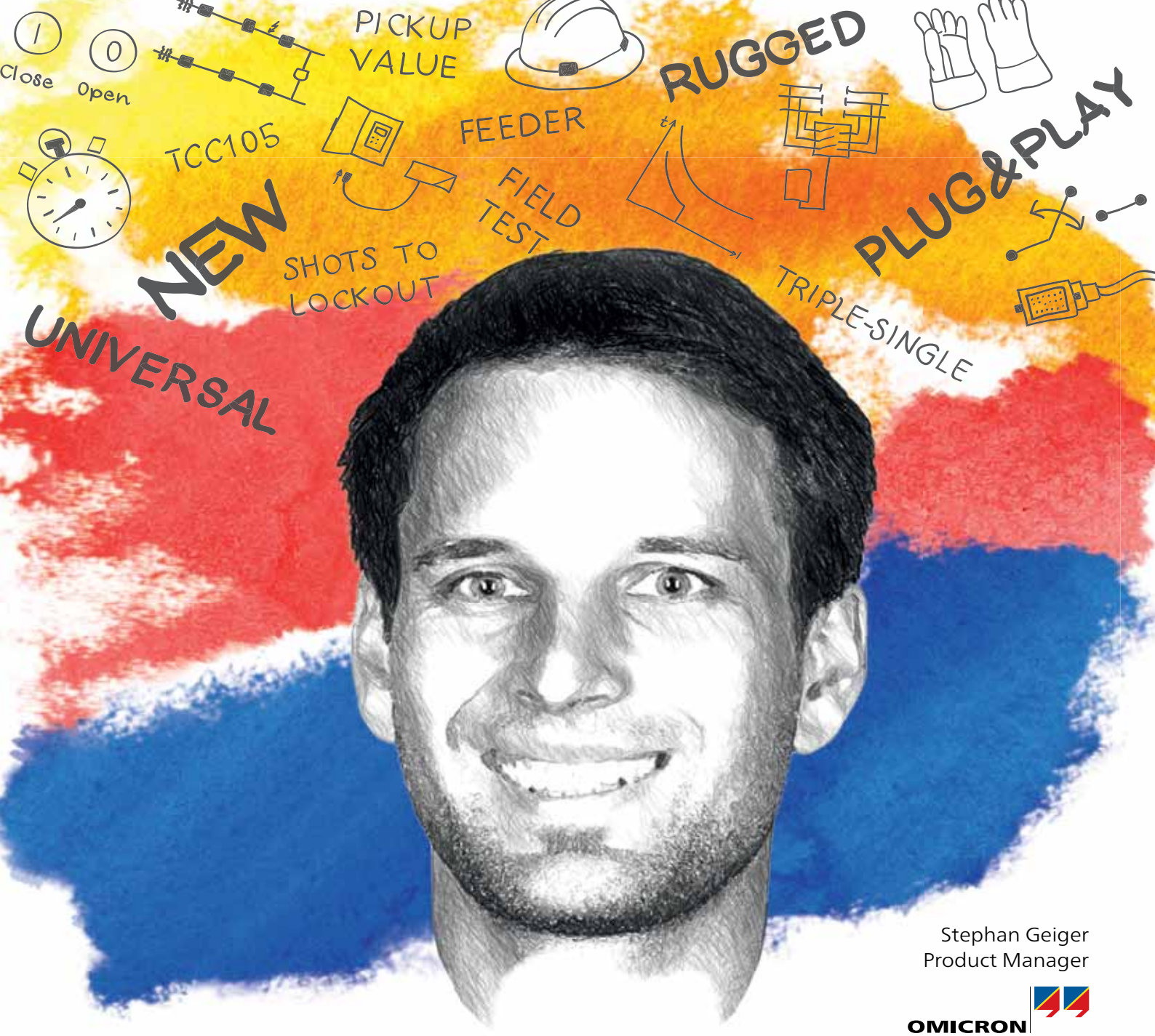


Figure 7: Compare S11 response of proposed filter with DGS plate and non-DGS plate



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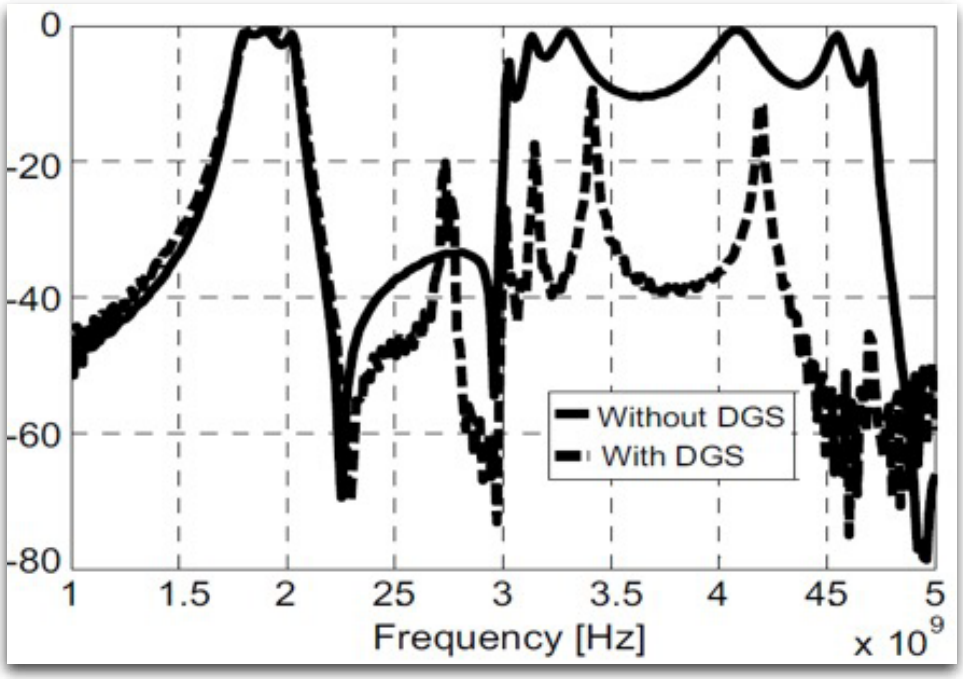

Figure 8: Compare S21 response of filter with DGS plate and non-DGS plate

CHARACTERISTICS	CENTURE FREQUENCY (GHZ)	BANDWIDTH (MHZ)	REF
Defected ground simple bandpass filter	5.115	46	[16]
Superconductor bandpass microstrip filter with narrow band	3.25	110	[10]
Defected ground four-polar bandpass filter	2.4	19.39	[11]
Defected ground Hairpin bandpass filter	2.1	500	[12]
simple bandpass filter	3.2	200	[17]
Defected ground three-polar hairpin bandpass filter	2	300	proposed

Table 2: Comparison of 3 polar band-pass filter with suggested defected ground plate with previous research.

Finally, the optimum dimensions are selected, and the improved filter is simulated with the defected ground gap. In Figs. 7 and 8, S11 and S22, respectively, are shown for a typical and improved filter with defected ground. In the figure, it is clear that the filter performance has improved in the band-pass area.

Table 2 compares the proposed structure with previous designs.

CONCLUSION

In this paper, a three-polar band-pass filter with defected ground structure was introduced and described. Initially, the traditional transient filter was designed, the results were presented and unwanted performance in bandwidth was observed. By varying the size of the defected ground structure to get the best performance, the three-polar structure has been dramatically lost in the pass band of unwanted signals. Proposed designs were simulated by HFSS simulator. The results of this simulation for the proposed defected ground structure are:

- 2GHz Central Frequency
- 300MHz Bandwidth
- Insertion loss less than 0.4dB
- return loss equal to 12dB
- suppression better than 25 dB over the unwanted passband

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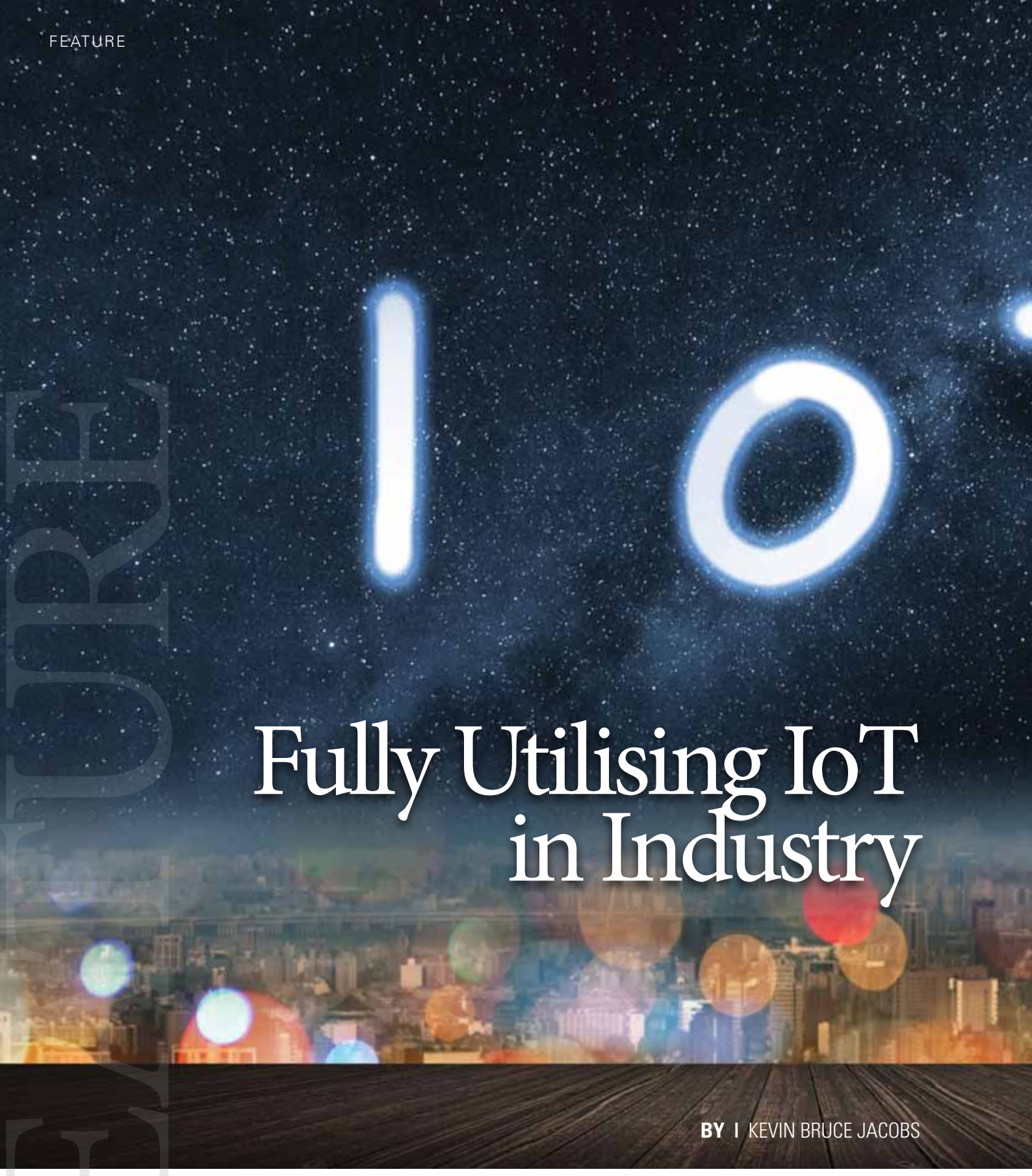
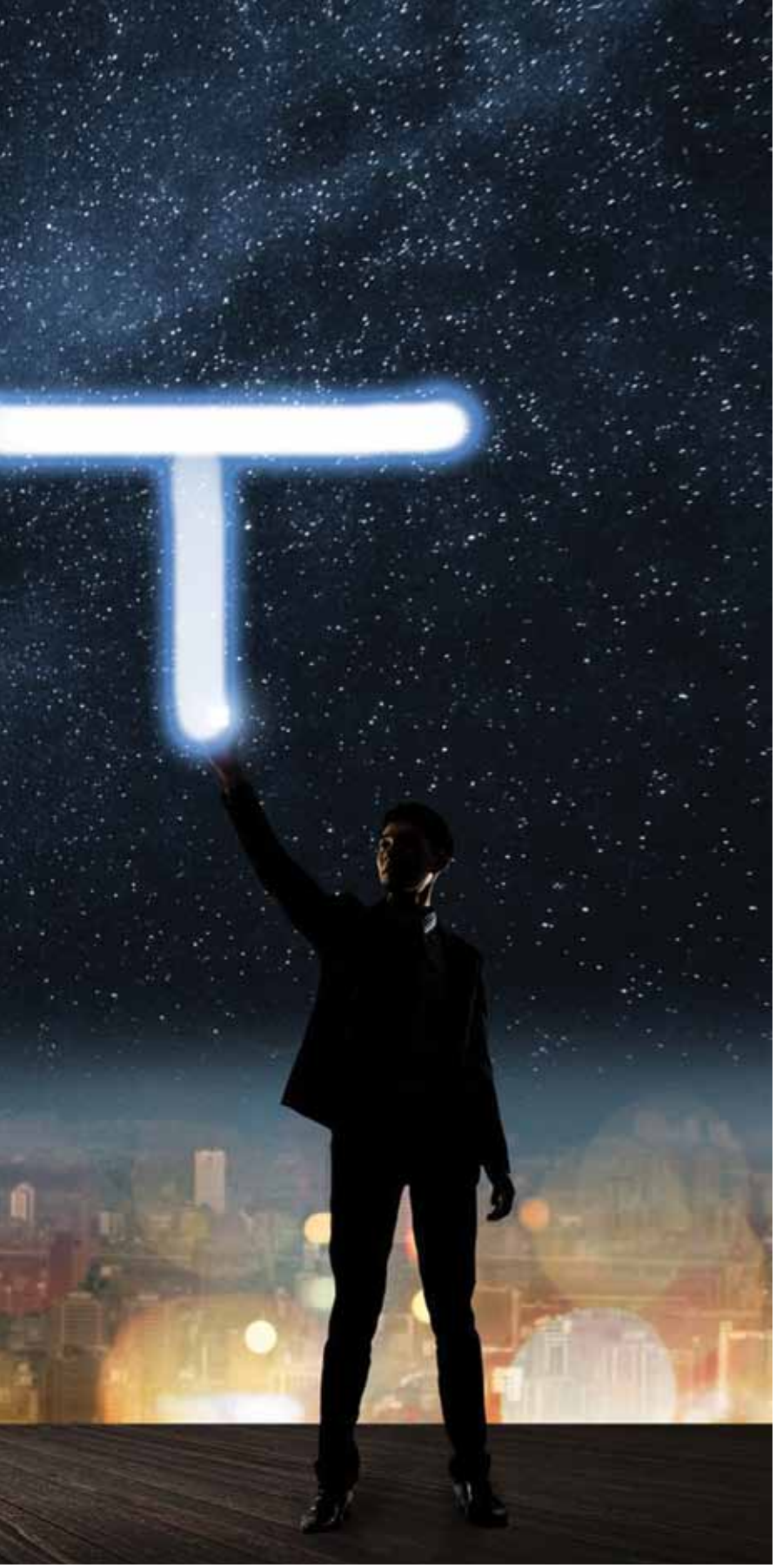


Fully Utilising IoT in Industry

BY | KEVIN BRUCE JACOBS

It is the time for Internet of Things (IoT) to take dominance and that includes integration with the cloud. What does this mean?



Virtually, every piece of interfaceable media needs to be able to communicate to the Cloud database.

Interfaceable Media (IM) can be identified as any piece of equipment which can be addressed onto a network for interfacing purposes. This includes but is not limited to; laptops, computers, phones, switches, routers, as well as any other addressable device on a network.

One of the concerns for Interfaceable Media Communication is the transition between current technology from legacy IPv4 to IPv6. The device addressing structure moves from a 32 bit to a 128 bit addressing system. This is a necessary change as more devices get connected to the network to establish unique addresses on the Cloud network domain. The concern is related to the legacy equipment addresses but this can be resolved by setting up different policies for the IPv4 and IPv6 networks to avoid duplicate addressing when utilizing the IPv6 DHCP Servers.

These are some of the hardware (software) integration issues which need to be addressed in establishing a workable uniform platform from which to seamlessly integrate the emerging technologies with previous generation equipment.

In relation to plant operations there are various software platforms or Manufacturing Enterprise Systems (MES) which perform data analysis based on plant input data. The plant input data is currently being stored on local databases at specific sites which is then analysed by the various software packages reporting to Enterprise Resource Planning (ERP) systems being used by Executive Committee's (EXCO) to make financial decisions for the good of the organisation. This places a heavy burden on the reliability of information fed from the lowest level of automation within the organization. If plants are not operated and maintained correctly having an adverse effect on the organisations EBITA, then EXCO cannot make accurate decisions due to the unaccounted productions losses having a negative effect on the share price of the organisation.

Utilising IoT

continues from page 45

Looking at the solution holistically, additional automation controls can be added to the existing operating systems for example; reliability and predictive maintenance. Every component in the field has an expected life cycle or MTTF (mean time to failure) based on the accelerated life testing from the component manufacturers.

This information can be incorporated seamlessly into plant automation controls to raise alarms for number of operations raising awareness of plant conditions. When a field device has reached an expected number of cycles or number of uses it can raise alarms within the MES system for early warnings on end-of-service expectancy for field device or for maintenance intervals which will in turn improve plant equipment reliability by making use of predictive maintenance.

Furthermore, the component suppliers can make use of the information by publishing the information to the cloud to pre-empt component replacement or failure for manufacturers whom in turn can order replacement components or provide other necessary services to meet the demands of the plant as and when required. This will serve as an early warning system for both plant and supplier working in harmony to increase both client productivity and overall customer satisfaction.

Full utilisation of IoT within industry, which is not only limited to plant operations will only become a reality when all participants in the field are working towards the same standards and goals.

A supplier will find it difficult to utilise the IoT effectively in servicing a clients needs when the customer bases are diverse utilising the same products but delivering different levels of feedback making it difficult to predict storage holdings and consumption rates.

Suppliers will have vested interest in working closely with their customers to invest in the development of predictive maintenance schedules for their products. Some suppliers may not have this information readily available any may need to perform accelerated life testing on their products to assist their clients.

Other suppliers may need to re-test their equipment at different parameters based on varying conditions of use which could vary from altitude, humidity, temperature, accessibility and/or other contributing ambient conditions.

Take cognisance of the endless possibilities and capabilities of IoT and the integration between supplier and consumer bringing together the field data and analysis behind making the marketplace less susceptible to product related concerns and focus more or customer satisfaction.

IMPORTANT NOTICE

MEMBERSHIP FEES

EFFECTIVE 1 DECEMBER 2017

The SAIEE Council approved the following subscription and entrance fees effective from 01 December 2017 as indicated below.*
Pay the 2018 Annual Membership fees before 31 March 2018 and qualify for a great discount!

GRADE OF MEMBERSHIP	ANNUAL SUBSCRIPTIONS *Paid before 31 March 2018*		ANNUAL SUBSCRIPTIONS *Paid after 31 March 2018*		NEW MEMBERS FEES ** see Notes 1 & 4 below.*	
	RSA incl VAT	Outside RSA	RSA incl VAT	Outside RSA	RSA incl VAT	Outside RSA
STUDENT	167	118	200	142	200	142
After 6 yrs study	1 074	752	1 289	902	1 289	902
ASSOCIATE	1 074	752	1 289	902	1 289	902
MEMBER	1 187	831	1 425	997	1 425	997
after 6 years	1 387	971	1 664	1 165	1 664	1 165
after 10 years	1 452	1 016	1 742	1 219	1 742	1 219
SENIOR MEMBER	1 452	1 016	1 742	1 219	1 742	1 219
after 6yrs/age 40	1 573	1 101	1 888	1 321	1 888	1 321
FELLOW	1 573	1 101	1 888	1 321	1 888	1 321
RETIRED MEMBER (By-law B3.7.1)	667	466	800	559	n/a	n/a
RETIRED MEMBER (By-law B3.7.3)	nil	nil	nil	nil	n/a	n/a

1. The fee for all new applications is R2808 which includes an entrance fee of R920. On election to the applicable grade of membership the new member's account will be adjusted accordingly and refunds made on request. Entrance fee for Students is free and new Student applicants require payment of R200.
2. Transfer fee to a higher grade is R500.00 for all grades of membership (except Student within 3 months of qualifying).
3. Members are encouraged to transfer to a higher grade when they qualify. It will be noted that the fees of Member and Senior Member grades after 10 and 6 years respectively are equal to the fees at the next higher grade.
4. Members elected after May 2018 pay a reduced subscription fee.

By-law B3.7.1 reads "Where a member in the age group of 55 to 70 years has retired from substantive employment in the engineering profession, such member may make written application to Council for recognition as a retired person and a reduced membership fee".

By-law B3.7.3 reads "any member complying with the conditions of B3.7.1 but who has been a member of the Institute for not less than 25 consecutive years, shall be exempt from the payment of further subscriptions." Members who comply with the requirements of By-Law B3.7.3 may make written application to Council for exemption from paying subscriptions".

By-law B3.9 reads "any member in good standing who has been a member for fifty (50) consecutive years shall be exempt from the payment of further subscriptions."

Members not in good standing by failing to pay their subscriptions by end of May of each year will subject to Council decree may be struck-off the SAIEE membership role.

Members in good standing and no longer in substantive employment and do not receive payment or salary for work done may apply to Council for a reduction in their annual subscriptions.

The members monthly magazine will be online and members who require a hard copy may acquire same on request and for a nominal fee.

* In terms of Bylaw 3.2 annual subscriptions are due on 1st December 2017

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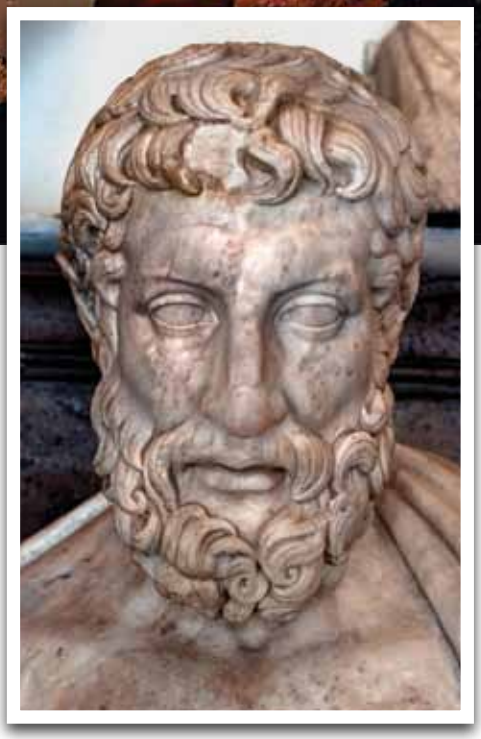
Communicating with ET



Metrodorus of Chios

Metrodorus of Chios (4th Cent. BC) put it this way: *To consider the Earth as the only populated world in infinite space is as absurd as to assert that in an entire field of millet, only one grain will grow.*

Metrodorus could have only known of a few thousand stars in our own Milky Way galaxy. The galaxy is now known to contain billions of stars as well as billions of planets and that it is only one of billions of other galaxies. To put this in easily grasped terms, there are many times more planets in our galaxy than there are people on Earth and there also many times more galaxies than there

BY | DUDLEY BASSON

The possibility of extra-terrestrial life has fascinated astronomers and philosophers since ancient times. This is no longer a matter of idle speculation – the search for extra-terrestrial life has become a huge, many faceted enterprise, and sensational results can be expected within a decade.

are people on Earth. The probability that there are no other planets inhabited by life has become vanishingly small. There could well be millions of planets inhabited by living creatures in our own Milky Way galaxy.

Roman poet Lucretius (99-55 BC) wrote: *Granted then, that empty space extends without limit in every direction and that seeds innumerable are rushing on countless courses through an unfathomable universe… , it is in the highest degree unlikely that this earth and sky is the only one to have been created. So we must realise that there are other worlds in other parts of the universe, with races of different men and different animals.*

We do not know what Lucretius had in mind about 'seeds' but this takes on new meaning with the discovery that amino acids and other vital organic molecules are to be found in profusion in space and did not originate on Earth. Another vital ingredient to life as we know it is water. This is to be found in vast quantity in space and many planets are water worlds completely covered by ocean. Saturn's moon Enceladus is covered by a 65 km deep ocean topped with an ice crust.

Carbon is a vital ingredient to organic chemistry. This is found in vast quantity on exoplanets (also referred to as extrasolar planets) and expired stars in both graphite and diamond form. Phosphorus is essential to the DNA molecule - this has also been detected in the cosmos.

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Giordano Bruno (1547-1600)

Dominican monk Giordano Bruno (1547-1600) wrote his controversial *'On the Infinite Universe and Worlds'*. Among other things, the Italian philosopher advanced the following: *"Innumerable suns exist; innumerable earths revolve about these suns in a manner similar to the way planets revolve around our sun. Living beings inhabit these worlds."*

These ideas got Bruno into very serious trouble.

Christiaan Huygens (1629-1695) physicist, astronomer and mathematician described a universe brimming with life in his book 'Cosmotheros.'

Biophysicist Jeremy England, associate professor at the Massachusetts Institute of Technology, proposed a new theory in 2013 that cast the origin of life as an inevitable outcome of thermodynamics when, under certain conditions, groups of atoms will naturally restructure themselves so as to burn more and more energy, facilitating the incessant dispersal of energy and the rise of entropy in the universe. England said this restructuring effect, which he calls dissipation-driven adaptation, fosters the growth of complex structures, including living things. The existence of life is no mystery or lucky break, but rather follows from general physical principles and "should be as unsurprising as rocks rolling downhill."

Sir John Herschel (1792-1871)

The famous British astronomer Sir John Herschel (1792-1871) travelled to the Royal Observatory at Cape Town, South Africa in 1834 to commence a full sky survey of the southern hemisphere. The project was well known throughout the educated world at the time and, unbeknownst to Herschel, gave rise to wild stories of the Moon being inhabited by winged men and women, animals and forests.

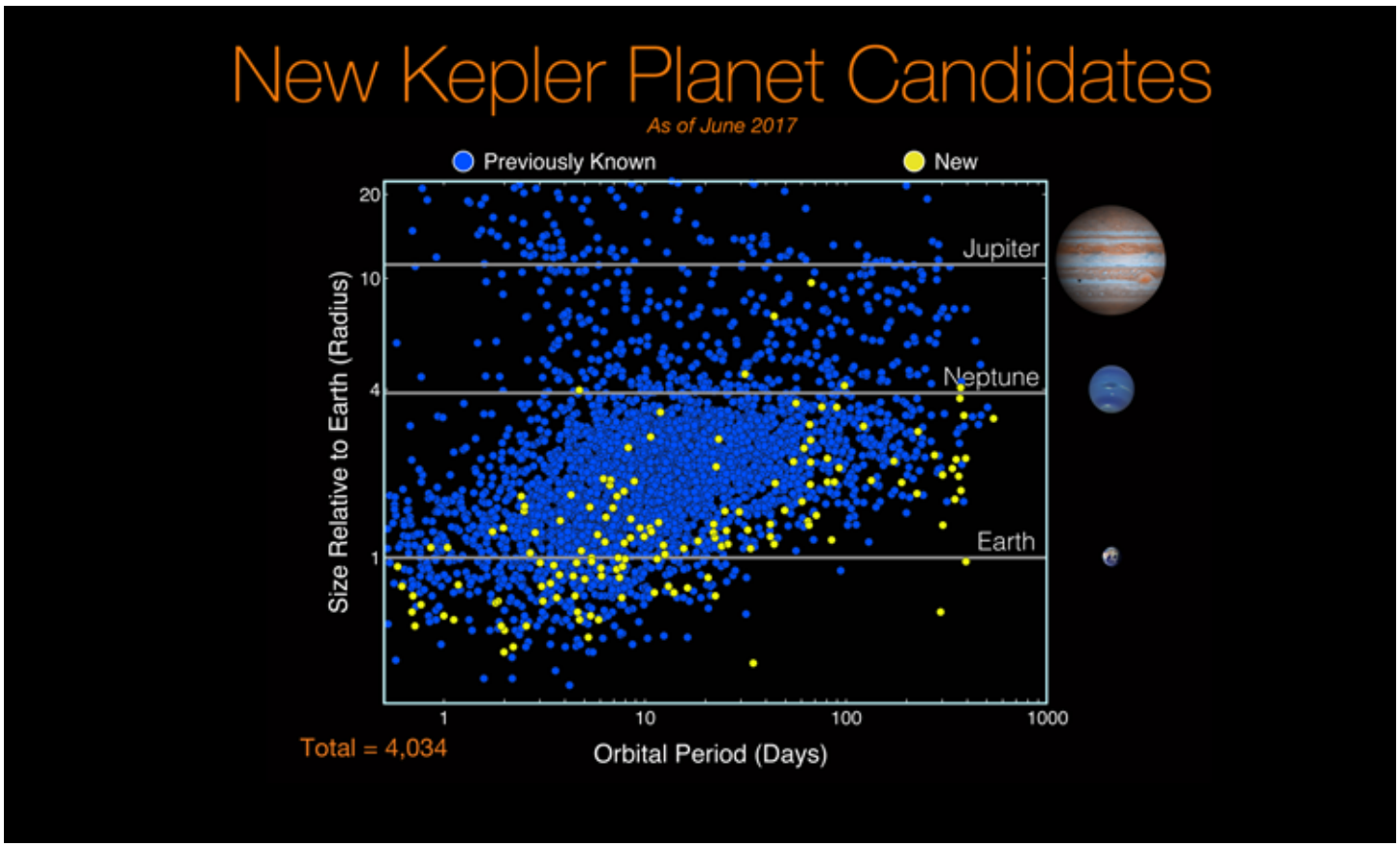
The search for extra-terrestrial life was given a huge boost when the NASA Kepler Space Mission was launched in March 2009. On 4 April 2012 the mission life was extended to 2016. The instrument was specifically designed to detect the presence of planets orbiting stars. It is quite different to space telescopes such as the Hubble, as this is not a telescope but a multiple channel photometer.

The instrument was designed to observe a much larger area of sky than that of a telescope and was not intended to produce images. The photometer locked on to 145 000 main-sequence dwarf stars in the Cygnus-Lyra region, to continuously measure their brightness. This was in order to detect the extremely slight reduction in brightness when a planet transits in front of a star. Measurement of such sensitivity would be difficult from an Earth based instrument due to the presence of the atmosphere. Only a small percentage of stars will have planets orbiting in a plane permitting transits to be observed, however with such a large sample of stars there should be nevertheless be many candidate solar systems.

The mission concentrated on habitable zone planets – those that could maintain liquid water on their surfaces, both larger and smaller than planet Earth. The data gathered permitted calculation of the size, orbit and year length of the planets. Kepler could not characterise the planets – this must be done by the most powerful telescopes available. Kepler was placed in an Earth trailing heliocentric orbit which would allow it to permanently lock on to target without interference from any solar system body.

Kepler has detected 4496 candidate *exoplanets, of which 2337 have so far

** Exoplanet - a planet outside our solar system that orbits a star.*



been confirmed. Of these 30 have been confirmed to be in the habitable zone and are less than twice Earth-size. The extended mission detected 521 candidate planets of which 157 have so far been confirmed.

On 7 January 2013, William Borucki, principal investigator for the KEPLER mission, received the National Academy of Sciences 2013 Henry Draper Medal for founding concept and visionary leadership. The NASA Transiting Exoplanet Survey Satellite (TESS) has been planned for a launch in March 2018 as a successor to the Kepler mission. This will be an all-sky survey searching for exoplanets using the transit method.

The Spitzer infrared space telescope is the fourth of the NASA Great Observatories. This was launched on 25 August 2003 at a cost of $800 million. This instrument has an 85 cm beryllium mirror operating in the 3 to 180 micron infrared range. The Spitzer was equipped with three instruments:

IRAC - Infrared Array Camera
IRS - Infrared Spectrograph
MIPS - Multiband Imaging Photometer for Spitzer

The results achieved are spectacular. NASA's ten-year survey GLIMPSE (Galactic Legacy Infrared Mid-Plane Extraordinaire) was taken by Spitzer to do a deep panorama of our galaxy in the mid-infrared range, and to penetrate our galaxy's dark molecular clouds, where some of our Milky Way's estimated 400 billion stars are actually still forming. The telescope's Charge Coupled Device (CCD) was cooled to an astonishing cryogenic temperature of only 5,5 K in order to obtain maximum signal to noise ratio. The observatory has been given an Earth trailing *heliocentric orbit. The liquid helium coolant became exhausted on 15 May 2009 but the two shortest wavelength modules of the IRAC camera continued to function normally, extending the life of the mission. Although not part of the original mission plan, Spitzer has made a considerable contribution to the search for exoplanets.

In February 2017, NASA's Spitzer Space Telescope team announced the discovery of five of seven Earth-sized planets, the most ever, found around a single star, called TRAPPIST-1. Three of these planets are firmly located in the habitable zone, the area around the parent star where a rocky planet is most likely to have liquid water.

** Heliocentric - representing the sun as the centre, as in the accepted astronomical model of the solar system.*

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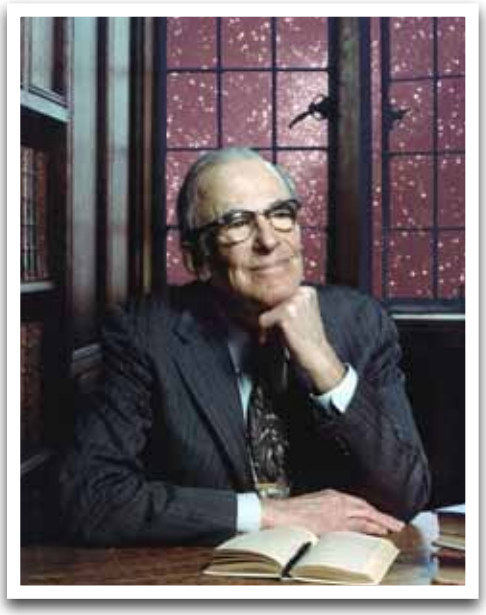
An exciting rocky planet dubbed HD 219134b studied by the Spitzer, was initially discovered using the HARPS-North instrument on the Italian 3,6 metre Galileo National Telescope in the Canary Islands. This is only 21 light-years away and although not likely to sustain life, will be intensely studied and characterised.



Dr Lyman Spitzer Jr. (1914-1997)

The telescope has been named in honour of Dr Lyman Spitzer Jr. (1914-1997). The Spitzer as well as the Hubble will be superseded by the James Webb Space Telescope (JWST) when this becomes active in 2018.

The High Accuracy Radial velocity Planet Searcher (HARPS) is a high precision echelle spectrograph installed in 2002 on ESO's 3,6 m telescope at La Cilla, Atacama Desert, Chile.

HARPS-North on the Canary Islands is able to access the planets detected by KEPLER. HARPS measures the velocity of a star moving toward or away from the Earth as it is moved by the gravitation of an orbiting planet. HARPS can attain a phenomenal precision of 0,9 metres per second. The instrument, fed by optical fibre from the Cassegrain focus, is contained within a vacuum vessel and the temperature controlled to within 0,01 K.

The velocity measurement is relative to the *barycentre of the Solar System. The calibration and operation of this instrument is complex to say the least. HARPS has produced spectacular results discovering more than 130 exoplanets. It also discovered Alpha Centauri Bb, a possible planet in the Alpha Centauri system only 4,4 light-years away.

Current estimates show that 5,4% of all stars host Earth-size planets and that 17% of all stars have multiple planets. It was further estimated that there are at least 30 000 habitable planets within 1000 light years of the Earth, and between 100 billion and 400 billion planets in the Milky Way galaxy.

The only interstellar telecommunication medium available at present is electromagnetic radiation, but the time delay for receiving a reply would make it only useful for one way communications. The speed of light may seem unbelievably fast within the solar system, but on the galactic scale it is extremely slow, taking 100 000 years to travel from one side of the Milky Way to the other. Radio frequency energy has the advantage/disadvantage of a wide target area but this will also cause the signal to attenuate quickly. Radar energy is more directional but will also attenuate excessively before reaching neighbouring stars. Laser light could well be a useful medium for detecting signals from other solar systems. Using a laser beam would also imply a small target area.

The Shanghai Institute of Optics and Fine Mechanics created the world's highest peak power pulsed lasers in 2016 – 5,3 petawatts ($5{,}3 \times 10^{15}$ W) for a duration of less than 30 femtoseconds (30×10^{-15} seconds). A laser signal of this power could easily be detected from the other side of the galaxy – the only constraint is the time delay for the signal to travel the distance. Like all electromagnetic radiation, laser beams will disperse with distance. As a typical example, a collimated beam with a waist radius of 1 mm and wavelength of 1064 nm, will have a divergence half-angle of only 0,34 milliradians. (34 cm per km).

The method of communicating with ET remains an intractable problem permitting only one way communications. However, receiving any intelligent signal at all would create a worldwide sensation. It is quite possible that an advanced civilisation could have developed a communication method using a short cut through space-time, but at present this remains a matter of science fiction.

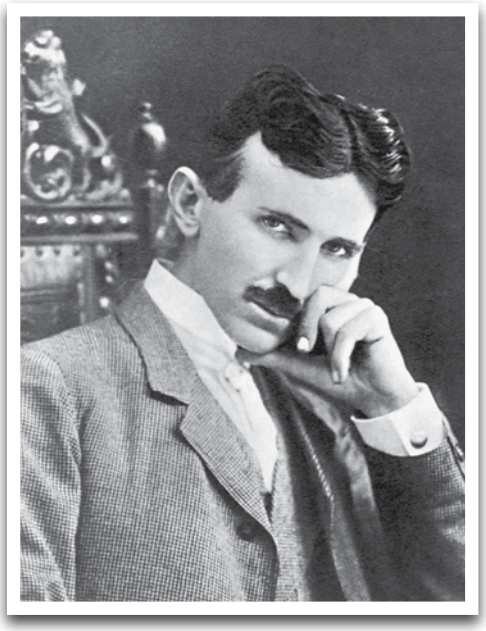
The search for life in the cosmos is focused in two distinct directions:

- The search for extra-terrestrial intelligence (SETI).
- The search for biomarkers indicating a life form.

SETI - SEARCH FOR EXTRA-TERRESTRIAL INTELLIGENCE

Nikola Tesla (1856-1943) was the first scientist to launch a SETI project. When using his newly discovered radio transmitting and receiving equipment in 1898 he detected RF signals coming from

** Barycentre - the centre of mass of two or more bodies that are orbiting each other.*



Nikola Tesla (1856-1943)

space. He at first thought that these were from extra-terrestrials and spent much effort in trying to detect intelligent content.

A comment from Tesla: *I think that nothing can be more important than interplanetary communication. It will certainly come someday, and the certitude that there are other human beings in the universe, working, suffering, struggling, like ourselves, will produce a magic effect on mankind and will form the foundation of a universal brotherhood that will last as long as humanity itself.*

It was subsequently found that energy spanning the entire electromagnetic spectrum is received from the cosmos.
The newly launched Breakthrough Initiatives is the largest SETI program yet established. This is in three stages:

- Breakthrough Listen - for detecting signals from intelligent life in the cosmos. It will detect lasers with any power above 100 watts from the nearest stars and above 1000 gigawatts from the nearest galaxies.
- Breakthrough Message - for setting up messages to the extra-terrestrials which will meet with international approval.
- Breakthrough Starshot - which is a highly ambitious plan to send autonomous swarming small craft to Proxima Centauri.

There is some controversy about making ourselves known to the extra-terrestrials. There is no guarantee that they will be friendly – they could well regard the human species as a verminous infestation of the planet. The Breakthrough Initiatives projects are described in more detail in the October 2016 issue of **watt**now.

Several major radio telescopes are superbly suited to SETI programs. These are: the Arecibo big dish, the Green Bank Telescope, the Allen Telescope Array, LOFAR in Europe, the Murchison Wide Field Array in Australia and the Lovell Telescope at Jodrell Bank Observatory.

Earlier this year a new instrument was installed at Green Bank, which enabled SETI observations to be done in parallel with other astronomical observations. This is known as "piggy-back" observing.

The signal from ET need not necessarily be intentional. The Earth has been transmitting leakage radio and TV signals to the cosmos for more than half a century and it is quite possible that other planets are doing the same. Super sensitive observatories such as ALMA and the future SKA should be able to detect such leakage radiation from as far as 1000 lightyears away. The powerful radar energy from Arecibo could be detected from across the galaxy. The SKA Headquarters are located at the Jodrell Bank Observatory near Manchester, UK. There are 10 SKA member countries, and approximately 100 organizations from 20 countries participating in its development. The United States is not currently an SKA member country.

On a disappointing note – NASA no longer provides funding for SETI experiments and there is also a possibility that Arecibo might be shut down due to lack of funding. At present SETI research is predominantly in the RF portion of the electromagnetic spectrum, however laser technology already developed could produce a signal that could outshine the Sun by many orders of magnitude at distances of more than 1000 lightyears. These optical and infrared SETI experiments come in two forms, searches for pulses of light of short duration, and searches for light emission at a single wavelength using a spectrometer. Relative to radio transmissions, optical signals could potentially convey much more information content and are more easily focused for directed communication.

ATA (Allen Telescope Array) is the first major observatory to be used primarily as a SETI instrument. This ambitious project was largely funded by grants totalling $30 million from the Paul G Allen Family Foundation. The first 42 radio dishes (6,1 m Gregorian) were installed on 11 October 2007 at the Hat Creek Observatory near Mount Shasta, California.

A total of 350 dishes are envisaged. The observatory is at an altitude of 1000 m and surrounded by volcanic peaks which effectively shield it from unwanted signals from TV, radio and cellphone radiation. Scanning is from 0,5 GHz to 11 GHz. The observatory has a multi-tasking capability,

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so that SETI observations can be done concurrently with other astronomical research. Since its inception, the ATA has been a development tool for interferometric array technology, specifically for the SKA project.

Peng Bo, head of China's National Astronomical Observation, has said of China's new, 500 metre supermassive radio telescope: *"FAST's potential to discover an alien civilization will be five to ten times that of current equipment, as it can see farther and darker planets."*

Like Arecibo, FAST is a spherical dish installed in a natural depression and aimed vertically. Unlike Arecibo, which requires spherical aberration correction, FAST is able to form a 300 metre parabolic dish within the spherical dish, which can move to suit the telescope tracking up to 40˚ from vertical.

LOFAR (Low Frequency Array for Radio-astronomy) is an innovative and ambitious project by the Netherlands Foundation for Research in Astronomy - ASTRON (Stichting ASTRonomisch Onderzoek in Nederland). LOFAR consists of a vast array of simple omnidirectional dipole antennae, using a new concept in which the signals from the separate antennae are not combined in real time as they are in most array antennae.

The electronic signals from the antennae are digitized, transported to a central digital processor, and combined by software to emulate a conventional antenna. The project is based on an interferometric array of radio telescopes, using about 20 000 small antennae concentrated in at least 48 stations, spread over several European countries. Although primarily designed for advanced astronomical work, LOFAR will also serve as a pathfinder for the SKA and also do useful work on exoplanets as well as SETI research.

Other SETI laser research is being done at the Keck Observatory on Mauna Kea, Hawaii as well as the Lick Observatory, California. Research is also being done at Harvard University and research institutes in France and Italy.

Thomas Zurbuchen, associate administrator for the Science Mission Directorate during the congressional hearing of the committee on 'Advances in the Search for Life,' on 29 April 2017, declared: *"Taking into account all of the different activities and missions that are specifically searching for evidence of alien life, we are on the verge of making one of the most profound, unprecedented, discoveries in history."*

SEARCH FOR BIOMARKERS AND CHARACTERISATION

The characterisation of the exoplanets cannot be done by the instruments that find them – this must be done by the most powerful and sensitive telescopes available. Telescopes ideally suited to this task will be the JWST to be launched in 2018 and the E-ELT with expected first light in 2024. The E-ELT will have extreme adaptive optics spectrographic instruments for characterising exoplanets. The ALMA will also play a crucial role as well as the SKA, which will initially become partially operational in 2020, and will have unsurpassed sensitivity.

An international research team, led by Chin-Fei Lee at the Academia Sinica Institute of Astronomy and Astrophysics (ASIAA, Taiwan), used ALMA to detect complex organic molecules for the first time in the atmosphere of an accretion disk around a very young *protostar. These molecules play a crucial role in producing the rich organic chemistry needed for life. The discovery suggests that the building blocks of life are produced in such disks at the very beginning of star formation, and that they are available to be subsequently incorporated into planets that form in the disk. It could help us understand how life came to be on Earth.

Dr Paul Clarke, of the University of York's Department of Chemistry commented: *"The molecules that form the building blocks of DNA had to come from somewhere; either they were present on Earth when it formed or they came from space, hitting earth in a meteor shower. Scientists have already shown that there were particular molecules present in space that came to Earth in an ice comet; this made our team at York think about investigating whether they could be used to make one of the building blocks of DNA. If this was possible, then it could mean that a building block of DNA was present before amino acids."*

When the Mars Curiosity Rover landed in the 3,8 billion year old Gale Crater in 2012, it detected borates, which are a possible bridge from simple organic molecules to RNA. This shows that conditions for life could have appeared on Mars independently from Earth.

COROT (COnvection ROtation et Transits planétaires) was a space observatory which operated from 2006 to 2012. The mission was led by CNES (Centre National d'Etudes Spatiales) in association with French Laboratories (CNRS) and partners

Protostar - a very young star that is still getting its mass from its parent molecular cloud.

in Belgium, Spain, Germany and Austria. The objectives were to search for exoplanets with short orbital periods and to perform astero-seismology by measuring solar-like oscillations in stars. COROT detected its first exoplanet in May 2007. COROT made numerous discoveries and also detected a number of exoplanets.

CHEOPS (CHaracterising ExOPlanets Satellite) is an ESA small class space telescope for the study of known transiting exoplanets orbiting nearby stars. The mission is a joint partnership between (European Space Agency) ESA and the Swiss Space Office. This is the first mission of ESA's Cosmic Vision program, planned for launch in 2018 and with a 3,5 year duration. The 30 cm Ritchey–Chrétien telescope will be placed in a Sun-synchronous Earth orbit at 800 km altitude. The spacecraft will be powered by 60 W solar panels which will also serve as a sunshield.

PLATO (Planetary Transits and Oscillations of stars) is a proposed ESA space mission planned for launch in 2026. The mission goals are to search for planetary transits of up to one million stars, to detect and characterise rocky exoplanets, and to study stellar oscillations to characterise the planet's host star. The payload will include 24 cameras, each with its own CCD focal plane array of 4501 x 4501 pixels. The cameras are based on a fully dioptric telescope including 6 lenses.

WASP (Wide Angle Search for Planets) is an international consortium of eight academic/astronomical institutions searching for exoplanets using transit photometry.

SuperWASP-North is located at Roque de los Muchachos Observatory on la Palma, and SuperWASP-South is located at Sutherland, South Africa. The eight observatory cameras each have Canon 200 mm f/1.8 lenses backed by 2048 x 2048 pixel CCDs. The large field of view gives 490 square degrees per pointing. Follow up characterisation work is done by HARPS at La Silla. Since 2006 the WASPs have detected a large number of exoplanets as well as solar systems with the planets rotating in the opposite direction to their stars.

WFIRST (Wide Field Infrared Survey Telescope) was declared in February 2016 as a NASA space mission. The payload will be a 288 megapixel multi-band near infrared camera, and a *coronagraphic instrument and spectrometer for imaging and characterising exoplanets. A coronagraphic instrument attempts to block the direct light from a star in order to make the orbiting planets visible. Launch to the Sun-Earth L2 Lagrangian point is planned for the mid-2020s. The mission will be primarily directed at advanced astronomical research.

A great advance in direct exoplanet imaging is expected from the proposed New Worlds Mission. This is a spacecraft with a large baffle or occulter, of several tens of metres diameter, which can block the direct starlight and allow imaging of the planets. This would typically be positioned 80,000 km in front of the observing spacecraft.

It may seem likely that the shade should be of circular shape but this is not the case. A circular shield would diffract the starlight which would then interfere constructively on the optical axis making imaging of the planets impossible. The envisioned occulter would have the shape of a sunflower. The pointed petals would diffract the light away from the optical axis.

Some comments by University of Colorado Professor Webster Cash of the centre for Astrophysics and Space Technology: *"In its most advanced form, the New Worlds Imager would be able to capture actual pictures of planets as far away as 100 light years, showing oceans, continents, polar caps and cloud banks. If extra-terrestrial rainforests exist, they might be distinguishable from deserts. To me, one of the most interesting challenges in space astronomy today is the detection of exo-solar planets. We have created an affordable concept with very practical technology that would allow us to conduct planet imaging in visible and other wavelengths of light."*

When the eventual intelligent communication is received from the cosmos, this will be the most sensational news item in the history of journalism.

An overwhelming flood of questions will arise: What kind of language do they have; can they communicate telepathically; do they wear clothing, do they have music, art and literature; what kind of mathematics do they have; what about their medical science; what do they use for transport; what fauna and flora; what kind of power distribution; do they have a form of government that actually works; do they have buildings and cities; do the life forms have a similar DNA to ours; do they have any developed philosophy or religion?

With the vast resources being mobilised to finally settle this matter, we might not have too long to wait. wn

**Coronagraphic - photograph of a star and its spectrum of neighbouring stars.*

IN MY OPINION - ALAN CAMERON

How fibre broadband will help SA compete globally

Disruption. You've heard the word before. It means times, they are a'changing – just quicker than before. But how can a low-to middle-income economy like South Africa use this hastening change to prosper?

BY | ALAN CAMERON

Technological advances are increasing at an exponential pace, challenging and irrevocably changing the ecosystem that national economies use to compete with one another. This the World Economic Forum calls the 'Fourth Industrial Revolution'.

KNOWLEDGE-BASED ECONOMIES ADAPT TO A CHANGING WORLD

National economies that are based on knowledge, not agriculture or labour, navigate disruption better by reacting in a more holistic manner. This lets them ride the winds of change instead of falling victim to them.

Being able to transfer knowledge or intellectual capacity as a source of economic growth requires highly-skilled people readily accessing technology platforms, which enable new business models, said Chief Strategy Officer of Dark Fibre Africa, Reshaad Sha, during an interview with me.

EFFICIENT INTERNET ENABLES MORE BUSINESS MODELS

The effect of these models pivot on the speed and reliability of the network used, and fibre is commonly considered the best network technology to handle the quickly growing data and speed demands. Fibre networks enable pulses of light along very thin strands of glass, as thick as a human hair, to transmit data. The high capacity of speed and volume means that fibre can deliver data at significantly lower prices than what can be delivered over a wireless network.

"Data prices are typically set per megabits per second (Mbps) and are influenced by the initial and ongoing costs of the networks. Fibre networks involve a higher upfront cost, while wireless networks have a higher operating cost. Fibre prices are typically less than 0.2c per gig," said fibre to the home specialist Juanita Clarke, CEO of the FTTH Council Africa, in response to my questions.

FIBRE NETWORKS SCALE MORE EFFICIENTLY

As data demand keeps climbing, Internet Service Providers (ISPs) who use fibre networks keep pace by simply upgrading the transmission hardware, Juanita explained.

This relatively simple hardware upgrade means that the technology is able to scale far more efficiently than a wireless network where spectrum (frequency used to transmit data through radio waves) availability and a more fine-grained network maintenance and operating environment increases the complexity and cost of upgrades, agreed Reshaad.

"Once an area has been trenched, ducts laid and fibre blown through, the passive network is able to scale up to cope with increased bandwidth demands through just equipment upgrades, and not additional builds," he explained.

INSTALLATION COSTS MITIGATED, BUT COMPETITION INCREASES

The installation expenses of a fibre network are onerous. However, according to Juanita, *"The long-term business case still stacks up and companies are willing to make the investment. Having said that, this is not an industry to invest in if you are very risk averse. Depending on uptake, returns on investment can take longer, but in communities where uptake is greater than 40%, the business model makes sense. With this in mind, ISPs and operators naturally opted for areas where there is a high demand and better returns."*

With about 80% of the cost of infrastructure in the trench, infrastructure sharing becomes attractive, but it needs to fit into an operator's overall strategy, Juanita said. *"We have seen a mammoth increase in sharing taking place and a more coordinated manner of deployment amongst operators.*

In Cape Town, that is often because the City has strictly enforced 'one trench' policies. Having said that, one has to consider technical issues such as redundancy – if you deploy all infrastructure in a single trench on a single route, this makes the network vulnerable. In addition, one has to keep in mind that sharing in the access (last mile) is more difficult as companies are closer to their customers [and want to protect their client-base from being poached]."

LEASING OPEN ACCESS NETWORKS HELP SERVICE PROVIDERS COMPETE

As market forces compete to meet the growing demand for data, wholesale provider network operators will not be exempt from looking for more cost-efficient and appropriate ways of building, deploying and managing networks, Reshaad noted. As the market converges on the internet connectivity sector, profit margins at every link of the value chain are being squeezed, and the result is cheaper fibre-supplied internet to regular users. But, only 5.3% of South Africans have access to a physical,

Fibre

continues from page 57

fixed, broadband connection. The internet is by far first experienced via smartphone, with a national access rate of just more than 40%.

PLANS TO GET SA UNIVERSAL INTERNET ACCESS

So, if so few people are benefitting from the scale of benefit that fibre-fuelled internet access brings, what more can be done?

"Wireless access networks are far more appropriate to deliver widely available and accessible coverage in low-income and peri-urban areas," Reshaad said. *"However, fibre networks which provide the wireless site backhaul connectivity, make it possible for these areas to have accessibility to higher-speed wireless broadband services."*

Each year the urgency of how South Africa can keep up with the Fourth Industrial Revolution increases, leading the South African government to publish, in late 2014, the national broadband policy known as South Africa Connect, with the goal of providing internet access to the homes of all citizens by 2030. The benefits of connecting rural areas to broadband internet will attract the jobs, investment and social inclusion that enables smaller, more vulnerable communities to remain intact and become stronger as they connect with the rest of the world, Reshaad said.

However, despite good policy, the state has been inactive. Already a year ago, analysts suggested that this inactivity and 'business as usual' approach will harm South Africa's ability to meet the urgent milestones required to enable South African residents to compete in the Fourth Industrial Revolution, and not fall victim to the winds of change.

WHAT HAPPENS AFTER ACCESS?

"Let's assume that [internet] services are universally available and affordable in South Africa. Would this mean that the masses of our population can access services?" challenged Reshaad.

Digital literacy is as important as digital access to enable people to use the internet and so participate in the social and economic benefits of the digital economy (currently 2.5% of national GDP).

Concurrent to internet access becoming a reality to South Africans, we should also look at relevant services that will encourage people to use it, aspects of affordability such as data and device costs.

"We have policies in place that encourage the development of local content, support the availability of low-cost devices and aim to increase digital literacy and capacity.

"Authorities can contribute by developing the detail in plans and programs in this regard, implementing them and making policy a reality," said Reshaad.

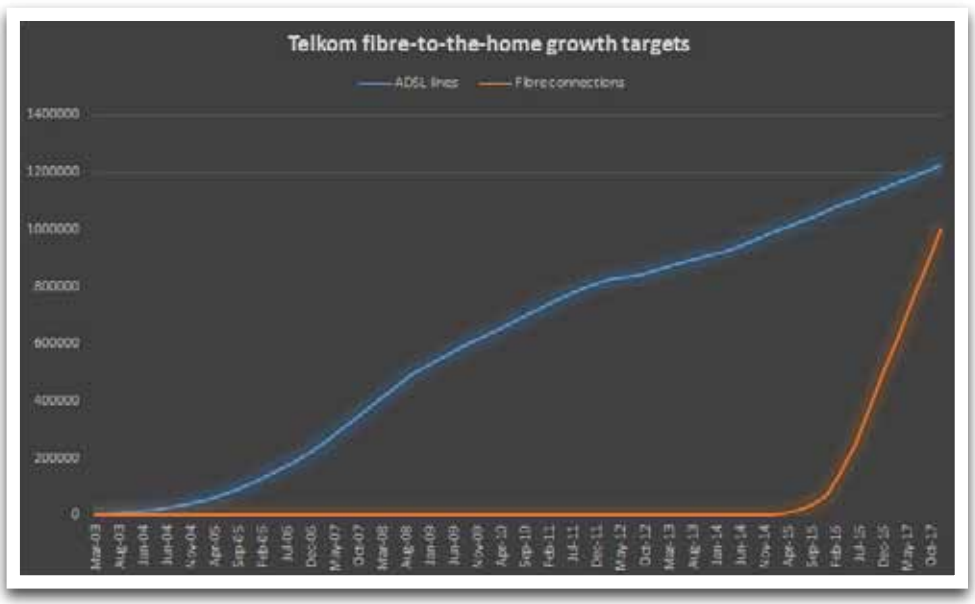
VERY AMBITIOUS TARGET

To put Telkom's one-million FTTH target into perspective, it took the company 13 years to reach the same milestone with its ADSL service.

There is one big difference, though. The ADSL infrastructure – copper lines – already existed and were already installed in people's homes.

Telkom's new fibre-to-the-home infrastructure is still being rolled out. This includes both last mile and other network components.

The graph below shows the growth of ADSL in South Africa, and Telkom's new fibre-to-the-home target. wn



The growth of ADSL in South Africa, and Telkom's new fibre-to-the-home target.

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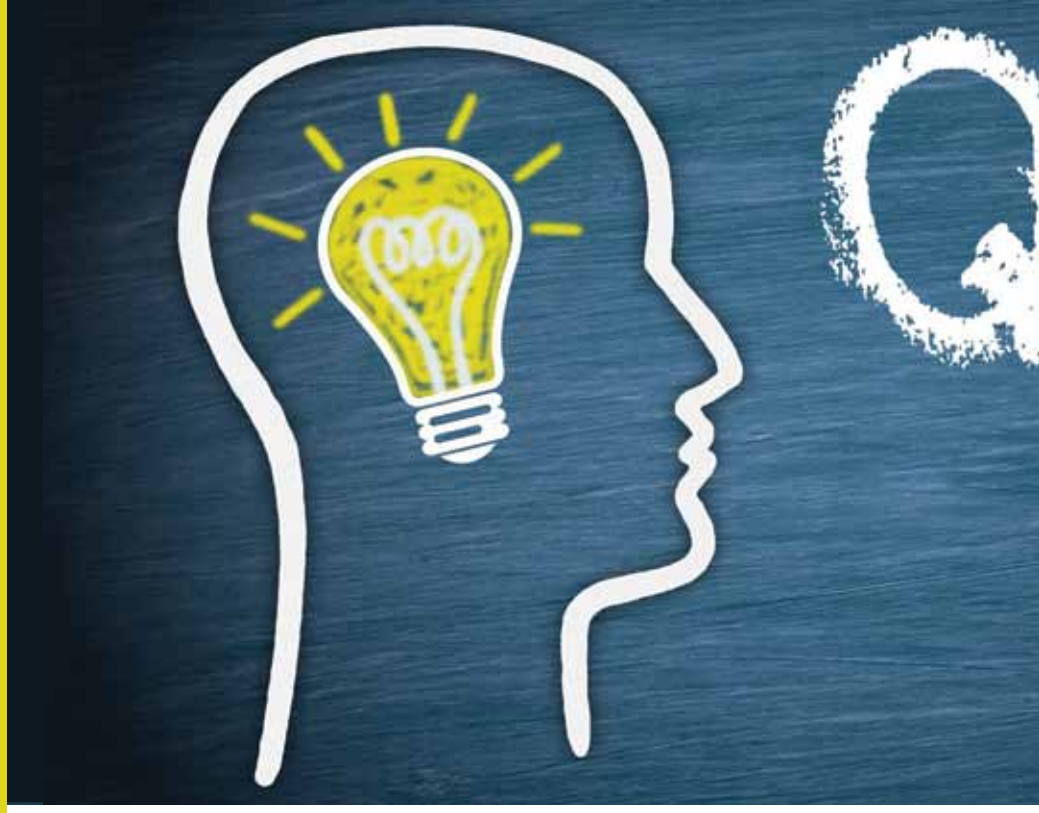
Do you have any burning questions, topical issues or points of interest about the electrical industry, from the perspective of a contractor, supplier or professional service provider? Submit your comments, thoughts, ideas, suggestions or questions for the attention of our industry experts, and these will be addressed in a future issue of the magazine. This is your forum, and we would like to hear from you!

WATT? is an opportunity for people on the ground to engage with each other and related professionals in an informative and friendly manner. This is a platform for you to discuss anything related to your particular sector, to highlight anything new, or to ask a specific question related to a technical topic or to engage in general industry issues. . Please note that we will not be considering anything related to the domestic sector, such as residential wiring.

We hope that this section of the magazine not only becomes a regular feature, but that it is widely read and distributed among your peers. Remember, it can only become a success with the full participation of our readers! Send your burning questions to minx@saiee.org.za - subject 'WATT?'.

We look forward to hearing from you.

- Ed



QUESTION ONE

Why is aluminium considered as an increasingly attractive option in transformer windings?

ANSWER ONE

Copper has been the traditional metal used in transformer windings, and its price has fluctuated widely depending on global demand. The price of copper has recently risen much faster than the price of aluminium, making the winding of conductors with aluminium increasingly cost-effective. One of the factors behind the price difference is that worldwide copper reserves are declining, and are in total much lower than those of bauxite – from which aluminium is made. While copper reserves are currently estimated at 5,6 billion tonnes, the reserves of bauxite are more than 13 times greater, at 75 billion tonnes.

QUESTION TWO

Has aluminium proved itself as an alternative to copper in this application?

ANSWER TWO

The use of aluminium in transformers began as early as the Second World War when industry experienced a shortage of copper, which was in huge demand for the arms industry. By the 1960s, when copper prices rocketed due to high demand, aluminium again became popular in windings.

Since 1970, aluminium was used intensively in the United States and the technology of aluminium-wound transformers was further enhanced; it has now gained widespread acceptance in European countries and other parts of the world.

QUESTION THREE

What is the performance differential between aluminium and copper in transformer windings?

ANSWER THREE

Many years of testing has established that there are no significant differences between the use of aluminium windings and copper windings in designing and manufacturing distribution transformers, as well as small to medium power transformers. Either metal gives the transformer the same quality of operation and performance.

One of the related myths, which has since been disproved, is the belief that aluminium-wound transformers experience bigger losses of electricity. While the aluminium conductors are larger than copper conductors, they are lighter; the result is that the mass of the core in an aluminium transformer is 5-20% more, but the total transformer mass is almost the same for the same level of electrical loss.

QUESTION FOUR

What is the impact of the two metals' different thermal properties?

ANSWER FOUR

With regard to the respective thermal properties, aluminium has a lower melting point than copper but it is still well above the real working temperatures of the windings. In normal circumstances, the 'hot-spot' temperature in the windings is between 105°C and 120°C, while aluminium only melts at 665°C.

More importantly, the lower thermal conductivity of aluminium does not affect the performance; the temperature differences in the conductor are negligible in relation to the temperature difference between the ambient air and the windings. Also, as a result of the difference in the material properties of the two metals, Eddy loss in aluminium winding is 38 % less than in copper with the same volume of conductor.

QUESTION FIVE

What is the effect of aluminium's resistivity on Eddy losses?

ANSWER FIVE

Skin effect is the tendency of an alternating electric current (AC) to become distributed within a conductor, such that the current density is largest near the surface of the conductor and decreases with depth. The electric current flows mainly at the 'skin' of the conductor, between the outer surface and a level called the 'skin depth' or 'penetration depth'.

The skin effect causes the effective resistance of the conductor to increase at higher frequencies where the skin depth is smaller, thus reducing the effective cross-section of the conductor. At high frequencies, the skin depth becomes much smaller. This is because the interior of a large conductor carries so little of the current.

In a good conductor, skin depth is proportional to square root of the resistivity. This means that better conductors have a reduced skin depth. The penetration depth of copper (50 Hz) is 9,4 mm, while for aluminium it is 12,3 mm. The conductivity of copper at 75°C is 47.03.106 [Ohm.m]-1, while for aluminium it is 28.935.106 [Ohm.m]-1. As result of this difference in the material properties, Eddy loss in aluminium winding is 38 % less than in copper – with the same volume of conductor.

QUESTION SIX

Are there any problems with joining or terminating when aluminium is used?

ANSWER SIX

While there was historically some concern about joining and terminating aluminium – either to itself or to copper – when it was to be used outdoors, these joints and terminations are today made without any problems. Techniques such as bolting, crimping and arc welding under inert gas (with or without refractory electrodes) have undergone severe testing over many years and have been proven. wn

Information provided by Zest WEG Group

October

Movers, shakers and history-makers

COMPILED BY | JANE BUISSON-STREET
FSAIEE | PMIITPSA | FMIITSPA

1 OCTOBER

1998 SA's first commercial service television station that depends solely on advertising, e.tv, started broadcasting.

2 OCTOBER

1925 Die Volksblad, an Afrikaans newspaper, was published in Bloemfontein for the first time. It is South Africa's oldest Afrikaans newspaper and is now owned by Media24.

3 OCTOBER

1971 According to the SABS Metrication News of this date, 'massmeter' was adopted as the correct name for scales and balances in SA.

4 OCTOBER

1922 The inauguration of the University of the Witwatersrand, Johannesburg (Wits) was celebrated a few months after the University College, Johannesburg was granted full university status on 1 March 1922.

5 OCTOBER

1582 Because of the implementation of the Gregorian calendar this day did not happen in Italy, Poland, Portugal and Spain.

6 OCTOBER

1902 A 3200 km railway line running from Cape Town, South Africa, to Beira, Mozambique, is completed.

7 OCTOBER

1954 IBM researchers modify an existing model 604 vacuum tube calculator to use transistors. This experiment didn't shrink the desk-sized machine nor make it any faster, but it did use only 5% of the power the vacuum tube-based design did.

8 OCTOBER

1828 Dr James Barry, who had graduated from the all-male Edinburgh College of Medicine in 1812, left the Cape in order to go to Mauritius. After qualifying, James Barry joined the British Army as a medical officer and was sent to South Africa a year later, where he gained a reputation as a first-class surgeon. It was while posted to the Cape that Barry performed what is believed to be the first recorded, and successful, caesarean operation (1826). Barry died in 1865, in London, whereupon it was found that the physician was actually a woman.

9 OCTOBER

2005 Lance Dyer, a 38-year-old South African man was arrested by French police after he walked through the Channel Tunnel, between Folkestone in England and Calais, in France in his flip flops. Eurotunnel officials were amazed he had survived the 15-hour trip as he would have been passed by trains doing nearly 160km/hr; the vacuum effect of the trains would normally suck up and kill anyone walking in the tunnel.

10 OCTOBER

1958 Albert Munyai, South African sculptor, was born in Venda.

11 OCTOBER

1886 Standard Bank became the first bank to open a branch on the Witwatersrand, in a tent, in Johannesburg, then known as Ferreira's Camp.

12 OCTOBER

1898 German South West Africa's first newspaper, the Windhuker Anzeiger, was published.

13 OCTOBER

1881 Adderley Street, possibly the most historically rich street in Cape Town, had its first electric lights installed. The street got its name from the man who vehemently opposed a proposal by the British to turn Cape Town into a convict colony, Charles B. Adderley.

14 OCTOBER

1931 Pretoria achieved official city status.

15 OCTOBER

1989 Five of the eight African National Congress (ANC) long term political prisoners were released from Robben Island, namely Walter Sisulu, Ahmed Kathrada, Raymond Mhlaba, Endrew Mlangeni and Elias Motsoaledi.

16 OCTOBER

1939 Charlotte Makgomo Maxeke, teacher, social worker, politician and founder of the Bantu Women's League of South Africa, died in Johannesburg at the age of 65. In 1905 she became the first African woman from South Africa to graduate with a Bachelor of Science degree.

17 OCTOBER

1887 The Star newspaper went on sale for the first time in Johannesburg as The Eastern Star. It was founded in Grahamstown, under that title, on 6 January 1871, and was moved to the Witwatersrand sixteen years later by its owners, brothers Thomas and George Sheffield. In 1889, the name Eastern Star was changed to "The Star".

18 OCTOBER

2013 NASA discovered Asteroid 2013 TV135, which has a 1-in-63,000 chance of colliding with the earth in 2032.

19 OCTOBER

1925 Discovery of sea-shells in Algeria proves that the Sahara was once partially submerged.

20 OCTOBER

1987 Doctors at Chris Hani Baragwanath Hospital completed the first stage of an operation to separate Siamese twins Mpho and Mphoyana Mathibela. The Chris Hani Baragwanath Hospital is the 3rd largest hospital in the world.

21 OCTOBER

1879 Thomas Edison demonstrated the first commercially practical incandescent light bulb. Edison's successful design came only after he had tested over 6,000 different vegetable fibres during a span of over 18 months, running 1,200 experiments and spending $40,000.

22 OCTOBER

1938 In a makeshift lab on the second floor of his mother-in-law's house (in Astoria, Queens, New York USA), Chester Carlson and his assistant Otto Kornei (an Austrian physicist) successfully invented the process that would lead to the PHOTOCOPIER. Carlson wrote "*10.-22.-38 ASTORIA*" on a glass microscope slide and these became the historic words that were the first photocopied. Ironically, Kornei had so little faith in the invention that within a year he quit working for Carlson.

SEPTEMBER

continues from page 63

23 OCTOBER

1901 The first motorists' organisation in SA, the Automobile Club of South Africa (called the Royal Automobile Club of SA since 1911), was founded in Cape Town.

24 OCTOBER

1995 The United Nations celebrated its 50th anniversary. The celebration was the largest gathering of world leaders in history, with President Nelson Mandela addressing the gathering.

25 OCTOBER

1999 South African author J.M. Coetzee won England's prestigious Booker prize for fiction, for the second time, for his novel Disgrace. In 2003, he was also awarded the Nobel Prize for Literature.

26 OCTOBER

1657 The first pineapples were planted in SA. The main producing areas are Northern KwaZulu-Natal and the Eastern Cape and, on a smaller scale, the Limpopo Province.

27 OCTOBER

1932 Judge FW Beyers delivered the first court verdict in Afrikaans in the Bloemfontein Appeal Court. The government had recognised Afrikaans as an official language in 1925, but only a few respected works, fiction or non-fiction, had as yet appeared in the language.

28 OCTOBER

2000 Pieter Venter discovered three coelacanths at 104m while scuba diving in the Jesser Canyon off Sodwana Bay in the St Lucia Marine Protected Area of Kwazulu-Natal.

29 OCTOBER

2013 The first phase of the Marmaray Railway under the sea, first proposed by Ottoman Sultan Abdulmejid 150 years ago, was officially opened. The sea tunnel, connecting Europe and Asia, is the deepest submerged railway tunnel of its kind in the world.

30 OCTOBER

1965 On Derby Day at Flemington Racecourse, Australia, English model Jean Shrimpton wore a white minidress that sparked controversy and was later described as a pivotal moment in women's fashion. The dress was made by Shrimpton's dressmaker, Colin Rolfe, and its hem was a daring 10 cm above the knee because he had not been supplied with enough fabric to the intended design.

31 OCTOBER

2011 According to the UN's Population Division, the world population reached 7 billion. In about 1800 the world's population reached one billion, the second billion was achieved in only 130 years (1930), the third billion in 30 years (1960), the fourth billion in 15 years (1974), the fifth billion in only 13 years (1987) and the "Day of 6 Billion" was 12 October 1997. It is hoped, that with the declining birth rate, that the "Day of 8 Billion" is 200 years away.... wn

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calendar

OCTOBER | NOVEMBER 2017

OCTOBER 2017

2 - 3	Optical Fibres, Cables & Systems Fundamentals	Johannesburg	roberto@saiee.org.za
3-5	FTTH Council Conference	Cape Town	www.ftthcouncilafrica.com
8-11	AMEU Convention	Port Elizabeth	www.ameu.co.za
9-11	International Water Association IWA Specialist Conference (IWAIWASP)	Skukuza	www.iwa-network.org
11 - 12	Fundamentals of Practical Lighting Design	Johannesburg	roberto@saiee.org.za
17-18	African Rail Evolution (ARE)	Durban	www.rail-evolution.com
18 - 19	Core Financial Management Skills for Engineers	Johannesburg	roberto@saiee.org.za
18-19	ELPA Installer's Exam	Johannesburg	www.elpa.org.za
22	AfrikaBot	Centurion, JHB	michael@uj.ac.za
25 - 27	Smart Meters for Smart Grid Training	Johannesburg	roberto@saiee.org.za
25 - 27	MV/HV Regulations for Authorised Persons	Johannesburg	roberto@saiee.org.za
26 - 27	Generator & Standby Power Conference	Johannesburg	www.vukanicomms.co.za
27	SAIEE Annual Banquet	Wanderers	www.saiee.org.za
31	Internet of Things (IoT)	Johannesburg	roberto@saiee.org.za

NOVEMBER 2017

08	Sub Saharan Africa Power Summit 2017	Zambia	www.ssapower.com
08 - 09	Photovoltaic Solar Systems	Johannesburg	roberto@saiee.org.za
14	The 8th Southern Africa Regional Conference	Western Cape	www.saiee.org.za
14 - 17	Advanced Microprocessor Based Power System Protection	Johannesburg	roberto@saiee.org.za
15 - 16	Power Transformer Unit Protection and Testing & Maitenance	Johannesburg	roberto@saiee.org.za
21 - 23	Fundamentals of Medium Voltage Protection	Johannesburg	roberto@saiee.org.za
28 - 29	SA Energy Storage Conference 2017	Johannesburg	www.energystorage.co.za

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