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INDUSTRY SETS ITS SIGHTS ON 6G

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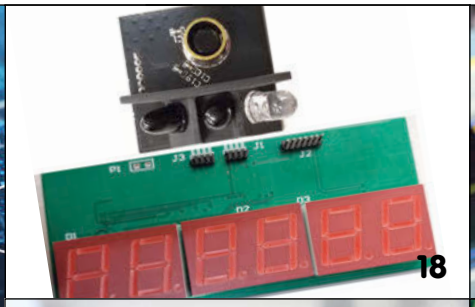

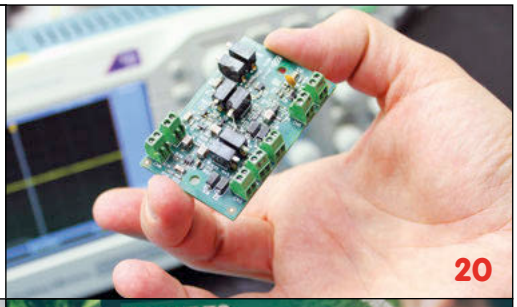

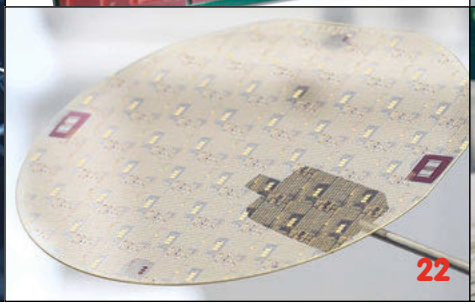

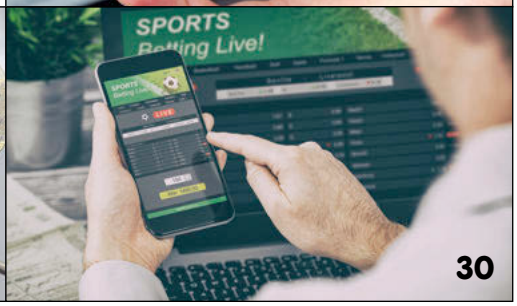

COVER IMAGE: Karla Gowlett

MISSION STATEMENT

'New Electronics keeps designers and managers abreast of the latest developments in the world's fastest moving industry'

Are data fears misplaced?

SHOULD FITBIT USERS BE WORRIED ABOUT THEIR PERSONAL DATA, FOLLOWING GOOGLE'S RECENT ACQUISITION?

The news that Google has acquired Fitbit in a deal that valued the wearables company at $2.1bn, while welcomed by some industry watchers, has raised a number of concerns when it comes to how users' intimate health details – whether that is the number of steps they take each day to breathing patterns – might be exploited by the tech giant.

Fitbit currently tracks the health data of over 28 million users worldwide and the company has stated that user data would not be sold or used for Google advertising, pointing to the company's strong privacy and security guidelines that have been in place since the company's launch.

Despite that, many Fitbit wearers have been expressing their concerns – throwing away their Fitbits and deleting their accounts.

For many, there are real concerns that large tech companies like Google already have a vast amount of information on people – whether that's location data, search histories, income or viewing habits – and they don't need access to more.

Enough is enough, seems to have been the response of many who are determined to prevent Google grabbing their personal data.

Users in Europe benefit from GDPR which enables them to not only know what data is held on them but to have that data deleted.

Even if Fitbit's claims that it will not be sharing health data with Google are true, a large number of individuals are uncomfortable with the news and despite Google itself saying that it won't use Fitbit health data for advertising, many industry watchers have pointed out that it will have access to plenty of other sources of data.

Google says it is acquiring Fitbit to bring together "the best AI, software and hardware" in order to "spur innovation in wearables and build products to benefit even more people around the world."

There's a chance that this purchase might not be approved by regulators, especially at a time when the likes of Google and FACEBOOK have been coming under mounting scrutiny and criticism.

But while many users may be expressing their disquiet there are others who argue that there's nothing wrong with massive tech companies having access to our daily health statistics.

While consumers should be concerned about privacy and security the mistakes made by both Google and FACEBOOK mean that the issues of privacy and security are now taking centre-stage.

And who better to securely manage that data than those tech giants with the resources, technologies and skills to secure it properly?

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ISSN 0047-9624 Online ISSN 2049-2316

Annual subscription (22 issues):
UK £108. Overseas; £163. Airmail; £199.
New Electronics, incorporating *Electronic Equipment News* and *Electronics News*, is published twice monthly by MA Business, Hawley Mill, Hawley Road, Dartford, DA2 7TJ.
T: 01322 221144 E: *ne@markallengroup.com*

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Cyber security dominates TechWorks Awards

FIVE OF THE THIRTEEN PRIZES AWARDED TO THOSE IN THE CYBER SECURITY SECTOR. REPORTS **CHARLOTTE HATHWAY**

The TechWorks Awards celebrate the year's key electronics innovations, people and companies from across the UK and Ireland, and this year's ceremony had cyber security at its heart.

People and organisations working in the cyber security sector took home five of the thirteen prizes, including the big three awards. 'Company of the Year' went to Secure Thingz, 'Contribution to Industry' was awarded to Professor Paul Dorey from CSO Confidential, and Darktrace's Enterprise Immune System won 'Product of the Year'.

Commenting on taking home the Company of the Year award, Haydn Povey, CEO and founder of Secure Thingz, said, "I am extremely proud and honoured to have received the TechWorks Company of the Year award for all the team at Secure Thingz and IAR Systems. This is further proof that we are on the right track in our mission of making security available for all and transform the embedded industry into a security-first mindset."

Secure Thingz was founded in 2016, is a partner to Arm and gained significant backing from IAR Systems last year. It is one of the world's leading IoT security experts and enables organisations to implement straightforward, scalable and sustainable security from a device's inception.

Speaking at the event, TechWorks' CEO, Alan Banks said Secure Thingz is "an exemplar [that] symbolise[s] the ever increasing value of technology to our economy, industry and society".

He added, "We look for a company that's universally admired for its practice and dedication to success. [Secure Thingz is] a UK success story."

In presenting the Contribution to Industry award, Banks described Professor Dorey as a "true champion to the industry", and highlighted Dorey's "outstanding leadership and flair [to] campaign and drive best practice over time."

Professor Paul Dorey has been a key player in information security for over 25 years. He has provided consultancy to numerous governments, run global strategy, security and risk management functions for BP, Morgan Grenfell and Barclays Bank, sat on the Permanent Stakeholders Group of the European Network Information Security Agency (ENISA), and co-founded the Jericho Forum and the Institute of Information Security Professionals (IISP).

The sensor tech start-up Nanusens was the only company to take home two awards, winning 'Disruptive Technology', and 'Emerging Technology Company of the Year'.

The full list of winners is:

- Company of the Year Award – Secure Thingz
- Contribution to Industry Award – Professor Paul Dorey, CSO Confidential
- Product of the Year Award – Darktrace, Enterprise Immune System
- Disruptive Innovation Award – Nanusens
- Emerging Technology Company of the Year Award – Nanusens
- Automotive Electronics Innovation & Excellence Award – Blu Wireless
- IoT Security Foundation Champion Award – Signify
- Manufacturing Site of the Year Award – Diodes Inc (Oldham site)
- Manufacturing Supplier of the Year Award – Compugraphics International
- R&D Excellence Award - Compound Semiconductor Applications Catapult
- Young Engineer of the Year award – Gethn Pickard, Plessey Semiconductors
- Cyber Student of the Year in Automotive Award – Angela Mison, University of South Wales
- UKESF Scholar of the Year Award – Hugo McNally, University of Southampton/On Semiconductors, and Mary Bennett, University of Surrey/Embecosm

The TechWorks Awards have run annually since 2001.

Engineers identify their top design trends for 2020

Extending battery life, 5G and sustainability have been identified as the biggest trends driving electronic product design in 2020. That's according to new research from thermal simulation provider 6sigmaET, conducted at this year's Engineering Design Show.

6SigmaET polled 100 electronics professionals and engineers, asking what they thought would be the biggest trend impacting new product development in the electronics industry in 2020.

The design priorities in 2020 were:

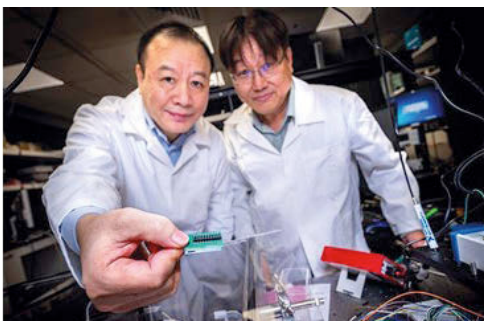
- Extending device battery life (26%)
- 5G capabilities (18%)
- Making devices greener/more sustainable (13%)
- Internet of things capabilities (12%)
- Making devices smaller/more compact (10%)
- Making devices faster/more powerful (8%)
- AI capabilities (6%)
- VR and new display technologies (4%)
- Edge computing (3%)

Commenting on these findings, Tom Gregory, Product Manager at 6SigmaET said, "For those of us working at 6SigmaET, this research provided some really interesting findings. Whether you're looking to incorporate 5G, make devices smaller or more sustainable, or preparing your designs for the Internet of Things, all of these new trends have major thermal implications that could seriously affect the reliability and sustainability of devices."

Given that fact, Gregory warned that engineers need to place a far greater emphasis on thermal management within their designs.

Tiny quantum chip developed by researchers

RESEARCHERS DEVELOP A 'TINY' QUANTUM COMMUNICATION CHIP. **CHARLOTTE HATHWAY** REPORTS



Researchers at Nanyang Technological University (NTU) in Singapore have developed a quantum communication chip that is 1,000 times smaller than current quantum setups.

The chip, roughly 3mm in size, uses quantum communication algorithms to provide enhanced security compared to existing standards. It does this by integrating passwords within the information that is being delivered, forming a secure 'quantum key'.

It also needs 1,000 times less space than current setups that can be as big as a refrigerator or even take up the space of an entire room or office floor. This opens doors for more secure communication technologies that can be deployed in compact devices. It also lays the foundation for better encryption methods for online transactions and electronic communication.

The research was led by NTU Professor Liu Ai Qun, and Associate Professor Kwek Leong Chuan, with the findings published in Nature Photonics, a peer-reviewed journal.

"In today's world, cyber security is very important as so much of our data are stored and communicated digitally. Almost all digital platforms and repositories require users to input their passwords and biometric data, and as long as this is the case, it could be eavesdropped on or deciphered," explained Prof Liu. "Quantum technology eliminates this as both the password and information are integrated within the message being sent, forming a 'quantum key'."

The chip offers the same level of security provided by quantum technology, and the researchers suggest it will be cost effective and easy to manufacture as it uses standard industry materials, such as silicon.

GLOBALFOUNDRIES and **SiFive** look to unlock AI application possibilities

GLOBALFOUNDRIES and SiFive are working to develop a platform that can deliver the capacity, speed and power required for cloud-based artificial intelligence (AI) applications.

The two companies said they will do this through extending high DRAM performance levels with High Bandwidth Memory (HBM2E) on GLOBALFOUNDRIES's recently announced 12LP+ FinFET solution.

In order to achieve the capacity and bandwidth for data-intensive AI training applications, system designers are challenged with squeezing more bandwidth into a smaller area with a reasonable power profile.

SiFive's customisable high bandwidth memory interface on GLOBALFOUNDRIES's 12LP platform and 12LP+ solution will enable easy integration of high bandwidth memory into single SoC solutions to deliver fast, power-efficient data processing for AI applications in the computing and infrastructure markets.

Mohit Gupta, vice president and general manager, IP Business Unit at SiFive commented, "Extending SiFive's reference IP platform, with HBM2E, on GF's best-in-class performance 12LP+ solution delivers new levels of performance and integration for next generation SoCs and accelerators.

"Deployment of highly optimised silicon requires highly customisable capabilities in order to realise the much-needed higher TOPS per milliwatt with low latency performance required for AI, while balancing the needs for low power and smaller area footprints."

As a part of the collaboration, designers will also have access to SiFive's RISC-V IP portfolio and DesignShare IP ecosystem, which will use GLOBALFOUNDRIES's 12LP+ Design Technology Co-Optimisation (DTCO).

The companies say this will help designers significantly increase silicon specialisation, and improve design efficiency.

TINY Bluetooth low energy SoC and module

DIALOG SEMICONDUCTOR CLAIMS WORLD'S SMALLEST AND MOST EFFICIENT BLUETOOTH 5.1 SOC. **NEIL TYLER** REPORTS

Dialog Semiconductor has unveiled the DA14531, said to be world's smallest and most power-efficient Bluetooth 5.1 SoC, and the DA14531 module, that is intended to simplify Bluetooth product development and encourage wider adoption.

The chip, the SmartBond TINY, looks to lower the costs of adding BLE functionality to applications, with the aim of supporting the next wave of the IoT, that's been estimated to include over 1 billion devices.

The cost of enabling a complete IoT system has been coming under pressure and this device looks to address the growing breadth and costs of IoT devices by reducing the complete system cost through a smaller footprint and size, while maintaining performance quality.

The DA14531 looks to extend wireless connectivity to applications where it would have previously been prohibitive in terms of size, power or cost, especially those within the growing connected medical field.

The device is available in packages as small as 2.0 x 1.7mm. Moreover, the SoC's high level of integration means that it only requires six external passives, a single clock source and a power supply to make a complete Bluetooth low energy system.

SmartBond TINY is based on a 32-bit Arm Cortex M0+ with integrated memories and a complete set of analogue and digital peripherals. Its architecture and resources allow it to be used as a standalone wireless microcontroller or as an RF data pipe extension for designs with existing microcontrollers.

The module looks to make it easier for customers to leverage the new SoC as a part of their product development, instead of having to certify their platforms themselves.

SmartBond TINY and the module use just half of the energy of their predecessors and that low power consumption ensures a long operating and shelf life. The DA14531's integrated DC-DC converter enables a wide operating voltage (1.1 to 3.3V) and can derive power directly from environmentally-friendly, disposable silver oxide, zinc air or printable batteries required for high-volume applications, such as connected injectors, glucose monitors and smart patches.

ZF and Cree announce strategic partnership

ZF and Cree have announced a strategic partnership to create highly efficient electric drivelines in a move that extends existing cooperation agreements.

"We're delighted that we're building on our cooperation with Cree using their Wolfspeed silicon carbide technology and are absolutely convinced that combining our strengths will further improve efficiency and competitive edge for our components and systems," said Jörg Grotendorst, Head of the ZF E-Mobility Division.

The future use of silicon carbide-based power semiconductors will increase the range for electric vehicles in contrast to today's standard silicon technology.

The efficient electric drive represents an enormous growth potential for the foreseeable future due to high battery costs. In particular, silicon carbide technology, in conjunction with the 800-volt vehicle electrical system voltage, makes a significant contribution to further increasing efficiency.

"Partnering with a tier-one leading global automotive supplier like ZF for the use of silicon carbide-based power inverters in next generation electric vehicles is indicative of the integral role silicon carbide plays in extending the capabilities of EVs everywhere," said Gregg Lowe, CEO of Cree.

Through the partnership, ZF expects to make silicon carbide electric drivelines available to the market by 2022.

Researchers develop new transformative electronics system

A research team at KAIST has invented a multifunctional electronic platform that can mechanically transform its shape, flexibility, and stretchability.

The 'Transformative Electronics Systems' platform, allows users to seamlessly and precisely tune its stiffness and shape.

The researchers said that the system consists of a special gallium metal structure, hermetically encapsulated and sealed within a soft silicone material, combined with electronics that are designed to be flexible and stretchable.

The mechanical transformation of the electronic systems is triggered by temperature change events controlled by the user.

"This new class of electronics will not only offer robust, convenient interfaces for use in both tabletop or handheld setups, but also allow seamless integration with the skin when applied onto our bodies," said Professor Jae-Woong Jeong, who led the research. Professor Jeong is from the School of Electrical Engineering at KAIST, a research university in South Korea.

Once the transformative electronic platform comes in contact with a human body, the gallium metal encapsulated inside the silicone changes to a liquid state and softens the whole electronic structure, making it stretchable, flexible, and wearable. The gallium metal then solidifies again once the structure is peeled off the skin, making the electronic circuits stiff and stable. When flexible electronic circuits were integrated onto these transformative platforms, it could be manipulated into being either flexible and stretchable or rigid.

As this system can be applied to both traditional and emerging electronics technologies, the researchers believe it can reshape the consumer electronics industry, especially in the biomedical and robotic domains.

New era for semiconductors

A REVOLUTIONARY TRANSISTOR WAFER PROCESS OPENS POSSIBILITY OF BUILDING COMPLEX ICS IN UK FABS. **CHARLOTTE HATHWAY** REPORTS

CMOS has been an essential ingredient in IC construction for decades, but its authority could be challenged by a promising new technique. Nottingham-based start-up Search for the Next (SFN) has created a new transistor wafer process – dubbed Bizen – that it says will cause disruption to the entire electronics industry.

This is made possible due to the discovery of a new type of transistor. "It's been 50 years or so since a truly new transistor has been developed, and that's what this is," explains David Summerland, SFN's CEO. "The quantum tunnelling transistor – the Bizen transistor – is a new type of transistor. It's as different from a BJT as a MOSFET is."

The Bizen transistor might look like an existing transistor, but its key difference is in its structure. "The BJT has a metal contact, and the FET has an isolated gate. We introduced quantum tunnel mechanics as a different way to connect to that gate or base. We've found that quantum tunnel mechanics can be used to remove the disadvantages of a bipolar system."

"The BJT has a metal contact, and the FET has an isolated gate. We introduced quantum tunnel mechanics as a different way to connect to that gate or base."
David Summerland

This is significant as the Bizen transistor can help electronics designers build circuits that are controlled by an isolated tunnel connection, rather than a direct metal contact. That set up unlocks the possibility of simpler circuits with far fewer layers. To put that into context, the number of layers needed for Bizen range from four to eight for devices supporting low to high voltage operations, compared with ten to seventeen for CMOS.

Summerland adds that that requirement for a higher number of layers means that the lead time for the development of new wafers "goes through the roof". He knew there had to be a simpler way, so found himself looking for "a technology that was at least as good as CMOS – so it gave you that same integration, similar low power – but didn't have that crazy lead time."

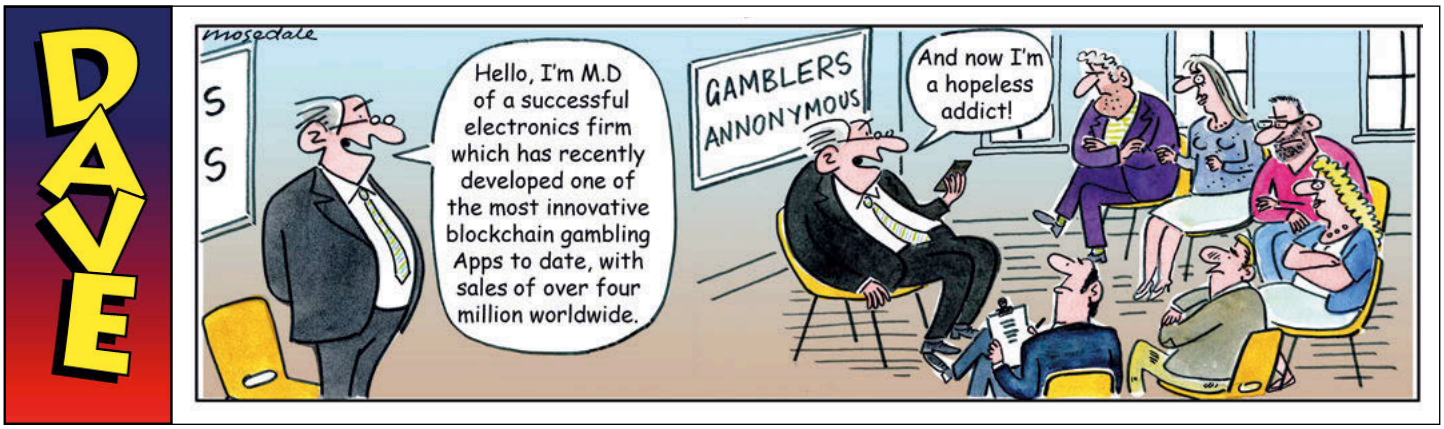
With Bizen, Summerland and his team have been able to get that time in the fab down to two to three weeks. "That's the USP, it's no worse than CMOS – so it's still the designer's dream – but it's very fast to produce."

So, why has this remained untapped until now? Summerland explains that simulation software has been instrumental in unlocking Bizen. "Simulation tools have helped us discover things faster. The reason the tunnelling mechanics of the Bizen transistor did not exist [until now] is because, back when CMOS was invented, the simulation tools did not exist to simulate [the potential of tunnelling]. [This discovery] required a lot of specialist simulation software – in this case it was Silvato's Athena – and that process simulation allows you to model a wafer process."

Yet simulation tools alone aren't why SFN is so confident its technology will reshape how circuits are built. Summerland clarifies that simulation tools might have helped with research and development, but working with Semefab, the semiconductor and MEMs fab based in Glenrothes, Scotland, was essential in proving Bizen's worth.

"A company is of no value … until it's actually produced something in silicon to prove something shown in simulation." With Bizen, designers can produce the physical silicon much more quickly, so the development time can rapidly accelerate.

To date, SFN has demonstrated the Bizen digital wafer process and produced a Bizen power wafer process in physical silicon. Its IPU processor architecture exists in simulation, and the company expects to release a discrete programmable junction transistor (PJT) that uses quantum tunnel mechanics in early 2020.



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Researchers and industry setting their sights on **6G**

Talk around 6G is starting to gather momentum, but is this the hype machine in action or is there some substance behind it? By **John Walko**

The wireless communications sector – like many others - can often sound like a hype machine. The lure of something smarter, quicker and apparently better, has long driven it.

So, it should come as no surprise that the next generation of mobile – not 5G but 6G - is now gathering momentum, even as most of the big equipment makers and operators are frantically trying to meet expectations for a fast roll-out of 5G networks.

Is it too early to talk about '6G'? One prominent global communications equipment supplier thinks so, having declined to contribute to this article. Others were less reticent to outline their (at least initial) views of how to get to 6G and what it will – could - mean for consumers.

One theme is obvious – a huge amount of research needs to be undertaken - and not just in the electronics domain. There is a growing consensus that some of the biggest challenges relate to the Terahertz (THz) frequencies that will be the cornerstone of 6G communications.

The whole area got a boost earlier this year when the FCC, the US regulator, gave the go-ahead for testing in 21.2 GHz of spectrum between the 95GHz and 3THz range.

The new regulations and licences will give innovators the flexibility to experiment that, according to experts in the field, will bear fruit in about 12-14 years' time.

While deploying THz signals involves serious challenges, it also offers the potential for hugely exciting applications, such as sensing and the ability to "see" around corners and support data rates high enough to provide the real-time computations needed for wireless remoting of human cognition. In short true artificial intelligence.

Perhaps more relatable applications will include transmission at data rates suitable for super high-speed wireless back-haul, and even faster communications within and between data centres. There are also hopes the short wavelengths at mmWave and THz will allow massive spatial multiplexing and incredibly accurate imaging as well as sensing

One specific issue at THz rates that is also wavelength related concerns antennas and electronics. The potential stumbling block is that sensors need to be so small that their electronics become a limiting factor, in terms of size and power consumption leading to complexities in integration.

And while the conventional wisdom holds that as you go higher up in frequency, you suffer bigger losses, researchers at NYU Wireless note this is only true if you use an omnidirectional antenna, as is the norm today. With directional antennas, they suggest it is possible to do better as you go higher in frequency for a given power level and a given antenna physical size.

Huge challenges

"There are huge challenges ahead to achieve the ten-times improvements that will be needed to achieve what the industry is currently defining as 6G", Professor Tom Marzetta, the director of NYU Wireless, one of the foremost centres globally for research into communications technologies told New Electronics.

Marzetta is renowned for originating the concept of Massive MIMO during his 22-year tenure at Nokia Bell Labs. Recently appointed, he takes over from the founder of NYU Wireless within the University's Tandon School, Professor Theodore (Ted) Rappaport.

Rappaport led the group's pioneering use and understanding of Millimetre Wave frequencies that along with Massive MIMO has become the cornerstone of 5G.

Interestingly, the two inventors have somewhat divergent views on the emerging technologies that will drive

iaremenko/stock.adobe.com

6G. It seems Rappaport is committed to exploiting the potentials of the higher frequency regions of the EM spectrum, in part because they are so vast and underutilised.

Meanwhile Marzetta seems more concerned with better utilisation of the sub-6GHz bands.

Marzetta says one immediate focus of his work will be a "whole series of interconnected concepts and principles of operation that might result in wireless systems that work at previously unimaginable levels.

"I call this concept 'Beyond Massive MIMO'. The research seeks to benefit from a closer fusion of electromagnetic theory and communications theory."

He readily acknowledges such ideas are still at an early stage. "They are mainly theoretical, not even in the lab yet, and serious mathematical computing over the next three years will prove whether they will work or not. But then this is the way the concept of Massive MIMO became today's reality. I conceived that concept in 2008. We are 10 years in, and that rate of pick up and deployment seems typical of the industry."

Looking more generally at the future of wireless communications, Marzetta notes that some of the current, simplified models will just not work for much longer.

"We need more physics, new thinking. All the current wireless technologies and many of those under development are actually grounded in notions developed in the 19th century and suffer from perceived limitations that nature appears to impose on wireless communications."

He laments that there seems to be insufficient focus on fundamental research into wireless technologies. And while 6G is "a really interesting and exciting area, so you might think the fundamental science would be covered. Unfortunately, this is not the case."

A significant percentage of the funding for NYU Wireless' work comes through the Industrial Affiliate Programme that Marzetta is keen to expand and which already includes the likes of Ericsson, Nokia, AT&T, Qualcomm, National Instruments, Keysight Technologies and InterDigital.

Projects in the pipeline at NYU Wireless and at other research centres focusing on 6G include new technologies such as beamforming and novel antenna approaches that could help mitigate the spectrum propagation problems that dog transmission in very high spectrum bands.

Elsewhere, and perhaps not surprisingly, Finland late last year established an eight-year project with a budget of Euros 251 million, to research 6G technologies and applications. Funding will come partly from the Finnish government, and equal amounts from public and private sector partners, with participation from some of the key equipment suppliers in the mobile communications sector.

Much of the initial work will be done at the University of Oulu. The University organised the first 6G Summit earlier this year, a three-day event in collaboration with the IEEE that was by invitation only and included researchers, regulators, operators and senior representatives from all the major, global equipment makers.

"There are huge challenges ahead to achieve the ten-times improvements that will be needed to achieve what the industry is currently defining as 6G."
Professor Tom Marzetta

"What is clear is that we will need an architecture with even more robustness, significantly better latency and improved security than in the 5G era that is just taking off."
Magnus Frodigh

"We had over 270 participants and have now prepared an in-depth and first White Paper on 6G that attempts to define the initial ideas and realistic targets for the technology", Professor Ari Pouttu, vice director of the 6G Flagship programme told New Electronics.

That White Paper includes roadmaps, use cases, spectrum allocation requirements, hardware demands and much more that will be needed for 'ubiquitous wireless intelligence' for 2030 and beyond, says Pouttu and "opens the door for defining the 2030 wireless era."

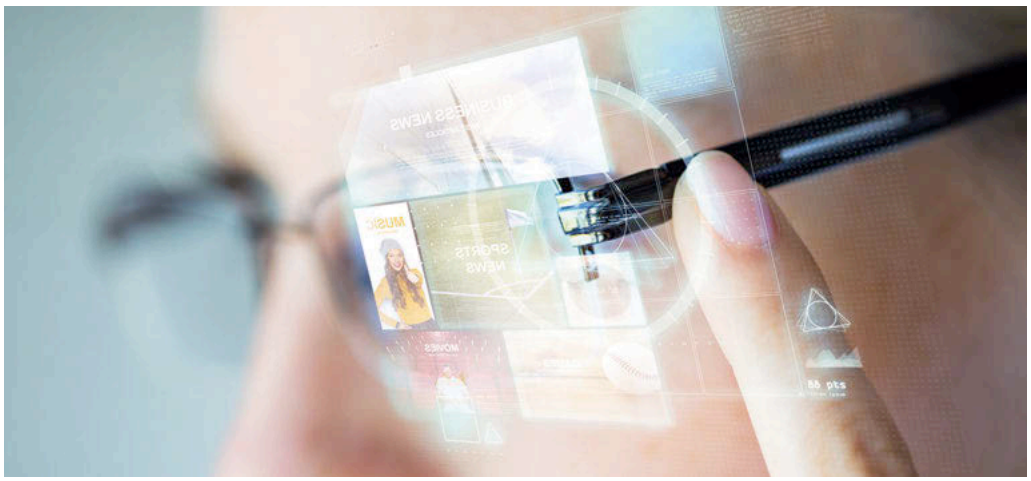
"In our Flagship project, we will focus on four key and fundamental research areas: wireless connectivity; distributed computing; services and applications; and, importantly, devices and circuits."

Putting some flesh on these underlying technology trends and bullet points, Pouttu notes the first refers to the evolution of the disruptive radio access that is inherent in 5G core networks. He suggests the industry will need to start thinking about completely new ways of providing over-the-air communications. "For this we will need new kinds of waveforms to transmit data – OFDM will not suffice."

Distributed computing refers to moving the computing power to the edge of the network, enabling novel machine learning capabilities as well as giving the network Artificial Intelligence.

6G applications

As to applications and services, Pouttu noted that a recent paper prepared by researchers at Oulu, in collaboration with engineers at Virginia Tech in the US and the Beijing Institute of Posts and Telecommunications, outlined some of the applications likely to drive 6G. The list includes multisensory AR/VR/MR (M for 'mixed') applications, connected robotics, and autonomous systems, wireless brain-computer interactions (BCI) and blockchain technologies.



They suggest future multisensory and BCI applications will be mainly deployed on smart wearables, integrated handsets and perhaps even body implants and such advances are likely to render smartphones as we know them now obsolete.

"At some point smartphones will be replaced by devices such as glasses with gesture control."

Other researchers have also suggested that 6G capabilities will include connectivity to surfaces - rather than devices - and support a whole variety of sensory applications.

The 6G Genesis team also consider the dynamic management of the data-rate latency /reliability trade-off based on use-cases and applications needs to be a key area of work and is considered a serious challenge.

Semiconductor advances

Pouttu acknowledges that one of the biggest challenges to make 6G a reality in the timeframes suggested will depend on advances in semiconductor technologies.

"We will need new thinking here. The circuits will be significantly different from today's standard CMOS silicon based ICs. These will just not work for transmissions above 95GHz. New materials may be needed – perhaps graphene, InP, SiGe or maybe even plastics?"

In fact, groups around the world are already working on potential solutions. For instance, researchers at the University of California, Irvine have demonstrated a wireless transceiver chip capable of sending signals at frequencies above 100GHz, and claim lower consumption than existing devices.

The single-channel 115-135GHz prototype is made on a 55nm SiGe BiCMOS process and exhibits data rates of 3Gbit/s across a gap of 30cm. Similar devices have been described by researchers at the University of Wuppertal, Germany.

Looking at the bigger picture, there are several other 6G initiatives already out of the blocks, including one from China's Mobile Research Institute. And the ITU has formed a Focus Group – dubbed Networks 2030 - looking at the backbone technologies that will be needed "beyond 5G"

In the US, the Semiconductor Research Corporation has formed the 'Centre for Converged Terahertz Communications and Sensing' (ConSenTer), a group of universities and research institutes looking to develop technologies using hubs with massive spatial multiplexing.

And of course, some of the biggest infrastructure equipment players have entered the fold, including Samsung and Huawei, the latter with researchers at labs in both Ottawa, Canada and in its home territory.

Huawei senior executives have already started to boast that they are already ahead in the field, though with little concrete evidence that this is the case. Inevitably, alliances are being hatched. The University of Oulu has signed an MoU to collaborate with South Korea's leading research Institute ETRI on 6G technology, as well as 5G network variants. The deal shows foresight as South Korea is the most advanced in rolling out 5G networks.

"At some point smartphones will be replaced by devices such as glasses with gesture control." Professor Ari Pouttu

Company agreements

The same goes for companies. Earlier this year, South Korea's leading carrier SK Telecom said it had signed separate agreements with Samsung, Ericsson and Nokia on further 5G and novel 6G developments.

Details of the exact nature of the work between the companies are scarce, but they agree the target is to draft technical requirements and business models for "beyond 5G". All that will feed into the forthcoming standardisation efforts for 6G

According to Magnus Frodigh, head of research at Ericsson, 5G is likely to have an unusually long lifespan, perhaps longer than the traditional ten years for each generation.

"What is clear is that we will need an architecture with even more robustness, significantly better latency and improved security than in the 5G era that is just taking off."

He added that machine learning and artificial intelligence will need to be at the core of such a network, and that it needs to be aligned to communications between machines as much as humans.

But he stresses the focus for a company like Ericsson is very much getting 5G right and if the industry achieves that over the next decade or more, there will be less pressure to move to the next generation. And he suggests that many of the ideas, potential applications and technologies that are now being discussed as '6G' will be included in advanced iterations of 5G.

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Security in Connected Cars

Imagination's Marc Canel, Vice President of Security, talks to New Electronics about connected vehicle security

Having recently joined Imagination to head up its security efforts, Marc Canel, VP of Security, spoke with New Electronics to discuss why, as more cars become connected and are fast turning into 'computers on wheels', the issues of security and privacy are now taking centre stage.

"There have been multiple advances in connected cars, and we will see more progress in the years to come as the driving experience changes even more," said Canel. "The car has moved from being a standalone device with limited electronics to a system that has Bluetooth, Wi-Fi and cellular connectivity. Most cars now integrate a GPS receiver and a satellite radio and with Apple CarPlay and Android Auto, the smartphone has become an integral part of the automotive experience."

According to Canel the smartphone is not just an 'adjunct device' that people have with them.

"It's fully integrated into the driving experience, with entertainment and navigation functions and it has its own independent communications capabilities. Multiple systems in the car have self-diagnostic functions that report their status over-the-air to a cloud-based operator, while some cars are able to automatically report an accident."

The advent of 5G will also bring in advanced autonomous driving functions with its very high speed and low latency capabilities and, as a result, the connectivity systems of the car will play an active role in vehicle to vehicle and vehicle to infrastructure communications.

"5G will become the fundamental enabler of autonomous driving," suggested Canel.

But, as cars become more connected, what new security issues does this introduce?

The more connections a car manages the greater the attack surface. The greater the number of applications processors and cyber tasks performed by the car, the more opportunities for weaknesses and vulnerabilities. The car is made up of multiple systems that cooperate in a network for the operations of the vehicle. Millions of lines of code are executed in a car and multiple connectivity systems interface with the outside world.

"Security issues range from basic safety problems such as the one demonstrated in the Jeep hack of 2015, to loss of privacy with smartphone applications tracking the activities and location of the user, to theft of the car through an interface," explained Canel. "As vehicles become autonomous, the security challenges increase with safety considerations, theft of the vehicle, privacy and theft of entertainment and guidance content."

Privacy issues

How about privacy issues - what should users be aware of?

"Loss of privacy can come from multiple angles. Location with built-in navigation systems, that have connectivity beyond a GPS receiver, could become vulnerable to sophisticated hackers. Upcoming systems in cars will track the user, their skills at operating the car, how they respects road laws, their level of attention and alertness, even a driver's mood.

"Regulators in some countries are looking into the automatic detection of alcohol consumption. All this information is personal data that can be legitimately used by the car system for safety purposes, or by insurance companies to offer discounts to good drivers and safe drivers.

"Cars will integrate payment systems for highways, entertainment content, traffic information, guidance systems as services on demand gain in popularity. Identity and payment materials on the users will all be available in the car," said Canel.

Private materials in a car can certainly be the object of attacks but at the same time, given the importance of the transportation industry and its intersection with other services such as payment, it is expected that regulators will define the framework for privacy of data.

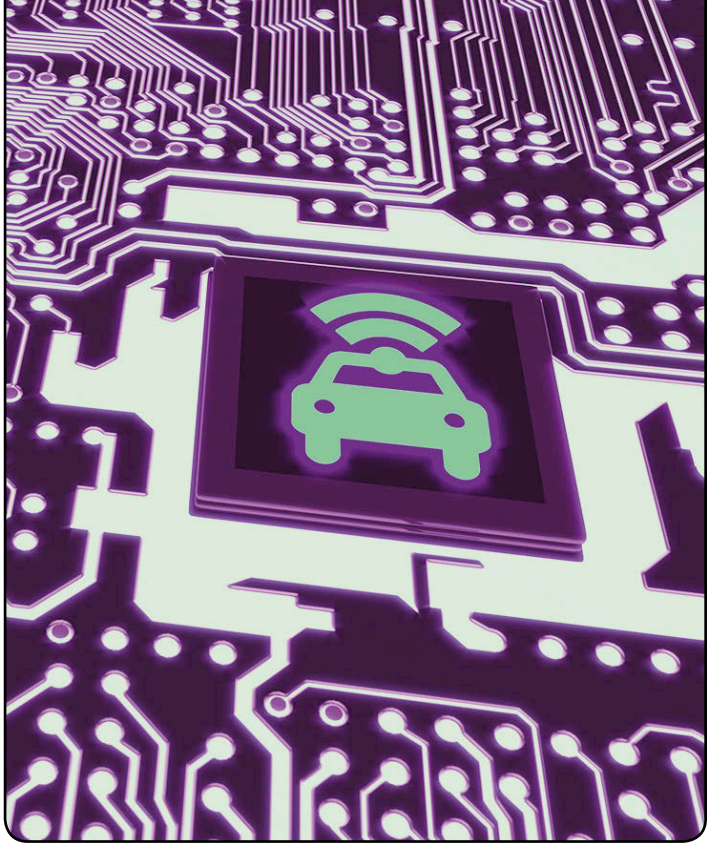
"Personal information that is closely tied to the user or to regulated services, such as payments, will have to be protected with levels of robustness that will be defined in legislation," explained Canel.

In this increasingly connected world, how will GDPR affect the automotive sector?

"The automotive sector will be very much the object of GDPR. Driving skills, driving patterns, location information, payment and entertainment choices are all information that represent the profile of an individual. This information is protected by GDPR regulations. The usage of some of the information by services providers such as insurance companies and others will be regulated. The data will have to be protected by the actors that use it and its analysis will have to be accepted by the user."

When it comes to manufacturers how are they dealing with these issues? What aren't they doing that you think they perhaps should be?

"Manufacturers will adjust their products and how they handle the metadata generated by the products on a local basis. As described earlier, privacy regulations play an important role in how personal



MARC CANEL

Marc Canel has extensive experience in both the IoT and mobile markets and at Imagination Technologies he is now working on the next generation of security architectures. Prior to joining Imagination, he drove Arm's security strategy for IoT security systems. He was also VP of software and security systems at Qualcomm, where he also worked on software ecosystem management. Before joining Qualcomm he worked at IBM for 12 years, where he held various product development and management roles in data networking products.

data gets protected and processed. Manufacturers will create architectures that meet the requirements of the local regulators, region by region, country by country.

"Some services will require loss of privacy and they will require a trade-off that the user will have to decide upon. For example, letting the insurer adjusts rates based upon driving patterns, behaviour and location may be an acceptable trade-off for some people.

"In other situations, the car will send metadata about its operations at the engine level. This will be very useful information to the manufacturer to prevent failures and warn the user of necessary maintenance."

One security issue is the risk when a car is sold and the new driver is able to access all of the same apps the previous owner used.

"The risk, in this case, is no different than when loaning a smartphone to a stranger. The seller of the car will need to go through a hard reset of all his applications and private data.

"Manufacturers should offer hard reset functions, removing the applications and the private data of a user when a car is being transferred from one individual to the next."

The impact of 5G

What will be the implications on privacy and security when autonomous vehicles with 5G capability become more mainstream?

"I expect that 5G will create opportunities for the car industry, most notably in the area of autonomous driving systems. 5G delivers the high-speed communications and the low latency that cars will need to operate as autonomous entities on busy roads.

"Whereas a car today is an anonymous entity in a large fleet of vehicles on a highway, cars with autonomous systems that take advantage of 5G will broadcast information about themselves to other cars and to the infrastructure. The car is no longer an anonymous entity, it operates as a living and moving entity within a network and it is connected to its neighbours and the infrastructure. In other cars, the car will always be tracked. Its precise location is an information in the system. It is correct that today, a driver can be tracked by smartphone, but there is always the possibility of shutting the phone off and escaping its tracking capabilities," according to Canel. "This will not be possible in an autonomous car as it will be required to broadcast its location at all times. Communications with the car through the 5G network, either for navigation purposes or other functions, will have to be protected by fast and robust cryptography and session level protocols between applications."

As for the future of connected cars and the role privacy will play in their development, Canel said that regulators will need to play a role in defining privacy frameworks.

"To a certain extent, they already do when they set up rules for payment data, privacy rules around the tracking of users watching entertainment content, the protection and usage of regulated airwaves. The car industry will inherit some of these, but new rules will be needed to protect the information on the usage of the vehicle when it comes to autonomous driving systems."

Sensing how to serve the **assembly line**

Smart factories rely on real world data from a plethora of sensors, **Alex Brinkley** discovers how analogue technology adds intelligence to industrial scenarios

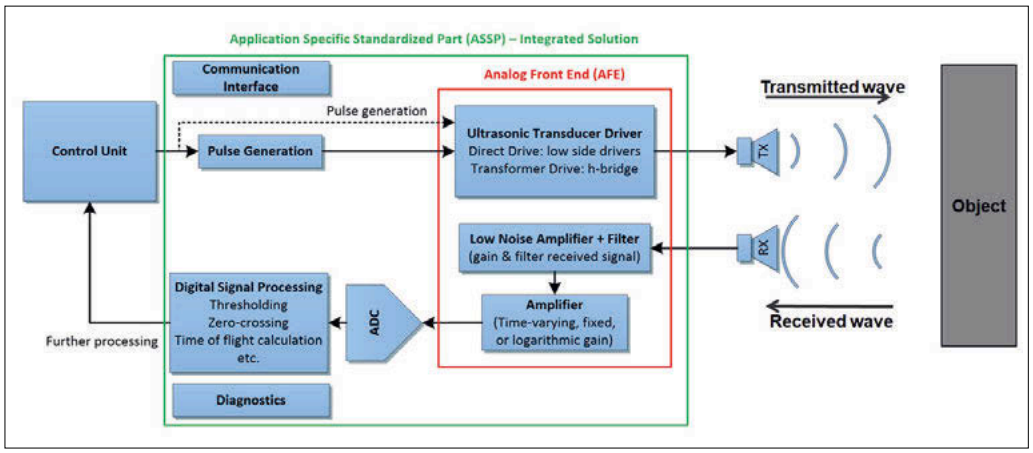


Figure 1: Block diagram shows the difference between an integrated (typically digital) solution and an analogue front-end solution.

The industrial landscape is changing. Increased automation and the Industrial Internet of Things (IIoT) are bringing intelligence across the connected factory. A report by Grand View Research earlier this year, estimated that the global IIoT market would be worth $950bn by 2025. It attributed a predicted 29% CAGR between 2019 and 2025 to the reduced cost of sensors and data analytics software.

The sensors used in these industrial scenarios are binary or analogue. Binary, or digital, sensors show two states, on or off. Analogue sensors are more nuanced.

"With an analogue sensor, you are tracking very fine grain, real-time data. The real world is analogue," reasoned Jeff DeAngelis, Marketing Director, Industrial and Healthcare Unit, Maxim Integrated. "We don't typically operate in a one-zero world," he added.

For Mubina Toa, Product Marketing Engineer, Current and Position Sensing Group at Texas Instruments (TI) analogue sensors are more flexible. "Digital sensors, typically, are more integrated and provide extensive signal processing capabilities, whereas solutions designed for flexibility provide an analogue output, allowing for more customisable processing by a microcontroller (MCU)," she explained.

Will Cooper, Marketing Director for TI's Temperature and Humidity Sensing Group, believes the difference between an analogue and digital sensor is essentially integration of an ADC. "Full integration of digital sensors can enable a smaller overall solution and better accuracy, due to no reliance on outside components to translate the sensor measurement to a digital signal. On the other hand, analogue sensors enable more flexibility and smaller component size. Since the customer is separating the sensing element from the ADC, it enables more layout flexibility as the sensor can be smaller and potentially closer to a heat source, and then simply be connected to an ADC elsewhere."

"With an analogue sensor, you are tracking very fine grain, real-time data. The real world is analogue. We don't typically operate in a one-zero world."
Jeff DeAngelis

Analogue sensors are also easy to implement. "The linearity and thus simplicity of implementation… also drive customers to replace NTC (negative temperature co-efficient), thermistors with these types of sensors in order to achieve better performance," advocated Cooper. In some areas applications rely on 'good enough' temperature measurements, necessitating the use of NTC thermistors.

Analogue sensors are also limited in very high temperature environments. "Even in a ceramic package, 200°C is the highest temperature supported by TI temperature sensors. Most only reach 125 or 150°C. This limits the ability of analogue temperature sensors to replace resistance temperature detectors (RTDs) going into very high temperature environments," he said.

Sensor types and functions

The industrial environment – manufacturing, food and beverage and assembly lines – typically requires 24-bit sensors, what DeAngelis calls "very fine, very accurate measuring of temperature in the real world". This is in contrast to building automation, where monitoring the temperature of an office environment, typically requires a 12- or 16-bit accuracy.

Mainstays of analogue sensors

are temperature and pressure sensors, together with proximity sensors, said DeAngelis.

Temperature sensors can be used to monitor the temperature of a mix or liquid and can also monitor the health or status of a piece of equipment. For example, it ensures a motor does not overheat, which can cause damage to equipment and result in expense repairs and delay production.

"We continue to push sensing technology and accuracy to new levels, but this really does bring trade-offs with it," said Cooper. "Can you narrow the guard banding of a system in order to keep it running longer as the temperature rises without damaging the system? With higher accuracy, you can, but it requires a more costly analogue temperature sensor and ADC."

Some analogue sensors have a digital output. For example, time of flight (ToF) sensors measure distance based on the time it takes for a wave pulse to travel to and reflect off an object and return to the sensor. The precision allows systems to make smarter decisions, says Karthik Rajagopal, Systems Engineer for TI's Medical and Imaging group.

"A good example in industry 4.0 is AGV (Automated Guided Vehicle), or warehouse robot navigation systems. With an integrated ToF sensor the AGV can be autonomous in its navigation. With precision distance measurements from ToF sensors, robots are aware of their surroundings and obstacles, so they can react by slowing down, stopping or navigating around the obstacle, making the system more efficient and safer," he said.

Ambient light sensors also have a digital output. They continuously measure light levels for appropriate settings, such as high above work benches, and lower in less frequently used areas, to improve energy efficiency.

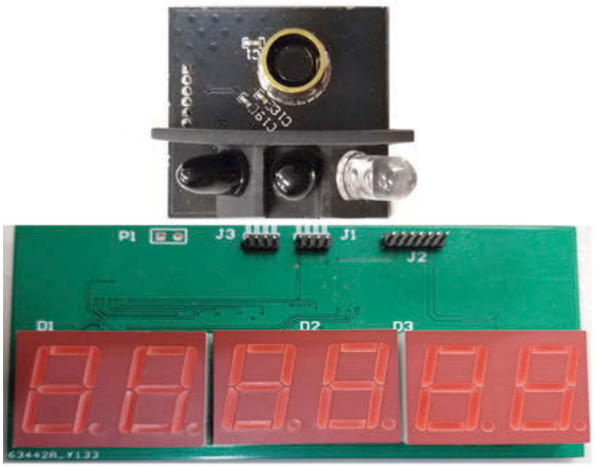


Figure 2: To support adoption, companies provide tools for development, such as this OPT3101 ToF system evaluation module.

Rajagopal continued, "Although the output is digital – with several digital bits, typically binary weighted, representing the measured value,– they represent a continuous analogue measurement of the measured parameter."

Analogue ultrasonic sensors are also prevalent in factory automation. They measure distance by calculating the distance for sound waves to be reflected back and can be are used as position sensors to count products or liquid levels . Contactless sensors are commonly used in the food and drink industries for bottling lines and food safety applications.

Using sound waves means that ultrasonic sensors can detect the presence and proximity of objects. They can differentiate shapes – sound waves reflect directly off flat objects, producing a stronger echo, whereas curved ones disperse the sound waves – but not colours.

Photoelectric or optical sensors are simple electromagnetic sensors that detect if there is a break in the link between the receiver and transmitter. They can be used to protect an operator in a shielded area, to signal that a gate has been opened.

The difference between photoelectric and optical sensor is distance; a few centimetres for the former and from 10 to 100m for an optical sensor.

"Digital sensors are more integrated and provide extensive signal processing capabilities, whereas solutions designed for flexibility provide an analogue output, allowing for more customisable processing by a microcontroller." Mubina Toa

Adding intelligence

IO-Link is a standard for Single Drop Communication Interface (IEC-61131-9). It brings a two-way communication that enables a traditional analogue sensor to gather data while also allowing its settings to be changed remotely, based on status updates.

"Historically, sensors have a lot of information but it is usually just one way," DeAngelis explained. "With IO-Link, you have the ability to talk back to it. Now, you don't have to have a technician reconfigure the sensor for a different product that you want on the same assembly line."

There is also the ability to extract more data. He continued, "With IO-Link sensors, you are now able to focus on a specific set of data that may help you with generating data that an intelligent algorithm could interpret, to improve efficiency as the product flows through the factory."

Industrial future

The hunger for intelligence to make industry lean and efficient is expected to continue. "Decentralised local sensing is driving the industry to make systems smarter and more autonomous," confirmed Rajagopal. "In examples like AGV/robotic navigation or smart lighting control, having independent autonomous systems in factories and industries helps save on cost and creates a compelling case for faster adoption."

"What everyone is trying to do is push intelligence to the edge, as per industry 4.0," continued DeAngelis. "Companies in the IC world are doing that via diagnostic tools, or the ability to extract more information with IO-Link technology. Because of that, we can make more real-time decisions right at the edge, where it is potentially mission critical."

Enhancing design flexibility

Why discretes tend to win out over ICs when it comes to designing 'folded cascode' charge amplifiers. By **Tolga Aydemir**

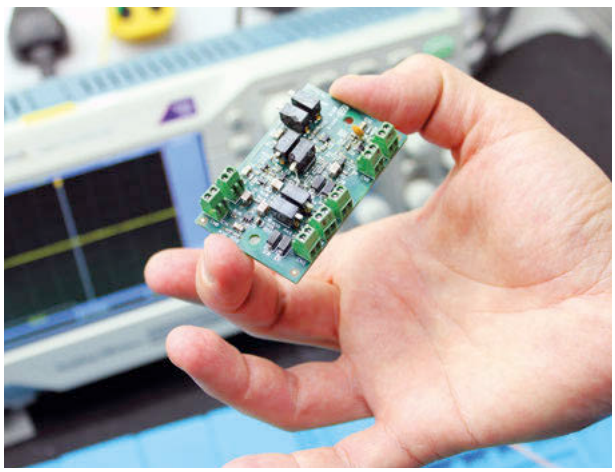
Integrated circuits (ICs) are vital in helping to reduce the cost, size and development timescales for many analogue designs. But they can have some significant drawbacks too, such as increased noise and crosstalk, reduced temperature coefficient performance and most importantly, ICs can restrict design flexibility.

Whenever designers are working on high performance applications, such as high-end audio amplifier front ends, medical imaging systems or specialist scientific equipment, they tend to opt for discrete designs to help overcome these limitations. For example: the current sources, sample and hold, and pre-amplification functional blocks within the analogue front-end circuits of a 7 ½ digits bench top multi-meter are almost always designed partially or fully discrete to achieve the highest dynamic performance and the lowest noise.

Despite their potential to improve system performance, most designers avoid attempting to design with discrete components because of the engineering challenges and time involved in using them. These devices require a deep understanding, experience and creativity in electronics and physics, and can also add considerably to design and development timescales and costs compared with integrated solutions.

As a result, many designers steer clear when it comes to complex discrete circuitry, even if it means reduced performance in the final product.

Signal amplification is one of those key areas where discrete solutions almost always win over the use of ICs because they are a much more effective way of achieving very low



noise amplification. For example, the input stages of many high-end audio amplifiers are typically made using fully discrete or hybrid circuits.

Discrete circuits are also extensively used in sensor signal amplification and conditioning where low noise is crucial. In the case of piezoelectric charge output sensors, they are often employed within sensors for dynamic measurement applications such as accelerometers and hydrophone transducers, and where two alternative circuits are typically used for signal conditioning: a voltage mode amplifier circuit or a charge mode amplifier circuit.

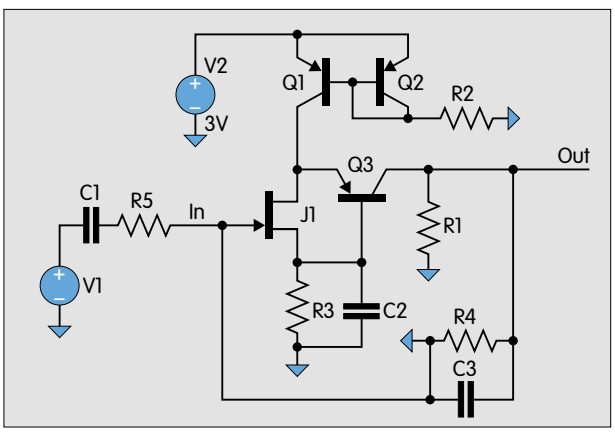


Figure 1: Folded cascode amplifier

Voltage mode amplifiers are capable of linear operation at high frequencies. However, they have a noise floor which may be an order of magnitude higher than the equivalent charge amplified solution. For this reason, low noise high resolution charge amplified sensors are typically used for low amplitude dynamic measurements. Charge mode amplifiers are also routinely employed for amplifying signals from semiconductor detectors, such as photoelectric detectors used for industrial manufacturing applications.

Target parameters

There are three key target parameters within a charge amplifier: low input capacitance, low noise and low input leakage current. In general, op amps have a combination of higher noise and input capacitance when compared to discrete JFETs. For example, the typical input capacitance of a standard FET input op amp may be about 20pF, whereas many discrete JFETs have input capacitances of less than 5pF. Paralleling up a few low noise JFETs can result in an equivalent input noise voltage density lower than any IC can achieve, while at the same time low noise JFETs have the added benefit of often exhibiting low input gate current.

JFETs have relatively high output capacitance which limits the bandwidth but a cascode circuit can be used to overcome this and to achieve higher bandwidths without intermodulation distortion. The cascode topology does this by eliminating the Miller effect that can multiply the effective gate drain stray capacitance and its associated nonlinear effects.

Using a JFET and a cascode

topology in a discrete circuit requires a current source and biasing arrangements which increases component count and cost. But it gets even more complicated if the circuit needs to be used within a battery operated portable appliance: where low voltage operation and low power consumption are essential, and the design needs to remain stable and consistent across the operating temperature range without any significant performance degradation.

Figure 1 shows the proposed solution for a charge mode amplifier that uses a method of integrating a discrete current source within a "folded cascode" topology.

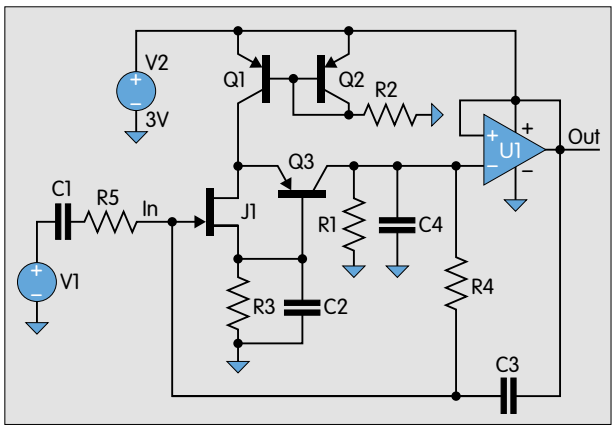
Using this particular implementation of the topology provides a wider voltage swing and incorporating a current source enables low voltage operation. Depending on the JFET selected, the circuit can easily run as low as 2.5V making it feasible to operate from a single lithium thionyl chloride battery cell. The example circuit shown runs at 3V and provides 2.4V output voltage swing before the output starts clipping.

The core of the design is formed around a low noise JFET in a folded cascode circuit. JFET J1 and pnp transistor Q3 together form a folded cascode amplifier. Transistors Q1 and Q2 are configured as a current source to provide a high impedance fixed current source with a large voltage swing. Q1 provides fixed current into J1 and Q3, which is determined by R2 as well as the operating voltage.

Resistors R3 and R1 play a key role in controlling current flow through Q3 and setting biasing points for J1 and Q3. R3 together with C2 creates a biasing point for Q3 and J1, while J1's biasing point also depends on R1.

Using this interlaced biasing approach helps to reduce component count and simplifies the circuit.

Figure 2: Folded cascode amplifier with op-amp buffer



Although the current flowing through the circuit is almost proportional to the operating voltage, the performance is not affected within 2.5 to 5V voltage range. The feedback loop is created from the output of Q3 and routed back to the J1 input via C3 and R4.

However, introducing an IC to create a hybrid version of the circuit can deliver further benefits including design simplification, reduced output impedance, increased bandwidth or improved reliability.

Figure 2 shows one potential implementation where adding a standard low cost and low power op amp IC to the output stage can reduce output impedance and increase bandwidth. This op amp, typically costing a few cents, has a standard noise density so its noise contribution is negligible as it has unity gain; and C4 is required to increase stability of the circuit and prevent oscillation.

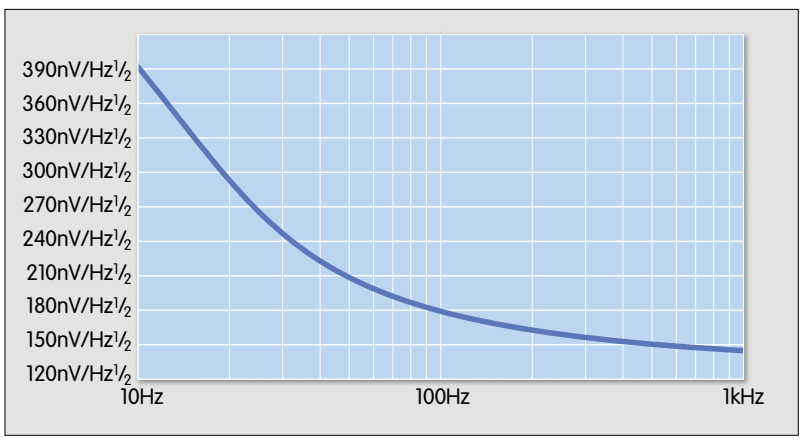


Figure 3: Output noise spectral density

The final circuit as shown provides 34dB gain in the 10Hz to 4kHz range and achieves 5µV output noise for the same frequency range, while consuming only 0.2mA from a 3.6V source (e.g. a lithium battery). Figure 3 shows the output noise spectral density for the design.

The total BOM cost for the hybrid circuit is still low, at around US $0.3 for 10k manufacturing volume: whereas any alternative solution taking a fully integrated approach would either have a higher BOM cost or require higher power consumption for the same output noise performance.

The circuit which has been developed can be used in a variety of applications where low noise, low cost and low power are all essential requirements. However, as it has been designed with discrete components it can also be easily modified depending on the application. For example: increasing the power consumption and paralleling up multiple low noise JFETs can significantly reduce the output noise.

The input referred noise of the circuit is currently around 3nV/√Hz at 1kHz but it can be lowered down to 0.5nV/√Hz using these techniques.

Different methods can also be applied to help further reduce power consumption if required, and to exploit the inherent flexibility within the circuit that would be almost impossible to achieve with a design relying solely on the use of ICs.

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EuMW highlights new frontiers for 5G

With the roll-out of 5G a reality, this year's Microwave Week focused on technologies suitable for large-scale production. By **Helen Duncan**

This year's European Microwave Week in Paris was dominated, as it has been for the past few years, by the latest components and test technology that are enabling 5G. The key difference this time is that 5G networks are now a reality in many countries, and the focus has moved to technologies suitable for large-scale production.

This is a particular challenge in the new mmWave frequency bands, where volume requirements have been much lower up to now. It has also highlighted the need for high-capacity backhaul in all its forms, including wireless links that are an economical and easy-to-deploy alternative to traditional fibre, and these are now moving up in frequency to E-Band and beyond in the quest for greater bandwidth.

In response to the need to connect areas of the world that are still off the map for mobile communications, there is also a growing emphasis on exploiting space, which is proving to be the 'final frontier' for 5G and backhaul.

Among the key enabling technologies for both 5G and mmWave satellite communications are phased arrays and beamforming: advances in respect of the design, and also in addressing characterisation challenges, of this technology were prominent both in the conference and on the show floor. The number of antenna elements in a beamforming array, and their proximity to each other, also place demands on the power efficiency and thermal characteristics of the transmitter power amplifiers (PA), so advances in the design and packaging of GaN PAs and front-end modules are also increasingly in the spotlight.

Space

The satellite market was explored in the Defence, Security and Space Forum, where Eric Higham of Strategy Analytics said that all satellite applications are growing rapidly, and by 2028 commercial applications will account for 80% of a satellite market that will be worth a total of $94bn.

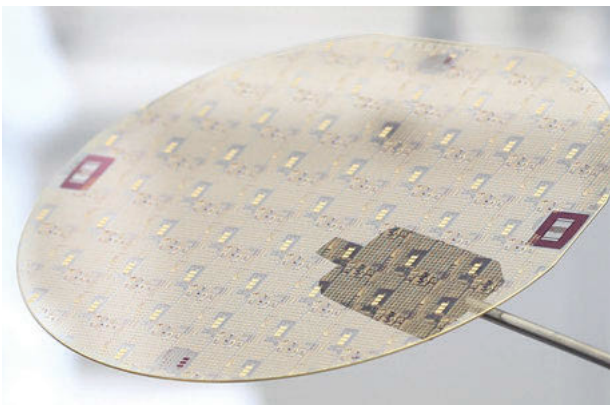

Figure 1: The new UMS 0.15µm GaN HEMT process is optimised for high power, efficiency and linearity up to 35GHz

5G is the main driver for this growth – in 2029, mobile satellite traffic is forecast to be around 370,000PB per month, 30 times greater than that in 2017, and around 2.6 times greater than the yearly traffic figure for 2017.

The Forum addressed the application of RF and microwave technology in extending the mobile Internet into space. Recognising that vast areas of the globe have little or no Internet connectivity, attention is focused on a new class of satellite communication services that use platforms ranging from LEO to GEO satellites.

The distinction between military and commercial satellites is becoming blurred too, with some platforms offering dual-use capabilities and being financed by a combination of public and private funds. Skynet, for example, is operated by Airbus Defence and Space on behalf of the MoD, an arrangement that will continue with the recently-placed Skynet 6A contract. According to Higham, just one of the satellites in the latest ViaSat-3 GEO constellation will carry 1Tb/s of data – as much capacity as all the satellites currently in orbit put together. ViaSat-3, which is co-funded by the European Space Agency (ESA), is intended to provide 100Mb/s Internet connectivity to users.

Going forward with GaN

France has a particularly strong indigenous microwave semiconductor manufacturing sector. UMS, a compound semiconductor manufacturer with a fab in France, launched its latest GaN process at EuMW, a 0.15µm GaN-on-SiC HEMT process optimised for high power, efficiency and linearity up to 35GHz.

The GH15 process (Figure 1) is targeting mmWave applications in point-to-point radio, 5G, satellite communications, radar and high-reliability products. It is specified with a power density of 3.5W/mm at 30GHz and 20V drain supply. The GH15 device library includes a set of models of transistors for high-power and low-noise amplifiers, switches and Schottky diodes, and the process design kit (PDK) also includes electro-thermal and noise models.

OMMIC, another French compound semiconductor vendor, is currently expanding its 6" GaN-on-Si line to meet the growing demand for mmWave components for 5G and automotive applications. On its exhibition stand, OMMIC was demonstrating the performance of the CGY2651UH/C1 GaN 10W power

amplifier MMIC under modulated wideband signal stimulus, operating over 37 – 43 GHz.

The PA has 30% power added efficiency at saturated output power and at 40GHz, and is suitable for radar, 5G and space applications. Error Vector Magnitude (EVM) and Noise Power Ratio (NPR) measurements were performed under non-linear conditions using a Keysight Technologies S93070xB Modulation Distortion Application embedded on the PNA-X Network Analyzer.

Despite the emphasis on GaN, there was a reminder from Netherlands-based Ampleon that a significant proportion of sub-6GHz 5G base stations are still using LDMOS (laterally diffused metal oxide) amplifiers, due to their cost-performance ratio.

On display was a 5W integrated Doherty LDMOS amplifier with 33dB gain for 3.4 – 3.8GHz 5G massive MIMO applications. The company also launched a new line of ceramic- and plastic-packaged 12V transistors targeting commercial, public safety and defence mobile radio applications from 2MHz to 941MHz. With 25W and 55W outputs, they offer 18dB minimum gain and greater than 65% efficiency across all bands.

Addressing the need for wideband measurements up to 110GHz to enable the development of mmWave 5G, backhaul, satellite communications and radar applications, Keysight Technologies was demonstrating over-the-air (OTA) measurements on a 28GHz 8 x 8 cross-polarised beamforming array, using the latest single-box multi-channel functionality that has been added to its UXR-Series of oscilloscopes.

The UXR-Series oscilloscopes enable dynamic wideband analysis up to 110GHz, with the ability to configure optional 5GHz or 10GHz analysis bandwidth windows. It uses Digital Down Conversion (DDC) analysis, which removes the need for downconverters that would otherwise impair test results. EVM accuracy is below 0.6% for 5G new radio (NR) FR2 tests, and 1% for 802.11ay (WiGig) measurements, meaning that EVM measurements now reflect the true performance of the device under test (DUT), without any impairments caused by noise in the measurement system.

Once 5G is deployed in the field, lightweight portable instruments are needed for validation and troubleshooting. Anritsu's Field Master Pro MS2090A is a real-time handheld spectrum analyser with continuous frequency coverage from 9 kHz to 54 GHz.

Demonstrations at the Show included its use as a test tool for the rollout of both sub-6GHz and mmWave 5G NR, and also for compliance testing.

The Anritsu Spectrum Master MS2760A portable spectrum analyser series was also on show, with an extended broadband frequency coverage over 9kHz – 170GHz,

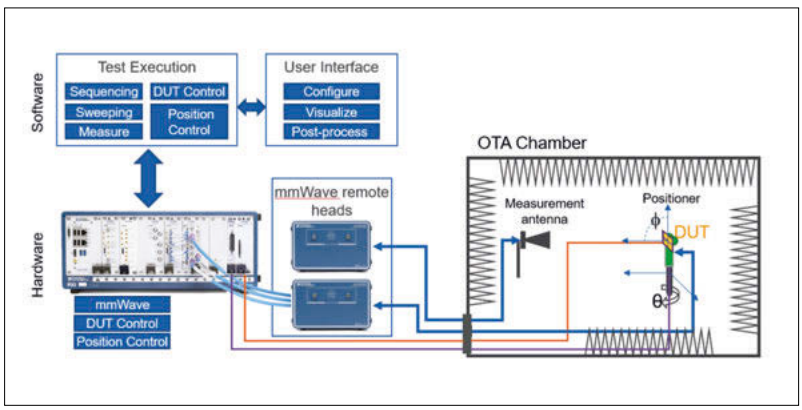

Figure 3: Diagram of NI mmWave OTA Validation Test reference architecture components

Figure 2: Anritsu's latest Spectrum Master MS2760A 170GHz portable spectrum analyser

along with a new series of higher sensitivity models, the Spectrum Master MS2762A, which has a noise floor down to -141 dBm in the range below 90GHz. This allows accurate spectrum mask testing of mmWave point-to-point radios during production, and is also suitable for measuring automotive radar, and applications above 110 GHz that include object detection radar, radio astronomy, and high-resolution military radars.

Design and production of 5G mmWave devices demands new test regimes, and with beamforming it is essential that this is performed over-the-air. National Instruments (NI) was demonstrating a newly-launched PXI-based test system capability to address this need. The 5G mmWave OTA Validation Test reference architecture is designed for the characterisation and validation of 5G mmWave beamforming Antenna-in-Package (AiP) devices.

Using real-time motion control combined with PXI triggering and synchronisation, the integral Vector Signal Transceiver (VST) acquires fast, high-bandwidth RF measurements synchronised with the instantaneous polar coordinates of the positioner's motors.

Because this approach moves the DUT in a smooth, continuous motion across the 3D space while the taking the measurements, it is much faster than a conventional OTA test setup that moves discretely from point to point. 3D spatial sweeps in the 5G mmWave bands from 24GHz to 44GHz, with thousands of points, can be executed in seconds rather than hours, shortening development schedules and improving accuracy when testing beamforming performance with complex 5G NR signals.

The system, shown in Figure 3, includes an isolated RF chamber for true far-field radiated testing in a quiet environment, and mmWave OTA Validation Test Software.

INFORMATION IS POWER

Board-level design is reaching out to the supply chain, as **Chris Edwards** discovers

It remains a cliché of electronics that the connection between design and manufacturing is a brick wall. But that wall is beginning to break down as companies try to streamline production and avoid being stymied by sudden inventory problems and test failures. One big area that is changing is how the design team puts together the bill of materials (BOM) and making purchasing-based decisions much earlier in the process.

"There are a lot of reasons as to why engineers need supply-chain input early on," says Daniel Fernsebner, product marketing director for PCB products at Cadence Design Systems.

To the designer, a specific manufacturer's part may look to be an obvious choice based on its datasheet. But an examination of price breaks for different volumes and likely availability may well cause them to select an alternative. Obsolescence remains an ongoing problem.

"The particular component that you are looking to use: its lifecycle status is good today. But tomorrow it's not. Traditionally, we have had to have purchasing look at what are the buying trends are. If the buying trend is heading downward, it's often a good indication that it's not the part you want," explains Fernsebner.

Leigh Gawne, chief software architect at Altium, says: "Getting lifecycle status information is one of the bigger problems in the industry. The end-of-life notifications often don't make it to the right people. We need a way to get the information where it needs to get."

In other cases, supplies can simply run dry during production because of sudden inventory shortages with the manufacturing line unable to select an alternative because they do not have the power to make a change even though, for passives and similar multi-sourced components, other options often exist.

Joe Bohman, senior vice president of lifecycle collaboration software for Siemens Digital Industries Software, says there are clear opportunities to build closer links between contract manufacturing and design following the integration of PCB-design subsidiary Mentor's tools with the Teamcenter product-lifecycle management (PLM) software. He claims: "Customers want the contract manufacturers to get right in and make modifications in a controlled way."

Under this new process, the contract manufacturers would, in PLM parlance, "red-line" parts of the design to replace components with alternatives they believe would be better or simply let them avoid production delays. However, there can be knock-on effects of such course corrections.

"Getting lifecycle status information is one of the bigger problems in the industry. We need a way to get the information where it needs to get."
Leigh Gawne

Questions around substitutions

Hemant Shah, product management group director for PCB tools at Cadence, points to changes in reliability that might come with a substitution.

"Correlating a change back to design data is an important step: customers are very interested in that. A customer may use one supplier's part in a batch and order a different one for the next, assuming the equivalent part would not impact the design. But the change could impact the reliability of that product.

"We are seeing customers asking to have the real-time ability to bring that information back into a change and analyse it."

EDA vendors have taken the first steps to closing the circle with manufacturing by building links to live supply-chain data into the PCB schematics-capture and layout tools.

The ActiveBOM facility in Altium

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365, launched at the beginning of the year, has a three-tier model for each component instance. The CAD component has symbol and footprint.

"All we care about with his is the design intent," says Gawne. "There could be many manufacturer parts that meets those specifications. The physical part we call the manufacturer component. It's a one-to-many relationship that allows us within ActiveBOM to have secondary and tertiary parts where multisourcing is possible. You can rank them: it could be lowest cost or the one that's most widely available, or let the EMS decide which one. The third type is the supplier component, which represents the supply chain: where can I go to get that manufacturer part?"

Cadence is using an approach it calls BOM validation in the Pulse platform that it has built into the latest releases of its PCB tools. This checks the availability of components the design team has picked. One issue with live supply-chain data is that it changes rapidly, says Fernsebner. The company is looking to incorporate ways to model supply-chain patterns. "Making a better choice off of predictive analytics is where we're going with Pulse."

Similarly, Altium sees the use of historical data as being a useful guide to availability over the course of a product's lifecycle. "That's not in the system right now but it's something that will come."

Designers could head off supply problems through the use of defensive planning.

"When searching for a part you could type in a part number or do a faceted search, based on case type, tolerance and other factors. If you end up choosing something with specific characteristics and only get one or two results that implies there aren't too many of those parts around," says Gawne. Subtle changes to a filter circuit that allows for a different tolerance band could open up more possibilities that loosens the constraints on the supply chain.

The EDA vendors see the process data that comes back from manufacturing as becoming a bigger influence on design. As with supply-chain intelligence, the issue is one of information flow. "That kind of thing is coming back informally through a phone call or email. But does it make it back to the designer? We will see an improvement in that formal feedback," says Gawne.

Dan Hoz, general manager of Mentor's Valor division, says he sees the potential to take this manufacturing data back to design. The design-for-manufacturing (DFM) analysis that some companies already use to minimise the impact of things like solder-paste issues will help, often by respecting keep-out zones and overlaps to account for variations.

Hoz, however, sees further optimisations in the way in which manufacturing can influence design. The orientation and neighbourhood around a component may influence the failure rate and this information will appear during inspection and test. This information is today being used to tune the assembly processes.

Manufacturing analysis can highlight components that are more prone to failure during assembly than others. Hoz points to the problem he sees frequently where the way in which boards move around the shopfloor can cause problems.

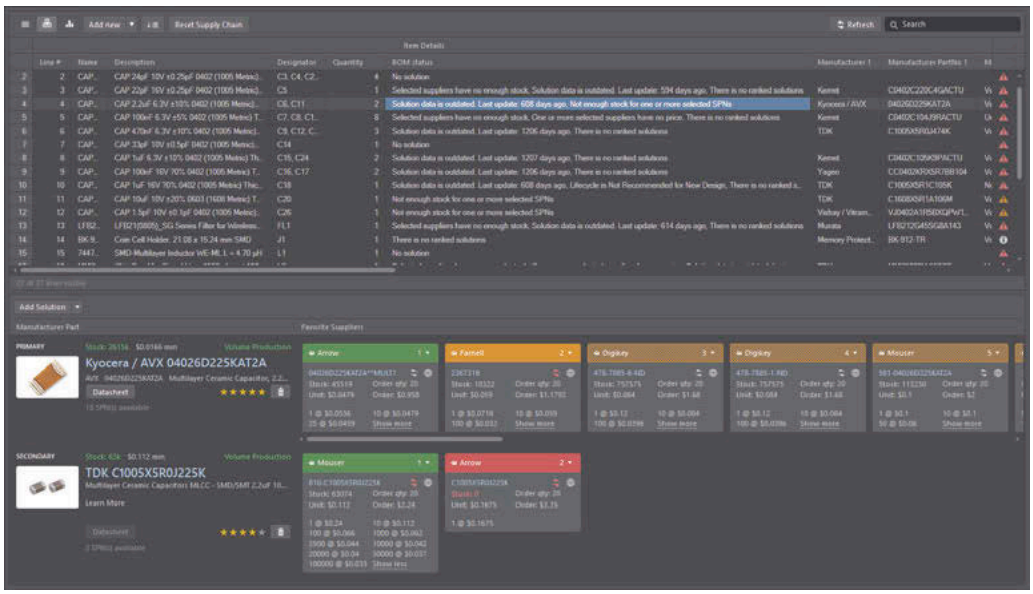
"You have the issue of sensitive components: there are components that can only survive for a few hours outside but we find them sitting on the line for days."

Subtle changes to the PCB layout may be able to reduce that wastage further. The problem may be the choice of component or it may be one that can be addressed by changing the layout of the board to make it easier to mount the more sensitive devices later in the process or by taking the step of moving to a different facility if the reason why the boards are getting held up is due to bottlenecks forming.

Hoz says the use of a digital-twin approach for storing data about board designs and production outcomes will help reduce waste.

"Using the metrics we can go back to the design and run some course corrections," he says, adding that the software is not ready yet but it is something the company is working on. The feedback may, ultimately, go back to component manufacturers if it turns out materials choices lead to unexpected failures after assembly.

After decades of living apart, design and manufacturing are gradually getting to know each other better.



Below: Altium's ActiveBOM facility 365 provides a three-tier model for each component instance.

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5G and the security challenge

5G brings seemingly endless possibilities, but **Alex Farrant** warns that the right cyber security measures are just as important

The last few years have seen multiple critical remote vulnerabilities in mobile handsets, with the potential to affect millions of users, but the impact was mitigated by legacy walled garden designs. Take the 2019 Apple iMessage bug or the 2017 Samsung SMS bug, which could be leveraged by attackers to target an Apple iPhone or Samsung Galaxy handset if the victim's number was known.

If an attacker doesn't have the number but wanted to target every device in an organisation, they would either have to get access to the closed signalling network or establish their own fake base station. Both options are complex, expensive and require substantial specialist knowledge of cellular air interfaces and arcane signalling protocols like Stream Control Transmission Protocol (SCTP).

Security researchers looking for vulnerabilities in mobile basebands and user equipment (UE) such as handsets and tablets for example, must invest a substantial amount of effort in supporting infrastructure to be able to test a device 'over the air' (OTA). As a minimum, a researcher would need high end radios, a GPS timing source, spectrum licensing, protocol stacks and for 3G/5G testing, programmable SIM cards to get past the mutual authentication.

This substantial requirement list is why cellular vulnerabilities aren't more common. It doesn't mean they aren't there, it's just that they're beyond the reach of most. In our experience, cellular interfaces are less scrutinised than Wi-Fi/IP for example, because they're harder to reach.

Removing the wall

The flatter design of 5G networks will remove many barriers to cellular security testing; in particular the air interface which will lead to increased security focus on this previously opaque and remote interface.

However, more attacks on the cellular side of user equipment are anticipated with the onset of 5G. This is because the walled garden architecture of cellular networks up until now largely shielded UE from external security because they connect to the world via a gateway, which uses Network Address Translation (NAT) to prevent attackers from accessing them directly.

From our experience in OTA testing, we have seen weaker than standard software security on cellular interfaces because the OEMs shirk responsibility for traffic security and label this the obligation of the network, which, until 5G, was true. There is an unhealthy degree of ignorance among integrators, especially around traffic security, as it is common knowledge that cellular traffic has been encrypted since the 90s. But there's far more to cellular security than protecting signals from eavesdroppers. The previously listed SMS exploits operate several layers further up the Open Systems Interconnection (OSI) model and have no concept of encryption or even physical medium as they can be delivered via GSM, UMTS or LTE.

"The flatter design of 5G networks will remove many barriers to cellular security testing; in particular the air interface which will lead to increased security focus on this previously opaque and remote interface."

With 5G's decentralised design, the technology will be opened up to scrutiny by a much wider range of threat actors. For example, an intelligent, low budget and amateur hacker with the skill to crack software might lack the budget for cellular testing equipment but will be able to afford a budget 5G picocell. This will then give them a route to 5G devices for cellular security testing.

Cellular software stacks could easily go from being the least scrutinised interface to the most scrutinised, as the barrier to entry is lowered and they are forecast to handle the most traffic in the future.

Super botnets

As 5G technology is designed for dense Internet of Things (IoT) networks in the order of 1 million devices per square kilometre, the sheer number of projected and insecure devices using 5G means an exponential increase in attack surface and potential vulnerabilities. The size of botnets (networks of devices that have been compromised and are controlled to some extent by malicious software – aka 'zombies') is likely to

increase, given the scale of the future IoT; Gartner is predicting more than 20 billion connected things by next year and if recent experience with IoT security is anything to go by, they will be largely insecure.

As a result, Denial of Service (DoS) and Distributed Denial of Service (DDoS) attacks are increasingly likely to be a focus for malicious activity. One of the core features of 5G will be the dynamic re-allocation of resources, especially bandwidth. This may be a great feature when a 'flash' crowd appears in a specific location, but at the same time it could be 'rocket fuel' for botnets and the extra bandwidth allocated to them could exacerbate the impact of a DDoS attack.

The fact that many UE devices will be opened up to more intense scrutiny, means that we can expect to see botnets appear in more unusual places. For example, imagine a future firm with a fleet of robots, staff with wearables, smart vehicles and a smart building, all connected, for convenience, to a private cloud. Prior to 5G, these devices would co-exist on distinct mediums via 4G, Wi-Fi or LPWAN.

As 5G is forecast to become the dominant method of wireless communications, not only will many eggs be placed in one basket, but they will be reachable from one another. Once just one of these devices is compromised, dozens more are then reachable. Fixing this kind of scenario would be an enormous undertaking, which is exactly why the security of UE devices and the cloud infrastructure will be critical.

Responsibility and risk

5G will see a move from a walled garden monolithic architecture to an Infrastructure-as-a-Service (IaaS) model where key components will not be owned by the network operators. This change underpins the 5G tensions between nations regarding the risk of espionage. The reason for the change is capacity. No single operator can support the quantity of devices forecast, so an elastic infrastructure service is needed. This will mean operators relinquish control, which will pass into the hands of router OEMs and middleware service providers. New technologies, like Software Defined Networking (SDN) and Network Function Virtualisation (NFV), will enable infrastructure to be more flexible and opaque than the brittle cellular network designs that we are currently used to.

The responsibility of tackling security problems, as well as botnets on IoT devices, will be diluted due to shared infrastructure and is likely to be delegated to the UE OEMs who to date have not had a good track record for endpoint security.

While the flexibility and potential are huge, so is the risk if the underlying infrastructure were to be compromised. By virtualising functions like SMS or voice calls, multiple functions will share a single point of failure – the hypervisor on which they are hosted. In the event of an attack on a hypervisor or hosting environment all 5G functions could potentially be compromised or disappear simultaneously, which would be worse than current outages which typically affect a single function like the May 2019 EE 'voice only' outage and the day long O2 'data only' outage.

"An intelligent, low budget and amateur hacker with the skill to crack software might lack the budget for cellular testing equipment but will be able to afford a budget 5G picocell."

These outages describe hardware failures in brittle systems, dedicated for one function – which isn't an entirely bad idea when you run critical systems as despite the failures, EE customers could still text and O2 customers could still make calls.

Precision geo-location for attackers

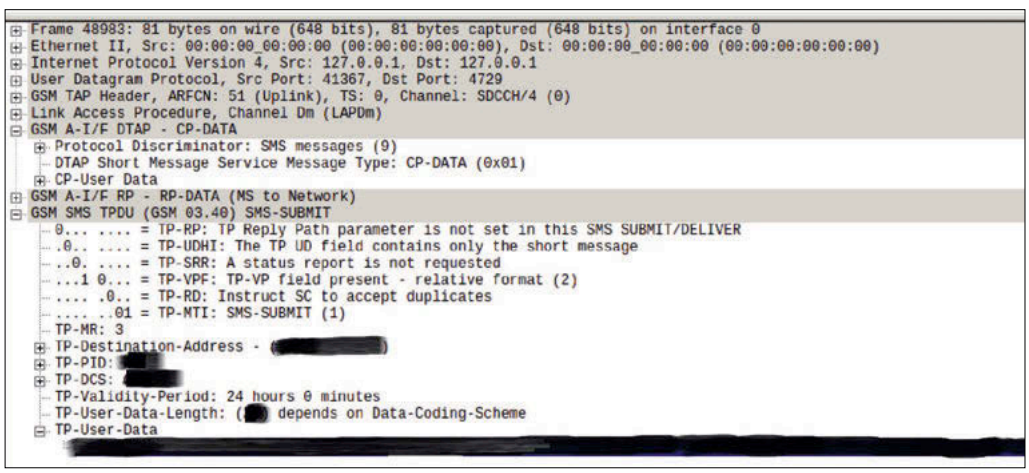
The erosion of anonymity is another concern. 5G precision could reveal the specific floor within a building a device is located on, because the macro cells used in deployment are substantially smaller than in cellular networks.

By design, each base station has a unique ID, so if you can find the base stations near or inside your target on the 5G network, much like a home router, you can begin to enumerate devices attached to it.

Using a watering hole cross-domain attack, a device from an unreachable private network is lured to an external website where its browser is tricked into scanning and reporting identifiers for adjacent devices on the internal network. This technique is used against IP NAT networks already and 5G will be no different due to abstraction.

The precision available, if abused by malware either on the UE or at the network level, would present an increased risk as amateurs could perform precision targeting of organisations and users remotely, which would need mitigation by end point and cloud security solutions. Mitigating the risk through solid defence-in-depth principles and security testing of products is recommended to reduce the risks associated with an increasingly egalitarian – and opaque – 5G architecture.

Author details:
Alex Farrant is a senior researcher at Context Information Security



A REVOLUTION IN **GAMING**

How are the latest technologies driving new developments in online betting and gaming? **Neil Tyler** investigates

The online gaming sector has grown exponentially over the past few years and the global market is now estimated to reach $94billion by 2024.

It is a sector that is not without controversy. Gambling related harm is becoming an increasing concern and a recent report, from MPs in the UK Parliament, into online casinos called for limits on bets and for a raft of measures to protect vulnerable people.

In the UK alone, online gambling generates annual revenues of over £5.6billion – so it's certainly a big business.

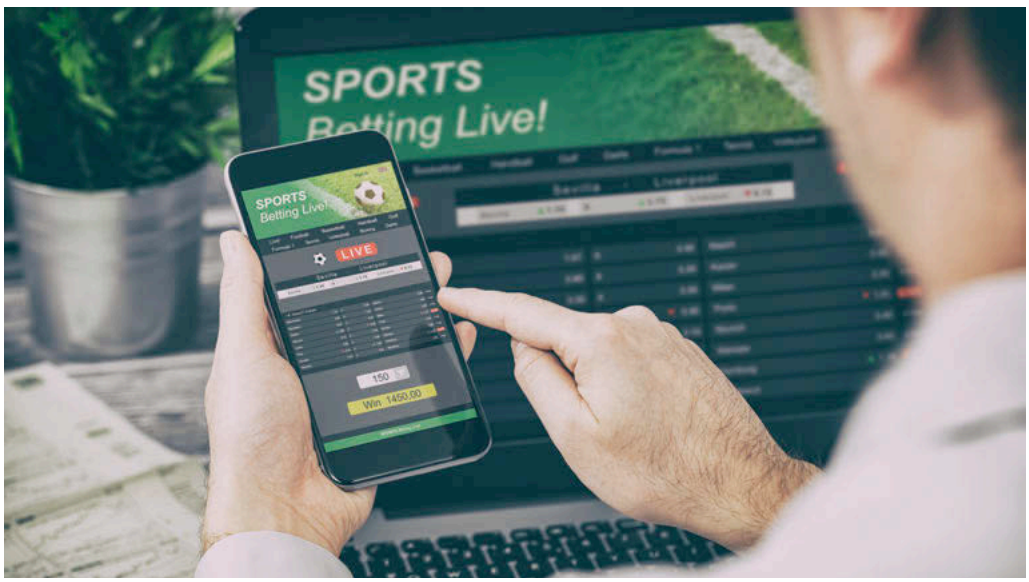
Whatever the moral and legal issues that exist around gambling, the online gambling industry is ever-changing and continuously adapting to new technologies and the changing demands of its audience.

"As competition among businesses becomes stronger than ever, rival betting companies are continually on the lookout for the next big thing in technology to lure in customers and set themselves apart from others in the industry," explained Adrian Thompson, Global VP of Marketing at Sapphire Technology, a manufacturer of graphics and mainboard products.

The association between technology and gambling has grown stronger in recent years.

"Technology has been a huge contributor in the development of the online betting and gaming industries, with customer expectations shifting as a result," said Thompson.

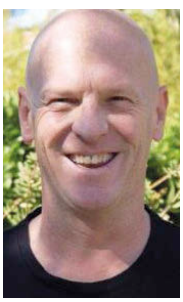
"As technology has evolved, so has the need for more advanced hardware and software. Therefore, developers are building sophisticated embedded motherboards to provide the eye-catching graphics to enable more engaging and rewarding experiences for customers.



"Additionally, these developers are always constantly in need of finding new ways to stay ahead of the competition as online betting and gaming are becoming increasingly more versatile and moving closer to reality," Thompson explained.

Virtual Reality (VR) is a technological area that has been making its way into the gambling industry over a number of years, with gamblers increasingly able to feel like they're really playing games like roulette.

"VR is one of the biggest advancements and is revolutionising the gaming industry. It offers gamers the chance to be fully immersed in the gaming experience and interact with other live gamers. As more money continues to be invested in VR technology we can expect to see further advancements in this space as the gaming industry looks to deliver a closer to reality experience," according to Thompson.



"Online gaming suppliers and hardware providers are under more pressure to continue driving innovation."
Adrian Thompson

Casinos and online slot games have certainly reinvented themselves using VR. Thanks to various VR headsets such as Oculus Rift, Sony PlayStation VR and the Samsung Gear VR, it is now possible for players to step into a virtual casino or a sports event and participate in an immersive gambling experience.

Some major types of online gambling activities that have started adopting VR technology include the likes of: Slots, Blackjack, Roulette, and Sports Betting.

Skill-based games

Established casinos are also looking at new ways to entice back existing audiences as well as encourage new ones.

Skill-based games have been one way to achieve just that and in Las Vegas they are becoming increasingly popular, in that the game is determined by a player's physical

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or mental skill – it should be noted, however, that playing games of chance for money is still illegal in many localities.

"Despite that, gambling regulations are becoming more relaxed around the world, and hardware providers are becoming more innovative and creative by adopting high quality displays and enabling advanced functionalities," suggested Thompson.

Mobile technology is also having a major impact in terms of online gambling – people want to be able to access sites wherever they are, and online casinos are developing user experiences that address the need for mobile gambling and companies are having to provide players with better graphics and a more immersive gaming experience.

"Mobile gaming has become more popular due to mobile devices getting smarter along with the ability to place bets in real time, with the market expected to reach a value of $72.3 billion in 2020. Therefore, online gaming suppliers and hardware providers are under more pressure to continue driving innovation," said Thompson.

Sport and gambling are inseparable and there has been considerable growth in term of live in-play betting, but with the development of virtual sports, which use random number generators to create high-quality animated versions of popular sports, bettors no longer have to wait as long to see and bet on the real thing.

According to Thompson, "Live streaming within the betting industry has become popular amongst betting and gambling companies, therefore adopting hardware that is high quality has become vital to keep customers interested and engaged."

Technology advancements

Technology advancements such as touch screens, 3D graphics and multi-display in 4K and UHD resolutions have meant that the meaning of online gaming has developed, with gamers wanting to play games as a means of escapism more than ever before.

"3D games have been around for a number of decades, with the games in the early stages lacking any visually pleasing graphics and any kind of detail. Fast forward to today and most games on the market are now 3D, showcasing advances in graphic software and imagery which is significantly improving the value of these games," said Thompson.

"Accelerated processing units are being integrated within the online betting and gaming industries to provide customers with state of the art graphics and a solution that is pushing past HD to 4K.

"An Accelerated Processing Unit (APU) combines the powerful machinery benefits of a Computer Processing Unit (CPU) with the visual benefits of a Graphics Processing Unit (GPU) into a single chip."

According to Thompson, "Customers are demanding a higher level of performance and, as a result, providers are now pushing the limits to achieve this. Integrating APU's within sophisticated motherboards provides high quality visuals that deliver more compelling content.

"Products such as the AMD Ryzen Embedded V1000 and R1000 APUs provide improved levels of performance by merging the AMD 'Zen' CPU with the AMD 'Vega' GPU architectures into seamlessly-integrated SoC products."

He continued, "These solutions enable features like quad display support, dual Ethernet, M.2 slots, USB and COM ports in a compact form factor so customers can quickly develop high performance embedded solutions for the gaming market."

Adapting to the changing technology landscape is vital for online betting and gaming industries, in order to continue moving forward and meeting customer expectations.

The adoption of new technologies and the integration of APU's, for example, mean that these industries are able to stay ahead of competition and continue driving innovation.

One area of particular interest, when it comes to online gambling, is the use of blockchain and the growing penetration of cryptocurrencies into the market.

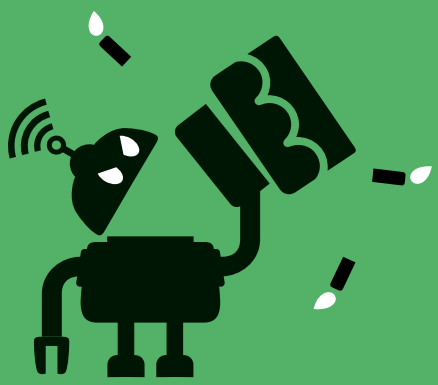
At present gambling-focused currencies are valued at more than $245m according to data from CryptoSlate, however, the use of cryptocurrencies in the online gambling and betting industry is a controversial one due to fluctuations and volatile prices in the market.

But while there might be market risks, in terms of crypto gambling, there are also a number of advantages such as: anonymity for users and transactions – personal information is kept safe and secure via the blockchain; access to provably fair gambling – for honest and transparent gambling systems; instantaneous acceptance and withdrawal of funds; no extra transaction cost/tax as cryptocurrencies are, at present, not regulated by governments and irreversible transactions which can prevent fraud and money laundering

"Both the online betting and gaming industry providers have huge opportunities to continue growing but will need to adopt new technologies to satisfy customers and add to the overall experience. If they do, the incentive for those operating in the space will continue to be significant," concluded Thompson.

AVNET SILICA

Microsoft



Birthday party.
Boy gets smart toy robot.
Robot gets hacked.
Cake ruined. Party ruined.
The end.

Prevent IoT dramas. Go for Microsoft Azure Sphere – Go for Maximum IoT Security.
Now available at Avnet Silica. All info at msembedded.biz/azuresphere