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23 February 2021

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INNOVATION AND NEW OPPORTUNITIES

How is the immersive sector looking to commercialise its ideas?

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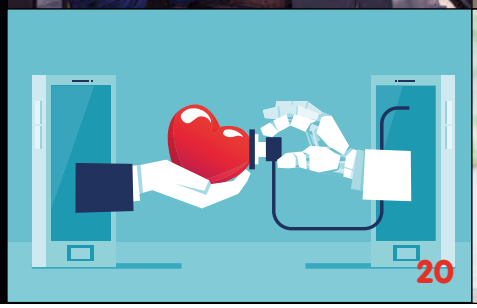

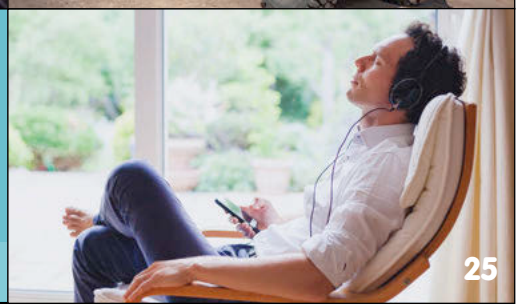

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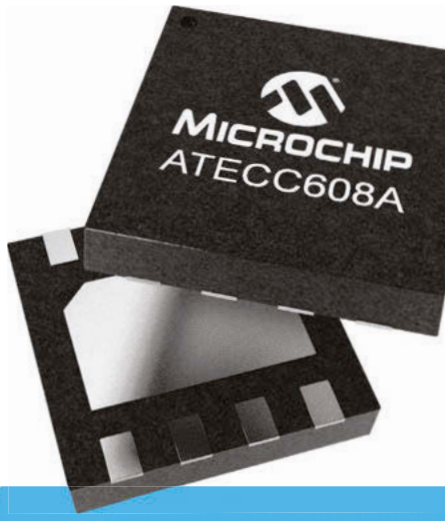

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Renewables bring new challenges

AS RENEWABLE POWER GENERATION EXCEEDS TRADITIONAL SOURCES OF POWER, A NEW TYPE OF INFRASTRUCTURE WILL BE REQUIRED

Last year was a record year for renewable power in the UK and wind power produced a quarter of Britain's electricity. However, that led to more than £250 million having to be being spent on costs where energy had to be dumped because of network constraints.

While this has led to a call for additional technologies like nuclear, hydrogen and carbon capture to compensate for when the wind doesn't blow or the sun doesn't shine, it also demonstrates that the next steps we need to take towards achieving a net zero power system will be more challenging.

With this greater reliance on renewable energy the UK's power infrastructure system will be exposed to greater swings in power production which can then lead to surges in power prices, and much higher grid balancing costs.

Systems for storing energy such as batteries are going to be critical if we are to provide grid balancing services to make up for a drop in renewable power.

So it was interesting to see that a team of engineers had developed a hydropower system that uses gentle slopes rather than steep dams or mountains to store electricity and, as a result, hundreds of hills across the UK could be used to store renewable energy, acting as giant batteries.

This hydropower system, embedded underground, could see the unlocking of many potential hydropower sites across the UK, with fewer environmental impacts.

These projects mimic traditional hydropower plants by using surplus electricity to pump water uphill, then releasing it through turbines to generate electricity when it's needed.

These are described as "high-intensity" hydro projects and use a mineral-rich fluid, which has more than two and a half times the density of water, to create the same amount of electricity from slopes which are less than half as high.

RheEnergise, the company behind the project, said it would be possible to pump the dense fluid up a hill with a height of 200 metres, at times of low electricity demand where it would be stored in an underground storage tank.

This technology could allow around 700 sites across the country to play host to these new high-intensity hydro projects, which in theory could create a total of 7GW of energy storage to help the UK use more renewable electricity.

These types of technologies are going to be critical to the UK's ambition of delivering cleaner and more effective forms of power generation and storage, as by the end of the decade the UK is expected to need around 13GW of flexible clean energy generation and storage to help balance the electricity grid.

Neil Tyler, Editor (neil.tyler@markallengroup.com)

> "Hundreds of hills across the UK could be used to store renewable energy, acting as giant batteries."

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Energy-harvest technology to make roads safer

AN ECO-FRIENDLY ENERGY-HARVESTING SMART SENSOR COULD HELP MAKE ROADS SAFER BY IDENTIFYING DANGEROUS DRIVER BEHAVIOUR. **NEIL TYLER** REPORTS

Triboelectric nanogenerators (TENGs) are an emerging technology that harvests the freely available mechanical energy from daily human activities and could be used to identify dangerous driver behaviour, improving the safety of roads.

In a study published by Nano Energy, engineers from the University of Surrey have revealed how they used recycled plastic cups and silk cocoon waste to develop a soft and skin-friendly self-powered sensor, which can be used to sense human activities.

When coupled with an AI system and applied in a car setting, the smart sensor could flag potentially dangerous driving trends, including slow brake reaction times. The highly flexible and biocompatible sensor could either be used as a wearable item on clothing or placed within the fabric of the steering wheel, horn, gear stick and brake pedal. In tests, it provided real-time feedback on the driver's actions, which allowed the AI system to compute performance.

Commenting Dr Bhaskar Dudem, principal author of the study and Research Fellow at the University of Surrey's Advanced Technology Institute, said, "We are all excited by how AI

will influence future consumer electronics, but this future must also be friendly to our planet's environment. Our recycled silk-based smart sensor technology is a hint of what the future holds and, with support from industry, we believe we can soon bring it to market."

Professor Ravi Silva, Director of the ATI and corresponding author, added, "Whilst in this example we tested our sensors to monitor driver behaviour, we believe the ideal application of the self-powered smart sensor technology is in future driverless cars and other Industry 4.0 automation systems. This eco-friendly cutting-edge project with international collaborators inspires us at the Advanced Technology Institute to keep inventing solutions to real-world problems faced by society."

Cambridge GaN Devices raises Series A funding

Cambridge GaN Devices (CGD) has raised $9.5 million in Series A funding. The investment was co-led by IQ Capital, Parkwalk Advisors and BGF, and will be used by CGD to expand its product portfolio of energy-efficient power devices and to double the size of its team.

CGD was spun out of the power device group at the Engineering Department of the University of Cambridge in 2016 to exploit a revolutionary technology in power devices, a market that's said to be worth in excess of $30 billion.

The company's core business is to design, develop and commercialise power transistors and integrated circuits based on the most energy-efficient material available, Gallium Nitride (GaN).

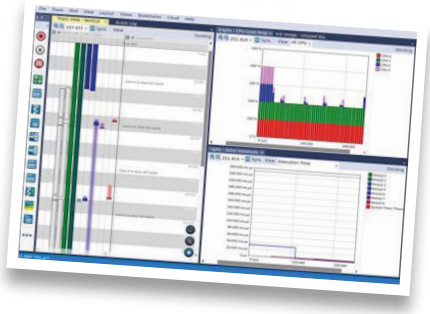
GaN power devices are significantly higher performing than state-of-the-art silicon-based devices, and CGD is developing a range of GaN transistors that are customised for key applications in market segments such as consumer and industrial Switch Mode Power Supply (SMPS), lighting, data centres and automotive HEV/EV.

The higher efficiency of CGD devices combined with the unique ease-of-use introduced by the Company's proprietary IP will allow CGD GaN to easily replace silicon in those key applications, while enabling more compact power systems and better use of energy resources.

Giorgia Longobardi, CEO and founder of CGD, commented, "This latest round of investment is a great recognition of our success to date, with new and existing investors confirming the strength of our technology. Since 2016, CGD has grown significantly and we are thrilled to be in a position to deliver several products to market, following decades of industry-leading research in reliability of power devices. This investment will allow us to supplement our experienced team with additional experts and expand our markets globally, creating more sustainable electronics worldwide."

Visual trace diagnostics

PERCEPIO ANNOUNCES TRACEALYZER SUPPORT FOR AZURE RTOS THREADX SMP. **NEIL TYLER** REPORTS



Percepio, a specialist in visual trace diagnostics for embedded systems and the Internet of Things (IoT), has announced Tracealyzer support for Azure RTOS ThreadX SMP systems.

As a result, Azure RTOS developers will have the same level of insight into multicore systems that is currently available to embedded Linux developers, such as the ability to track software threads as they migrate between cores and to view CPU load per core.

Tracealyzer provides visual trace diagnostics and will be helpful for users of Azure RTOS ThreadX SMP who want to improve software reliability, system performance and development productivity. It is able to leverage the event-logging already present in Azure RTOS ThreadX SMP, so developers can deploy Tracealyzer in new and existing projects. This is a pure software solution that runs on all processors supported by Azure RTOS ThreadX SMP, including Xilinx Zynq and other Arm Cortex-A processors.

"More embedded and IoT software systems rely on multicore processors, enabling developers to build more powerful and complex systems," said Johan Kraft, CEO, Percepio. "As a result, it's even more important to have quality insight into the runtime system, which is what we offer with Tracealyzer's new support for Azure RTOS ThreadX SMP."

SEGGER Embedded Studio build for Apple M1Cloud Platform

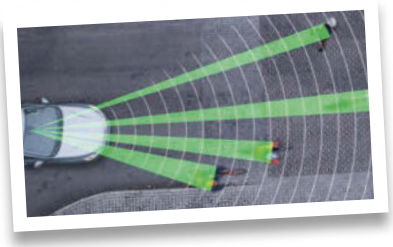
SEGGER has announced its Embedded Studio build for the newly released Apple M1, Apple's first ARM-based system-on-chip (SoC) designed specifically for Mac.

The Embedded Studio is SEGGER's cross-platform Integrated Development Environment (IDE) for ARM/Cortex and RISC-V.

While the ARM-based M1 can execute applications for Intel x86-based CPUs using Apple's Rosetta 2 translator, applications built specifically for the M1 core execute much faster and use less power.

To fully utilise the speed and performance potential of a natively compiled application, SEGGER has created a build of Embedded Studio for M1. There are now two macOS packages available – one for the Intel x86-64 and one for the Apple M1.

"The Embedded Studio build for the Apple M1 is truly cutting-edge," said Ivo Geilenbrügge, Managing Director of SEGGER. "This is the first commercial embedded system IDE optimised for the M1 and the performance results of our comparison tests show it was worth the work."



RadSee launches high-performance 4D imaging radar

RadSee Technologies is making available the automotive industry's first 4D imaging radar for ADAS and autonomous vehicles that's capable of delivering ultra-high performance and scalability to OEMs and Tier 1 suppliers.

By combining the company's algorithms and patented antenna and system architecture with 77GHz commercial off-the-shelf (COTS) components, RadSee said that it has been able to reduce development risks and strike a better balance between cost and performance.

The platform scales to accommodate different autonomy levels – standard, premium and LiDAR-like – that can be easily integrated, enabling widespread adoption and the technology is available for immediate integration into current ADAS design cycles as well as emerging autonomous vehicles.

"With constant progress in ADAS, and direct feedback from key automotive industry players, the need for affordable, high-accuracy radars has never been greater," said RadSee Co-founder and CEO, Arnon Afgin. "Our team focused on developing a radar solution that specifically addresses cost and risk – the key obstacles to widespread adoption by OEMs and Tier 1s."

Co-founder and CSO Dr. Dani Raphaeli added, "Industry-leading performance has historically come with a high price tag plus significant development complexities and risks. In contrast, RadSee's radar technology eliminates the usual trade-offs between cost, risk and performance, making widespread adoption of 77GHz radars a real possibility for the first time."

3D network simulation

AIMOTIVE INTEGRATES MATHWORKS' ROADRUNNER 3D SCENE EDITING CAPABILITY INTO AISIM. **NEIL TYLER** REPORTS

AImotive is collaborating with MathWorks to integrate RoadRunner into aiSim allowing users to create road and 3D networks for simulation in aiSim.

To enable end-to-end testing of automated driving software, a simulator needs to include high-fidelity environment and realistic sensor simulation and to enable this, the simulator will require precise, well-defined maps and quality assets as an input.

AImotive has integrated RoadRunner, which is an interactive editor from MathWorks that lets users design 3D scenes for simulations, into aiSim, the company's ISO26262 certified automotive grade simulation platform, to solve this challenge.

The collaboration will provide a user-friendly way to create various environments by using

RoadRunner's intuitive map editor, ranging from dense urban scenes to compliance specific test cases.

In addition, the integration allows users to create and edit OpenDrive maps and import GIS data and place the built-in high-fidelity assets of aiSim mixed with RoadRunner's extensive asset library. The created content can then be imported to the ASIL-D certified simulator, exercising its advanced sensor simulation capabilities.

"Automated driving engineers use virtual testing to reduce the cost and risk of in-vehicle testing. To achieve the most benefit from virtual testing, engineers need to simulate scenes that closely match the real-world, which are time consuming to create" said Avinash Nehemiah, Principal Product Manager - Autonomous Systems at MathWorks. "With the connectivity between RoadRunner and aiSim engineers can now easily author complex, simulation-ready scenes in RoadRunner for virtual testing in aiSim".

"This new collaboration fits well and extends our existing integration with other MathWorks product like MATLAB and Simulink. More importantly we think this is a big step forward for our users having the benefit of an intuitive and well-designed content creation tool seamlessly integrated with a deterministic, flexible and certified simulator engine." – said Szabolcs Jánky, Product Manager of aiSim.

Vehicle ethernet audio video bridging

Microchip has launched the first hardware-based audio endpoint solution for AVB – the LAN9360, a single chip Ethernet controller with embedded protocols.

The device is intended for connected vehicles that are increasingly relying on Ethernet for network connectivity and for developers looking to streamline infotainment system development and to more quickly adapt to manufacturers' evolving requirements.

The LAN9360 audio endpoint controller interconnects vehicles' infotainment devices including speakers, amplifiers, microphones, navigation systems, radio tuners and smart headrests with Ethernet AVB.

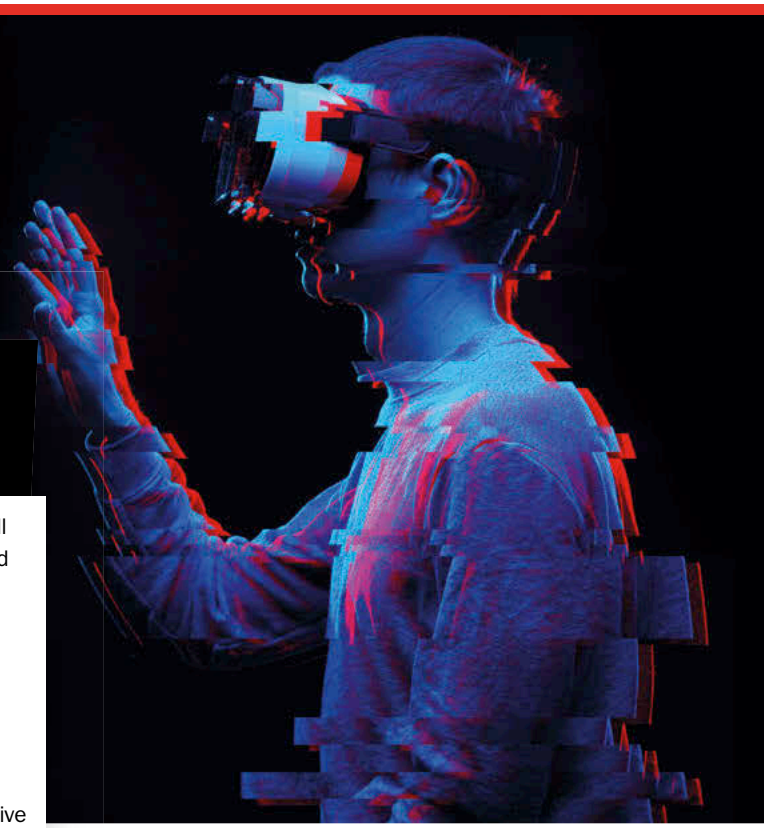
The device bridges audio between Ethernet AVB and Inter-IC Sound (I2S), Time Division Multiplexing (TDM) and Pulse Density Modulation (PDM) local audio interfaces and is able to support audio transmission over Ethernet AVB, including generalised Precision Time Protocol gPTP, timestamping, transport protocols and content protection with High-bandwidth Digital Content Protection (HDCP).

It also supports secure boot and secure remote updates over Ethernet and, unlike other Ethernet bridging networking solutions, the LAN9360 endpoint device requires no software integration, which means that designers are able to configure the device simply and quickly to meet manufacturers' audio and networking requirements.

The LAN9360 audio endpoint controller has been validated to industry standards for Ethernet interoperability for AVB protocols. The device is validated to the IEEE 802.1BA-2011, IEEE 802.1AS, IEEE1722 and IEEE1733 specifications for Ethernet networks and is certified to the standards for AVB interoperability and reliability established by the Avnu Alliance consortium.

INNOVATION AND NEW OPPORTUNITIES

With the latest group of start-ups graduating from the Digital Catapult's Augmentor programme, **Neil Tyler** looks at the UK's immersive sector



Last month saw ten of the UK's most promising start-ups, working with immersive technologies, graduate from the Digital Catapult's Augmentor programme.

All of those involved left with investment ready, disruptive and commercially focused applications, but while immersive technologies are helping to unlock new business models and are seeing increased investment it's still a sector that's struggling to deliver a significant commercial breakthrough.

Whether it's supporting research and innovation, building on strong research systems and encouraging greater collaboration, or working with educational providers to develop the skills and training programmes to support the sector, there are still plenty of barriers to the technology's adoption and commercialisation.

According to Jessica Driscoll, Head of Immersive Technology at the Digital Catapult, the UK's advanced digital technology innovation centre, "While this year's Augmentor programme saw some amazing start-ups take part, and the quality of the products and ideas were outstanding, it remains difficult to spot significant trends.

"The programme is a very broad-based. We saw products intended to help luxury retail brands to survive the epidemic, a platform to visualise data in new ways as well as pioneering new kinds of shared audio experiences.

"The value of the programme for those that took part comes from being able to meet other companies, to directly engage with investors, to talk through problems with experts and have access to the Catapult's immersive laboratory, as well as using the Demo Showcase that's held at the end of the programme to pitch their ideas to interested companies, investors and the like."

Last year's Augmentor programme had to be delivered entirely online with workshops, mentoring and networking sessions all done virtually.

"Despite those challenges we brought on board 24 partners, 41 mentors and 19 community partners to help accelerate growth and investment, and we were able to pull together over 160 interested parties for the Demo Showcase including some of the world's leading investment funds such as HTC Vive, Remagine Ventures, MMC Ventures and Ascension Ventures."

According to Driscoll, the cohort comprised of more late stage companies.

"Quite a few were further along in terms of raising funds than is usually the case, and I think we'll need to structure future programmes slightly differently to better help companies that are further along in funding and nearer to commercialisation.

"In the UK we have a very complex funding landscape and we need to look at how we fund start-ups."
Jessica Driscoll

"In the UK we have a very complex funding landscape and we need to look at how we fund start-ups. Perhaps, we need to move away from competition-based funding and focus more on developing a better grant model, which isn't restricted to a specific time period or to a competition."

The Digital Catapult was set up to drive the early adoption of technologies and looks de-risk innovation through uncovering new commercial applications for technologies like immersive, future networks, distributed ledger and artificial intelligence, but Driscoll believes that the UK is still playing catch-up with the likes of the US and Germany.

"We certainly don't see the same level of funding and while the government has pledged to raise

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R&D spending there remains a lack of detailed planning, which can be frustrating."

Driscoll makes the point that a lot of work still remains to be done in encouraging greater collaboration between start-ups and more established businesses, and suggested there should be greater focus on cross-tech applications and called for a move towards what she described as more 'technology fusion'.

"The UK immersive industry is still struggling to reach commercial scale and while many small companies have created a startling mix of really impressive and innovative applications, few have been able to scale their operations," she said.

"The perception of the immersive industry is another issue," Driscoll conceded. "It's up against 5G, AI and the Internet of Things, which are far larger markets that have scaled more effectively. Not only are there plenty of tech start-ups working in these spaces but significant government funding is available.

"The immersive industry, here in the UK, lacks a large home-grown champion so there's certainly an issue when it comes to raising the sector's profile."

According to Driscoll it's hard to break out of the niche view many hold of the sector – there's been limited research into headset use, which has made it harder to build a business case while, "anyone can use a mobile handset."

"We need to embrace more innovative business models going forward, perhaps using a licensing model, but the opportunities, and the ideas, are there."

Augmentor start-ups

Among the companies that took part in what was the fourth edition of the Augmentor programme were Manchester-based Evidential. It has produced EVITA, a major incident VR training platform that has been designed to equip police officers with essential soft and hard skills.

Having already received backing from Innovate UK it has also developed another product, Golden Hour that uses AR to improve the preservation of crime scenes.

Another, Emperia, has developed a platform to boost sales and customer engagement for businesses in art and luxury fashion and has created a variety of virtual reality experiences that help to improve the way that products can be seen online in 3D - it's currently working with more than 25 clients, including Maddox Gallery and Skarstedt, to bring different physical experiences into the virtual world.

Based in Sheffield Slated Theory has created a platform that visualises data and has developed a cloud based 3D data visualisation tool called "Alaira" that uses XR and immersive analytics to bring people together to analyse multiple data sets in real time, with the aim of driving faster decision making within organisations.

Another is MOONHUB, which is looking to disrupt traditional training models through the use of a high quality, immersive training platform which uses VR to convert e-learning solutions into interactive training scenarios to improve employee engagement.

According to CEO and founder, Dami Hastrup, "We use deployable VR to enable our clients to provide immersive and interactive training using their own learning and development content. It's both intuitive and easy to use and our aim is to make the use of VR as easy as using a tablet is today.

"The technology has come a long way and we're now deploying platforms and presenting solutions that are live, scalable and easy to use."
Dami Hastrup

Above and left: The police service is turning to VR to train new recruits

"When we set the business up we saw a glaring gap in the market for a unified platform capable of deliver training and we thought a VR platform was a great tool for providing more information and data, enabling clients to get more out of their training content."

Turning to the Augmentor programme Hastrup said that their decision to get involved was because, "we wanted to surround ourselves with like-minded businesses – immersive start-ups facing the kinds of problems that, perhaps, other new businesses wouldn't necessarily face. Having a cohort of likeminded companies was really important to us and the programme helped to raise awareness of the business among both potential investors and clients."

Hastrup said that the industry has had to contend with reputational issues from previous waves of failed VR projects.

"The technology has come a long way since then and we're now deploying platforms and presenting solutions that are live, scalable and easy to use – but it's an innovative and new technology and you need to educate users."

Laura Smith, co-founder at Slated Theory, a VR/AR company from Sheffield would agree with that. The start-up's platform has been designed to enable people to enter their company data and visualise it in new, innovative 3D ways.

"It's about enabling businesses to visualise their data in an immersive, manipulable and scalable 3D environment, making it easier for them to analyse and explore their data," Smith explained. "It's possible for a number of people to look at far more data at the same time, to then drill down into that data and better understand it and discover trends."

According to Smith the business was set up in response to the amount of data companies and projects were generating and the need, as they saw it, to give people the ability to explore data more effectively.

"One of the biggest issues that we found was effective communication and the sharing of large scale and complex data among different stakeholders, so we wanted to provide an easy to use platform. VR lends itself to the exploration of both historical and real-time data," said Smith, "and if you can bring different data sets into one place you can use visualisations to better understand what's actually going on and address problems and situations more effectively."

For Smith the Augmentor programme provided an opportunity to better understand how to engage with investors.

"It was a chance to see how investors responded to the technology," Smith said. "While immersive technology isn't new, data visualisation within immersive tech is still relatively young and requires a certain mind-shift as to how data can be represented in a 3D environment. Those who 'got' what we were doing were certainly excited by the platform and how data could be analysed."

Unlike some of the other companies in the programme Evidential, which specialises in the use of the Electronic Presentation of Evidence in the criminal justice system has already received significant funding from Innovate and is working with a number of police services in the UK.

"As an expert witness company we use technology to explain complex evidence to juries," explained the company's owner, Sean Murphy.

"We've already been involved with a number of high profile cases since we were established in 2014 – Dr Harold Shipman and the Hillsborough trial - and we're using immersive technology to recreate crime scenes in 3D, developing animations and using graphics to take a jury through a crime scene."

"We can provide significant cost savings especially when it comes to high cost crime cases, but this technology also has a role in volume crime. It's about taking large amounts of complex data and evidence and then presenting it in a more understandable format."

"The Augmnentor programme was a chance to see how investors responded to the technology."
Laura Smith

Left: VR is being used by businesses to better visualise their data

Evidential already has a contract with the Crown Prosecution Service (CPS) and has worked on cases for the Criminal Court in The Hague and the United Nations.

"We've been using technology over many years – 3D printers to demonstrate injuries, for example - and started to use VR to recreate crime scenes enabling users to explore evidence and get a better spatial understanding of a crime scene."

This technology was initially designed for use in court but Murphy soon realised that there was a strong need, and a good business case, for its use in police training.

"That resulted in the creation of EVITA our VR training platform and we've had significant interest from police services across the UK. Not only can we create different scenarios for training but can measure training outcomes."

According to Murphy the company's involvement with the Augmentor programme was less about finding investors – grants from Innovate and the government and the commercialisation of its EVITA programme meant that was of less interest.

"For us it was about the mentoring that was available and learning how to build a brand."

Whether it's training, data management or simplifying the presentation of evidence in court the variety of applications for immersive technology are immense.

More data is certainly needed to encourage investors and while investment is happening it still tends to be skewed towards gaming.

There's still a significant job to do in educating people and in developing solid business models, let alone ensuring that we have an infrastructure that's fit for purpose in supporting and enabling this type of technology, but it does look like that we are getting there – slowly, but surely.

AI: HOW LOW CAN YOU GO?

Embedded machine learning is driving new accelerator architectures but there are ways to reduce its thirst for processor power. By **Chris Edwards**

Markets are subject to fads and the embedded-control sector is far from immune to them. In the 1990s, fuzzy logic seemed to be the way forward and microcontroller (MCU) vendors scrambled to put support into their offerings only to see it flame out.

Embedded machine learning (ML) is seeing a far bigger feeding frenzy as established MCU players and AI-acceleration start-ups try to demonstrate their commitment to the idea, which mostly goes under the banner of TinyML.

Daniel Situnayake, founding TinyML engineer at software-tools company Edge Impulse and co-author of a renowned book on the technology, says the situation today is very different to that of the 1990s.

"The exciting thing about embedded ML is that machine learning and deep learning are not new, unproven technologies - they've in fact been deployed successfully on server-class computers for a relatively long time, and are at the heart of a ton of successful products. Embedded ML is about applying a proven set of technologies to a new context that will enable many new applications that were not previously possible."

ABI Research predicts the market for low-power AI-enabled MCUs and accelerators for the TinyML market will climb from less than $30m in annual revenues this year to more than $2bn by the start of the next decade.

Despite the rapid growth, ABI principal analyst Lian Jye Su expects competition to become fiercer as large companies such as Bosch enter the market. Already, some start-ups such as Eta Compute have moved away from silicon to software tools.

"We do see some consolidation. At the same time, the huge fragmentation in the IoT market means a significant number of providers will survive, like the MCU or IoT chipset markets in general," he says, pointing to the large number of suppliers who focus on specific vertical markets.

TinyML faces severe constraints. Pete Warden, technical lead of the TensorFlow Micro framework at the search-engine giant and Situnayake's co-author on "TinyML: Machine Learning with TensorFlow Lite on Arduino and Ultra-Low-Power Microcontrollers", said at the Linley Group's Fall Processor Conference that the aim is to take deep-learning models and "get them running on devices that have as little as 20KB of RAM. We want to take models built using this cutting-edge technology and crush them down to run on very low power processors.

"Because it's open-source software, we get not only to interact with product teams inside Google but also get a lot of requests from product teams all over the world who are trying to build interesting products. And we often have to say: no, that's not possible yet. We get to see, in aggregate, a lot of unmet requirements," says Warden.

The core issue is that deep-learning models ported from the server environment call for millions or even billions of multiply-add (MAC) functions to be performed in a short space of time even for relatively simply models. Linley Gwennap, president of the Linley Group, says relatively simple audio applications, such as picking up words in speech that can activate voice recognition, calls for around 2 million MACs per second. Video needs far more.

Silicon vendors have been able to push the MAC count by taking advantage of the relatively low requirement for accuracy in individual calculations when performing inferencing. Whereas training on servers generally demands single or double-precision floating point arithmetic, byte-wide integer (int8) calculations seem to be sufficient for most applications.

There are indications that for selected layers in a model, even int8 MACs are unnecessary. Binary

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or ternary calculations that can be performed using little more than a few gates each do not hurt overall accuracy in many cases. Potentially the performance gains are enormous but lack the combination of hardware and software support needed to exploit them fully, says Situnayake.

Though the tooling for the TensorFlow Lite framework typically supports int8 weights, support for lower resolutions is far from widespread. "This is changing fast," Situnayake notes, pointing to accelerators such as Syntiant's that support binary, 2bit and 4bit weights as well as work by Plumerai to train binarised neural networks directly.

"While these technologies are still on the cutting edge and have yet to make it into the mainstream for embedded ML developers, it won't be long before they are part of the standard toolkit," he adds.

"Embedded ML is about applying a proven set of technologies to a new context that will enable many new applications that were not previously possible."
Daniel Situnayake

Reducing the arithmetic burden

There are other options for TinyML work that reduce the arithmetic burden. Speaking at the TinyML Asia conference late last year, Jan Jongboom, co-founder and CTO of Edge Impulse said the key attraction of ML is its ability to find correlations in data that conventional algorithms do not pick. The issue lies in the sheer number of parameters most conventional models have to process to find those correlations if the inputs are raw samples.

"You want to lend your machine-learning algorithm a hand to make its life easier," Jongboom says. The most helpful technique for typical real-time signals is the use of feature extraction: transforming the data into representations that make it possible to build neural networks with orders of magnitude fewer parameters.

Taking speech as an example, a transformation to the mel-cepstrum space massively reduces the number of parameters that can efficiently encode the changes in sound.

In other sensor data, such as the feed from an accelerometer used for vibration detection in rotating machinery, other forms of joint time-frequency representations will often work.

This approach is used by John Edwards, consultant and DSP engineer at Sigma Numerix and a visiting lecturer at the University of Oxford, in a project for vibration analysis.

In this case, a short Fourier transform had the best trade-off coupled with transformations that compensate for variable speed motors. The feature extraction reduced the size of the model to just two layers that could easily be processed on an NXP LPC55C69, which combines Arm Cortex-M33 cores with a DSP accelerator.

Jongboom says though it may be tempting to go down the route of deep learning, other machine-learning algorithms can deliver results. "Our best anomaly detection model is not a neural network: its basic k-means clustering."

Where deep learning is a requirement, sparsity provides a further reduction in model overhead. This can take the form of pruning, in which weights that have little effect on model output are simply removed from the pipeline. Another option is to focus effort on parts of the data stream that demonstrate changes over time. For example, in surveillance videos this may mean the use of image processing to detect moving objects and separate them from the background before feeding the processed pixels to a model.

It's been a learning experience for Jongboom and others. In describing his progress through the stages of TinyML, in the summer of 2017 he thought the whole concept was impossible. By the summer of 2020, having looked at ways to optimise application and model design together, his attitude had changed to believing real-time image classification on low-power hardware is feasible. As low-power accelerators that support low-precision and sparsity more efficiently appear, the range of models that can run at micropower should expand.

The result, Situnayake claims, is likely to be that "ML will end up representing a larger fraction than any other type of workload. The advantages of on-device ML will drive the industry towards creating and deploying faster, more capable low-power chips that will come to represent the majority of all embedded compute in the world". Though there will be plenty of devices that do not run these workloads the need for speed as model sizes inevitably grow will focus attention on its needs and begin to dominate the development of software and hardware architectures, as long as the applications follow through.

MOSA HAS MOMENTUM

The new Modular Open Systems Approach (MOSA) opens the door to more innovative possibilities, as **Paul Garnett** explains

The last couple of years have seen the US and UK military adopt open architectures as the preferred alternative to custom and proprietary electronics technology designs. The Commercial-off-the-Shelf (COTS) Initiative was first introduced in 1994 but, arguably, the real paradigm shift took place in 2019, when the U.S. DoD issued a memorandum mandating the use of the Modular Open Systems Approach (MOSA) for all weapons systems going forward and which was then made law, requiring all defence acquisition programs (MDAP) to be designed and developed using a MOSA.

According to the DoD, the use of MOSA solutions will "support a more rapid evolution of capabilities and technologies throughout the product life cycle through the use of architecture modularity, open systems standards, and appropriate business practices." Among the MOSA-related open systems standards supported by COTS suppliers are the module, backplane and chassis standards defined by the VITA trade association, including 3U and 6U form factor OpenVPX (VITA 65) board and backplanes, the C5ISR Modular Open Suite of Standards (CMOSS), and the Sensor Open System Architecture (SOSA), currently working towards its rev. 1 release, sometime this year.

The move to MOSA is driven by the fact that each new capability or function that's added to a platform is a complete system with its own subsystems, so the duplication of physical and logical components increases complexity and costs. It's an unsustainable approach, especially as platforms and budgets continue to shrink in size.

Interoperability is another significant issue with discrete, closed solutions. Closed solutions based on propriety technologies are designed to operate in isolation. As a result, they are very difficult and time- consuming to deploy on platforms where systems and people must work together to ensure personnel safety and mission success. They are also challenging to maintain and repair, especially if the vendor no longer supports it, or has gone out of business.

The use of MOSA components promises to shorten the path to field new technology to defeat emerging threats.

There are several open standards including: Open Mission Systems/ Universal Command and Control Interface (OMS/UCI); Sensor Open Systems Architecture (SOSA); Future Airborne Capability Environment (FACE) and Vehicular Integration for C4ISR/EW Interoperability (VICTORY)

Modern efforts like the US Army's VICTORY initiative and the UK's Generic Vehicle Architecture (GVA) are helping to pave the way for a modern battlefield where system upgrades and modifications are quicker and less expensive.

The VICTORY specification was officially kicked off in 2010 by the US army and a consortium of defence and industry participants, including Curtiss-Wright, and promotes the use of open standard physical and logical interfaces between LRU subsystems on C4ISR/EW combat vehicles, mitigating the problems created by the 'bolt-on' approach to fielding equipment on military vehicles. Its implementation enables tactical wheeled vehicles and ground combat systems to recover lost space while reducing weight and saving power.

Additionally, it enables platform systems to share information and provide an integrated picture to the crews. What's more, VICTORY provides an open architecture that enables platforms to accept future technologies without the need for significant redesign.

Similar to VICTORY, GVA mandates open, modular, and scalable architectures in the design of land vehicles. Its standards apply to electronic and power infrastructures, mechanical interfaces, Human Machine Interfaces (HMI) and Health and Usage Monitoring Systems (HUMS). Where VICTORY specifically aims to provide an architecture for C4ISR/ EW systems, GVA plays a wider role across the entire land vehicle platform.

The SOSA Technical Standard defines a common framework for transitioning sensor systems to an open systems architecture. With so many existing and emerging sensor systems to consider, the SOSA

Figure 1: The MPMC-9335 is a GVA-compliant 3 slot 3U OpenVPX-form factor rugged mission computer

Image credit: Air Force Tech. Sgt. Shawn Nickel/U.S Defense

Consortium's goal, to "allow flexibility in the selection and acquisition of sensors and subsystems that provide sensor data collection, processing, exploitation, communication, and related functions over the full life cycle of the C4ISR system," is extremely important.

The SOSA standards initiative was initially developed as part of the FACE consortium. SOSA standards are compatible with FACE and OMS standards, and they leverage a number of VITA standards, including VITA 65, the OpenVPX standard that ensures interoperability among the COTS solutions that are used to create subsystems and systems.

Increased Interoperability

Modular and ruggedized COTS solutions provide the interoperability and flexibility that's needed to rapidly integrate systems suitable for deployment in all application spaces.

CMOSS defines sharing mechanisms across software, hardware, and network layers. To define these mechanisms, CMOSS standards leverage the:

- VICTORY standards for network interoperability
- OpenVPX standard for combining cards in a common chassis
- Modular Open RF Architecture (MORA) standard for sharing RF resources
- FACE standard for software portability

There are discussions about including FACE in the VICTORY Shared Processing Unit definition.

With open standards-based COTS solutions, organisations are no longer forced to choose the proprietary offerings of a particular vendor. Instead, they have the freedom and flexibility to choose solutions from a far broader selection of vendors who are operating in a more competitive environment.

This more competitive landscape gives system developers access to a wider range of functionality combinations, availability timelines, and price points so they can keep programs on spec, on time, and on budget. They can also choose the optimal solution for the challenge at hand, rather than the only solution offered by the vendor to which they are tied.

In some cases, it will make sense from capability and cost perspectives to choose different solutions from different vendors and combine them. As long as each solution is designed and proven to meet the requirements in the relevant open standards, the risk in taking this approach is manageable. A multivendor strategy also allows defence and aerospace organisations to spread risk across multiple vendors.

Once the system is deployed, open standards compliance and interoperability enable faster, easier, and more frequent technology refresh cycles. Systems, cards, and components can simply be swapped out for updated versions. And, those updated versions don't have to come from the original vendor, providing the opportunity to incorporate more sophisticated, SWaP-friendly, or cost-effective replacements.

On a similar theme, the ability to choose an appropriate solution from any vendor makes it possible to obtain and deploy the most up-to-date technology available to counter or overmatch a particular threat.

Finally, interoperability among system components increases operational availability levels because it's much easier to ensure a reliable, long-term supply chain for spares and replacement parts. As a result, a total life cycle management approach can be adopted that reduces risks and increases the return on technology investments over the long term.

Lowering SWaP-C

Space inside a military vehicle is at a premium, and with such strict restrictions on what a military vehicle can fit inside, an interior cluttered with a myriad of systems, cables, and power supplies limits the amount of supplies that can be carried and hinders the in-vehicle experience.

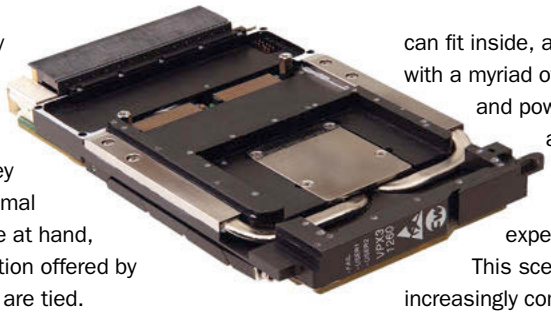

Figure 2: Curtiss-Wright's VPX3-1260 is a rugged 3U OpenVPX single board computer based on the high-performance 9th Gen Intel "Coffee Lake Refresh" Xeon E-2276ME processor

This scenario has become increasingly common as technology has evolved, resulting from military vehicles being retrofitted with new or upgraded capabilities. Historically, adding functionality meant equipping a vehicle with a new standalone system. Each of these line replaceable units (LRUs) came with its own cabling and power supply, and integrating the LRU meant finding space to accommodate all this equipment. What's more, finding the space to add a LRU comes down to more than just physical volume. The options for placing a new LRU may be limited by a platform's mounts and harnesses, and the orientation of an LRU's connectors can make finding the right space to accommodate the system a challenge.

Open standards like SOSA and CMOSS shift electronic systems away from an LRU model. Instead, a chassis can be installed to house LRMs, which can be replaced in order to upgrade functionality without changing the system's physical footprint or peripherals. In addition, multiple functionalities can be incorporated into a single chassis, greatly reducing the number of boxes taking up space in a SWaP-constrained platform. Costs are also reduced since there are fewer pieces of equipment to maintain.

The establishment of MOSA for designing military systems has the potential to significantly change the landscape for COTS vendors and their customers. By lowering costs, fostering interoperability and competition and delivering cutting edge technologies to the battlefield faster, open standards promises to field critical new capabilities to the warfighter. Open architectures open the door to many new possibilities!

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How **AI** is transforming the **NHS**

Whether being used to discover links between genetic codes, power surgical robots or maximise hospital efficiency, artificial intelligence (AI) is transforming the healthcare industry. By **Tom Austin-Morgan**

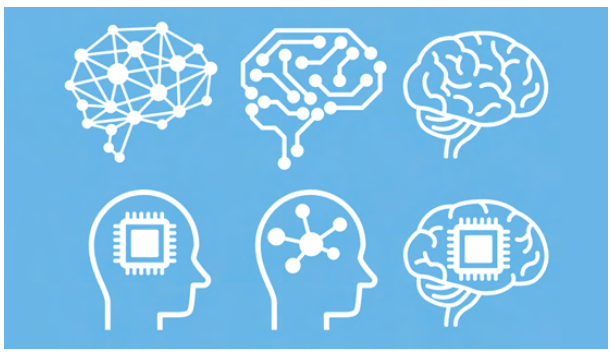
According to the ONS, approximately 22% of all UK deaths in 2018 were considered avoidable. Of these, 64% could be attributed to causes considered preventable and 36% to treatable conditions. Improving the diagnostic process is therefore one of the most important areas where AI is being implemented.

For example, incomplete medical histories and large caseloads can lead to serious human error. Immune to human error, AI can predict and diagnose disease faster than most medical professionals. In one study, an AI model using algorithms and deep learning diagnosed breast cancer at a higher rate than 11 pathologists.

"Healthcare at every level is dependent on algorithms of one kind or another," said Parashkev Nachev, Professor of Neurology, Brain Repair and Rehabilitation at UCL Queen Square Institute of Neurology. "They are needed to ensure care is reproducible, objective and scalable. What I'm trying to do is maintain these characteristics while introducing greater complexity, so care can be better tailored to individual patients."

This means that when you present to your doctor, your treatment is informed not by the average of the population – from which you may be very distant – but by the "neighbourhood" of people like you, those whose characteristics are most similar to yours.

He adds that these ideas can also be applied to how hospitals are run. For example, the UCLH's work on non-attendance, which drew intelligence from complex algorithms in order to work out which patients were more likely not to attend their appointment and remind those who need to be reminded.



Prof Nachev said, "The objective was to increase the yield of reminding interventions so that the fewest number of patients missed their appointments, ensuring consequent delays to care are minimised. Already established at UCLH, it is an approach that others, such as DrDoctor, are helping disseminate across the NHS."

"Without supercomputers we'll be confined to basic models, and there will be a hard ceiling on what we can achieve."
Prof. Parashkev Nachev

Diagnosing and reducing error

The NHS Accelerated Access Collaborative (AAC), chaired by Lord Ara Darzi, aims to make the UK one of the most pro-innovation health systems in the world by pooling the knowledge and expertise of its board members who represent various departments across the NHS, government, and industry.

The AAC runs the Artificial Intelligence in Health and Care Award in partnership with NHSX and the National Institute for Health Research. The award will make £140 million available over three years to accelerate the testing and evaluation of promising AI technologies – from initial feasibility to evaluation within the NHS.

The winners of the first round of the competition were announced on the 8th September 2020.

Among them were Oxford University spin out, Brainomix's 'e-Stroke suite' - a collection of tools that use state-of-the-art AI algorithms that provide real-time interpretation of brain scans to help guide treatment and transfer decisions for stroke patients.

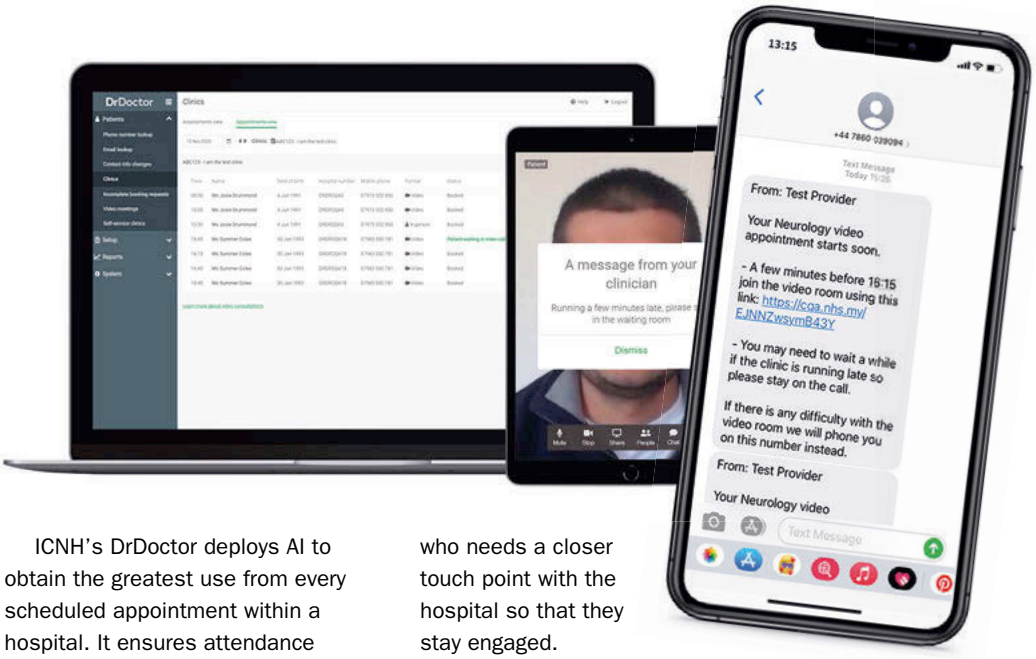
Another was RITA (Referral Intelligence and Triage Automation), Deloitte's solution that automates the triage of GP referrals by reducing the administrative burden on healthcare professionals by assessing the urgency of referrals.

Dutch company, Aidence, has developed Veye Chest, an AI platform to optimise oncology pathways, to automate early lung cancer detection.

Healthy.io's home test kit and mobile app allows patients to self-test at home with clinical grade results. Integrated into the Electronic Medical Record (EMR), real-time results are available for clinicians to review and follow-up. Shifting to testing at home is said to increase uptake, improve quality, reduce workload in primary care, and create savings.

Deep learning software has been developed by Kheiron Medical Technologies to solve critical challenges in the NHS Breast Screening Programme, including reducing missed cancers, tackling the rising shortage of radiologists and improving delays that put women's lives at risk.

DLCExpert by Mirada Medical uses AI software to automate the time-consuming and skill-intensive task of outlining (or 'contouring') healthy organs on medical images for radiotherapy planning so that they are not irradiated during treatment.



Above: DrDoctor deploys AI to schedule appointments and customise communications

ICNH's DrDoctor deploys AI to obtain the greatest use from every scheduled appointment within a hospital. It ensures attendance is as high as possible by using past appointment attendance and demographic data to predict those less likely to attend in future and customising communication with these demographics accordingly.

The AAC is now working with these companies to finalise which site they will be selected for use at and match them to appropriate NHS healthcare services to support testing for each product. It will also evaluate where appropriate evidence is collected to enable faster roll-out of these AI innovations into the NHS.

Streamlining patient experience

Time is money. Efficiently providing a seamless patient experience allows hospitals, clinics and physicians to treat more patients on a daily basis. AI is streamlining the patient experience, helping hospital staff process millions, if not billions of data points, faster and more efficiently.

Netta Myrhinen, head of communications at DrDoctor, explained, "We took patient demographics and used this data to find out why some people turn up, and why some don't. The data we received helped us work out who needs to be sent extra reminders, or bespoke communication, or who needs a closer touch point with the hospital so that they stay engaged.

"We found that men in their early 20s are the least likely to keep an appointment. This could be, for example, that they've moved away from home for the first time, perhaps they're in university and their parents used to sort out their appointments.

"We can now send them a reminder that says 'let us know and we can find you a time that suits you', to give them that control, not just tell them that they have to come in."

Guys & St Thomas hospital in London achieved a 25% reduction in DNA (did not attend) rates via DrDoctor's appointment management solution – which equates to £2.6m in savings per year.

At the Royal Orthopaedic Hospital (a smaller, more specialist Trust with an entirely different patient demographic), DrDoctor achieved a 35% reduction in DNA equating to £100,000 savings annually.

Myrhinen adds: "There is huge potential to improve upon these results once AI is employed in decision making. By using machine learning to predict who should be sent additional communication (such as an appointment reminder) it is possible to ensure that clinic utilisation is optimal and patients that need care actually receive it."

Further funding

Prof Nachev says that for AI to work most effectively in healthcare applications, three things are required: safely accessible data of adequate scale and inclusivity, complex algorithms that can deal with the immense heterogeneity of clinical data, and as much compute capacity as possible. The last is often neglected.

He said, "If you gave me a 400 petaflop machine, such as the Cambridge-1 AI Supercomputer that Nvidia is developing with King's College London and other partners, I could use all of it even on a single task such as predicting outcomes in stroke. The underlying biology is so complex no model could ever be perfect: only different shades of good. And compute is increasingly the limit on achieved model fidelity."

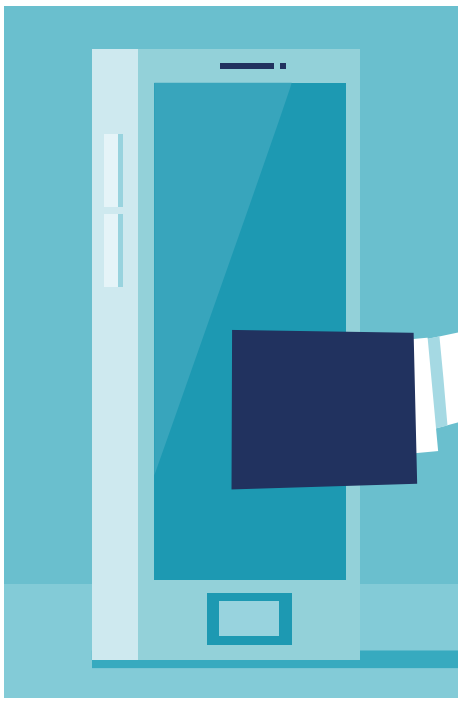
He adds that funds being spent in other industries should be matched in healthcare: "The government is planning to buy the Met Office a £1.2billion supercomputer, yet the NHS lacks even modest computing capabilities. If the decision to pick up an umbrella in the morning is so expensively informed, shouldn't the rather more important decisions taken in hospitals be at least comparably assisted?

"I think the government should think hard about investing more in computation; their focus now appears to be mostly data, and to some extent algorithmics. Without supercomputers we'll be confined to basic models, and there will be a hard ceiling on what we can achieve."

Below: UCLH in London is using AI to diagnose patients

New opportunities for **medical devices**

TINY applications for connected health made possible by Bluetooth Low Energy, as **Adrie Van Meijeren** explains



This past year saw the COVID-19 pandemic put the future of healthcare, and healthcare technology specifically, under a microscope. Leading the way on that future is connected health, which looks to offload the healthcare system through self-monitoring Internet of Things (IoT) connectivity, which has been made possible by new innovations like Bluetooth Low Energy (BLE) devices.

Whether it's a smart thermometer automatically feeding data back to a hospital's cloud, or connected blood pressure meters that measure blood pressure readings over a longer period of time, the benefits of BLE make these applications viable thanks to a combination of low power requirements, disposable batteries, affordability, small solution size, built-in security and extensive IoT connectivity.

Improving patient care

The IoT has already begun creating new opportunities for medical devices to help doctors improve patient care, and with new innovations like BLE, these devices are improving dramatically.

Take wearables, such as a wristband style blood pressure meter, as an example. Wearables and connected health go hand-in-hand. Today, if you need your blood pressure measured, typically you have it done at the doctor's office. But for many patients, a trip to the doctor's office, no matter what the reason, is not exactly a relaxed, care-free time. The stress of being in a doctor's office alone might elevate a patient's blood pressure reading higher than usual, resulting in inaccurate numbers.

With the help of BLE via a sensor node controller, patients can use a connected blood pressure meter at home, helping to ensure a more typically at-rest blood pressure reading, which is then transmitted straight to the cloud for your doctor's office to access. That's higher-quality information for both the doctor and the patient, leading to more accurate diagnoses and prescriptions.

Diabetics are another group of patients that can benefit from innovations in BLE. There is a clear trend away from traditional blood glucose monitors toward glucose meter patches, which don't require patients to prick their fingers. Instead, injection devices such as insulin pens use BLE to send dosage and time stamp data, next to monitored glucose levels from patches, automatically to a smartphone app for self-monitoring and a doctor's office or hospital, ensuring that healthcare providers are kept apprised of any changes as they occur in real-time. Not only is this a pain-free, longer-lasting alternative, it's also a new way of gathering and storing data about patients' glucose levels in real time, made conveniently accessible right on their phones for easy reference later on.

Smart inhalers are another example of how BLE and IoT connectivity are improving medical devices. Traditional inhalers require asthma patients to wait about 30-60 seconds in between puffs for the medication to go into effect. But studies have found that 84% of patients weren't waiting 30 seconds (the bare minimum recommended time) in between inhalations. The majority of patients (54%) didn't even wait 15 seconds between puffs, meaning they likely are not receiving their proper dosage of medicine.

As a result, inhalers aren't as effective as they need to be, and the patient has no idea because they don't have a doctor on-hand to provide immediate feedback. With the help of BLE, smart inhalers can address this problem, measuring the device's usage in real-time and providing feedback about the effectiveness of a patient's inhalations, the dosage they're receiving and how frequently they're receiving it.

If there is an underlying theme connecting devices such as wearables, smart glucose monitors and inhalers, it is that they are all able to be improved via the implementation of BLE. BLE devices with IoT connectivity have created the opportunity for remote self-monitoring, allowing patients and their caregivers to monitor their health and manage

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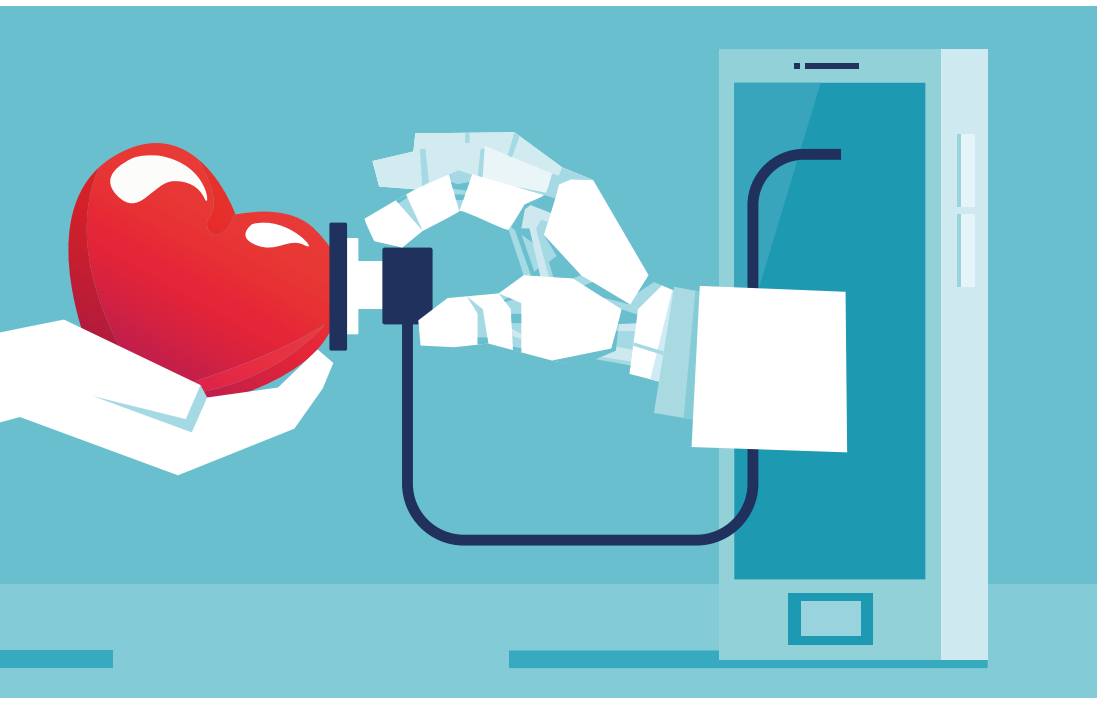

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conditions at home.

Historically, connected medical device engineers have been challenged by a number of factors, such as cost and power availability.

For example, the bill of materials, for both the SoC and external components needed to design a smart blood pressure meter or smart inhaler, has been a major roadblock for engineers trying to deliver meaningful connectivity for these applications.

Meanwhile, power consumption and shelf life have also been major design hurdles.

Medical devices often have long shelf lives, lasting anywhere between 18 months and four years. If the SoC is not consuming power efficiently it simply won't be able to keep up with user needs.

Tackling these challenges

To overcome these challenges, back in November 2019, Dialog introduced the DA14531. As the world's smallest and most power-efficient Bluetooth 5.1 SoC, the DA14531 SoC and DA14531 module were designed specifically to simplify Bluetooth product development and enable wider adoption in industries such as healthcare.

The chip, also known as SmartBond TINY lowers the threshold in terms of cost of adding BLE functionality to a level where it's not any longer prohibitive, even not for disposables. an application to as little as $0.50 in high volumes. The SoC's high level of integration only requires six external passives, a single clock source and a power supply to make a complete Bluetooth low energy system. Combined with its ultra-small form factor of just 2.0 x 1.7 mm, the SmartBond TINY can easily fit into any medical device engineer's design.

SmartBond TINY is based on a powerful 32-bit ARM Cortex M0+ with integrated memories and a complete set of analogue and digital peripherals, delivering a record score of 18300 on the latest IoTMark-BLE, the EEMBC benchmark for IoT connectivity.

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.

"Historically, connected medical device engineers have been challenged by a number of factors, such as cost and power availability."
Adrie Van Meijeren

TINY's low power consumption also ensures a long operating and shelf life, even while powered by the smallest of batteries. The DA14531's integrated DC-DC converter enables a wide operating voltage (1.1 to 3.3V) and derives power directly from environmentally-friendly, disposable silver oxide, zinc air or printable batteries required for high-volume applications, such as smart glucose monitors.

The future of BLE connectivity

As the list of devices requiring wireless connectivity continues to grow, so does pressure and cost of delivering a complete IoT system with medical applications. SmartBond TINY looks to address the growing breadth and costs of IoT devices by enabling a complete system cost reduction through a smaller footprint and size, while maintaining performance quality at a level unmatched by competitors.

The DA14531 makes it possible 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. In instances where wearable products will be considered to support medical monitoring functions, the DA1469x family is a perfect choice – it is fully equipped with an on-board sensor node controller and all functionality required for wearable-on-chip designs.

From blood pressure wearables to smartphone-connected glucose monitoring and connected inhalers, the number of connected medical devices that are possible is limitless - and so is the opportunity for innovating patients' quality of life with BLE.

With the ability to turn any device into a connected application, the TINY SoC and module are opening new markets and driving the adoption of BLE beyond what was previously thought possible in today's landscape.

Software unit verification of medical software

What engineers need to do in order to meet the requirements for software unit verification in IEC 62304. By **Frank Büchner**

In its section on medical device software IEC 62304 requires software unit verification for software of class B and C but does so in a single, terse sentence, "The manufacturer shall perform the software unit verification and document the results."

So as an engineer, how do you go about fulfilling this requirement? Two important things need clarification: What is the definition of a software unit in IEC 62304 and what do you need to verify it?

The regulation defines a software unit as a software item that is not further decomposed and forms the lowest level of the software system. It should be noted that the standard does say that a software unit cannot be subdivided further.

This avoids a contradiction, because elsewhere in the standard it allows the manufacturer to define the granularity of software units.

The definition is intentionally vague because it then allows the standard to be applied to different types of software and different development methods.

Elsewhere in the standard it mentions another characteristic of a software unit, "Software units can be tested separately."

It's vague, so one can also take the programming language into account i.e. the smallest software unit in the programming language C is a function in the sense of C; object-oriented programming languages like C++ or Java take a method as a software unit.

Nevertheless, keep in mind that it's the manufacturer of the software that defines what a software unit is.

Medical software for embedded systems is often written in the C programming language.

Which units exist and which functionality they should have is determined for software of classes B and C by the software detailed design. The software design then results in the software architecture.

A good architecture is characterised by narrow interfaces between the units and a reasonable size when it come to the units. A unit can include several C functions.

Definition "verification"

In IEC 62304, verification is defined as, "Confirmation through provision of objective evidence that specified requirements have been fulfilled". These requirements are specified in the software design, which must be carried out and documented for software of classes B and C.

In the process, the requirements for the entire software are assigned to the software units, which ultimately results in the description of the functionality of the units.

For software of class C, the design must be detailed enough to allow the correct implementation of the software unit. The detailed design must also be documented for the interfaces of class C software, both for the interfaces to external components (from hardware or software) and for the interfaces between software units.

According to IEC 62304, the verification of the software units is established by strategies, methods and procedures. Testing is obviously considered, since the appropriateness of the test procedures must be assessed for software of classes B and C.

Accordingly, acceptance criteria need to be established for the software units and their observance ensured for software of classes B and C.

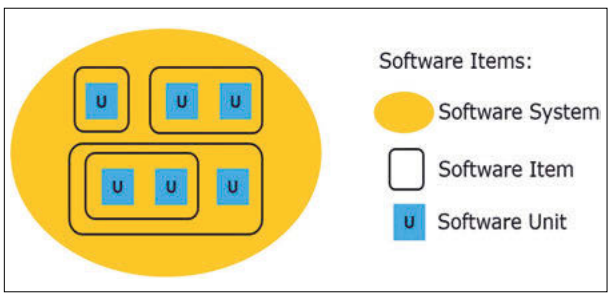

Figure 1: In IEC 62304 the items on the lowest level are called 'units'

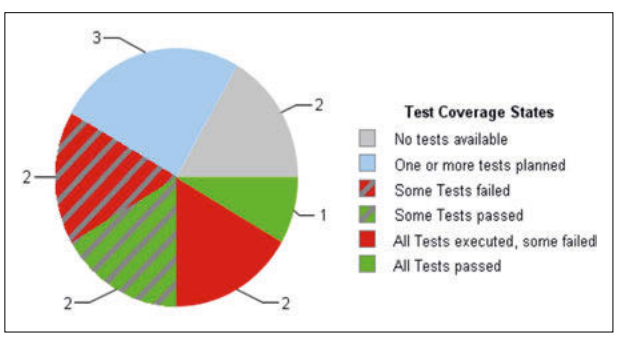

Figure 2: Display of the coverage of the requirements by test cases in the TESSY tool

Acceptance criterion "requirements"

Among the criteria is does the software code implement requirements including risk control measures? This is typically checked using appropriate test cases. If there is at least one test case that tests a certain requirement and this test case has been executed and it has

passed, the code implements this requirement.

However, if this assignment has been made in an appropriate tool, it is possible to determine, with the aid of the tool, whether all requirements are linked to test cases and whether these have been passed.

TESSY is a unit test tool (see Figure 2) that can manage requirements and their relationship to test cases.

The goal is a completely filled green circle, indicating that all requirements are linked to test cases and that all of these test cases have been executed and passed.

Acceptance criterion "interface design"

Is the software code without contradictions to the interface design of the software unit? TESSY can determine the interface of a software unit from the software code and display it in human readable form in its GUI and reports, and additionally in machine readable form (XML). This can be used to check whether the software code of the software unit contains contradictions to the interface design of the software unit.

The passing direction IN (Figure 3) indicates that the variable is only read by the software unit, and as a consequence, an input value must be specified for this variable prior to the test. The passing direction OUT requires for a proper test an expected value, which is then compared with the actual value after the test.

If the interface description as result of the detailed design exists in machine-readable form, it might be feasible to automate the comparison of the expected interface (from the design) with the actual interface (from the code) by utilising the machine-readable format (XML) that TESSY creates. This would reveal contradictions of the implemented design to the intended design. Without effortless automated comparison, manual review/inspection is needed.

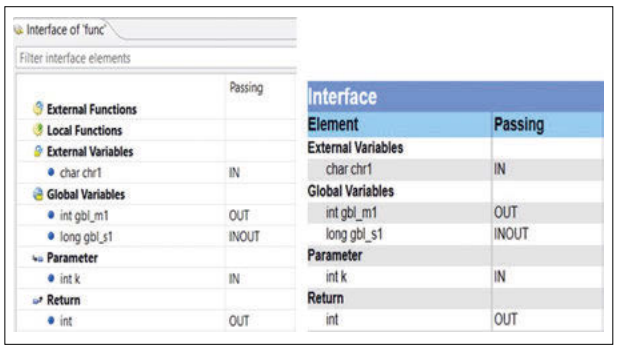

Figure 3: Interface of the software unit "func"

"Procedures and coding standards"

Does the software code conform to programming procedures and coding standards? IEC 62304 recommends using coding standards in order to consistently achieve the desirable code characteristics.

Examples of coding standards include (a) requirements for understand-ability, (b) language usage rules or restrictions on the use, and (c) complexity management.

Requirements for understand-ability of the code are usually satisfied by application of a programming style guide. Stylistic rules usually concern aspects like naming (e.g. CamelCaseNotation, underscores in identifiers), indentation, the setting of the curly braces, and more.

Other sets of guidelines do restrict the language, trying to prevent undefined, unspecified, or implementation-defined language constructs. As a result unintended behaviour of the software (e.g. a crash) can be avoided. Examples for guidelines which restrict the language are in the MISRA guidelines.

To manage complexity certain metrics should not exceed certain values. For example, the Lines-of-Code (LOC) metric, which indicates the number of lines in a software unit, prevents larger software units. One metric that is often used to measure complexity is McCabe's cyclomatic complexity. This metric is based on the control flow graph of the software unit and indicates the number of complete, linearly independent paths through it. This is also the number of binary decisions plus one in a software unit. Unfortunately, this metric does not consider calculations or compound decisions, so you get surprisingly low values for large calculations and complicated decisions.

Figure 4 shows the cyclomatic complexity for software units in the TESSY tool. The value for nine units is shown in the CC column. The values are highlighted in colour: If the value is highlighted in green, it is lower than the threshold value for a warning, which in the present example is set to the value 10; values highlighted in red are greater than or equal to the threshold value for an error, which in the present example is set to the value 20; values highlighted in yellow are between the two thresholds.

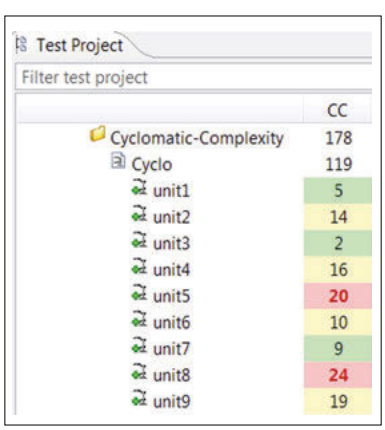

Figure 4: The cyclomatic complexity for some software units in TESSY

Further acceptance criteria

IEC 62304 specifies further acceptance criteria for class C software, for example related to data and control flow or related to boundary values in test cases.

The manufacturer must assign a security class to the software system. Class A software poses no unacceptable risk to people; class B software can cause non-serious injury; and class C software can cause death.

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'A SHOCK THAT SEEDS INNOVATION'

What kind of audio market is set to emerge after the pandemic?

By **Neil Tyler**

The Covid-19 pandemic is the kind of shock that seeds innovation and shapes industries," said Geir Skaaden, Chief Products and Services Officer, Xperi, speaking at last year's Audio Collaborative virtual event.

"Over the past twelve months there has been an opening up of consumer expectations with more people, for example, embracing e-commerce. With people having to spend increased amounts of time at home, how they spend their entertainment budgets has changed radically. The big question for the industry is, are these changes temporary or permanent when it comes to how consumers engage with audio experiences?"

Skaarden suggested that with people spending more time at home so more content was being consumed and that, as a consequence, consumers were looking for a different type of experience that was not available to them elsewhere.

"I think post pandemic we'll see a continuation in this trend, with consumers spending more on TVs and on audio technology. We are seeing new demand patterns emerging as consumers look to invest in equipment for other rooms, beyond the traditional living/sitting room. They want excellent audio quality anywhere they consumer content.

"They're expecting far more from their technology. There's always a desire for a 'better experience', immersive technologies is a good example of that, but there is also a risk that with greater choice and more offerings consumers will have to navigate a more chaotic audio market."

Voice will remain a key driver in how people engage with content, said Skaarden, whether in the home, in the car or on the move.

"Today's experiences will stick, as we move into 2021. New content is being driven by a demand for more offerings and this will encourage further advances in smart speakers, artificial intelligence and technologies that will make it easier to engage with new forms of content – whether that's broadcasting on demand, new models of engagement or the better curating of content."

"I think that's a cause for optimism; better access to content is essential for consumers and I think there will be ample opportunity to adapt and change to meet new demands, with interesting opportunities for new products."

"The Covid-19 pandemic is the kind of shock that seeds innovation and shapes industries."
Geir Skaade

One market that has seen dramatic changes is headphones, which has experienced phenomenal growth over the last decade and as a result, has become one of the fastest-selling personal electronic devices on the market.

According to Futuresource research analyst Luke Pearce, "Covid-19 has accelerated their adoption due to the increase in remote working, the growth of gaming and further potential in use cases, such as health and hearing augmentation."

In a panel discussion chaired by Pearce, Stuart George, Managing Director at Cambridge Audio said that headphones were no longer simply being used for work purposes but increasingly for leisure and relaxation.

"Today, people have chosen to use audio as a place to find private space and personal isolation. In many ways, seeking solace to escape the stress and strains of

Song_about_summer/stock.adobe.com

Covid-19 has been a key reason to utilise headphones within the home environment."

Bernice Cramer, Director of Product Management and Global Marketing at Bose, added that headphones were no longer simply about passive listening alone but were now being used for multi-tasking.

As we've got use to juggling remote working with other personal commitments and family time, Cramer suggested that Covid-19 had accelerated the need to move between different spaces and that, "headphone devices are now being used as an interface with the world."

Tim Johnston, Vice President of Engineering at Starkey Hearing warned that while headsets and headphones were providing a broad range of innovative solutions for improving communication and providing a form of escapism, the fact was that with so many people now being exposed to more sound than ever before, with total exposure over one day since lockdown having increased phenomenally, there was a growing risk to hearing health.

He made the point that, "A growing number of young people are now experiencing hearing loss through sound exposure. We also have to consider the fact that with more people living longer lives so they will be living with hearing loss for longer."

Multiple-product ownership

George made the point that the headphones market and the rate of innovation for new products is helping to fuel an addictive need, among consumers, for premium audio quality.

While consumer preferences for audio devices will certainly differ, the panel agreed that we would be seeing an overlap between what consumers are seeking with headphones products and what is requested from the hearing aid market.

According to Chris Havell, Senior Director of Product Marketing, Voice & Music at Qualcomm Technologies, "While we will see multiple-product ownership, there are very significant differences between certain use cases and therefore where a product has its focus. Our requirements will certainly differ for work purposes, for fitness and for entertainment – so I don't think we will see an over-arching dominant technology."

Cramer added that, "the single most reliable predicter about whether consumers will buy a pair of premium headphones, is whether they already own another pair of premium headphones."

According to Cramer, people remain interested in custom-built devices for many different activities and we will not be looking at a 'one-size fits all' solution.

"Sound quality is a universal requirement," commented George. "First and foremost, it's purely about the listening experience and the ability to listen to music in better quality."

However, as all headphones products are becoming more specialised, there was agreement that audio quality, by itself, would no longer be sufficient.

Microphone quality will also be crucial and the implementation of AI allowing users to distinguish voices from background noise will be particularly important given the amount of time now spent attending virtual meetings remotely.

"Situational hearing enhancement will be invaluable," added Cramer, "and hearing enhancement is likely to become wrapped up in the audio quality of devices."

Looking to the future of audio Havell said that there were still numerous improvements to be made.

He pointed to immersive audio quality, microphone audio quality and protecting users' health as all being of importance.

"Sound quality is a universal requirement, it's purely about the listening experience and the ability to listen to music in better quality."
Stuart George

In addition to this, consumers were now gaming and watching movies more using headsets, which will mean that audio quality will also have to address other issues such as delivereing lower latency.

Havell added that it would be essential for the industry to start implementing these features, moving forward, into standard headphone products for consumers.

"With multiple product ownership likely, it will be about delivering a particular product for a specific purpose. Working from home will be about good communications, blocking out background noise to deliver a more professional experience; while with sport applications I doubt users will be worried about the quality of a call, but rather the audio experience."

Future trends

Over the next decade audio demand is expected to increase substantially and there is likely to be a requirement for more personalised audio, along with more voice control.

Users will expect the audio experience to be seamless and transferable, so they will be able to move from the office, to their car and to the home with no drop off in quality.

The need for more personalised audio will be achievable because of more intelligence being available, so it will be possible to create better individual audio experiences, although that may require users to give up some degree of privacy.

Immersive technologies will also require significant advances in audio technology as the need for generative sound systems for virtual objects, meeting the need to not only 'feel' and 'believe' in virtual objects but create the sounds that are associated with objects in order to believe in them, will be required.

Audio continues to matter and in this space it's no longer simply about delivering an experience that is 'just good enough'.

Blaize Delivers First Open and Code-free AI Software Platform

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Blaize Delivers First Open and Code-free AI Software Platform Spanning the Entire Edge AI Application Lifecycle

Blaize today fully unveiled the Blaize AI Studio offering, the industry's first open and code-free software platform to span the complete edge AI operational workflow from idea to development, deployment and management. AI Studio dramatically reduces edge AI application deployment complexity, time, and cost by breaking the barriers within existing application development and machine learning operations (MLOps) infrastructure that hinder edge AI deployments. Eliminating the complexities of integrating disparate tools and workflows, along with the introduction of multiple ease-of-use and intelligence features, AI Studio reduces from months to days the time required to go from models to deployed production applications. "While AI applications are migrating to the Edge with growth projected to outpace that of the Data Center, Edge AI deployments today are complicated by a lack of tools for application development and MLOps," says Dinakar Munagala, Co-founder and CEO, Blaize. "AI Studio was born of the insights to this problem gained in our earliest POC edge AI hardware customer engagements, as we recognized the need and opportunity for a new class of AI software platform to address the complete end-to-end edge AI operational workflow."

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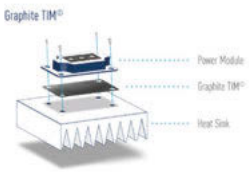
Panasonic Industry introduces new type of its Graphite Thermal Interface Material (TIM) for efficient thermal dissipation on power modules



Handling heat is a major challenge when operating power modules in demanding and even harsh industrial or automotive contexts.

Mounted on dedicated heat sinks, heat dissipation is traditionally achieved with a particular layer of grease – that, of course, has to be replaced from time to time. A labor-intensive frequent task, next to the fact that grease naturally doesn't stay only where it is applied. That, in turn, counteracts an effective thermal dissipation.

All these issues are addressed – and solved by Panasonic Industry's GraphiteTIM. Now, the renowned manufacturer has released its highly compressible EYGR type, reducing the thermal resistance by filling the gap and the unevenness on the surface of both power module and heatsink, and thus enhancing the thermal dissipation performance.

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Lattice Announces Training Center for Award-Winning FPGAs and Solution Stacks

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Created in Partnership with Leading European FPGA Consulting Firm, Lattice Education Competence Center to Focus Exclusively on Lattice Technologies

Lattice Semiconductor Corporation (NASDAQ: LSCC), the low-power programmable leader, today announced an agreement with Krassin Consulting GmbH to establish the Lattice Education Competence Center (LEC2), a comprehensive training center. The LEC2 will provide Lattice's customers and partners with the hands-on product training and application design expertise needed to get Lattice-based solutions to market quickly and easily. Focused solely on low-power Lattice FPGAs and award-winning solutions stacks, the LEC2 will help customers design and implement solutions for the industrial, automotive, communications, and computing markets.

Eugen Krassin is the owner of Krassin Consulting GmbH and founder of PLC2, Europe's leading field application engineer (FAE) training and design services company. Krassin said, "We are excited to work with the company who has modernized the low-power FPGA. The Lattice Nexus platform is a completely redesigned FPGA fabric based on a 28 nm FD-SOI process technology that delivers previously unavailable levels of low-power performance, reliability, and ease-of-use to the FPGA ecosystem. Lattice technologies are enabling FPGA-based solutions that were previously not possible."

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Nexperia launches compact '2 in 1' protection for high-speed data lines

www.nexperia.com

Best-in-class ESD and system robustness for USB3.2 and HDMI2.1

Nexperia, the expert in essential semiconductors, today announced three new TrEOS protection devices that provide the most compact method to suppress ESD in USB3.2, HDMI2.1 and other high-speed data lines. The new PUSB3BB2DF, PESD5V0C2BDF, PESD4V0Z2BCDF devices provide best-in-class ESD protection and system robustness by combining high RF performance with very low clamping and very high surge capability.

Stefan Seider, product group manager at Nexperia comments: "Electrical engineers designing HDMI2.1, USB, Thunderbolt and other high-speed interfaces can miniaturize their designs while benefiting from industry-leading RF performance."

The new parts combine two TrEOS protection diodes in one miniature DFN0603-3 package – effectively delivering two diodes in the footprint of one. As well as saving space, this reduces component count and increases reliability. Also, the package is well-known so there are no unforeseen manufacturing challenges to address.

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Powell Electronics now Europe's largest Positronic stockist

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$2.5M investment following European New Business franchise deal

Powell Electronics, the supplier of connectors and more for high-rel applications including defence, aerospace and industrial, is to become Europe's largest stocking distributor of Positronic connectors following a franchise deal signed by the two companies. Powell will hold $2.5M of inventory at its new European warehouse and headquarters in Dublin, Ireland and focus on developing new business.

Positronic builds high-reliability power and signal connectors for a wide variety of global industries from medical to deep space where failure is not an option for critical systems. Examples of the company's range of versatile high-performance connectors include the Scorpion family, described by the company as 'the most versatile modular power/signal connector on the planet', and the Combo D-subminiature families which offer a mixture of power and signal contacts in standard and high-density variations.

Commented Anita Warner, Positronic's global director of sales: "We welcome Powell to our European network. We are sure that we can build on our successful relationship in the USA, and are excited that Powell will be offering such large and wide stocks of our parts in Europe."

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Powell Electronics signs European deal with EMC leader, P&P Technology

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Innovative range of EMC gaskets, honeycomb shielded vents and silicone solutions available ex-stock in Europe

Powell Electronics, the supplier of connectors and more for high-rel applications including defence, aerospace and industrial, has signed a Pan-European franchise distribution agreement with P&P Technology, one of Europe's leading and most trusted manufacturers of radio frequency and EMI screening products. As well as providing highly-effective EMC solutions, P&P also offers very fast turnaround on custom parts and competitive pricing.

Powell is stocking a broad portfolio of P&P Technology's EMC products at state-of-the-art warehouse facilities outside Dublin, Eire. Included in the range are EMC gaskets which fit all standard connector profiles, 'honeycomb' EMI shielded vents and air filters, and filters produced using oriented wire in silicone rubber that combine excellent environmental protection with a high level of shielding effectiveness.

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Two New Gen 3 PXI Express (PXIe) Chassis from Pickering Interfaces

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Two New Gen 3 PXI Express (PXIe) Chassis from Pickering Interfaces Ensure Maximum PXI Application Flexibility

All hybrid, high-performance and low-cost for a broad range of applications

Pickering Interfaces, the leading supplier of modular signal switching and simulation solutions for use in electronic test and verification, today launched new 8- and 18-slot Gen 3 PXIe chassis designed for high-performance, benchtop or rack-mount applications. Both chassis feature an intelligent chassis management system that monitors the power supply voltage, internal temperature and cooling fan speed.

Pickering's 42-924 8-slot chassis provides seven hybrid-compatible slots for application flexibility. The 42-925 18-slot chassis provides one PXIe system slot, one PXIe timing slot and 16 hybrid-compatible slots for similar versatility. Any 3U PXI, PXIe, or Compact PCI-compliant module will work in any module slot.

The 4U high chassis also benefit from high-capacity system power supplies rated at 400W (8-slot) and 1200W (18-slot).

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