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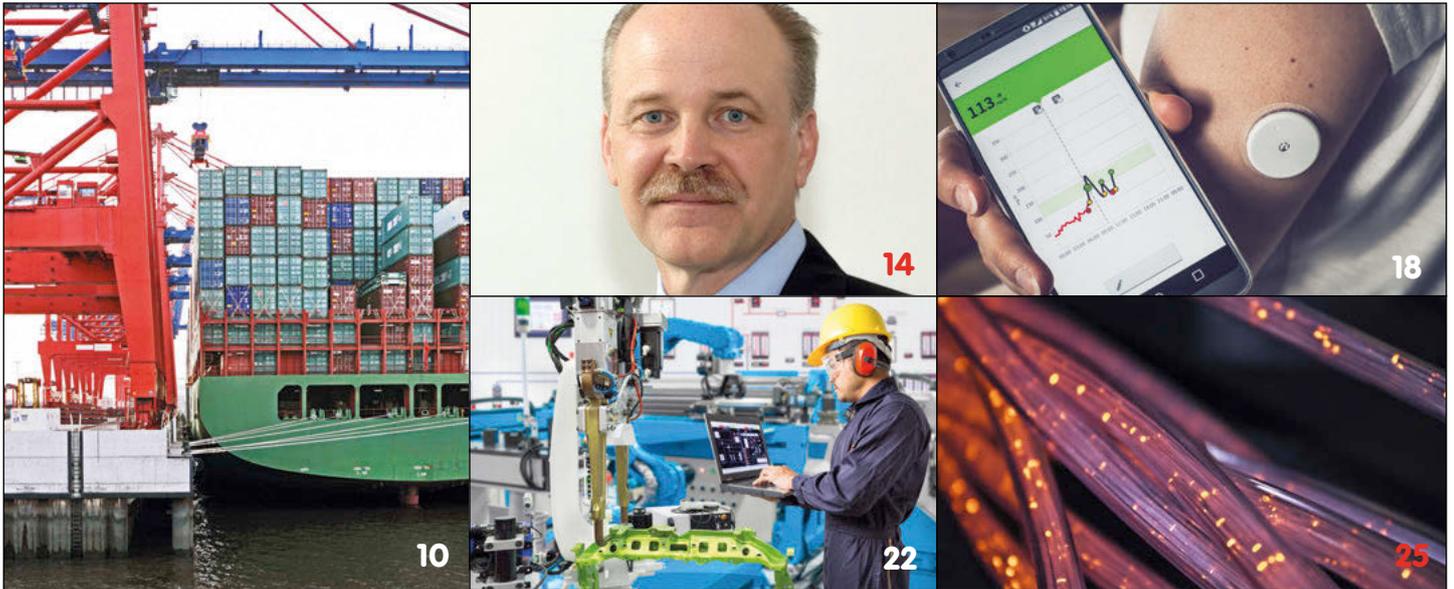


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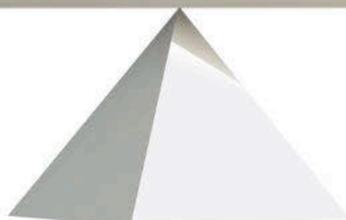
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Building a Britain fit for the future

WAS LAST MONTH'S SPENDING REVIEW A STEP IN THE RIGHT DIRECTION OR A MISSED OPPORTUNITY?



Who'd be Chancellor of the Exchequer, given the historically tight financial circumstances the UK economy finds itself in. But given those challenges did Rishi Sunak do enough to lay the foundations for a recovery and put in place the building blocks to create an economy for the post-pandemic world?

The Spending Review did contain £14.6 billion towards R&D in 2021-22, building on the government's commitment to increase public R&D investment to £22 billion per year by 2024-25. That's significant and recognises the importance of a strong and thriving research base to drive an economic recovery.

The Chancellor also committed to a multi-year UK Research and Innovation and National Academies core research budget, reaffirmed the establishment of a Global Talent Route to better attract scientists, researchers and innovators and re-committed 'to maintaining and enhancing the UK's position at the forefront of global science collaboration'.

But for many, the Chancellor's statement felt like a missed opportunity.

While planning to spend more on things like infrastructure there really was no longer term planning when it came to outlining support for new industries such as green energy, biotech, advanced materials and artificial intelligence.

And although he committed to a new UK infrastructure Bank, Levelling Up Fund and UK Shared Prosperity Fund Sunak's Spending Review lacked clout and coherence and appeared to be little more than tinkering at the edges.

With the UK economy expected to contract by 1.1 per cent – its worst performance in over 300 years – and our recovery forecast to be among the slowest of the G20, surely now was the time to trigger a wholesale transformation.

The way we live, how we conduct business and interact with one another has fundamentally changed, so wasn't now the right time to rise to the challenge of what has been the biggest economic upheaval in generations?

Wasn't now the time to reshape and redefine the economy and to nurture the modern, digital and technical skills that people need if they are to retrain and up-skill?

Government documents show that only £3bn in new money has actually been allocated to a green stimulus, for example, significantly less than in countries like France and Germany who are spending over £60bn on carbon-cutting stimulus measures. By contrast Sunak announced £27bn for new roads – so much for the green revolution!

No vision, no imagination and a missed opportunity to be truly transformative.

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

“While planning to spend more on things like infrastructure there really was no longer term planning when it came to outlining support for new industries, such as green energy, biotech, advanced materials and artificial intelligence.”

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New integrated supply chain

FIRST-EVER SUPPLY CHAIN FOR GRAPHENE HALL EFFECT SENSORS. NEIL TYLER REPORTS

Paragraf, a specialist in graphene-based electronic sensors and devices, is leading a project to set up a supply chain for graphene Hall-Effect sensors used in high-temperature power electronics, electric machines and drives (PEMD) within the aerospace sector.

The project, named High-T Hall, stems from the UK Research and Innovation's (UKRI) 'Driving the Electric Revolution' challenge and brings together Paragraf, Rolls-Royce, TT Electronics (Aero Stanrew) and the Compound Semiconductor Applications Catapult (CSA Catapult) to demonstrate how graphene-based Hall Effect sensors can operate reliably at high temperatures, paving the way for more efficient electric engines in aerospace and other sectors.

Hall Effect sensors play a major role in monitoring current levels and magnetic fields in PEMD applications, which is critical in monitoring drive power consumption and machine speed and position.

The deployment of conventional silicon Hall sensors is restricted to environments with temperatures below 150°C and frequencies below 100kHz, which can constrain system level design. Project High-T Hall aims to demonstrate that graphene-based Hall Effect sensors will operate reliably up to 180°C, and potentially up to 230 °C, allowing them to be mounted within the machine or power module enclosure enabling much greater flexibility in the design of new PEMD equipment aligned to Silicon Carbide power devices and higher



performance more compact electrical machines.

Commenting Ivor Guiney, co-founder of Paragraf said, "This pioneering project will hopefully lead to better efficiency in all-electric engines and help accelerate the adoption of e-planes and, more generally, electric vehicles."

As the lead partner in High-T Hall, Paragraf will design and manufacture custom Hall Effect sensors for integration into the systems of Rolls-Royce and TT Electronics. The CSA Catapult will provide their packaging expertise to develop innovative packaging solutions and advanced assembly processes for realising the prototypes.

Martin McHugh, CTO and Acting CEO at the CSA Catapult added, "The aim of project High-T Hall is to demonstrate an integrated UK supply chain solution for advanced Hall sensing within PEMD. This will address the issues PEMDs experience when switching frequencies across a broad range of temperature conditions."

Project High-T Hall started in July 2020 and is due to run for one year. It is funded by UK Research and Innovation.

New Kit powers-up sensor projects

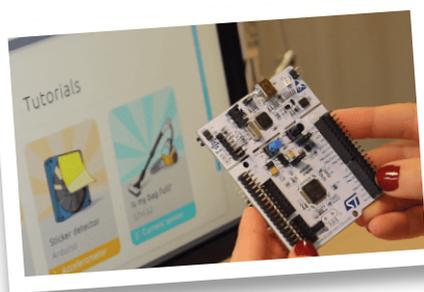
Arduino, the open-source hardware, software and content platform, has collaborated with Chinese electronics company, Seeed to create the Arduino Sensor Kit. The kit brings Seeed's Grove sensors to Arduino's most popular board - the Arduino UNO - making it easier to design applications incorporating sensors.

The kit integrates the 10 most popular Grove sensors and actuators all on one board and users can plug, sketch and play without any additional wiring required or learning how to solder.

The Sensor Kit is available as a standalone kit and contains a Base Shield and ten modules that can be connected either through the digital, analogue or I2C connectors on the shield, to make unique projects. The modules include an OLED screen, four Digital modules (LED, Button, Buzzer and a Potentiometer), five Sensors (Light, Sound, Air-Pressure, Temperature and Accelerometer), as well as a range of learning materials to guide users through their projects.

Designed to fit on top of an Arduino UNO, the Base Shield comes equipped with 16 Grove connectors, which, when placed on the board, provides functionality to various pins. With 7x digital connections, 4x analogue connections, 4x I2C connections and 1x UART connection, the Base Shield can be easily mounted onto an Arduino UNO board and programmed through the Arduino IDE.





Cartesiam launches NanoEdge AI Studio V2

Cartesiam has unveiled the NanoEdge AI Studio V2, the first integrated development environment (IDE) that simplifies the creation of machine learning, inference, and now classification libraries for direct implementation on Arm Cortex-M MCUs.

With thousands of commercially available industrial IoT (IIoT) embedded devices already in production with NanoEdge AI Studio V1 for anomaly detection, the addition of classification libraries to NanoEdge AI Studio V2 will enable developers to go beyond anomaly detection to qualify problems directly in endpoints.

“Cartesiam makes tools for embedded developers, offering an intuitive push-button approach that requires no background in data science, opening AI to the billions of resource-constrained embedded devices built with Arm Cortex-M MCUs,” said Joël Rubino, CEO and co-founder, Cartesiam. “We initially designed NanoEdge AI Studio to meet demand from our customers in predictive maintenance, who, having accumulated data on the use of their equipment, asked us to help them easily qualify their events as well as to anticipate them. The new version of our IDE allows those customers - and any other embedded designer - to develop a classification library without the usual challenges associated with signal processing and machine learning skills. This dramatically reduces costs and speeds time to market.”

Cartesiam has also launched ‘Use Case Explorer’ at data.cartesiam.ai, a web-based platform that will enable users to download real datasets and try out the NanoEdge AI Studio IDE on representative use cases.

Cartesiam said that it would be continuously enhancing the portal with additional datasets.

Andes adds new RISC-V processors

ANDES TECHNOLOGY ADDS TO ITS ANDESCORE SERIES WITH NEW MULTICORE PROCESSORS. **NEIL TYLER REPORTS**

Andes Technology has launched a series of new processors as part of its AndesCore series, including: high performance superscalar A45MP and AX45MP multicore processors and A27L2 and AX27L2 processors with a Level-2 (L2) cache controller.

The AndesCore 45-series IPs are in-order 8-stage dual-issue RISC-V processors, and come equipped with an optional DSP (RISC-V P-extension) unit, single or double precision Floating Point Unit and MMU (Memory Management Unit) that is also able to support Linux-based applications.

Its performance-efficient single core members, including 32-bit A45/D45/N45 and 64-bit AX45/NX45, have been designed in by several customers since they appeared in the last quarter.

The new multi-core members, the 32-bit A45MP and 64-bit AX45MP, are able to support up to 4 cores with an optional L2 cache controller to meet the computing demands of heavy-duty applications such as AR/VR, AI/machine learning, 5G, enterprise-grade storage device, and networking.

The newest members of the AndesCore 27-series, the 32-bit A27L2 and 64-bit AX27L2, inherit the MemBoost feature, where multiple outstanding data accesses and I/D cache prefetch greatly boost the memory subsystem performance. The L2 cache controller of the A27L2 and AX27L2 further raise memory bandwidth by 2x and reduce memory latencies by 70%.



“Multicore processors boost performance by using more cores and are suitable for applications with high parallelism,” said Dr. Charlie Su, CTO and Executive VP of Andes.

“Compared with the single-issue 27-series processors, the dual-issue 45-series processors achieve more than 70% total performance enhancement with less than 50% additional logic area and dynamic power consumption. Furthermore, their maximum operating frequency can run up to 2.4 GHz at the popular 12nm process node. Similarly, the 27L2 processors with L2 cache controller and MemBoost are suitable for those designs that need only single core, but still require substantial performance on memory subsystem. The 45-series and 27-series together provide a wide spectrum of processor solutions to address diversified SoC requirements.”

All the new cores fully support Andes V5 architecture and are compliant with the most updated RISC-V extensions, as well as all Andes V5 features such as PowerBrake, QuickNap, and WFI for additional power saving; StackSafe for stack overflow/underflow protection; and CoDense for additional code density enhancement on top of RISC-V C-extension.

Xilinx acquires Falcon Computing Solutions

Xilinx has acquired Falcon Computing Solutions, a privately-held provider of high-level synthesis (HLS) compiler optimisation technology for hardware acceleration of software applications.

The acquisition will make adaptive computing more accessible to software developers by enhancing the Xilinx Vitis Unified Software Platform with automated hardware aware optimisations.

The integration of Falcon Computing’s compiler technology into the Vitis platform will allow software developers to accelerate C++ applications with minimal hardware expertise. Falcon Computing’s source code transformation

reduces the need for application developers to adapt their code, or add architecture-specific programming directives, in order to achieve significant hardware acceleration.

“The growing demand for adaptive computing is driving a new era of FPGA adoption in the data centre and embedded applications,” said Salil Rajee, executive vice president and general manager, Data Center Group at Xilinx. “Falcon Computing’s innovative compiler technology and highly specialised compiler team will provide critical expertise that will advance software programmability and help bring the benefits of adaptive computing to more developers.”

Ultrathin spray-applied MXene antennas

DREXEL UNIVERSITY RESEARCHERS HAVE PRODUCED A FLEXIBLE, SPRAY-APPLIED ANTENNA. **NEIL TYLER** REPORTS

Researchers from Drexel University have developed antennas that are so thin that they can be sprayed into place and can provide a strong signal at bandwidths that will be used by 5G mobile devices.

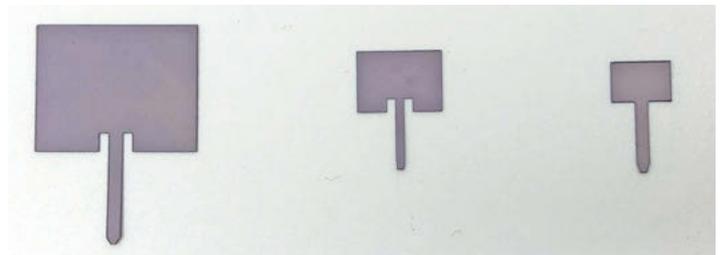
Performance results for the antennas, which are made from a new type of two-dimensional material called MXene, could have ramifications for mobile, wearable and connected “internet of things” technology.

The MXene antennas, which have been in development at Drexel for just over two years, are already performing nearly as well as the copper antennas found in most mobile devices, but with the benefit of being just a fraction of their thickness and weight.

“This combination of communications performance with extreme thinness, flexibility and durability sets a new standard for antenna technology,” said Yury Gogotsi, professor of Materials Science and Engineering in Drexel’s College of Engineering, who is the lead author of a paper, recently published, on the MXene antennas. “Copper antennas’ physical limitations have prevented connected and mobile technology from making the big leaps forward that many have predicted. Due to their unique set of characteristics MXene antennas could play an enabling role in the development of IoT technology.”

When it comes to antennas for future devices they will need to be able to operate in a variety of environments. According to Gogotsi, this makes MXene an appealing material for new antennas because it can be spray applied, screen printed or inkjet-printed onto just about any substrate without sacrificing performance.

“Generally copper antenna arrays are manufactured by etching printed circuit boards, this is a difficult process to undertake on a flexible substrate,” said Meikang Han, a researcher at the A.J. Drexel Nanomaterials Institute. “This puts MXene at a distinct advantage because it disperses in water to produce an ink, which can be sprayed



or printed on to surfaces to create antennas.”

In the paper the performance of three sets of spray-coated MXene antennas, which were between 7-14 times thinner and 15-30 times lighter than a similar copper antenna - were addressed. The antennas were tested in both lab and open environments for key performance measures of how efficiently the antenna worked across the three radio frequencies commonly used for telecommunication, including one in the target frequency of operation for 5G devices.

In each instance, the MXene antennas performed within 5% percent of copper antennas, with their performance increasing with the thickness of the antenna. The best performing MXene patch antenna, about one-seventh the thickness of standard copper antennas, was 99% as efficient as a copper antenna operating at the 16.4 GHz frequency in an open environment. MXenes were also 98% as effective as their copper counterparts operating in the 5G bandwidth.

Their performance exceeded that of several other new materials being considered for antennas, and did not waiver when the MXene antennas were subjected to as many as 5,000 bending cycles - a key mark of durability.

SiC FET power semiconductors

UnitedSiC, a manufacturer of silicon carbide (SiC) power semiconductors, has launched four devices based on its advanced Gen 4 SiC FET technology platform.

As the first and only 750V SiC FETs currently available on the market, they enable new performance levels, based on leadership Figures of Merit (FoM), that will benefit power applications across automotive, industrial charging, telecom rectifiers, datacentre PFC, and DC-DC conversion as well as renewable energy and energy storage.

Available in 18 and 60 mohm options, these SiC FETs deliver FoMs with reduced on-resistance per unit area, and low intrinsic capacitance. In hard-switching applications, the Gen 4 FETs exhibit the lowest RDS(on) x EOSS (mohm- μ J) resulting in lower turn-on and turn-off loss. In soft-switching applications,

their low RDS(on) x Coss(tr) (mohm-nF) specification provides lower conduction loss and higher frequency.

According to United SiC, these devices not only surpass existing competitive SiC MOSFET performance whether running cool (25C) or hot (125C), but also offer the lowest integral diode VF with excellent reverse recovery delivering low dead-time losses and increased efficiency.

In expanding UnitedSiC’s offering to 750V, the new devices will offer more designer headroom and reduced design constraints. This higher VDS rating also makes these FETs beneficial for 400/500V bus voltage applications. With a widely compatible gate drive of +/-20V, 5V Vth, all devices can be driven with 0 to +12V gate voltages. This means they work with existing SiC MOSFET, Si



IGBTs and Si MOSFET gate drivers.

Commenting Anup Bhalla, VP Engineering at UnitedSiC, said, “These devices help address the challenges facing engineers working across sectors with the highest voltage and power demands - from DC-DC conversion and on-board charging to power factor correction and solar inverters.

“We will be announcing many new Gen 4 devices over the next 9 months which will further improve on cost-effectiveness, heat efficiency and design headroom.”

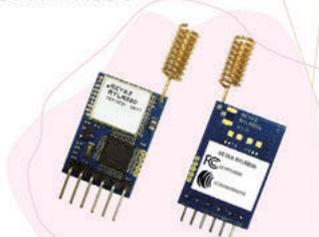


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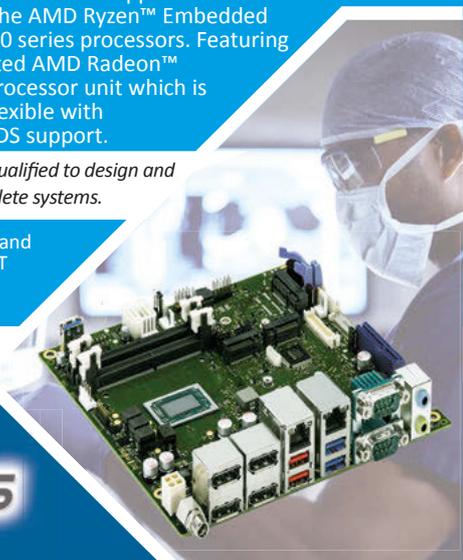
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Ports are fundamental to the way in which the global economy operates, handling upwards of 90% of world trade. As part of the Fourth Industrial Revolution there is accelerated investment in, and development of, smart ports with the aim of delivering significant reductions in the time and cost of handling ships and their cargoes through digital transformation.

While maritime logistics and port operations are experiencing ever more extensive digitalisation, what exactly is a 'Smart Port'?

For Lars Bøddeker, Sales Director Transport & Logistics Europe, Advantech Service-IoT, a smart port is one in which, "processes are automated and connected using emerging technologies such as 'Big Data', the Internet of Things (IoT), artificial intelligence (AI), blockchain



THE SMART PORT NETWORK

and other technologies that improve both the port's performance and its competitiveness."

Advantech is an example of a company that provides a broad range of infrastructure components to ports, from 5G routers and edge computing devices to IoT sensor technology that are being used to collect, aggregate, store, analyse and communicate data.

"By harnessing these technologies both facilities management and inventory management can be greatly improved. Ports will be able to handle bigger ships and containers through a combination of intelligent load automation and more efficient transportation," says Bøddeker.

Ports are using sensors and cameras, which automatically collect and share information such as weather, traffic and pollution data, to optimise operational planning, while the use of AI is speeding up security checks and automating screening

Embracing technology, from 5G to artificial intelligence, is helping to create a network of smart interconnected ports. By **Neil Tyler**

processes improving both safety and reliability.

"Determining the traffic flow of ships may be difficult to do manually, but by automating the task you can achieve shorter loading and unloading times, allowing more cargo to be cleared in less time," adds Bøddeker.

These smart technologies also have a critical role in ensuring the environmental sustainability of ports. With more automated processes enabling more mandatory environmental reporting, maritime businesses will be able to handle more stringent environmental regulations, for example, complying with the 'Paris Agreement' and the '2030 Agenda for Sustainable Development'.

"The port of Hamburg has effectively utilised a system of

Above and right: Through the use of technology smart ports will reduce the time and cost of handling cargo

sensors, cameras and smart lights on roads to help monitor and direct traffic, helping to optimise traffic and reduce emissions," says Michael Mehlem, Senior Technical Project Manager, Advantech Service-IoT. "The 'Green Port' and 'Smart Port' are closely intertwined when it comes to intelligent port development."

Technology is shaping how international ports and our borders conduct their business. For example, a platform, co-developed by Dutch start-up Teqplay and the Port of Rotterdam, allows vessel operators to cut waiting times by up to 20%. Once ships are in port, autonomous, unmanned gantry cranes handle cargos efficiently and quickly, while at the Port of Valencia, a smart IoT network spans 200 cranes, straddle carriers, trucks, and forklifts that



Image credits: Fotolia

are able to gather data on location, status of operations and energy consumption.

The largest seaport in Europe, Rotterdam has created a digital twin of the port to test and learn about the transformational process for this smarter future and the physical properties and characteristics of the port have been transferred into a simulation where multiple variables can be changed and tested quickly and effectively.

Technology shaping ports

Hamburg has been testing 5G technology as it sets itself up as a hub for next-generation industrial mobile communications, while the Hong Kong based port and shipping conglomerate China Merchants Port (CMP) Group is leading a 5G-enabled port transformation project with Huawei, Alibaba and Tencent at the Haixing (Mawan) port in Shenzhen, China. It represents the first upgrade in China of a traditional sea port to an automated smart port.

“Ports are looking at the potential offered by 5G and how it could

improve the flow of information and enable automation and the harnessing of artificial intelligence (AI),” explains Mehlem.

Another example can be found in Northern Ireland, where BT and Belfast Harbour have signed a partnership to build a 5G ecosystem within the Port of Belfast with the aim of delivering a series of 5G-led innovations that will help to accelerate the harbour’s digital transformation.

BT will build and manage a live 5G private network delivering ultrafast mobile connectivity, coverage, reliability and security across the port’s operations in transport, logistics, supply chain and shipping.

The partnership will explore how 5G could help pave the way for other technologies, functioning in tandem with the Internet of Things (IoT) and AI. The IoT, for example, will enable equipment to transfer data through sensor technology and make operations more independent, automated and efficient - supporting data analytics-enabled decision-making.

“IoT provides connectivity between port assets (vessels, containers, cranes) and a vast amount of data. This is leading to intelligent terminals, with total automation as the ultimate goal,” explains Bøddeker. “Automation can involve the deployment of drones (monitoring discharges, asset inspection), robots and ‘cobots’, smart sensor technologies, mobile equipment, video analysis, wireless RF technologies, and 3D printing (repair and maintenance of parts and accessories). The efficiency of all these new technologies will increase when built on 5G network connectivity.”

While the Internet of Vehicles (IoV) remains at an early stage of development



“Ports will be able to handle bigger ships and containers through a combination of intelligent load automation and more efficient transportation.”
Lars Bøddeker

autonomous vehicles will have a role in terms of supporting more effective management of port traffic, increasing safety by lowering the chance of collisions, thinks Bøddeker.

“Leading port facilities in Europe are integrating IoV technology, with the Port of Valencia and MSC Mediterranean Shipping Company working together to integrate new truck solutions with specially designed IoT devices that can be tracked in real time, helping the port predict and prepare for potential arrivals and congestion at the port’s gates.”

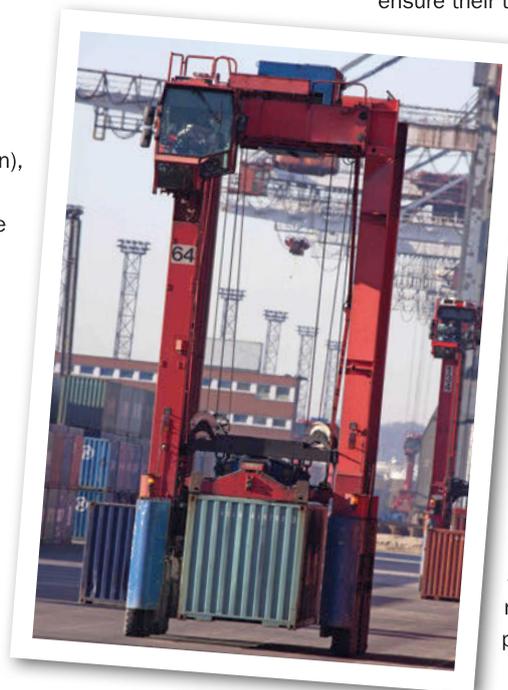
Sensors, when combined with autonomous vehicles, can be used to generate information on parking availability, the best route to reach them, and the expected cost delivering better capacity utilisation, a less negative environmental impact and increased safety.

Several ports are currently running autonomous applications in closed areas that are not dependent on many compatibility standards but, ideally, port operators should look to familiarise themselves with this technology and establish test sites equipped with supporting systems such as additional sensors and wireless or mobile networks to ensure their technical capability,

suggests Mehlem.

Ports are also using AI technologies such as ANPR cameras at entrance gates to automatically guide arriving trucks to their destination, while IoT Gateways are transferring machine data from port equipment enabling predictive maintenance and more detailed planning with reduced vehicle downtime.

“With the IoT, sensors play a pivotal role in measuring the physical characteristics of



objects, which can be read by another device or by the user,” explains Böddeker.

A network of smart sensors and actuators, wireless devices, and data centres make up the key infrastructure of the smart port, allowing the port authorities to provide essential services.

“Various sensors such as inertial sensors, ultrasonic sensors, eddy current sensors, radar, lidar, imaging sensors, and RFID readers and tags are all being used to collect the required data in order to transform a port into a ‘smart port’,” says Böddeker.

Ports, like any industrial operation, will need to employ a cybersecurity strategy to protect as many assets as possible; certainly the most important ones.

“Since it is not feasible, sensible or even efficient to try to protect everything in equal measure, it is important to identify what is valuable and needs greatest protection. The next step is to identify vulnerabilities in order to prioritise and to erect a defence-in-depth architecture that ensures business continuity,” argues Mehlem.

Resilience is not achieved simply by installing secure technology. According to Mehlem, it is mostly about understanding and mitigating risks in order to apply the right protection at the appropriate points in the system.

“It is vital that this process is very closely aligned with organisational goals because mitigation decisions may have a serious impact on operations. Ideally, it should be based on a systems-approach that involves stakeholders from throughout the organisation.”

Smarter port networks

As referenced earlier the deployment of 5G will make it possible to connect and interact with billions of devices across all aspects of a port’s commercial operations.



In a complex eco-system that makes up a modern port reliability and security are two critical elements ensuring that ports run effectively.

“Ports operate over several square kilometres and are filled with moving metal objects and radio frequency-emitting devices. Using communication technologies, such as 4G and Wi-Fi, are relatively straightforward, given range, bandwidth and resilience considerations, but 5G will be essential in delivering the smarter port,” suggests Mehlem.

In order to maintain security and manage costs Deloitte has predicted that ports, airports, and similar logistics hubs will account for a third of the 2020-2025 private 5G market and will be early adopters of this new technology.

“The biggest advantage of 5G is not its speed, but its capability of transporting vast amounts of data simulations, making 5G-powered technologies one of the key building blocks in digital ports,” says Mehlem.

Projects related to smart ports in the IoT era can be found from Europe to Asia, to Australia and North America; in all these new architecture implementations, sensing technologies play a key role.

But beyond the individual port the major benefit of port digitalisation is that in time it will create a wider network of hubs that are equally

digitised and ambitious; in short, a Smart Port Network.

Once several ports are automated, they can connect with each other to form an integrated network of systems, all working in unison to exchange data and improve the efficiency of their collective operations.

“This is called a Port Community System and will form the basis of a global logistics chain, which optimises transport modes and allows all participants to benefit from lower costs and faster delivery speeds, therefore increasing competitiveness and driving further innovation,” says Böddeker.

There is no doubt that the application of Smart Technology in ports in the future will not only increase but become a necessity. However, such transformational development of ports will require massive capital investment from operators and government bodies.

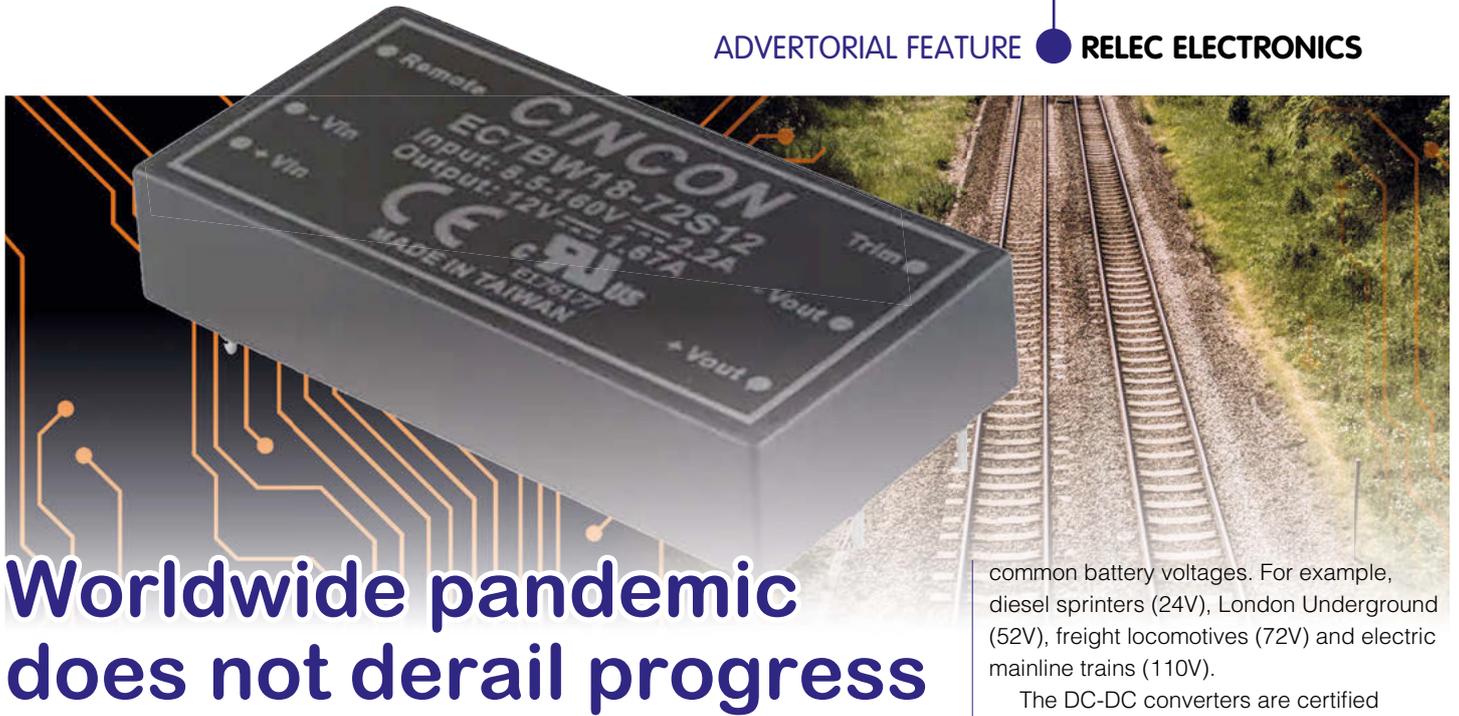
As a consequence proper planning will be needed to ensure a successful transformation.

According to Böddeker, “Port developments have close relationships with other industrial activities such as manufacturing, refineries and inland logistics so planning for land use and digital infrastructures should also consider optimal logistics flow and operational efficiency, in order to maximise the value and productivity of land and assets. The components, especially the digital infrastructures and facilities, will be in use for up to 20 years or longer and the cost of maintaining and repairing these infrastructures could be significant if not properly managed. Hence, it is imperative to adopt a life-cycle costing approach for development options evaluation to shortlist the optimal development combined with the desired cost profile.”

In order to deliver on the promise of digitalisation and smarter ports, proper planning will be an imperative as well ensuring that greater connectivity is both secure and safe.



“The biggest advantage of 5G is not its speed, but its capability of transporting vast amounts of data, making 5G-powered technologies one of the key building blocks in digital ports.”
Michael Mehlem



Worldwide pandemic does not derail progress

Ensuring power conversion is suitable and compliant requires a wide ranging knowledge and specialist skills, says John Stone, sales director for Relec Electronics

The Covid-19 pandemic has meant that passenger numbers on the UK's railways have fallen to the lowest levels since the mid-19th century. In the first quarter of 2020, there were 35 million passenger journeys, compared to 439 million in the same quarter last year, reports the Office of Rail and Road (ORR).

Before this pandemic, the primary concern of rail engineers and designers was to ensure the reliable performance of equipment and the comfort and safety of passengers on-board.

The railway standard, EN50155, was revised in 2017. While many parts are unchanged from the 2007 edition, (i.e. shock and vibration, supply change over and EMC) it adds definition to other areas.

For example, EN50155:2017 introduces six operating temperature classes and requires equipment manufacturers and end-users to define equipment operating temperatures and constraints.

Power Specifications

The revised standard also has a tighter definition of the power supply ranges and includes details of 28V and 36V supplies. There is a new class (S3-20mS) in the definition of supply voltage interruption and supply voltages for rolling stock powered by combustion engines are also included. A new section defines what ripple factor is likely to be seen on supply voltages.

Requirements for proof of reliability for end-user equipment are further defined in this revision, together with a tiered system for the useful life of equipment. Now there are five classes, starting with five years, replacing the previous 'flat rate' of 20 years.

The revision also makes low-temperature start-up, cyclic damp heat and EMC tests mandatory. It also introduces a new Power Supply Test and stipulates that the Dry Heat Thermal Test is performed over three test cycles and reduces the duration for routine test from 60 seconds to 10 seconds.

DC-DC Conversion

One of the latest examples of DC-DC conversion technology applied to EN50155, as well as railway standards EN62368-1 and EN45545-2, are the CHB150W12 and CHB200W12 families. They have an ultra-wide universal input of 14 to 160Vdc and offer 150W or 200W of regulated DC output. Manufactured by Cincon, they are available with 5, 12, 15, 24 or 48V outputs and have 3000Vac reinforced input to output isolation as standard. Units operate with efficiencies up to 91% with case temperatures from -40°C to +100°C.

The wide range of input voltages encountered in the rail industry can add complexity in design and inventory. Cincon also offers the EC7BW18-72 20W DC-DC converter series which has an input range of 8.5 to 160Vdc, making it suitable for all

common battery voltages. For example, diesel sprinters (24V), London Underground (52V), freight locomotives (72V) and electric mainline trains (110V).

The DC-DC converters are certified to EN62368-1, EN 50155 (EN61371), EN45545-2 (fire and smoke), EN50155/EN50121-3-2 with external circuits and UL 62368-1 (reinforced insulation).

Additionally, the wide input range means the units meet the requirements of RIA12 Surge A on 24V and 52V systems (3.5 x V_{in} nom 20mS).

Its efficiency, up to 90%, allows for a case operating temperature range of -40°C to 105°C. An optional heat sink is available to extend the full power range of the unit. The EC7BW18-72 also has very low no-load power consumption (8mA), making it an ideal solution for energy-critical systems.

Specialist Support

When designing power systems for rail, an understanding of the regulations, standards as well as the complexities of power conversion is essential. To ensure the most suitable product for a particular project, specialist companies representing leading manufacturers can offer a wide overview of products available. Select one with close relationships to key suppliers in the sector and one which is staffed by qualified, knowledgeable engineers who can support you through the design process. Staff should be able to offer support in refining an initial specification or brief to integrate bespoke features or meet specific performance requirements. Another consideration is short lead times; make sure standard modules and accessories are readily available.

For more information, please visit www.relec.co.uk or call 01929 555700

New investor, new opportunities

With the recent investment in the business by DBAG congatec is poised for strong growth in 2021, as CEO Jason Carlson explains to **Neil Tyler**

Congatec has developed a strong reputation, since it was set up in 2004, in developing Compute-on-Modules and has taken a leading role in the development of new standards – from COM Express to the very latest COM-HPC – establishing itself as the supplier of choice for embedded and edge computing technology.

Jason Carlson was appointed CEO in 2015 with a mandate to turn what was a well-established business operating in EMEA, into a global one.

Five years on, Carlson is able to point to a company that's significantly expanded its presence both in the US and Asia and, with the recent investment in the company by Deutsche Beteiligungs AG (DBAG), that's a trend he expects to continue.

"We've seen a strong internationalisation of the business and the expansion of congatec's product range, which now includes computer modules for new processor types, will help drive future growth.

"The recent investment by DBAG has come at the right time for the company," he says. "It's going to help unlock a diverse range of new market opportunities, as well as bring considerable financing and M&A experience to the table. We are well positioned going forward."

Looking back on 2020 Carlson describes the year as being, "at best a challenging one."

"Where we have been fortunate is that we address a diverse range of markets, so a decline in industrial has been offset by growth in the medical sector. As a result, we've closed out the year flat to slightly up on 2019 which, considering the circumstances, should be viewed as a success.

"While the pandemic has seriously impacted certain markets, medical has performed well. But you need to 'peel the onion' and look a little deeper. The medical market has been driven by demand for ventilators and if it's not Covid-19 related, it's been more of a struggle."

Turning to actual design wins, Carlson says that 2020 has seen demand grow for next generation modules and the pandemic has given a strong boost to the Internet of Things and Industry 4.0.

"If anything it's been business as usual for us and there now seems to be more opportunities. While evaluations are taking a little longer

as far as we are concerned, when it comes to design wins, it's been a fantastic year."

The company has also benefited from operating a diverse manufacturing base as well as maintaining shorter supply chains, avoiding some of the political and trade winds that have impacted other companies.

"Our experience over the past few years has cemented our belief that this model works. I don't think we would have been able to put up the number we have this year if we had operated differently."

Technology trends

Looking at how the demand for technology is changing Carlson points to the growing demand for edge computing and VR, that's driving demand for higher levels of computing and more complex designs.

"We are seeing advanced CPUs that are able to deliver industrial embedded type reliability and the shift to more edge devices requires increased compute power to enable processing to be carried out locally, avoiding the latency and security issues that occur when you send data up to the cloud." He points to developments in video analytics, security and intelligent autonomous robots as examples.

"These are all highly complex devices that require much greater computing power and it's this, along with increased levels of complexity, that is driving the need for new standards," Carlson explains.

congatec has taken a leading role in developing standards, whether that's COM Express or the new COM-HPC.

"Whenever you are developing a new standard there will always be limiting factors to do with power, bandwidth and connectivity, but with our COM-HPC and COM Express solutions we're able to offer a broad range of options for engineers looking to use the very latest processor technologies."

The COM-HPC standard, for example, provides for a broad range of high-speed interfaces such as PCIe Gen 4 and USB4, a future proof high-speed connector, and a comprehensive feature set for remote management which is becoming increasingly important for emerging broadband connected edge applications – whether that's dedicated edge devices or rugged edge clouds.

“COM-HPC is needed primarily to address new applications with particularly high performance requirements, such as those we’ve seen emerging with Server-on-Modules at the edge layer level, or those requiring very fast GPGPU connections for AI and machine learning,” adds Carlson.

The range of new applications is certainly huge.

“Take robotics, for example. We’ve seen growth in unmanned or autonomous robots capable of navigating the last mile to make deliveries, or tasked with intelligently navigating through a shop or warehouse. “There’s a whole new area around collaborative robots that are capable of working together or alongside human co-workers.”

According to Carlson, greater complexity and more computing power at the edge is driving the Compute-on-Module space but drill down into a sector and there will be specific issues to be addressed.

“In terms of industrial automation predictive maintenance is becoming more important. But here, you are looking at upgrading existing technology to use automation to make lines smarter and that takes time to implement. Drones, by contrast, are a new market. There is no existing infrastructure to upgrade, so it’s about the rules and regulations that you have to work with.”

DBAG investment

Carlson is optimistic about the company’s future and points to the recent investment made by DBAG which is, for him, a game changer.

“congatec is 16 years old and we have been supported by the same set of investors since our inception. So over the years our growth has been primarily organic.

“We operate in an embedded market that is highly fragmented. There are plenty of exciting small players out there that could provide us with opportunities to look at acquisitions. Everything we have done to date has been self-financing and that’s been challenging and, in our history, we’ve only bought one company – Real Time Systems.

“DBAG is a large publicly traded private equity firm with considerable financial resources, and that is going to open up new opportunities for congatec from an M&A point of view,” Carlson suggests.

“They have considerable expertise and have already invested in the embedded electronics sector. They have a portfolio of businesses across the German-speaking world with whom we can build new connections, co-sell and make introductions – it’s a great opportunity.”

But Carlson goes on to make the point that congatec needs to stay focused on what it does best – that’s developing world-leading Computer-on-Modules – and to that end, “we most likely will do smaller deals going forward.” He makes clear that, “everything we do will be driven by the desire to increase the value proposition we are able to offer our customers.”

New standards, new products and now a new investor congatec is certainly well positioned to exploit developments across the embedded space and deliver higher levels of performance.



“While the pandemic has seriously impacted certain markets, medical has performed well. But you need to ‘peel the onion’ and look a little deeper. The medical market has been driven by demand for ventilators and if it’s not Covid-19 related, it’s been more of a struggle.”

Twenty years ago, Nvidia was squarely focused on one thing: 3D graphics. Not long from now, its founder and CEO Jen-Hsun Huang expects to preside over a company that reaches into every corner of the computing world thanks to a financial war chest the company built up from a strategy that saw its graphics processing units (GPUs) become the work horses of artificial intelligence (AI) in data centres.

Alongside the ability to handle many floating-point operations in parallel – an attribute needed for training deep neural networks – the main reason Nvidia’s GPUs became more commonly used in data centres than competitors such as AMD lay in its CUDA environment. This is a strategy Nvidia aims to repeat following its acquisition of networking specialist Mellanox, coupled with some rebranding before it rounds out the portfolio with the addition of Arm and its general-purpose processor architectures.

But Huang is far from alone. A number of companies have seized on the idea of creating a novel class of processor and giving it a name: the data-processing unit (DPU).

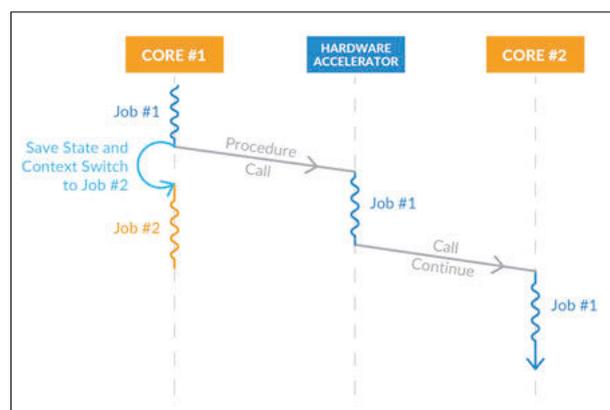
“We believe data centricity will drive next-generation architectures,” claimed Pradeep Sindhu, founder and CEO of Fungible, at HotChips 32 in August as the company prepared for the autumn launch of its own take on the concept.

The DPU is not an entirely novel concept: the architecture evolved from the Smart Network Interface Controller (SmartNIC) that began to appear in servers several years ago. Rather than attempting to load all the functions needed for a cloud application into individual server blades, the emphasis in computer design for data centres is on scaling out. Individual nodes run a small number of functions, typically called microservices, cooperating with each other in different ways to handle changing workloads.

Operations like search or data analytics can be split or in data-centre

Processor makers embrace DPUs

With data processing units (DPUs), designers are pitching for a new slot in server architectures. By **Chris Edwards**



parlance “sharded” across tens, hundreds or thousands of servers or pushed down to smart disk drives.

The sharding provides the ability to support huge numbers of simultaneous users in a way that a smaller number of high-powered servers could not. But there is a catch.

“These new workloads put tremendous pressure on the network,” Huang explained in his keynote at his company’s autumn developers’ summit.

More packets

This surge of internal traffic means each system has to deal with many more packets per second than conventional servers. On top of that, the machines have to handle the overhead of virtualisation in order to keep different customers’ tasks separated as well as increasing use of deep packet inspection and other operations to protect against hacking.

Though all these functions can be run in software on the core processors, they eat into the overall cycle budget.

Figure 1: Fungible-call-continue - in this model, tasks flow across the SoC as each function in a chain of tasks completes

Huang says close to a third of the core processors’ cycles can go into this packet handling infrastructure work rather than the application. SmartNICs made it possible to offload the simpler tasks. Now DPUs add more general-purpose processing abilities, often in the form of multiple Arm cores able to run Linux in concert with specialised packet, search and security coprocessors that handle the burgeoning packet-handling jobs.

Rather than Arm, Fungible picked MIPS64 as its main processor architecture, though Sindhu notes the company is not wedded to a particular instruction set architecture (ISA).

“This is a macro-architecture problem. There is a misunderstanding in the industry as to whether data-centric computations need a specific ISA.”

For most suppliers, the DPU is effectively a mashup of a multicore processor and a network switch armed with a collection of accelerators. At the Linley Group Fall Processor Conference, Marvell distinguished architect Wilson Snyder said almost a third of the die on its flagship DPU the CN98XX is given over to accelerators, sitting alongside six clusters of six custom-designed Arm processors, all connected to the I/O and each other using an x-y mesh with 1Tb/s of aggregate bandwidth.

The need to process data at speed that does not hang around for long has subtle effects on the architecture of the core processors. Marvell has several levels of cache in the CN98XX but the level-two cache, only stores

instructions not data in contrast to most designs, which opt for a shared design.

“Because these applications deal with large amounts of data, the data keeps throwing out the instruction lines,” Snyder says, which leads to slowdown, because instructions keep needing to be reloaded. “Some applications show more than a doubling in performance by having that instruction-only cache.”

A further distinction from conventional multicore processors is how many of the cores that are allocated work. Though DPUs can generally run a multiprocessor Linux distribution much like a general-purpose processor much of the infrastructure around them is designed in concert with domain-specific software environments such as DPDK and the P4 programming language. P4 is designed around the flow generally used in packet processing, with an assumed flow based around parsing headers, breaking them into components to be matched and analysed before being reconstituted to be forwarded to a destination.

“We believe the P4 language is best-suited to describe these tasks,” says Francis Matus, vice president of engineering at SmartNIC specialist Pensando, adding that the company has defined hardware extensions that have fed into the open-source language.

The interdependence of hardware and software is illustrated by aspects such as task scheduling. For jobs that do not need special attention from more complex processes running on the Linux subsystems, DPU execution is generally based on run-to-completion, a technique used in some real-time systems to minimise task-switching overheads.

In this model, once a thread activates it runs without yielding the processor until it has finished its assigned work. On a single processor, this would impose severe delays on other threads waiting to start their own work. But in the context of a massive array of processors, schedulers can simply pick target cores based on criteria such as quality of service. Low-priority tasks can sit in a long queue while others are directed to those that are available to work more or less immediately.

Typically, a DPU associates each packet with a block of data that determines the sequence of jobs that need to be run on it.

Upcoming applications

Though SoCs at the SmartNIC end of the market are very much focused on packet routing and firewall operations, DPU vendors see a rich set of upcoming applications for the more advanced devices.

Changhoon Kim, CTO of applications in Intel’s Barefoot

division, points to the example of the GPU being redeployed for tasks such as AI. “We believe we will see the same kind of explosion of applications given the general-purpose programmability and high I/O capability of these P4 data-plane machines. You will see more I/O intensive compute-related applications emerging.

“One thing that some of our customers and Intel did together was deep-learning training acceleration,” Kim adds, noting that speedups in GPUs have not been followed by networking up to now, which causes bottlenecks for jobs such as sending neuron weight updates to individual GPUs running in a distributed setup.

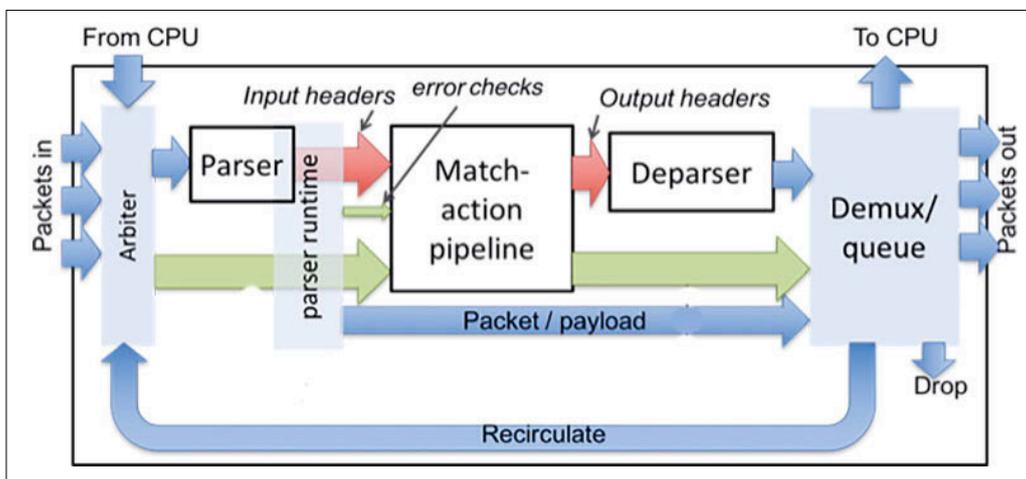
A DPU can offload a lot of the data manipulation from the GPUs and more efficiently schedule updates. It can go further, he says, by having a DPU handle the allocation of work to the worker GPUs as well as rescaling data values on the fly and adding very large vectors that need to aggregate results produced by multiple workers. In one experiment, the data orchestration performed by the DPUs boosted training speed threefold, according to Kim.

To try to capitalise on a more general-purpose use of DPUs, Nvidia is using much the same approach as it did with GPUs. The CUDA equivalent in this case is called DOCA.

“The DOCA SDK lets developers write infrastructure applications for software-defined networking, software-defined storage and in-network computing applications yet-to-be-invented,” Huang says, adding that the company has not reinvented the wheel but incorporated P4 for packet processing and other widely used libraries.

In contrast to the situation with GPUs over the past couple of decades where there were a handful of suppliers, there is a lot more competition among DPU suppliers. Nvidia may find this environment harder to dominate.

Figure 2: P4-switch-flow – this design is built around typical packet flows that disassemble, check and then reassemble headers for forwarding



KEEPING IT CLEAN

When it comes to designing wearable medical electronic devices it's critical to ensure PCBs are clear of contamination, as **Emily Peck** discusses

Wearable medical devices allow people more control over their own health by letting them monitor themselves. There are bio-sensors that measure real-time heart rate, blood pressure, body temperature, skin moisture, blood oxygen levels, respiration rate, and ECG (electrocardiogram). All help detect any irregularities before they develop into dangerous health problems.

Wearables are also used with patients returning home from hospital to monitor their post-operative recovery and watch for any complications. This helps ease the health provider strain by letting the patients return home sooner, but still monitor their conditions closely.

For those with diabetes, glucose sensors under the skin check blood sugar levels and connect to smartphones for easier readings. There are also fitness trackers to measure exercise levels and calorie intake and to analyse sleep patterns to encourage healthier lifestyles. Wearable devices are also used to monitor loved ones and summon assistance in the event of a fall or medical emergency.

These small devices only continue to grow in popularity and function and have a big impact on patient health and safety.

The challenge of small

As these wearable devices get more complex and powerful, there is a challenge to keep them small, discrete and comfortable for patient use. This also means the internal PCBs (printed circuit boards) that power the devices must shrink too.

The result is devices filled with densely-packed and multi-layered PCBs that are sometimes difficult to clean during production. Contaminated or dirty PCBs are vulnerable to a number of problems including parasitic leakage, electrochemical migration, delamination, dendrite growth and shorting.

Reductions in pitch between conductors along with the increased use of leadless, zero-clearance or bottom-terminated components increase the probability that contamination, like active fluxes or flux residue, gets trapped on the PCBs. Add in other contaminants, like ink and fingerprints, and the threat of unreliable PCB performance and possible catastrophic field failure escalates.

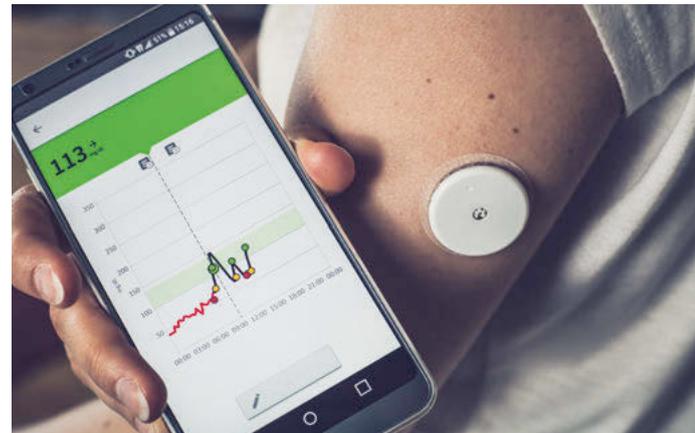
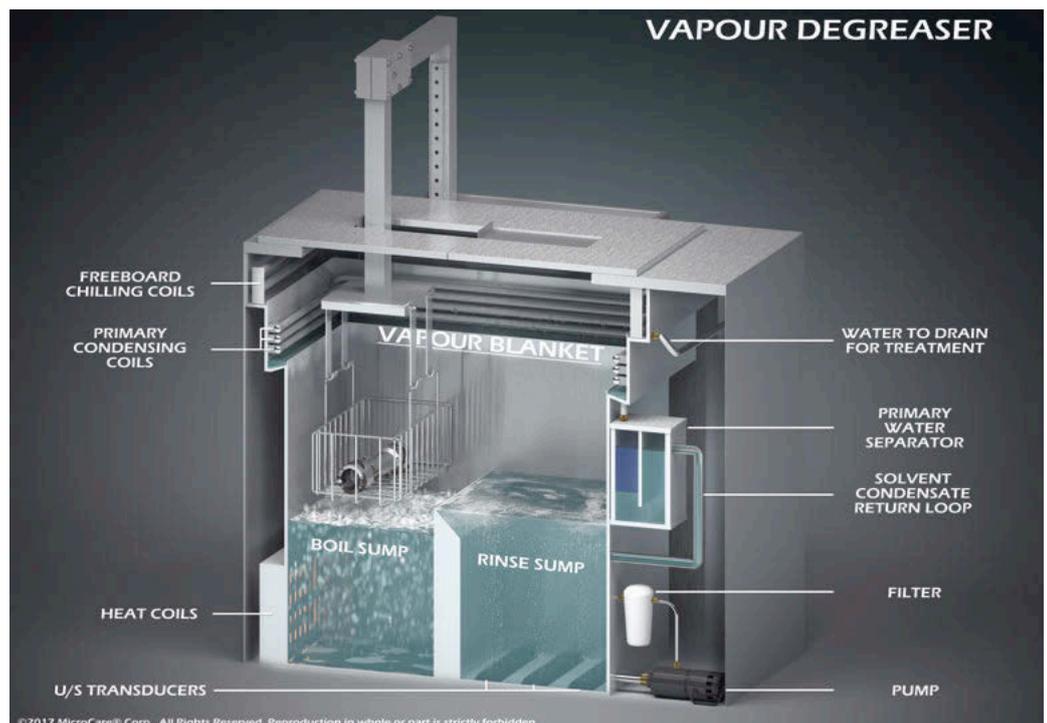


Figure 1: As wearable devices get more complex, the challenge is to keep them small, discrete and comfortable for patients

It is vital to clean PCBs to ensure they function as intended. It is of equal importance to plan the cleaning fluid and cleaning method before PCB production starts.

Planning ahead for a cleaning process while other decisions about coatings and solder pastes are made helps ensure the chosen cleaning fluid and technique are successful. It also prevents PCB fabricators from scrambling at the end of the production line to find a cleaning solution that might work on a particularly difficult-to-remove contaminant or flux residue.

Figure 2: Vapour degreasers clean, rinse and dry electronics in one step



Choosing a cleaning fluid

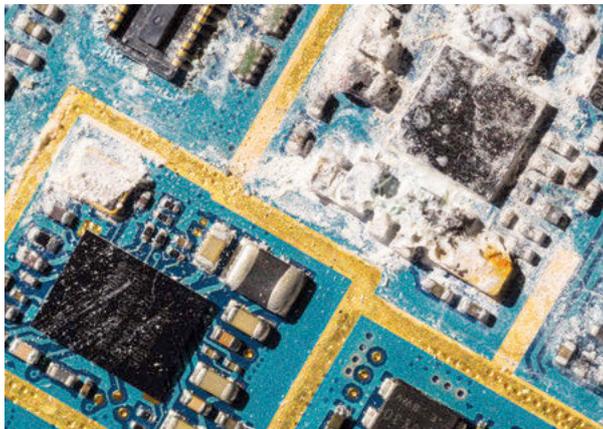
PCBs can be exposed to a variety of different contaminants during the production process. They are categorised into four main groups: insoluble particulate, organics, inorganics and water.

Insoluble particulate is a polar contaminant that cannot be dissolved by water or a cleaning fluid. Common particulate contamination includes things like dust, cloth fibres and metal chips. Particulate electrostatically bonds to PCB surfaces and requires an electrostatic polar cleaning fluid. A dense cleaning fluid that contains slightly conductive molecules will break the static bond of the contaminant and displace, or float, the particulate off the PCB substrate. Sometimes agitation helps enhance the cleaning fluid's effectiveness as well.

Organic or non-polar contaminants include rosin solder pastes and fluxes that come in grades of activation including R (Rosin), RA (Rosin Activated), RMA (Rosin Mildly Activated) and SA (Synthetic). Organic contaminants can also include non-polar oils and greases. Organic contamination can be dissolved and removed with mild to medium strength organic flux removers.

Inorganic, polar contaminants are the residue left by lead-free and no-clean fluxes and solder pastes. Inorganic contamination sometimes appears on PCBs as white residue which can be extremely difficult to remove. Inorganic contaminants usually require more aggressive flux removers to dissolve contaminants, especially the stubborn white residue. It is important in these instances that the material compatibility of the cleaning fluid is known before use. If a cleaning fluid is too strong, it may damage sensitive PCB materials such as soft plastics.

Water comes in contact with PCBs through the use of aqueous cleaning systems and is easily trapped in more densely populated circuit



boards. Water is typically removed by air knives or other dryers. However, this may still leave moisture and allow water spots to form. Water contamination can be chemically removed using batch drying inside a vapour degreaser outfitted with a water separator.

Choose a cleaning method

There are a number of ways to clean PCBs, from benchtop manual cleaning to in-line aqueous operations. However, as PCBs become more challenging to clean, PCB fabricators are turning to vapour degreasing as they realise the benefits of this tested and proven cleaning method.

Vapour degreasing is a simple process that is effective at removing contaminants. It also satisfies the economic, validation and regulatory requirements needed within the medical device manufacturing industry.

Vapour degreasers use a closed-loop system containing two chambers, the boil sump and the rinse sump. The boil sump contains a specially-formulated low-boiling, non-flammable cleaning fluid. The PCBs are immersed and cleaned inside the heated fluid. Once cleaned, the PCBs mechanically transfer to the rinse sump for final rinse and dry in more pure, uncontaminated fluid, or inside the fluid vapours themselves. The PCBs come out clean, dry, and spot-free.

Figure 3: Inorganic contamination sometimes appears on PCBs as white residue which can be challenging to remove

Author details:
Emily Peck is a Senior Chemist at MicroCare

Figure 4: Small, densely-packed PCBs are sometimes difficult to clean during production



The process is simple, repeatable and easy to validate.

Many modern PCB cleaning fluids used inside the vapour degreaser have exceptional materials compatibility, making them suitable for cleaning delicate plastic parts or mixed-material printed circuit boards. They also have low surface tensions and high liquid densities. This allows the cleaning fluid to easily flow around tight-fitting and low-mounted components to clean under them thoroughly. It also enables the fluid to flow back out from under the components, preventing the fluid and the contaminants from getting trapped. This ensures all contaminant gets completely removed.

Importantly, vapour degreasing fluids are hostile to bacteria. So, by using this cleaning process it ensures a sterile cleaning environment. Vapour degreasing simplifies process control requirements for eliminating bioburden and offers an easy way to validate the PCB manufacturing process.

Find a cleaning partner

Wearable medical devices continue to gain in popularity as people become more proactive in maintaining their health. This is even more apparent since the COVID-19 outbreak, where more of our medical care is now remotely monitored and socially distanced.

As medical monitoring devices get smaller and more complex, cleaning their internal PCBs becomes more critical to ensure they perform without fail.

By planning PCB cleaning in advance, knowing the contaminant and choosing a trouble-free cleaning method, PCB fabricators can be well-prepared to produce clean, reliable boards.

Before deciding on a cleaning fluid or method, consult with a critical cleaning expert. They can suggest compatible and effective fluids for PCB cleaning success.

A question of scale

A quiet 3D transition and design tweaks are helping to keep Moore's Law on track, as **Chris Edwards** explains

Is Moore's Law dead, dying or in rude health? It depends who you ask. In turn, it depends on how they are applying the ruler when it comes to measuring the scaling factors as semiconductor processes move down the nanometre curve.

Together with colleagues from MIT, TSMC, UC Berkeley and his own institution, Philip Wong, professor of electrical engineering at Stanford University, wrote a paper for April's Proceedings of the IEEE on the progress made by silicon scaling and used it as the basis for his keynote at July's Design Automation Conference. In their view, Moore's Law is still in operation but the assumptions that underpin it have changed. As a result, technologists should look far less at simple areal scaling of transistor footprints and spacing but take a view on the effective density of each successive node.

In looking at other factors, you could argue that the chipmaking industry is going back to basics. It is less famous than the article in Electronics magazine published a decade earlier, but Gordon Moore's speech at the 1975 International Electron Device Meeting (IEDM) is the point at which the Intel executive settled on a two-year cadence for the regular doubling in device density. Up to that point, the industry had been moving at a faster clip, with doubling occurring on an annual basis. By 1975, Moore had seen that the rate of progress was dropping.

In the IEDM speech 45 years ago, Moore saw 2D geometric scaling as only part of what would deliver double the functions for the same cost over time. He saw it as a sizeable fraction

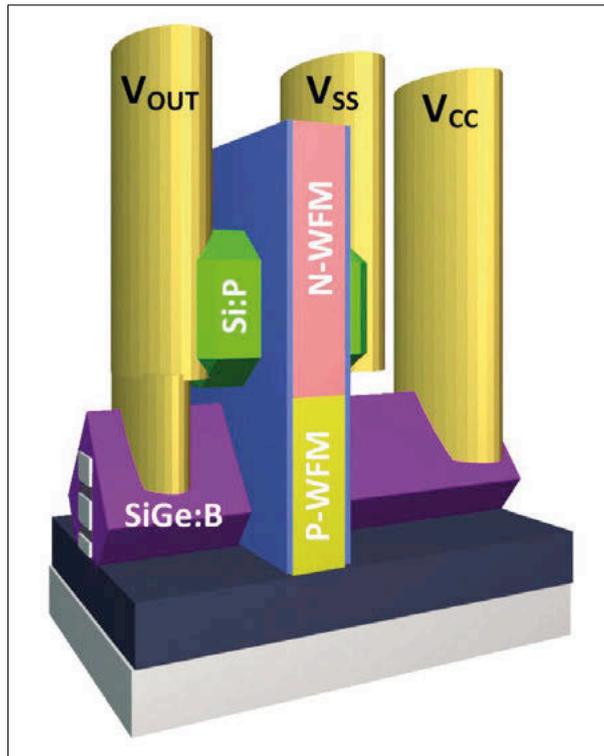


Figure 1: The Intel transistor architecture

but certainly not all of it. He predicted significant increases in chip size and improvements in circuit design would deliver the rest. However, at that point, the fab owners had only begun to take advantage of scaling factors noticed by IBM researcher Robert Dennard: that smaller, more closely packed transistors would be able to not just achieve cost but energy improvements.

The transition to CMOS in the 1980s pushed that along at full speed until the industry had exhausted most of the benefits of Dennard scaling by the mid-2000s. After that, simple 2D scaling would become increasingly troublesome.

This has been most noticeable in recent years in the trends for SRAM

scaling, which has historically been a good guide to density improvements. Though it kept pace with logic up to around the 28nm generation, it then began to fall behind because it is hard to make incremental improvements when metal pitches and transistor dimensions are not doing the same.

Circuit cleverness

One of the presentations that takes place at the upcoming IEDM will be given by a team from EDA tools supplier Synopsys. It will show how the contributions to scaling are changing the past few years.

"Circuit cleverness" as Moore termed it has made a dramatic comeback, though in a different guise to the form proposed originally. This time around, it goes under the name of design-technology co-optimisation (DTCO). By having designers advise on what process changes make most sense for circuit layout purposes, process engineers can make better trade-offs. This is something that shows up in the SRAM scaling changes, with the odd sudden jump in density thanks to a change in the way the cells are laid out.

It is DTCO that Wong, the Synopsys team and others see as the most important contributor to density in the coming decade on the way to the so-called 1nm node. But pure dimensional scaling is not quite dead yet. Though there is little room for 2D scaling, the third dimension is showing promise and not necessarily through the stacking of chips as seen in memory standards such as HBM. You could regard it as 3D by stealth.

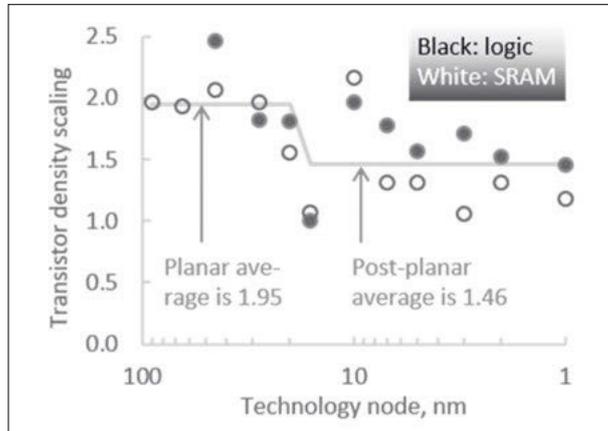
One way of using the vertical dimension is to turn the transistor on its side. This continues the evolution of the field-effect transistor from a purely planar device with a top gate contact through the vertical fins of the finFET. The fin provided greater electrostatic control over the transistor channel by having the gate wrap around three sides. But past 5nm, a gate all-around structure is needed. That can be

satisfied by the use of nanosheets that, in effect, are passed through the gate electrode. Even better, though it increases process complexity and cost, you can stack nanosheets to get more drive current in the same way finFETs generally use two or more fins. The stack consumes potentially less area than the multifin structure.

A stumbling block to nanosheet scaling is the separation needed between the n- and p-channel devices of a CMOS pair. But Imec last year proposed the forksheet. This stacks complementary n- and p-doped sheets next to each other, built out of a common pillar. With that you have a full CMOS inverter built into single transistor structure for an area saving of about 30 per cent.

Getting power in and out of a logic cell takes up valuable area but that is another place where the third dimension comes to the rescue. Imec's proposal at the 2018 VLSI Symposia was to bury power rails under the silicon surface. The next step was the CFET: a two-storey structure that forms the n-channel transistor of an inverter directly on top of its p-channel sibling.

At the upcoming IEDM, Intel's engineers will describe their take on a CFET-type structure based on nanosheets. The combination transistor



uses epitaxy to build a vertically stacked source-drain structure with the threshold voltage tuned individually for the two types of transistor. Though the gates in this work are comparatively long at around 30nm, the Intel team expects significant cell-size reductions being possible through the self-aligned stacking.

According to Synopsys' calculations, CFET does a lot for SRAM though it does take some DTCO to get there. One drawback of the CFET is that the stacking introduces another form of variability but, again, design tweaks will help deal with that. For example, the most compact structure does not rely entirely on gate-all-around transistors. Instead, it includes a dummy p-channel transistor with a

Figure 2: The evolution of key vehicles of transistor density scaling in the semiconductor industry extended beyond 1nm

three-sided gate to get a good enough write behaviour.

Major issue

Even as transistor density scales, a major issue with chip design lies in the parasitic resistance and capacitance in long metal interconnects. This may force future processes away from the mainstay of copper to more exotic metals such as ruthenium.

Intel proposes a design-based alternative that relies on the observation that although cutting resistance and capacitance together seem desirable, not all circuit paths will benefit in the same way.

Individual paths can benefit from individually tuned resistance and capacitance. This is the intuition that guided work at Intel on what calls staggered interconnect.

Rather than make every parallel line the same, the staggered approach has alternating tall and short lines, with the short lines sitting on top of taller piles of insulator material. This reduces the net effective capacitance between lines. In effect the tall lines, which will suffer more from crosstalk and similar effects are spaced further apart. Simulations by Intel showed register files and memory arrays can benefit from the structure. Decoder and wordline memories receive the taller lines while bitlines use the shorter traces. Longer-length interconnects also show an improvement by making it possible to pack more traces into a smaller area without worsening RC delays.

The greater complexity of these DTCO-inspired designs, Synopsys says, will drive wafer costs higher: averaging 13 per cent per node. But effective density remains plausible as far as the 1nm node and it will still be possible to maintain a per-transistor cost reduction of 32 per cent per node.

It's not yesterday's Moore's Law but scaling should continue for more or less a decade. How many companies will be able to command the huge volumes to justify the start-up costs remain another matter.

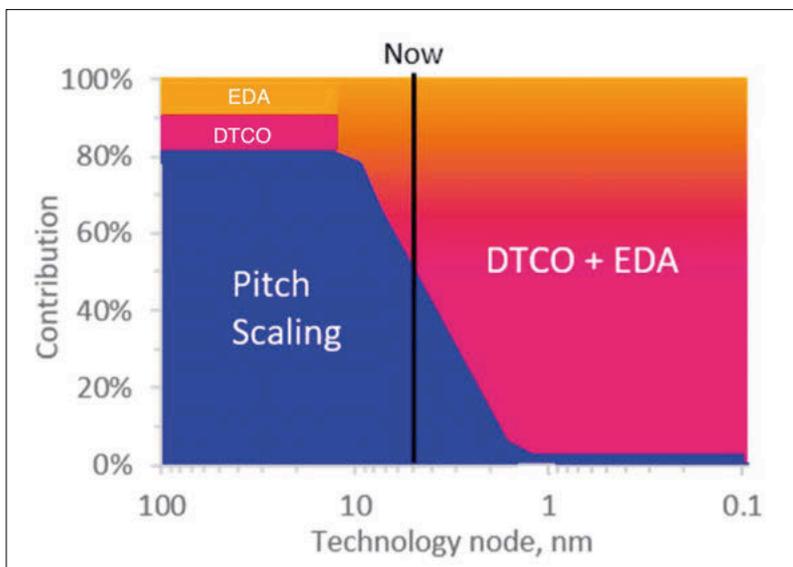


Figure 3: Scaling figures for SRAM and logic

PROCESS, PEOPLE, TECHNOLOGY

When it comes to the adoption of technology, manufacturers need to take a strategic approach that brings processes, people and technology together.

By **Neil Tyler**

A recent survey conducted by the Made Smarter North West pilot of small businesses operating in the region, found that too many were operating without a strategic plan when it came to digitalisation and investing in new technology.

“Manufacturers recognise that digital tools and technology are essential to remain competitive, cut costs, increase growth, and enhance the customer experience, and without capitalising on the opportunities digital technology offers, risk getting left behind,” said Donna Edwards, programme director for the Made Smarter North West pilot. “But it is also clear that too many makers have employed technology without the technical understanding of which areas to focus on first – which leads to disparate, disconnected equipment, and increases the risk of wasted time, money and effort.”

Manufacturers must take a strategic approach to capitalise on technology adoption yet, according to this survey, 55% don’t include technology in their vision and growth strategy, despite there being a huge appetite and motivation to introduce new digital tools into their operations.

The research suggests that too few UK businesses are approaching the opportunities and challenges of Industrial 4.0 in a planned, strategic manner and despite an appetite for technology adoption, barriers remain with the biggest being insufficient capital and a need for guidance.

According to Edwards, “Before

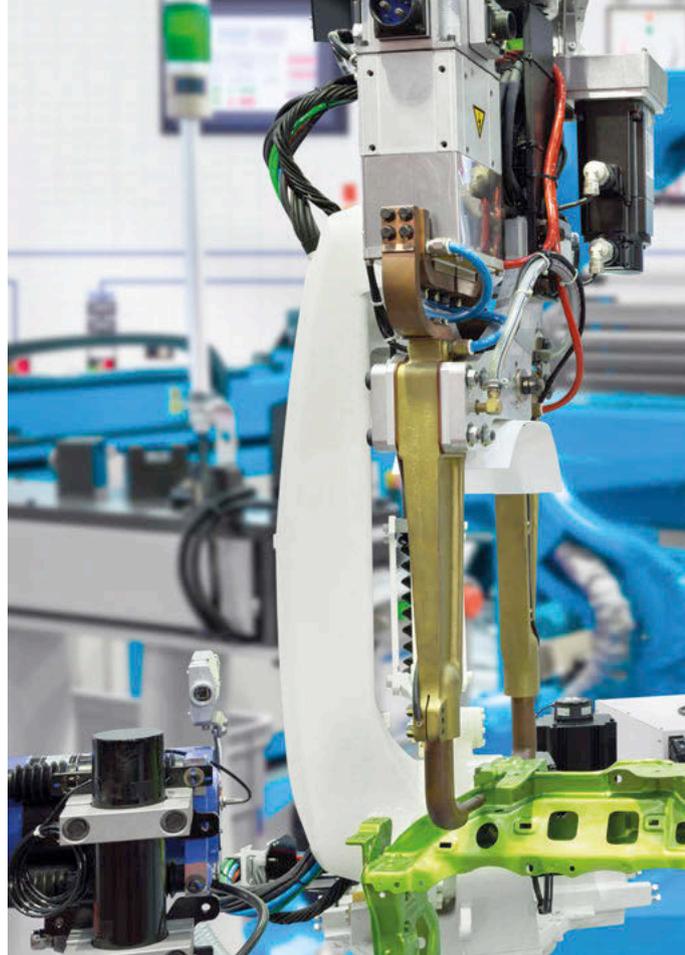
implementing technology, makers need to consider whether they have a culture of innovation, the right skill sets, good digital leadership, and the buy-in and support of the team. Then they need to identify the most effective technologies to overcome their operational challenges and create a digital transformation roadmap to help them achieve their goals.”

Jumping in at the deep end

“Too often businesses think they need to jump in at the deep end and deploy automation technology straight away, hoping it will solve problems they are experiencing. But if the aim is to improve efficiency and productivity, technology is just one part of the overall solution,” explained Dr Paul Rivers, CEO, Guidance Automation a specialist in autonomous mobile robots.

According to Dr Rivers for a successful automation programme companies need to take into account the process needs and its people, as well as the technology, so that automation can not only augment the workers’ experience but help transform productivity.

“Industry 4.0 can transform organisations’ processes and operations. It can revolutionise productivity, improve accuracy and unleash new levels of efficiency. It can help in operating environments where skills are thin on the ground and staff recruitment and retention is a challenge. For many, automation often appears to be a fast track to nirvana.



“Before implementing technology, makers need to consider whether they have a culture of innovation, the right skill sets, good digital leadership, and the buy-in and support of the team.”

Donna Edwards

Yet the reality is somewhat different,” Dr Rivers warned.

Automation should not be viewed as a direct replacement for a human workforce – and while it offers huge opportunities to improve productivity, it’s currently unable to replicate the activities of a human workforce in a like for like manner.

“By failing to truly consider how the technology will be deployed – and, critically, how it will work in tandem with a human workforce – organisations are failing to get the point of automation or reap the rewards,” he said.

According to Steve Richmond, Director Logistics Systems at Jungheinrich, an intralogistics provider, the key to successful automation is taking a staggered approach.

“Instead of completely overhauling your current setup, it should be about deploying the right technology and processes in collaboration with the right people, at the right time,” he suggested.

“This collaborative approach is more than plugging different systems together. It’s about combining people, process and technology together to achieve common goals.”



“The technology is brilliant; but it is the way technology is deployed and the way people are managed and skilled, that is the key to truly realising the potential of automation,”
Dr Paul Rivers

process from the very beginning is essential because their day to day activities will change,” explained Dr Rivers.

When technology can completely eradicate arduous or repetitive tasks, individuals tend to respond well to the change.

“But people need to be educated, trained and confident. They need to understand how the technology works and how they work together. A workforce that does not understand the system will neither work, or be harmonious,” warned the doctor.

The skillsets required will need to change but in a market desperate to recruit and retain experienced individuals, the use of automation will provide companies with the opportunity to retrain and retain highly skilled staff.

Highlighting the specific skills that are simply not in the purview of automation today is an important part of this automation evolution and key to creating an operating environment that combines excellent technology with an engaged and motivated workforce.

“The automation technologies available to organisations today are compelling. From autonomous mobile robots to automated guidance vehicles, as Industry 4.0 gains both momentum and maturity, confidence in the quality of the technology to deliver and enable significant operational change will continue to grow. But, if businesses fail to get processes aligned and truly understand the goal of any automation investment, problems will arise,” said Dr River.

By considering both the processes and people, organisations can take a far more intelligent approach to automation.

Combining analytics to monitor conditions in real time will also enable continuous improvement.

“The technology is brilliant; but it is the way technology is deployed and the way people are managed and skilled, that is the key to truly realising the potential of automation,” concluded Dr River.



“This collaborative approach is more than plugging different systems together. It’s about combining people, process and technology together to achieve common goals.”
Steve Richmond

without engaging the workforce.

“Either can lead to serious operational problems that risk derailing essential investment in improvement,” Dr Rivers said.

Assessment is vital

Assessing the way in which automation will fit within an existing process is vital.

“If, for example, one of the biggest issues within a warehouse is vehicle congestion, especially at peak times, simply replacing human operated vehicles with autonomous vehicles, without considering the timing and location of the routes, is not going to address the problem.

“Reconsidering the traffic flow, the way orders are batched, the tasks and schedules is essential if you want to maximise the specific value of this type of investment,” said Dr Rivers.

When it comes to investing in technology, running a simulation of how an automated model will work in practice will be essential and optimising any new process can still be derailed if the workforce does not understand how to work with new technology.

“Ensuring people are part of this

The aim for a company should be about creating a highly motivated and skilled workforce that’s willing to embrace new opportunities that are derived through automation.

According to Richmond it is only possible to achieve the best results when companies are clear and concise about the specific business objectives they aim to meet, as well as having their customer expectations and emerging technology solutions in mind.

“By transitioning in stages you will allow the workforce to gradually understand and become familiar with each stage of the automated process and enjoy the benefits,” said Richmond.

Industry 4.0 is compelling and businesses in all sectors are finding new, innovative and cost-effective ways to better their processes whether that involves the Internet of Things (IoT), Artificial Intelligence (AI) and Automated Guided Vehicles (AGV).

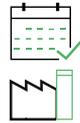
When it comes to implementation while some mistakes are basic, usually when it comes to installation, others are more fundamental, such as overlooking the implications of dropping technology into a workplace

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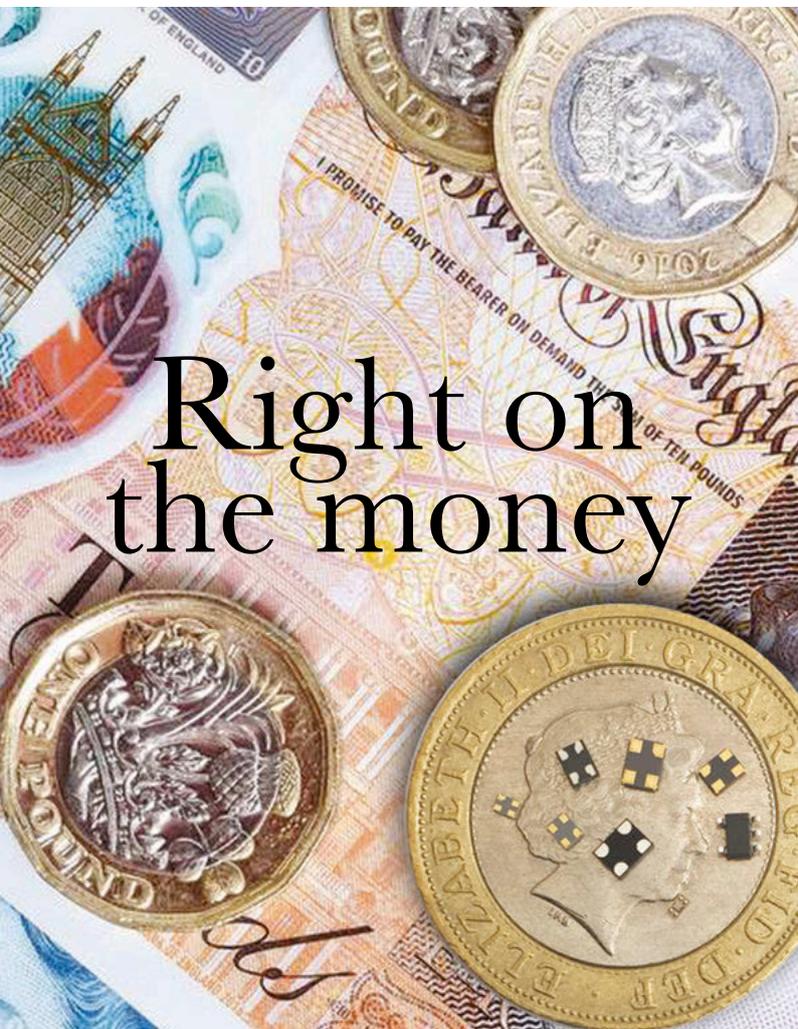
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PROTECTING RAIL ELECTRONICS

Easy to install, durable edge protection is used in train carriages to protect cables from damage, as New Electronics discovers

The modern train is full of communication technology in order to exchange information between on-board systems and the outside world.

Each carriage contains an extensive network of cables that are hidden in walls, floors and ceilings, and sometimes in very confined spaces. The cables pass sharp edges, which, if inadequately protected, can cause cracks and lead to a short circuit – which could, in turn, result in data loss, system failures or fires.

As a consequence, hard-wearing materials are required which are able to protect cables from abrasion, vibrations, or extreme temperature fluctuations.

DTi is a European subsidiary of Device Technologies, companies that are specialised in developing high-performance cable protection solutions for critical electronics systems. DTi has developed the SL-FST cable protection solution specifically for use in trains. It is particularly durable and can also be attached by simply plugging it on without the use of adhesives.

In this way, productivity can be increased as fewer work steps are required and additional costs, for

example adhesives, are eliminated reducing installation costs by as much as 50%.

The steel reinforced SL-FST solution is also heat and flame resistant. As a result, variants are able to meet the high requirements of the European rail industry, including EN45545 or FST/UV exposure. The material was initially used in the aviation industry and has proven itself in environments with high vibration levels, making it suitable for use across a wide range of rail applications.

Protecting communications

The driver's cab, passenger monitors, train-land communication interfaces or automatic door

controls are just a few examples of on-board systems in trains that need to communicate with each other to ensure smooth train operations.

As a result, modern trains are becoming more and more like high-performance computers on wheels, whose most important lifelines - the connecting cables between the individual electronic components and signalling devices - must pass through sharp edges and narrow transitions.

"If the cables are damaged, for example by continuous abrasion, short circuits can occur, which in the worst case can paralyze a critical system such as the brakes or cause a fire," said Meike Kurzak, Managing Partner of DTi. "But data loss or faulty signal control can also occur because of abrasion damage. In addition, these cables are laid in very confined spaces with very little play and are also sometimes subject to high vibration or temperature fluctuations.

"For this reason, the edges to be passed are equipped with a special edge protection, which previously had to be applied with the use of adhesives in a time-consuming process. Especially, in case of fire, the nylon grommets

Figure 1: Modern trains are full of communication technology in order to exchange information between the individual on-board systems and the outside world



themselves which when combined with the adhesives were found to cause an increased toxic load and smoke development. For this reason, DTi customised its leading grommet edging solution Spring-Fast by optimising it for use in the rail transport.

“The SL-FST edge protection consists of a particularly hard-wearing, non-flammable and steel-reinforced special thermoplastic, so that in the event of a fire it does not burn further or produce additional toxic smoke. Compared to conventional plastic edge protection, this material also cannot dry out or become porous, even if it is exposed to extreme changes and temperatures,” explained Kruzak.

Minimising potential hazards

“The SL-FST consists of a stainless-steel core that is completely encapsulated in a halogen-free and low-toxic thermoplastic compound,” said Kruzak.”

This special material is flame-retardant and particularly corrosion-resistant. Because of its properties, the plastic edge protection normally used in the rail industry is more likely to dry out and become brittle if exposed to heat or cold for long periods of time. It can break under sufficient pressure, stress or vibration.”

The special composition of SL-FST makes it very resistant to these extreme temperature fluctuations. As a result, the edge protector can be attached to the train both inside and outside. Even the high vibrations occurring on high-speed lines can be absorbed by the special construction of a securely fitting steel core and resistant plastic.

SL-FST is designed with a steel core with castles, or gripping teeth, that angle into the edge creating edge retention without adhesives.

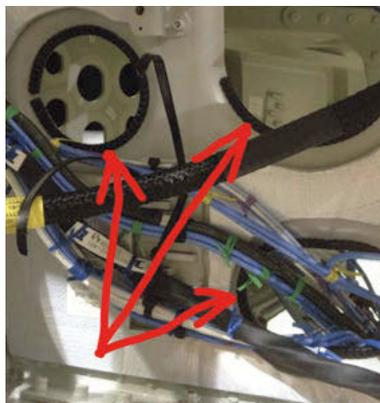


Figure 2: An extensive network of cables is hidden in walls, floors and ceilings, sometimes in very confined spaces

Figure 3: The SL-FST can be installed without using adhesives minimising the production or set-up time

DTi’s engineers have used their experience working in the aviation sector to develop the SL-FST, as the material has to perform under extreme speeds, G-forces and vibration environments in aircraft.

“As more and more high-speed lines are being laid for trains in Europe, this synergy was a logical step in the development process,” Kruzak reported.

In particular, how the material behaves when it comes into contact with fire was a key factor in its adaptation to the European railway sector.

“As many sections of track run through tunnels, fire safety requirements are particularly high,” explained Kruzak. “We therefore optimised the plastic so that in terms of flammability and toxicity it does not add to the smoke and fire development, as would be the case with a plastic that contains questionable additives or is

attached with adhesives.”

In practice this means that in a fire the SL-FST will not combust and will burn insignificantly, and will only produce a very small and manageable amount of smoke. As a result, the material meets the strict requirements of DIN EN 45545-2 and is qualified for Hazard Levels 2 and 3, which are the highest material-technical requirements within the framework of this DIN.

Easy assembly

The SL-FST edge protection system can be completely installed without adhesives. This minimises the production or set-up time from several minutes to simply a matter of seconds.

As a result, productivity can be increased because the same amount of parts can be installed in a fraction of the time normally required. This even leads to an overall cost reduction when compared to adhesive-based plastic variants, as less working time and costs are required for the additional steps and materials that would otherwise be necessary. To achieve this, the edge protector simply has to be pushed on along the shape of the edge and pressed firmly into place.

The SL-FST castles lock automatically and provide strong edge retention. Nevertheless, the protection can be easily removed again. Since no adhesives are used, workers are no longer exposed to toxic chemicals (VOCs) and odours and do not have to wear gloves or masks when attaching the edge protection.

“Adhesives and other solvents must be specially stored and disposed of and must be identified there by warning notices. Since the SL-FST installs completely without this, it is much easier to work with and at the same time it’s a very green alternative to what is currently being used,” concluded Kruzak.

Figure 4: The SL-FST edge protection consists of a particularly hard-wearing, non-flammable and steel-reinforced special thermoplastic, so that in the event of a fire it does not burn further or produce additional toxic smoke



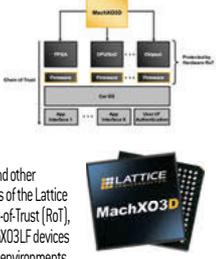


Lattice Extends Industry-leading Security to Automotive Applications

Lattice Extends Industry-leading Security and System Control to Automotive Applications

MachXO3LF and MachXO3D FPGAs Support Extended Temperature Range for Automotive and other Ruggedized Applications

Lattice Semiconductor Corporation (NASDAQ: LSCC), the low power programmable leader, today announced new versions of its MachXO3LF™ FPGAs for flexible deployment of robust automotive control applications and MachXO3D™ FPGAs for system security that support extended temperature operating ranges for automotive and other ruggedized applications. MachXO3D FPGAs augment the popular system control capabilities of the Lattice MachXO FPGA architecture with industry-leading security features, including hardware Root-of-Trust (RoT), platform firmware resilience (PFR), and secure dual-boot support. The MachXO3D and MachXO3LF devices target control, bridging, and I/O expansion applications that must operate reliably in rugged environments, including advanced driver assistance systems (ADAS), infotainment, motor control, 5G communications infrastructure, industrial robots and automation systems, and defense systems.



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New Switch'Air™ Domes with Hole from Nicomatic

New Switch'Air™ Domes with Hole from Nicomatic enable integration of LEDs into electrical membrane switches and eliminate suction effect for faster, easier automatic assembly

Patented Switch'Air™ non-stick technology, guaranteed to 1 million actuations; suit medical, industrial, marine applications

Nicomatic, the leading manufacturer of high performance interconnect systems, has added new Switch'Air™ Domes with Hole to its successful Switch'Air 4-legged Domes range. Switch'Air™ Domes feature patented technology with a cushion of air that prevents domes sticking to each other during automated pick & place manufacturing, resulting in faster, easier, more accurate assembly. With a life expectancy of up to five million actuations and guaranteed for one million actuation cycles, Switch'Air domes provide reliable, extended-life performance for demanding applications in the medical and industrial markets among others. New Switch'Air Domes with Hole are specifically designed for membrane switches, sitting free in the spacer layer of the membrane. They have a superior tactile feel with a large sweet spot.



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Panasonic Industry releases EKM and EKMC series Wide Area and Ultra Slight Motion Detection Sensors, covering a wide field of detection & high sensitivity

There is an ever growing demand for automated surveillance and monitoring applications within the smart building automation and public security infrastructure. All such devices in these sectors depend on modern sensor technology that is expected to function reliably and to appear as unobtrusive/non-visible as possible. Now, Panasonic Industry releases its new EKM versions of Pyroelectric Passive Infrared Motion Sensors (PaPIRs) with two distinct functional purposes. While being "equal twins" in terms of their physical nature, with only a 14mm small lens diameter and same pinning structure, each type has a unique and specific detection performance. The Wide Area Detection type has a maximum detection area of 12.9m @ 3M which is unrivaled in the market in such a small package. Thus, it renders the perfect motion sensor for large areas, such as entrance halls, open space offices, corridors or parking lots and many other public spaces.



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Pickering Electronics' miniature HV reed relay at the heart of IC test system

Pickering Electronics' miniature HV reed relay at the heart of IC test system for On Semiconductor

Custom request becomes industry's smallest high voltage reed relay

Pickering Electronics, the reed relay company which has pioneered miniaturization and high performance for over 50 years, has announced that it has developed a miniature high voltage relay for use in a new test rig, designed by globally-renowned chip maker, ON Semiconductor. In switching systems for test and measurement applications, reed relays are often the best solution thanks to their small size, high isolation resistance, hermetically sealed contacts, fast operate time and long-life expectancy. When developing a new test rig, ON Semiconductor – a long-standing customer of Pickering - identified the need for a reed relay with a stand-off voltage of at least 400VDC, which was also small enough to meet its demanding high switching density requirements.

The internal clearance constraints required by the updated specs would not fit within the package dimensions of other miniature relays in Pickering's broad portfolio. However, in just seven weeks, Pickering was able to send first prototypes of a device housed in the mini-SIP package with a footprint of 12.5mm x 3.7mm and a height of 6.6mm able to deliver a minimum stand-off of 1500V.



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Powell Electronics now Europe's largest Positronic stockist

\$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 Wamer, 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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Power Integrations Demonstrates Continued Industry Leadership

Power Integrations Demonstrates Continued Industry Leadership as InnoSwitch IC Sales Surpass One Billion Units

Newest GaN-based devices provide up to 100 W of power and support applications from USB PD adapters to auxiliary power supplies for appliances

Power Integrations (Nasdaq: POWI), the leader in high-voltage integrated circuits for energy-efficient power conversion, today announced that shipments of the groundbreaking InnoSwitch™ family of ICs have surpassed one billion units. Launched in 2014, the InnoSwitch family was the first to incorporate Power Integrations' innovative FluxLink™ communication technology, which provides highly accurate secondary-side control without the need for an optocoupler, resulting in exceptional energy efficiency, reliability and robustness.

InnoSwitch ICs, including the InnoSwitch3 family which launched in 2017, support a diverse range of power-supply applications including USB PD chargers, consumer electronics, PCs, displays, servers, appliances, industrial devices and automotive. The InnoSwitch product range has expanded to include a wide range of variants:

- InnoSwitch3-CP for USB PD and other constant-power applications



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Programmable PXI Simulator Modules Effectively Mimics Current Loop Based Sensors in Industrial Control Applications

41-765 Analog Output/Current Loop Simulator Modules tests transceivers using 4–20mA current loops

Pickering Interfaces, the leading supplier of modular signal switching and simulation solutions for use in electronic test and verification, today launched its model 41-765 Analog Output/Current Loop Simulator Modules, which are aimed at simulating industrial control transceivers, utilizing 4–20mA current loops. Part of an expanding range of PXI simulation modules from Pickering, the 41-765 also enables slew rates to be programmed so that different sensors can be effectively mimicked.

The 41-765 Analog Output/Current Loop Simulators feature multiple output modes, 4–20mA, 0–24mA, +/-24mA, 0-5V, +/-5V, and +/-12mV, which also improve simulation accuracy and versatility. The modules include built-in relays for shorts and opens functionality enabling fault insertion testing on every channel. Devices can also work in Full Isolation mode to avoid ground loops.



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Keep an eye on the BEEAs website for more details and to find out how you can get involved!

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