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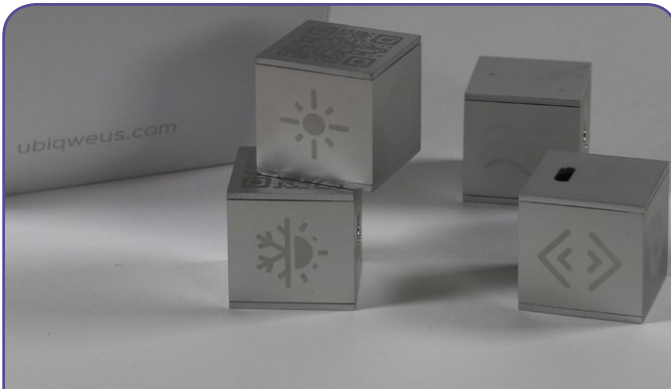


*AspenCore's 11th Design Engineer and Supplier Interface Study gathered information from engineers regarding their need for product information and other services, as well as how and when they interface with suppliers and how they see the quality and value of that interface. 1,750 U.S. engineers participated in this year's web-based survey. The results represent those surveys completed by April 2016. Rankings reflect results among the industry's electronic component distributors.



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Uncommon Market:

Canadian startup aims to connect everything with style

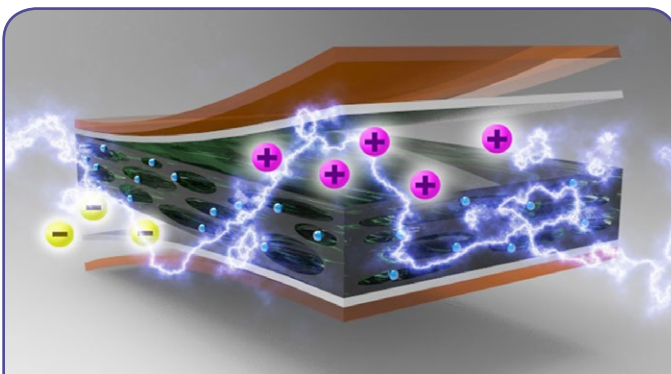
Last Word: The five stages of machine learning implementation industrial, IoT roles



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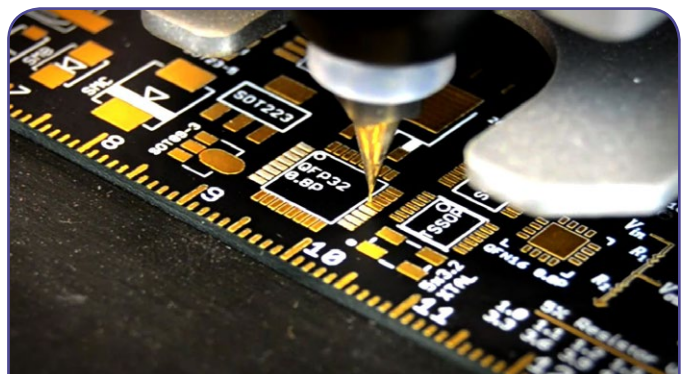
Everke of AMS on four pillars of sensing

Alexander Everke, CEO of Austria's AMS AG, has said he intends to double the size of the company over the next three years by building on four pillars of sensing.



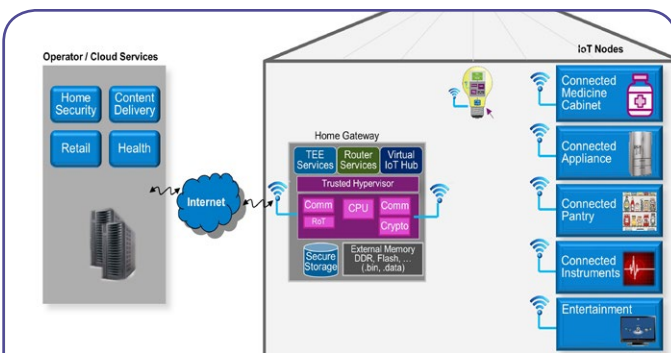
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Thin and flexible energy harvesting could be cheap too claim researchers from Michigan State University



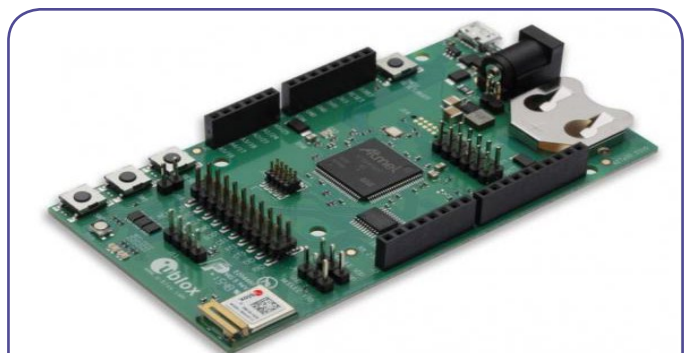
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Canadian startup aims to connect everything with style

By Julien Happich

Founded only a few weeks ago, Canadian startup Ubiquweus Inc. is launching a Kickstarter campaign for a set of super easy to deploy Wi-Fi-enabled one-inch cubic sensors, packaged attractively and made to last.

Of course there are many motes, beacons and sensor nodes on offer out there, so what's the novelty in adding yet another pack of motion, light, temperature and humidity sensors to the market place? We asked Ubiquweus' co-founders Sean Stephens and James Daigle.

"Let me tell you how it all started", said Stephens. "Sitting in an office, there were people complaining about how cold their side of the office was, whilst others were saying they were too warm on the other side, and there was never any consensus reached nor any easy way to monitor the actual temperature across the building. We could have painstakingly logged the temperature the old way, with pen and paper and a thermometer, but we wanted something more immediate and easy to share".

"When we looked around for a solution, we found that the least expensive solutions were little boards like the Raspberry Pi, but you had to hack it in order to make it work your way, there were no easy consumer product able to do this. Any readily integrated industrial solution would cost over US\$500 to have a hub and a few sensors and still, it took the most of a day to set up and make it work" Stephens told *EE Times Europe*.

"We were looking for a very simple sensor that anyone could use without requiring skills or a computer degree. So we decided to simplify it to the maximum and make one sensor per device, with each device connected independently", said Stephens, adding that instead of enticing consumers to buy new connected devices, with hubs and satellites, they could now directly connect whatever existing items in their household, cheaply.

Once commercialized, the co-founders expect the qBiq sensors to retail for about CA\$59, just over US\$40. The Kickstarter campaign promises even more competitive pricing at CA\$40 for early birds.

"Just scan the QRcode on the cube, and you get to the device's website address, with a user interface that displays data the way you want" he said, other graphics on the cube unambiguously indicate its functionality.

One of the reasons to use Wi-Fi is so that the sensors connect directly to the local Wi-Fi network, so users can monitor things without having to be in the room or



without requiring a dedicated hub like it is usually the case for Bluetooth-enabled solutions, we were told.

The most striking feature of the qBiq sensors is that they are attractively designed, for sensors, that is. "They feature a high quality aluminium enclosure, they are rugged and they are not intended to land in a landfill" insisted the co-founders.

"Our engineers also spent a lot of time on the battery design, we have integrated a 500mA rechargeable battery that can last as long as 6 months depending on the use case. It recharges through a microUSB port. All this should keep us from landing into the landfill".

"These devices can be put anywhere, they are aesthetically pleasing, and when you see them, you know immediately what they are for. What we strive for is that if you buy it, you are not going to throw it away. We want to be the Apple of the IoT world." concluded Stephens on the design front.

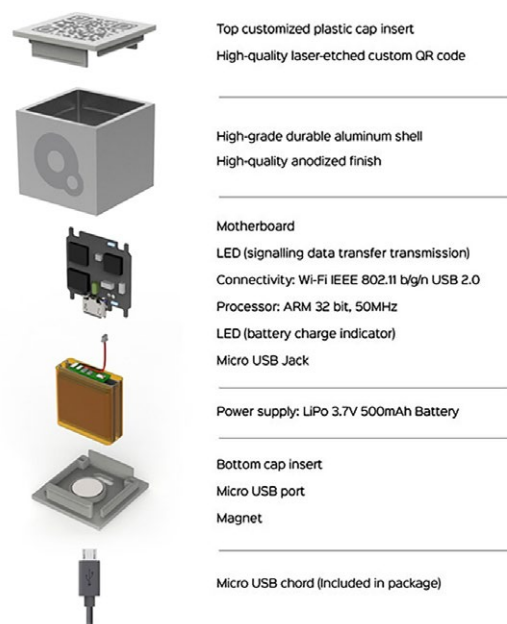
"The cubic form factor, one inch by one inch by one inch, means contractors don't need to know more detailed specifica-

tions. There is still plenty of room on the board to add different types of sensors, and we open source plans for 3D printers to print holding brackets" added Daigle, although each qBiq sensor integrates a small magnet for an easy fit to most steel-clad appliances.

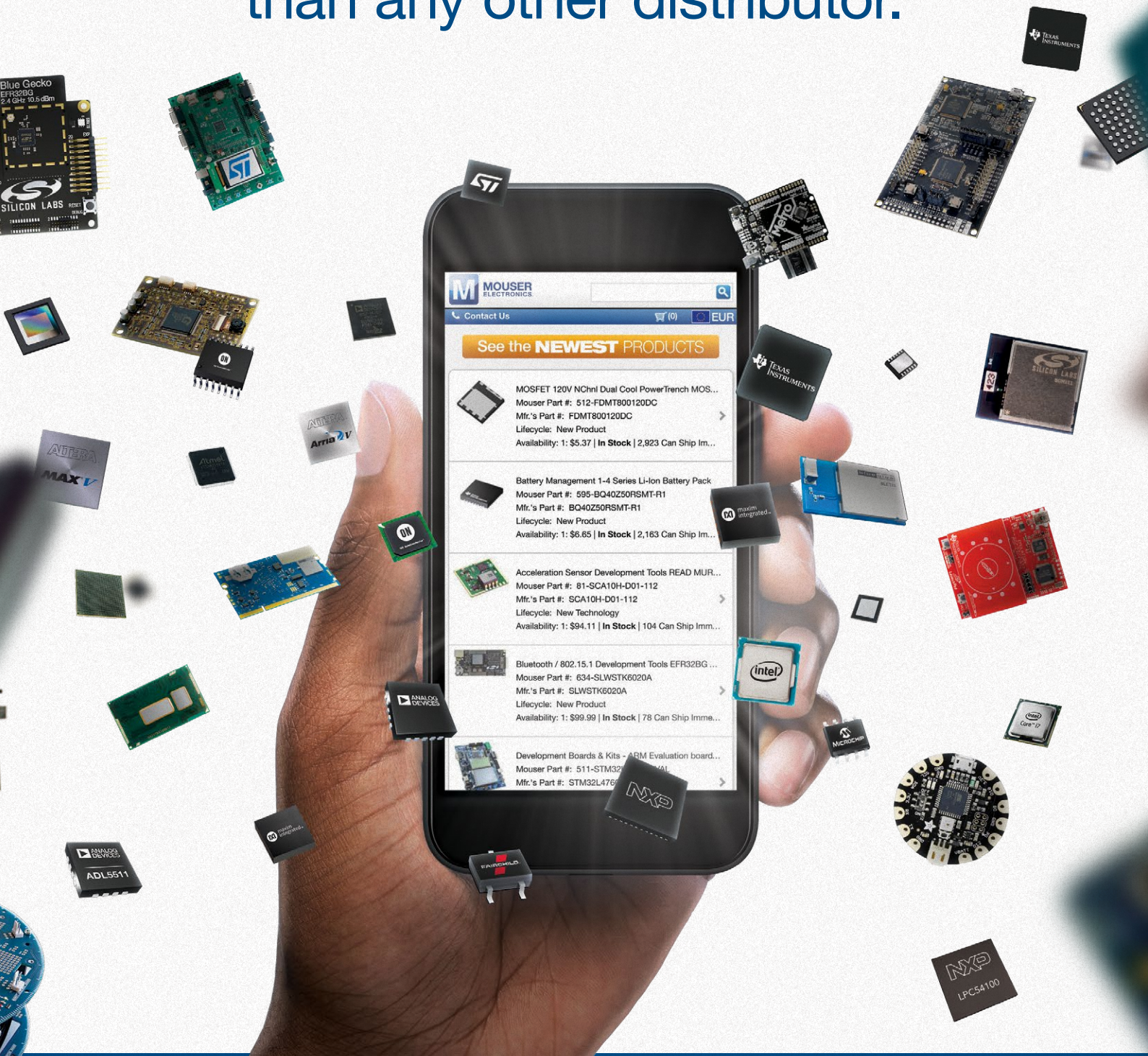
With appropriate permissions, the data is also accessible through open source technology to allow developers to build mobile apps for new use cases.

The company only starts with a few basic sensors for temperature, humidity, light intensity and motion monitoring, but if all goes according to plans, it has on its roadmap many other sensor variants, including shock, tilt, proximity, chemical sensing.

"There are lots of sensors out there that are not easy for consumers to use or configure, but we have to see first what sort of sensors they want. We need to probe the market before investing in more R&D", Daigle said, expecting the Kickstarter campaign to provide valuable feedback.



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Intel buys into map services provider Here

By Christoph Hammerschmidt

Chipmaker Intel will acquire 15% of Here, a company that offers digital map services and real-time location-based services for the automotive industry. The move follows similar announcements from other major high-tech companies like Microsoft and Mobileye. Thus, it becomes obvious that services around digital maps are becoming the next major arena in the battle about the digital mobile consumer.

According to a press release from Here, Intel has agreed with Here owners Audi, BMW and Daimler to acquire 15 % of Here's shares. In addition, Here and Intel agreed to develop a proof of concept for a highly scalable software architecture that will enable near-realtime updates of high-resolution digital maps. Such electronic maps are considered a major technological enabler for automated driving. In addition, both companies will enter intensive discussions about strategic options related to the interplay between location-based data with edge computing devices.

"Cars will be among the smartest and most intelligent devices", explained Intel CEO Brian Krzanich. "We are very excited to provide an important basis technology for the connected vehicle of the future".

High-resolution maps of the next generation and the scalable software architecture to be developed by Intel will enable vehicles to navigate at a precision of a few centimeters and thus recognize exactly their position in relation to relevant objects such as the traffic lane or the curb – a major prerequisite for automated driving. Updates to this map almost in real time would also enable the vehicles to stay continuously informed about deviations, traffic stalls, weather-based traffic obstructions and

other facts relevant for navigation.

Intel will test the architecture to be developed with Audi, BMW and Daimler. Intel and Here plan to make it available industry-wide as an integrated offering, enabling carmakers to significantly reduce their time-to-market.

Intel's move acknowledges the importance of electronic map services to autonomous driving. At the same time, it highlights the attractiveness of Here as the partner for location-based, automotive-related location based services over competing services from digital top dogs like Apple and Google. Intel's acquisition follows similar moves from other major players. Recently, an Asian group integrating Chinese mapping company Navinfo, internet giant Tencent and Singapore-based investment firm GIC acquired a 10% stake of Here, accompanied with announcements to offer Here's map services in China. In December, autonomous driving technology company Mobileye announced a collaboration with the goal of integrating Mobileye's Roadbook data layer into Here's Live Map – a move that ties Mobileye's automotive sensor data into the navigation system. Thus, Live Map users basically get access to the sensor data generated by other cars.

Also classic PC software giant Microsoft has joined the automated driving fray: In December, Microsoft and Here announced to intensify and expand their collaboration on next-gen location-based services. The agreement enables Microsoft to integrate Here's data and services into Microsoft's Bing maps platform and into the Bing Maps API offered developers through the Azure Marketplace.

Magna partners with Innviz on Lidar technology

By Christoph Hammerschmidt

Expertise in the infrared-based Lidar sensor technology is currently in high demand in the automotive industry. Indicators are increased funding and collaboration activities in this market segment. The latest one: The Canadian automotive supplier Magna International and Israel-based startup Innviz Technologies said they are partnering to deliver Lidar remote sensing solutions for the implementation of autonomous driving features and full autonomy in future vehicles.

Recognizing that Lidar is imperative for achieving the desired levels of performance and safety, Magna selected Innviz's technology to be integrated into its autonomous driving systems to provide a complete sensor-fusion solution to automakers.

According to Magna, Innviz offers a comprehensive market solution that is driven by a unique hardware architecture and innovative software technologies. Innviz' high-definition, solid-state Lidar enables 3D remote sensing to produce accurate real-time images of

the vehicle's surroundings while meeting automotive standards and significantly reducing cost and size. In contrast to solutions currently on the market, the Innviz Lidar can be integrated into any vehicle and is designed to effectively manage changing light and weather conditions.

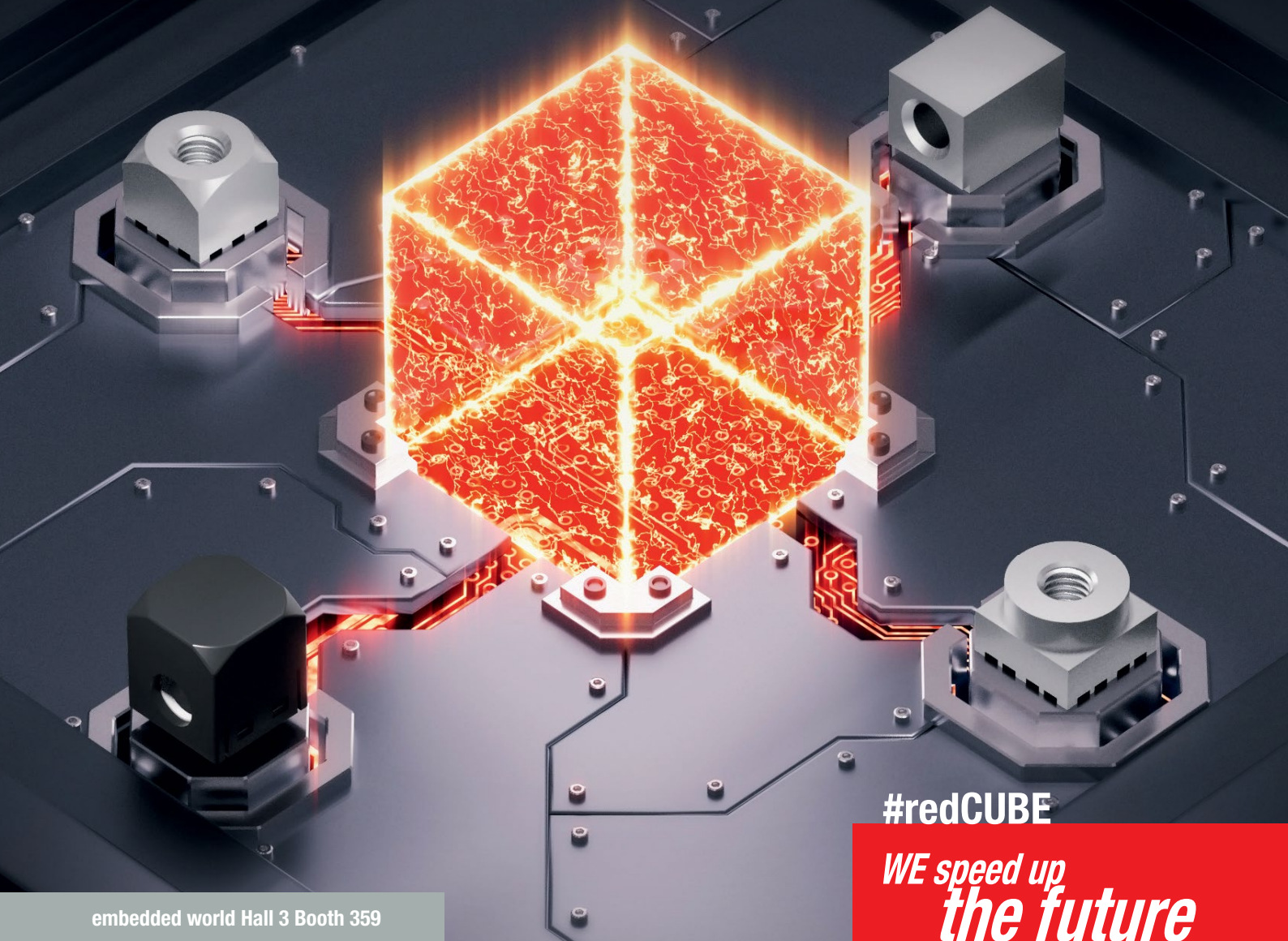
"We are pleased for the opportunity to partner with Innviz, as we have confidence in their multi-disciplinary team and this gives Magna a full suite of sensing systems – camera, ultrasonic, radar fusion, and Lidar – to complement our autonomous vehicle capability," said Swamy Kotagiri, Magna Chief Technology Officer.

"The integration of Lidar into driving systems is pivotal to enabling full autonomy and in ensuring a comprehensive sensing solution that satisfies the highest safety standards. The cooperation with Magna affirms Innviz's technology and product capabilities as well as our ability to adhere to Magna's high bar on safety requirements," said Omer Keilaf, Co-Founder and CEO of Innviz.



High resolution, long range, no moving parts make Innviz' Lidar sensors attractive for automotive deployment

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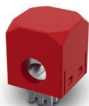
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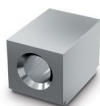
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Flexographic printing nears 1 μ m resolution for electronics

By Julien Happich

Publishing their findings in the *Science Advances* journal under the title “Ultrathin high-resolution flexographic printing using nanoporous stamps”, researchers from the MIT re-visited flexography to give it a high-resolution twist, with low-cost, large-area printed electronics in mind.

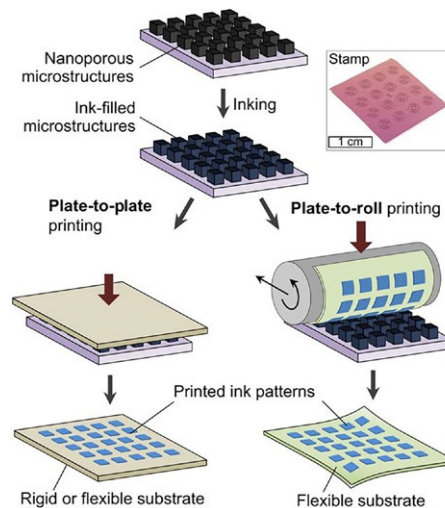
Where the resolution of flexographic printing using elastomeric stamps is typically limited to tens of micrometres, due to liquid instabilities and ink spreading issues during stamping, the researchers have developed a novel type of stamp material specifically engineered to work well with a number of commonly available electronic inks at near 1 μ m resolution.

The material had to have pores large enough to host colloidal ink particles when wetted with the electronic inks, yet not so large as to impact negatively the printed features. It had to be solvent resistant, mechanically compliant to establish uniform contact, yet durable.

The researchers found what they were looking for by growing vertically aligned carbon nanotubes (CNTs) on a lithographically patterned silicon substrate, creating repeatable microstructures, 99% porous. After various chemical surface treatments and a conformal pPFDA polymer coating, the stamps were fit for purpose, supporting the capillary-driven loading of ink and nanoscale contact-mediated ink transfer.

As a demonstration, the researchers then printed a number of micrometre-scale patterns of a variety of functional nanoparticle inks, including Ag, ZnO, WO₃, and CdSe/ZnS, onto both rigid and compliant substrates. That was performed at a resolution and a printing speed (0.2 m/s) far superior to today's industrial printing technologies, they wrote in their paper, hinting that their process could make cheap mass-produced electronics a reality if translated into roll-to-roll tool fabrication.

In one example, the MIT team printed conductive networks of transparent electrodes, a key layer to connect to LEDs, LCDs, touch-screen panels, or solar cells to name a few applications. In a single flexographic printing step using the an honeycomb-patterned nanoporous stamp, the researchers were able to print a thin Ag honeycomb with a minimum linewidth of 3 μ m between adjacent holes, with a transparency of 94% (from 200 to 800nm) and a sheet resistance of 3.6 ohm/sq. The sheet resistance is half that of comparable 90% transparency indium tin oxide achieved today, and one-tenth the value reported for



The printing process, transferring ink from the nanoporous stamp to the target substrate. (Source MIT)

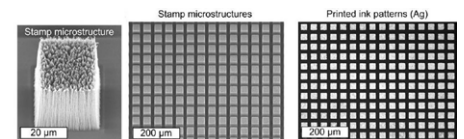
other Ag nanowire networks at 90% transparency. The printed patterns exhibited a rather uniform nanoscale thickness, from 5 to 50nm.

Another demonstration was the printing a colloidal quantum dot ink (CdSe/ZnS), in a honeycomb pattern with a minimum internal linewidth of 5 μ m and holes 11 μ m in diameter.

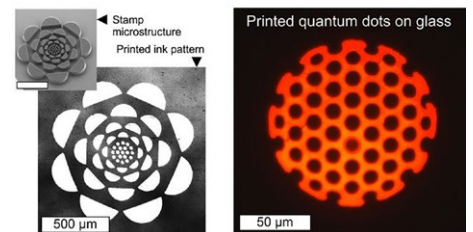
To ensure precise printing and to apply the right stamp pressure for a thin uniform result, the team developed a model taking into consideration the stamp and the substrate's respective roughness as well as the concentration of nanoparticles in the ink.

Here the resolution of the printed patterns was somewhat restricted to the resolution of the lithographic equipment used and the researchers think that using single-walled CNTs of significantly smaller diameter (1 to 2nm) and spacing could push flexographic printing to submicrometer features.

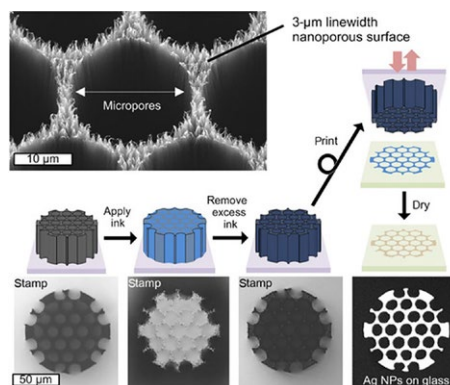
The researchers expect that a multi-layered roll-to-roll printing approach could yield complete electronic circuits and energy harvesting solutions on the cheap, at industrial scale. This could range from pervasive sensors on food packaging to weather monitoring solutions printed on glass windows.



SEM images of a stamp microstructure, 25 μ m by 25 μ m (left), and (right) optical and atomic force microscopy images of an array of such structures and the resulting printed Ag ink patterns.



SEM image of the stamp feature (upper left) and optical microscope image of the printed Ag NP ink pattern (lower left) of a flower-like pattern with feature widths varying from 20 to 150 μ m. On the right, fluorescence microscope image (wavelength emission, 620 nm) of printed QD ink (CdSe/ZnS, from 5 to 6nm) of a pattern with minimum internal linewidth of 5 μ m and hole size of 11 μ m.



(top left) Magnified SEM image of honeycomb-structured CNT stamp with a minimum internal linewidth of 3 μ m. The schematics paired with optical microscope images show the CNT stamp in various conditions, dry, inked, and the resulting printed pattern on a glass substrate (after solvent evaporation). (Source MIT)

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Autoliv, Volvo launch software company for autonomous driving

By Christoph Hammerschmidt

By signing the final agreement to form a joint venture dedicated to developing software for autonomous driving, carmaker Volvo and safety systems suppliers have substantiated an earlier announcement. The JV, named Zenuity, will also develop software for driver assistance systems.

The joint venture will create a new entrant in the growing global market for autonomous driving software systems. According to the founding companies, the move marks the first time a leading premium car maker has joined forces with a tier one supplier to develop new advanced driver assist systems (ADAS) and autonomous driving (AD) technologies.

As part of the agreement announced today, at the time of closing Autoliv will make a total investment of around 1.1 billion SEK (about €115 million / \$ 120 million) into the joint venture, the large majority of which is an initial cash contribution, and which also includes certain assets. Volvo Cars will also contribute certain assets to the joint venture. As previously announced, Autoliv and Volvo Cars will own the joint venture 50/50. Headquartered in Gothenburg, Sweden and with additional operations in Munich, Germany, and Detroit, USA, the initial workforce of around 200 people will come from Autoliv and Volvo Cars. The company is expected to grow to over 600 employees

in the medium term. Operations are expected to start during the first half of 2017.

Both Autoliv and Volvo Cars will license and transfer the intellectual property for their ADAS systems to the joint venture. From this base, the company will develop new ADAS products and AD technologies. The new company is expected to have its first driver assistance products available for sale by 2019 with autonomous driving technologies following shortly thereafter.

The mission for the joint venture is to use the latest ADAS/AD know-how to create robust and flexible solutions that are at the technological forefront. This will be achieved by a speed to market with robust solutions, utilizing extensive experience and real-life tested solutions. Customers will be offered flexibility to choose based on a platform with modular solutions. The joint venture is further committed to shape the industry through delivering spearhead solutions that continuously push the AD boundaries.

Autoliv will be the exclusive supplier and distribution channel for all the new company's products sold to third parties, and there will be no exclusivity toward any customer or the owners. Volvo Cars will source such products directly from the new joint venture.

BMW speeds setting up R&D center for autonomous driving

By Christoph Hammerschmidt

To reach its goal of bringing the electric, connected and autonomous vehicles of its iNEXT series to series production, carmaker BMW kicks on the pedal: the company announced to establish an additional R&D center dedicated exclusively to autonomous driving.

In the new R&D center, more than 2000 engineers will be engaged in the development works, from devising software to road tests. The center will be located in Unterschleißheim near Munich and complement BMW's existing R&D center where more than 10,000 engineers from BMW and its suppliers ponder over next-generation vehicle technology. Starting in mid-2017, the new Unterschleißheim campus will conflate all activities and competencies related to autonomous driving currently dispersed across various locations.

In the new campus, BMW also will establish and test innovative project management approaches. "Within the scope of our project I 2.0 we will establish new ways of collaboration: Small project teams that act like speedboats, enterprise-spanning collaboration and high individual decision-making competencies",

explained Klaus Fröhlich who oversees BMW's R&D activities at the board level. "This will combine the advantages of a start-up company like speed and flexibility with those of an established enterprise such as process maturity and industrializing competency". The new R&D campus will enable BMW to bring the company's first commercial self-driving vehicle to the market in 2021. Already in 2017, the carmaker plans to start driving tests

with highly automated vehicles in urban environments, namely in Munich.

Currently at BMW some 600 engineers and software designers are involved in highly automated driving technologies, with most of them being dedicated to software development. "We indeed are devising our algorithms by ourselves and can implement our ideas in-

dependently", explained André Müller, software developer in the autonomous driving team. "We are using the latest technologies such as ROS (Robot Operating System) and can experience the results quickly and directly in the vehicle." Currently the carmaker is hiring many more developers, IT experts and software designers with expertise in the areas of Artificial Intelligence, Machine Learning and Data Analysis.

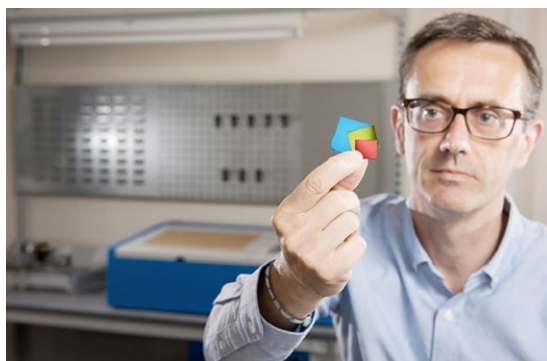


Phase-change display startup achieves primary colours

By Peter Clarke

Bodle Technologies Ltd. (Begbroke, England), a spin out from Oxford University developing a non-volatile display based on thin films of phase-change material, claims it has achieved a key milestone in bringing its Solid-State Reflective Display (SRD) technology to market.

"We have achieved reflective specifications for the three primary colours required for manufacture of the core optoelectronic



Founder of Bodle Technologies, Professor Harish Bhaskaran holding several colour samples.

can be read in sunlight.

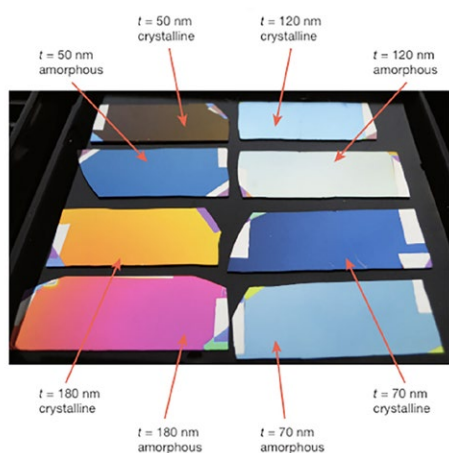
Bodle materials are based on thin films of $\text{Ge}_2\text{Sb}_2\text{Te}_5$ (GST) electrically switchable between amorphous and crystalline states. The material is essentially the same as that used on rewritable DVDs where changes in the refractive index of a thin layer of the material is used to denote a one or a zero for the purpose of digital storage. In Bodle's case thicknesses are reduced to the order of 50 to 200nm.

The company claims Bodle displays will offer vivid colour and bright white for e-readers, wearables and other screen-based equipment. Little energy is required to change pixels and non to maintain a static display thereby minimizing power consumption for mobile equipment.

Bodle also points out that the thin-ness of the pixels make SRD fabrication compatible with flexible substrates and they are scalable down to the pixel size of current high-resolution displays.

Bodle has also recruited staff from Sharp Laboratories Europe, which has long been based in Oxford, and from the Oxford University Innovation group.

Ben Broughton has joined from Sharp to serve Bodle as vice president of display technologies to lead a team of engineers to adapt SRD to a range of consumer and industrial and products. Richard Holliday has joined Bodle from Oxford University to serve as senior vice president of business development and intellectual property.



The crystallization of thin GST layer induces a colour change in the entire film, visible when incident white light is reflected back. Source: Nature and Bodle Technologies.

films in our Solid State Reflective Display technology," said Professor Harish Bhaskaran, founder of Bodle Technologies.

The SRD technology offers two advantages over LCD displays; it is non-volatile and therefore achieves power savings and it is a reflective display meaning it

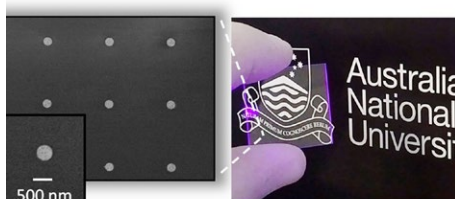
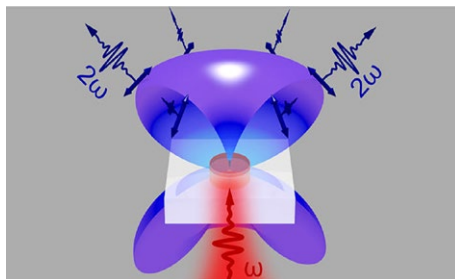
Nanoantennas on glass: the path to full photonics night vision?

By Julien Happich

In a paper published in Nano Letters, a team of researchers from the Australian National University (ANU) are revealing a new way to fabricate nanoantennas so as to be able to lay them evenly on top of a transparent glass substrate. This new feat, they explain in the paper "Nonlinear Generation of Vector Beams from AlGaAs Nanoantennas", makes it possible to observe and characterize the nanoantennas' behaviour with respect to different light frequencies shone at them, from any direction. And what they found was that when lit at infrared frequencies, the embedded nanophotonic components (AlGaAs nanodisks tested with various diameters from 340 to 690nm and 300nm thick, laid out periodically 5µm apart) were capable of manipulating light locally and spatially. The nanoantennas were emitting second harmonics in a preferential direction with a backward-to-forward ratio of up to five.

By tuning the nanodisks, the researchers were able to shape

the second harmonic radiation pattern in forward and backward directions as well as its polarization state.



Although this research was rather fundamental, Prof. Dragomir Neshev from ANU later envisaged that one application could be the direct conversion of infrared light (or other frequencies non visible to the human eye) to visible frequencies, directly in line of sight. Instead of designing bulky optoelectrical conversion apparatuses relying on sensors and displays, this may be done by embedding the right combination of nanodisks onto the lens surface of conventional glasses.

Due to its obvious military applications, the team has put in a proposal to DARPA, seeking funds to develop such a technology in the next 5 years. Other applications could include anti-counterfeit markings only detectable under specific lighting.

"It is still too early stage for patenting or a start-up, but I hope we can secure the funding to get closer to a real product" commented Neshev.

GE spins out MEMS startup: wants cheaper power switches

By Julien Happich

Last week, GE Ventures, Microsemi, Corning and Paladin Capital Group jointly launched MEMS startup Menlo Micro, investing a total of \$18.7 million in the brand new company.

The newly formed company will expand General Electric's unique Digital-Micro-Switch (DMS) platform to broader markets across multiple industries. The novel MEMS-based high power handling switch technology has been in the R&D stage for the last 12 years at GE who has been using it in its MRI systems for two years now.

EE Times Europe caught up with Menlo Micro's CEO, Russ Garcia so he would share the story behind that launch. What MEMS technology are we looking at and why couldn't GE keep this in house?

Garcia unfolded the story "Mechanical switches have been around for a long time, they can handle quite a lot of power, hundreds of volts and tens of amps. But they are bulky and expensive. SiC solid state switches have their own set of issues, they draw a lot of current and heat dissipation is also problem. GE being a power company, it uses a lot of power switches. About ten to twelve years ago, well before industrial IoT was popular, the company had a vision. What if we could make remotely programmable circuit breakers? "

"GE started looking for a source of commercially available remotely programmable circuit breakers but it couldn't find any. It characterized all the MEMS switches available at the time but the reliability wasn't there. Basically, GE's engineers determined the failure mechanisms of the MEMS switches, the material fatigue, the stiction, and they figured out they had to solve the problem themselves. GE pooled its resources in house, the metallurgists from making fins for turbine engines and semiconductor physicists, it needed high power with RF performance and billions of switching events", continued Garcia.

"The result was a new material solution that solved the reliability issue and could switch high power with a very low 'on' resistance and very low losses. They developed the technology from scratch, and tens of thousands of pieces were shipped inside GE. The first application was a PIN diode replacement in a MRI coil, handling hundreds of watts", Garcia told *EE Times Europe*.

"But remember that originally, GE was looking for an external supplier, because the company is not a components supplier, it is a systems supplier.

By spinning out a dedicated company, it wants the technology to be scaled to many other applications and benefit from



Menlo Micro's CEO Russ Garcia

the unit cost reduction when the switch will be produced in large volumes".

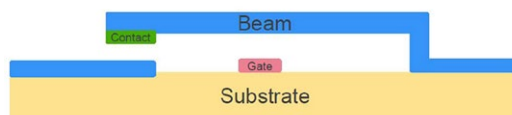
But why couldn't other MEMS players tune their materials and deliver this solution? We asked.

"The primary issue in MEMS is holding to the materials available in the fab you are going to. In the case of contact switches, they use pure metals. We've developed materials that you would not find in typical fabs".

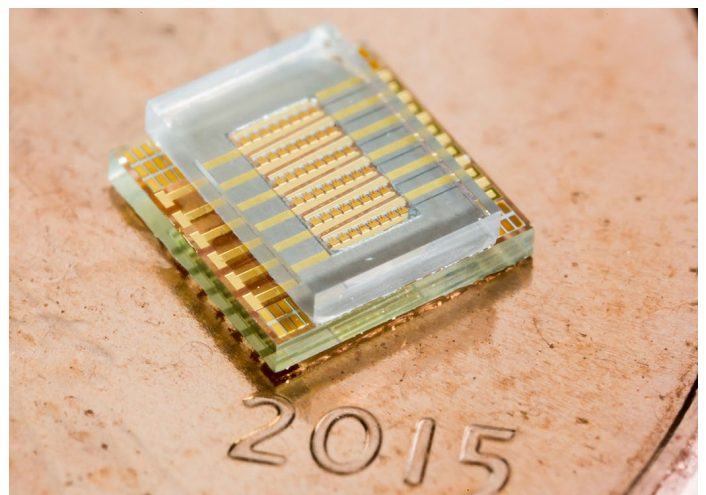
All Menlo Micro's MEMS power switches rely on the same fixed unit cell, a micrometre-sized cantilever beam with an electrostatic actuation that establish a ohmic contact at its tip. A single switch only needs a few pA to function. By combining hundreds of such cells in series or in parallel, the startup can change the voltage or the current handling capability of its

devices. The technology is scalable from milliwatts to kilowatts, has been rated to tens of billions of cycles and a given design layout requires less than a dozen mask layers, according to Menlo Micro's literature.

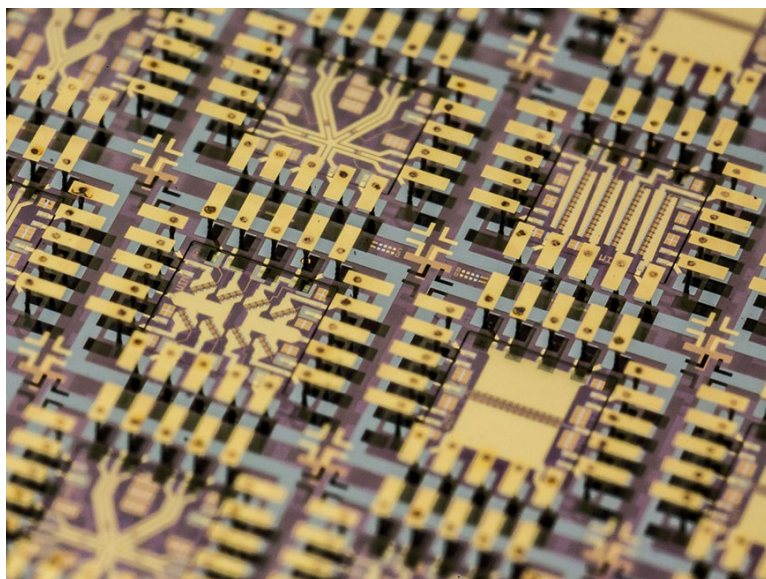
"The MEMS can be built at a substantially lower cost than solid state switches and many product variants can be designed very quickly while always retaining the unit cell's proven reliability", explains Garcia.



Schematic of the electrostatic-actuated MEMS.



Built using a scalable design platform, Menlo Micro's first MEMS power switch MM3100 features 6 channels each capable of carrying 25W per channel at 1A. Each of the channels features 8 high reliability cantilever switches. The MM3100 die only measures 3.6x4mm.



A wafer-level view of different MEMS switches patterned on glass.

"We've designed several cantilevers but for now we've only retained one because we got so close to an ideal switch. Putting them in series or in parallel is much more robust than figuring out another cantilever design. A unit cell is for us like a transistor for a given processor node, our next cantilever design will be like the next transistor node", the CEO said, envisaging further technology refinement as the company grows.

Garcia explains that because the 'on' resistance is so low, the switches don't require a heat-sink, making the end power solution more compact. He admits that if you need to switch in nanoseconds, then solid state switches are still a winner, but anything that needs switching power in microseconds could be competitively served by the MEMS switches.

Could you give us a practical example where these MEMS switches would displace incumbent solid state devices and how the final product would compare? *EE Times Europe* asked.

"A high power filter we had was using GaAs PIN diodes for the switches. It was a 2W UHF filter. With our MEMS, we reduced the component count from approximately 200 parts to 25

parts, we reduced the board size by 75% and power dissipation was reduced by an order of magnitude, from 1W to 100mW", revealed Garcia.

"There were 40 or 50 PIN diodes plus support electronics, we replaced that with 6 MEMS devices. Several of our customers are designing this into high power filters. Because they are electrostatic devices, once they are 'on', there is no dissipation. In comparison, you have to draw current to keep GaAs or SiC devices 'on'. The 'on' resistance will always be better for contact switches", added the CEO, mentioning that Menlo Micro had developed a demonstrator relay handling 240V and 10 or 25A, with only tens of mOhms of 'on' resistance, all on a few square millimetres.

"GE was our first product customer, it has been using our MEMS switches in its MRI systems for the last two years. Menlo Micro has raised the money for product proliferation.

We need to figure out the die size and the different combinations, so that we won't be just selling a switch but subsystems and multi-channel switches", Garcia said about the initial round of funding.

"We are still scaling up. We'll have revenue this year but we'll be moving to a commercial fab over the next two years (for now, the MEMS are produced at GE's small fab) and we still have a lot of product development activity to finance. Our break-even target is about 30 months from now. GE continues investing in the company, it is our partner for advanced R&D on MEMS technology. Many startups don't have a big brother like GE to support their R&D" Garcia continued.

"We use glass wafers, because of the isolation performance in RF, hence the interest from Corning as an investor", the CEO concluded.

The startup will set its sight on high value applications including DC, AC and RF products, covering such diverse markets as battery management, home-automation, electric vehicles, medical instrumentation, and wireless base stations. Its first official product is the MM3100, a 25W continuous (200W pulsed) 6-channel SPST digital-micro-switch in an hermetic 6x6x1.3mm LGA package.

Europe lags as chip market motors

By Peter Clarke

Europe was the only region to show its semiconductor market shrinking in November 2016 on an annual basis as the global market grew by 7.4 percent and the year-to-date came close to parity with the same period in 2015, according to the European Semiconductor Industry Association (ESIA).

The ESIA reported numbers gathered by the World Semiconductor Trade Statistics organization. With the Asia-Pacific region, including China, showing year-on-year growth in November of 10.4 percent, the likelihood is that 2016 will be a growth year for the semiconductor market.

The pace of year-on-year global chip market growth increased again in November led by the regions of the eastern hemisphere and with the Americas regions starting to show growth as well.

The global three-month averaged chip market in November was \$31.027 billion an increase of 7.4 percent. Year-on-year sales increased 15.8 percent in China, by 8.2 percent in Japan

and by 10.4 percent in the Asia-Pacific Region including China but excluding Japan.

As a result, chip sales for the first 11 months of 2016 are now just 0.3 percent behind those achieved in the same period in 2015. If the sales growth continues 2016 will be a growth year, although the best that can be looked for is low single-digit percentage growth for 2016 compared with 2015. Nonetheless this would exceed the predictions of recent months from almost all the market analysts and forecasters.

The sales numbers are compiled by WSTS. Monthly data is given by the ESIA as a three-month average, although the WSTS organization tracks actual monthly data. The ESIA and other regional semiconductor industry bodies opt to use averaged data because it evens out the actual data that typically show troughs at the beginnings of quarters and peaks at the ends of quarters.

Europe to rethink 10/100/20 chip project

By Peter Clarke

The European Commission intends to reconvene a high-level group of European CEOs and executives to exchange views on Europe's 10/100/20 nanoelectronics and chip manufacturing project and make adjustments as necessary for a wave of European Union investment supposedly starting in 2020, according to industry body SEMI.

Rania Georgoutsakou, SEMI's director of public policy for Europe, has written that a recently held closed meeting of company CEOs and national ministries and other participants came to the conclusion that the EU 10/100/20 strategy "was on track."

Europe's 10/100/20 strategy was launched in 2013 with the goal of raising European chip production to 20 percent of the global total by 2020. At that time, Europe's global share was less than 10 percent and had been falling for decades. The three numbers in the project title stand for €10 billion in public/private research funding, €100 billion spent by industry on manufacturing and achieving 20 percent of the global chip production market by 2020.

The high-level group of CEOs convened to implement the 10/100/20 strategy passively resisted the plan from the start. Instead they sought to persuade the bureaucrats that chip manufacturing output was not the appropriate measure of success.

It should be noted that Sir Peter Bonfield is a director at foundry Taiwan Semiconductor Manufacturing Co. Ltd. (Hsinchu, Taiwan) and therefore works in the interest of world's leading foundry manufacturer of chips. Sir Peter Bonfield is also chairman of NXP Semiconductors NV and a director with Mentor Graphics Corp. NXP is in the process of being acquired by

Qualcomm Inc. and Mentor in the process of being acquired by Siemens AG.

The closed meeting of CEOs and other parties was held at a nanoelectronics forum held in Rome at the end of November.

According to Georgoutsakou the meeting did discuss increasing capital expenditure although the idea that the 10/100/20 strategy is "on track" seems strange.

There is almost no leading-edge digital chip manufacturing left in Europe as the local companies have embraced outsourcing of digital semiconductor manufacturing to foundries. The two most advanced wafer fab locations left in Europe in terms of deep sub-micron miniaturization belong to Intel in Leixlip, Ireland and Globalfoundries in Dresden, Germany. And these sites are relatively mature.

Guenther Oettinger, European Commissioner for the digital economy and society, spoke at the event and said the European Union was committed to reinforcing Europe's global competitiveness in nanoelectronics, Georgoutsakou said.

However, it was also indicated at the meeting that discussions will start in 2017 on the priorities for EU spending after 2020 and that micro- and nanoelectronics had received "significant public funding" in recent years. Georgoutsakou added:

"With a number of investment priorities fighting for a limited budget, industry advocacy is needed to maintain and reinforce the EU's financial commitment to Europe's micro-/nanoelectronics value chain."

In other words: the European nanoelectronics industry, having rejected the idea of spending €100 billion on manufacturing, needs to continue to make the case to the European Commission for support.



European chip project worth 'billions' is making progress

By Peter Clarke

Talks on a funding project valued in the billions of euros and that could include support for European chip manufacturing are making progress, according to a senior executive with ECSEL.

ECSEL, which stands for Electronic Components and Systems for European Leadership, is a public-private partnership and secretariat that selects and funds projects of collaborative research in Europe.

Speaking at the European Nanoelectronics Forum held in Rome on November 24, 2016, Ben Ruck, chairman of the ECSEL public authorities board, said that five countries together with relevant industrial partners are actively involved in the development of an Important Project of Common European Interest (IPCEI) in the field of micro- and nanoelectronics.

It is not clear whether this is the same IPCEI proposed by Rutger Wijburg, general manager of the Dresden wafer fab of Globalfoundries, in his Semicon Europa keynote given in November 2015. Wijburg's aim was to gain support for chip manufacturing in Europe focused around the fully-depleted silicon-on-insulator (FDSOI) process Globalfoundries is developing with support from STMicroelectronics.

Getting an investment labelled as an IPCEI can unlock large-scale public investment. According to semiconductor industry body SEMI up to 20 percent of an IPCEI project cost can be covered by public funds, which might otherwise be against rules on state subsidy.

In his speech in Rome Ruck said the nanoelectronics IPCEI currently under discussion could be valued at billions of euros.

However, it also seems likely that discussions have opened up the nanoelectronics IPCEI to cover support across the breadth of the nanoelectronics supply chain.

Ruck quoted European Commissioner Guenther Oettinger as saying: "This IPCEI facilitates first production of innovative future-proof energy efficient smart technologies.

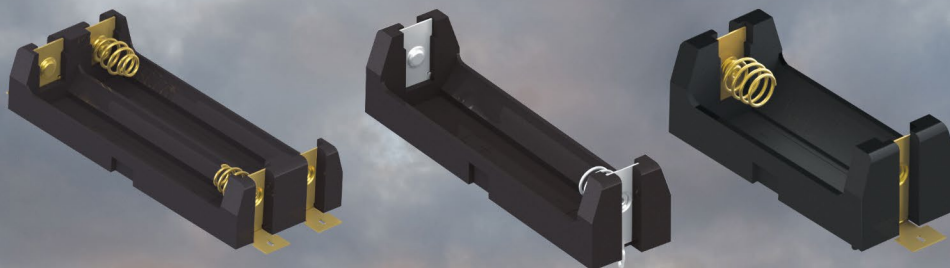
It is to secure that the next wave of digital products can be conceived, designed and manufactured in Europe." Ruck added: "Really, this is European industrial policy in the making!"

Talks on the IPCEI are making progress and could be concluded by the end of the first quarter of 2017, a source said. That person, speaking on a condition of anonymity, said an announcement might be expected by summer 2017.



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MEMS optical filters give hyperspectral powers

By Julien Happich

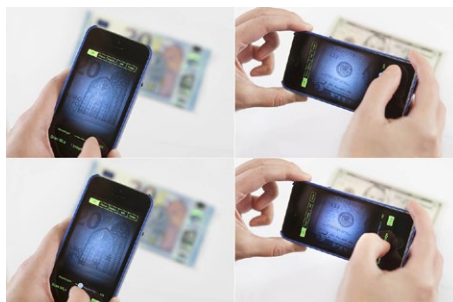
Integrating thin electrically-tunable Micro-Opto-Electro-Mechanical (MOEMS) structures within the camera optical stack of an iPhone, researchers from the VTT Technical Research Centre of Finland have created what they believe is the first fully integrated hyperspectral smartphone.

The MOEMS here is a tunable MEMS Fabry-Perot Interferometer (FPI) consisting of atomic-layer deposited TiO_2 - Al_2O_3 $\lambda/4$ -thin film Bragg reflectors, with an air gap formed by sacrificial polymer etching. Metal electrodes are integrated into the mirror membranes to that the air gap height can be tuned by capacitive actuation, influencing the passband wavelength.

The researchers fabricated an iPhone 5s hyperspectral imager (HSI) demonstrator with a single MEMS FPI tunable filter for the visible-range around 500 nm (with an operation range of 450 to 550nm), but in SPIE proceedings "MEMS FPI-based smartphone hyperspectral imager", they also demonstrated that a tandem-FPI set-up could be used to scan a larger wavelength range.

They reported a configuration of two cascaded FPIs centred at 500 and 650nm (combined with an RGB colour camera), to expand the wavelength tuning range from 400 to 700nm. Although they didn't integrate the cascaded setup inside an iPhone, the mechanical thinness of such MOEMS filters would be easily compatible for smartphone integration within the optical stack, providing OEMs would license VTT's technology.

The demonstration was performed in the visible range, but VTT's researchers aim to develop similar MEMS-based

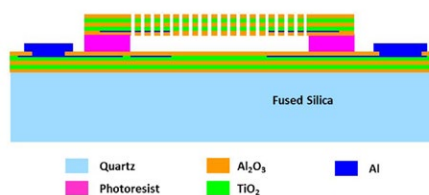


Inspecting the authentication features of a 20 euros note using the "hyperspectral slider app" of a modified iPhone 5s

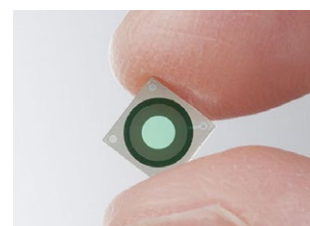
hyperspectral imaging in the visible-NIR region between 700 and 1000nm where more spectral fingerprints can be identified for authentication, counterfeit detection and potential health/wellness and food sensing applications.

Because the MOEMS can be fabricated below 150°C, they could be monolithically integrated into other ICs such as photo detectors for very compact and cost-effective hyperspectral imaging solutions that could address consumer applications.

Compared to expensive piezo-actuated FPIs which are typically precision-assembled from discrete parts, the monolithically integrated MEMS FPIs could be produced in large volumes at low cost to be integrated with camera optics. What's more, the low-mass surface-micromachined MOEMS withstand up to 18 000 G of shock impact while being insensitive to vibrational effects, making them rugged enough for use in automotive or in drone applications.



Capacitively tunable MEMS Fabry-Perot Interferometer made of drilled-out TiO_2 - Al_2O_3 $\lambda/4$ -thin film Bragg reflectors



A single tunable FPI wavelength filter, thin and rugged.

TDK agrees to buy InvenSense for \$1.3B

By Peter Clarke

TDK Corp. (Tokyo, Japan) has agreed to purchase inertial and microphone MEMS InvenSense Corp. (San Jose, CA) for about \$1.3 billion in what will presumably be one of the last acts of consolidation in what has been the highly consolidatory 2016 for the semiconductor industry.

The deal is expected to complete in the second quarter of the fiscal year ending March 31, 2018, which is the third calendar quarter of 2017, and InvenSense will operate as a wholly-owned subsidiary of TDK.

It had been reported that the two companies were in discussions although \$12 per share offer has apparently been increased to \$13 per share. InvenSense announced that it hired a financial advisor to evaluate indications of interest in the company in November.

The deal has now been approved by the boards of directors of both companies.

TDK already sells magnetic sensors that employ thin-film magnetic technology as well as pressure, temperature, electric current, and various other sensor types. The company has identified sensors and actuators as a key expansion area address-

ing applications in the automotive and industrial sectors and the Internet of Things. TDK said it intends to expand its sensor business.

InvenSense is a relative newcomer to the MEMS sensor scene but rose quickly to gain design wins with smartphone companies such as Apple and Samsung and to go public in 2011. It competes against Bosch Sensortec and STMicroelectronics in consumer electronics applications.

InvenSense's "fabless" manufacturing model enables development of high-performance and cost effective products via its unique CMOS-MEMS production process. InvenSense has also been a pioneer of sensor fusion where multiple sensor inputs are processed locally to produce more meaningful data.

"TDK's sensor business, one of its strategic growth areas, can be strengthened by merging TDK's portfolio of magnetic sensor technologies, where its strength lies, and its wide range of sensor products with InvenSense's expanding sensor technology," said Shigenao Ishiguro, CEO of TDK, in a statement.



Leti's 5nm node to stack Si nanowires

By Julien Happich

At last year's IEEE International Electron Devices Meeting (IEDM) held in San Francisco, researchers from CEA-Leti presented two papers unveiling promising nanowire architectural blocks for the 5nm node.

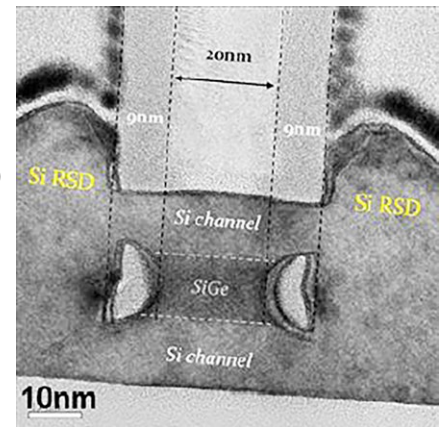
One of the papers, "NSP: Physical Compact Model for Stacked-planar and Vertical Gate-All-Around MOSFETs", presents a predictive and physical compact model for NanoWire/NanoSheet (NW/NS) Gate-All-Around (GAA) MOSFETs. By using a novel methodology for the calculation of the surface potential including quantum confinement, the researchers claim the model is able to handle arbitrary NW/NS cross-section shape of stacked planar and vertical GAA MOSFETs (circular, square,

rectangular), providing an excellent tool for design exploration.

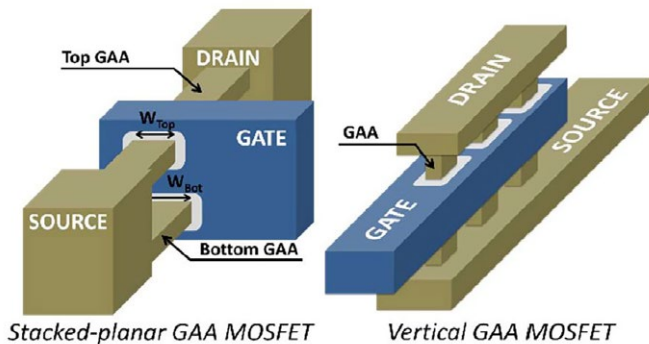
This Nanowire Surface Potential (NSP) based model, they write, was validated both by numerical simulations and experimental data, which leads us to the second paper, "Vertically Stacked-Nanowires MOSFETs in a Replacement Metal Gate Process with Inner Spacer and SiGe Source/Drain" demonstrating an actual physical implementation.

In this paper, Leti shares its finding on the very first functional devices featuring stacked-NWs transistors with integrated inner spacers to reduce parasitic capacitances and SiGe source drain (S/D) stressors to boost performance.

Both building blocks are required for the 5nm node, the researchers believe, which would extend the scaling limits of CMOS technology as a natural progression from FinFETs.



Cross-sectional TEM image of stacked-NWs FET after the integration of inner spacers.



Typical stacked-planar and vertical GAA NW/NS MOSFET architectures.

Imec stacks Gate-all-Around Si nanowires vertically in CMOS transistors

By Julien Happich

At San Francisco's International Electron Devices Meeting 2016 (IEDM), imec researchers reported the CMOS integration of vertically stacked gate-all-around (GAA) silicon nanowire MOSFETs. Key to their integration scheme is a dual-work-function metal gate, enabling matched threshold voltages for the n- and p-type devices.

As well as building the GAA nanowire MOSFETs, the researchers also reported their findings on how the intrinsic ESD performance of the MOSFET is impacted by the novel nanowire architecture, proposing the integration of two different ESD protection diodes, a gate-structure defined diode (gated diode) and a shallow-trench isolation defined diode (STI diode).

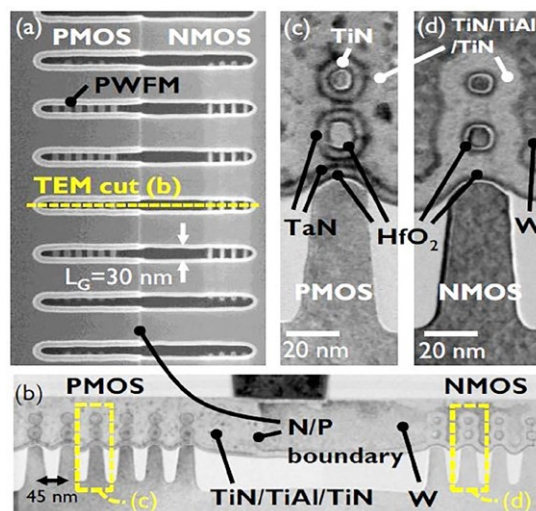
"GAA nanowire transistors enable ultimate CMOS device scaling, with low degree of added complexity compared to alternative scaling scenarios," stated Dan Mocuta, Director Logic Device and Integration at imec. The proposed integration scheme for Si GAA CMOS technology and the results on ESD protection are important achievements towards

realizing these 7nm and beyond technology nodes. Future work will focus, among others, on further optimizing individual process steps, for example through the co-optimization of the junction and nanowire formation."

In a horizontal configuration, GAA nanowire transistors are seen as a natural extension of today's mainstream FinFET technology. In this configuration, the drive current per footprint can be maximized by vertically stacking multiple horizontal nanowires.

Earlier this year, imec scientists demonstrated GAA FETs based on vertically stacked 8nm diameter Si nanowires. These devices showed excellent electrostatic control, but were fabricated for n- and p-FETs separately.

Namely, the two papers presented at IEDM 2016 were: "Vertically stacked gate-all-around Si nanowire CMOS transistors with dual work function metal gates", and "ESD diodes in a bulk Si gate-all-around vertically stacked horizontal nanowire technology".



(a) Top view SEM image after PWFMT etch from the n-FETs, and (b) – (d) cross-sectional TEM images of p- and n-FETs at the end of process (LG = 30nm).

CEA-Leti operates Qubits in super cool CMOS

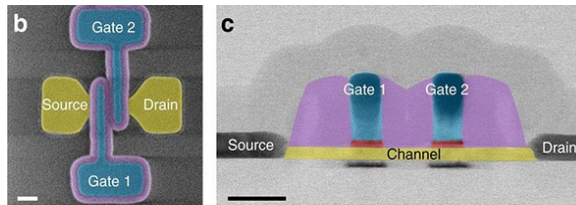
By Julien Happich

In their Nature Communications paper “A CMOS silicon spin qubit”, researchers from Leti, along with Inac, a fundamental research division of CEA, together with the University of Grenoble Alpes demonstrate what they claim is the first quantum-dot-based spin qubit built on an industry-standard fabrication process.

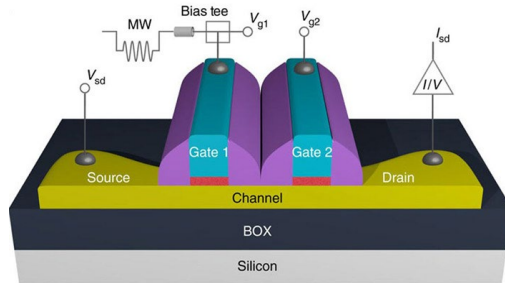
The work whose results will be presented at IEDM 2016 is based on a device consisting of a two-gate, p-type transistor with an undoped channel, all built on a 300-mm CMOS fab line. The qubit device, explains the paper, is derived from silicon nanowire field-effect transistors and relies on confined hole spins. It consists of a 10nm-thick and 20nm-wide undoped silicon channel with p-doped source and drain contact regions, and two 30nm-wide parallel top gates, side covered by insulating silicon nitride spacers.

At cryogenic temperatures (circa absolute zero °K), hole Quantum Dots (QD) are created by charge accumulation below the gates and the double-gate layout enables the formation of two QDs in series, controlled by voltages applied to their respective gates. The first gate defines a quantum dot encoding a hole spin qubit, and the second one defines a quantum dot used for the qubit readout.

Unlike other qubit demonstrations



(b) Colourized device top view obtained by SEM just after the fabrication of gates and spacers. Scale bar, 75 nm. (c) Colourized transmission electron microscopy image of the device along a longitudinal cross-sectional plane. Scale bar, 50 nm.



(a) Schematic of a silicon-on-insulator nanowire field-effect transistor with two gates, gate 1 and gate 2. Using a bias tee, gate 1 is connected to a low-pass-filtered line, used to apply a static gate voltage V_{g1} , and to a 20 GHz-bandwidth line, used to apply the high-frequency modulation necessary for qubit initialization, manipulation and read-out.

so far, the present research uses regular (albeit cooled down) FDSOI field-effect transistors. The standard single-gate transistor layout is only modified in order to accommodate the second gate for the qubit readout.

Another key innovation, the researchers emphasized, is the use of a p-type transistor, meaning that the qubit is encoded by the spin of a hole and not the spin of an electron. This specificity makes the qubit electrically controllable with no additional device components required for qubit manipulation. Indeed, all electrical, two-axis control of the spin qubit is achieved by applying a phase-tunable microwave modulation to the first gate.

“Our one-qubit demonstrator brings CMOS technology closer to the emerging field of quantum spintronics,” said Silvano De Franceschi, Inac’s senior scientist and co-author of the paper.

While superconducting circuits are already providing basic “quantum processors” with several qubits (up to nine), spin qubits in silicon are at a much earlier stage of development. The immediate next steps will be demonstrating a few ($n > 2$) coupled qubits, and developing a strategy for long-range coupling of qubits.

Leveraging the integration capabilities of CMOS technology will be a clear asset for large-scale qubit architectures, expects De Franceschi who is also contributing to the MOS-QUITO (MOS-based Quantum Information Technology) European collaborative project, developing cryogenic CMOS electronics for the future co-integration of silicon qubits and classical control hardware.

First UK fund dedicated to robotics

By Nick Flaherty

The UK’s first dedicated fund for startups in robotics has been launched. The British Robotics Seed Fund will be managed by High Growth Robotics and Sapphire Capital Partners to support up to 12 companies a year with early stage investments. The fund will see backing of a ‘few hundred thousand’ pounds for UK developers of software and components for robotics and autonomous systems in construction, logistics, agriculture and domestic robots.

Unlike the US, there are currently no specialist UK investment vehicles to provide financial backing and strategic support for early stage robotics companies, says Dominic Keen, CEO of High Growth Robotics, which already backs a number of UK robotics startups.

“I genuinely believe that some of the world’s finest robotics businesses are currently being established in the UK and the British Robotics Seed Fund is ideally positioned to ensure that these companies are able to maximise their future success,”

said Keen (above).

“It’s a relatively broad definition of robotics – any system with physical, manipulation or sensing. A lot of the systems will have a heavy element of artificial intelligence (AI) to them but rather than virtual AI we are looking at the end use.”

According to market intelligence firm Tractica, robotics is set to grow at rates in excess of 45% with the global market to approach a quarter of trillion dollars by 2021.

The fund is looking to raise around £5m from investors with a minimum of £10,000 to invest under the tax efficient Seed Enterprise Investment Scheme (SEIS). “Robotics represents one of today’s most exciting investment themes and investors now have the opportunity to enhance their portfolio with a mixed basket of exciting early-stage robotics businesses whilst also benefiting from the significant tax advantages of SEIS,” said Boyd Carson, CEO of Sapphire Capital Partners.

Encapsulating fabric-based OLEDs

By Julien Happich

Researchers from the Advanced Display & Nano Convergence Lab at KAIST, Korea, have unveiled a new encapsulation method to design fabric-based OLEDs with performance levels comparable to that of glass-based devices, while benefiting from the flexibility and mechanical characteristics of the fabrics.

Publishing their results in *Advanced Electronic Materials* under the title “Reliable Actual Fabric-Based Organic Light-Emitting Diodes: Toward a Wearable Display”, the researchers disclose a multi-step planarization and encapsulation method including both organic and inorganic multi-layered moisture barriers.

The researchers started with polyester-fibre-based woven fabric substrates, 100µm thick, which they planarized via a dual-step lamination process. To smooth out the rough fabric structure (the wefts and warps of the interwoven yarns), they used a 20 to 40µm thick PU film made of a low viscosity layer on the bottom side laying against the bare fabrics, and a higher viscosity film on the upper side to create a reliable flat surface onto which to deposit their OLED structure.

First, the researchers proceeded to lay a multilayer barrier film on top of the prepared fabric, consisting of aluminium oxide (Al_2O_3) deposited by atomic layer deposition (and poly(vinylalcohol) (PVA) used as further planarization layers, with respective thicknesses of 30 and 250 to 300nm. Inverted top-emitting OLEDs were then stacked by

thermal evaporation. To further protect the OLED and prevent contamination during their fabrication, multilayer capping layers consisting of N,N'-Bis(naphtanlen-1-yl)-N,N'-bis(phenyl)-benzidine (NPB)/zinc sulfide (ZnS)/NPB/ZnS were inserted in the stack by in-situ thermal evaporation before the deposition of the first Al_2O_3 layer of the top multilayer barrier film.

In this experiment, turn-on voltage was 4 to 4.25V for a luminance over 1cd m^{-2} and current efficiency was around 5cd A^{-1} . At 8.5V, the luminance was around 1300cd m^{-2} out of a prototype with an active area of 9mm^2 .

The double-sided encapsulated devices showed stable operation for 1000h when driven at a constant current density of 11.1mA cm^{-2} , they still operated after 3500h, with very few dark spots when kept in ambient air. Their lifetime tendencies were similar to those of the glass-based control devices, the researchers wrote in their paper.

While the bending length slightly increased from 15 to 21mm after coating with the PU films, they noted that OLEDs with the multilayer capping barely degraded the flex stiffness. But the multilayer barrier films (seven layers of Al_2O_3 and six layers of PVA) increased the bending length to 40mm. In the whole, the $122.2\mu\text{m}$ thick fabric-based OLED had exhibited a flex stiffness characteristic similar to that of $50\mu\text{m}$ thick PET films, something they ought to improve in

order to make these fabric-based OLED a compelling display proposition.

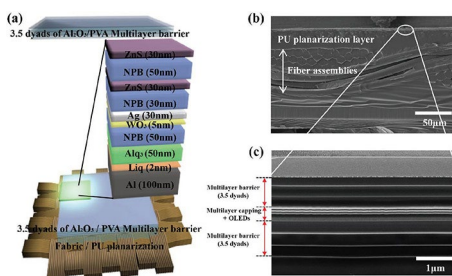


Fig. 1: a) The fabric-based OLEDs with planarization layers and multilayer barrier films. b) SEM image and c) FIB-SEM image of the device's cross-section.

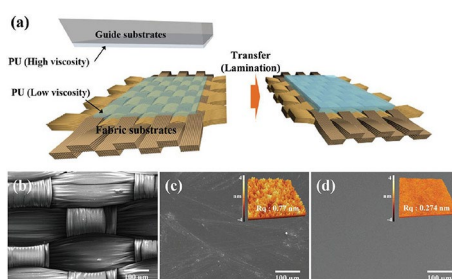


Fig. 2: a) The PU planarization process. b to d) SEM images of surface morphologies during each planarization process. Inset: 3D profile measured by AFM.

LCDs go plastic, flexible and cheap

By Julien Happich

FlexEnable announced the development of a 12.1" glass-free, conformable organic liquid crystal display (OLCD), which the company says is marking an important milestone in the commercialization of large area flexible displays.

The technology is compatible with existing LCD production lines, and is scalable to even larger area displays to meet the immediate market needs for applications including automotive, consumer electronics, and digital signage.

FlexEnable's OLCD platform is said to bring vivid colour and smooth video content to flexible displays, and is completely free of glass; instead, it uses organic transistors on a plastic sheet, making the display four times thinner and more than ten times lighter than conventional glass-based displays.

Less than 0.3mm thin, the OLCDs can operate with a radius of curvature below 3cm and can conform to small as well as large curved surfaces.



FlexEnable is already supplying small and large area display prototypes to strategic partners for integration into next generation products. In parallel, the company is working with Asian display manufacturers to support the transfer of its OLCD platform into conventional flat panel display (FPD) lines, enabling a full range of plastic LCD display shapes and sizes.

It claims that due to the use of low-cost plastics and the low-temperature manufacturing process (below 100°C), its technology is the lowest cost flexible display technology available today.

Everke of AMS on four pillars of sensing

By Peter Clarke

Alexander Everke, CEO of Austria's AMS AG, has said he intends to double the size of the company over the next three years by building on four pillars of sensing.

EE Times Europe caught up with Everke, who has been in post since March 1, 2016, at a busy Electronica and asked him whether much had changed since he had taken the top job at AMS.

"Yes a lot has changed. We have undergone a strategic review. We want to be the leading player in sensor solutions. And the key to the change is very active portfolio management we want to support product sectors where we are number one or can be number one," Everke said. "And this is based on four pillars of business; optical sensors, imaging sensors, audio sensors and environmental sensors. To complement this, we have our ASIC competencies to provide interfaces."

It is notable that Everke's predecessor as CEO, Kirk Laney, is now chief strategy officer for the company, providing for a smooth transition and evolution of strategy.

"It was clear that for a €600 million [annual revenue] company we are active in too many places. That is why we made the sale of the NFC/RFID business to STMicroelectronics," said Everke.

"We had already acquired NXP's environmental sensor business; CMOSIS a specialty image sensor business to strengthen the high-end; Mazet for spectral sensing; Cambridge CMOS Sensors for gas sensing."

Everke said there was additional potential in the combination of these acquisitions. For example Cambridge CMOS Sensors' expertise in hot plate technology for CMOS gas sensors was a good complement to AppliedSensors GmbH, bought two years previously, which has expertise in long-term stable pastes to go on such hotplates.

"And now we are spending up to \$850 million to buy Heptagon, a company with expertise in advanced wafer-level packaging for optical. This gives the opportunity to include multiple sensor modalities in one package. The market is changing in optical sensing and standard packaging is no longer sophisticated enough. About 80 percent of all investment will go through those four pillars. Other sectors at AMS may be divested or may continue but not receive investment," said Everke.

While it is clear the inertial sensor market has become worth multibillion dollars per year, driven by deployment in mobile phones, tablets and other portable equipment for such functions as screen orientation and step counting for dead reckoning, the same cannot be said for environmental sensing. Despite talk that environmental sensing including gas sensing could be about to come into the smartphone handset.

"Today the environment sensor market is small. And gas sensing is present more in automotive and industrial. But we are noticing Chinese customers have a strong interest in CO₂ levels, in air quality, in alcohol on the breath for mobile markets and wearable fitness bands. Our customers are under pressure to differentiate so it may find take up in mobile."

The breath analyser as an enabler of the ignition of the engine will come, Everke said, but in the automotive sector developments take a long time. In the consumer market it will happen with a combination of metal-oxide gas sensors together with relative humidity and temperature sensing.

"In mobile the holes are going away.

The last two holes are the speaker output and the microphone input so we are developing solutions that put audio and environmental sensing together but it is a challenge."



AMS AG CEO Alexander Everke

In the area of optics Everke stressed that AMS is not going after commodity CMOS image sensor business but is looking to add value with specialist sensing. "We have business with a camera manufacturer that combines an image sensor with spectral imaging that can identify the freshness of produce. We want to be at the high-end for industrial applications or for 4K/8K image sensors. We have a time-of-flight (ToF) chip under development that will be introduced in 2017." And Heptagon already has a ToF component albeit based on a third party silicon, Everke said.

AMS also has expertise in analog and mixed-signal IC development for audio. In active noise cancellation AMS is an ASIC provider to leading microphone supplier Knowles. "We intend to expand the portfolio step by step. In the past we were pure analog but we are adding digital. Analog provides the lowest power, highest performance and smallest form factor but digital eases design, interfacing and lowers cost."

Untethering equipment, both for power and signals, is also an essential part of modern equipment development and is set to be key to the Internet of Things but Everke did not mention wireless in his four-pillars opening. "We don't have the strategy to be number one in wireless," said Everke.

"But when we sold those NFC/RFID assets we retained wireless design capability to address wireless sensor nodes. We will gain expertise in Bluetooth Low Energy that will come with Heptagon," Everke said. Heptagon acquired RF Digital Corp. (Los Angeles, Calif.) in June 2016 for an undisclosed sum of money. "So we have the BLE, RFID, NFC capabilities to provide around sensor nodes," said Everke.

He added the situation was the same in digital with regard

to microcontrollers. "We have a biosensor coming out that will integrate a microcontroller. You don't need to be a market leader in wireless or MCUs to use the technology and increasingly we need sophisticated firmware and algorithms." Everke added that there is a need for software for sensor fusion and to manage sensor hubs and wireless to communicate results back towards the phone, PC and cloud.

It could be argued that optical and imaging as technologies are so close to each other as to be a single pillar and that the fourth pillar is inertial sensing as deployed so plentifully by the likes of Bosch, ST and others.

So perhaps AMS should be in inertial sensors? "Clearly it's a lower margin business," Everke said re-iterating that was one reason why AMS has no desire to compete in commodity image sensors for smartphones.

But, just as there is a way AMS is taking the higher margin ground in imaging so there may be a way to do the same in inertial sensing? "We're not ruling out anything," Everke said.

However, Everke indicated that the possibility of a big deal to bulk up AMS was unlikely and that the possibility of merging with Dialog Semiconductor would not have been entertained under the new strategy. An AMS-Dialog merger was discussed in 2014 but failed. "It doesn't fit our strategy. Dialog is a power company," said Everke.

But in the rapidly consolidating semiconductor industry does a lack of size leave AMS at risk of being acquired itself? "We will have no problem to survive even though we are relatively small. We have told investors that we will provide 30 percent CAGR for the next three years. That is in a semiconductor market averaging 4 percent CAGR and our TAM [total available market] at 10 percent CAGR and our SAM [serviceable available market] at about 15 percent. CAGR. We are in one of the fastest growing sectors of the semiconductor market and we aim to double in size. We can do this organically but we will do whatever it takes."

We wanted to check with Everke on the progress and implications of one of Kirk Laney's last big decisions before stepping down from the top job.

That was the decision to commit to manufacturing by way of an unusual leasing arrangement on new-build wafer fab at Marcy in New York State.

"The ground-breaking was in April 2016 and we are on plan to ramp up production in 2018. And that growth I talked about can be done without the fab. Where we can differentiate in silicon we manufacture in house. Where we can use standard manufacturing processes we can outsource," said Everke. "So we run a mix of in-house and outsource in both the front-end and the back-end. We have our own back-

end facility for testing in the Philippines. So we can choose the pace at which we ramp in New York." The nature of the deal is such that New York State bears the upfront cost of building the shell but AMS owns the chip manufacturing equipment going into the building and operational costs.

Everke said he would expect to run foundry business in New York and that foundry might expand as New York ramps initially. "It is part of our business. It is not strategic but it is very profitable. It keeps us in touch with our sector and helps us find acquisition targets. TAOS was a foundry partner prior to its acquisition in 2011."

Everke added that AMS would not transfer manufacturing to what will be a newly-built and presumably highly automated and efficient New York fab at the expense of its manufacturing in Austria, which dates back to the origins of the company in 1981. "We will keep the fab in Austria at the maximum load. But what products get manufactured where is another issue."

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Light nerves to equip soft robots

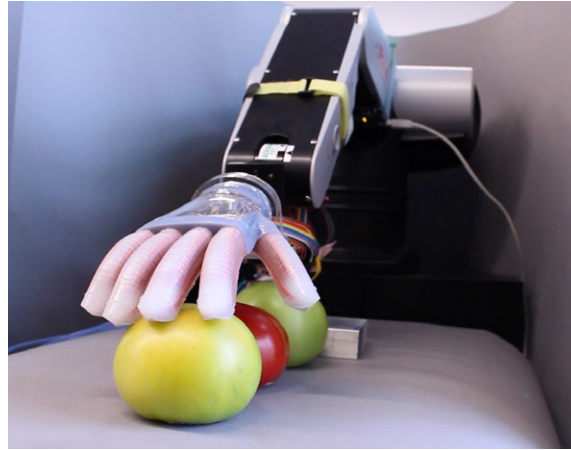
By Julien Happich

Being compliant, soft robots offer promising solutions to emulate human limbs in prosthetic applications, where touch and force sensing ought to be combined with full prehension capabilities. Though, reliable sensor implementation can be difficult on flexible extremities such as finger-like grips. This is what a team of researchers from Cornell University (Ithaca, NY) proposed to address with a novel type of soft waveguide-based light sensors readily embedded into deformable grips.

Their paper “Optoelectronicallly innervated soft prosthetic hand via stretchable optical waveguides” published in *Science Robotics* details the fabrication and operation of chemically inert stretchable and flexible optical waveguides made up of an optically transparent core (2dB/cm propagation loss at 860nm) clad into a light blocking elastomer. Once fitted with a LED on one end and a photodiode on the other end, these elastomeric optical waveguides can be monitored for any deformation (stretching, bending, compression) affecting light propagation.

Fabricated using cheap custom molds obtained through 3D printing, the elastomeric optical waveguides unveiled in this paper had an overall square profile of 3mm by side, with an inner core 1mm wide. Several of them could be accommodated within the fingers of a pneumatically-actuated soft prosthetic hand to actually try their sensing capabilities in a real application context.

While typically on traditional mechanical hands, proprioceptive sensing is performed through motor motion encoders combined with bulky and rigid multiaxial force/torque load cells, here only one type of continuous flexible sensor was effectively innervating the soft prosthetic hand. In their soft robotic hand, each finger featured three waveguides bent into a U-shape to



detect axial strain throughout the finger. Fitted with a stiff plate in a neutral bending plane where there is no axial strain, one of the waveguides also served as a touch sensor at the fingertip.

By design, because the original waveguide mold's surface roughness depends on the 3D printing resolution, the waveguide's optical transmission properties are anisotropic. This is due to the “top” of the waveguide core interface being atomically smooth while the “bottom” core interface has an average roughness of 6nm due to demolding. This anisotropy means that the

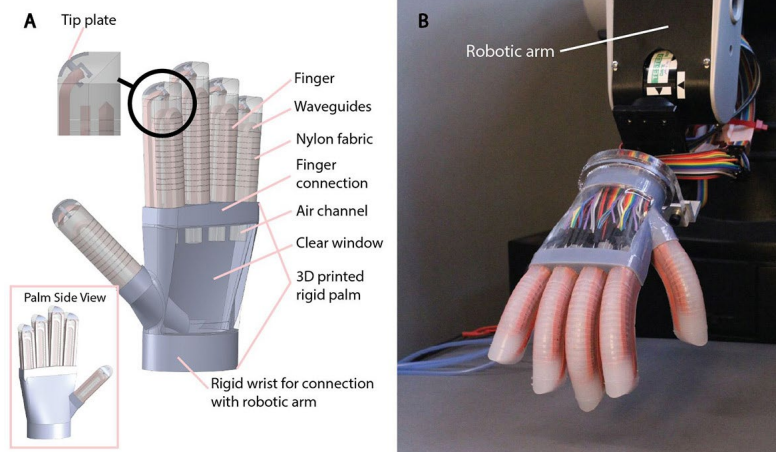
signal output depends on the direction of bending (up or down). Such a signal propagation anisotropy could also be designed on purpose for side-to-side bending detection.

The researchers were able to use these waveguide-based optoelectronic sensors to detect curvature, elongation, and force applied to the separate elastomeric silicone fingers.

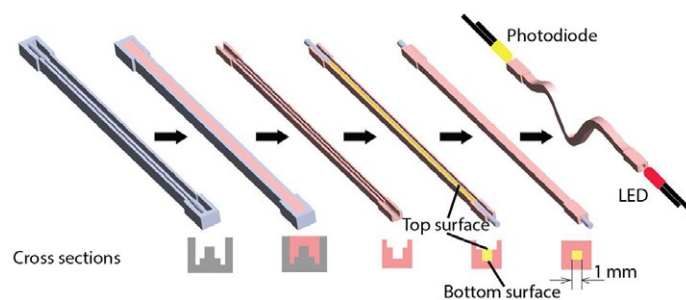
Analyzing the optical data (light losses upon waveguide deformation), they showed that such a soft prosthetic hand could distinguish curves as small as 5m^{-1} and roughness on the order of 0.1mm. As a demonstration, using a scanning motion with the finger dragging across simple objects such as a computer mouse, they were able to reconstruct the mouse's shape including the scroll wheel and the click of the mouse purely out of the optical data.

The hand could not only perform shape and texture detection, it was also tested to detect the softness of various test objects, based on the strain and stress analysis of the three waveguides.

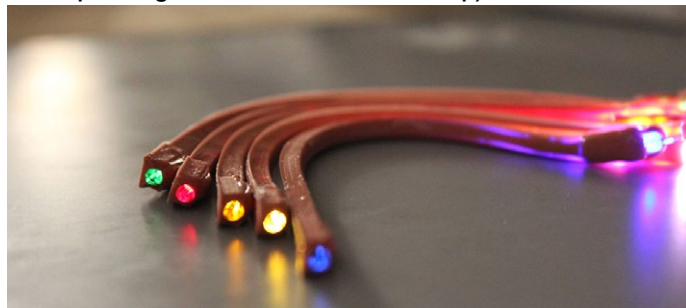
The paper concludes that although the soft prosthetic hand was only a research prototype, it highlighted the versatility of the



Schematic of a soft innervated hand and its implementation mounted on a robot arm.



The process steps for fabricating a waveguide (with the corresponding cross section for each step)



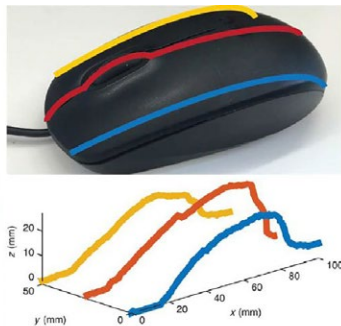
The actual waveguides in a curved shape.



The fabricated hand mounted on a robotic arm, scanning a computer mouse and profile reconstruction from the sensing data.

soft optical waveguides implemented as sensors.

What's more, because the waveguide sensors and the body of the actuator share the same material library (silicones, elastomers etc...) more sensors could be incorporated into the actuators or even replace the body of the actuators, for higher sensor density. Sensitivity could also be increased by using a larger power range from the



LED (from the baseline power to ambient light power) and by increasing the pressure range of the soft actuators to press on objects with more force.

The researchers noted that although the sensors were built in different places within the finger actuator, they still observed signal coupling.

They expect that by incorporating more sensors in order to extract denser information, the output signals would be increasingly coupled, but they anticipate that because the outputs of waveguide sensors are precise and repeatable, machine-learning techniques could be used to map inputs to outputs or to perform more subtle object recognition through the collection of large quantities of data.

Europe kicks off GSA-based autonomous driving project

By Julien Happich

The European Agency for the global navigation satellite systems (GSA) has kicked-off ESCAPE, a three-year and 5.4 M€ project to exploit the services offered by Galileo, the European satellite navigation system, in the field of the automated driving.

ESCAPE (European Safety Critical Applications Positioning Engine) is led by the Spanish company FICOSA in collaboration with partners from across Europe: GMV

from Spain, Renault and IFSTTAR from France, STMicroelectronics and Istituto Superiore Mario Boella from Italy.

By 2019, the ESCAPE consortium aims to deliver an innovative positioning engine tailored to meet the safety requirements expressed by those road transport applications that will involve automation. ESCAPE will enable a high grade of data fusion with different vehicle sensors and the exploitation of key technological differentiators such as the "precise point positioning" service (PPP), the potential use of the Galileo ionospheric model and the provision of

an "integrity layer" to assess the degree of trust one can associate to the position information provided by the device.

According to the companies involved in the project, ESCAPE will set a new

paradigm among and across the technologies enabling road vehicle automation. The main keyword of this new paradigm is "safety-oriented" while the pathway is the integration of multiple sources of positioning information (multiple satellite constel-

lations, multiple signal frequencies, and multiple on board sensors including maps) and high accuracy services.

ESCAPE has been funded under the Fundamental Elements programme of the GSA. This is a new EU R&D funding mechanism supporting the development of EGNSS-enabled chipsets, receivers and antennas, with the major objectives of facilitating the adoption of the European GNSS Systems while improving the competitiveness of the EU industry, by addressing specific user needs in priority market segments.



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Silly putty inspires ultra-sensitive graphene-based sensor

By Julien Happich

Playing in their lab, student Conor Boland and supervisor Prof. Jonathan Coleman doing research in AMBER at Trinity College Dublin made a chance discovery by mixing viscoelastic compounds with graphene.

"The idea came from playing in the lab. My student, Conor Boland, thought it would be interesting to mix graphene with the x-linked polymer that makes up silly putty. It was! It turned out that the very soft matrix resulted in quite interesting properties. This started a 30 month research program" told us Prof. Coleman in a telephone interview with *EE Times Europe*.

The resulting paper "Sensitive electromechanical sensors using viscoelastic graphene-polymer nanocomposites" published in the Science journal details how mixing graphene nanosheets to highly viscoelastic polysilicone matrices (also commercialized as children's play material silly putty) gave rise to unusual electromechanical properties that could be exploited to manufacture ultra-sensitive strain sensors.

What the researchers have shown with their homemade "G-putty" as they call it, is that the dense uniform and isotropic network of graphene nanosheets formed within the low viscosity cross-linked polymer not only drastically increased the electrical conductivity of the compound (reaching about 0.1 S/m at a 15 volume %) but also remained highly mobile and compliant.

This high mobility of the graphene nanosheets means that as a small tensile strain step is applied to the G-putty, a sharp increase in electrical resistance is observed before decaying slowly as the network of graphene nanosheets slowly relaxes, reforming connections and giving a resistance decrease.

The researchers were able to develop a quantitative model to describe accurately that post-deformation temporal relaxation of the electrical resistance and the non-monotonic changes in resistivity with strain.

"This network relaxation can be thought of as a self-healing process. Such filler mobility is unprecedented in nanocomposites at room temperature. However, it also represents plasticity,



Prof. Jonathan Coleman is with his graphene-putty alongside his son Oisín, trying out the novelty children's material silly putty.

meaning deformations are not fully reversible" the researchers wrote in their paper.

By monitoring their electrical resistance, the G-putty performed as a very sensitive electromechanical sensor with a gauge factor over 500, able to measure pulse and blood pressure (when pressed against the carotid artery) or acting as an impact sensor. In the case of impact on a thin sheet of G-putty, the resistance waveforms show a rapid jump on impact followed by a power law decay. The sensor was able to discriminate

the individual footsteps of a small spider which happened to be wandering in the lab.

"In a practical device, the putty would have to be mounted in some sort of wristband with appropriate encapsulation. This should be straightforward" told us Coleman.

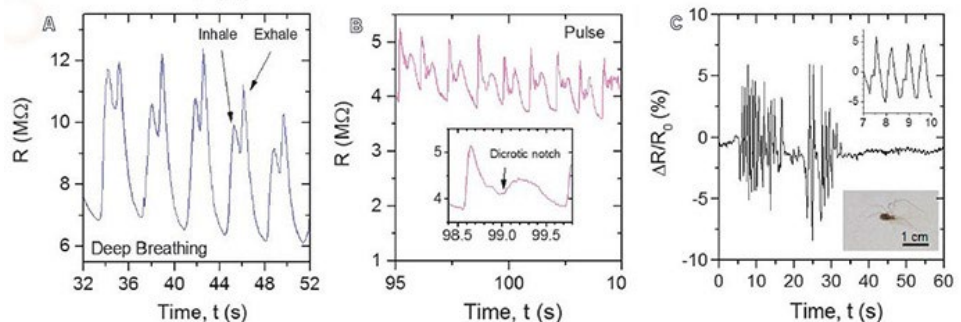
"Due to the viscoelasticity nature of the composite, the dynamic sensitivity will depend on frequency. This makes the sensor particularly suitable for dynamic sensing at a well-defined frequency such as pulse or breathing" he added.

So would these properties limit the G-putty's use as a strain sensor to relatively fast events?

"It's probably better for fast (higher frequency) sensing as then the elastic part dominates and the viscous response is minimised. However, we have not done high frequency testing yet" concluded Coleman.



Prof Jonathan Coleman (left) with Dr Conor Boland (right) stretching some G-putty.



(A) breathing, and (B) pulse. The inset in (B) shows a single period of the pulse-waveform, with the characteristic dicrotic notch indicated. (C) Fractional resistance change associated with a spider (cellar spider, bottom inset) walking across a thin circular sheet of G-putty about 2mm thick. (Top inset) Magnified response showing individual footsteps.

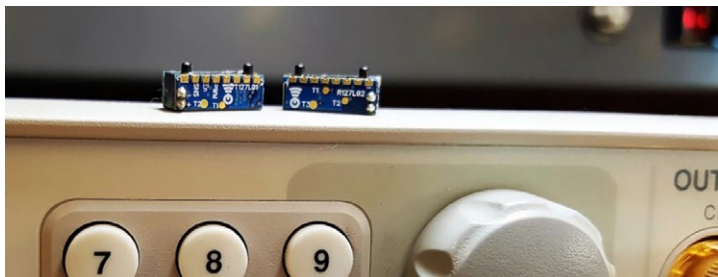
Startup aims to replace power connectors with magnetic module

By Nick Flaherty

US startup NuCurrent has launched an ultra-small power module that it believes could replace the traditional power connector. The ultra-small power and sense modules were created for engineers looking to reduce connector field failures in traditionally high-use, harsh environments or in new designs which were not previously possible without a physical power connection. The new connectors, launched at the Consumer Electronics Show (CES) in Las Vegas, allow power transfer of 165mW at 3.3V across a gap of up to 1.5mm (and 132mW across 2mm), and can validate the presence of a mating receiver through non-metallic materials.

Already designed into demanding medical applications, these power and data expandable devices provide greater orientation / offset freedom, infinite mating cycles, and environment flexibility within an ultra-small, rectangular package measuring 11x4x4.5mm. Each receiver and transmitter uses NuCurrent's PCB coils and proprietary electronics in a single block which can be surface mounted for automated manufacturing. The Chicago-based company has 17 patents for its 'CoolSkin Technologies' and proprietary design methodologies which ensure high efficiency, shape flexibility, tight tolerance and repeatable performance.

"This new category of cost-sensitive power and sense products delivers solutions to real issues for applications such as portable medical, IOT sensors, robotics, lighting and security. NuCurrent's practical R&D-to-production focus delivered a reliable family of solutions where others could not," said Michael Gotlieb, Vice President of Business Development at NuCurrent.



"This technology complements our broad range of existing antennas and consumer focused 'drop-in' 1 watt to 5 watt receiver modules for wearables, hearables and other portable applications."

NuCurrent also announced a range of medium power, wireless power coils for Qi low frequency applications at CES. Joining NuCurrent's single substrate multimode (Qi, AirFuel) medium power coil, four newly created coil designs are now available. Easily customizable, yet production-ready, the new 10 watt to 15 watt receiver coils deliver the highest performance of any other market offering targeting mobile and consumer accessory OEMs.

Connector maker Molex has invested in the company and last November launched a range of wireless power coils with NuCurrent technology support low, high and proprietary frequencies, in standard and custom sizes. A high Q-factor results in lower heat generation and faster charging in a range of applications, including mobile phones, tablets, gaming systems, wearables and other consumer electronics, medical devices, furniture, and in-vehicle transmitters. The PowerLife wireless power coils with NuCurrent technology withstand vibration, heat and humidity, and excel in transmitting power through air, wood, or any non-metallic surface.

"A logical next-step in connectivity, wireless power requires the right technologies to achieve optimal device charging," said Steve Zeilinger, product manager at Molex. "Compact PowerLife wireless power coils provide an extremely tight electrical tolerance and low rate of field failures for a better product design, performance and end-user experience."

Graphene proves its worth as transparent OLED electrodes

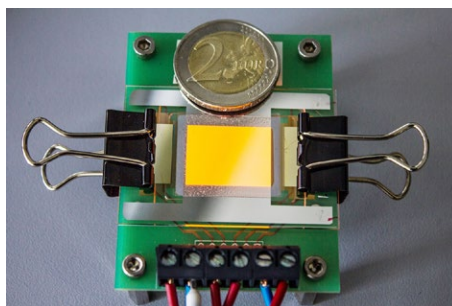
By Julien Happich

Together with industrial partners, the Fraunhofer Institute for Organic Electronics, Electron Beam and Plasma Technology FEP from Dresden has demonstrated the use of graphene in the production of OLED electrodes. The research centre created an orange OLED with graphene electrodes measuring 20x10mm.

The graphene-based electrode production process was developed and optimized in the EU-funded project "Gladiator" (Graphene Layers: Production, Characterization and Integration) together with partners from industry and research.

The production of the OLED electrodes takes place in a vacuum. In a steel chamber, a wafer plate of high-purity copper is heated to about 800 degrees. The research team then supplies a mixture of methane and hydrogen and initiates a chemical reaction. The methane dissolves in the copper and forms carbon atoms, which spread on the surface. This process only takes a few

minutes. After a cooling phase, a carrier polymer is placed on the graphene obtained and the copper plate is etched away.



Orange luminous OLED on a graphene electrode. © Photo Fraunhofer FEP

The Gladiator project was launched in November 2013 and will reach its conclusion in April 2017. During the remainder of the project, researchers aim to minimize the impurities and defects which occur during the transfer of the wafer-thin graphene to another carrier material.

Industrial partners of the Gladiator project include Spanish company Graphenea S.A. responsible for the production of the graphene electrodes and British company Aixtron Ltd. responsible for the construction of the production CVD reactors.

"The first products could already be launched in two to three years", expects FEP's project leader Dr. Beatrice Beyer. The large but ultra-thin and flexible graphene electrodes could find their way as a replacement for brittle ITO electrodes in touch screens, but also in photovoltaics.

Being smart about the future of rail

By Steve Hughes

Between the drive towards smart cities, new high speed rail links and increased rail travel across the UK, the pressure is on to make sure our railways can keep up. Progress is not without its challenges, and as the world struggles to balance being more connected there is a real risk that power quality could be affected. Here, Steve Hughes, managing director of REO UK, explains why monitoring power quality onboard our trains is going to become even more important.



designed to test static converters used in the production of auxiliary power supplies for onboard power. High power frequency converters are a vital component in supporting the evolution of rail technology, particularly as we become smarter and power towards higher speed trains. To ensure efficiency and safety, these converters have to be tested so that power quality is not adversely affected.

Did you know that Milton Keynes is well on its way to becoming a fully functional smart city? The MK:Smart initiative is partly funded by the Higher Education Funding Council for England (HEFCE) and led by The Open University, and it aims to develop innovative solutions to support economic growth in Milton Keynes.

One such solution, targeted at supporting transport links within the city, is MotionMap. This tool uses information gathered by a sensor network around the city to feed updates about congestion and car park occupancy to a mobile app. Any smart city will inherently be reliant on smart systems like this, which in turn rely on data and energy transfer.

This all increases the levels of disruptive electromagnetic interference (EMI) that can have a seriously detrimental effect on power quality. Smart cities will live and breathe data and communications through the many devices that will exist on the Internet of Things (IoT) web, but power quality issues could seriously affect the efficacy of these devices if proper precautions are not taken. For instance, prolonged exposure to EMI could cause major disruptions to vital rail signalling or to onboard services, putting passengers at risk.

Train lovers

There is no doubt that the UK is reliant on rail travel and we're not slowing down. We've seen an increase in rail passengers in recent years, with a reported 1.6bn passenger journeys equating to 62.9bn passenger kilometres in 2015, which was a 4.5 per cent rise on the previous year.

To keep all of these passengers safe it's vital that operating companies adhere to operational licenses and agreed service levels specified by network authorities. As smart technology takes over and passenger numbers continue to increase there are increasing challenges to overcome obstacles in achieving this goal. The pressure really is going to be on to avoid the hefty fines and penalties associated with non-compliance – especially with the impending launch of the UK's High Speed 2 (HS2) line.

Testing is the key

To help national rail operators, we've developed the REOLAB, which is a range of high voltage variable power supplies



The REOLAB high voltage variable power supplies are designed to test static converters used in the production of auxiliary power supplies for on-board power.

As REOLAB can simulate three-phase mains power it is the ideal tool to test static converters in research and development (R&D) proving grounds, for regular maintenance, in end-of-line products and during production. The ability to manipulate voltage is the key to any good power supply, especially in countries where national energy grids can be unreliable and sometimes outright dangerous. To combat this, REOLAB is designed with a built in soft-start, capable of slowly and gradually bringing the power up to level.

All change

The world of train travel will have to advance at a phenomenal rate to keep up with the move to smart cities. With increasing connectivity across smart cities and projects such as the UK's high speed HS2 network in the pipeline, it's not difficult to envisage the increasing role testing and safety will play a few years down the line. However, with adequate consideration of a sustainable development infrastructure we can meet and exceed our expectations for the future of rail travel.

Steve Hughes is managing director of REO UK - www.reo.co.uk

Next-gen battery market to post 'stupendous' growth by 2020

By Nick Flaherty

The market for next-generation batteries is set to grow 71% a year over the next three years to over a billion dollars.

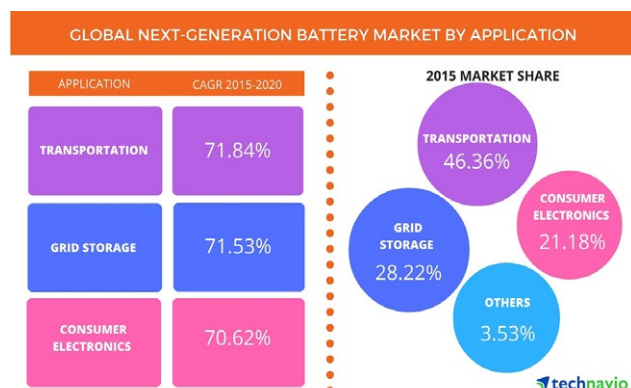
Although small at \$95m last year, the growth of renewable energy and electric vehicles will drive the market to \$1.4bn by 2020 says a report from market analysts Technavio.

Next generation battery technologies such as lithium sulphur and sodium ion will become mainstream by 2020, driving the growth in this area, says Thanikachalam Chandrasekaran, one of the lead analysts at Technavio for energy storage research.

One of the key drivers of growth is investment in renewable energy production. Increasing demand for energy and proactive governments pushing for green energy initiatives are the main reason for these investments. Renewable sources of power are not constant, and require the most technologically advanced battery technologies to harness the complete power generated. This has resulted in the large-scale adoption of next-generation batteries.

The other important drivers for this market are the increased government support for electric vehicles (EVs) and market-driven innovations to find a balance between energy efficiency and renewable energy. The report looks at applications in transportation, grid storage and consumer electronics.

Countries all over the world are shifting their focus from vehicles powered by fossil fuels to energy-efficient EVs. The global EV market is expected to post a CAGR of over 42% through 2020, which is a good indicator for the next-generation battery market. The popularity of EVs is due to their high frequency, instant torque, and smooth acceleration.



"Some governments are implementing policies to accelerate the use of EVs as a step toward controlling greenhouse gas emissions. For instance, the US government is increasingly adopting emission reduction mandates and alternative vehicle programs to reduce emissions. This has called for a heightened focus on developing

larger EVs to replace normal fossil-fuel powered vehicles," said Chandrasekaran.

With increased adoption of smart grids and growth in renewable energy production, the demand for grid energy storage has increased. These storage systems store excess power, and this stored power is made available to the consumer during peak hours of demand. This ensures a cleaner and low-cost supply of power, even when the renewable energy systems are not producing continuous power.

The widespread adoption of lithium ion battery technology has raised questions about its sustainability in the long run. This has led to several types of research, funding, and partnerships for the development of the next-generation batteries such as Li-air, Lithium sulphur and sodium-ion batteries.

These next-generation batteries are still at a nascent stage of development and are being tested in small applications. Their transition to full-scale grid storage is expected to take place during the forecast period, leading market growth. "Products in the consumer electronics are all powered by compact batteries. The innovations to these devices in the 21st century have brought forth a demand for longer lasting devices. Traditional batteries cannot stand up to the demands of the modern consumer, which has driven for the innovation and development of next-generation batteries, which can last longer, are more durable, safer," said Chandrasekaran.



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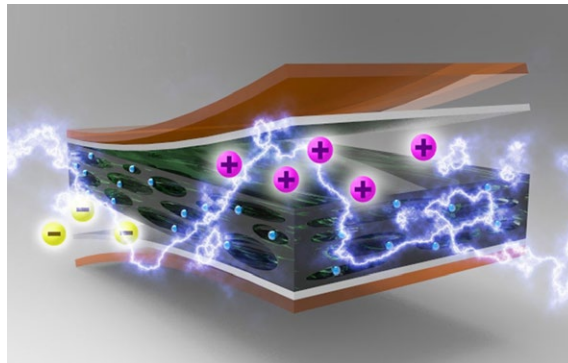


Thin and flexible energy harvesting could be cheap too

By Julien Happich

In a Nano Energy paper titled “Flexible and biocompatible polypropylene ferroelectret nanogenerator (FENG): On the path toward wearable devices powered by human motion”, researchers from the Michigan State University shared an innovative polymer-based ferroelectret doing away with magnets and ferroelectric materials altogether.

The researchers have built a thin polypropylene ferroelectret (PPFE) by creating a cheap polypropylene foam whose empty voids they charged through microplasma discharges (by applying a large electric field to the PP film). The artificial voids in the foam, spanning from the $1\mu\text{m}$ scale to the $100\mu\text{m}$ scale then form highly oriented giant dipoles across the $80\mu\text{m}$ thick film. Two conductive silver layers sputtered on the surfaces of the PPFE film complete the device, turning it into a sandwich-like metal-insulator-metal (MIM) structure. Supporting their practical experimentations with finite element method (FEM) analysis, the researchers explain that as the charged voids change their thickness and thus their dipole moments under mechanical stress (compression for example), the change of dipole moments is capable of driving the electrons from the electrode with negative charge to the electrode with positive charge, generating a voltage under open circuit conditions, or generating current under short circuit condition (a flow of charge from one electrode to the other). They also highlight the PPFE films’ piezoelectric coefficient (d_{33} is about 400pC/N) as being significantly greater than that of typical piezopolymers like PVDF (d_{33} is about 15pC/N) or parylene-C (d_{33} is about 2pC/N).



The fully encapsulated FENG bent by fingers. Source Michigan State University.

An interesting property of this seemingly very simple to manufacture polypropylene ferroelectret is that it is not only robust and easily scalable in area, but stacking several PPFEs to increase voltage or current output is as simple as folding a single unit upon itself. In effect, the symmetric folding process keeps the surfaces of same polarity in electric contact, akin to electrically connecting single layers of PPFE in parallel.

Effectively, the researchers’ experiments show that both the open-circuit voltage (V_{oc}) and shortcircuit current (I_{sc}) are doubled with each folding along an axis of symmetry (equivalent to doubling the piezoelectric coefficient d_{33} of the unfolded state).

Applying touch pressure, a non-folded $35\times 25\text{mm}$ PPFE film would output about 1V in open circuit, or generate a current of about $0.1\mu\text{A}$ in short circuit. Opposite charge changes and signals are generated when releasing the pressure, the material exhibiting a pretty much symmetrical behaviour.

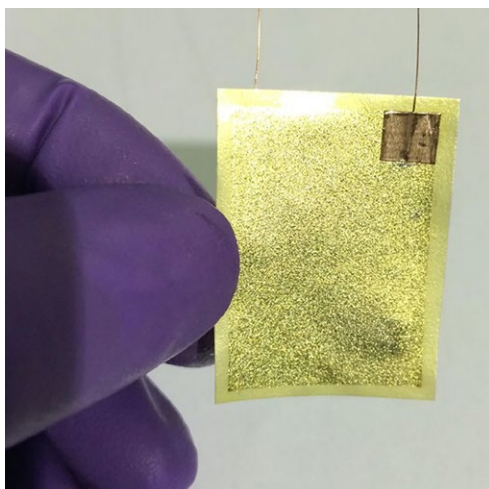
The charges could either be cumulated into a nearby capacitor for energy storage (connecting the PPFE through a Schottky bridge rectification circuit) or used to power small electronics.

To demonstrate the energy harvesting capability of the novel PPFE film, the researchers created a $2\times 2\text{cm}$ FENG consisting of a stack of 7 PPFE film layers. Upon one press of the hand, the 40mm^2 device provided enough energy to power a series of 20 commercial LEDs operating at around 3V (in this configuration V_{oc} and I_{sc} reached higher than 50V and $5\mu\text{A}$, respectively).

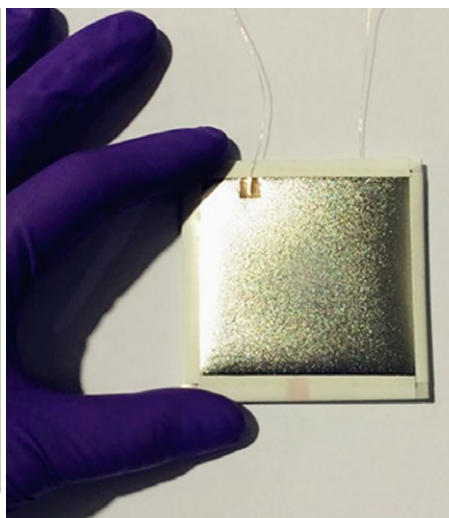
In another demonstration, the researchers created a foldable PPFE-based self-powered keyboard (with stickers for the keys). Here the PPFE’s top and bottom surfaces were uniformly coated with electrically conductive paint (through a simple bar-coating process). Key strokes were enough to power the individual signal traces for the corresponding characters to be sent to a nearby device, which could make the rollable and foldable keyboard an interesting alternative to today’s rigid battery-powered designs.

Associate Professor of Mechanical Engineering at the Michigan State University and corresponding author Nelson Sepulveda envisages that the new FENG could be used in many energy harvesting applications, converting human motion to electrical energy in order to power wearables or even implantable electronics (the devices can be coated with bio-compatible polyimide).

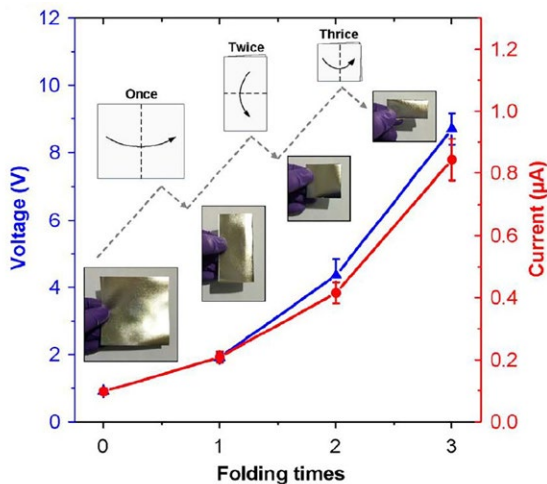
Another tentative application show-



Exploded-view illustration of the encapsulated FENG consisting of a stacked metal-PPFE-metal structure without moving parts or micro-fabricated features. Source Michigan State University.



A stacked FENG, about 40mm^2 whose common electrical contacts are made on alternating metal layers. Source Michigan State University.



Output voltage and current signals are amplified with each folding action along an axis of symmetry. The performance follows a 2^n behaviour, where n is the number of folds. Source: Michigan State University.

energy from the users' touch during regular operation" the researchers wrote in their paper, "thus reducing the frequency of required battery charges from external energy sources".

Module-level thermal management: LEDs and power electronics learn from each other

In 2015, all economic indicators pointed to continued market growth for both industries, power electronics and LEDs, especially with IGBT modules boosted by EV/HEV industry and general lighting applications, a killer application for LEDs since 2012, observes market research firm Yole Développement.

To support this growth and answer the thermal management needs in power electronics and LED, lot of innovative technologies are emerging. According to Yole, one of the most impressive technical developments is the convergence of thermal management for both sectors, LED and power electronics, particularly the materials used for thermal management.

The Thermal Management Technology & Market perspectives in Power Electronics and LEDs report powered by Yole's Power Electronics & LED teams, reviews insight into synergies between power electronics and LED for thermal management.

It describes and analyzes drivers and challenges that are facing industrial companies. This latest report proposes an overview of the market trends and technology evolution including 2015-2021 market figures, technology status and technical roadmap analysis and more. Under this report, Yole's analysts also offer business model and supply chain analysis across various materials used for thermal management.

A rapid convergence of key technologies is driving unprecedented change. In this dynamic environment, Yole's goal is to understand their customers' strengths and guide their success.

"Power electronics and LEDs are different industries that today face similar challenges", explains Dr Pierrick Gueguen, Business Unit Manager at Yole. "Needs for green energy with lower CO₂ emissions have led these industries to develop more efficient and smaller solutions."

At the device level, cost pressure and the need for better performance is pushing designers towards smaller and thinner chips, also leading to increased power density. Such power density targets in both power electronics and LEDs bring a

convergence of thermal management requirements, supporting the development of new materials.

"Power electronic modules represent a healthy market, worth about US\$2.9 billion in 2015 and set to reach US\$4.5 billion in 2021, growing at 9% CAGR", explains Pierrick Gueguen. In parallel, the LED packaging market reached US\$15 billion in 2015, after years of strong growth led by LED TV and general lighting.

However, price pressure will moderate growth in coming years, with a 3.4% CAGR leading to a market worth US\$18.5 billion in 2021.

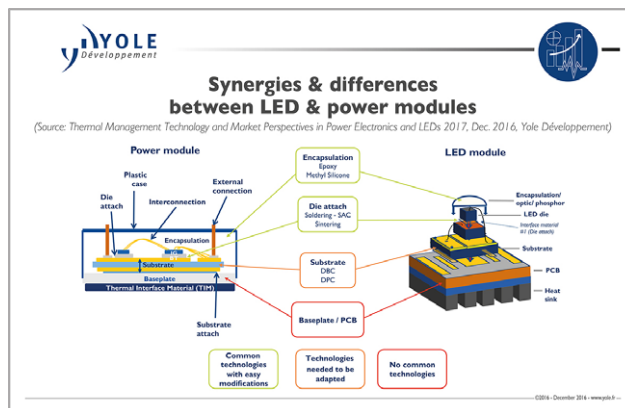
Power electronics and LEDs need the right materials to handle thermal management challenges. As those applications are driven by similar technical requirements, one technical solution can be adopted and developed for one industry before being used by another industry. "The 30% of the overall thermal management material market that is common to both LED and power

electronics represents US\$660 million in 2015", announces Pierrick Boulay. "According to our estimations, such market segment will reach US\$1014 million in 2021". Moreover, another 30% can be reached by adapting existing technologies used in LED or power for the other application...

From perspectives ranging from manufacturers and material suppliers through to end users, market dynamics, drivers and challenges are presented in this report, for both power electronics and LEDs.

Among materials used for thermal management, Yole specifically investigated the market and technology evolution of die attach, substrates, baseplates/PCBs and encapsulants. Overall, the market for these materials was worth US\$1.98 billion in 2015 and will grow to US\$3.16 billion by 2021 at a CAGR of 6%.

"Their value proposition has the potential to bring business to their suppliers and key differentiating factors to device manufacturers", comments Pierrick Boulay, Technology & Market Analyst at Yole.



McLaren self-powers the Internet of Things with Sharp and Ilika

McLaren Applied Technologies and Sharp Laboratories of Europe are working with UK battery maker Ilika to develop



an autonomous energy harvesting power source for the Internet of Things (IoT).

A £500,000 grant from Innovate UK will focus on an energy harvesting wireless sensing platform with applications in industries that

could include motorsport and automotive along with potentially healthcare and wearables.

Over £320,000 of the Innovate UK grant will be provided to Ilika to lead a two-year project which will see Ilika's Stereox solid-state battery technology integrated with Sharp's photovoltaic (PV) technology to provide a power source for McLaren Applied Technologies' wireless sensing platform.

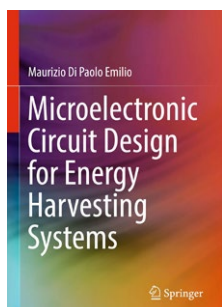
The objective is to develop robust, low maintenance sensor nodes for demanding environments. The power source must be robust, operate at up to 100 °C and be maintenance-free. The target footprint must be small with attractive aesthetics for easy integration into the sensor and its operating environment. It should also have dimensions comparable to the sensor and other electronic elements, but deliver sufficient power to fully operate the sensor.

McLaren Applied Technologies

www.mclaren.com/appliedtechnologies

Keeping pace with energy harvesting

Start the new year with instructive reading from serial author Maurizio Di Paolo Emilio who has just published "Microelectronic Circuit Design for Energy Harvesting Systems", a 169



page hardcover book written as a single-source reference to energy harvesting and its applications. Rich with 133 illustrations, including 33 in colour, the book was conceived to serve as a practical guide to microelectronics design for energy harvesting, with application to mobile power supplies for wearable and mobile electronics. The author starts with the fundamentals of energy harvesting

before reviewing the different energy harvesting technologies in use or in development today, including the different principles of transducer and related materials, power management, storage and system design. The author then moves on to practical applications and design considerations to harness the harvested energy and power microsystems effectively, with power conditioning. The book concludes with a review of various types of energy-harvesting applications and their related markets, with a focus on future architectures.

Maurizio Di Paolo Emilio

<http://www.springer.com/us/book/9783319475868>

Power entry module for Protection Class II equipment

Schurter's 5145 power entry module is already popular for use in Protection Class I equipment, due to its circuit breaker and



EMC filter functions integrated into one compact package.

The Protection Class II version is suited for medical equipment used at home according to the IEC standard 60601-1-11.

Protection Class II equipment, in contrast to Protection Class I equipment, generally has no metal case. This category of

equipment is called double insulated, and requires higher safety levels for energized components relative to exposed surfaces. The 5145 Class II power entry module provides double insulation between energized components and exposed parts. This reinforced insulation is tested with a voltage of 4000 VDC between the energized conductor (L) and the neutral conductor (N) relative to the filter case. The EMC filter is available in medical and low leakage, M5, versions. This integrated filter at the power input provides highly effective interference suppression, which results in optimized electromagnetic compatibility. Current ratings range from 1-10 A at 250 VAC. Versions with quick-connect or solder terminals are available.

Schurter

www.schurter.com

Dimming modules support colour temperature shifts from 2000K to 8000K

GRE Alpha's tuneable white SLD-DimTW dimming module has been designed for VC-type dim-to-warm and warm dimming applications.



A constant voltage tuneable white LED dimming module, this unique 0-10V/1-10V device provides a control signal and enables smooth, dynamic colour

temperature shifts of 2000K to 8000K. Depending on the application situation, this plug-and-play dimming module creates eye-catching, colour temperature changing effects without colour distortion. The company offers a two channel SLD-DIM2 0-10V dimming module and a 7-in-1 dimming module (model XDL-7DV1-48V5A) with further options in warm dimming. The two channel dimming module offers 0/1-10V PWM dimming with no shift in LED colour temperature, up to 1024 dimming levels of high resolution smooth dimming and 97 percent efficiency. Additionally, GRE Alpha's 7-in-1 LED dimmer provides full range zero to 100 percent high resolution dimming performance for constant voltage LED dimming applications. The 7-in-1 unit has a multi-coloured LED indicator, integrated strain release cover, settable dimming transfer characteristics (linear or logarithmic), and built-in thermal shutdown with auto restart and overload protection.

GRE Alpha

www.grealpha.com

Three phase bridge modules provide higher efficiency and reliability

Vishay Intertechnology has introduced three new series of three-phase-bridge power modules designed to increase efficiency and reliability for heavy-duty industrial-level applications. The VS-130MT...C, VS-160MT...C, and VS-300MT...C series feature high output current from 130 A to 300 A and blocking voltage to 1800 V. For high efficiency, the power modules offer surge current to 2,512 A and an electrically insulated case for excellent junction-to-case thermal resistance down to 0.23 °C/W. The devices' robust MTC plastic package provides high reliability, while its screw terminals allow for compatibility with competing solutions. The devices deliver higher output current, blocking voltage, and surge current than the previous modules with improved thermal resistance down to 0.23 °C/W in a 5-terminal MTC package. The RoHS-compliant devices offer 3600 VRMS insulation voltage and are pending UL approval. Samples and production quantities of the new power modules are available now.

Vishay Intertechnology
www.vishay.com



Triac-dimmable LED controller/driver up to 25W

The AL1692 LED controller/driver introduced by Diodes Inc. is a platform-based design solution for triac-dimmable LED



lamps.

The internal MOSFET versions provide a low-cost solution with compact PCB size and directly drive lamps rated from 3W to 13W.

The controller-only version with an external MOSFET can support higher power

applications up to 25W. Intended for offline triac-dimmable LED lighting applications, the single-stage, buck-boost, non-isolated configuration of the AL1692 provides a high power factor, low total harmonic distortion and high triac dimmer compatibility solution to meet National Electrical Manufacturers Association (NEMA) Solid State Lighting (SSL) standards. The AL1692 eliminates auxiliary winding and provides an accurate output LED current that ensures excellent line and load regulation, while its operation in boundary conduction mode (BCM) achieves high-conversion efficiency and eases EMI design to further reduce BOM cost.

Diodes
www.diodes.com

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NÜRNBERG MESSE

From mind to market: hardware platforms for creative IoT application development

By Amir Sherman

Professional teams developing embedded systems like Internet of Things (IoT) devices typically focus on innovating at the application level, to differentiate their end products in the marketplace. At the other end of the spectrum, independent makers are an increasingly important source of fresh ideas that have potential to become disruptive products.

In either case, the traditional embedded development flow that involves bringing up basic hardware to host the application can present a barrier to success. A lack of hardware-design skills, or the finance or manufacturing resources to build a prototype, can prevent great applications from ever advancing beyond the concept stage.

Component suppliers and some innovative distributors have identified the potential to unleash application-design talent from across the spectrum, by making available flexible hardware platforms with all the functionality developers need to quickly start developing a prototype application. A suitable board needs to provide a superset of features relevant to the types of applications that will be developed. Prototyping IoT applications, for example, will probably require at least a low-power microcontroller, connectivity such as Ethernet, USB, or wireless support like Bluetooth® Smart or Wi-Fi, and various sensors such as temperature, motion, pressure, or ambient light.

Beware following the crowd

A large variety of community computing boards are already in the market, and some have become popular prototyping platforms among makers and professional developers. Some, like the Raspberry Pi, are not originally conceived as development platforms, and have become popular almost by default. One of the main drawbacks of these types of boards is that key parts such as the host processor are not ideally suited to some applications – such as power-constrained IoT devices – and may not be easily purchased on the open market. This can restrict opportunities to customise the hardware after the application has been proved and the investment is available to take the product to market.

Amir Sherman is Technology Marketing Director Embedded at Arrow Electronics - www.arrow.com



Linaro and Arrow's jointly developed DragonBoard 410c.



The 96Boards initiative is an example of a concept created to overcome such limitations and deliver all the flexibility developers need to realise their new product ideas in any way they want. There are three 96Boards specifications, each aimed at key embedded market sectors.

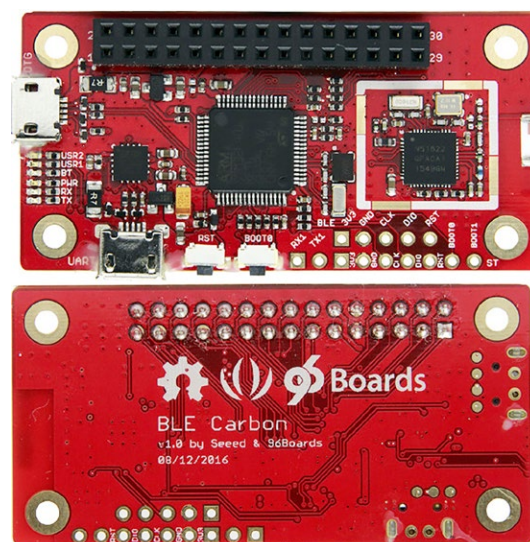
The boards are based on ARM® Cortex®-A Microprocessors and Cortex®-Mx Microcontrollers, which can be ordered directly from the manufacturer or a distributor. Moreover, developers can leverage their familiarity with this industry-standard 32-bit and 64-bit cores, as well as existing, proven code. In addition, standard form factors are specified, which simplifies designing them into the end product, if required. There are currently three 96Boards specifications:

- The Consumer Edition (CE) targets the mobile, embedded and digital home segments
- The Enterprise Edition (EE) targets the networking and server segments
- The IoT Edition (IE) targets the Internet of Things (IoT) and embedded segments

The CE platform is a low-cost platform suitable for running standard Linux-based operating systems such as Android or open-source/maker community software. The specification defines a compact card-type form factor measuring 85x54x12mm, and sets out minimum hardware requirements including at least 0.5GB RAM, a MicroSDHC Socket for up to 64GB Flash storage, WiFi and Bluetooth 4.0 LE (Bluetooth Smart), USB Host and Device support, as well as common PC media interfaces like HDMI, and 40-way and 60-way headers for developer use. Any 32-bit or 64-bit Cortex-A SoC may be used.

96Boards members can certify their board designs in accordance with this specification. The boards can then be

made available to developers, off the shelf and ready to use as an embedded platform. Arrow, as a 96Boards member, pioneered the creation of one of the first and currently most successful CE boards; the Dragonboard 410c. Featuring the Qualcomm® Snapdragon™ 410 64-bit ARMv8-architecture processor popular with smartphone makers, and available for just \$75, it enables affordable design starts leveraging advanced mobile technologies.



Carbon BLE: the world's first certified 96Boards IoT Edition compatible board.

Over the last year, Qualcomm Technologies, Inc., Linaro, and Arrow have built strong software and ecosystem support around the DragonBoard 410c. There is a broad choice of operating systems, including Android, Debian Linux, OpenEmbedded, Ubuntu Core and Windows 10 IoT, which work well with popular IoT development kits such as Amazon Web Services (AWS), AT&T M2X, Brillo, IBM Bluemix Watson and Microsoft Azure.

Recently, the 96Boards team has made the Carbon BLE, the world's first certified 96Boards IoT Edition compatible board, available through its distribution network. Because the IE specification allows 32- or 64-bit SoCs in Cortex R/M or Cortex-A profiles, Carbon BLE takes advantage of this flexibility to target the STMicroelectronics STM-32F401RE 84MHz Cortex-M4 microcontroller.

It is also pre-loaded with the new lightweight Zephyr RTOS from the Linux Foundation, and so delivers a blend of high performance and high energy efficiency to extend the lifetime of sophisticated IoT applications. Wireless connectivity is via the Nordic Semiconductor nRF51822 Bluetooth LE SoC and chip antenna, and developers can add sensors or other functionality as required via the low-speed 30-way expansion header. The board uses the compact IE "Standard Micro" 60x30x9mm form-factor.

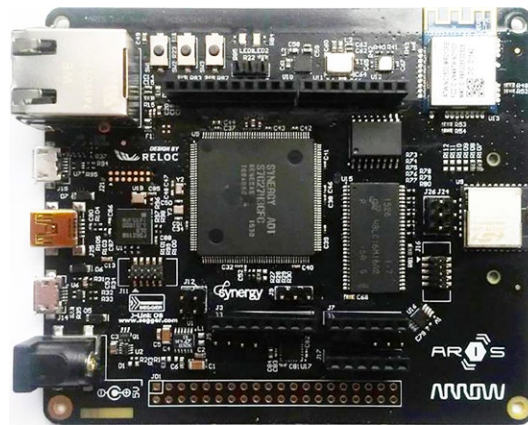
Broadening the choice

In addition to supporting the 96Boards specifications, Arrow is taking advantage of its links with leading semiconductor and IP vendors to provide even more flexible routes to market for IoT designs. By teaming with Italian IoT-focused embedded experts RELOC and Renesas, Arrow has driven development of the ARIS (Arrow Renesas IoT Synergy™) board. This highly integrated platform combines the power of the Renesas S7 240MHz Cortex-M4 processor with built-in MEMS accelerometer and gyroscope, as well as temperature and humidity sensors, making this board ideal for a variety of logging or context-sensing applications. Bluetooth LE, Wi-Fi, and NFC (Near-Field Communication) wireless connectivity are all supported. Built-in support for NFC enables applications such as industrial sensors to push data to the Cloud via an NFC reader or NFC-enabled smartphone.

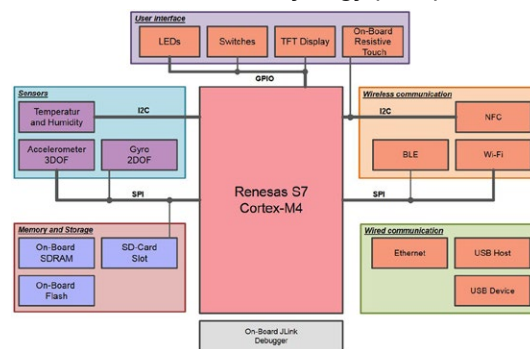
The extensive software support provided gives developers a powerful advantage when working on ARIS. RELOC has developed a complete set of drivers and middleware for managing the peripheral devices, creating an out-of-the-box IoT development environment. The Renesas Synergy development platform provides powerful resources to help complete the software development, including Board Support Package (BSP) and code examples.

Sharper security focus

Another IoT platform initiative driven by Arrow, the SmartEverything Board, combines hardware-based security with extensive sensor integration and low-power ARM Cortex-M0+ proces-



The Arrow Renesas IoT Synergy (ARIS) board.



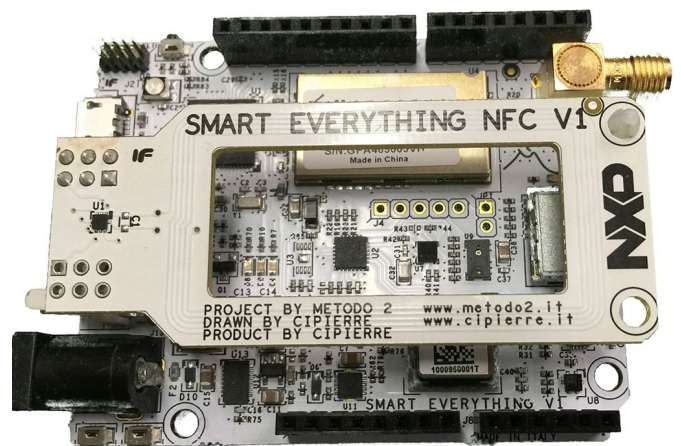
sing. Securing smart connected devices against physical or online attacks is the number one concern of many IoT developers today. SmartEverything contains an Atmel ATSHA204 CryptoAuthentication™ device that provides much of the functionality of a Trusted Platform Module (TPM) in a device suitable for embedded applications. It implements a full SHA-256 secure hash algorithm and support for message authentication, and can be used for validating software, firmware or hardware authenticity, assisting secure boot, checking passwords, exchanging session keys, and providing secure data storage.

Sensors on the board include motion, temperature, pressure and ambient-light sensors, as well as a proximity sensor that uses time-of-flight ranging to deliver enhanced accuracy over conventional proximity sensors. Local wireless connectivity includes Bluetooth Low Energy and NFC. To provide a low-power wireless connection to the Cloud, the board supports ultra-narrowband technology allowing license-free long-range communication via the global SIGFOX network. The SIGFOX modem on-board

also contains a GPS receiver and a built-in antenna.

Conclusion

Amid huge interest in the IoT, developers ranging from makers to professional embedded-design teams are looking for suitable prototyping platforms that can help accelerate their projects and overcome key challenges such as power consumption, security, sensor integration, and wireless connectivity. Many boards are being positioned as candidates, and software-biased engineers can be tempted to choose the most popular or well-known. Time spent considering some basic hardware selection criteria, such as sensor integration, cryptographic support, and processor/microcontroller availability and supporting software-development ecosystem can help identify the best target for a fast and uncomplicated route from idea to marketable product.



The secure SmartEverything board.

Hardware development on the fast lane

By Katarina Ilic

If only hardware development was as fast paced as software development, imagine how many more electronic devices would be impacting our lives and driving the global economy.

Each cycle of designing and testing requires prototype circuit boards, however, the delays traditionally begin compounding because the only source of these boards in low volumes are the same large factories that have been optimized for high volume production.

Every designer has at one point been faced with the high minimum order quantities, set up costs, labor costs, shipping costs, and most infuriatingly, the lead times that can span several weeks – and that is for every iteration!

A unique additive approach

Recently, additive processes for fabricating circuit boards have drawn much attention in the field of rapid prototyping. Since material is added and not removed, there is minimal waste. Additionally, the equipment can be small enough to fit on a benchtop, eliminating the need for a full factory for prototyping and the travel time to the customer.

As pioneers in this industry, Voltera recognized the advantages that this additive approach can provide during early hardware development and created the award winning Voltera V-One (see figure 1).

The V-One is a multifunctional desktop tool that allows hardware developers to prototype PCBs in as little as an hour.

A user can use the V-One to:

- Create circuitry on the standard FR-4 substrate and other materials by dispensing a fully-solderable conductive ink
- Dispense solder paste onto boards created by the V-One as well as traditionally fabricated boards
- Reflow solder components directly on the heated built-in platform

How it works

All of this is done through software that is as intuitive and visually appealing as an app on a mobile phone. The interface guides you through every step from uploading your Gerber files (from Altium, CadSoft EAGLE, PADs, OrCAD, KiCad, etc.) to dispensing paste and reflowing the board once the circuit has been printed and thermally cured.

This is possible because the V-One is currently offered with three detachable tools that magnetically snap onto the gantry system with a satisfying click. These include a dispensing head for the conductive ink, a dispensing head for the solder paste, and a touch probe for generating a topographical map of the printing surface with 20µm precision.

First, this touch probe will zero itself in the XYZ directions before making contact with a series of points on the board to store the distance between the substrate and the nozzle tip. This is critical for accurate printing and consistent resolution. The machine can currently print down to 8 mil traces and can even dispense features as small 0402 passives.



Fig. 1: Voltera V-One PCB prototyping tool.

Printing with silver nanoparticles

Once the height map is created, a highly specialized silver nanoparticle ink is dispensed from a precision-machined 200µm nozzle (see figure 2). Print time varies by size and complexity. Finally, the V-One's integrated 550W heater thermally cures the ink during a 20 minute bake cycle. During this process, solvents are evaporated and the nanoparticles fuse into tight silver matrix that is fully conductive and solderable (see figure 3).

Finishing with solder paste dispensing and reflow

With traditional prototypes, one would normally begin the tedious task of hand soldering components or stenciling solder paste onto the pads. While both are still doable with these new printed boards, most users opt for the automatic paste dispensing and reflow.

Iterating stencils is as costly and time prohibitive as board iteration and it wastes significant amounts of paste through the screen printing process. Outsourcing all this assembly often has more exorbitant costs and procedures.

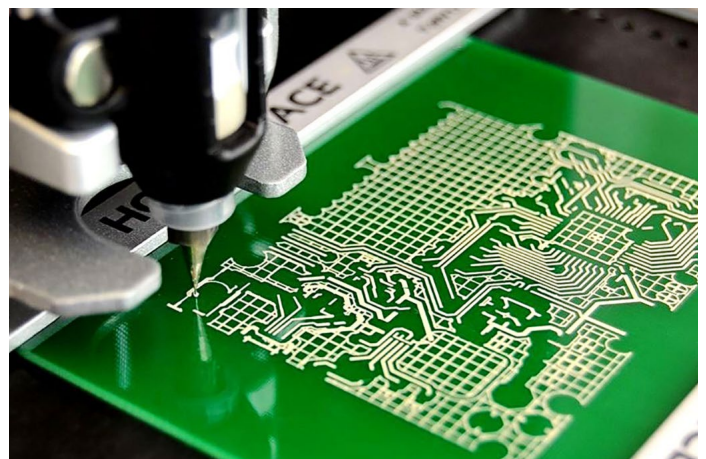


Fig. 2: V-One printing a circuit with conductive ink.

Katarina Ilic is Cofounder of Voltera Inc. - <https://voltera.io>

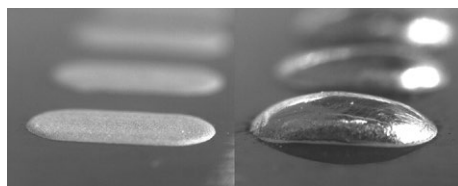


Fig. 3: Microscopic view of silver nanoparticle printed pad before (left) and after soldering (right).

If applying paste onto a traditionally fabricated board (as in figure 4), the touch probe and two user-selected pads or fiducials are used for board alignment. This technique also allows for dispensing onto boards with pre-existing features such as recessed areas.

Printing the popular Arduino Leonardo

To get further insight into the workflow and design considerations when prototyping PCBs with the tool, an Arduino Leonardo will be used as a demonstration. After clamping a blank FR-4 substrate to the V-One platform, the accompanying software guides you through the workflow by providing detailed instructions on the left panel of the screen, and complementary videos of each step on the right side.

A few design considerations

Several steps must be taken to ensure a smooth and crisp print

- the pin-to-pin distance and trace

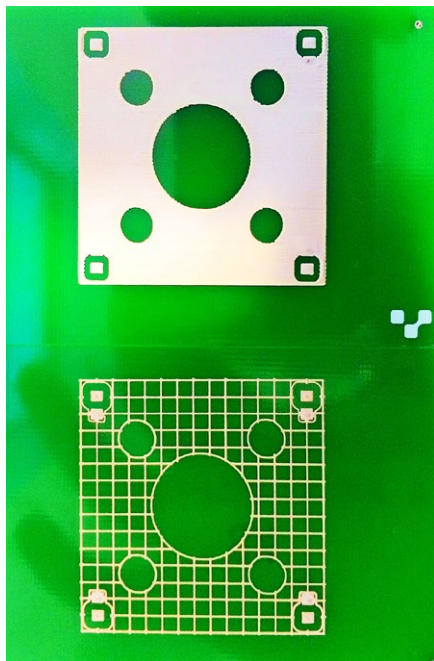


Fig. 5: V-One printed ground plane (top) and complementary hatch plane (bottom).

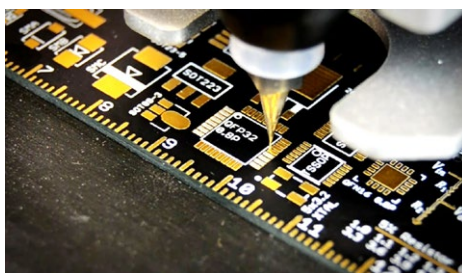


Fig. 4: V-One dispensing solder paste on pre-fabricated PCB.

width was set to 8 mil and 10 mil respectively which is compatible with all the original components of the Arduino Leonardo

- all ground planes were converted to a hatch pattern. The density of the hatch presents a trade-off between resistance versus ink consumption and print time. For this application the density was set to 16 mil. Figure 5 shows a comparison between a ground plane and its complementary hatch pattern
- the isolation was set to 16 mil indicating how much space to leave between the hatch and non-connected features
- the via diameters were designed no smaller than 0.6 mm keeping in mind the bits used to drill them were too fragile at smaller diameter
- through holes were used for USB ports, tactile switches, and larger components that were expected to undergo shear stress
- In this scenario, the Gerber files were generated through EAGLE from the layout files provided by Arduino

Creating two sided boards

The Leonardo has traces routed on both sides of the board. The V-One is capable of aligning features on both sides by using the touch sensor to identify holes and vias just as it would for a traditionally manufactured board.

After the first side of the board has been mapped, printed on, and thermally cured, the substrate can be removed for the holes and vias to be drilled (figure 6). Currently, it is suggested that this is done on a small drill press or Dremel press. Conveniently, any holes are printed as a donut allowing the drill bits to self-center for easier alignment.

Vias can then be filled with ink to create an electrical connection between both sides of the board, while through holes can be left empty. The board then gets remounted to the platform with the bottom side up. The touch probe locates key features of the board

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and is then swapped with the conductive ink dispenser to complete printing of the bottom side (see figure 7).

After the final cure, solder paste was dispensed onto the pads using the solder paste dispenser, components were manually placed onto the board, and the substrate went through a reflow profile, provided by the integrated V-One heated bed, to create the electrical and mechanical connections. Any through hole components were then hand soldered with the lead-free solder that ships with the printer.

Review of the demonstration

Ultimately, it took 2 hours to create this board using a completely additive manufacturing approach. The V-One was left unattended the majority of this time as it dispensed material and completed baking cycles. Apart from a few minor design considerations, small calibration steps, and drilling the vias, it was a fairly hands-off procedure.

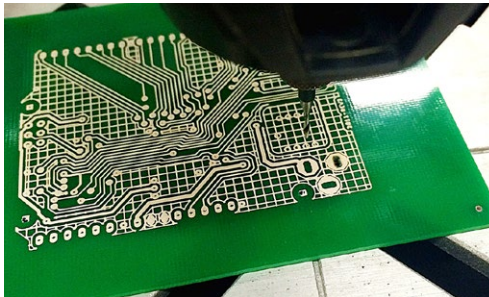


Fig. 6: Vias drilling through top side of V-One printed Arduino Leonardo.

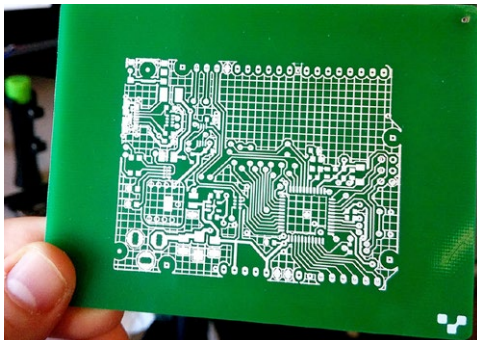


Fig. 7: Bottom side of V-One printed Arduino Leonardo.

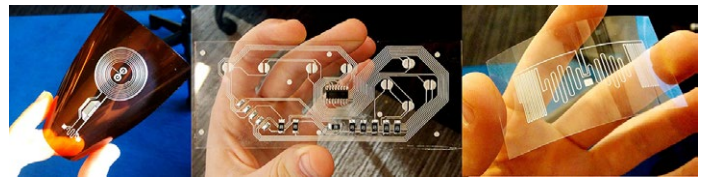


Fig. 8: V-One printed circuitry on different materials.

The board was then used in a project that an engineering student from the University of Waterloo was working on in their spare time. Future iterations of this board will likely change the layout of components to meet the necessary form factor and integrate the sensors and actuators required specifically for that project. It is worth mentioning that before the through hole components were added, it was noticed that one of the ICs was rotated 180 degrees. The heated bed on the V-One was turned on once again to de-solder the components, rotate the chip in question, and then re-solder the board.

Multi-material prototyping

A refreshing additive approach to PCB manufacturing allows for experimental prototyping that was not possible before. Prototyping is not limited to circuitry on conventional, rigid FR-4, but is versatile to an abundance of materials such as Polyimide and PET, glass and silicon, bio-compatible thin films, consequently allowing for accelerated research efforts in fields of flexible electronics, radio frequency applications, and medical diagnostics devices, respectfully.

Figures 8 a-c show a variety of circuitry applications that were printed on Kapton, Glass and PET, respectively, thus demonstrating the ability of electronic prototyping on multiple materials. We look forward to watching as the technology matures. Such an approach allows for potentially boundless prototyping and can conceivably be a true catalyst for innovation.

NFC click module expands wearable platforms

The MikroElektronika NFC click is a mikroBUS add-on board with a versatile NFC PN7120 IC controller from NXP that makes it easy to incorporate Near Field Communications (NFC) technology to any electronic device. NFC click supports use cases such as pairing, personalization, extended user interface, maintenance, logical access control and other typical NFC uses for home appliances, wearables, accessories and other low-power devices in smart homes and Internet of Things (IoT). The NFC click module for Hexiwear removes the complexity of NFC integration by enabling developers to easily leverage the full potential of NFC in Card Emulation, Read/Write and Peer-to-Peer Modes with NXP's PN7120 chip, which is ideal for designing prototypes intended to interact with existing NFC infrastructure or prototype new ideas. All necessary NFC drivers are included in the Hexiwear SDK. NFC click is also compatible with other development platforms, including NXP's Freedom development boards. Developed by MikroElektronika, in partnership with NXP, NFC click has full compliance with NFC Forum specifications. The new board communicates with the target board MCU through the mikroBUS I²C interface, in compliance with NCI 1.0 host protocols. Via its integrated firmware, NXP's PN7120 provides a high-level API which requires fewer resources from the host MCU to enable easier integration into designs. It comes out of the box with all NFC protocols.

MikroElektronika NFC
www.mikroe.com



Arduino-compatible multi-sensor evaluation kit

Rohm has unveiled a sensor evaluation kit equipped with 7 sensors and designed as an expansion board for use with existing open-source prototyping platforms such as Arduino and mbed. The SensorShield-EVK-001 evaluation kit consists of an open-source expansion board (shield) with multiple sensor modules developed by the Rohm Group including an accelerometer, a barometric pressure sensor, a geomagnetic sensor, an ALS/proximity sensor, a colour sensor, a Hall effect sensor, a temperature sensor and a UV sensor. The sensor shield can connect to an existing open-source MCU-based platform such as Arduino Uno to measure acceleration, temperature, and other physical quantities and conditions. The kit makes it easy to immediately verify sensor operation and facilitates the design of sensor devices, significantly lightening development load.



Rohm
www.rohm.com

Development platform shows near-zero power voice activation

Acoustic sensors developer Vesper, DSP Group and Sensory, Inc have created a turnkey development platform that boasts the lowest overall power consumption for far-field always-listening voice interfaces. This platform is the first to achieve overall power consumption low enough to enable battery-powered always-listening far-field systems, the companies claim. The new development platform integrates Vesper's VM1010 wake-on-sound piezoelectric MEMS microphone with DSP Group's DBMD4, an ultra-low-power, always-on voice and audio processor based on Sensory's Truly Handsfree voice control embedded algorithms. The platform gives developers the ability to initiate voice processing through Sensory's wake-up word technology, which ensures that only a specific trigger word activates the device.

Vesper

<http://vespermems.com>

Wearables dev board links power management to Cortex-M4F MCU

A recent report (link below) that generated a high level of interest outlined Maxim's MAX32630 ARM Cortex-M4F microcontroller. The chip is also available on a rapid development platform, the MAX32630FTHR Pegasus board, designed to quickly implement battery optimized solutions in sectors such as wellness monitors and wearables.

This board was inspired by the Adafruit feather series of boards and it is compatible with many of their peripheral wings. A complete getting-started guide is available at (ARM's) developer.mbed.org site with the. The board also includes the MAX14690 wearable PMIC to provide power conversion and battery management. The form factor is a 23x52mm dual row header footprint that is compatible with breadboards and off-the shelf peripheral expansion boards. On board is a variety of peripherals including a dual-mode Bluetooth module, micro SD card connector, 6-axis accelerometer/gyro, RGB indicator LED, and pushbutton. This provides a power-optimized flexible platform for quick proof-of-concepts and early software development to enhance time to market. Maxim suggests applications in areas such as; fitness monitors, portable medical devices, sensor hubs, sports watches and wearable medical patches.

Maxim Integrated

www.maximintegrated.com

Raspberry Pi easy-to-solder prototyping board

Distributor RS Components has launched a 40-pin solder-tag board for the highly popular Raspberry Pi credit-card sized computer board. The RS Pro solder-tag board is aimed at electronics engineers developing prototypes based around the Raspberry Pi board, but is also well suited for education and the training of students and electronics beginners. The solder-tag board is the same size and offers a total of 40 solder-tag terminals, matching the 40 pins on the Raspberry Pi. Connecting via the Raspberry Pi's GPIO header connector, essentially the RS Pro board offers users and developers flexible prototyping abilities by providing a simple means of soldering and de-soldering electronic components via easy to make and break solder connections. The very low cost of the high-quality SRBP board also means it can be replaced cheaply. The holes in the tag board align with the mounting holes in the Raspberry Pi, which enables the tag board to be mounted beneath the Raspberry Pi board using an additional mounting kit that consists of four legs and eight screws. In addition, the central slot in the solder-tag board allows a ribbon cable to pass through it

RS Components

www.rs-online.com

ARM-based starter kit presents complete design environment

Distributor Rutronik has ARM-based Starter Kits from Advantech; they are presented as allowing a user to begin the ARM

development with only ten minutes of setup time; and that the kits include all key elements of a development environment. The ARM-based Starter Kits host NXP and TI processors for ARM platform evaluation and development. They include key elements of

a development environment including main boards with CPU cables, adapter cards, LCD panel and power adapter. The starter kits are designed for performance evaluation and validation, fast hardware design and application development. ARM users can become familiar with Advantech ARM platforms. A built-in OS image in Linux allows users to start their evaluation immediately. Other OSs such as Android, Yocto Linux and Ubuntu are also available for different applications, each verified for online download. The source codes of the supported OS are open and available for users to help develop application code easier. Tools for application development include Qt, the cross-platform tool for device creation, UI and application development, and Advantech WISE-PaSS/RMM APIs for device access, control and monitoring. All add-on software offerings are totally verified and free of charge.

Rutronik

www.rutronik.com

Security by separation: a 'must have' with new embedded applications

By Majid Bemanian

Today microcontrollers (MCUs) are finding their way into nearly every application – in traditional areas such as industrial machinery and automotive to new areas such as wearables and even 'smart' clothing. More and more, MCU designs incorporate some kind of connectivity e.g. Bluetooth Smart, ultra-low power Wi-Fi, NFC and Zigbee. Connected MCUs must control their own states and resources, capture and process sensory data, perform some analytics and maintain secure storage; they must also communicate to a remote host for data transport, platform management, and OTA updates.

With embedded applications growing increasingly sophisticated and connected, threats to embedded platforms are increasing significantly. Security must be an up-front design consideration, not an afterthought.

Within an MCU there are several methods to build security. This includes secure boot and secure code updates. In addition, CPUs with a Memory Protection Unit (MPU) can improve system security by preventing unauthorized access to boot code and execution of non-trusted kernel mode code.

Key protection and tamper resistance are other important security measures.

Anti-tamper features can prevent external 'snooping' devices from reading the core memory and/or working out what code is executing – providing yet another layer of security against potential external attacks.

Another key security implementation method is to take advantage of hardware virtualization technology offered in some CPUs. With hardware virtualization it is possible to build a micro-controllers that can run multiple, unmodified, isolated applications independently and securely at the same time on a single, trusted platform. End customers can use this feature to provide a secure path to deliver updates/downloads, and benefit from enhanced IP protection.

Why Micro-virtualize

Hardware virtualization is commonly associated with server-class processor technology. It has been used on 64-bit server platforms for many years and is proven and widespread in the enterprise. Virtualization can enable consolidation of multiple similar or dissimilar workloads in datacenters to decrease capex (hardware and infrastructure costs) and opex (reduce power consumption, cooling), etc.

In an embedded platform, the use of virtualization is different; the primary purpose is to ensure security through separation. We define 'security' as the ability to isolate, police, and enforce behaviors on guest software. Such a technique enables consolidation of multiple different embedded CPUs into a single core resulting in lower silicon area and development effort, ultimately decreasing the overall cost and extending battery life.

It all starts with isolation. With virtualization, common resources on a hardware platform can be partitioned into logically separate environments referred to as virtual machines (VMs).

Majid Bemanian is Director of Segment Marketing for security at Imagination - www.imgtec.com

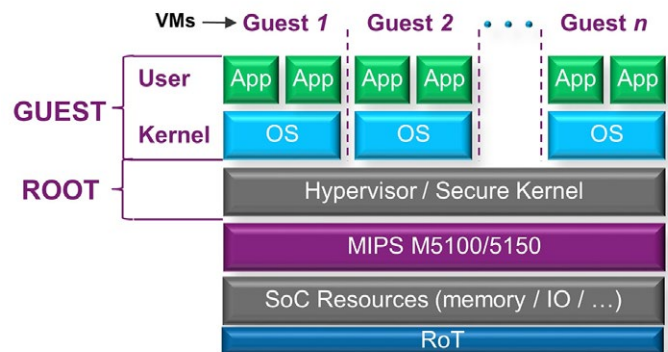


Fig. 1: a simple overview of embedded virtualization

Each VM is comprised of applications and relevant operating systems (if required). Through hardware virtualization, it is possible to separate and protect critical assets such as communication interfaces (and software stacks), storage and other resources into their own address spaces, and ensure there is no access from/to any other applications' address spaces.

A simple view of virtualization in an embedded environment is shown in Figure 1.

The MIPS M5100 and M5150 IP cores are small footprint CPUs with the ability to enforce isolation of up to seven Guests. In most of today's embedded virtualized applications, up to three isolated environments is typical; the M51xx CPUs allow for future scalability.

Once the critical assets are isolated from potential vulnerabilities, the next step in protection is implementing and ensuring trust for each isolated environment. A hardware Root of Trust (RoT) and associated security services can be used to enforce trust -- both authentication and privacy. The virtualized platform is based on a trusted hypervisor, which creates and manages the VMs, executing at the highest privileged Root level of the processor – also shown in Figure 1.

The structural integrity of the hypervisor can be maintained by following a trusted boot process. The operational integrity is not compromised since the hypervisor runs in its own unique context provided by the hardware, and is isolated to its own address space. Each address space is protected by the root memory management unit (MMU); whose contents can be locked down immediately after boot to provide absolute isolation of all address spaces.

Figure 2 shows the potential benefits of virtualization in embedded applications. In this case, a MIPS M5150 CPU is configured to support up to three distinct isolated environments. Each environment is isolated and protected from the others, including memory and IO.

Generally, the RoT and security services provided are assigned to the trusted environment. RoT security services requested by other environments (VM2 or VM3) are redirected and managed by the secured environment of VM1.

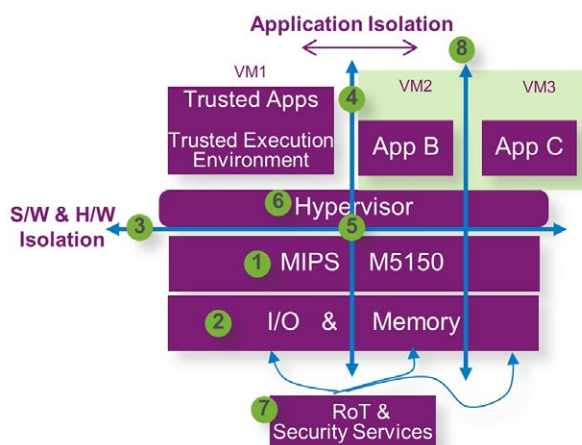


Fig. 2: Three isolated virtual environments in an embedded platform

Building Trust in a virtual environment

Figure 3 demonstrates the four quadrants required for creating security by separation and establishment of a trusted environment.

The MIPS M5150 can be divided into 4 areas / quadrants based on two axes. This is in contrast to the traditional single axis operation of User and Kernel space. The User and Kernel spaces are grouped into Root and Guest context.

Guest-User: user land with lowest privileged state where rich applications are generally executed

Guest-Kernel: typical kernel space of a CPU where privileged OS level tasks are executed. Examples are Linux; Input-output, interrupt handling and memory allocation.

Root-User: a single privileged state of the CPU that can executed protected applications

Root-Kernel: The highest privileged execution state of the CPU where privileged instructions execute. Exceptions from violation can be handled in this state. Second level memory management is used to enforce protection of resources are also managed at this state. A trusted hypervisor can manage the operation of trusted applications and all other protected Guests.

Both Guest-User and Guest-Kernel can be replicated to create multiple isolated domains. The Guest contexts are replicated into parallel domains or environments, each isolated by a hardware mechanism. In the case of the M5150, up to seven Guest contexts can be established bringing the total number of contexts to eight.

The Root context executes at a privileged state in the M5150; this allows privileged instructions, software routines, interrupts and exceptions to execute within this context, providing a mechanism for control, management and termination of Guest services as needed. Accesses from any Guest to Root resources can be prohibited by hardware. However, the Root context may act as a proxy to provide indirect access to restricted or protected resources.

The Root context can maintain an isolated state; however, to establish and maintain trust, an RoT can be implemented to start the SoC after power-up into a known state. The complex-

ity of the RoT may vary from application to application and is a function of the attack and protection profile.

Dual-core features in a single core footprint

In addition to providing a basis for security by separation, hardware virtualization can provide other significant benefits for MCUs. In an embedded device, hardware virtualization can be used to reduce CPU overhead, dynamically allocate CPU bandwidth per application, increase hardware utilization and provide more flexible system management.

For many industrial, connected home and connected vehicle applications, it is possible to save costs by replacing multiple CPU cores with a single core.

Dual-core MCUs are typically targeted at applications that have a mixed use case situation, Figure 4(a). One lower-performance core is targeted at lower-level functionality such as sensor control while another higher performance core manages the more complex tasks for audio processing or other multimedia applications. This type of configuration can be seen in many wearable, IoT and embedded applications.

The use of a single core allows the tasks to be managed with separate resources in both memory and IO, enabling separation of tasks without the added complexity of dual cores, Figure 4(b). The additional performance also gives more flexibility to scale to new applications without the fixed limits of the dual-core partitions. In comparison to competing dual-core embedded CPUs, a single-core MIPS M5150 offers a performance boost of up to 35%, while lowering area by as much as 10%, resulting in more efficient operation. The single virtualized

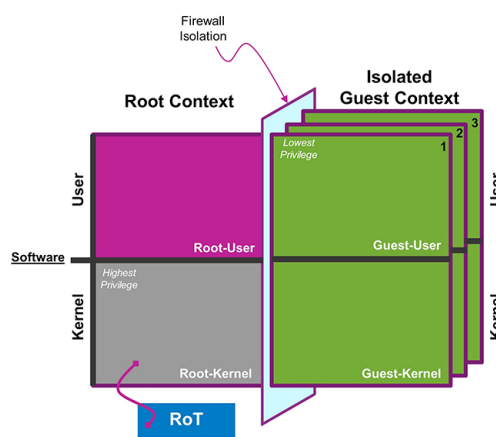


Fig. 3: the four quadrants needed to create security by separation and a trusted environment

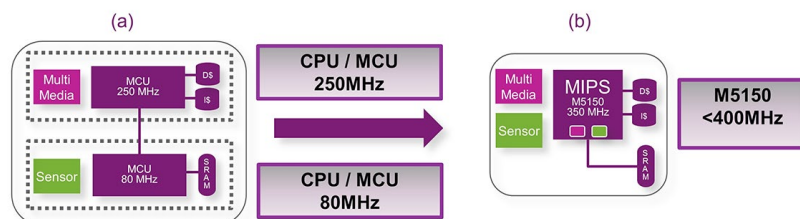


Fig. 4: Dual-core features in a single core footprint

core design reduces complexity, interconnect and debug time, and improves security and flexibility.

Use case

An IoT node device must handle multiple security requirements, including trusted boot, trusted and secure operation and communication – just to name a few.

Hardware virtualization allows the flexibility of implementing a solution that can scale and adapt to the requirement of the IoT node device while maintaining the overall cost of implementation, validation, certification and operation of the device. In Figure 5, the trusted application handles all the security related tasks such as control of the sensors while capturing, processing and storing sensitive data; separately establishing secure communication to the host, either locally or over the cloud. The OEM application maintains isolation from any third party applications. For a third party application, being deployed in its own environment simplifies validation, deployment, and revocation

while providing another level of security for the base services.

In a connected home environment (like that shown in figure 6), there are many distinct IoT node devices that must securely be provisioned and managed by remote trusted service providers under the supervision of the home owner.

Conclusion: embedded security by separation

Security is critical to the successful and safe deployment of connected devices in the smart home and city, industrial environments, automotive applications, wearables and many other areas. Security fundamentals require that we use a trusted operating environment enabled via a Root of Trust that is impervious to attack – leveraging a root of trust engraved in hardware, which is the basis for establishing a chain of trust for all subsystems.

Security by separation enabled by hardware virtualization

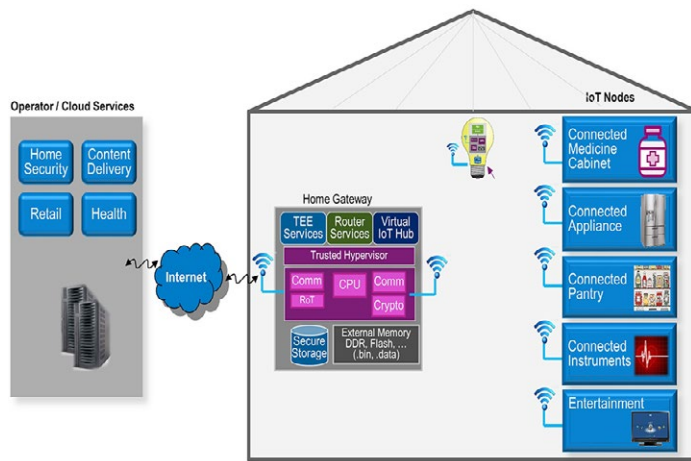


Fig. 6: Example connected home environment

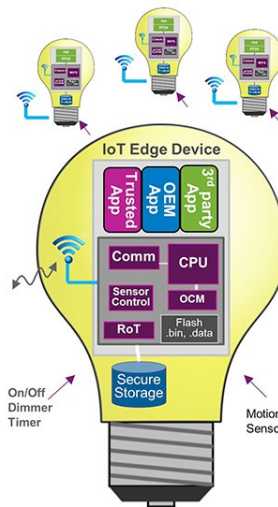


Fig. 5: security by separation in an IoT edge device

provides an additional layer of trust by ensuring that applications and guest OSes are kept separate from each other. Separating the Guests running in VMs from the real hardware and isolating VMs from each other provides a strong foundation for security through enforced isolation, with the hypervisor as the high-privilege base for security services; provisioning security services per VM.

This implementation can keep user and application data separate from each other to secure against external hacking, keep certified software away from user edits, and isolate communications interfaces and user application software for better internal security / data privacy.

Such an implementation must go beyond a binary approach (one secure zone/one non-secure zone).

The minimum implementation in a connected device would ensure separate, isolated environments for the critical device assets, communication interfaces and the software stack running them, storage and other resources in the system.

Imagination's OmniShield multi-domain separation-based architecture can scale far beyond a binary world, enabling each secure or non-secure application to exist in its own isolated environment where it operates independently. Implemented in many MIPS CPUs including the MIPS M5100 and M5150 IP cores, OmniShield provides a foundation for trust that is a growing concern in connected devices – including tomorrow's microcontrollers.

Biometric sensor dev kit for smart wearables and IoT

Valencell is a company active in high-performance biometric data sensor technology; in a joint announcement with STMicroelectronics the two companies have disclosed an accurate and scalable development kit for biometric wearables that includes ST's compact SensorTile turnkey multi-sensor module integrated with Valencell's Benchmark biometric sensor system. Together, SensorTile and Benchmark comprise the most useful portfolio of sensors to support the

most advanced wearable use cases, according to their designers. The SensorTile is an IoT module (13.5x13.5mm) that hosts an STM32L4 microcontroller, a Bluetooth Low Energy chipset, a wide spectrum of high-accuracy motion and environmental MEMS sensors (accelerometer, gyroscope, magnetometer, pressure, temperature sensor), and a digital MEMS microphone. Integrating ST's SensorTile development kit with Valencell's Benchmark sensor technology simplifies the prototyping, evaluation, and development of innovative wearable and IoT solutions by delivering a complete Valencell PerformTek technology pack-

age, ready for immediate integration and delivery into wearable devices. The collaboration with ST expands on previous work that incorporated the company's STM32 MCUs and sensors into Valencell's Benchmark sensor system. At just over 180 mm², STMicroelectronics' SensorTile can be used as a sensing and connectivity hub for developing firmware and shipping in products such as wearables, gaming accessories, and smart-home or IoT devices. It includes a Bluetooth LE transceiver including a miniature single-chip balun on-board, as well as a broad set of system interfaces. It can be simply plugged to a host board, and when powered it immediately starts streaming inertial, audio, and environmental data to ST's BlueMS smartphone app that can be downloaded free of charge from app stores. Valencell's PerformTek sensor systems provide accurate, robust and flexible technology, powering biometric hearing devices and wearables. The technology gives devices the ability to continuously and accurately measure blood flow signals, even during extreme physical activity or when the optical signals are weak. These signals can be translated into biometric data, including continuous heart rate, VO₂ and VO₂ max, resting heart rate, heart rate response, heart rate recovery, continuous energy expenditure (calorie burn), cardiac efficiency and heart rate variability assessments.

STMicroelectronics
www.st.com

Voice biometrics is optically clear for VocalZoom

Israeli startup VocalZoom has released a voice biometrics solution based on its optical sensor that performs all voiceprint acquisition and embedded template matching, while eliminating the need for microphones and noise reduction software of traditional acoustic solutions. The solution also takes voiceprint verification out of an external processor or cloud-based server to the security of an embedded, match-in-sensor architecture. The company's patented VoiceMatch-in-Sensor technology for embedded speaker verification products acquires data from users during the biometric enrollment process as their facial skin vibrates during speech. The VocalZoom optical HMC sensor converts this data into a voiceprint associated only with the person who was actually speak-



ing, and stores it inside the sensor. This enables the sensor to meet FIDO compliance requirements, enabling easy plug-and-play installation as compared to existing fingerprint or other biometric sensors that don't offer secure embedded biometric acquisition and template matching. Each time users authenticate, a voiceprint is again acquired in real time, again optically confirmed to be from a living person rather than a recording, and then securely matched inside the sensor solution against information in its embedded template to verify the user and complete the authentication process. The sensor also offers the ability to optically acquire other biometric information to be used as additional authentication factors, including the speaker's unique heartbeat and facial characteristics.

VocalZoom
www.vocalzoom.com

Multi-modal biometrics to ease ID authentication

ImageWare Systems' GoVerifyID Enterprise Suite is a cloud-based, multi-modal, multi-factor biometric authentication solution aimed at the enterprise market. An algorithm-agnostic solution, GoVerifyID Enterprise Suite is claimed to be the first ever end-to-end biometric platform that seamlessly integrates with an enterprise's existing Microsoft infrastructure, offering businesses a turnkey biometric solution for quick deployment in an afternoon or less. "Last year nearly 80 percent of businesses reported a data breach. As the digital workforce expands, with data extended to external stakeholders and across numerous types of devices and systems, the need for high-assurance, enterprise-wide protection has intensified," notes Jim Miller, Chairman & CEO of ImageWare. "The traditional security perimeters have changed and executives are being held accountable for safeguarding data against potentially devastat-



ating breaches that can tarnish a brand's reputation. Armed with GoVerifyID Enterprise Suite, corporations have access to a scalable and affordable solution that works with their existing

Microsoft infrastructure and gives them the ultimate peace of mind." User authentication logins are possible for a tablet or laptop even when disconnected from the corporate network. The solution is linked from the cloud to an enterprise's Microsoft infrastructure and is backward compatible with Windows 7, 8 and 10. Additionally, because the solution is SaaS-based it can easily scale to process hundreds of millions of transactions and store just as many biometrics. ImageWare boasts to

have extensive relationships with leading biometric algorithm vendors, and its Biometric Engine is specifically designed to easily add and support new biometric algorithms, future proofing a corporation's investment in GoVerifyID Enterprise Suite.

ImageWare Systems
www.iwsinc.com

emCrypt gets hardware acceleration with NXP

Segger has announced the availability of hardware acceleration support for its emCrypt offering. emCrypt is a comprehensive library of cryptographic algorithms which are at the heart of all cryptographic software products from SEGGER, such as emSSH and emSSL, as well as security focused products like emSecure. This pure software solution is the fastest available, achieving a performance of 2.17MBytes/s AES-128 encryption on a 168MHz NXP Kinetis K66 MCU. Written entirely in C, it is compatible with any 16-, 32- or 64-bit CPU and can be used in microcontroller-based applications, as well as tablets or PCs. The new version now also supports hardware acceleration.

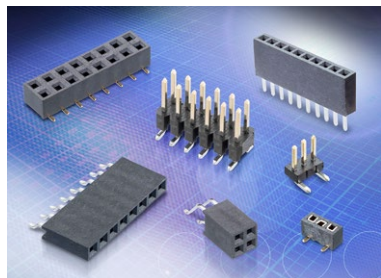


On the same MCU, the hardware supported algorithm nearly quadruples the performance to 8.20MBytes/s. "NXP's Kinetis series of MCUs is highly optimized for implementing security. The Kinetis Crypto Acceleration Unit (CAU) significantly improves the performance, resulting in higher communication speeds, lower CPU utilization and a reduction in power consumption. Our already efficient algorithms used for TLS and SSH gain even more by using the CAU," explained Alex Gruener, CTO at Segger.

Segger
<https://www.segger.com>

1.27, 2 and 2.54mm pitch SMT board connectors expand their options

Hi-rel connector and SMT board hardware manufacturer Harwin, has extended the number of models available in its



Industry Standard Connector ranges, including the Archer M50 (1.27mm pitch), M22 (2mm pitch) and M20 (2.54mm pitch) interconnects. The range extensions add new orientations, different connector pin counts and soldering methods.

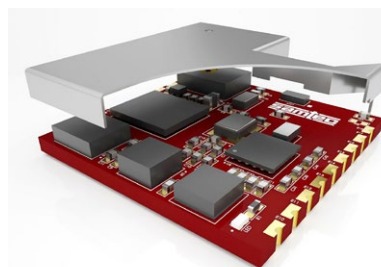
Harwin expanded its choice of connection systems to suit an increased variety of PCB layouts and offer customers more flexibility. Additionally, all of the new surface mount connectors are available supplied in Tape & Reel packaging, for use with automated pick and place assembly. Harwin's Archer M50 connectors, based on 1.27mm pitch, now include a complete range of single-row pin headers and sockets, both available in through-board and surface mount options. The M22, 2mm pitch Industry Standard range has been extended with the addition of single and double row SMT horizontal sockets, plus a double row vertical SMT pin header with location legs for precise board placement. Harwin's extended M20, 2.54mm pitch Industry Standard Connector range has seen the addition of single and double row SMT horizontal sockets, a double row vertical SMT pin header with location pegs, plus a low-profile dual-entry vertical SMT socket.

Harwin

www.harwin.co.uk

Wireless sensor module is only 13.5x13.5mm

The Samtec nMode wireless sensor module is a production-ready solution that allows engineers to remotely sense and measure inertial, environmental and acoustical parameters.



The 13.5x13.5mm unit contains a MEMS accelerometer, gyroscope, magnetometer, pressure sensor, and a MEMS microphone, all from STMicroelectronics. The standalone node is suitable for products such as wearables,

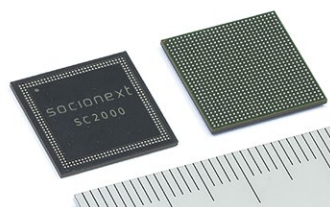
gaming accessories, and smart-home or Internet-of-Things (IoT) devices. Samtec has collaborated with ST to position the nMode wireless sensor module as an FCC-certified production version of ST's SensorTile development kit. It leverages standard ICs and, like ST's SensorTile, it's compatible with the STM32 ecosystem through STM32Cube support. The nMode core system is based on an STM32L476 Ultra-low-power with FPU ARM Cortex-M4 MCU, a BlueNRG-MS Bluetooth low energy network processor, an integrated balun filter, and the different MEMS sensors. The Samtec nMode wireless sensor module (OMS-1-1313) will be available in Spring 2017.

Samtec

www.samtec.com

Full featured 4K image processor aims drones and action cameras

Socionext's SC2000 image processing IC is the eighth-generation version of the company's Milbeaut image processors.



Equipped with a digital signal processor optimized for computer vision, it also features advanced functionalities such as 360-degree, real-time panorama stitching with four cameras, image stabilization without mechanical gimbals,

and rolling shutter correction. The image processing rate is 1.2 gigapixels per second, three times faster than the company's previous processor, while the power consumption is as low as 1.7 Watt in typical operating conditions.

Socionext

www.socionext.com

Hybrid Log-Gamma test solution targets video consumer electronics

Rohde & Schwarz is expanding its R&S VTx video tester family to include tests for HLG-capable devices in line with the HDMI 2.0b standard. Hybrid Log-Gamma (HLG) is an enhancement



to the high dynamic range (HDR) technique that allows good-quality replay of state-of-the-art picture material even on non-HDR-capable devices. This is a

crucial factor in the successful introduction of the spectacular HDR technique for a more intensive and realistic home theatre experience. The R&S VTC/VTE/VTs video tester family is based on the recently introduced flexible T&M module for HDMI and HDR tests. The new module offers generator and analyzer functionality for data rates up to 18 Gbit/s as well as functions such as scrambling introduced with the new HDMI standard. Now it can also test HLG-capable devices. This includes testing and emulation of the signalling function and the generation of new test patterns. The solution is downward compatible with HDMI 1.4 and supports HDCP 1.4 and HDCP 2.2. It covers realtime protocol testing and compliance testing in line with HDMI CTS 1.4/2.0, providing users with a test tool that can be used in various applications throughout the consumer electronics value chain. The generator function can be used to edit the Dynamic Range and Mastering InfoFrame specifically for HDR and HLG. It displays the Enhanced Extended Display Identification Data (E-EDID) of the connected sink, including the HDR metadata block. It also permits the playback of customer-specific, uncompressed moving picture sequences. The analyzer unit provides suitable E-EDID and displays the Dynamic Range and Mastering InfoFrame. The video analyzer functionality provides bit-accurate display of the electro-optical transfer function (EOTF) in use. HDR CTS tests are available for both the generator and the analyzer.

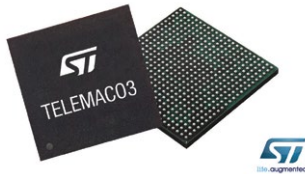
Rohde & Schwarz

www.rohde-schwarz.com

Telematics processors tweaked for higher performance

Chipmaker STMicroelectronics has announced a new generation of its Telemaco processor family that offers higher performance and security to meet the requirements of tomorrow's connected car applications.

Future-proof telematics processors for secure connected-driving services

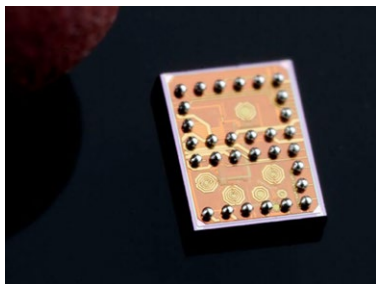


Telematics systems that monitor on-board sensors and exchange information with the Cloud are becoming increasingly sophisticated to support high-value services including remote vehicle diagnostics, roadside assistance, and Over-The-Air (OTA) software updates. Infotainment features like location-based services and access to personal content and contacts add further benefit for end users. Over 72% of new cars globally will be fitted with factory-installed telematics systems by 2021, according to ABI Research, and there are opportunities for aftermarket systems, as well as OEM and independent telematics service providers. ST's Telemaco concept helps maximize consumer access to these advanced connected-driving services through the cost-effective integration of the telematics processor, secure in-car connectivity, and sound boosting in a single chip. Unlike alternative devices, which are typically based on an application processor or a GSM modem with integrated CPU (Central Processing Unit), ST's latest Telemaco3 chips are tailored for telematics applications and give extra flexibility to choose the connection type, such as 2G, 3G, or 4G. At the same time, the secure interface with the in-vehicle network is enhanced with a hardware cryptographic accelerator, and connectivity extended with Gigabit Ethernet support and the option to host a Wi-Fi module that can be used as an in-car hotspot.

STMicroelectronics
www.st.com

Bluetooth 5-ready silicon RF IP

The Bluetooth SIG recently released the highly-anticipated Bluetooth 5, which extends the performance of Bluetooth Low Energy (BLE). New features include a doubling of speed (from 1Mbps to 2Mbps), allowing twice as much data to be transferred (or reducing the time to transfer a fixed amount of data), as well as a 4-fold increase in range, thus enabling smart home applications. CSEM's IcyTRX silicon RF IP is believed to be the first BLE RF to be fully validated as

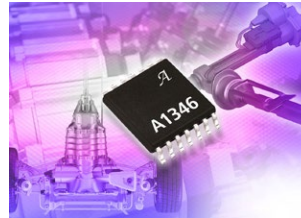


Bluetooth 5 compatible. Complete validation of all certification tests has been made possible due to a close cooperation with RF test equipment supplier Rohde & Schwarz, who has implemented the new Bluetooth functionality in its line of R&S CMW wideband radio communication testers.

CSEM
www.csem.ch

Full die redundancy programmable linear Hall sensor IC

The A1346 from Allegro MicroSystems Europe is a dual-die, highly programmable linear Hall sensor IC that aimed at safety-critical applications. The chip incorporates full die redundancy with the added benefits of full diagnostics.



The combination of these two features allow for a higher level of diagnostics without interruption to the application (where diagnostics would otherwise render a die temporarily unresponsive), and also allows the controller to know which die to trust when the two outputs do not agree. The new device incorporates dual high-precision, programmable Hall-effect linear sensor integrated circuits with open-drain outputs, for both automotive and non-automotive applications. The signal paths in the A1346 provide flexibility through external programming that allows the generation of accurate and customised outputs from an input magnetic signal. Each BiCMOS monolithic integrated circuit incorporates a system-on-chip configuration that includes a Hall sensing element, precision temperature compensating circuitry to reduce the intrinsic sensitivity and offset drift of the Hall element, a small-signal high-gain amplifier, proprietary dynamic offset cancellation circuits, advanced output linearisation circuitry, and advanced diagnostic detection.

Allegro MicroSystems
www.allegromicro.com

Quad-PID feedback loop offers PLL capability

Zurich instruments just added the MF-PID option with 4 independent PID (proportional - integral - derivative) controllers to its MFLI, a 500 kHz / 5 MHz lock-in amplifier.

New
4x PID/PLL



The MF-PID option builds on class-leading specifications of the MFLI such as low input noise of $2.5nV/\sqrt{Hz}$ and a high dynamic reserve of 120 dB. Each controller is seamlessly integrated with the lock-in amplifier, using inputs from a multitude

of internal measurement data and analog input signals. The maximum control loop bandwidth is 50 kHz. The LabOne PID-Advisor offers users a selection of models that can be picked and adjusted to have a close match with different applications. After defining the target bandwidth, the PID-Advisor suggests a set of parameters and graphically displays the corresponding transfer-function and step-response. Once the feedback loop is running, the auto-tune function optimizes the parameters to minimize the residual PID error. The software toolset included in LabOne also offers a parametric sweeper, oscilloscope and spectrum analyzer. These tools can be used to efficiently analyze the performance of the loop and compare to the selected model. In phase-locked-loop (PLL) mode, phase unwrapping extends the input range to $\pm 1024\pi$, meaning a reliable feedback at start-up and robust operation throughout.

Zurich Instruments
www.zhinst.com

ESD protective paper doubles up as corrosion inhibitor

Cortec Corporation has developed a static dissipative corrosion inhibiting paper that serves as a complete packaging paper for valuable electrical and electronic items. Sensitive electronic metal items can be wrapped in EcoSonic ESD Paper to be protected from damaging static electricity buildup and corrosion. The EcoSonic ESD Paper eliminates



static electricity buildup through the use of an environmentally friendly coating made from soybean oil and coated on the surface of the paper. The paper performs better on the static half-life test (a test with an environment consisting of little or no humidity) than papers with conventional anti-stat coatings consisting of alkyl ammonium chlorides, typical ethoxylated amines, typical imidazolines, phosphated esters, and nonionic based antistat coatings. The antistat protection from this paper is thermally stable at high temperatures in excess of 200°C and pH stable between 2 and 11 at temperatures in excess of 38°C for several days. The novel packaging material also provides contact, vapor, and barrier phase corrosion inhibition for ferrous and non-ferrous metals. It is non-toxic, biodegradable, and fully recyclable/repulpable.

Cortec

www.cortecadvertising.com

Enhanced radiation hardened MOSFETs for mission-critical space applications

IR HiRel, an Infineon Technologies company, has launched its first radiation hardened MOSFETs based on the proprietary N-channel R9 technology platform. The 100 V, 35 A MOSFETs are aimed at mission-critical applications requiring an operating life up to and beyond 15 years. Target applications include space-grade DC-DC converters, intermediate bus converters, motor controllers and other high speed switching designs. De-



veloped by the Infineon IR HiRel business, the IRHNJ9A7130 and IRHNJ9A3130 are fully characterized for TID (total ionizing dose) immunity to radiation of 100 kRads and 300 kRads respectively. An $R_{DS(on)}$ of 25 m Ω (typical) is 33 percent lower than the previous device generation. In combination with increased drain current capability (35 A vs. 22 A), this allows the MOSFETs to provide increased power density and reduced power losses in switching applications. The MOSFETs have improved Single Event Effect (SEE) immunity and have been characterized for useful performance with Linear Energy Transfer (LET) up to 90 MeV/(mg/cm²); at least 10 percent higher than previous generations. Both of the new devices are packaged in a hermetically sealed, lightweight, surface mount ceramic package (SMD-0.5) measuring just 10.28x7.64x3.12mm.

Infineon Technologies

www.infineon.com/R9-space-grade-MOSFET

Embedded NAND flash targets automotive applications

Toshiba has added to its embedded NAND flash memory products that support AEC-Q100 Grade2 requirements and are



JEDEC e-MMC Version 5.1[1] compliant. The line-up offers densities of 8 GB, 16 GB, 32 GB and 64 GB. The products integrate NAND chips fabricated with 15 nm process technology with a controller to manage basic control functions for NAND

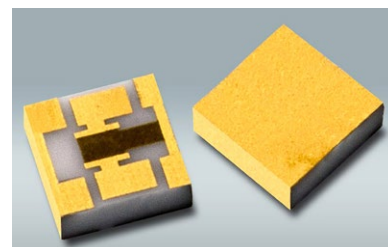
applications, in a single package. Toshiba's previous product group of e-MMC are rated for an operating temperature range of -40 to +85°C, for example, for infotainment applications. The new products support applications such as instrument clusters that require e-MMC storage solutions to operate at higher temperatures up to +105°C. The JEDEC e-MMC Version 5.1 compliant interface handles essential functions, including writing block management, error correction and driver software. It simplifies system development, allowing manufacturers to minimize development costs and speed up time to market for new and upgraded products. Additionally, new features standardized in JEDEC e-MMC Version 5.1, such as BKOPS control, Cache Barrier, Cache Flushing Report, Large RPMB Write and Command Queuing, are applied to the new products to enhance usability. "BKOPS control" is a function where the host allows the device to perform background operation when the device is idle. "Cache Barrier" is a function that controls when cache data is written to the memory chip. "Cache Flushing Report" is a function that informs the host if the device's flushing policy is FIFO (First In First Out) or not. "Large RPMB write" is a function that increases the data size that can be written to the RPMB area to 8KB. Toshiba is also developing automotive UFS (Universal Flash Storage) products that support AEC-Q100.

Toshiba Electronics Europe

www.toshiba.semicon-storage.com

Surface mount attenuator covers DC to 50 GHz

SemiGen now offers a selection of fixed attenuators pads with an attenuation of 0 dB up to 100 dB.



These attenuator pads feature precise resistor films and superior metallization resulting in a flat response from DC to up to 50 GHz. Attenuator pads offer power handling from 1W to 5W continuous wave (CW)

with minimum return losses of 18 dB up to 14 GHz and 16 dB from 15 GHz to 50 GHz. These attenuators are optimized for coplanar waveguide or microstrip PCB and microwave module assemblies. SemiGen's advanced thin-film technology allows these parts to have full side wraps for surface mount or on-board installations with a chip size of 0.03"x0.03" on most of the designs.

SemiGen

www.semigen.net



HV Zeners withstand surges in automotive ECUs

Rohm Semiconductor has added high voltage Zener diodes optimized for protection and constant current applications. The UDZLV and KDZLV series comprise 12 models in Zener voltages ranging from 51V to 150V. They are AEC-Q101 compliant and provide superior surge resistance for greater reliability in automotive ECUs, industrial and consumer applications. Rohm has previously offered a popular lineup of low-voltage (2V to 47V) Zener diodes; these introductions respond to an increased focus on automotive and industrial sectors. The expanded lineup of UDZLV diodes includes the high-voltage UDZLV series, which features a rated power of 0.2W in a 2.5x1.2mm sized package, making it suitable for consumer electronics as well as automotive ECUs, MFPs, and inkjet printers. The KDZLV series of high voltage 1.0W rated Zener diodes for automotive and industrial applications is available in a 3.5x1.6 mm form factor.

Rohm Semiconductor
www.rohm.com/eu

Advanced bus converter delivers up to 450W and 37.5A

Ericsson has launched a low-profile, 450W DC/DC converter module that is designed to deliver a tightly regulated 12V output voltage at up to 37.5A to point-of-load (POL) DC/DC converters. Offered in a 5-pin 1/8-brick footprint, compatible with the DOSA (Distributed-power Open Standards Alliance) standard, the new PKB4413D advanced bus converter has an input

range from 36V to 60V and is suitable for intermediate bus conversion in ICT (Information and Communication Technologies) applications. The PKB4413D incorporates the company's cutting-edge HRR (Hybrid Regulated Ratio) technology to deliver high-power conversion from a wide input voltage range, while keeping power losses low. Offering class-leading performance in thermally challenging environments and delivering a typical efficiency of 96%, with a 48V input and 12V output at half-load, the module significantly reduces energy and cooling costs. Competitive products typically dissipate 18% or more of their input power at 30A loads. Designed to be through-hole mounted, the PKB4413D comes in the industry-standard eighth-brick format, measuring 58.4x22.7x13.2mm. Providing 1500V(dc) I/O isolation, the module also integrates a number of I/O protection and operational features, including: monotonic start-up and remote control as well as input under-voltage shutdown, output over-voltage, over-temperature and output short-circuit protection.

Ericsson Power Modules
www.ericsson.com/powermodules

Get Bluetooth LE on-board your IoT projects

This month, u-blox is giving away ten EVK-NINA-B1 evaluation kits worth 69 Euros each, for *EE Times Europe's* readers to win. Designed to be used as a reference design for u-blox'



NINA-B1 series Bluetooth Low Energy modules, the evaluation board supports ARM mbed and allows the quick prototyping of a variety of Bluetooth low energy sensor applications for IoT. For use cases requiring NFC, the included NFC antenna can be used. Additional

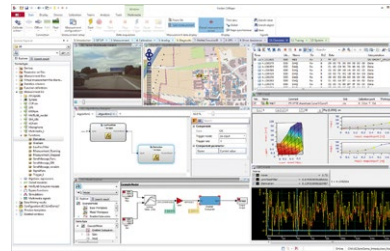
hardware interfaces such as SPI, I2C, UART, ADC, and GPIOs are available using ARM mbed. The EVK-NINA-B1 can also be used to evaluate the pre-loaded u-blox NINA-B1 Connectivity Software using the s-center tool on a PC. A USB cable and a Quick Start card are also included in the kit. The NINA-B1 stand-alone Bluetooth LE module is compliant to the latest Bluetooth 4.2 specification and certified to global radio type approvals. Version NINA-B112 featuring an internal antenna has a footprint of 10.0x14.0x3.8mm.

u-blox
www.ublox.com

Check the reader offer online at
www.electronics-eetimes.com

CANape 15.0 targets ADAS with ECU calibration optimization

In Version 15.0, Vector is extending its CANape measurement and calibration tool with many new functions. Its scalable, decentralized recorder solution makes it possible to reliably capture very high bandwidth measurement data rates of over 1 GByte/s, such as those that occur in the ADAS field. The tool's advanced user



operation concept makes it easy to quickly access frequently used functions. In ECU calibration work, the necessary sharing of parameter sets within a team is now convenient and transparent. Video streams, raw radar data and internal ECU signals place enormous demands on data acquisition, especially in the areas of ADAS development and autonomous driving. For these applications, CANape 15.0 offers the "High Performance Mode" for measuring sensors and ECUs. In addition, this extension enables time-synchronous recording over multiple PCs. This enables implementation of measurement data rates of more than 1 GByte per second. The redesigned graphical user interface is now organized by feature sets to enable fast intuitive operation of CANape. The ribbon combines menu control, dialogs and toolbar. Clearly recognizable graphic symbols make it easier for the developer to use the various functions. The new "vCDM Teams" option in CANape assures convenient and loss-free editing of parameter sets within a team.

Vector
www.vector.com/canape

dSpace enhances production code generator

With its latest version 4.2, the TargetLink production code generator from software tool vendor dSpace supports on-target



bypassing for function development on existing electronic control units (ECUs). For production code development, TargetLink 4.2 also provides extended Autosar support for multicore and automotive Ethernet applications

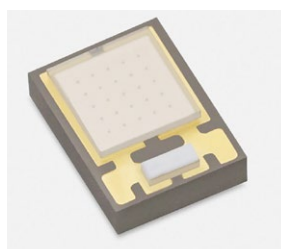
and also lets software developers generate enumeration types (C enums). TargetLink 4.2 also complies with the latest additions to the MISRA guidelines. By supporting on-target bypassing, TargetLink 4.2 merges production software development and function development. If developers want to extend the software functionality of an existing production ECU, they can now perform function development directly on the ECU if it provides sufficient I/O and available resources. By using the code generator in combination with the dSpace ECU Interface Software, developers benefit from highly efficient TargetLink code as early as close-to-production prototyping. Thus, they can identify the required resources early on which reduces project risks and ensures a smooth transition to series production. TargetLink 4.2 improves the performance of multicore systems via asynchronous client-server communication. Version 4.2 simplifies data exchange within Autosar software components by using non-scalar component variables (interrunnable variables). In addition, the tool now fully supports automotive Ethernet in Autosar Software components for the first time.

dSpace

www.dspace.com

380-390nm UV LED packs high power density in SMD package

Leveraging its leading expertise in chip scale packaging, Lumileds has introduced the Luxeon UV U1 LED for use in



UV curing, counterfeit detection, analytical instrumentation, inspections and other UVA and Violet (380-420 nm) applications. This third generation of UV LEDs maintains the same micro package size as Luxeon Z UV, but enables a higher power density. The new LED also features a robust design

that eliminates materials like silicone over mold, which tends to yellow and crack upon UV exposure, and the elimination of wire bonds that can lead to catastrophic connection failures. The UV U1 LED is nominally tested at 500mA but can be driven at up to 1A to achieve higher irradiances. For the application of UV curing at 395 nm, the chip outputs 700mW at 500mA and over 1300mW at 1A under 25°C. The Luxeon UV U1 footprint is a drop-in replacement for the Luxeon Z UV, while providing twice the typical radiometric power as its predecessor at 380-390 nm. The surface mount LEDs can be tightly assembled with spacing as small as 200 µm for high system flux density.

Lumileds

www.lumileds.com

Multi-gigabit Ethernet controllers to revive copper

Following its success in pioneering and deploying an Ethernet PHY connectivity solution capable of delivering multi-gigabit



Ethernet over copper cables, Aquantia is now announcing AQtion, an Enterprise-class client controller technology supporting Multi-Gigabit speeds. The AQC107 and AQC108 support 5 and 2.5 Gigabit Ethernet over copper, or

2.5/5GBASE-T, and are compliant with the NBASE-T specification and the new IEEE 802.3bz standard that was formally ratified in September 2016. In addition, both devices also support backward compatibility with 100MbE and Gigabit Ethernet. The AQC107 has the extra feature of supporting up to 10 Gigabit Ethernet, or 10GBASE-T, on Cat6A copper cables, complying with the IEEE standard 802.3an. "We are now delivering the last piece of the puzzle in Enterprise and SMB networks, the Multi-Gigabit client connectivity," said Kamal Dalmia, Sr. VP Sales & Marketing at Aquantia. "Targeting the hundreds of millions of high-performance machines selling every year worldwide and their upgrade to the Multi-Gig speeds is exciting and has caught the attention of major OEMs." Both devices are sampling now with production release scheduled for Q1-2017.

Aquantia

www.aquantia.com

Energy-efficient FPGA acceleration takes only 2.15x2.55mm

Lattice Semiconductor's iCE40 UltraPlus FPGA devices are claimed to be one of the industry's most energy-efficient and



programmable mobile heterogeneous computing (MHC) solutions. The new chip delivers eight times more memory (1.1 Mbit RAM), twice the digital signal processors (8x DSPs), and improved I/Os over previous generations.

Well suited to support voice recognition, gesture recognition, image recognition, haptics, graphics acceleration, signal aggregation, or I3C bridging, the iCE40 UltraPlus brings added intelligence to smartphones and IoT edge products, such as wearables and home audio assisted devices, in a package as small as 2.15x2.55mm. The MHC paradigm is concentrated around a highly energy-efficient method for computing algorithms quickly and locally using dissimilar processors to offload power hungry application processors (APs) in battery-powered devices. More DSPs offer the ability to compute higher-quality algorithms, while increased memory allows data to be buffered for longer low-power states. The flexible I/Os enable a more distributed heterogeneous processing architecture. The device draws less than 100 micro watt in standby.

Lattice Semiconductor

www.latticesemi.com

DISTRIBUTION CORNER

Submit your safety-oriented wearable designs 'till the end of the month

element14 has launched a new design challenge for designers and engineers called 'Safe and Sound'. Sponsored by Texas Instruments (TI), element14 will challenge 15 community members to design a personal safety-oriented wearable device or solution that protects a person from personal and environmental risks, monitors personal health or protects personal property from theft. The application areas for this challenge are endless, touching on all areas of work and life, whether you are walking home by one's self late at night or working within an industrial setting with potential personal safety risks. Applications for the Safe and Sound challenge will run until January 27, 2017. Then fifteen official challengers will be announced on February 13, 2017.

element14
www.element14.com/safeandsound

TI's SensorTag dev kit and antenna kit in stock at Mouser

Mouser Electronics is now stocking two new development kits for the CC1350 SimpleLink wireless microcontroller from Texas



Instruments: the CC1350 SensorTag development kit and Sub-1 GHz and 2.4 GHz antenna kit for LaunchPad and SensorTag. The CC1350 microcontroller is designed for low-power wide area networks (LPWAN) and features dual-band connectivity that ex-

pands the functionality of a sub-1 GHz network with Bluetooth low energy (BLE) implementations. The TI CC1350 SensorTag development kit expands the SensorTag ecosystem with a single-chip Bluetooth Smart radio and a sub-1GHz radio.

Mouser
www.mouser.com

Raspberry Pi 3 to be produced in Japan

Together with the Raspberry Pi Foundation, RS Components announced that the credit-card-sized single-board computer's latest iteration, Raspberry Pi 3 will be manufactured in Japan under a local contract manufacturing arrangement. This increase in global production of Raspberry Pi is to serve large and increasing demand for the popular platform in the Asia Pacific region. Driven by an on-board 64-bit ARM Cortex-



A53 quad-core processor, the first "Made in Japan" model will be the Raspberry Pi 3 Model B, which has significantly upgraded processing capabilities and delivers 10x faster performance than the original Raspberry Pi.

Raspberry Pi
www.rs-online.com

PCB terminal blocks rated from 16A up to 125A

Meeting the need for PCB terminal blocks for use in applications requiring higher current and voltage capabilities, distribu-



tor Switchtec has introduced Euroclamp's MV series of high power terminal blocks. The expansive range of MV terminals embraces many different types and formats to exactly meet the needs of the specific requirements; they are 'no compromise' components. The range includes models with current carrying capabilities from 16A up to 125A. Specifically they are the 16A rated MVE27, the MVSP25 and MVSP27 at 24A, the MV46, the MV47 and MV49 at 32A, MVL47 at 41A, MV10VA at 49A, MV10 at 70A, and the 'monster' MVP35 at 125A. Voltage ratings up to 1000V are available.

Switchtec
www.switchtec.co.uk

Molex' Mega-Fit power connectors at TTI

Interconnect manufacturer Molex has expanded current-carrying capabilities up to 23.0A with its new Mega-fit power



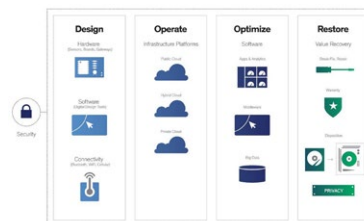
connectors, now available in Europe at TTI. The power-dense split-box terminal design of 5.70mm pitch Mega-Fit power connectors incorporates high-current terminals and tight pitch and row spacing to produce more power per linear and square millimeter

than any other mid-range power product currently available on the market. As well as maximum current of 23.0A, electrical specifications include maximum voltage of 600V and contact resistance of 6 milliohms.

TTI
www.ttieurope.com

Arrow Electronics and Vodafone join forces on IoT/M2M solutions

Arrow Electronics announced a new agreement with for cellular network services provider Vodafone, to market the company's



IoT services as part of its eVolve IoT offering. The Arrow eVolve offering is a comprehensive framework enabling businesses to globally deploy, manage, monitor, analyze and monetize secure connected devices throughout their

entire lifecycle. This cooperation with Vodafone extends the services offering with managed data connectivity solutions that Arrow can now provide to its extensive global customer base.

Arrow Electronics
www.arrow.com

The five stages of machine learning implementation

By Alexander Khaytin

Imagine your company was planning to transition into Industry 4.0. Now imagine that it's your job to implement the big data analytics, machine learning and artificial intelligence technologies needed, into the business environment. You're going to need to know: where to begin, what kind of problems to expect, and how the specific related projects and services differ from what you are used to.

If you've stumbled upon this article, you may already be in this position. However, what's more likely is that this is going to become your situation in near future, and learning from someone else's experience is now needed to prepare. While there's a plethora of theory around business applications for data analytics; there is a significant lack of practical, real-life experience to draw on. This is largely due to the fact that adoption of these technologies, for many industries, is new and the results of pilots are just coming to light now. Drawing on our work with one of the world's largest steel producers, here I will detail some of our most useful and practical learnings.

Decreasing steelmaking costs with Magnitogorsk Iron and Steel Works (MMK)

Machine learning technologies are successfully used in predictive and recommendation services. The basis of accurate predictions is formed by historical data which is used as a training set. The result of this work is one or more models that can predict the most likely outcome of the technical process or the set of options, among which the best is chosen.

For example, Yandex Data Factory developed a recommender service for Magnitogorsk Iron and Steel Works (MMK) that helps to reduce ferroalloy use by an average of 5% at the oxygen-converter stage of steel production. Not only it saves about 5% of ferroalloys but, more importantly, this happens with sure and steady maintenance of the high quality of resultant steel.

When you choose the task for applying machine learning technologies, you should choose the one with measurable results and economic effect. In addition to this, the availability of data is required, as well as understanding how these recommendations and predictions should be used practically.

However, as we have learnt, finding a solution is not simply reached at one giant leap. The process of creating a predictive or recommendation project consists of several stages.

Stage one – Determining objectives, metrics and constraints

The first and very important stage is determining the objectives and constraints used in the modelling process. In the case of ferroalloy optimisation service, the key constraint is the need to adhere to the target chemical composition of resultant steel using the ferroalloys that are available at this specific melting. The objectives are the minimum possible cost of ferroalloys used and the maximum ratio of recommendations that were accepted



by the operator for execution. The second objective is important because if the recommendations seem to be sudden or aggressive, they are often rejected by the operator responsible for the management of this smelting. For each objective, there should be chosen a metric, and the model should be trained specifically for it – its success will be determined in terms of this specific metric. Therefore, choosing the right metric is a critical factor of success. If the metric is chosen badly, all the work on the model goes in the wrong direction.

Stage two – Assessing data

The next step is the assessment of available data sources, estimation of available data volume and composition. Depending on the task, a set of fields and parameters and historical depth of data, experts decide how realistic the task is. An important difference between machine learning technologies, from the more conventional ways of data analysis, is that the most valuable data is raw data, without aggregation and pre-processing. For the modelling it is preferable to have a larger amount of data, even when inconsistent and containing errors and omissions, rather than a small amount of "clean" data. If the data is not enough, at this stage, you can define which data will help solving the task and start collecting them.

When building a model for MMK, the data used consisted of 200,000 smelting entries collected over 7 years. The dataset included scrap and pig iron masses, target chemical composition of resultant steel, technical parameters of the oxygen-conversion and the refining stages, results of chemical analyses.

Stage 3 – Model training

Training the model, in contrast to conventional software development, does not require pre-development of rules and algorithms.

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LAST WORD



Data analyst determines the range of factors that may affect the process being modelled – this is often an extensive process to ensure important factors aren't missed. At this stage we need the experts, who know the subject area and a process being modelled, to cooperate with the analysts who train the model and possess the necessary tools. The training process is iterative, 1 to 2 months are spent on designing the model, where the level of accuracy of this model constantly increases.

Unfortunately, the quality of the model can be estimated only after its training and testing are ended. For many tasks it is advisable to combine determined formula, reflecting the known properties of the process, with the refining models that are based on machine learning technologies.

In this case, the generalised calculation, using the formula, is refined by the machine learning model. This combination allows you to take into account both the general characteristics of the process, and local variations that cannot be included within the formulas. This approach allowed us to ensure both an adequate proportion of the accepted recommendations and significant savings in ferroalloys at the same time in the MMK project.

However, some may find this as a disadvantage that even after the successful training, machine learning models do not interpret their own results to explain why something has been recommended, like business analytics.

While the quality of the predictive model is measurable and stable, it does not generate any new knowledge.

Model training is conducted on a limited dataset and requires a lot of computing power.

Stage 4 – Integration and testing

After model training, it is integrated into the client's management system. This integration is simplified by the fact that the model realises only one function – it predicts or recommends. In this regard, the interface is very simple and the integration is reduced to data transfer and displaying those recommendations.

Practical tests are carried out with client's side experts participating. During testing, it is necessary to measure the accuracy of the model, and achieved economic effect.

In the service designed for MMK, the board of experts involved in the testing waived any responsibility from the operator if he did not quite agree with the recommendation made. This allowed us to estimate the effect of the model use and to determine the necessary changes for its use in production. During testing, model showed a decrease in ferroalloy use of about 5%, and the projected savings comprised \$4.3 million per year.

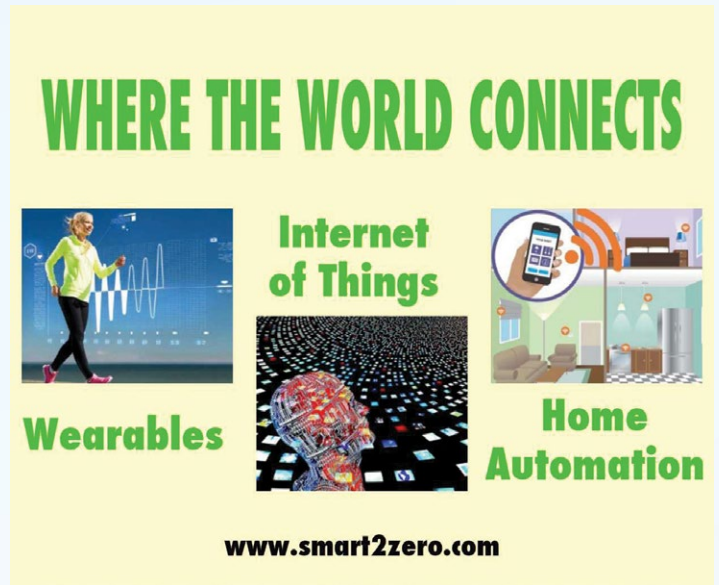
Stage 5 – Model monitoring

The last stage is the production use of the service that successfully passed testing. The production use requires constant monitoring of the model quality and its regular additional training on newly collected data. Unfortunately, completely self-trained machine learning systems are in the research stage now, and their application for business and industry use is not possible.

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