



NMI YEARBOOK 2017

NMI YEARBOOK 2017

Training Engineers of the Future

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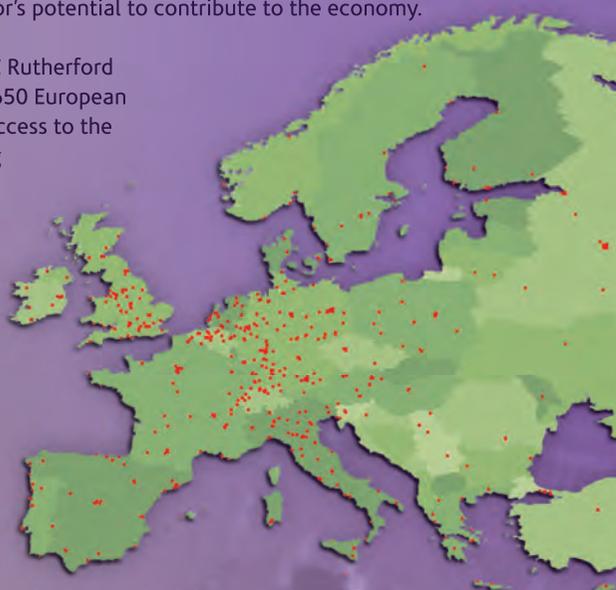
The electronics system design sector in the UK and Ireland requires a continuous supply of well-trained graduate and post-graduate students in order to continue to flourish, compete with other regions and fully exploit the sector's potential to contribute to the economy.

The Microelectronics Support Centre at STFC Rutherford Appleton Laboratory has, on behalf of over 650 European academic institutes, negotiated affordable access to the latest tools from many of the world's leading design tool vendors and provides them in a managed way that offers fully integrated multi-vendor design flows for research and student training.

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Sir Hossein Yassaie

NMI Chairman

CHAIRMAN'S STATEMENT



As many of you know, it's been my pleasure to be a member of the NMI Board since 2009. Over the years, I have been connected with many industry bodies but what has always struck me about NMI is its connection to real people, developing and making real things, here in the UK. That is what sets NMI apart and, as this is something I care deeply about, it gives me great pleasure to be elected as Chairman following November's EGM. Now, more than ever, I believe the industry needs a body such as NMI, but there are clearly some challenges we need to face-up to, and that we've now begun to address.

FIRSTLY, we have to manage the transition to TechWorks ensuring that we retain the support of our existing members. Those who have put so much into NMI may wonder why this change is necessary. It is necessary because the hard work that you have done has made it possible for the NMI to address a wider constituency with great impact and credibility. We must necessarily seize this possibility for the good of a future UK in which electronic systems are a cornerstone of the economy. I was one of the

instigators of the change to TechWorks and, whilst I recognise microelectronics and semiconductors are the critical enabling technologies that everything else can be based on, it is the nature of the industry today that collaboration on multiple levels of the technology stack is required to develop products and business models. Therefore, embracing a wider community is of benefit to everyone and I believe a new identity was needed to take that wider collaboration forward.

“NOW, MORE THAN EVER, I BELIEVE THE INDUSTRY NEEDS A BODY SUCH AS NMI, BUT THERE ARE CLEARLY SOME CHALLENGES WE NEED TO FACE-UP TO, AND THAT WE’VE NOW BEGUN TO ADDRESS.”

We also need to bring more punch to the grass-roots connections. There are different aspects to this that I believe we've possibly lacked on the NMI Board until now. In order to really make a difference, we need the most senior people in the UK in the communities that we represent on the TechWorks Board. I'm therefore delighted that Simon Segars, CEO of ARM, and Luke Ibbetson, Group Head of R&D at Vodafone are joining Stan Boland, now Founder of exciting start-up Five.AI, and me, in this venture. I have also long been a believer that we need to build better connections to the investment and financial community.

We know intuitively and have clear evidence from a variety of sources that we are not delivering on our full potential to create and

“THOSE WHO HAVE PUT SO MUCH INTO NMI MAY WONDER WHY THIS CHANGE IS NECESSARY.”

build companies of scale at a global level. Whilst this is not solely down to a lack of investment, that is one of the major challenges and an area we really need to work on. On discussing this with some well-recognised

TechWorks Board



Sir Hossein Yassaie
Chairman, TechWorks



Dr Derek Boyd,
Chief Executive Officer,
TechWorks



Hermann Hauser
Amadeus Capital



Simon Segars
ARM



Tim Luke
Barclays Capital



Stan Boland
Chief Executive Officer,
FiveAI



Mike Risman
Vitruvian Partners



Luke Ibbetson
Vodafone Group R&D



figures, I discovered we shared the same ambition to improve the current situation and I therefore welcome Hermann Hauser, Founder and Partner at Amadeus Capital, Mike Risman of Vitruvian Partners, a leading private equity fund and Tim Luke, Chairman of Tech Investment at Barclays, as new board members too. Tim has experience as the lead Technology Advisor to the former Prime Minister which will help us develop interaction with the new government at the most senior levels. The current Board is a very good start and we'll continue to add members to the TechWorks Board, including leading academics, as we go forward but I'm very pleased so far with the response of these individuals to share the challenges that we need to address.

Anyone who knows me personally will tell you that once I agree to do something I become fully committed to it. I have already spent time bringing myself up-to-speed with the current work and am impressed with the scope of the activities, the commitment and hard work of the team. One of my key aims is to bring more investment into the organisation so that we can

deliver on the full potential of the current projects whilst also moving forward to address the vital challenges facing our industry. As we go forward with Brexit, it is vital that we avoid a 'Techxit' and take all steps to build on the UK's position as a vital node in the global technology development eco-system.

In closing, I make one request. If you're part of this UK ecosystem then I believe NMI has already been working for your benefit and that TechWorks will carry this forward in a stronger way than ever before. You have a part to play in this too and I ask you to lend your support by joining and getting involved. I look forward to working with all of you as we go forward.

Sir Hossein Yassaie
TechWorks Chairman



Derek Boyd

NMI Chief Executive Officer

CHIEF EXECUTIVE'S STATEMENT



As I write this statement, the NMI members have recently unanimously supported the Board's proposal to create TechWorks a new 'Hub' that will be the focal point of our established Connected Communities on Power Electronics UK, AESIN (Automotive Electronic Systems Innovation Network), IoTSF (IoT Security Foundation) and more to come.

NMI WILL CONTINUE TO EXIST as two Connected Communities; one covering Electronics and Semiconductor Manufacturing, the other, NMI ESD, covering Electronic System Design. This change reflects a clear trend of collaboration at multiple levels of different technology stacks as well as an increasing number of members outside of the semiconductor domain. Building these linkages beyond semis into systems is something that's clearly of great value to many or most of the semiconductor members and has been a welcome trend. It's also clear that our identity of NMI, or our Sunday name "National Microelectronics Institute", was not relevant to a growing proportion of our member base and that a change to something that could have broader appeal, and accuracy, was required; hence TechWorks was proposed to members and will soon become a reality. This Yearbook therefore is the final NMI Yearbook as we'll be publishing under the TechWorks banner from next year onwards. As such, it seems that a bit of sentimental reflection is appropriate.

When starting at NMI in 2001, I was greatly impressed by the collaboration between

individuals across multiple disciplines. Many of these individuals were from companies who competed in various market-segments and, whilst everyone has always steered well-away from IP, the desire to collaborate for the good of the industry in the UK has been something that has characterized NMI's work and member participation over many years. This sort of goodwill between companies gives all of the team here at NMI a strong signal that our role is vital to the industry and it's what makes our jobs feel worthwhile.

I could give many examples but, for me, there is no better example than the Annual Dinner. Since starting the event in 2002 and thoroughly enjoying its early title of "The industry's social event of the year", it's increased to a scale we wouldn't have thought possible and yet still retains a unique atmosphere that has carried it forward from the early days. It just so happened that the final NMI Annual Dinner in 2016 also marked our 20th Anniversary celebrations and, for me personally and for those there, I am sure it will stick in our memories and raise a smile. Plans are already well-underway for our first TechWorks Annual Dinner and I hope to see

“PLANS ARE ALREADY WELL-UNDERWAY FOR OUR FIRST TECHWORKS ANNUAL DINNER.”

many of you in London on 23rd November for the occasion.

More than anything, it is this spirit of goodwill and collaboration for the greater good that gives me confidence that TechWorks will be a roaring success. We've already proven our new model in the automotive world and facing the challenges of IoT Security, and we are confident that, with your help and with the backing of the leaders in the UK technology community, we can not only

continue to deliver the valuable forums and peer groups greatly valued by members today, but can also move forward and have a bigger impact than ever. We have great ambition for TechWorks, and most of all for the vital industry that it represents. I look forward to working with you all on that journey.



Derek Boyd

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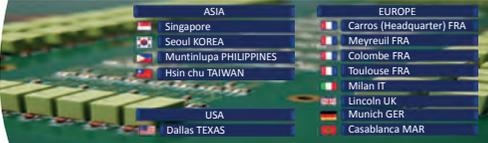
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ANNUAL REVIEW OVERVIEW

Established in 1996 by a handful of British-based semiconductor manufacturers, NMI is now the champion for the UK's thriving electronic systems and technology industry.

Our mission is to support the UK's position as a leading location for electronic systems and technology businesses.

Through our work covering connected communities, engineering and manufacturing excellence, industry cohesion and leadership, future skills, influence and celebrating success, we support both our members' short-term priorities and our industry's long-term needs.

This Annual Review shows you how by highlighting some of NMI's key achievements in this, its 20th year of serving our industry.



CONNECTED COMMUNITIES

When you look at the breadth of our membership today and the diversity of the electronic systems community it represents, you realise one size can't fit all. Over the years, NMI has therefore developed an ever-expanding family of connected communities.



From Manufacturing Excellence and Semiconductor Design to Automotive Electronic Systems and Internet of Things security, these connected communities are all united in a common pursuit of innovation, while each has a value proposition that's special and unique to them.

There are too many highlights to list in full, so here is a selection of our connected communities' major achievements from the last 12 months.

Automotive Electronic Systems Innovation Network (AESIN)

The first connected community to spin out from NMI, AESIN was established in 2012 and sets the standard for others to follow.

Its most advanced workstream is the Connected Corridor. Here, AESIN is working at the leading edge of one of the most exciting developments in the sector. Funded by a multi-million pound grant from Innovate UK, the UK CITE (Connected Intelligent Transport Environment) project aims to create the most advanced environment for testing connected and autonomous vehicles not just in the UK but the world. And AESIN is in the driving seat.

During 2016, AESIN also increased its number of workstreams from three to five, adding Automotive



Security and Software to the original More Electric Powertrain, ADAS (Advanced Driver Assistance Systems) and Autonomous Vehicles, and Connected Corridor.

At the same time, it extended its sphere of influence. As well as exploring opportunities for funding with government, AESIN secured a strong voice on the UK Automotive Council through the appointment of AESIN's Chairman to its Intelligent Connected Vehicle Working Group. AESIN also recruited its first Vice Chairman to drive forward the increasing workload.

Just how significant a role AESIN now plays – and after such a short time – was highlighted by the Chief Executive of Highways England. Speaking at AESIN's flagship annual conference, Jim O'Sullivan said that AESIN is integral to the delivery of innovation within the automotive sector. At the same event, AESIN launched its first Automotive Capability Directory showcasing the wealth of talent within the UK.

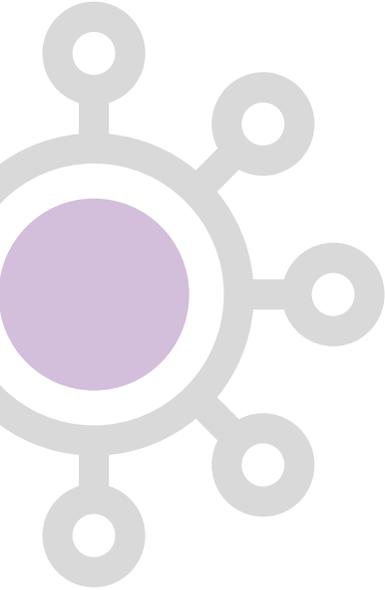
Next year looks like being just as productive with the creation of AESIN's own dedicated R&D board. Headed up by Coventry University, this will be a first for an industry-led group. 2017 will also see the introduction of 'Meet the Innovator' sessions. Run in partnership with KPMG, these will provide SMEs and disruptive companies with expert advice on how to get ahead in the sector.

Power electronics

NMI has been supporting and facilitating PowerElectronicsUK for longer than AESIN has been around. Here too 2016 marked a major milestone.

Recognising NMI's ability to 'make things happen', industry asked us to swap our supporting role for a leading one by taking on responsibility for realising this important cluster's potential. We've since made PowerElectronicsUK our newest, official connected community, with all the benefits that brings.





“NMI BRINGS CUSTOMERS AND SUPPLIERS TOGETHER, ENABLING EACH TO BENEFIT FROM THE OTHER.”

With a formal steering group now in place and the resources of NMI behind it, members can look forward to a renewed focus that will, in turn, deliver positive results. We've already seen the start of this with November's Power Electronic Systems for Future Transport event at Imperial College London.

Moving ahead, we'll be using our close relationship with the Engineering and Physical Sciences Research Council (EPSRC) Power Electronics Centre to build better academic-industrial relations in the space, working with Innovate UK to ensure that the new Compound Semiconductor Applications Catapult meets the needs of the community, and releasing a white paper highlighting industry's other priorities for the future. Yes, there's an exciting year ahead for power electronics in the UK.

Manufacturing Suppliers Network

The UK may be home to a vibrant and diverse manufacturing suppliers community, but that doesn't in itself make it any easier to get products in front of potential customers, especially the big players. NMI brings customers and suppliers together, enabling each to benefit from the other.

On the international stage, we helped members attend Semicon Europa in France in our capacity as a Trade Challenge Partner for the Department for International Trade's Tradeshow Access Programme. The largest microelectronics event in Europe, Semicon Europa gave exhibitors the opportunity to engage and network with over 5,800 engineers, executives and key decision-makers. We also ran targeted table-top exhibitions at Infineon in Dresden and, closer to home, Oclaro in Cambridge, as well as at our Utilities Best Practice event at Diodes and Manufacturing Excellence Conference in Warwick.

Showcasing the capabilities of around 130 companies, specialising in everything from analytical tools to vacuum-related equipment, we also produced our Manufacturing Supplier Directory. An eagerly anticipated

annual publication, 2017's Directory will be available in print and online soon.

Internet of Things Security Foundation (IoT²SF)

New to the pages of the Yearbook in 2016, the IoT²SF got off to a flying start and hasn't taken its foot off the pedal since. By the time of its first anniversary in September, IoT²SF had already attracted over 70 members, ranging from homegrown start-ups to multinationals, and established five working groups to address the priorities agreed by those members.

One of the IoT²SF's chief objectives is to promote knowledge and clear best practice in appropriate security, and here too it made significant progress during 2016. Following the publication of its free whitepaper on establishing principles for IoT security, the Foundation launched a Security Compliance Framework and two sets of best practice guidelines, covering Vulnerability Disclosure and Connected Consumer Products.

Promoting the concept of a Supply Chain of Trust, the IoT²SF developed a 'Best Practice User' mark. Displayed on marketing materials, this is designed to help companies demonstrate that they're aware of IoT security and take their 'duty of care' responsibilities seriously.

Rounding off 2016, the Foundation: appointed its first Plenary Group Chair to lead the implementation of IoT²SF's strategy; entered into a collaboration agreement to put 'security by design' at the heart of embedded computing; and staged its second annual conference. Entitled 'Building an Internet of Trust', the conference attracted over 200 attendees and featured both management and technical tracks.

Looking forward to 2017, the IoT²SF is set to go on growing in size and stature, especially after profile-raising appearances at national and international events, such as



“PROMOTING THE CONCEPT OF A SUPPLY CHAIN OF TRUST, THE IoT²SF DEVELOPED A ‘BEST PRACTICE USER’ MARK.”

Blackhat, DEFCON, CeBIT and ETSI Security Week. There are more best practice guidelines in the pipeline, as well as updates to the existing ones, since part of IoTSF's role is always staying at least one step ahead of the evolving threats.



Technology Scotland

Whether action is required at an international, national or – as with Technology Scotland – at a regional level, NMI does whatever it takes to make things happen.

Established as a joint venture between NMI and the SOA (Scottish Optoelectronics Association) in 2016, Technology Scotland acts as an incubator for enabling technologies clusters north of the Border. Now fully operational, and growing, its core focus is on optoelectronics and photonics. Complementing this, Technology Scotland has established special interest groups in other emerging areas of significant potential, including compound semiconductors and MaaS (Mobility as a Service).

Combining the best of NMI's wider connections with the level of local support and autonomy that regional organisations need, we believe that Technology Scotland provides a blueprint for other joint ventures elsewhere in the UK.

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From manufacturing operations and digital design to packaging, and embedded systems and software, our industry strives for excellence in all that it does. Helping members to reach that goal, NMI has created a portfolio of peer forums and technical networks that enable them to share best practice, stay abreast of the latest developments and network with others who share the same challenges and aspirations.

Manufacturing

NMI's activities are shaped by its members. There's no better example of this than manufacturing. We started the year with a Plant Managers' meeting, followed by a series of one-to-ones to discuss the issues and challenges facing members. These established our priorities for 2016, which we duly went on to deliver.

Sharing best practice and learning from each other – whether through the medium of forums, surveys or conferences – has always been fundamental to the way NMI works. So, in response to members' requests, we increased engagement levels throughout our existing Health & Safety, Facilities, HR, Utilities and Equipment Groups. At the same time, we broadened the scope of our Lean Manufacturing Group to include Business Improvement. Judging by the positive response, there's plenty of appetite for this newly formed Continuous Improvement Group.



“NMI'S ACTIVITIES
ARE SHAPED BY
ITS MEMBERS.”

Although it's not always easy to make the time to attend, members clearly get a lot out of these forums and benefit from the face-to-face contact in a way that isn't possible over the phone or via email. For these same reasons, we re-introduced our popular Supervisor Development Workshop and have more planned for 2017.

Energy is a perennial challenge, so we ran a productive Utilities Best Practice event at Diodes, with speakers from several energy companies in attendance. Close to the top of the agenda was the Climate Change Levy (CCL) and we've delivered a series of workshops and webinars to update on latest policy developments and review reporting requirements for members. Apparently global warming is all a hoax invented by the Chinese though, and such policy measures to support emissions reduction may be subject to future change.

Celebrating our industry's unsung heroes, we staged our annual Manufacturing Excellence Conference at the University of Warwick. Built around the theme of 'Engagement with Cultural and Behavioural Change', this event once again recognised and rewarded the operators, technicians and supervisors personally responsible for delivering manufacturing excellence, but who rarely make it into the limelight.

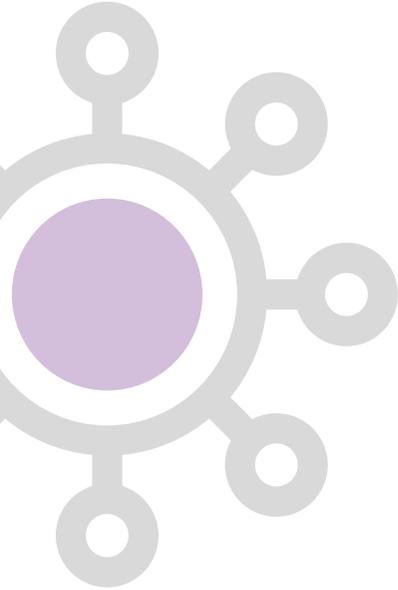
In much the same way, NMI continued to respond to ad hoc requests from members on subjects ranging from environmental compliance to shift patterns. Though not headline-making in itself, this has always been a core part of NMI's offering and remains of real value to members.

Design excellence and industrialisation networks

Keeping an eye out for the next big thing isn't easy when you're already working flat out on the latest breakthrough. Helping to keep members informed and bang up to date, NMI ran a series of cutting-edge network events.



“MEMBERS CLEARLY GET A LOT OUT OF THESE FORUMS AND BENEFIT FROM THE FACE-TO-FACE CONTACT.”



For our Systems and Software network, these included 'Design for Test (DfT) in Changing Markets' with sessions on 'DfT in Millimeter Wave Testing', 'A Method for Yield Debug on New Chips', and 'NMI's Product Realisation Initiative' amongst others.

October's Packaging network event, entitled 'Embedded Device Technology: Disappearing Die – Ember your Chips', introduced members to how embedded die technology can miniaturise, improve performance and reduce cost for applications such as power, wireless and wearables.

Lastly, in November, our Silicon for Systems network event on 'Easy Access ASIC' was hosted by IMEC in Belgium, in partnership with local industry association DSP Valley. The event unveiled the latest thinking on how to develop low cost Application Specific Integrated Circuits (ASICs) for almost any application, taking cost out and improving performance and functionality at the same time.





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"My time as an UKESF scholar has really helped bridge the gap between the fundamentals I've been taught at university and what it takes to be an effective engineer in the workplace."

Robert Eynon, UKESF Scholar of the Year 2014



The **UK Electronics Skills Foundation** connects sector-specific companies with dedicated young electronic engineers

UKESF is addressing the skills challenge in the UK electronics industry by supporting the country's top STEM students and electronic engineering undergraduates through a school programme and university scholarships. With UKESF's help, employers in the electronics sector are able to stay ahead of the game by engaging with young people at school and through university to graduate employment. To find out more and how you could be involved, email info@ukesf.org



"This is the most exciting initiative we've seen to help us nurture the skills that will secure an even brighter future for our business and the UK economy."

Kirsty Gill, Vice President Corporate Human Resources Services, ARM Ltd

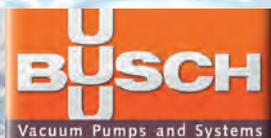
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INDUSTRY COHESION AND LEADERSHIP

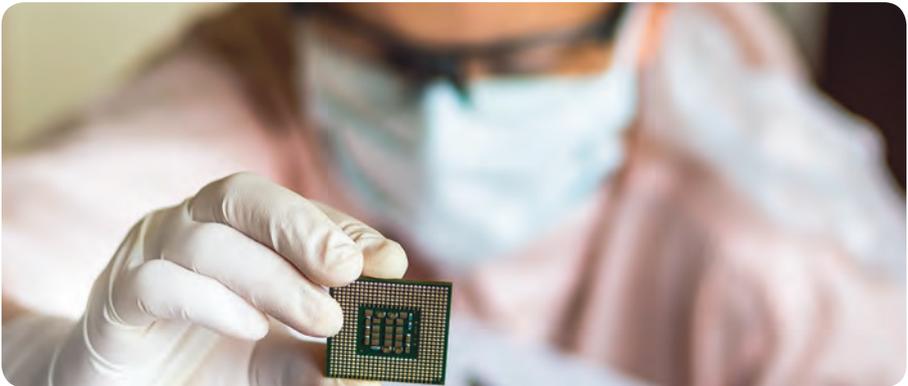
Our industry's diversity may be one of its key strengths, but it's only through acting cohesively and speaking with one voice that we can achieve our common goals. Together, we can influence future policy and investment decisions, respond authoritatively to Government calls for input, and attract the new talent our industry needs to fuel future growth.

Research & Development

One of NMI's key roles has always been to help members grow their business through R&D.

During 2016, we strengthened existing relationships with the main funding bodies, formed new alliances between academia and industry, and laid the foundations for the connected communities of tomorrow.

Building on our already strong links with the EPSRC, NMI established a joint initiative with the University of Southampton. The first initiative of its kind in the UK, Impactech connects the university's research strengths in





embedded intelligent software, autonomous systems and photonics, for example, with our members' development skills, acting as a catalyst for commercial collaboration. Based on Impactech's promising start, we're keen to help other universities make the most of their Impact Acceleration Grants from EPSRC to deliver tangible results and real success.

Working at the leading edge of innovation means always looking ahead. So while NMI continued to act as a dissemination partner for several groundbreaking EPSRC projects, we continually scanned the horizon for the next big thing. Whether that's in an area such as autonomous systems, machine learning, smart energy systems or one that's yet to be discovered, NMI has the necessary skills, experience and proven framework to nurture it, whether that's by creating a new connected community or through other forms of support.

“BREXIT WON'T
DO THE UK'S
ELECTRONIC
SYSTEMS
COMMUNITY
ANY FAVOURS.”

One area where we've done just that is compound semiconductors. Recognising the UK's early capability in this field, NMI had been lobbying for a Catapult Centre that could exploit the undoubted potential. We were therefore delighted when the Government gave the go-ahead for a Compound Semiconductor Applications Catapult Centre, along with £15 million in funding each year.

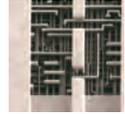
Exciting though these new, uncharted waters may be, we wouldn't be doing our job if we neglected our more traditional members and their specialisms. That's why, on top of all this new activity, we also continued to provide direct one-to-one advice and assistance to members on tailored collaboration and funding support, as well as running events around key research threads, including April's Analog and Mixed Signal Design R&D workshop.

Building on our recent progress in Europe, NMI continued to maintain close ties with like-minded clusters through the Silicon Europe Alliance and European Semiconductor Industry Association. BREXIT won't do the UK's electronic systems community any favours, but we're keeping up a dialogue with our Continental cousins be that through industry associations or NMI-organised events, such as our 'Silicon for Systems: Easy Access ASIC' day run in conjunction with IMEC and DSP Valley in Belgium. European collaboration remains vital for our industry and NMI is determined to develop that with or without Government support.



European Semiconductor Industry Association

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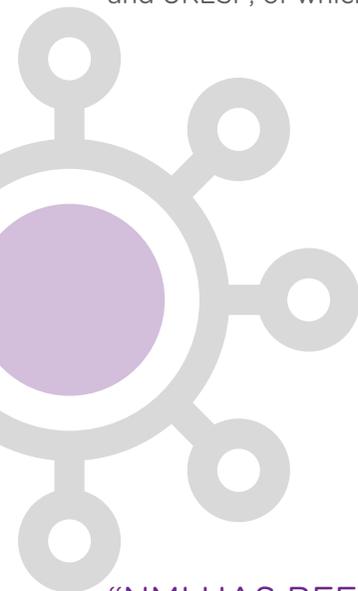
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FUTURE SKILLS

The particular skillsets may have changed as our industry has evolved, but right from day one NMI has been tackling the skills shortage that could still prevent electronic systems from reaching its full potential in the UK. 2016's activities focused on the new Apprenticeship Trailblazer and UKESF, of which NMI is a founding partner.

Following the Government's decision to reform the apprenticeship system as a whole and NMI's successful bid to create the trailblazer programme for our industry, we consulted with members and did exactly that. Now fully approved, we'll be working to ensure that this new standard for a Graduate Embedded Electronic Systems Development Engineer is adopted as widely as possible during 2017.

Complementing this, the Government is introducing an Apprenticeship Levy that will provide even more of an incentive for companies to invest in future skills development. From April 2017, companies with a payroll



“NMI HAS BEEN TACKLING THE SKILLS SHORTAGE THAT COULD STILL PREVENT ELECTRONIC SYSTEMS FROM REACHING ITS FULL POTENTIAL.”



of more than £3 million will pay 0.5% of that payroll into the levy, which can only be spent on training and development provided through approved apprenticeships. While NMI isn't in favour of any additional taxation on industry, we're in the ideal position to help companies work together to develop the standards they need for their future workforce. This will ensure they're able to reap the long-term rewards of the Apprenticeship Levy.

UKESF

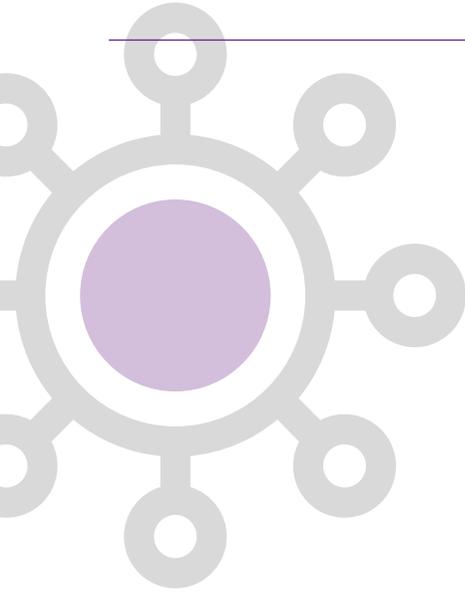
Established in 2010, the UK Electronics Skills Foundation (UKESF) stepped up yet another gear during 2016.

Among the many highlights was the growth in its scholarship scheme. UKESF's flagship programme, the scheme nurtures the talent of tomorrow by offering high-achieving electronics undergraduates scholarships at partner universities. 2016 saw record numbers of applicants, sponsoring companies and partner universities



**UK Electronics
Skills Foundation**





“NEW FOR 2017, UKESF IS EXPLORING INNOVATIVE WAYS TO ENGAGE WITH PRIMARY SCHOOL AND PHYSICS TEACHERS.”

involved, not to mention the award of UKESF's 300th scholarship since the scheme began.

There are no better or more enthusiastic advocates of the programme than the scholars themselves, so with the increasing level of participation, UKESF was able to inspire, engage and enthuse more children than ever before about the opportunities offered by electronics.

During 2016, UKESF also began to address the challenge of gender imbalance within our industry through a series of initiatives specifically targeting girls. Working with the WISE (Women in Science and Engineering) Campaign, for example, UKESF produced the 'People Like Me' campaign, featuring successful female role models from the sector.

Collaboration is key to tackling the skills shortage, so as well as working with WISE, UKESF also strengthened or developed new partnerships with the Institute of Engineering and Technology (IET), the Engineering Development Trust (EDT)/Headstart and Smallpeice Trust.

Towards the end of 2016, UKESF launched a major fundraising campaign at NMI's Gala Dinner, which it's hoped will help the Foundation to achieve its ambitious goals. Over the next five years, UKESF aims to double the number of UK undergraduates studying electronics, to increase the number of female undergraduates by 50%, and for more than 10,000 children to be completing an electronics STEM activity with the Foundation annually.

If you haven't contributed to the fundraising campaign yet, please lend your support to the vital work UKESF is doing in the electronics sector.

New for 2017, UKESF is exploring innovative ways to engage with primary school and physics teachers so that they're able to promote electronics – and the many exciting opportunities it offers – in a more practical and visual way. An event is also being planned to celebrate the fifth anniversary of UKESF's flagship scholarship scheme.



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'Certified by **RoodMicrotec**' concerns certification of products to the stringent ISO/TS 16949 standard for suppliers to the automotive industry. The recently launched Automotive Competence Centre offers dedicated support for customers wanting to supply to the automotive market, from early stage advice & consultancy to full AEC-Q100 qualification and all required Supply Chain Management services.

The company has an accredited laboratory for testing and calibration activities in accordance with the ISO/IEC 17025 standard.

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- eXtended Supply Chain Management* (Turnkey Service) which includes ASIC design services, silicon manufacture, package and test resulting in fully tested parts ready for product manufacture. * Working with business partners as appropriate
- Failure & Technology Analysis
- Qualification & Monitoring Burn-In
- Test & Product engineering
- Production Test (including device programming and end-of-line service)
- ESD/ESDFOS assessment & training
- Quality & Reliability Support
- Consulting

INFLUENCE

One of the biggest changes we've seen over the years is in NMI's ability to communicate the needs of industry to Government, academia and funding bodies effectively. Originally established to support a handful of semiconductor manufacturers, our role has evolved to the point that NMI is now the 'go to' organisation and leading authority on everything to do with electronic systems.

“OUR ROLE HAS EVOLVED TO THE POINT THAT NMI IS NOW THE ‘GO TO’ ORGANISATION.”

Early in 2016, we were delighted to see one of the initiatives we had lobbied hard for coming to fruition. The Catapult Centre for Compound Semiconductor Applications will capitalise on the UK's strengths in this area and NMI is keen to explore how it can support the centre's development.

2016 also saw the formation of a new Government. NMI was quick to engage with its representatives, participating in a consultation on industrial strategy, and we look forward to redeveloping Ministerial connections with the new team. Helping us to do that and ensuring that our industry's voice is heard loud and clear will be the new Chief Executive of ESCO, Tony King-Smith.

We don't just want to represent and promote our members' interests within the UK though. Maintaining vital business to business connections beyond our shores, NMI also strengthened links with mainland Europe through the Silicon Europe Alliance and European Semiconductor Industry Association.

Whether we're lobbying the Government for more funding, shaping the future of the power electronics community or rolling out the Electronic Systems Apprenticeship Trailblazer with which we've been entrusted, you can be sure your industry is in safe hands.

CELEBRATING 20 YEARS OF SUCCESS

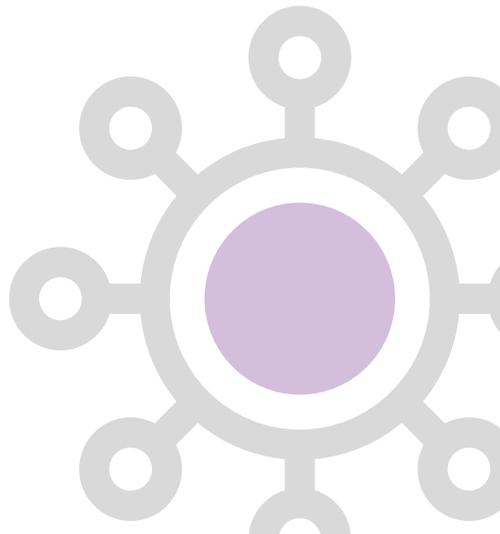
The social highlight of the year, NMI's Annual Awards and Gala Dinner is always a special occasion because it provides a rare opportunity to review how far our industry has come over the last 12 months.

Celebrating not just one but 20 years of success, 2016's event was bigger and better than ever. Around 400 executives and professionals came together to recognise the achievements and behaviours that are conducive to a healthy and vibrant industry in the UK and Ireland.

Congratulations to all the winners – including Company of the Year Renishaw, Innovation Award Winner Ultrahaptics and Emerging Technology Company of the Year Senseye. You can see all of 2016's Award Winners on pages 32-35. A big thank you also to everyone who attended for marking NMI's 20th anniversary in such style.



“NMI'S ANNUAL AWARDS AND GALA DINNER IS ALWAYS A SPECIAL OCCASION.”



CONCLUSION

As NMI celebrates this, our 20th anniversary, we realise we couldn't have done it without you. It's only thanks to the continuous support from our members and other supporters that we're where we are today. By the same token, we'd like to think – and hope you'll agree – that the industry wouldn't be in the shape it is today without NMI.

Run by and for industry professionals, NMI has spent the last two decades securing our industry's future and representing the interests of our members. Times and the make-up of the industry may change, but we hope you'll continue to support us in the same way that we're going to continue doing everything we can for you.

We've all come a long way but the best, as they say, is yet to come.

“THE INDUSTRY WOULDN'T BE IN THE SHAPE IT IS TODAY WITHOUT NMI.”



ANNUAL AWARD WINNERS 2016



NMI Awards 2016



THE YOUNG ENGINEER OF THE YEAR AWARD

Winner: Keno Mario-Ghaer,
Imagination

Award Sponsored by: ARM



L-R: Ian Phillips (ARM), Keno Mario-Ghae
(Imagination Technologies)



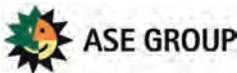
THE INNOVATION AWARD



L-R: Sebastain Leguizamon (ASE), Matt Booker (ASE),
Steve Cliffe (Ultrahaptics), Patricia MacLeod (ASE)

Winner: Ultrahaptics

Award Sponsored by: ASE Group



THE PRODUCT OF THE YEAR AWARD



L-R: Hans Kemper (Maser Engineering), Miriam Evans (XAAR),
James Pattison (XAAR), John Parkes (XAAR) and Kees Revenburg
(Maser Engineering)

Winner: XAAR

Award Sponsored by: Maser Engineering





THE RESEARCH COLLABORATION AWARD

Winner: Ultra Electronics

Award Sponsored by: Science & Technology Facilities Council



L-R: Mark Willoughby (STFC), Bob Hunt (Ultra Electronics)



THE SILICON TO SOFTWARE DESIGN AWARD

Winner: Cascoda | Vertizan

Award Sponsored by: Synopsys



L-R: Alec Vogt (Synopsys), Bruno Johnson (Cascoda), Ross Addinall (Vertizan) and Sean Redmond (Cascoda)



THE MORE THAN MOORE AWARD

Winner: Sequans Communications

Award Sponsored by: Cadence



L-R: Chris Malkins (Sequans Communications) and Alan Runcie (Cadence)

NMI Awards 2016



THE AUTOMOTIVE ELECTRONICS INNOVATION & EXCELLENCE AWARD

Winner: Fusion Processing

Award Sponsored by: Mentor Graphics



L-R: Jim Hutchinson (Fusion Processing) and Andrew Paterson (Mentor Graphics)



THE UNIVERSITY RESEARCH GROUP OF THE YEAR AWARD



L-R: Soroush Faramehr (University of Swansea), Petar Igic (University of Swansea) and Chris Firth (Thales)

Winner: Swansea University, Electronic Systems Design Centre

Award Sponsored by: Thales



THE MANUFACTURING SITE OF THE YEAR AWARD



L-R: Gerry Thurgood (Thermco), David Ogden (Diodes) and Ian Sharp (Thermco)

Winner: Diodes Incorporated

Award Sponsored by: Thermco Systems





THE EMERGING TECHNOLOGY COMPANY OF THE YEAR AWARD

Winner: Senseye

Award Sponsored by: Kore



L-R: Anna Murdoch (KORE Wyles) and Alex Hill (Senseye)



THE MANUFACTURING SUPPLIER OF THE YEAR AWARD

Winner: KMG

Award Sponsored by: Oclaro



L-R: John Harries (KMG Ultra Chemicals) and Steve Reilly (Oclaro)



THE COMPANY OF THE YEAR AWARD

Winner: Renishaw

Award Sponsored by: IC Resources



L-R: Peter Leonard (Renishaw) and Steve Anderson (Renishaw)

Congratulations to all the winners of the NMI Awards 2016



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Andrew Patterson
Mentor Graphics

ENABLING CONNECTED CARS FOR AN INTEGRATED TRANSPORT SYSTEM



We have achieved almost 100% connectivity between people via SmartPhones, and now it's the turn of the automotive industry to define the best ways to connect vehicles to each other and to roadside infrastructure. New threats concerning occupant safety and security have meant that car makers are proceeding cautiously.

RESPONDING to the rapid growth of the automotive electronics market, NMI set up a dedicated Innovation alliance for automotive electronic systems called "AESIN (Automotive Electronic Systems Innovation Network)". It is estimated that 90% of automotive innovation now involves software and electronics, and AESIN alliance members are responding to this challenge by setting up centres of excellence in areas such as ADAS, Powertrain and Security to name a few. One current project is based on the real-time transmission of safety-critical information into vehicles from road-side infrastructure (V2X), which is further discussed in this article.

ADAS and V2X technologies can dramatically reduce many accidents caused by driver error, and environmental "surprises" – technology can be used to warn drivers of problems ahead, and give them time to react. With the 2020 European road safety goals of below 15,700 fatalities and a longer term vision for zero road fatalities in mind, vehicle manufacturers are already designing-in technologies that will play an essential role in road-traffic safety.

INTELLIGENT TRANSPORT SYSTEMS (ITS)

A key component of this automotive safety initiative, is an Intelligent Transport System (ITS). There are many components to an ITS – ranging from the systems within the vehicle such as navigation, traffic signal alerts, parking guidance, real-time road information, weather updates, to external cloud based resources which aggregate data from vehicles and the environment. Outside the vehicle, the wireless infrastructure has to be capable of communicating with all vehicles in range, and pass back data in real-time,

**"IT IS ESTIMATED
THAT 90% OF
AUTOMOTIVE
INNOVATION NOW
INVOLVES SOFTWARE
AND ELECTRONICS."**

that is position-relevant to that vehicle. If there are road-works on the opposite carriageway to the direction of the vehicle, that has less relevance than a line of traffic stalled half a mile ahead. Data available from vehicles can be transmitted to a cloud-based server for fusion and processing. Crowd-sourced event-detection such as rain (multiple wiper activity) and congestion (frequent braking activities) can then be communicated back to individual vehicles as a driving recommendation.

In November 2016, the European Commission adopted an agreed strategy on Cooperative Intelligent Transport Systems (C-ITS), aimed at cooperative, connected and automated mobility. The objective of the C-ITS Strategy is to facilitate the convergence of investments and regulatory frameworks across the EU, in order to see deployment of mature C-ITS services in 2019 and beyond.

THE STAKEHOLDERS

Many parties will benefit from safer vehicles which can communicate with each other and the cloud.

Car makers need to provide features that sell cars, and also meet their obligations on safety, security and reliability to avoid expensive downstream litigation and loss of brand-value. The car owner will care about personal safety, ADAS features to make driving easier and safer. They will also care about the cost of any wireless data services, and how well they work in different geographic areas. Drivers will want to know that their data is secure and safe from any denial-of-service attacks, or uninvited use of their vehicle and personal data.

Highways agencies are interested in connected vehicles as a way of crowd-sourcing traffic

“HIGHWAYS AGENCIES ARE LOOKING FOR MEANS TO STREAM UP-TO-DATE TRAFFIC INFORMATION.”

information, and making the highways safer. In a world where there may eventually be many millions of connected autonomous vehicles, highways agencies will want to be able spread driver journeys across available highway capacity. Already, highways agencies are looking for means to stream up-to-date traffic information from gantries and road-side equipment into vehicle electronics systems.

Network providers also have a large vested interest in connected vehicles: Alongside the Internet-of-Things (IoT), car connectivity is a lucrative source of new customers, all needing high-bandwidth data plans. How will these plans be shared with existing personal smart-phone plans? Not many of us will want to pay a lot more for additional data usage, however network service providers will need to recover their investment in spectrum bandwidth and infrastructure.

THE CITE PROJECT

The UK Connected and Intelligent Transport Environment (UK CITE) that NMI and AESIN are involved in, creates a real-world-laboratory for companies to evaluate how connected and autonomous vehicles (CAV) can interact with

communications infrastructure. The project will install wireless transmitters along sections of the M42, M40, A45, A46 and Coventry city centre. This test environment will be available to vehicle manufacturers or fleet users who wish to test new V2X technologies, and will act as a world class research asset to attract R&D to the UK.

An early goal of the project is to maximise the connectivity options for each vehicle, so automotive supplier Visteon has designed a modem that can support WiFi, DSRC and embedded cellular capabilities and automatically tether to the strongest signal. Additionally, communication through a smart-device is enabled, as most drivers and passengers will have these available in vehicles.

The equipped test vehicles will examine the impact of V2X on road safety, and traffic flow and provide an alternative to information provided via overhead road gantries. Secure communication will be a priority from the outset. The impact on the UK road network will be estimated based

on these trials – enabling the UK to get the most benefits from CAV for the least infrastructure cost. Mentor Graphics is providing Linux-based in-car head-units, that will coordinate the acquisition and display of this information for vehicle occupants.

COMMUNICATION TECHNOLOGIES

Smart Device integration is expected on a new vehicle these days, and allows the driver to instantly have access to contacts, music, video and favorite apps, as well as making use of the smart device connectivity to 4G/LTE networks. Smart-Devices are unable to provide the right connectivity in isolation, and Embedded Modems will increasingly be used by manufacturers, allowing the full range of data communication needed by a connected car. Embedded Modems offer car makers several additional capabilities, including WiFi hotspots, and can fulfil needs related to emergency services requests (e-Call), and provide internet streamed concierge services to drivers and passengers.

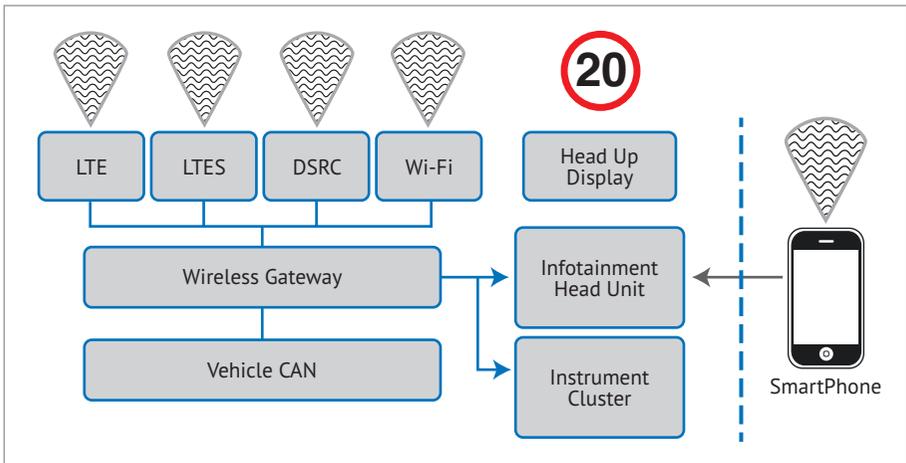


Figure 1: Choice of Communication Interface Technologies for vehicles

Join us at the National Motorcycle Museum for our one-day conference dedicated to professionals and leaders.

The AESIN Annual Conference 2017 will provide insight into the latest thinking from Industry leaders and champions and will offer your company the opportunity to engage in UK programmes driving the automotive revolution enabled by electronic systems.

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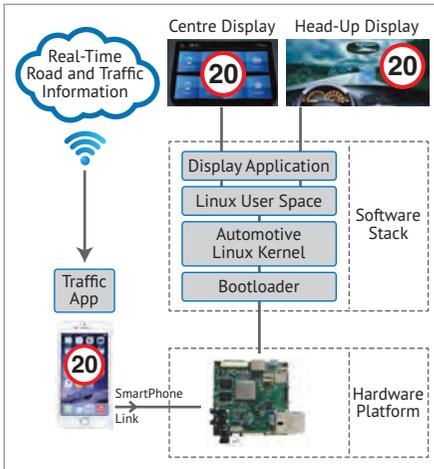


Figure 2: Display Architectures for in-vehicle V2X

Wireless services appropriate for connected cars include:

- Dedicated Short-Range Communications (DSRC) providing communications between the vehicle and the roadside in specific locations.
- Wireless Communications Systems dedicated to Intelligent Transport Systems and Road Transport and Traffic Telematics will provide network connectivity to vehicles and interconnect them.
- Continuous Air interface Long and Medium range (CALM) provides continuous communications between a vehicle and the roadside using a variety of communication media, including cellular, 5 GHz, 63 GHz and infra-red links. CALM will provide a range of applications, including vehicle safety and information, as well as entertainment for driver and passengers.
- Mobile Phone service providers, with 4G and coming 5G network coverage.

The end result is a choice of wireless interfaces to the vehicle, with priority messages received and passed to real-time displays such as the

ABOUT THE AUTHOR

ANDREW PATTERSON MENTOR GRAPHICS

Andrew Patterson is the Market and Business Development Director for Mentor Graphics Embedded Software Division. The division has a specific focus on automotive software and electronics, and Andrew has led many of the recent product initiatives in this area, working with Linux and RTOS solutions on a range of silicon platforms. Prior to Mentor, Andrew spent over 20 years in the design automation market specialising in technologies including wire harness design, automotive simulation model development, virtual prototyping, and mechatronics. Andrew holds a master's degree in Engineering and Electrical Sciences from Cambridge University, UK.

Infotainment Head Unit (IHU), Instrument Cluster, and Head-Up Display (HUD). The overall system diagram is shown in Figure 2 above.

CONCLUSION

Vehicles are already part of the internet of Things (IoT), and road safety will be greatly improved with the benefits of an Integrated Transport System, and real-time communication of safety-critical traffic information. NMI and AESIN are helping to drive research in this area by pulling together expertise from their members, and will see this technology tested on UK Motorways as part of the CITE project.



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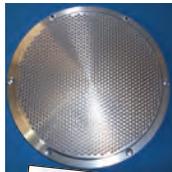
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EDA Solutions Founder and CEO

PACKING A PUNCH FOR SYSTEM HOUSES



WHY ASICS ARE SYSTEM HOUSES NEW BEST FRIEND

As the millennium was ushered in, Moore's Law was in full swing. The acronym SoC (System-on-Chip) was on everyone's lips. And if the business term Unicorn had been imagined back then, it would be the fabless chip start-up guys who would be aspiring to it.

Fast forward to today and VC funded chip start-ups in Europe are almost non-existent, Moore's Law is grinding to a halt and Fabless is a dying term.

A NEW BAND OF INNOVATORS

At the same time, working away in the wings a band of engineers are realising the benefits of ASIC (Application Specific Integrated Circuit) and innovating in their world. Companies developing systems with electronics at their heart find themselves in a new era with exciting options opening. Some are large corporations and some are the SMEs who are the work horse of UK industry and a significant portion of the NMI membership.

"We use high voltage, mixed signal ASICs in our printhead products. Highly optimised designs implement innovative algorithms and signal conditioning techniques that extract full performance from our leading-edge MEMS actuators. ASIC technology is key to Xaar's delivery of industry leading print productivity and image quality, at the right cost."

Nigel Heather,
Head of Program
Management, Xaar



The list of niches benefiting from the new era is lengthy. Medical imaging and telehealth sensing, automotive, industrial control, oil and gas exploration, home automation, printing and everything which comes under the IoT collective. And the list goes on.

Companies developing product relying on electronics which:

- sense something in an environment,
- make decisions and provide control,
- communicate data, actuate other devices are constantly impacted by market forces demanding them to be ever more competitive.

The Product Manager is kept awake at night because the product:

- has a lengthy bill-of-materials of components which ought to be cheaper,
- needs to be faster,
- make more intelligent decisions,
- perform to specialist set of criteria,
- is battery operated and needs to use less power,
- is too large.

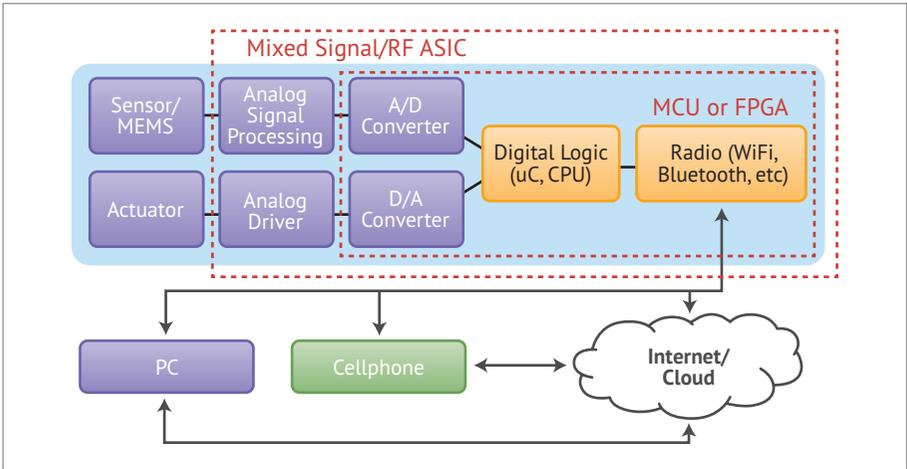


Figure 1: A typical IoT device

Integrating component parts into a chip reduces the BOM, can integrate processor unit for intelligence, is designed for specific specification, with a low power budget and consumes an undoubtedly smaller footprint.

“SWINDON Silicon Systems have been designing, testing and supplying high performance low cost mixed signal ASICs, including integrated MEMS pressure sensors, for five decades. We focus on the automotive and industrial markets.

Every year we see a higher diversity of applications that are using mixed signal ASICs. There is an important reason for this trend: competitive market forces.

Implementing a solution in an ASIC successfully, enables companies to differentiate their product for their chosen market and gain a competitive edge.”

Richard Mount, Director of Sales & Marketing, SWINDON Silicon Systems



And in sensitive markets or where there is risk of cloning, protecting intellectual property in a chip goes a long way to securing your design and is an attractive concept.

For example, UTC have successfully developed a number of MEMS based sensors with associated ASICs creating a range of low cost, high performance devices.

Our latest project was a MEMS based accelerometer plus ASIC. The ASIC route was selected to provide lower power consumption, lower cost and higher integration to provide a single chip accelerometer. Another significant reason was to achieve higher performance through close coupling of the MEMS with custom designed control.

The low cost mixed-signal design tool allowed the internal development of the ASIC alongside the MEMS and was key to achieving the best overall design. Low cost tools have significantly enhanced the overall design flow. SPICE domain co-simulation of the analogue with digital

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The low cost mixed signal design tools allowed the internal development of the ASIC alongside the MEMS and was key to achieving the best overall design. Low cost tools have significantly improved over the years with additions to enhance the overall design flow. SPICE domain co-simulation of the analogue with digital circuits can be a particular area of concern due to the excessive simulation times. However, tool improvements in this area helped us minimise risks prior to committing to the fabrication stage.

**Mike Durston, Consultant Electronics Engineer,
Sensors & integrated Systems,
UTC Aerospace Systems**



UTC Aerospace Systems

Where ingenuity takes off

circuits can be a particular area of concern due to the excessive simulation times. However, tool improvements in this area helped minimise risks prior to committing to the fabrication stage.

**Mike Durston, Consultant Electronics Engineer,
Sensors & integrated Systems**



UTC Aerospace Systems

Where ingenuity takes off

MORE-THAN-MOORE FOR LESS THAN YOU THINK

Shrinking a component based design into an ASIC can be economically competitive even for modest volumes. A mixed-signal ASIC is a perfect option for systems which need a range of components:

- Analog interfaces to real-world sensing and/or actuating.
- A micro-controller.
- Power management.
- Memory.
- Connectivity or wireless communication.

The non-digital functionality does not necessarily scale according to Moores Law but they do provide their own special value. Such devices are often called More-than-Moore¹ (MtM) devices and can incorporate MEMS sensors, RF, logic, analog, HV etc.

Stating an absolute cost analysis is beyond the scope of this article. The answer is always specific to the case in point. Actual manufacturing process choices, IP selection, tool requirements compared to original BoM costs etc., etc. However, EDA Solutions have seen examples where production volumes as low as 10,000 units per year yielded a break-even after 2 years comparing the board solution to their ASIC approach.

A CASE IN POINT - AN IIoT (INDUSTRIAL INTERNET OF THINGS) ASIC EXAMPLE

S3 Semiconductor Solutions has been delivering ASICs targeting the industrial and instrumentation segments for quite some time,

¹ Read about More-than-Moore in a white paper by ITRS (International Technology Roadmap for Semiconductors) www.itrs2.net/uploads/4/9/7/7/49775221/itr-its-mtm-v2_3.pdf

leveraging from its silicon proven mixed-signal IP together with its experience at integrating embedded processors. Included here is an example of one such ASIC developed for a specific customer operating in the industrial control market where low power consumption, remote deployment, reduced production costs and low development risks were key. The solution included a low power implementation of an ARM™ Cortex-M4, PIC microcontrollers, sensor interface AFE (analog-front-end), memory and industrial communication interfaces such as FOUNDATION fieldbus, Profibus and HART.

Using a mature cost effective 180 nm mixed-signal CMOS process, the digital system was fully integrated with a customised analog front-end consisting of:

- 2 integrated 12 bit DACs for actuator control.
- Integrated 14 bit low-power SAR ADCs, coupled to a switch that allowed up to 16 separate sensors to be independently interrogated.
- A variety of interfaces to on-board circuit elements (multiple SPI, UART, I2C and Parallel).
- Temperature sensor for measurement of on-chip temperature.
- Custom PWM.
- 2 types of Timers.
- High-performance Op amps, Analog switches/muxes.
- Clock gating of logic and power gating of RAM and ROM.
- Designed to run off 2.7 and operate from a 4-20mA control loop.
- Low power design: 160uW/MHz.

Significantly, the electronic bill of materials was reduced by up to 90% due to the level of integration onto the SoC of the discrete components that would otherwise have been used. In addition, with the incorporation of a customised SoC, it lead to an optimised total

solution, whilst allowing for additional customer defined differentiating features that otherwise would not have been possible with a discrete solution consisting of off the shelf components. Performance was enhanced due to better signal integrity at a chip level, without compromising on excess power or the cost associated with equivalent discrettes. Due to the reduction in total bill of materials, the overall system reliability and yield were hugely enhanced.

Newcomers to the MtM ASIC solution do face challenges and the second half of this article addresses these commonly cited concerns:

- Access to silicon manufacturing.
- EDA design tool complexity and support.
- IP availability.

MANUFACTURING – HIGH YIELDS AND SHARED COST OPTIONS

As foundries forged new advances to manufacture leading edge chips, the technology platforms they developed stacked up on the road side. Leading foundries are eight nodes on from 180nm which is generally regarded as the standard node for MtM devices. The 180nm process went live at the turn of the century with improved performance and mixed-signal capabilities being injected by mid 2000s. The result is a reliable, stable, high yielding process often with amortized plant with competitive pricing as foundries strive for full utilisation.

Costs and risks in mask and wafer production can be reduced by using multi-project wafer (MPW) services from organisations such as Europractice. Where small quantities of chips are needed for evaluation/qualification, or small production runs, several designs can be incorporated in a single mask set. Customers typically order 40 devices for evaluation before going to the expense of a dedicated mask set, but up to 1,000 devices

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 ASICs **Industry** Foundry Services
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 Automotive Active Noise Cancellation
Communications
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Sensors
 Automotive Wireless Connectivity
Spectral Sensing
 CMOS Imaging Sensors **Communications**
Consumer Active Noise Cancellation
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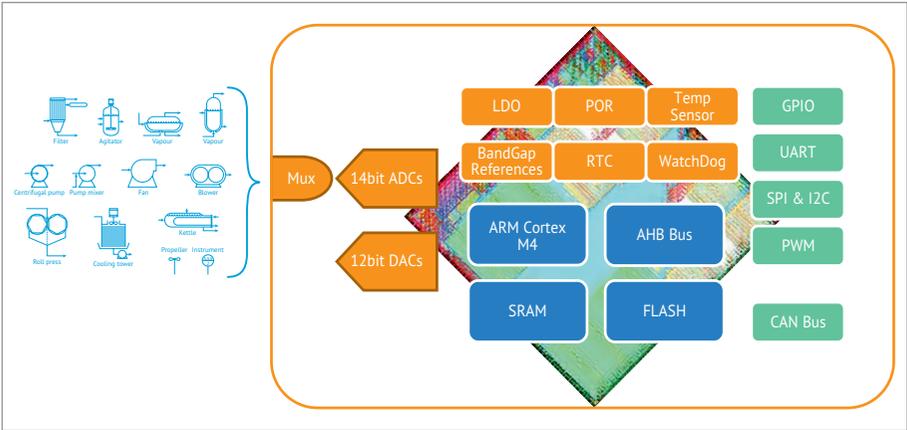
Our state-of-the-art facilities range from chemical vapour deposition (CVD) growth of silicon carbide (SiC) epitaxial material, all the way to the production of devices in our semiconductor fabrication and packaging cleanrooms. We conduct research in areas such as:

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- Design of smart grids and communication technologies for electricity networks



www.warwick.ac.uk/peater/





of any one design could be produced in a single MPW run.

MPW costs are just a fraction of those needed for complete set of dedicated masks and wafers, as customers only pay for the proportion of the wafer that their devices occupy. At NMI's November 2016 Silicon to Systems² event imec quoted a MPW run cost of €16k for 45 samples (2.5mm²) on 180nm process.

“Each year X-Fab works with more system companies designing analog mixed signal ASICs for use in their own electronic products. In 2016, we saw more than 500 design starts and, to give you an idea of variety, we have over 1,500 unique devices in production. The ICs are taken to market across a broad range of industry including automotive, industrial product, medical device and communications. Some chips are very high volume and there also many at smaller production volumes but with longer product life cycles.”

Ulrich Bretthauer,
Business Line Manager
Industrial & Medical,
X-FAB Silicon Foundries



SOPHISTICATED EDA DESIGN FLOWS

EDA Solutions has been a partner for Tanner EDA IC design solutions in Europe since 2001. The Tanner team prided themselves on providing easy to use technology and being a price performance leader to companies designing the range of devices collectively known today as MtM.

In 2015, Tanner was acquired by Mentor Graphics. Mentor immediately set out to help lower the barriers to entry for the low cost ASIC arena. The first step was to integrate their industry leading Calibre tool into the Tanner tool suite packaged and priced for the Tanner market.

Business models for Tanner software differs from other big players in the EDA world. Tanner is typically purchased on a “perpetual basis”. The cost is fixed and the license to use the software lasts forever. Customers value the assurance that they can review and respin a design any time in the future. Most customers

² 28/11/16 Silicon to Systems : Easy Access ASIC <https://nmi.org.uk/silicon-to-systems-easy-access-asic/> Keynote 1: Low cost pathways to volume production for CMOS ASIC and photonic ICs.

also invest in support options which enables licenses to be upgraded to stay in lock-step with the latest version of the design software. A minority of customers choose a rental license valued for peak usage requirements or for flexibility in financial management. Both models have their benefits and the choice depends on the customer requirements.

In recent years' another improvement has also opened to clients of the ASIC value chain. Open Access which originated in 1999 is a mechanism for interoperable IC design tool flows. The effort unlocked one of the challenges for foundries of providing their PDK's (process design kits) in a neutral format. PDK's are time consuming to create and verify. Specifying a process without the appropriate PDK for a company's tool flow carried a high CAD development cost. With Interoperable PDK support, foundries could more efficiently support all tool vendors. And for a company selecting a fab and process, the risk of not having access to a suitable PDK is significantly reduced.

READILY AVAILABLE, BEST-IN-CLASS IP

Semiconductor intellectual property (IP), a reusable unit of functionality, entered the commercial market in the '90's. By 2000 the IP industry was established and consequently as the 180nm manufacturing came online availability and quality of IP for this node was on the rise. Skip to today and there are significant analog and digital IP libraries for MtM process nodes with a proven history of silicon production.

Chips with an embedded element or an IoT set of requirements will need a processor. In 2016 ARM® announced a special platform called DesignStart™³ to support the low cost chip

ecosystem enabling users to create a custom system based around Cortex-M0. The Cortex M0 processor is suited to applications in sensor, control, mixed SoCs, IoT. It's the smallest footprint ARM 32 bit processor with low gate count and importantly low power. Through the DesignStart™ program clients can register for free expedited access to chip tooling with Mentor Graphics for evaluation. ARM have in place a fast track license program for when the design is ready for the commercial stage. Scroll back just a year or so and this step alone offers a quantum leap for a system house or an organically funded start-up to accelerate their time to market with reduced, controlled costs.

LANDING THE PUNCH

In the world of system houses, there's a growing demand to design ASIC's. The route to producing an ASIC is sophisticated but there is twenty years plus of amassed knowledge and processes on hand. If there's one barrier to exploring the ASIC route which shouldn't defeat you, it's the eco-system. Each part of the eco-system is strong and capable. Combined they open the door to possibilities for pragmatic solutions to business and technical pressures. More than that, they enable creative options to give your company a truly competitive edge.



IIoT case study contributed by
Darren Hobbs
Director of Product Management



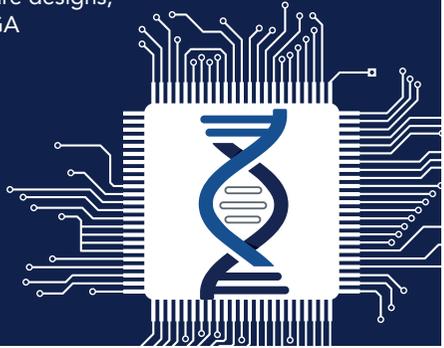
³ ARM DesignStart™ <https://www.arm.com/products/designstartx>

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John Moor
Managing Director
IoT Security Foundation

BIG IDEAS: IoT AND THE SUPPLY CHAIN OF TRUST



It wasn't so long ago that we used to refer to the Internet of Things (IoT) as the quiet revolution. More recently, IoT has hit peak hype and attracted a great deal of attention from the media, as analyst and vendor forecasts have been somewhat optimistic. Regardless of what you think of the bulging numbers and the speciation of IoT products, platforms and services being announced, it is clear to see that the rise of connected "things" and the low costs of technology, are creating disruptive forces throughout all industrial sectors, the effects of which are felt in virtually all corners of modern life. Not all those 'effects' are welcome however.

TECHNOLOGY is dual purpose, it can be used for good, yet it can also be used in nefarious ways, exposing unwelcome threats. With IoT, security is a top 3 challenge and is now moving to a board room agenda. Applications are typically composed of many moving parts; devices, gateways, networks, sensors, actuators, storage, compute, software, people and so forth, much of which is impossible to guarantee in action. The familiar adage that 'complexity is the enemy of security' and 'security does not compose' is ever real in the era of IoT.

Conceptually and practically, IoT is moving in the opposite direction to where the security experts would like it to be, and it's moving at an accelerating rate. If this wasn't challenge enough, cost, convenience, lack of security standards, questionable ethics, the threat of heavy handed regulation and blunt law, combine to create the dynamic of the 'IoT wild west'. From an industry perspective, we have to think carefully about our outputs and our relationships. We have to resist the urge to abandon best practice in pursuit of quick, short-term profits.

Security is often described as an arms race and perfect security is asymptotic. We begin with the technical aspects of course but that is not, and will not be sufficient. The IoT industry will need to develop new working practices across convergent groups whilst new cultures evolve. Supply chains will also need to collaborate in effective ways to avoid the vulnerabilities that exist between organisational boundaries and promote a duty of care towards the customer

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THE OPPOSITE
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WHERE THE SECURITY
EXPERTS WOULD
LIKE IT TO BE."**



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CONFERENCE 2017

5th December

Sauvoy Place - LONDON

The 3rd IoTSF Conference is a one-day event and follows on from the 2016 *Building an Internet of Trust* Conference at IET Sauvoy Place, IoTSF Conference 2015 held at the Royal Society and the original IoT Security Summit at Bletchley Park.

Beyond scare stories; the conference will further promote IoTSF security values and look at what it takes to build trust into IoT.

iotsecurityfoundation.org

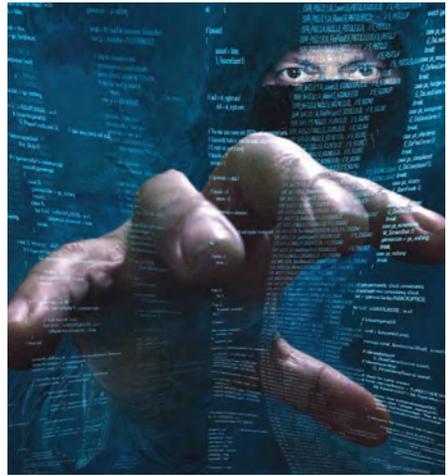
“WE’RE UNDER CONSTANT ATTACK WITH MORE AND GREATER THREATS ENABLED BY IoT ZOMBIES.”

throughout. This is crucially important – adversaries will test defences for weakness across the entire system and often only needing one flaw in the armour to get their intended payload. We need a supply chain of trust.

THE STATUS WITH IoT TODAY IS VARIABLE

Whilst some parts of the IoT industry are quite robust, certain segments are woefully inadequate and certainly not fit for purpose. With cyber-crime on the increase and IoT attracting more and more attention, there is now significantly more at stake than financial fraud and industrial espionage. It is not an overstatement to say that with hyper-connected systems, the potential for sabotage in our critical national infrastructure could threaten us more substantially – even physically.

Take a cursory look at the media and you’ll see it is not difficult to find IoT scare stories in the news – in fact, they’re rife. A short overview such as this cannot do it justice however we’ve selected a few examples to provide flavour: The story of the year in 2015 was arguably the Jeep Cherokee hack (www.wired.com/2015/07/hackers-remotely-kill-jeep-highway/). Other connected car hacks also exist – for example the Tesla (see Marc Rogers talk here: [https://iotsecurityfoundation.org/iot-security-](https://iotsecurityfoundation.org/iot-security-conference-2015/)



conference-2015/) and the Mitsubishi Outlander (ref: www.bbc.co.uk/news/technology-36444586). At the other end of the ‘thing’ scale, lightbulbs have the potential to compromise your home network – in July 2016 vulnerabilities were discovered in the Osram Lightify range (www.bbc.co.uk/news/technology-36903274). And poorly secured IoT devices are already being zombified, amassed into armies and turned against specific targets. In the final quarter of 2016 Brian Krebs, a high profile security blogger, had his website taken down by a 620 Gbps distributed denial of service (DDoS) attack from IoT devices. That episode was almost immediately eclipsed by an attack on

a French hosting firm (OVH) with a malicious datastream that peaked at over 1 Tbps. And as I write, the emergence of the Mirai and Bashlight malwares are competing for poorly secured devices to create even bigger bot armies that target centralised internet services such as DynDNS. The DDoS trend is clear, we're under constant attack with more and greater threats enabled by IoT zombies.

The rise in ransomware is also beginning to target IoT devices as this scales beautifully as a criminal business model. These have also been accompanied by dubious behaviour in 2016; one grey hat organisation deliberately targeted a medical equipment company's share price and monetised a vulnerability report via short-selling the stock (www.theregister.co.uk/2016/09/07/st_jude_sues_over_hacking_claim/).

SOMETHING NEEDS TO CHANGE - AND FAST

Many of these reported issues could be avoided in relatively simple ways as certain vendors are making it easy for the hackers and criminal gangs. In far too many cases, these attacks are

possible because even the most remedial of precautions have not been attended to, (ahem) default passwords, (ahem) hard coded passwords, (ahem) no encryption – clear text format. This really is 101 stuff, as David Rogers, CEO of Copper Horse Solutions says 'we can't carry on like this'.

Stop already! Finding hacker stories is easy and by itself, provides a sense of the scale and scope of the problems. Spreading fear, uncertainty and doubt is also easy but ultimately not very helpful. We are engineers, we are technologists, we are entrepreneurs and we need to act.

“CERTAIN VENDORS ARE MAKING IT EASY FOR THE HACKERS AND CRIMINAL GANGS.”



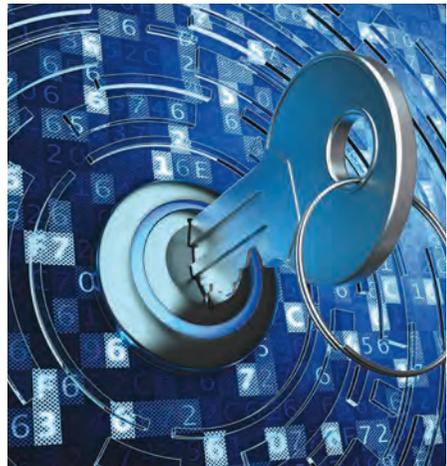
“WE NEED TO ACKNOWLEDGE THE PROBLEM, UNDERSTAND THE THREATS AND MAKE INFORMED DECISIONS TO MANAGE THE RISKS AT EVERY LEVEL.”

We need to acknowledge the problem, understand the threats and make informed decisions to manage the risks at every level. We need to provision defences in depth and given the ‘many moving parts’, our efforts need to be co-ordinated.

WHO OWNS THE PROBLEM AND HOW DO WE START TO SOLVE THE CHALLENGES OF SECURITY IN IoT?

In short, we all do – we all have a role to play – yet it needs to be coordinated to be effective. On September 23rd 2015 the IoT Security Foundation (IoTSF) was launched as a non-profit organisation seeking to meet the bigger picture challenges of IoT security head on. Its objective is to catalyse change, by working collaboratively to deliver accessible, actionable and low cost (i.e. free) best practices to industry. And that’s just for starters. Whilst cyber security is very advanced in certain quarters, the pressing and immediate issues in IoT are significantly more remedial and we must start with basics. We have to level the bar and then raise it from almost zero assurance levels (in some sectors) then ratchet upward from there.

Within the big picture context, IoTSF started the practical work by creating 5 priority working groups with its founder members



(<https://iotsecurityfoundation.org/working-groups/>). Each group tasked with producing high quality guidance which is easily consumed by industry – i.e. minimum resistance. Those priority groups are:

- **Security Framework** – a structured approach to implementing security measures. This aims to be easy to adopt, have minimal cost/overhead and applicable to any organisation in the IoT supply chain.
- **Connected Consumer Products/Smart Home** – the unregulated consumer space was prioritised for guidance due to the acuteness and volume of reported issues.

- **Vulnerability Disclosure** – a template and guidance documentation to help connected product organisations setup the mechanisms to be ‘vulnerability-ready’.
- **The IoT Security Landscape** – reference architectures which map sector implementations and inform the vulnerability areas/points of attack.
- **Patching Constrained Devices** – a consideration of what is required to patch and maintain the hygiene of resource constrained IoT devices.

Each of these work groups support the security principles of:

- Security First Approach.
- Fitness of Purpose.
- Resilience.

By the time this is printed, IoTSF will have published a number of these best practice guidelines and made them freely available for download from its website.

It may not feel like it to some, yet IoT is still very nascent and displays many of the problems associated with immaturity. Whilst the potential of IoT is new, the challenges we face are

familiar hence it needs organisations such as IoTSF to guide and support its development.

IoTSF itself is also maturing – 2016 was a start-up period, yet with the combined membership experience it has already made an impact internationally. There is a great deal more planned for 2017 now that the operation is firmly up and running, most notably addressing sectors beyond the connected consumer/connected home, promoting integrity in the supply chain, and educating users of the technology in appropriate security habits.

We would like to take this opportunity to thank our members for helping to make the world a safer place, and enabling IoT. We also encourage readers to do their part where possible in reducing the threats of IoT – whether you’re a provider, buyer or consumer – assist us to promote the concept of a ‘Supply Chain of Trust’ and passing on a ‘Duty of Care’ to the connected world – let’s make it safe to connect.

John Moor

*@JohnWMoor / @IoT_SF
Managing Director, IoT Security Foundation
<https://iotsecurityfoundation.org>*

ABOUT THE INTERNET OF THINGS SECURITY FOUNDATION (IoTSF)

IoTSF was formed as a response to existing and emerging threats in Internet of Things applications.

The mission of IoTSF is to help secure the Internet of Things, in order to aid its adoption and maximise its benefits. To do this IoTSF will promote knowledge and clear best practice in appropriate security to those who specify, make and use IoT products and systems.

IoTSF promotes the security values of a security first approach, fitness for purpose and resilience through operating life.

IoTSF is an international, collaborative and vendor-neutral members’ initiative, driven by the IoT eco-system and inclusive of all parties including technology providers and service beneficiaries.

For more information, news and further announcements, visit <https://iotsecurityfoundation.org>

MOORTEC'S JOURNEY FROM LOCAL DESIGN SERVICES COMPANY TO GLOBAL IP VENDOR

Getting a start-up off-the-ground is a big challenge at the best of times. In today's economic climate it's an even more challenging process. At NMI, we do all we can to help new and formative companies and we thought it would be a good idea to hear from some of the most exciting in our membership. We wish them every success and should you not already be aware of them then please don't hesitate to get in touch directly or through NMI. Here are the stories of their journey to date.



MOORTEC is a great example of a UK Semiconductor success story, starting small and moving up to compete globally amongst the biggest names in the industry. Moortec provide monitors and sensors that are found within today's cutting edge silicon chips, helping to increase their reliability and performance.

In 2005, fate prompted a group of us to combine our expertise and set up Moortec. Starting life as a design services company we soon identified an industry wide problem to do with making sure today's technology could continue to be reliable and perform. This was our chance, our "gap in the market" and that gap could be filled by Moortec's Embedded In-Chip Monitoring.

Very early on I spoke to a friend running a technology company in another sector, he was very helpful in the first few weeks and Business Link, at that time were also very supportive. We also had some support from Innovate UK

but our expansion is down to the fact that we are executing on our growth plan.

We were also quite fortunate that we had a small team already formed, the first day there were a small group of us who all had a shared vision. We continued with design services until our visions of an IP product portfolio had matured.

So in 2010, to address the problem we had identified we produced our first temperature sensor, no one else was really doing anything like that at the time, people were providing temperature sensors but they tended to be on the bigger nodes, specific to power amplifiers,

**“THERE WERE
A SMALL GROUP OF
US WHO ALL HAD A
SHARED VISION.”**

“AS A STARTUP IT IS VITALLY IMPORTANT TO DEFINE YOUR SALES PROCESSES, RECORD THEM AND LIVE BY THEM...”

RF amplifiers etc. No one was developing them on the open market specifically for digital circuits and not on the advanced nodes.

Without Moortec providing monitors for advanced node devices, circuit designers would struggle to make them perform. At a very high level, developing at advanced nodes is challenging as a media for designing circuits due to the issues related to process variability, our sensors help designers address these issues and allow them to lift the lid on the sometimes adverse conditions their chip could be facing.

Advanced node, analog mixed signal design brings challenges associated with the increased complexity and increased effort required to do the layout. It is imperative to make the circuits reliable and manufacturable, whilst still fulfilling the DRC checks.

One of Moortec's early challenges was gaining credibility as an IP vendor and gaining customers trust. If you are starting out developing IP you are not part of any foundry alliances which can be limiting.

Any great relationship starts with Trust and this is never more relevant when it comes to choosing your IP Vendor. Just talk to any of our existing customers and they will tell you that through great communication comes not only trust but

the peace of mind to focus on building a great final product instead of worrying about individual components.

With our embedded monitoring solutions, we are now several generations in, therefore you can trust our knowledge and expertise when it comes to proven results and accurate PVT.

Because we were hitting an untapped market we were able to self-fund our growth initially and we found that customer doors were quite open to us around the world. We were and continue to remain, IP vendor focused on these circuits. With a self-funded startup your role requires you to do every job, you are crossing between design engineering management, roadmap and sales and marketing.

We have been developing these monitors for seven years so we can demonstrate our capabilities through our experience and expertise and we can see the strong market and



we are selling into customers in China, Korea, Taiwan, Japan, Europe and the United States.

As a startup it is vitally important to define your sales processes, record them and live by them accordingly, this will then free you up to focus on your key customers. You must also retain a ruthless focus on your market and identify your Go-To-Market Strategy sooner rather than later. Focus on those areas that will make the boat go faster and avoid becoming a busy fool!

In 2016 Moortec received investment and we are fortunate to have supportive backers who share our vision for the company. Now, as we start 2017 we are a thriving IP vendor with 20+ staff and big plans for continued growth and product development the future. We have established ourselves as market-leaders in embedded monitoring solutions for today's technologies and will continue to be a local company with global ideas and world class engineers!



SO WHO REALLY CARES ABOUT SRAM POWER?

Duncan Bremner
CTO SureCore Limited

SRAM is SRAM; right? Wrong! SRAM is one of the silent killers of battery life on portable devices that no-one realises. No-one that is except sureCore who have been dedicated to the reduction of SRAM power consumption over the last 4 years; and with a significant degree of success. How much success? Well, up to 50% power savings in operating mode and 20% in standby mode. These results are not just based on simulation, sureCore have validation

silicon on both 40ULP and 28FDSOI to support these claims while only incurring a 10% area penalty for its ultra-low power SRAM IP for general applications.

However, not being satisfied with achieving world beating figures, sureCore's technical team have gone on to tackle a much more difficult problem; reducing the power for incredibly power sensitive IoT applications; applications where 'keep-alive' memory is required for quick recovery from sleep into full power operating modes. Here they have managed savings of up to 70% of operating power while maintaining reliable, full operation (not just data retention) down to 0.6V supplies.

What is the story behind sureCore and why have they developed an obsession with low power memory technology? Here is the story behind the philosophy and technology of this dynamic young company who has demonstrated previously unattainable power performance from SRAM memory while retaining the high reliability of the industry standard bitcell.

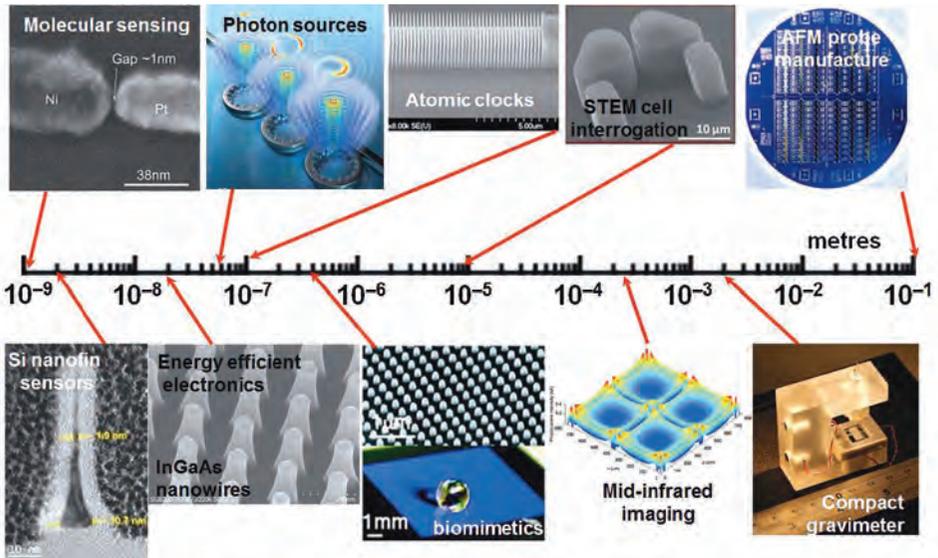
With the emergence of deep sub-micron processes (<50nm) and considerably reduced power supply voltages, the ability to manage power consumption through placing blocks into an 'non-operating' state by removing clock and data signals did not achieve the power reductions required; the inherent leakage currents present in these blocks became very significant (off state leakage).

As the industry moves towards the adoption of the emerging 16 nm technology node, the drive for greater functionality while extending battery life for mobile applications has created a perfect storm; the customer wants more for less on two fronts; more battery life (less power consumption) for less cost (area). When further constrained by



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The Centre runs an MSc in Nanoscience and Nanotechnology which is offered both full- and part-time.

Contact the Centre Director

Prof Iain Thayne

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www.jwnc.gla.ac.uk

**“FOR EVERY 10 WATTS OF HEAT GENERATED,
IT TAKES AROUND 5-6 WATTS TO MANAGE
THE HEAT AWAY.”**

the demand for more environmentally friendly technology solutions by customers, often referred to as ‘Green Computing’, this challenge has become a crisis affecting both low power and high performance applications market segments such as Internet of Things (IoT), Wearables, and remote sensing applications.

THE POWER CRISIS

In 2010, SureCore recognised this power crisis as applied to memory intensive devices, whether for high performance or low power applications and will be particularly problematic in high duty cycle SRAM products. As the percentage of memory incorporated into System-on-Chip (SoC) devices exceeds 50% of active die area, the power management challenges become more acute. Market predictions suggest that by 2017, the device area occupied by memory will exceed 70% placing even greater pressure to manage power more effectively. While the impact of power management will be felt throughout the industry, the two pathfinder use cases identified by SureCore occupy the two extremes of power management.

The first use case displaying acute sensitivity to power requirements are new devices addressing the emerging market for IoT and remote sensing applications. This market is characterised by small physical size, low cost,

and the ability (ideally) to operate without batteries. These devices’ energy supply may be supplied from renewable sources such as light, heat, or mechanical energy and the circuit’s power needs ‘scavenged’ or ‘harvested’ from these sources. As many of the IoT applications are designed around small, wireless connected, low-cost sensors nodes, the power challenge becomes a system level problem; trading the ability to store and process information locally against the power demands to enable wireless communication to a more computationally intelligent, centralised node.

The second use case for SureCore’s technology is high performance, computationally intensive applications such as graphics processors, network processors, or network routing engines. Here the challenge stems from the on-chip power dissipation generating excess heat that must be transferred away from the silicon component in order to increase reliability and operational efficiency. The impact on reliability is well documented but the commercial impact of reducing on-chip heating is less well understood. These commercial savings can be split into 3 separate benefits; operational, capital, and environmental.

The operational savings are realised by the direct energy reduction of the equipment plus the energy reduction in heat management.



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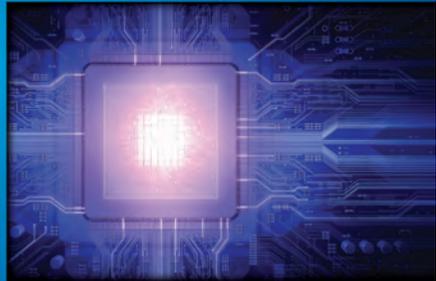
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Although the second term in the operational costs varies greatly depending upon the scale and complexity of the application equipment, a heat management solution for a rack mount server/network processor in a server farm is about 50-60% of the heat energy generated; i.e. for every 10 Watts of heat generated, it takes around 5-6 Watts to manage the heat away.

The second area of savings is through capital savings. Effective heat management requires equipment space, material, and real estate. Reduction of power consumption means smaller heat-sinks, fans, power supplies, and chassis components are needed. If these are scaled to a typical server farm, this translates into higher density (or smaller) racks culminating in a reduction of floor area for a given performance metric. The drive towards cloud computing and storage has resulted in major compute farm operators (Google, Apple etc.) locating their new facilities where low cost electrical power and environmental conditions are favourable.

The third benefit is environmental. According to Jeff Monroe, head of Verne Global, a data centre company in Iceland, "The data centre industry now is on par with the airline industry as far as the carbon footprint." As environmental concerns and the increasing costs of energy take hold,

organisations will seek to offset their energy consumption through the adoption of energy reduction technologies such as those invented by SureCore; bringing 'Green Computing' into the mainstream applications.

THE SURECORE PHILOSOPHY

To address this power problem, SureCore decided to take a holistic view and stood back from the whole problem. We started with a clean sheet of paper and asked, "Where does the power go when you start storing data on SRAM?" We discovered that a lot of the power is consumed hauling parasitic capacitance around. Our design strategy was therefore very simple; we developed a system architecture to optimise power while still retaining the area advantages of the standard foundry bit cell.

Simply stated, we architected the internal block architecture of SRAM to reduce the capacitance we have to drive resulting in significant dynamic power savings during the read cycle. In a similar fashion, we reduced the write cycle power by a similar amount. Whilst hierarchical solutions are not new, the sureCore "secret sauce" is at circuit level; developed by our engineering team leading to balance the conflicting demands of delivering power savings while maintaining performance.

At the outset, we determined it was important that our IP be process-independent. SureCore IP is based on architecture and circuit techniques rather than a reliance on process features. The result of this is a technology agnostic solution that reduces power in standard CMOS, and is equally applicable to FinFET or FD-SOI processes, across all geometries. We believe our approach is paying off and, because we insisted in retaining the foundry optimised bit cell, sureCore's technology can be retrofitted into

"AT THE OUTSET, WE DETERMINED IT WAS IMPORTANT THAT OUR IP BE PROCESS-INDEPENDENT."

“WE BELIEVE OUR
APPROACH IS
PAYING OFF...”

existing designs enabling extended product life cycles.

This is our story... we decided to take a fresh look at a fundamental SoC building block and delivered world-beating power performance. If you have application for our new, ultra-low power memory, please get in touch? You won't be disappointed.

ABOUT SURECORE

SureCore was incorporated in 2011 and established an embryonic engineering team in June of 2012. In addition to VC funding they received an Innovate UK grant which was initially used to silicon validate the core power saving technology. This investment has successfully funded the creation of compelling low power SRAM technology, demonstrating in excess of 50% dynamic and 20% static power savings compared to main stream industry offerings. Furthermore, test chip samples have been received and evaluated this year which demonstrate the company's latest innovation – an Ultra-Low Voltage memory with an operating voltage down to 0.6V. This is unprecedented in the industry and will revolutionise low power design particularly for markets such as medical (hearing aids), wearables and IoT.

sureCore™
when power is paramount

ultrahaptics 

I AM ENORMOUSLY proud to be CEO of Ultrahaptics, one of the fastest growing tech companies in the UK today, with a truly unique technology offering. Basically, it allows people to feel things that aren't really there; from virtual objects floating in free-space to controls, such as switches and buttons, which seem to magically form in mid-air under the users' fingertips. Ultrahaptics' sensations can be created and manipulated to focus on a finger-tip or palm to provide haptic feedback without the need to touch or wear any special equipment.

The first three questions I usually get asked when I tell people about Ultrahaptics are how, why and where. So, allow me to explain.

Firstly, how. How do you feel something that's not really there? Ultrahaptics uses a collection of tiny ultrasonic speakers and has developed clever algorithms to phase the array of speakers which carefully control when each one emits. The frequency of the ultrasound is then modulated, so that the combined effect of the sound waves very slightly displaces the users skin, giving the sensation of touch. The technology wows users when they first try it, but what wowed me, almost four years ago, was the potential.

The technology was developed in 2009 by a PhD Student, Tom Carter, who is now our CTO. Whilst he was developing the technology the x-box Kinect was launched into the market. This was the first time that so called 'gesture recognition' had come down from tens of thousands of dollars to a couple of hundred. The technology had become accessible to consumers. And they loved it. Product design engineers loved it too. It meant that they

could allow users to interact with their devices without having to physically engage. They no longer needed to clutter interfaces with knobs and buttons, and smears on small touchscreens could be avoided by simply hovering a finger, or waving a hand, near the interface. But there was a problem. People couldn't feel their controls, for the first time, they didn't even get the recognition of a piece of cool glass against their finger. There was no feedback, and this was unnatural. It took all the instinct away and the sense of any kind of precision was lost.

So, herein lies the 'why'. When I first tried the technology I knew that car manufacturers were keen to add gesture recognition to their infotainment systems, but as users weren't getting any feedback, they were taking their eyes off the road to use these controls. Our technology was an obvious solution.

I knew the market would be huge, and if the technology was needed for car manufactures it would only be a matter of time before other interface markets caught up. From industrial controls, medical, consumer electronics, computing there was a myriad of use cases. 'Where' became anywhere you interact with a device. With so many markets adopting touch screens as their interfaces, (we even have a touchscreen on the office coffee machine!) touchless controls were an obvious next step, and they would need feedback.

The only problem with huge potential, is the responsibility to see it through. So, when I met Tom in 2013 when he was still based in the university lab, I had a clear strategy on how to bring this technology to market.

First, and absolutely paramount, was to ensure the IP was protected. Universities are actually pretty good at this, but it was certainly key to ensure that patents were filed in multiple regions and that we had a strategy to identify any barriers to entry and protect them.

Secondly, the big question of funding. We quickly secured seed funding from IP Group. They came with the original founders to CES and saw the pull from the market and the names that turned up to those initial meetings and were sold on the potential. But we'd need an A Round. But what was clear to me was that we needed the right investors. Investors that would support us to grow and not just look to make a quick buck. We aspire to become a significant global technology businesses, we're not just here to sell IP and our investors needed to be behind us on that. And they were. We accepted investment from Woodford Investment Management, IP Group and a few others, of a combined £10.1m in October 2015.

I've worked in start-ups, corporates, seen management buy-outs and IPOs and the key component in success, to my mind, is always, always the team. So, I was keen to build a great

**“THE ONLY PROBLEM WITH HUGE POTENTIAL,
IS THE RESPONSIBILITY TO SEE IT THROUGH.”**

“WHEN IT COMES TO EMPLOYEES HAVING THE RIGHT EMPLOYEES, AND THE RIGHT ATMOSPHERE IS KEY.”

one. In the past 2 years, the company has grown from 3.5 employees to over 50. By the end of 2017, we're on plan to be over 100. There's three aspect to the broader term 'team'. Employees, The Board and Advisors. When it comes to employees having the right employees, and the right atmosphere is key. We simply do not hire anyone who doesn't have that 'spark'. All our employees are curious, kind and creative and it shows! We have a 'no-blame' culture. People can make mistakes and we work as a team to fix them when they happen. We also brought HR into the team very early on. Hiring the right people doesn't just stop when they sign the contract, but making sure they settle in well, have everything they need to bring their expertise to the fold and help identify and fill gaps in the team. The management team is a carefully crafted thing. We don't go in for big egos, but rather try and concentrate on balance. Recognising gaps is key, not everyone can do everything, so where there are gaps, we fill them. From people who love process, to the commercially savvy and the creative thinkers, everyone in the management team brings something unique. The team also extends to the board. We've been fortunate to have attracted some very experienced board members and advisors. From Chairman, Michael Tobin OBE, former CEO of Teleticity, to Sir Hossein Yassaie (who, incidentally, was introduced to our CTO, Tom at the NMI Dinner 2016 where Tom received the 'Young Engineer of the Year' award).

The combination of experience and innovation between those two in phenomenal for the business! Having experience of IP licencing, defending IP, scaling a business globally cannot be understated.

But of course, no matter how much you take advantage of unique technology, good timing, and a great team, everyone benefits from a bit of help along the way. For us, this came principally from the encouragement and support of the University, and then SET-Squared, a University incubator based in The Engine Shed, a Bristol Tech hub. The 'Entrepreuer in Residence' there, Greville Commins, was who first introduced me to Tom. He was both a board member of one of my previous companies and ran the Entrepreneurship course at the University. The interconnecting web of networks, centring around SET-Squared has been key to accessing the talent pool, and receiving the early stage support we needed to get off the round. From The Engine Shed, we branched out to our own offices, taking advantage of the Government sponsored 'Enterprise Zone', meaning we don't pay local business rates for 5 years. These kinds of incentives smooth the path for companies to ramp quickly.

If I were to give advice, it would be to plan how to scale and grow. At Ultrahaptics' we've delivered a multi-faceted strategy to enable growth. Firstly, we launched an evaluation program.

It's important to get your technology in the hands of your customers quickly, so they can start to build and experiment with it. This extends to letting customers know you've got it, so we put effort on PR from very early days. Then, with special projects our customers have supported our engineering efforts to build unique solutions for their markets. But, we couldn't support all the potential applications with a team of dedicated engineers so we put significant effort, and money (with the support of the European Commission's SME H2020 fund) into creating a development platform. This is a kit that we ship, through distributors, to customers worldwide, with all that they need to get cracking on their own. Customers can now edit a library of pre-designed haptic sensations, drop the kit into their prototypes, and get to production without needing complex knowledge of haptics or ultrasound wave forms!

The final piece of our growth strategy is to never stop innovating. If you stop innovating you're automatically stunting your growth. Tom now spends much of his time running the Advanced Research Centre within the business. This group aims to push the boundaries of where the technology can go and, significantly, has an academic network support channel so we can fully enjoy the benefits of some of the

**"IF YOU STOP
INNOVATING YOU'RE
AUTOMATICALLY
STUNTING YOUR
GROWTH."**

brightest minds in university labs around the world playing with our technology and learning new ways to interact with machines.



ULTRASOC is a great example of high-tech start-up: we began as some clever research in universities (for Google it was Stanford, for us it was Kent and Essex), got VC funding, developed the technology and are now selling it around the world.

Now, it hasn't been plain sailing (far from it!) and this piece will discuss some lessons learned and some suggestions for others doing start-ups.

But to give the context: UltraSoc has developed technology for the SoC industry.

Today's big chips can have (literally) billions of transistors, hundreds of sub-systems and dozens of different processors – all running their own code. And to understand how those things interact, in the real world, as things are running is hideously difficult. We solve that problem, and people develop complex chips more efficiently. By embedding our debug hardware into the chip, it makes it easier for engineers to understand exactly how it works, which helps people get that chip to market faster, with fewer bugs, while making it easier to improve performance and reduce power.

That means we are selling our product globally (my flight schedule usually features San Jose/Silicon Valley, Shanghai, Seoul, Shenzhen: I'm not sure why the electronics industry likes places beginning with "S" but I am relieved our office is in Cambridge rather than alliteratively in Swindon or Scunthorpe...)

And it means we sell very sophisticated technology to very demanding customers. With silicon IP there is a lot at risk: if our deliverable causes problems that could quite possibly mean the entire chip fails, and a \$20M-\$200M engineering project is derailed. That would not be good. So, customers are, quite rightly, cautious and there are high barriers to entry.

After a few years of not really commercialising enough, we are now growing nicely, with customers in USA, China, Korea and Russia. That does mean we need local sales reps who understand the specifics of the market and those customers.

The next steps for us are launching a series of new products, extending the existing capabilities into new applications and to new customers. There are a lot of ideas we are looking forward to bringing to market.

We are doing a funding round and growing nicely, so the future is looking very positive.

The key thing with a start-up is you must solve a problem, and it is vital that you understand the problem from the customer's perspective. What many start-ups do is start with some clever technology and assume that alone is enough.

That probably reflects our origins: UltraSoC started as university research. Now there is good and bad to that. The downside is this risk of being too focussed on the technology rather than customers. Indeed, that is a caricature of British firms in general which is sadly still all too true. There are a lot of companies with great engineers and brilliant products sitting in a room vaguely puzzled why people haven't driven up the road with a cheque...

The good side is that British universities are really good and many are very keen to work with industry. The research that led to us was genuinely ground-breaking. Even if you are not a spin-out, there are lots of ways to engage, whether sponsoring a PhD, supporting an undergraduate final year project or paying for contract research. This can be a great way to try new ideas or explore new technologies. The cliché that British industry and academia are too separate is fading, but is still true. Fortunately, the cliché that academics are uncommercial or disdain business has not been true for years.

At UltraSoc we have had both the good and the bad. We still have relationships, our initial funding came from university spin-out funds, the original academic is still involved as our Chief Scientist, and we are sponsoring several students and research projects. But for a long time, we not commercially focussed enough and that has changed.

A corollary of that inward focus is too many start-ups are too reticent. Promote your business. Do not be modest and English about it. If you have something good, then people will want to know. And if it isn't good, change to doing something that is.

“IT IS VITAL THAT YOU UNDERSTAND THE PROBLEM FROM THE CUSTOMER’S PERSPECTIVE.”

Another area where starts often go wrong is with external advisors. Start-ups often try to do everything themselves, or use the cheapest local suppliers, but accountants, lawyers can be hugely helpful with the business. Trying to do everything yourself is daft: it will cost you more in time, when you should be focussed on things only you can do. And if you get it wrong that is devastating.

The big firms now have very good, focussed, teams who can help start-ups at very reasonable rates. And they have a huge number of outstanding online resources available for free to download. For example, Taylor Wessing has a whole collection of contracts, NDAs, agreements; KPMG has a similar thing for accounting and finance. I mention those two but most firms have similar. Or use a regional medium size firm: big enough to have the resources and expertise, but may be cheaper and more responsive. But don't use a one-man firm or local person: the lawyer who did your aunt's divorce is not going to be much good in negotiating a Korean contract or unravelling Chinese withholding tax.

For what it is worth, at UltraSoC we use PEM and Grant Thornton as accountants, Birketts as our lawyer and Silicon Valley Bank. There are other good firms – but take the time to meet them, and to take their advice.

In similar vein, there is a lot of good advice out there. Try to find good mentors or an advisory board. You don't have to do what they say, but there are a lot of people with good ideas, relevant experience that is well worth listening too. That also includes joining networking organisations.

The UK used to be very bad at start-up funding and VC. That has got better: whilst not quite the US or Israel I think it is fair to say that if you have



**“BIG FIRMS NOW
HAVE VERY GOOD,
FOCUSSED, TEAMS
WHO CAN HELP
START-UPS.”**

a good idea and a good team you have a better shot at getting funded than most other places. What is also true is that this no longer “dumb money”: they are a number of tech-savvy VC funds who really do understand the technology, the market and how to make companies succeed.

The challenge and problem the UK faces has moved on: it is no longer “start up” but “scale up”. There is still a tendency for British firms to sell out very early, not to grow and become global players. And that is reflected in funding: whilst raising £1M is no longer hard, the growth funds that an Uber, Tesla or Airbnb have raised remain scarce in UK. As a result there are precious few “unicorns” (\$1bn valuations) and it is sadly true that the only two global tech start-ups (ARM and Autonomy) Britain had have both been acquired.

But start-ups rely on optimism, so I am confident this will change as we get more start-ups growing.

Finally, if I have the idea and the inspiration, go for it. I would say “you too can as successful as UltraSoC” – but that is not enough and I'm you can do a lot better. The next Apple? Why not? Someone has to be!

Shoot for the moon, and if you miss you'll end up in the stars.

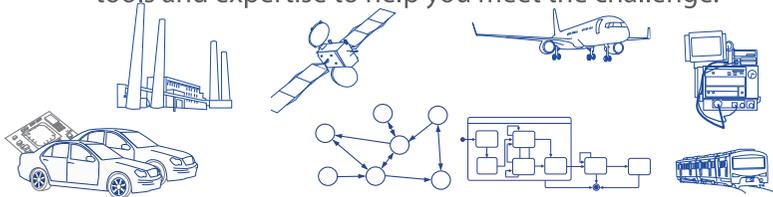
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A Division of Tetreon Technologies Limited

Thermco Systems

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Thermco Systems has, for the last 50 years, been a supplier of high-volume manufacturing systems to a global market. The company continues to provide total solutions for thermal diffusion and wet cleaning processes to the semiconductor, photovoltaic, MEMS, LED and nanotechnology industries.

Thermco Systems also produce pilot-line, R&D and bespoke designs for all thermal (up to 2,000°C) and wet chemical applications as well as offering upgrades, retrofits, repairs and support services.

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GLOBAL STEPPER & SCANNER PRODUCTS AND SOLUTIONS

NTEKlitho was formed in Jan 2003 as a third party alternative to servicing all aspects of Nikon Stepper and Scanner Systems. Our highly qualified team of engineers with a combined experience over 80 years ensure first class customer service.

Customer needs are at the heart of our organisation.

NTEKlitho is headquartered in Scotland, UK with facilities in the USA and the Netherlands. We provide service and support worldwide on the full range of Nikon systems G6-S307 and also the Nikon SF systems. With our state of the art cleanroom facility in the Netherlands which fully facilitated and our highly experienced team of engineers NTEKlitho has the capability of assessing, refurbishing and testing customer tools offsite.

With it's extensive customer base throughout the world and it's close relationship with brokers in the USA , Asia and Europe we have fast become the number one alternative to the OEM for customers looking to reduce their costs in this ever challenging economic environment. Completing mass projects on decommissioning, refurbishment and installations with pre agreed logistics and pricing.

NTEKlitho have an extensive supply of parts for the full range of Nikon Stepper and Scanners, we have currently manufactured our own illumination optics up to the S204 range with the S205-S207 currently at the testing stage before release. In addition to this we have successfully acted as agents on the purchase and sale of Nikon Equipment through our connections to our broker network worldwide.

In addition to the Nikon service that NTEKlitho provide, we have also partnered with IDL Semiconductor who have offices in San Diego, Singapore and Nijmegen to support the needs of customers on all their Cymer 5000, 6000, 7000/ XLA lasers, they also have an extensive supply of parts for their Cymer systems, IDL can also support Gigaphoton on service.

SUMMARY OF CAPABILITIES

Sales and support

G-line	G6, G7 and G8
I - line	I7, i8, i9, i10, i11, 4425i, i12, i14, SF100, SF110, SF120, SF130 and SF140
DUV steppers	EX12 and EX14
DUV scanners	S202, S203, S204, S205, S206, S207, S305, S306, S307

Illumination and Lens capabilities

Full optics refurbishment G6-i14 illuminators and BMU's up to S204.

Lens optimisation including Inclination, Distortion, Astigmatism, Curvature, Coma shift, Coma magnification, Inclination.

Refurbished BMU illuminators.

Lasers

Cymer sales and service.

Gigaphoton to Cymer laser change.

Parts

Please enquire for all your parts requirements, availability and pricing available on request.

Training

Nikon training is available at various levels and can be tailored to individual customer requirements.

For further information on all our products and services please contact solutions@nteklitho.com

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109 East 17th Street
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Celebrating 30 years and still growing!

Semefab operates 3 wafer fabs on its Glenrothes site, supplying silicon wafer foundry, probe tested die and packaged electronic devices and sensors to customers around the world.

The operation supports a broad technology base in IC's, Discrete semiconductors and MEMS Sensors. Usually our customers require custom processing.

Our teams are expert at inducting and if necessary optimising existing processes to run at high throughput with excellent probe and final test yields.

250 million die/devices and over 80 per cent of fabricated product is exported each year.



**Competitive,
Flexible and Responsive
Committed to Continuous
Improvement in
Operational Efficiency and
Environmental Impact**

**IC's
Discrete Semis
MEMS**

2016 Fife Business Awards
WINNER 'Best Performing Business (over 50 employees)'



Silicon Foundry, Global Partnerships

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