T H E   E L E C T R O N

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ELECTRONICS DESIGN

Last year Findlay Media launched *The Electronics Design Show* as a major exhibition alongside *The Engineering Design Show*. This year the show was held again, on 22nd and 23rd October at The Ricoh Arena in Coventry, and featured just over 80 exhibitors, a Workshop Programme comprising of ten presentations, and the *New Electronics Conference*, sponsored by the journal *New Electronics*, at which a further twelve papers were presented.

In addition to the above, following the success of last year's show, and recognition of a growing gap in the embedded electronics market, a new show was added alongside *The Electronics Design Show*, namely *The Embedded Design Show*, which featured a further 30 exhibitors and eight Workshop Presentations.

Papers presented included the following:

'Electronics Systems for Jet Engines' (Graham Bruce, Power Electronics Team Leader, Rolls Royce).

'The Route to Graphene Commercialisation' (James Baker, Business Director, The National Graphene Institute).

'Supporting Innovative Electronic Technologies' (Myrddin Jones, Lead Technologist, Electronics, Sensors and Photonics for Innovate UK).

'Protecting The Internet of Things Gateway' (Will Keegan, Technical Director, Lynx Software Technologies).

'Towards Driverless Cars and The Future of Transport' (Dr. Anthony Baxendale, Future Transport and Research, MIRA).

'Getting started with The Internet of Things' (Dave Locke, IBM Senior Inventor and Product Manager, IoT and M2M).

'Optimising Industrial Sensors' (Simon Jordan, Senior Sensing Engineer, Cambridge Consultants).

'Open Hardware Opportunities and Innovative Electronics at CERN' (Eric van der Bij, Group Leader, CERN European Organisation for Nuclear Research).

'Raspberry Pi – Creative Concepts to Commercial Products' (Pete Lomas, Cofounder and Director of Systems Engineering, Norcott Technologies).

'Keeping The IoT Private' (Paul Green, Director of Innovation, Arkessa).

'The Benefits of Rigid-flex PCB Design' (Robert Huxel, Industry Specialist – Enterprise Solutions, EMEA).

'Embedded and Cloud Worlds need to converge for IoT – see how we've done it' (John Jones, Technical Marketing Manager, Avnet Memec).

'Product based Virtual Prototyping just got easy' (Nikola Kontic, Development Manager, Zuken).

'Easy-to-use CFD for Electronics Thermal Design' (Tom Gregory, 6SigmaET Product Specialist, Future Facilities).

'Getting your IoT Project off the Ground with the IoT Team' (Andrew Cridland, Managing Director and Michael Leggett, Business Development and Marketing Manager for IO Electronics).

'MCU – Wireless and Software Solutions for the IoT' (Scott Cooper, Field Marketing Manager, MCU and Wireless EMEA, Silicon Labs).

'Avoid PCB and Enclosure Collisions with 3D Product Visualisation' (Nikola Kontic).

'BLIP – A Revolution in Advanced Occupancy Detection' (Chris Cockayne, Technial Solutions Manager, Analog Devices).

'Redefining Embedded RF Design and Debug' (Derek Maclachlan, Application Manager, John Marrinan, Application Engineer, and Dean Miles, Technical Marketing Manager for Tektronix).

'Securing The Internet of Things' (Anthony Webb, Field Applications Engineer, Green Hills Software).

'Introducing Intel's Edison Board' (Brendan Le Foll, Software Engineer, Software Services Group, Intel/Mouser Electronics').

'Integrating IoT and M2M Communications into Embedded Product Design' (Martin Schulte-Hobein, Supervisor, Tech Sales EMEA, Digi International GmbH).

'Reducing Development Costs using on-chip DAEC Technology' (Heinz Oyner, Senior Marketing Manager, ams AG).

'Game-changing Low Power RF for IoT' (Joint presentation from Texas Instruments and Mouser Electronics looking at the next generation of Low Power RF technology enabling IoT).

In this issue of The Electron an overview of the show and its key features are presented.

Contact details for the exhibition organisers are:

Ed Tranter, Executive Director, Findlay Media, Hawley Mill, Hawley Road, Dartford, Kent DA2 7TJ. Telephone: 01322 221 144. Email: etranter@findlay.co.uk

THE INTERNET OF THINGS

As may be deduced from the above list of papers, The Internet of Things (IoT) formed a major theme throughout the show with The Internet of Things Live Zone, spearheaded by *Electronics Design Show* Headline Sponsor Avnet Memec providing a focus for visitors to view interactive demonstrations and to discuss how to make The Internet of Things a reality.

At the show Steve Haynes, Avnet Memec President Europe, stated:

"The Internet of Things has, without doubt been the catchphrase of 2014 and it's no wonder when the potential for growth is so huge with Cisco predicting that 50 billion 'things' will be connected to the Internet by 2020.

There are many factors making 2014 the year of growth for the IoT and many of the vital ingredients for new applications are now in place. Demand is coming from industry, which sees the potential to efficiently manage field-based equipment, from consumers who are comfortable using the Cloud and have adopted smart devices as their central communications hub, and governments that need to effectively manage resources.

Key technical enablers are also ready. Component suppliers are releasing new low power technologies, many of them with a reduced footprint and at lower cost. Further, the launch of Ipv6 in 2011 is enabling practically limitless connections to the Internet. New IoT applications are emerging and component technologies and design technologies are continuing to evolve."

In their brochure 'IoT Solutions' Avnet Memec explain the concept more fully:

'Objects using sensors and actuators and with the ability to connect to remote services which create value is forming the "Internet of Things". Objects or devices are connected to the Internet. They can interact with and exchange data with applications hosted on remote servers or "the Cloud".

The vision is that these devices will be everywhere and will be delivering huge amounts of information to the Cloud generating "Big Data". It's then the challenge for software on the Cloud to make sense of the data and deliver valuable services not achieved before. There are many other challenges to overcome such as smart sensor design, network security, and the requirement for new networking technology.

For clarification: Is IoT different to M2M? No, although what we now refer to as M2M covers really niche applications closely defined around a business case. IoT brings the vision of everything reporting information creating Big Data. Then applications in the Cloud can be created to deliver value from this data.

There are many devices that are not currently IP addressable and at this stage it may not even be considered or necessary. However, as and when devices are acknowledged as offering useful information, there will be a way to connect through the Cloud via a growing selection of IoT services. For example using Bluetooth Smart through a Smartphone (gateway) or using RFID with a connected ID reader.'

In describing the landscape of IoTAvnet Memec list some of the challenges associated with increasing the reach and interact with Cloud devices as being:

- The need for a Wide Area Network appropriate for the application.

- Provision of gateways and bridges for devices that cannot access the network directly.

- Management of networks so as to be able to take into account the often limited functionality of the end nodes.

- Ability to manage end nodes and devices remotely through the network.

- Ability to deliver reliable Cloud services to the application layer once a reliable network is in place.

The growth in the number of Internet connected devices that is being forecast comes largely from the industrial sector and Avnet Memec has a very deliberate focus on serving this growing market. Their solution includes, notably, a Powerhouse Energy Monitoring Module that addresses the rapidly growing segment of the energy measurement market that is being driven by the requirement to real-time information about the electricity usage of household products, building automation devices, data centre servers and factory automation. The Module is based on the highly accurate energy measurement device from Cirrus Logic and the proven Power Line Communication technology from Echelon:

'The Powerhouse Module directly monitors usage and produces a local communications path over the power line. The smart server together with a GSM modem provides a gateway to the Internet. A web page served by the gateway can be accessed by any web browser on a PC or smart device.'

A gap has been recognised for the provision of low cost, low power IoT dedicated networks, that is Low Power Wide Area Networks, and to this end Avnet Memec are working with technology providers such as SIGFOX so as to deliver the embedded technology for objects to be connected into these networks:

'The ability to configure a single embedded SIM with multiple networks and to re-configure remotely is driving new applications and possibilities. Cloud services are now easier to access and implement in parallel with embedded designs.'

Securing the IoT

A major subject of concern with regard to the IoT is security, and this subject was addressed at The Embedded Design Show Workshop presentation ''Securing the IoT' (Green Hills Software – see list of papers).

In response to concerns about security Green Hills Software have recently launched the IoT Security Advisors Program, which is comprised of security experts from all of Green Hills Software's business units to provide security services for organisations that have a requirement to manage the considerable privacy and security challenges that are posed by the IoT.

The IoT Security Advisors Group consists uniquely of experts that have successfully achieved certification to IEC15408 (Common Criteria) Evaluation Assurance Level 6+, High Robustness, the highest software security level ever attained.

EAL6+, High Robustness, is the certification required to protect 'high valued information' against 'sophisticated threat agents.

The Group has enabled clients across many industries to certify to the highest levels of security and safety standards including:

- NIST FIPS 140-2 (cryptography)

- DIA DCID 6/3 (classified intelligence information services)

- NSA Type-1 (crypto devices)

- FAA/EASA DO-178B/C (avionics)

- FDA Class II/III (medical)

- IEC 61508 (industrial)

- ISO26262 (automotive)

- EN50128 (railway)

The IoT Advisor's services include:

- Embedded, enterprise, mobile, network and system security design consulting services comprised of security requirements management, secure software development processes, system architecture, data protection, testing and security training.

- Comprehensive certification assistance for IoT developers who must meet security, safety and quality standards.

- Embedded to enterprise threat and vulnerability assessment services performed by IoT Security Advisors white hat hackers and security experts regardless of industry, hardware an operating system.

Companies that work with IoT Security Advisors will be able to build products and systems that provide protection of valuable information, protect revenue streams through counterfeit prevention and secure application and enable remote software updates whilst reducing the business risks associated with negative brand reputation and negative lawsuits.

David Kleidermacher, Chief Technology Officer for Green Hills Software states:

"We enable companies to build the Things in the IoT that cannot be hacked and must never fail. Achieving absolute security and total reliability has been our focus spanning the last three decades. The threats associated with having 30 billion connected devices necessitate security becoming the top priority for companies participating in the IoT. Our team of IoT Security Advisors brings expert system design and security services to companies that need assistance in this area."

Further Information

Further information concerning the subjects in this article may be obtained from:

(i)   Avnet Memec (Avnec EMG Limited), Suite 4, First Floor, Oxford House, Oxford Road, Thame, Oxfordshire OX9 2AH. Telephone: 01844 263 600. Email: thame@avnet-memec.eu

(ii)   Green Hills Software – Telephone 01844 267 950. Email: info-uk@ghs.com

EMBEDDED SOFTWARE SECURITY AND SAFETY

Continuing with the security theme Lynx Software Technologies have introduced the LynxSecure separation kernel and embedded hypervisor.

The military and avionics industries rigidly mandate high security for safety critical software environments, operating systems and development tools. At the same time military networks increasingly need to interface with the civilian IT infrastructure, which exposes them to program bugs, design flaws and other vulnerabilities.

LynxSecure addresses this by providing a robust environment within which multiple secure and non-secure operating systems can perform simultaneously without compromising security, reliability or data.

LynxSecure expands on the proven real-time capabilities of the Lynx OS® real-time operating system (RTOS) with time-space partitioning and operating system virtualisation.

The LynxSecure operating kernel is a robust virtual machine monitor that is certifiable to:

    (i)   Common Criteria EAL-7 security certification (Evaluated Assurance Level 7) – a level of certification hitherto unattained by any known operating system.

    (ii)   DO-178B Level A – the highest level of FAA certification for safety critical avionics applications.

Unlike a traditional security kernel that performs all trusted functions for a secure operating system, a separation kernel's primary security function is to partition data and resources of a system and to control information flow between partitions. Partitions and information flow policies are defined by the kernel's configuration, which provides a robust foundation for the creation of multi-level secure systems.

The use of hypervisors and virtualisation technology allows one operating system (and its applications) to run within the environment of another kernel, in effect allowing multiple dissimilar operating systems to share a single physical hardware platform. Virtualisation technology allows for significant cost savings through hardware consolidation, whilst at the same time retaining the ability to leverage the ecosystem of applications that belong to different operating system domains into a single system.

In order to achieve virtualisation, LynxSecure uses a hypervisor to create a virtualisation layer that maps physical system resources to each guest operating system. Each guest operating system is assigned certain dedicated resources, such as memory, CPU time and I/O peripherals. This 'co-operative virtualisation' provides superior performance for the guest operating systems (such as Linux®, Lynx OS-SE and LynxOS-178).

A 100 per cent application binary-compatibility with the non-virtualised instance of the operating system is preserved. LynxSecure isolates each virtual instance by providing hardware protection to every partition with its own virtual addressing space. In addition it guarantees resource availability, such as memory and processor-execution resources, to each partition, so that no software can fully consume the scheduled memory or time resources of other partitions.

LynxSecure supports simultaneous use of system interfaces, including multiple instances of the same or different operating systems in different partitions.

More details may be obtained from Lynx Software Technologies UK, 400 Thames Valley Park Drive, Thames Valley Park Drive, Thames Valley Park, Reading, Berkshire RG6 1PT. Telephone: 01189 653 827.

DESIGN RESOURCES FOR ENGINEERS

Another of the Headline Sponsors of *The Electronics Design Show* was RS Components who are very much in the business of meeting demands for shorter design schedules. At the show their Marketing Director, Glenn Jarrett, stated:

"Overall, increasing resources and tools are now becoming available to enable the democratisation of electronics design – empowering individuals and also engineers within companies both small and large. There are three important trends that have enabled companies to take up an increasingly flexible 'try-it-and-see' design concept approach: the growth of open source software and hardware; free powerful design tools such as DesignSpark PCB and DesignSpark Mechanical; and rapid prototyping ability via increasingly affordable 3D printers, which allow the quick realisation of mechanical design concepts in hours. This new design approach can deliver the ability to rapidly react to market demands, reduce time-to-market and encourage innovation across a wider base of people including electronics and mechanical engineers."

In their brochure 'Design Resources for Engineers' RS Components promote their website called DesignSpark, which was launched in 2010 and now has around 250,000 members and some of the industry's most popular design tools.

In the past electronics design tools have tended to be costly and, in the eyes of many designers, over-complicated. In particular, many tools have been unnecessarily complex for concept and prototyping stages, even though they may be suitable for the final product design. DesignSpark aims to overcome this difficulty by enabling rapid creation of schematic captures, PCB board designs and layout.

With DesignSpark PCB the focus is very much on innovation, research and development rather than spending time on creating the basic building blocks of the design, and RS product catalogue integration has been a much sought-after feature:

'Guided by our dedicated global community, we decided to complement the existing set of components with brand new libraries created by industry experts in compliance with the IPC-7351 standard. DesignSpark PCB users now have access to over 80,000 components from the RS product catalogue through a dedicated interface with ModelSource, our online engineering models database.'

DesignSpark PCB is supported by DesignSpark Mechanical, which allows for the import of PCB layout files from electronic design software and drawing files from 2D electrical software. This allows for design, creation and modification without the limitations posed by two-dimensional design tools.

A DesignSpark magazine is available quarterly and may be downloaded in eight languages. It features projects from the community and embedded rich content in the form of 3D models, video and audio.

More information is available on 08457 201 201 or www.designspark.com

MULTISIM BLUE

Headline Sponsor Mouser Electronics were showcasing their innovative MultiSIM BLUE Design Integration tool, which was designed in collaboration with National Instruments.

This all-new PCB design integration tool utilises the Berkeley SPICE engine and includes a preloaded component library of over 100,000 frequently used components from multiple Mouser databases.

At the show, Graham Maggs, Director of Marketing for Mouser EMEA explained the concept behind the design:

"MultiSIM BLUE facilitates real-time BOM price quotes and component database updates enhance the creative design engineering efficiency. The tool supports pre-layout design convergence analysis and mixed-signal simulation, and can handle components as complex as BGAs with over 1,000 pins on pin-pitches down to 0.8mm. MultiSIM BLUE also provides a 3D visualisation of the PCB with no limits on the shape and size of the PCB, thereby enabling innovative forward-looking design."

More details from Mouser Electronics on 01494 467 490 or www.mouser.com

NEW MACHINES FOR SOLDERING OF COMPONENTS AND TESTING OF POPULATED BOARDS

Eurocircuits have launched four machines to help prototype and small batch customers achieve professional quality soldering of components and testing of populated boards without the need for a massive investment.

Prototype designers, under pressure to get new products to market, cannot afford to spend time debugging a new design only to find that the fault is due to a poorly soldered component. Small batch manufacturers know that their customers demand the highest levels of quality and reliability, but time spent fault-finding a defective joint or component comes straight off the bottom line.

The eC-stencil-mate screen printer, the eC-reflow-mate reflow oven and the eC-test-mate offer the same levels of accuracy as high-end automatic and semi-automatic machines but at a much lower cost and with greatly simplified set-up and operation. The eC-pre-heater is a new 100 per cent Eurocircuits design for pre-heating the boards for hand soldering, which quickly boosts the temperature of the PCB to allow for smoother and easier hand soldering and de-soldering of critical components.

The eC-test-mate has three different ergonomic test heads each with different functionality. T1 is used for generic applications, T2 to test communication interfaces and T3 to provide additional measurement functions when required for either application. These can be combined to create a complete suite of functional tests. Each test head has a unique keying pin so that it can only lock into its own footprint.

A dedicated docking station holds the three test heads and guarantees an insulated connection between the PC and the test heads, supporting the test heads with no less than 25W of power. It also performs a quick self-test of each test head.

The eC-test-mate is supported with the eC-my-test software, which is based on a powerful scripting language with standard test commands such as setting and reading analogue and digital inputs and outputs. Power supply control industry standard communication interfaces such as UARTs, CAN, RS-485 and I2C systems are also supported and the software is fully compatible with TEST-TRACK, the known TEST-OK testing software.

Details are available from www.eurocircuits.com

THE RISE OF BEACON TECHNOLOGY

Beacon technology is set to drive a new level of proximity-based services in smartphones and other devices according to Sally Ward-Foxton in *'Ultra Low Power Wireless'*, Quarter 2, Summer 2014.

Beacons are essentially low-cost Bluetooth Smart wireless transmitters adapted for indoor use and placed in a particular location or point of interest. They transmit their identity to any Bluetooth Smart Ready devices in range. Devices hosting a companion app can be located and the software can trigger various types of notifications.

The author states:

'Because beacons have the potential to locate smartphones indoors to within a few metres, they could provide a kind of indoor GPS, but, crucially, they could also allow content delivery specifically targeted to that location for users who want it.'

A notable application for this is in retailing where beacons can be used to offer proximity-based advertising and services in-store.

Any manufacturer's beacon can communicate with Android devices and other smartphones that are equipped with a Bluetooth Smart Ready capability.

Contributing to the rise of beacon technology is the fact that Bluetooth Smart ICs are widely available from many silicon vendors and a support infrastructure exists that is able to make beacon hardware and software relatively straightforward.

Business Insider magazine currently estimates that there are over 200 million iPhones and iPads currently deployed that are capable of acting as or receiving signals from iBeacons. This number rises still further once Android and other such devices become incorporated.

Current estimates by ABI Research suggest that Bluetooth Smart beacon deployment will be around 20,000 in 2015, but by 2018 over 80 million smartphones will be actively using indoor location for applications, meaning that the technology will be as widespread in smartphones as GPS is today.

New Reference Design

One company that is very much at the forefront of beacon technology is Nordic Semiconductor, who have recently released a reference design for Bluetooth Smart beacons based on their nRF51822 System-on-Chip (SoC).

This reference design allows beacons developed to Apple's iBeacon™ standards and proprietary smart beacon hardware for iOS and Android mobiles to be developed quickly and easily.

The nRF51822 Bluetooth Smart Beacon Kit makes use of the ability of the nRF51822 to support full Over-the-Air Firmware Upgrades enabling beacons to be updated in-situ.

Key features of the Kit include the use of small form factor beacons of 20mm diameter powered by CR1632 coin cell batteries, bundled iOS and Android apps, and source code for beacon firmware and smartphone apps.

Nordic Semiconductor has become the first company to be able to bring complete over-the-air updates to ULP wireless SoCs. This has been possible through the use of a 'soft device' that is a self-contained RF protocol software 'stack' designed for nRF51 Series SoCs that incorporates the stack and its associated management framework. The software is delivered as a pre-compiled binary file or pre-

programmed onto a chip. The SoftDevice therefore forms part of the nRF51 Series' unique software architecture.

Nordic state:

'In this architecture the stack and the developer's application code are already separated. This arrangement removes the need for the engineer to struggle with integration of application code as part of a vendor-imposed application development framework. This allows code development to be greatly simplified and accelerated while risks associated with integration of stack and application code are significantly reduced and software robustness improved. The software separation ensures that stack and application operated independently, but communicate when necessary via event-driven application programming interfaces.'

Prior to this development revising a ULP wireless chip's software in the field has been problematic.

Further details are available from www.nordicsemi.com

GRAPHENE ENGINEERING INNOVATION CENTRE TO BE BUILT IN MANCHESTER

The UK's second centre for research into graphene is to be built at Manchester University. The £60 million Graphene Engineering Innovation Centre is due to open in 2015 and will complement The National Graphene Institute.

Graphene has been identified as having considerable potential in the field of electronics as graphene treated nanowires can be used to produce flexible touchscreens at a fraction of the cost for current touchscreens.

Most existing touchscreens are manufactured using indium tin oxide, which is expensive and inflexible by comparison. The new technology could be of particular benefit in the field of wearable technology and bendable smart displays for which traditional touchscreens have serious cost limitations.

The National Graphene Institute was represented at The Electronics Design Show by its Business Director James Baker. Graphene itself was first isolated at The University of Manchester by Professors Geim and Novoselov.

FIBRE OPTIC LINKS FOR INDUSTRIAL AUTOMATION SYSTEMS

Optoelectronics pioneer OMC has announced that its fibre optic links are an ideal solution for industrial automation systems designers who are widely adopting Smart Factory/Industry 4.0 working practices that rely on the collection and feedback of equipment performance data which is then used to fine-tune production processes and increase efficiency.

The company produces glass and polymer fibre optic cable assemblies for many demanding industrial applications and has developed its own proprietary ACA™ (Active Component Alignment) technology in order to ensure that its fibre optic data links perform consistently and reliably from link to link. The company also designs complete optical links including the transmitter, receiver and cable assembly, which are performance-matched during manufacture to ensure that the system's optical budget is sound regardless of how the components are matched up in production.

Commercial Director for OMC, William Heath, explains:

"Industrial machinery and smart factory environments are often noisy and challenging environments for electrical signals, so optical transmission is often more appropriate. If high voltage, magnetic or noisy motors are present optical systems are definitely preferred. However, achieving consistency of performance in such applications can frustrate many would-be users of fibre-based systems in industrial applications.

Most manufacturers of optical fibre cables do not manufacture the transmitter/receiver part of the link – similarly few Tx/Rx providers produce fibre cable assemblies. In our experience customers, especially if they are installing multiple links within industrial machinery or site infrastructure, simply want to provide an electrical signal at point A and have that same electrical signal delivered consistently and reliably to point B.

We specialise in the manufacture of both Tx/Rx devices as well as the fibre optic cable assemblies to provide an optical link between the two. Our complete data link design and manufacturing service means that systems engineers can avoid 'mixing and matching' off-the-shelf components, which can result in unreliable systems, and, because we are technology-agnostic, we are able to advise on the correct choice of technology to suit the application. By tailoring one of our existing processes we are now able to supply production quantities of fully-characterised fibre optic links with 100 per cent link consistency to those involved in Smart Factory applications in a huge range of industries."

Further information is available from OMC, Candela House, Cardew Industrial Estate, Redruth, Cornwall TR15 1SS. Telephone: 01209 215 424. Email: Heathw@omc-uk.com

QUANTIFYING THE COST OF FIXING VS PREVENTING BUGS

This is the subject of a White Paper published by Vector Software, who were exhibiting at *The Embedded Design Show* alongside Green Hills Software, Lynx Software Technologies and the Qt Company.

Vector Software are a leading provider of testing solutions for safety critical software and business critical embedded solutions, and in this White Paper the case of Google, for whom incomplete testing had become a major barrier to progress, is used to present a case for the use of automated testing in the development cycle:

'Google was able to quantify the cost of their poor quality in terms of the number of engineers involved in fixing bugs. They then put a plan in place to improve software quality through continuous testing, and by testing earlier in the software development lifecycle, thus freeing up those same engineers to innovate new features and beat their competitors to market.'

Figures for a mid-sized automotive project are used to illustrate, based on some of Google's own numbers.

Central to Google's solution was creation of a test platform that ensures that bugs are identified as early as possible in the development process when they are cheapest to fix. Figures are used to illustrate how finding bugs earlier in the development process translates into a lower cost per bug. These figures show that where the bug was found in a system test it would typically cost $5,000 to correct, whereas if discovered in the Unit Test or Test Driven Development phase it would cost just $5.

In support of their approach Vector Software state the following:

'By adopting an approach that embraces the value of prevention, instead of fixing, your organisation can free up valuable engineering resources for innovation and new product development, enabling you to carve out a greater share of the markets you serve.

A great starting point is to introduce static analysis and code coverage tools. These tools can be implemented without changing the workflow of your development team, but will yield actionable metrics to help improve quality. The VectorCAST/Lint static analysis tool reports on coding constructs that have historically proven to be problematic and hard to maintain. The VectorCAST code coverage tool reports on which portions of your source code have been tested and, more importantly, which portions have not been tested.'

Copies of the paper may be obtained from Vector Software, Golden Cross House, 8 Duncannon Street, London WC2N 4JF. Telephone: 020 3603 0120. Email: anja.Schneider@vectorcast.com

DRIVING PRODUCT QUALITY BY ENSURING TESTING COMPLETENESS

This White Paper, also from Vector Software, examines current software testing challenges, including code coverage analysis, testing legacy code bases, applying coverage analysis across the lifecycle, the business case for adopting coverage analysis, and the ideal coverage analysis tool.

In the paper it is suggested that when an organisation is looking to improve its software quality rather than asking the question 'how will this affect schedule and developer workload?' one should ask 'how will we measure testing completeness?' It is then suggested that one of the easiest ways to measure existing testing completeness is to add code coverage analysis to the test process:

'Code coverage measurement can be deployed throughout the development lifecycle without requiring a huge investment in time and money, or negatively impacting the project schedule. Code coverage analysis leverages the testing that an organisation is already doing, and yields actionable testing effectiveness data.'

Code coverage analysis involves instrumenting the application source code with 'breadcrumbs' that generate trace data as the application is tested. This data is then post-processed to report what lines of source code have been executed by a test procedure or set of test procedures.

Emphasis is placed on identifying poorly tested sections of applications as it is these that tend to contain the most bugs. According to Vector, when organisations first adopt code coverage analysis it is discovered that less than 70 per cent of application code is being executed by existing test procedures. The result is a realisation that often important parts of an application have been left untested simply because they were overlooked by the team that developed the test procedures.

In order to improve the quality of legacy code bases code coverage analysis during system or functional testing is recommended:

'Running existing tools with code coverage will separate fully tested sections of the application that can be changed with confidence from poorly testes sections that should be modified with great care.

Once this information is known you can implement additional tests as new functionality is developed. Over time, you will end up with a more completely tested code base that offers better quality and is easier to maintain.'

A key learning point is the following:

'Without refactoring code bases become unmanageable, and without complete tests refactoring is impossible.'

A major benefit of coverage analysis is the fact that it can be applied across the complete development lifecycle:

'If code coverage is analysed during each phase of testing and then combined into a single report before each release fewer bugs will reach the integration team, release dates will be met, and fewer bugs will reach customers.'

Contact details as above.

BEYOND THE CODE: HOW DESIGNERS AND PROGRAMMERS CAN WORK TOGETHER TO DELIVER SUCCESSFUL GUIs FOR EMBEDDED SYSTEMS

This White Paper from the Qt Company, a leading cross-platform application and UI development framework for leading desktop, embedded and mobile operating systems, looks at the requirements for user interface design in embedded systems, and suggestions for those developing advanced GUIs.

The author, Tuukka Turunen, Director of R and D for Digia, Qt, argues that good coding alone is no longer adequate when it comes to building the interface for an embedded design. Understanding the user and choosing the right development tools are both critical success factors.

The paper begins with an analysis of the evolution of user interfaces (UIs) for embedded systems:

'In the past many embedded systems were just that, requiring little or no direct link to the end user and, therefore, only basic UI requirements (if any at all). However, as embedded devices become more capable and are found at the heart of almost every electronic system, their features need to be more accessible to the user. Paradoxically, this can result in them being more difficult to use and as a result more work must be done to abstract complexity away from the user. Add in functionality, such as touch-screen controls, dynamic content and web access and it is clear that user interface design (typically via a GUI) is now a critical element of embedded system design.'

Functionality is therefore essential, but the best GUI designs are distinguished by their usability. This has led to a marked distinction between coding an interface and designing an interface. Consequently, in a world where users will no longer accept devices and systems that are hard to learn and difficult to use, much work is now needed before coding can be started.

Pre-Coding Considerations

Once the designer understands what functionality the user needs, it is possible to move on to the look and feel of the interface and the underlying workflow:

'Story boards and prototype visuals should be created and discussed with the users and new iterations created based on their feedback. Modern tools can assist here, not only enabling fast prototype development, but also allowing this work to be utilised in the final product rather than having to begin again from scratch. Throughout, the designer should be looking to create an interface that is intuitive, consistent in form and function and "clutter-free".

Beyond the user requirements and task analysis, other factors that will impact the user interface design can range from the operating environment – high levels of ambient light or, as is the case for many medical or industrial automation requirements, the need to use gloved hands on a touch-screen may, for example have an impact on icon size, colour and position – to the need for portability across hardware and software platforms. Requirements for global deployment that may necessitate several language versions or the need to integrate web functionality will also need to be considered.'

Design Environment and Tools

For Graphical User Interface (GUI) design the environment is necessarily divergent – graphical on the one hand, source code on the other. Bringing the two together can successfully bridge the design and development aspects of GUI creation that begin with the pre-coding issues. A GUI design environment that supports a graphical approach to design (aesthetics) and development (coding), is seen as being particularly advantageous:

'In such an environment user controls represented graphically will ideally also contain, inherently, all of the code needed to invoke them on the target platform. In engineering terms, this implies an object-oriented approach to design; by selecting an element, all of its features are inherently invoked and, through this "inherency", anything built using these elements will implicitly have access to the individual element's features and functionality. Superficially such an approach is not restricted to visual elements; any "component" developed using an object-oriented approach methodology implicitly inherits the features of its component parts and passes on its features to any other components using it in a hierarchical fashion.'

It is seen as a benefit if the environment chosen offers a wide variety of pre-fabricated and customisable components for user interfaces along with classes and modules that abstract common functionality and operating systems. Ideally these classes offer more than just the GUI. For example, by also providing classes for XML, networking, inter-process communication, 2D and 3D graphics with hardware acceleration, threading, SQL internalisation and multimedia the engineer effectively has access to an application framework that helps speed the implementation of key functionality while at the same time allowing a focus on core competences that add competitive advantage to the final product:

'The Qt design environment provides for the rapid creation of graphical elements thanks to tools that allow, for example, drag and drop UI creation in addition to writing the code. High performance text rendering as well as pre-render fonts help to reduce processing overhead while, beyond the graphics, special web tools meet connectivity requirements by allowing designers to build advanced user interfaces that incorporate real-time web content and services. For global deployments a dedicated linguist tool enables engineers to translate and adjust applications to different world languages.'

Further details from info@qtcompany.com

THE PRiME PROJECT

How will engineers approach the challenge of designing chips with hundreds or even thousands of cores? This is the question posed by David Boothroyd in the article 'Priming the Multicore Pump' in the 14th October issue of *New Electronics*, which reports on the progress of The PRiME (Power-efficient Reliable Many-core Embedded systems) Project, under the direction of ARM Professor of Electronics at the University of Southampton, Dr. Bashir Al-Hashimi.

The Project began in 2012 when Professor Al-Hashimi discussed the possibilities for combining resources to overcome challenges in many core processing with colleagues at Imperial College London, The University of Manchester and Newcastle University. It is supported by Programme Grants, a new initiative run by The Engineering and Physical Sciences Research Council.

The two main challenges that are being addressed are energy efficiency and hardware reliability, which are affected adversely through the wearing out of transistors. It is argued that even if many core chips are available they are unlikely to be of much use in mobile and embedded solutions if these challenges are not overcome. Professor Al-Hashimi is quoted as follows:

"We are predicting that by 2020 processors with more than 100 cores will become available commercially and enable embedded devices that have the power of a supercomputer, but with the battery life of a smartphone. But what is used today to solve the energy and reliability challenges will not be good enough.

We think one effective approach to reducing energy is not to treat all cores equally. This is not a new concept – ARM already has a processor based on this approach – the big.LITTLE – in which the 'little' processor does the mundane tasks, such as handling email, while the 'big' one does more processing intensive tasks like video decoding."

A key question here, however, is how to distribute applications across a much larger number of cores. Another is how many different types of core may be needed.

Intelligent software is proposed as a solution to the first problem. As for the second a critical technique that has been identified is that of using adaptive mechanisms that will allow highly parallel embedded systems to manage and optimise their behaviour dynamically to achieve the desired system trade-offs between performance, energy and resilience to hardware failures, guided by feedback received from lower system layers.

The article then quotes Professor Michael Butler, Research Leader for Runtime Management, as follows:

"When you have hundreds of cores of different kinds, many decisions must be made – for example, about which core a part of an application should run on. Tasks that need to communicate a lot need to be on cores close to each other. To do this you need a smart runtime system – an extension of the operating system – that is making those decisions."

This requires that the runtime system monitors what is happening and existing hardware does not facilitate, hence the objective of PRiME to establish ways of giving the runtime more 'fine grained information' to enable it to make the decisions required. Smart software that works on information gathered from the hardware is proposed to achieve this.

Another important factor identified is that of scaling energy proportionately with the performance requirement:

'Typically you reach a certain minimum level after which it does not fall any further even if the performance requirement does. With hundreds of cores this will be a critically important factor. Achieving better power proportionality will require designers to change strategies towards embedded systems.'

To this end PRiME will investigate ways in which an embedded many core system consumes and distributes energy whilst maintaining its dependability in a wide dynamic power range. Measuring the power consumption at runtime is fundamental and for this performance counters on processors, that is very low level counters that look at such things as cache misses and how they correlate to the power consumption of the chip, are being deployed.

Another objective of PRiME is to investigate the potential of novel computer architectures, such as SpiNNaker, which has been pioneered at The University of Manchester.

SpiNNaker is based on a custom multiprocessor SoC featuring 18 ARM968 processor cores. Its novelty lies in the interprocessor communication mechanism that enables large numbers of very small packets, each representing a neural 'spike', to propagate across the machine in much less than 1ms, the requirement for biological real time.

Professor Al-Hashimi states:

"The machine will ultimately scale up to a system with more than one million ARM processors and, at this scale, fault tolerance and energy efficiency are significant engineering concerns. As an existing state-of-the-art platform, PRiME will use SpiNNaker to identify and develop new runtime approaches to reliability and energy efficiency."

Some cores may therefore be left uncommitted in order to provide fault tolerant redundancy. Others may be power gated so as to minimise power dissipation and protect against more permanent faults. There is also a need to consider the system's ability to recover from software crashes.

Professor Al-Hashimi adds:

"In order to permit run-time recovery we will consider forms of checkpointing – for example storing redundant data in non-local memory to reduce the chance of corruption. State restoration will also be investigated, migrating tasks to another core or, in the worst case, a different chip."

VDS(on) MEASUREMENT CIRCUIT REPLACES CURRENT SENSING RESISTORS

Measuring or detecting the current flowing through a power MOSFET or IGBT is one of the most fundamental and necessary functions performed inside any switched-mode power electronics circuit. Measuring current is typically used to limit the maximum peak current in order to protect the switch and other power components from damage or destruction.

Existing current sensing solutions typically include resistors or current transformers, which increase power losses, parasitic inductance, board space and cost, and may also require heatsinking if the current levels and associated power losses are high.

In the article with the above title by Tom Ribarich of International Rectifier in the May/June issue of *Electronic Specifier* a new design innovation is proposed which eliminates the need for such components.

The new current sensing method is a parallel-connected circuit that connects directly to the gate, drain and source of the MOSFET allowing for the series-connected sensing element to be eliminated:

'The circuit includes a high-voltage MOSFET (HVFET) that turns on and off synchronously with the gate of the power MOSFET. During the on-time and after a short delay, the drain voltage of the power MOSFET gets connected through the HVFET to the current sensing output. The VDS (on) of the MOSFET is then easily measured at the current sensing output. During the off-time, the HVFET is off and sufficiently blocks the high voltage occurring at the drain, and the current sensing output is held down through a PMOS transistor.'

A small adapter board (IRuCS1) was built to test the new circuit inside a switched-mode application. The adapter board was connected inside a high-current boost application and the switching waveforms compared with a conventional series-connected resistor current sensing method.

Results showed that with both methods the VCS output current-sensing waveforms matched the shape of the drain current quite well, but the situation is different for voltage spikes:

'The amplitude of the VCS signal using the board has a slightly lower peak amplitude than the resistor measurement due to the RDS (on) of the MOSFET (0.18 Ohms) being slightly lower than the current sensing resistor (0.21 Ohms).

Both methods show some voltage spikes on the VCS measurement during turn-off. The voltage spikes for the resistor method are due to the parasitic inductance in series with the resistor and they ring above and below ground which can give latch-up for the circuit which is monitoring this signal. The voltage spikes for the IR25750L method are due to the capacitance of the internal HVFET used to sense the VDS (on). These spikes, however, are only positive so they do not contribute to latch-up issues. In addition, as these spikes occur only during the off-time of the MOSFET, they should not cause any tripping of, for example, a cycle-by-cycle peak over-current limitation circuit.'

A further observation was that the gate-to-COM signal for the resistor method increases as the drain current increases due to the voltage drop across the sensing resistor. This results in a decrease in the gate-to-source which can give higher losses in the MOSFET. The adapter, however, exhibited no change in the gate signal.

Work is continuing to compensate for RDS (on) variation over temperature, which will improve overall accuracy and enable more applications for this new current sensing method.

Further details from www.irf.com

ENGLISH SCHOOLS TO SERVE RASPBERRY PI

The Autumn 2014 term in English schools has seen major changes to the way in which computer skills are taught with The National Curriculum 'computing programmes of study' replacing the former ICT curriculum.

All pupils who study the new curriculum will be required to understand the fundamental principles of computer science, analyse and solve problems by applying computational techniques, write a program for these problems, apply technology including new or unfamiliar technology to analytically solve problems, and be competent users of information and communication technology.

In the article 'Teacher: Don't leave those Kits alone' in *Engineering Technology* Volume 9 Issue 9 (October 2014) Alison Ebbage explains how the Raspberry Pi computer is being positioned at the heart of these new learning initiatives:

'The Pi has effectively roughly the same power as an Apple iPhone and is relatively inexpensive. Users can run apps on it, but the beauty is that it can be connected to other things via a series of general purpose input and output (GPIO) pins.

It can also be used right down at command level, making it ideal for both younger users to see how a computer can make something move and work, and older pupils to learn to program at command level.

Furthermore, because of its affordability, it lowers any barriers to adoption based on individual affluence: even a relatively inexpensive "200 computing device can prove a pricey purchase for many youngsters. If a Raspberry Pi gets lost or broken the

impact is nothing like the same as an equivalent loss hitting a laptop or tablet PC device.'

Types of Raspberry Pi

In order to meet the requirements of the new curriculum many educational suppliers are now offering educational and teaching kits to help teachers deliver learning material. These vary in composition and content, but are designed to provide a focus for project-led approaches to Raspberry Pi based work.

Among the offerings is The Little Pi Shop, a website that offers a small, but selective, range of Raspberry Pi education kits that are achievable and fun-oriented. Education kits come in bundles of five or ten for classrooms and have been designed to work with the Japanese Rapiro Robot as well as the MaKey MaKey 'invention kit for the 21st century'. The principle is to turn everyday objects into touchpads and combine them with the Internet. A Moodle offers online open-source support divided into jump-right-in starter questions as well as project-specific help and general forums to suit beginners through to advanced users. Key-stage specific sections show what the new curriculum demands and suggests ways to fulfil those requirements. The range includes the Iridium+ Starter Kit, designed for the latest model of Raspberry Pi, the B+, which was launched in July 2014 and designed very much with the new curriculum in mind.

The use of Scratch coding at primary level ensures that younger pupils can drag-and-drop commands, and so can still understand that their programming and commands (the dragging-and-dropping) has had an impact on something else.

The article quotes Paddy Fawcett, Director of The Little Pi Shop, as follows:

"Scratch doesn't use syntax and so the series of commands it offers can be used with click-and-drag, for instance 'hello', 'wait one second' and so on. It is a nice one as younger children quickly get to grips with it and can immediately see the impact of their programming. It is the whole concept of being able to make something happen."

The Little Pi Shop is also working to assist teachers with curriculum delivery and are offering free workshops to help with this.

Mr. Fawcett states:

"We think that up to 90 per cent of teachers have little or no skillset when it comes to programming and computer science, so to bridge that gap we have free workshops, which we are trying to get CPD accredited. The workshops also give us feedback on how to make our kits more user friendly – something we consider to be important since we are right at the start of this process."

Another offering is the Wishtrac Raspberry Pi Complete Curriculum Kit aimed at Key Stage 2 and Key Stage 3 of the curriculum. This contains everything except a display monitor to get started with Raspberry Pi and complete six units of work.

The kit comes with help sheets, medium-term planning, lesson plans, worksheets and presentations for teaching those six units of work with the Raspberry Pi computers. It also offers CD ROMs for teachers to get started with Raspberry Pi and guides for several additional projects such as controlling motors to make an illusion.

Timothy Jones, Marketing Manager for Wishtrac, is quoted as follows:

"At the teaching end we want the teachers to be able to jump straight into this and have tried to make it user friendly for them as well as for the children. Lots of teachers are finding that having a code club at school is a good approach as it allows for small incremental steps for both teachers and pupils and lets them ease into the new curriculum.

We wanted the coding, Scratch, to be easily usable and for pupils to be able to easily identify how to use the kits and what the variables are that affect how the commands work. For example, with a simple alarm the variable is set to be on or off and the output is the signal to the buzzer to tell it to go on or off."

Another offering is the three kits from CB Educational:

(i)   The Robot Arm Kit designed to provide an introduction to programming with real-world integration.

(ii)   The 4WD car, a small four-wheel drive aluminium car that can be controlled over a network with an Xbox controller.

(iii)   The Emotiv Education Kit with Emotiv EPOC headset and powerful software that allows students to writ a program to interpret brain signals into commands to control robots using the power of thought.

These kits can work independently or together to combine functionality. Thus, for example, the headset can be used to drive the 4WD car.

The kits are particularly suitable for all Key Stages of the new curriculum. There is Scratch virtual representation of the robot arm that looks, sounds, moves, and is controlled like the physical robot arm. This can then be transitioned from Scratch to Python, a script function.

At *The Electronics Design Show* The Raspberry Pi Foundation was represented by its co-founder and trustee, Pete Lomas, who is also Co-founder and Director of Systems Engineering for Norcott Technologies. He spoke about the Foundation's focus of putting creativity, experimentation and fun into the teaching of programming and electronic engineering through the use of the low cost Raspberry Pi single board Linux computer. He was responsible for the physical implementation of the final Raspberry Pi hardware and co-ordinates hardware design and manufacturing activities within the Foundation.

Contact Details

Contact details for the Raspberry Pi new Curriculum kits are:

www.littlepi.org

www.wishtrac.com/products/Raspberry-Pi-Complete-Curriculum-Kit.html

www.cbinfosystem.com/EducationalKits.aspx