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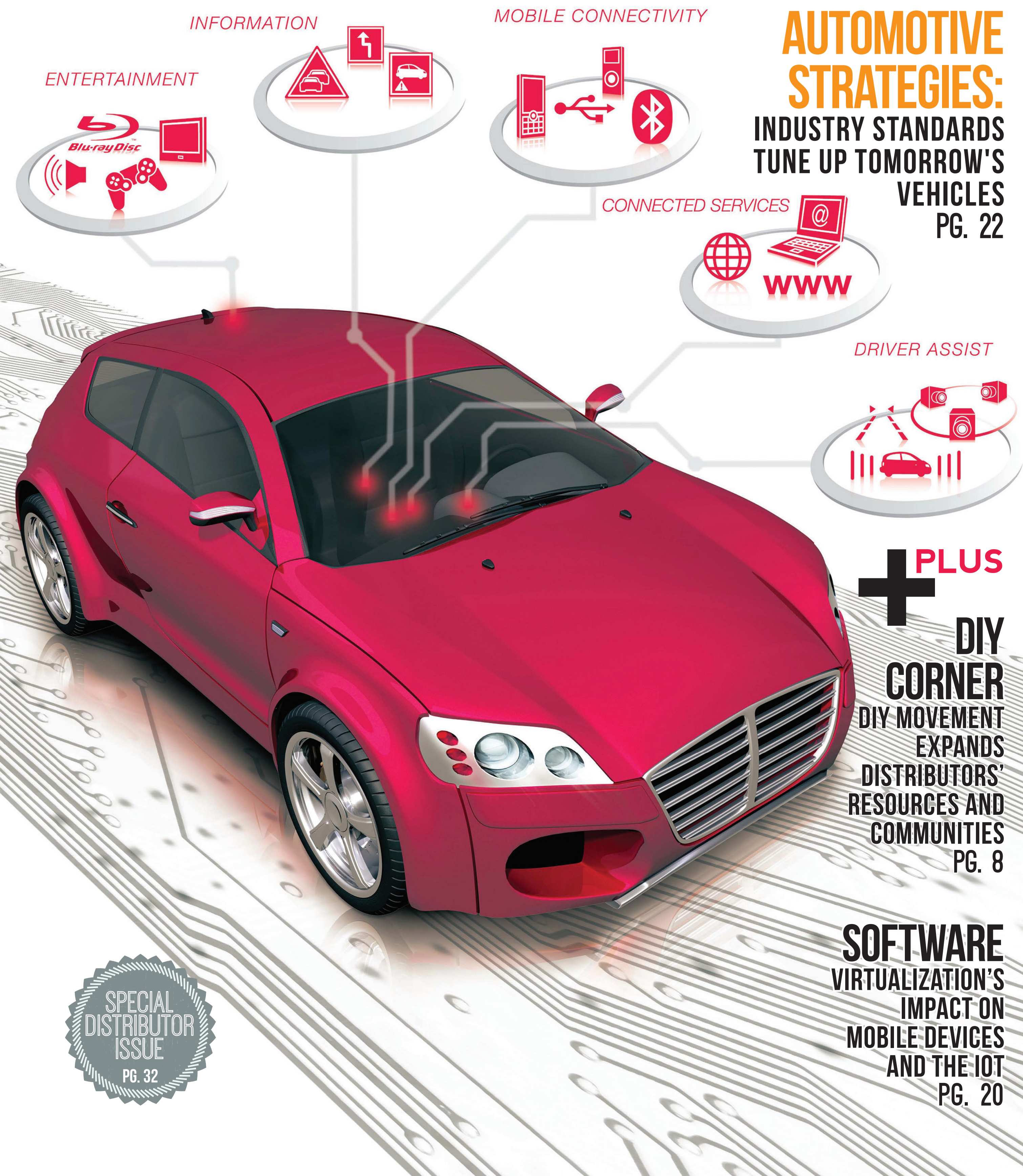

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Electric vehicle vision

By Rory Dear, Technical Contributor *rdear@opensystemsmedia.com*

In the rapidly expanding electric vehicle rollout, the future of embedded computing in this space will depend on how these heavily integrated systems find commonality across potentially various operating systems.

Few former skeptics of electric vehicles would now doubt the electric future of automobiles. The "greenness" of that electricity itself remains contentious, but the leap to more widely spread renewable energy conversion is surely a shorter leap than the combustion engine has taken to electric after more than a century of fossil-fuelled ignition.

How this future electric vision manifests itself is quickly becoming a corporate battleground. Competition dictates that innovation progresses rapidly, usually at the expense of standardization. To become truly mainstream, that uniformity must first be reached. Once the battle is won, early adopters tend to pay the price with suddenly obsolete hardware.

Interestingly, in this war the main battle will not be the electric vehicle technology itself – it will be the vital infrastructure that must be in place, with 24/7 reliability and seamless integration, to make the most significant migration the motor industry has ever seen a reality.

In a major boost to our own industry, naturally embedded computing will be found at the heart of all links in this vital chain.

Within the vehicle, the now ever-powerful local platform will intelligently control charging, battery conservation optimization, crash prevention, automatic parking – alongside every other de facto function of today's motor vehicle. A quick boot-up time will surely be paramount here.

At the charging point, dispensed kilowatts will be billed to a cloud-based portal, displaying charging progress to owners from the comfort of their sofas, alongside any required maintenance – or Windows Updates!

Whilst locally possible, it is unlikely that complex fault diagnostics would be displayed to the layman driver, in case he attempts a potentially dangerous repair. **At the maintenance point**, mating embedded hardware will download, probably wirelessly, a vehicle's reported service needs and re-inspect itself once they're undertaken.

All of these links require exceptional reliability. You'll have noted my earlier mention of Windows Update – Microsoft has already invested heavily in its collaborative effort, forging links with major car manufacturers to push its Operating System (OS) range throughout the chain. Microsoft's recent Parisian car-sharing infrastructure deployment with Autolib is most impressive, but is the embedded market ready to reconsider Microsoft's OS reliability?

A substantial part of what once was a Microsoft-dominated industry has since made the shift to alternatives, usually embedded Linux derivatives, or bespoke OSs such as QNX – typically citing the need for almost perfect reliability.

Now we come back to the standardization necessity: embedded computers have always been able to communicate across OSs, but can differing OSs offer the level of integration that this new chain demands?

That's what Microsoft can offer: having ownership of the entire range, with derivatives targeted at each link, all designed from the bottom up to integrate seamlessly at every level. Embedded Linux, whilst revolutionary, with its many variants, may be too disjoined to meet the needs of this rapidly developing technology before Microsoft has gained such a stronghold that alternatives are prevented. Historically such monopolies have been quelled, but can the standardization needed to make this all work occur without it?

Perhaps we'll see a new Linux flavor developed that meets this need for scalability and integration, though will its legally required open source nature be too big of a risk in itself – or will sufficient investments in embedded security be realized to negate this?

Maybe the anti-Microsoft feeling will be sufficiently strong that a breakaway, universal, and bespoke OS will be the winner; though I personally doubt this could happen anytime soon. Competition dictates that, whilst with hindsight such collaboration would negate millions of dollars of wastage, each competitor wants their lion's share and will throw millions behind marketing their product – such as the cases of Betamax/VHS and HD-DVD/BluRay.

Whoever and whatever wins the standardization war, I am excited to be a part of it. What free market competition does offer, despite some wastage, is a succession of increasingly functional and efficient technology, and it's to this we owe the standard of living we enjoy today. ECD

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IoT standards seek the "smartest stakeholder"

By Brandon Lewis, Assistant Managing Editor

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While many enabling technologies for the Internet of Things (IoT) are already available to developers and end users, the missing ingredient has been the glue connecting platforms into one enormous living system. Despite the plethora of communications protocols in use today, "smart devices" suffer from the seemingly dumb problem of not being able to talk to each other. For example, take the smart meters and smart appliances that have been sold into homes for years now. The smart meter can receive grid consumption metrics from the utility company, and smart appliances can be managed remotely. However, the value of both the smart meter and the smart appliances increases exponentially if the meter can act upon usage data it receives from the utility and instruct the appliances to run only during off-peak hours, thereby saving the consumer money. But this can't happen at present because the smart meter and smart appliances don't speak the same language.

This is a problem of application domains, as a lack of interoperability prevents the different systems from identifying each other, provisioning network resources, and exchanging information. It is also a reflection of the tendency to think of the IoT as simply a bunch of devices connected to the Internet, rather than groups of interoperable devices converging in the physical realm to make up a vast network structure.

"What is missing is looking at the IoT as a 'system of systems' so to speak, and trying to figure out application layer protocols – which would be called Layer 7 in conventional Open System Interconnection (OSI) networks – that would enable us to essentially provide a sufficient level of data exchange from one application domain to another," says Oleg Logvinov, member of the IEEE-SA Corporate Advisory Group and Director of Market Development at STMicroelectronics (www.st.com). "There are many developments at the moment. They're not very unified, they are not very global, but many groups are trying to innovate as we speak in the direction of how to provide seamless provisioning of the device, how the device can join the network without putting a burden on the user. And in some cases there is no user because if it's just Machine-to-Machine (M2M) communication, the device has to be provisioned to the system without any kind of user participation. That's one aspect of it and that's where you see a lot of work happening on the standardization side."

Standardization will be a fundamental component of IoT rollouts, primarily because it ensures interoperability between devices intended for use in different vertical markets. But as Logvinov points out, current efforts to regulate interactions between systems are disjointed, and require that some entity govern interoperability standards to build and benefit the ecosystems affected by the IoT. The IEEE Corporate Advisory Group is an arm of the IEEE board of advisors that works with industry to advance this concept, he continues.

"If you look at the concept of 50 billion devices based on some studies, and some studies 100 billion connected devices, it is very important to create a very interoperable experience where the economies of scale can help drive the cost down, drive the performance up, and make sure that ecosystems can be built," Logvinov says. "The IEEE's goal is to essentially create a platform where multiple vertical silos can actually get together and explore convergence, what is similar among them, and potentially start cooperating and trying to reuse developments. As an example, let's talk about the smart home. What was developed for home automation, maybe the same concept can now be propelled into e-health domain applications. If you look at the device configuration, device health monitoring, security, provisioning, data privacy protection – all of those concepts are very similar, regardless of which application silo you're looking at. And from cross pollination and cooperation of multiple silos you can actually derive a lot of value. That is probably the main overarching goal of IEEE, to become the 'smartest stakeholder' of platforms where multiple industries, multiple verticals can come together and benefit from this work.

"If you look at the practical example – why, as an example, am I spending the time in this domain – the proof is in the pudding," Logvinov continues. One of the areas where STMicro is involved on a daily basis is in the development of gateway platforms for smart homes. At CES 2014 we showed one of our products that is essentially built into a gateway device developed by our partner, and that gateway is focused on home energy management, home surveillance, home automation, e-health connectivity, and many other features. So it is really a practical example of how the smartest stakeholder approach can come together on a single platform and enable less expensive, more efficient, and probably from the customer point of view, a more useful experience."

Realizing that no single company can provide everything that the IoT needs, the IEEE is currently organizing a number of workshops and events to identify roadmaps and ecosystem requirements. More information on these activities can be found at standards.ieee.org/innovate/iot/. ECD

DIY movement expands distributors' resources and communities

By Monique DeVoe, Managing Editor

The maker movement is rapidly expanding its fleet of boards from a few big-name options like BeagleBone, Raspberry Pi, and Arduino, to dozens of others in various shapes, sizes, and capabilities, with more being created all the time. Distributors have quickly embraced the open source DIY movement, offering a wide variety of boards that can be classified as DIY, as well as creating their own boards and new business models to go with them.

The low-cost, easy-to-use board model is not new – in the late 1990s to early 2000s, for example, Avnet (www.avnet.com) offered low-cost FPGA and CPLD platforms for mass-market experimentation and prototyping. And distributors like Mouser Electronics (www.mouser.com) already strive to offer quick product availability, fast shipping, small-quantity purchasing, and affordable pricing, features that are important to the maker movement. But the extent of the current DIY movement – and the hobbyist community it brings with it – has led distributors to expand their knowledge and offerings to fit the needs of this new, non-corporate community that has sprung up around these DIY boards.

Expanding knowledge and resources for a new market

"With more DIY boards coming online, each will have advantages and disadvantages that come with it," says Glenn Carlson, Supplier Program Manager at Arrow Electronics (www.arrow.com). "It is our job to understand those differences and propose the best solution for our customers."

Distributors must also make this information available to their customers. Avnet, for example, offers a Design Resource Center that has tools to help match the right DIY board out of the many offered with what a customer wants. Mouser Electronics utilizes technology and application microsites to showcase the features of each offering along with related devices like daughter cards/shields/capes, cables, and powered USB hubs that users might need for their projects.

"We do tend to offer substantial information for DIY boards and their ecosystems because there is simply more documentation that comes with them," says Kevin Parmenter, Director of Technical Resources at Mouser Electronics.

Understanding different board features isn't the only important thing to consider. Newark element14's (www.newark.com) Dev Kit Portfolio Manager Kim Majkowski notes "the difference is in the focus application, from the standard vertical applications over to the more consumer and hobbyist applications."

Customer base changes

Distributors note that the DIY movement has expanded their customer base beyond professional engineers and large corporations to tinkerers, students, and those without formal engineering or professional experience.

"Our customer base has changed dramatically since the invention of these boards," Carlson says. "We are working with multi-million dollar corporations on their latest products, and the three friends in the basement working on their concepts as well. The average person can now take their idea from concept to reality without having much education or training in engineering."

Though we often think of DIY boards as belonging to the hobbyist realm, professionals – including professionals at Google and Fortune 100 companies – are using them too, albeit in different ways.

"The low price point of the boards make it too attractive for any designer to pass up," says Jim Beneke, Vice President, Global Technical Marketing at Avnet Electronics. "You get some incredible value in these boards and they are a very low-risk way to test out a new idea or build a proof of concept."

Despite their differences, these disparate groups of professionals and hobbyists have come together to form the very active DIY community.

Community is key

One addition that comes with the maker movement is an important sense of community. Newark element14 addresses an important point about speed and transparency for a population that puts heavy emphasis on community.

"This is a tight community and word gets around quickly," Majkowski says. "When word gets out about a new product, we need to get it in stock immediately. Regarding transparency, if there is ever an issue with a product, or even a perceived issue, it is critical to get out in front and address it."

Mouser Electronics monitors social media and social platforms to keep an eye on what the DIY movement needs, and has opened their site to comments and participation. They also offer local technical support around the world for a more personal connection.

Distributors are also building their own communities around DIY. Avnet has continued its how-to approach to tutorials and training, in addition to increasing its online product availability, training, and support to help less-experienced makers. On the other end of the spectrum, Avnet caters to the design veterans with advanced support and design examples that decrease time to market. Newark element14 has its own element14 community, as well as "the Knode" where people can exchange ideas as members of open source communities do. They offer project bundles and starter kits to help members of the community get started, host the Ben Heck Show – an online program featuring modding, console hacking, and other projects by podcaster Ben Heck – projects for all levels, Code Exchange, Ask the Industry Expert, webinars and training, a learning center, and other resources to foster the DIY community.

What the future holds

Distributors welcome the challenge the DIY community is bringing to the future of embedded developers and systems.

"We believe this market will only increase," Carlson says. "New players will come into the market and it will yield inventions beyond your wildest dreams."

Mouser Electronics sees the embedded industry as a whole shifting due to what they call the Open Source Hardware Movement, which is growing and becoming more sophisticated.

"The most obvious trend is one toward an increasing number of easy-to-use design platforms," Parmenter says.

"DIY has traditionally been a back-of-the-magazine advertisement venture," Parmenter says, citing the Heathkit offerings for hobbyists last century. "The Internet has enabled sharing of hardware ideas, and now semiconductor companies [like Intel and Texas Instruments] are paying attention, which for the humble DIY market is amazing to see.

"As the idea of 'open source' continues to gain popularity, more semiconductor manufacturers are joining the movement to create easy-to-use development platforms to attract more DIY designers to their licensed or proprietary core architectures," Parmenter says.

As DIY boards grow in popularity and diversity, they are rapidly maturing from projects based around tinkering with home electronics into applications important to the traditional professional embedded community. Newark element14 sees a cloud computing trend taking off in the DIY market. Avnet has noticed DIY targeting the Internet of Things (IoT) and an increasing wireless connectivity and sensor integration, areas they forecast will see innovation driven by the DIY segment.

In all, distributors view the DIY market as a source of great potential in the embedded space and beyond.

"The DIY community will enable a whole generation of non-engineering educated people to create and design meaningful products that are applicable in the real world," Carlson says. "These products will create new companies that we will look to become the trusted advisors in the future." ECD

Improving automotive safety system effectiveness with model-based development

By Monique DeVoe, Managing Editor

Embedded systems are controlling an increasing amount of the automotive experience, from infotainment systems and connectivity to drivers' portable devices to driver assist and vehicle safety/control features, making them smarter, but also more complex. Often contrary to the safety-critical nature of some embedded automotive systems are short development cycles; there isn't always time to make sure these systems are 100 percent bug free before they're deployed in vehicles. Arizona State University's Center for Embedded Systems (CES) is working on developing a software tool that can improve confidence in these designs.

An area of CES's research is based on the method of Model Based Development (MBD). In MBD, the system design and development always starts with a mathematical model of the system, with which system designers use to verify that the model satisfies the system's specifications. MBD has several advantages over traditional system development methods; particularly, by utilizing MBD practices, the main design choices are evaluated on the model of the system, removing the need for building costly prototypes.

Georgios Fainekos, Assistant Professor, School of Computing, Informatics and Decision Systems Engineering at Arizona

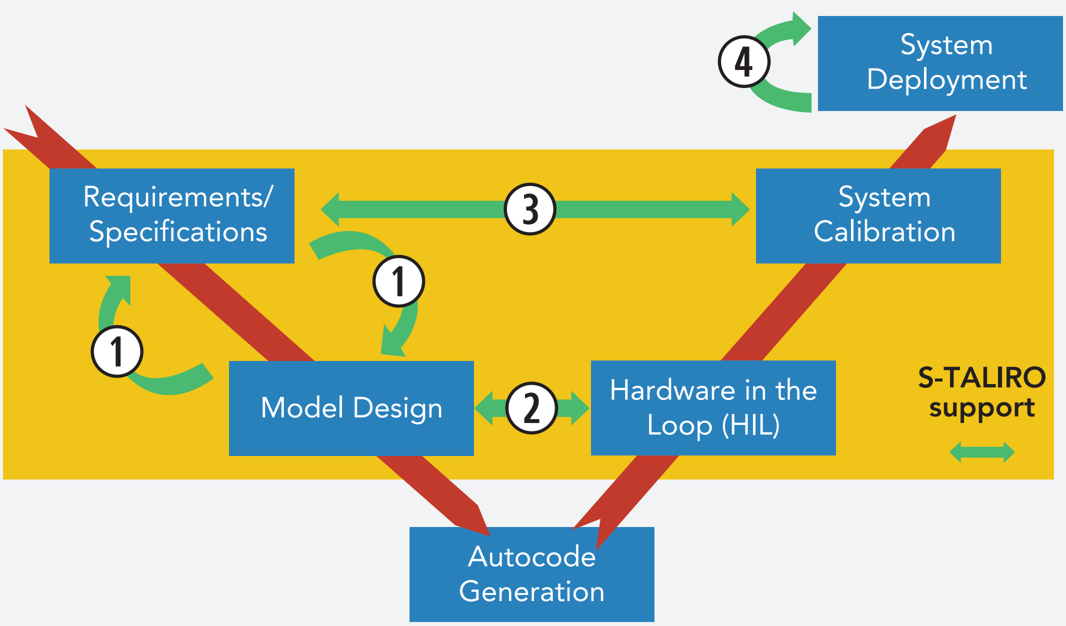

Figure 1 S-TALIRO's role in MBD: (1) Iterative development and testing/verification of model; (2) hardware/processor-in-the-loop conformance testing; (3) tuning and testing/verification of prototype system; and (4) monitoring of deployed system.

State University, is focused on MBD tools for Cyber Physical Systems (CPSs), or embedded systems that actively interact with the physical components of a control system – such as a car engine model or a person's body in the case of medical devices – and computations and communications that control the physical components. In automotive systems, CPSs include systems like drive by wire, ABS, and engine control. CES's focus on CPSs is achieving safety-critical dependability.

Fainekos, along with Dr. Sriram Sankaranarayanan at the University of Colorado, Boulder, has been developing the S-TALIRO or Systems TemporAL LogIc RObustness set of tools (Figure 1) over the last 5 years. It performs simulations to check the system model for behaviors that do not comply with system specifications, such as that the engine doesn't stall while the vehicle is cruising. In addition to checking for failures to meet specifications as many verification strategies do, it also checks for behaviors that produce close to the failure the simulation is looking for. In other words, it can find behaviors that will potentially fail the specifications and isn't restricted to finding actual failures, which means catching more potential, and potentially dangerous, bugs, thus giving system designers more confidence in their designs.

One potential effect of using S-TALIRO to analyze CPSs is to prevent recalls due to software errors that may slip through other methods of design verification. According to the CES, the complexity of modern automotive systems is influencing the industry to move into MBD practices to address the need for tools that can verify the correctness of a system's functional requirements. According to industry reports, software testing accounts for up to 22 percent of the total cost of a new vehicle. With the use of a tool like S-TALIRO, testing costs can be reduced by anywhere from 5 percent to 35 percent. CES member companies are experimenting with S-TALIRO in their applications, and the tools were nominated in 2012 as a Technology Breakthrough of NSF Industry/University Cooperative Research Centers (I/UCRC).

This year, Fainekos and his research team are focusing on creating a Graphical User Interface (GUI) for the tool. S-TALIRO relies on formal logic to formalize system requirements. The logic specifies when the system can perform what operations and not get unintended actions that could cause failures or potential failures. Writing the logic for these types of systems is not what engineers typically do and can require formal logic training. To make this system useful for those without formal training in logic, they are building a user interface that allows engineers to use the tools without having to write the underlying logic. Ideally, in the very long term, they want to come up with a system that can take the desired requirements, a partial model of the system, and synthesize the software so it satisfies the requirements. However, Fainekos says, "Once you can get it to that level it's the Holy Grail. The software design will come with formal correctness guarantees, but there will be no more need for large teams of testing and verification engineers." ECD

For more information, visit the TALIRO tools website:
http://opsy.st/ECDFeb14TALIRO

Best practices for designing high-throughput, real-time SoC systems

By Nick Ni

Today's System-on-Chip (SoC)-based systems are routinely asked to perform multiple, disparate tasks such as running a base Operating Systems (OS) while also handling throughput-intensive applications. As the number of cores within SoCs also continues to grow, developers are left with many hardware and software considerations that often result in a tradeoff between real-time determinism and low-latency performance.

Modern SoC software often consists of multiple applications, ranging from hard real-time (such as automotive motor control) to high-throughput (such as HD video streaming). These hybrid system designs are becoming more challenging as the modern SoC evolves rapidly into a high-throughput system with an increasing number of processor cores and high-bandwidth interconnects. Achieving hard real-time – μs-level response with less than one μs jitter – on such a system requires careful tradeoff analysis and system partitioning. It is also essential to consider future-proofing strategies for ever-increasing SoC complexity. Today, three main approaches exist from which designers can choose to optimize hybrid SoC systems: Asymmetric Multi-Processing (AMP), hypervisor, and Symmetric Multi-Processing (SMP) with core isolation (Table 1).

Asymmetric Multi-Processing

AMP is fundamentally a port of multiple OSs on physically different processor cores. An example would be to run a bare metal OS dedicated to handling real-time tasks on the first core, and to execute a full-blown OS, such as embedded Linux, on the other cores. Most of time, the initial porting of the OSs onto the cores is straightforward. However, the start-up

	Scalability	Initial Porting	Message Passing	Throughput	Real-time Jitter
AMP	Low	High	Slow	Reduced by core assignment	Low if no message passing
Hypervisor	High	Low	Slow	Reduced by the hypervisor decision	High
SMP w/ core isolation	High	Low/High*	Fast	Reduced by core assignment	Low

** Low if starting from an SMP OS, but high if starting from multiple OSs.*

Table 1 Comparison of AMP, hypervisor, and SMP with core isolation approaches to hybrid system design.

code and resource management, such as memory, cache, and peripherals, are very error prone. When multiple OSs access the same peripheral, behaviors become non-deterministic and could become extremely time consuming to debug. Hence, it often requires that a careful protection architecture, like ARM TrustZone, is in place.

To add more complexity, message passing between OSs requires memory sharing and needs to be managed together with the other protection measures. Because the cache is usually not sharable between different OSs, message passing needs to happen through non-cache memory regions, which adds latency and jitter to overall performance. It is also a poor software architecture from a scalability viewpoint, as it requires significant re-porting when the number of cores increases.

Hypervisors

A hypervisor is a low-level software layer that runs directly on the hardware and manages multiple independent OSs on top of it. Though the initial porting is similar to AMP, the benefit is that the hypervisor hides the non-trivial details of the resource management and message passing. One drawback, on the other hand, is that it incurs a performance overhead due to the extra software layer, degrading the throughput and real-time performance.

Symmetric Multi-Processing

SMP with core isolation runs a single OS on multiple cores with internal core partitioning. An example is to instruct an SMP OS to assign a real-time application on the first core and the rest of the non-real-time applications on the remaining cores. This approach is very scalable, as the SMP OS is designed to port seamlessly to an increasing number of cores. Because all cores are managed by a single OS, message passing between cores can happen at the L1 data cache level, resulting in faster communication with less jitter.

Core isolation can reserve a core for the hard real-time application to shield effects from other high-throughput cores, preserving the low-jitter, real-time data response. This is generally a good software architecture decision because it allows designers to consider which OSs to use instead of re-inventing error-prone, low-level software to manage multiple OSs. The initial porting may require some effort if there are multiple OSs from the outset, but this effort can be significantly reduced when starting from an SMP architecture.

Optimizing a high-throughput, real-time SoC with SMP

Based on analyzing the alternatives, SMP with core isolation offers the best architecture for optimizing high-throughput, real-time SoC systems. However, before further analyzing the tradeoffs of this approach, it is first essential to understand what a real-time response (or loop time) consists of:

1. Transfer new data to the system memory from an I/O (Direct Memory Access (DMA))
2. Processor detects the new data in the system memory (core isolation)
3. Copy the data to a private memory (processor memory access (memcpy))

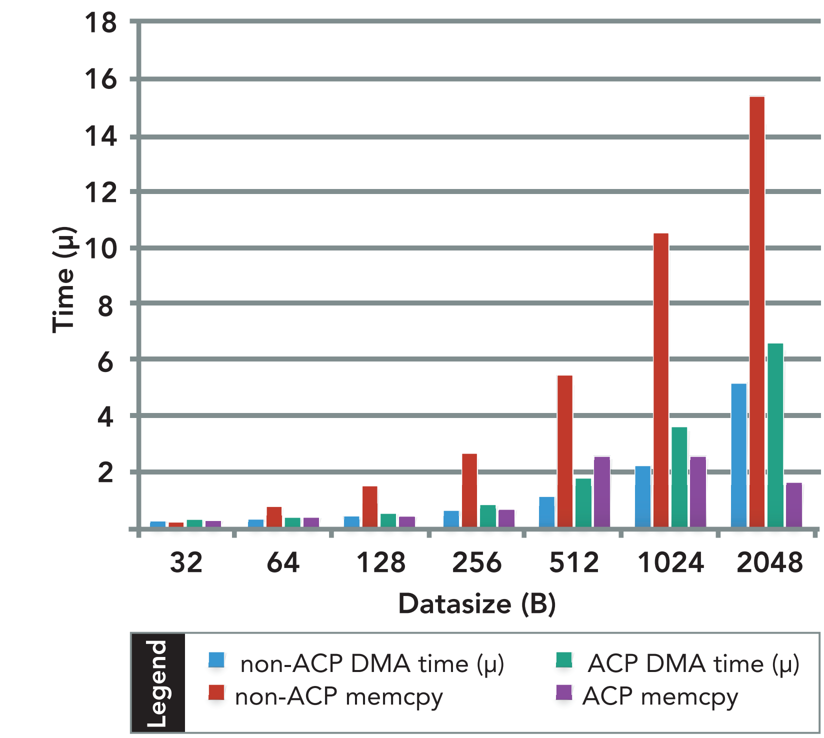

Figure 1 DMA and memcpy transfer performance with and without cache coherency.

4. Compute the data
5. Copy the results back to the system memory (memcpy)
6. Transfer the results back to an I/O (DMA)

Because jitter and latency are an accumulation of the six steps, it is essential to optimize each step. For a Real-Time Operating System (RTOS) such as VxWorks with core isolation, the polling/interrupt response can be bound in the ns range (step 2), and data computation is application specific and also fairly predictable (step 4). Therefore, designers should focus on the tradeoff between the DMA and the memcpy (steps 1, 3, 5, 6).

There are two major means of transferring data – with or without cache coherency – and the two methods have very different consequences for DMA and memcpy. As shown in Table 2, for example, although using the ARM Cache Coherency Port (ACP) results in a longer path for DMA, the processor only needs to access the L1 cache to obtain the transferred data. Therefore, memcpy time is significantly lower using cache coherency, and dominates the small degradation in DMA performance (Figure 1). This means cache coherent transfers result in much lower latency and jitter due to the direct cache access.

Case study: Best-practices in SoC design

A complete system based off the previous example can be demonstrated with a reference design using a Cyclone V SoC FPGA development kit. The device consists of a dual-core ARM Cortex-A9 core subsystem (called the Hard Processor System (HPS)) and a 28 nm FPGA in a single chip (Figure 2). The system architecture is as follows:

Hardware architecture

- Two DMAs to transfer data from the FPGA I/O to the ARM processors and vice versa
- Both DMAs are connected to the ACP to transfer data directly to and from the ARM processor cache
- Real-time control unit IP to initiate message passing between the ARM

processors and the DMA engines in the fastest way possible
- Jitter monitor collects the real-time performance and jitter by directly probing the DMA signals, achieving accuracy within ±6.7 ns

Software architecture
- VxWorks RTOS running in SMP mode on the dual-core ARM processors
- Core isolation used to assign the real-time application to the first core and the rest of non-real-time applications to the second core
- The real-time application continuously fetches data from I/O, computes the data, and sends the results back to the I/O
- The non-real-time applications stress the ARM core and other I/O performance by continuously running FTP transfers and decryption of the data

Without cache coherency:	*DMA: I/O->Interconnect->SDRAM* *Memcpy:* *CPU->L1(miss)->L2(miss)->Interconnect->SDRAM*
With cache coherency:	*DMA: I/O->Interconnect->Snoop Control Unit->L1* *Memcpy: CPU->L1(hit)*

Table 2 DMA and memcpy transfer paths with and without cache coherency.

Loop time and jitter experiments were run on the system using different data sizes that ranged from 32 bytes to 2,048 bytes. Each data size was run millions of times to collect a histogram of the loop time for jitter analysis, or the difference between the maximum and minimum loop times. As shown in Figure 3, even with heavy FTP traffic running on the second core, µs-level latency with less than 300 ps jitter was achieved over millions of test runs. There is some variation in jitter swings, but they are controlled within a range of 200 ps, which is insignificant at these throughput levels.

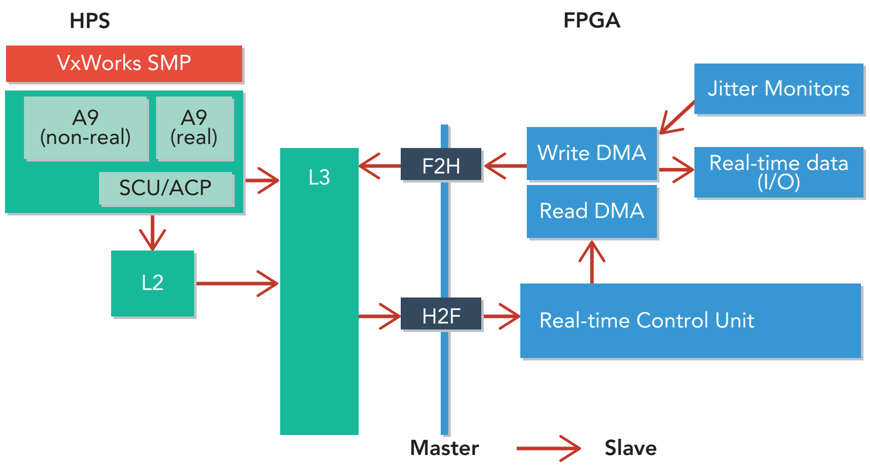

Figure 2 Experimental system reference design using the Cyclone V SoC FPGA development kit

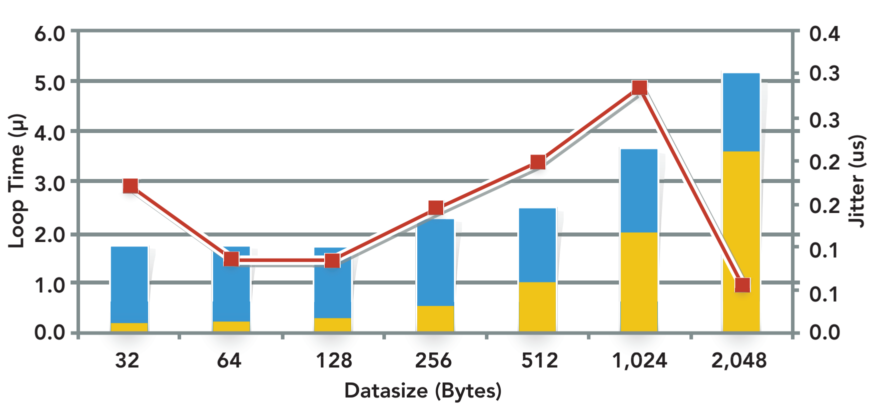

Figure 3 Loop time and jitter results of Cyclone V SoC FPGA development kit-based experimental system.

The same FTP application was also run on the VxWorks SMP utilizing both cores and achieved close to a 2x speed increase. Therefore, the SMP with core isolation technique does degrade throughput, resulting in a tradeoff decision between throughput and hard real-time applications. An AMP solution also exhibits the same degradation due to hard partitioning of the cores, however with much less scalability for an increased number of cores.

Best practices yield tradeoff considerations

Designing a balanced SoC system with high-throughput and real-time applications requires a number of tradeoff considerations, such as:

- DMA data transfer
- Cache coherency
- Message passing between the processor core and the DMA
- OS partitioning
- Software scalability with increasing number of processor cores

The "best-practice" system design using SMP with core isolation and cache coherent transfer described here achieved low-latency and low-jitter, real-time performance while maintaining software scalability for future generations of SoCs.

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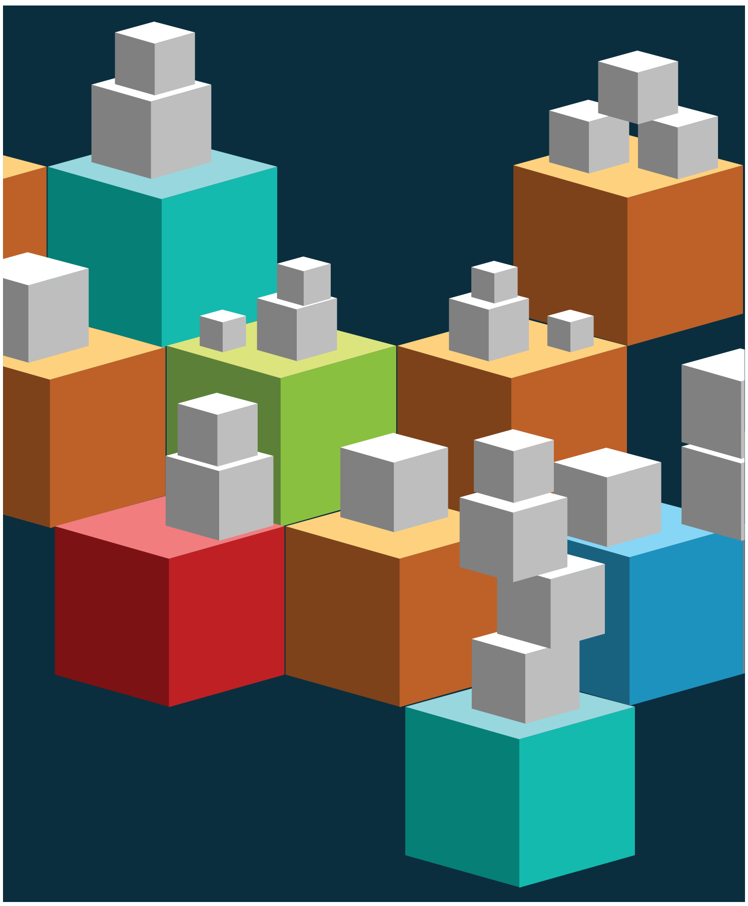
Embedded virtualization: Latest trends and techniques

By Curt Schwaderer

Data center network architectures have been increasingly influencing all areas of embedded systems. Virtualization techniques are commonplace in enterprises and data centers in order to increase capacity and reduce floor space and power consumption. From networking to smartphones, industrial control to point-of-sale systems, the embedded market is also accelerating the adoption of virtualization for some of the same reasons, as well as others unique to embedded systems.



What is virtualization?

Virtualization is the creation of software abstraction on top of a hardware platform and/or Operating System (OS) that presents one or more independent virtualized OS environments.

Enterprise and data center environments have been using virtualization for years to maximize server platform performance and run a mix of OS-specific applications on a single machine. They typically take one server blade or system and run multiple instances of a guest OS and web/application server, then load balance requests among these virtual server/app environments. This enables a single hardware platform to increase capacity, lower power consumption, and reduce physical footprint for web- and cloud-based services.

Within the enterprise, virtualized environments may also be used to run applications that only run on a specific OS. In these cases virtualization allows a host OS to run a guest OS that in turn runs the desired application. For example, a Windows machine may run a VMWare virtual machine that runs Linux as the guest OS in order to run an application only available on Linux.

How is embedded virtualization different?

Unlike data center and enterprise IT networks, embedded systems span a very large number of processors, OSs, and purpose-built software. So introducing virtualization to the greater embedded systems community isn't just a matter of supporting Windows and Linux on Intel architecture. The primary drivers for virtualization are different as well. Embedded systems typically consist of a real-time component where it is critical to perform specific tasks within a guaranteed time period and a non-real-time component that may include processing real-time information, managing or configuring the system, and use of a Graphical User Interface (GUI).

Without virtualization, the non-real-time components can compromise the real-time nature of the system, so often these non-real-time components must run on a different processor. With virtualization these components can be combined on a single platform while still ensuring the real-time integrity of the system.

Figure 1 shows a general embedded virtualization architecture. For enterprise Virtual Machine (VM) applications, it's typical to have a "host" OS, then running within the host OS a virtual machine running the "guest" OS. Figure 1 shows a component called a Virtual Machine Monitor (VMM) or hypervisor. In embedded systems, this hypervisor is a "to the metal" software layer that abstracts and partitions memory and I/O resources between the virtual machine environments. This approach leads to greater security and isolation between the two virtual environments as well as providing higher performance within each VM.

Technologies enabling embedded virtualization

There are some key capabilities required for embedded virtualization – multicore processors and VM monitors for OSs and processor architectures. In the enterprise/data center world, Intel architecture has been implementing multicore technology into their processors for years now. Having multiple truly independent cores and symmetrical multiprocessing OSs laid the groundwork for the widespread use of virtualization. In the embedded space, there are even more processor architectures to consider like ARM and its many variants, MIPS, and Freescale/PowerPC/QorIQ architectures. Many of these processor technologies have only recently started incorporating multicore. Further, hypervisors must be made available for these processor architectures. Hypervisors must also be able to host a variety of real-time and embedded OSs within the embedded world. Many Real-Time Operating System (RTOS) vendors are introducing hypervisors that support Windows and Linux along with their RTOS, which provides an embedded baseline that enables virtualization.

Where are we in the adoption?

As multicore processors continue to penetrate embedded applications, the use of virtualization is increasing. More complex embedded environments that include a mix of real-time processing with user interfaces, networking, and graphics are the most likely application. Another feature of embedded environments is the need to communicate between the VM environments – the real-time component must often provide the data it's collecting to the non-real-time VM environment for reporting and management. These communications channels are often not needed in the enterprise/data center world since each VM communicates independently.

LynuxWorks embedded virtualization perspective

Robert Day, Vice President of Sales and Marketing at LynuxWorks (www.lynuxworks.com) echoed much of this history and current state of the embedded industry and virtualization. "Enterprise systems are nowhere near as diverse as in the embedded systems environment. In addition, embedded environments are constrained – the virtualization layer must deal with specific amounts of memory and accommodate a variety of CPUs and SoC variants."

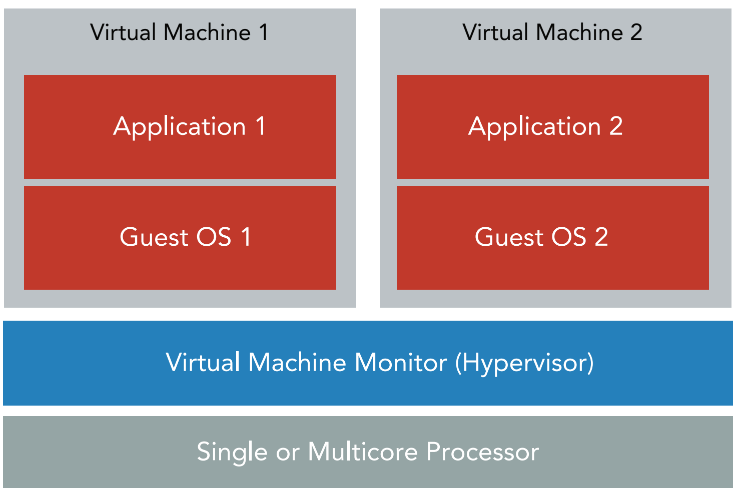


Figure 1 Typical embedded virtualization architecture.

Day notes that embedded processors are now coming out with capabilities to better support embedded virtualization. Near-native performance is perhaps more important in embedded than enterprise applications, so these hypervisors and their ability to provide a thin virtualization and configuration layer, then "get out of the way" is an important feature that provides the performance requirements the industry needs.

Day references the Type 2 hypervisors that run or depend on another OS – this kind of configuration simply doesn't work in most embedded environments due to losing the near-native performance as well as potential compromise of real-time characteristics. Type 1 hypervisors – the software layer running directly on the hardware and providing the resource abstraction to one or more OSs – can work, but tend to have a large memory footprint since they often rely on a "helper" OS inside the hypervisor. For this reason, LynuxWorks coined the term "Type 0 hypervisor" – a type of hypervisor that has no OS inside. It's a small piece of software that manages memory, devices, and processor core allocation. The hypervisor contains no drivers – it just tunnels through to the guest OSs. The disadvantage is that it doesn't provide all the capabilities that might be available in the enterprise VM world.

LynuxWorks has seen initial virtualization use cases in the defense applications. The Internet of Things (IoT) revolution is also fueling the embedded virtualization fire.

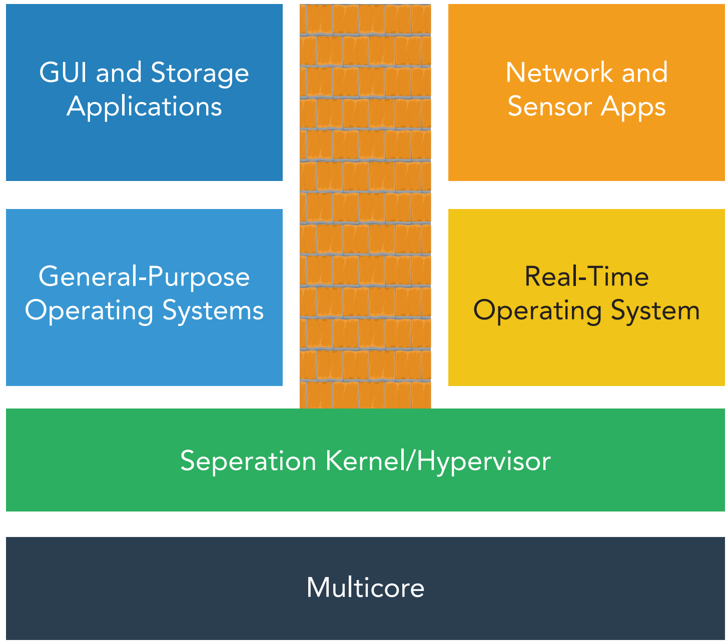


Figure 2 Embedded virtualization example for real-time data sensor sampling and GUI management and reporting.

Embedded system developers typically know the platform their systems run on, what OSs are used, and what the application characteristics are. In these cases, it's acceptable to use a relatively static configuration that gains higher performance at the expense of less flexibility – certainly an acceptable trade-off for embedded systems.

LynuxWorks has been seeing embedded developers take advantage of virtualization to combine traditionally separate physical systems into one virtualized system. One example Day cited was combining a real-time sensor environment that samples data with the GUI management and reporting system (Figure 2).

Processors that incorporate Memory Management Units (MMUs) support the virtualized memory maps well for embedded applications. A more challenging area is the sharing or allocating of I/O devices among or between virtualized environments. "You can build devices on top of the hypervisor, then use these devices to communicate with the guest OSs," Day says. "This would mean another virtual system virtualizing the device itself." Here is where an I/O MMU can provide significant help. The IOMMU functions like an MMU for the I/O devices. Essentially the hypervisor partitions devices to go with specific VM environments and the IOMMU is configured to perform these tasks. Cleanly partitioning the IOMMU allows the hypervisor to get out of the way once the device is configured and the VM environment using that device can see near-native performance of the I/O.

Virtualization is one of the hottest topics today and its link to malware detection and prevention is another important aspect. Day mentioned that malware detection is built into the LynuxWorks hypervisor. This involves the hypervisor being able to detect behavior of certain types of malware as the guest OSs run. Because of the privileged nature of the hypervisor, it can look for certain telltale activities of malware going on with the guest OS and flag these. Most virtualized systems have some method to report suspicious things from the hypervisor to a management entity. When the reports are sent, the management entity can take action based on what the hypervisor is reporting. As virus and malware attacks become more purpose-built to attack safety-critical embedded applications, these kinds of watchdog capabilities can be an important line of defense.

Wind River embedded virtualization perspective

Technology experts Glenn Seiler, Vice President of Software Defined Networking and Davide Ricci, Open Source Product Line Manager at Wind River (www.windriver.com) say virtualization is important in the networking world.

A network transformation is underway: The explosion of smart portable devices coupled with their bandwidth-hungry multimedia applications have brought us to a crossroads in the networking world. Like the general embedded world, network infrastructure is taking a page from enterprise and data center distributed architectures to transform the network from a collection of fixed-function infrastructure components to general compute and packet processing platforms that can host and run a variety of network functions. This transformation is called Software Defined Networking (SDN). Coupled with this initiative is Network Functions Virtualization (NFV) – taking networking functionality like bridging, routing, network monitoring, and deep packet inspection and creating software components that can run within a virtualized environment on a piece of SDN infrastructure. This model closely parallels how data centers work today, and it promises to lower operational expense, increase flexibility, and shorten new services deployment.

Seiler mentions that there has been considerable pull from service providers to create NFV-enabled offerings from traditional telecom equipment manufacturers. "Carriers are pushing toward NFV. Wind River has been developing their technical product requirements and virtualization strategy around ETSI NFV specifications. This has been creating a lot of strong demand for virtualization technologies and Wind River has focused a lot of resources on providing carrier-grade virtualization and cloud capabilities around NFV."

Seiler outlines four important tenets that are needed to support carrier-grade virtualization and NFV:

1. Reliability and availability. Network infrastructure is moving toward enterprise and data center architecture, but must do so and maintain carrier-grade reliability and availability.
2. Performance. Increasing bandwidths and real-time requirements such as baseband and multimedia streaming requires near-native performance with NFV.
3. Security. Intelligent virtualized infrastructure must maintain security and be resistant to malware or viruses that might target network infrastructure.
4. Manageability. Virtualized, distributed network components must be able to be managed transparently with existing OSS/BSS and provide the ability to perform reconfiguration and still be resilient to a single point of failure.

Wind River recently announced Wind River Open Virtualization. This is a virtualization environment based on Kernel-based Virtual Machine (KVM) that delivers the performance and management capabilities required by communications service providers. Service provider expectations for NFV are ambitious – among them being able to virtualize base stations and radio access network controllers – and to support these kinds of baseband protocols at peak capacity, the system has to have significant real-time properties.

Specifically, Wind River looked at interrupt and timer latencies from native running applications versus running on a hypervisor managing the VMs. Ricci mentioned Wind River engineers spent a significant amount of time developing with the KVM open source baseline to provide real-time preemption components with the ability to get near-native performance. Maintaining carrier-grade speeds is especially important for the telecom industry, as performance cannot be compromised.

The future is virtualized

Embedded virtualization is being used in a large number of embedded industry segments for a wide variety of reasons. Near-native performance, maintaining reliability, and the ability to work within constrained environments are the challenges. One thing is clear – virtualization is here and software companies rooted in embedded systems are applying virtualization technologies to meet the demanding requirements of embedded applications.

Virtualization resources

LynuxWorks virtualization pages:

- Embedded Linux Virtualization
  http://opsy.st/ECDFeb14Virt1
- Hypervisor
  http://opsy.st/ECDFeb14Virt2

Wind River virtualization pages:

- Open Virtualization
  http://opsy.st/ECDFeb14Virt3
- Enhancements to carrier-grade virtualization software for NFV
  http://opsy.st/ECDFeb14Virt4

For more information, contact Curt at cschwaderer@opensystemsmedia.com.

Virtualization's impact on mobile devices and the IoT

By Micha Rave

Virtualization is expanding from server applications to the mobile space of smartphones, automotive systems, and M2M systems. It is poised to address security issues while also reducing hardware costs for these connected systems.

In today's world, virtualization is ubiquitous. From on-site hosting services to the ever-expanding cloud, server virtualization has become the expected course of action. Securely separated virtual machines on cloud platforms can serve customers with widely varying business models and services side by side, isolated by trusty hypervisors. Now the use of virtualization is spreading far beyond its basic server roots.

Virtualization for embedded systems

The mobile and embedded worlds are hungry for virtualization technology, as devices become increasingly more powerful and ubiquitous. Virtualization presents many benefits for several areas of embedded computing, including increased security and isolation, better migration, faster time to market, enhanced CPU utilization, and cost savings.

Mobile

As smartphones become the hub that manages people's personal and working lives, the hardware driving them is rapidly becoming as powerful as desktop and laptop computers. More powerful hardware equals higher resolution content, and creates better mobile capability opportunities for mobile device manufacturers. Smartphone makers have used virtualization technology to consolidate hardware and run modem software and Android on a single chip, thereby reducing the total cost of smartphones in developing markets to as low as $30.

For example, smartphones today are comprised of two CPUs: one for communication (2G, 3G, LTE) and one dedicated to running applications. This architecture is mandatory to make sure an ill-written app or malware will not compromise the integrity of the cellular network. The two systems are certified independently and have different base Operating Systems (OSs) and life cycles. However, this also raises the cost of the phone and the power consumption. With virtualization, device manufacturers are able to build ultra-low-cost phones based on a single chip that runs both OSs – isolated and securely separated – to address developing markets' needs for low-cost hardware.

Automotive

Automotive companies are becoming more and more aware of the importance of a technology-driven user experience inside the car. The infotainment, navigation, telematics, and rear-seat entertainment systems are becoming high-end embedded systems that can be updated continuously with new applications and features, providing an opportunity for auto manufacturers to offer new entertainment and safety services throughout the car's lifetime. Paired with the fact that the car of tomorrow will always be connected – to the Internet, to other cars, and to roadside infrastructure – the need for additional computing power increases, as does the need to properly isolate open-world systems from the car's mission-critical internal functions, such as braking.

So, when combining consumer electronics and automotive-grade systems, a proper separation should be put in place to disallow any malware or misbehaved applications from gaining access to the car's functionality. By using virtualization inside the vehicle, several high- and low-end systems can be consolidated to run on the same hardware, eliminating miles of cabling and redundant hardware, thereby reducing fuel consumption, battery drainage, and, ultimately, the car's cost – all while keeping the systems securely isolated.

For example, today's car manufacturers and their Tier 1 technology providers are looking into running an infotainment system that includes navigation, multimedia, and climate control on the same chip in a "digital instrument dashboard." The infotainment system is by nature open and Internet-connected and thus open to outside attacks, while other mission-critical driving instrument systems cannot afford to be compromised. Installing the two systems on the same embedded device can yield up to several hundreds of dollars in saving per unit, and ultimately tens of millions of dollars in savings per year.

Machine-to-Machine (M2M)

In our connected world, and in the spirit of the Internet of Things (IoT), more and more devices are becoming "always connected" and remotely controlled. Vending machines, power and water meters, and communication equipment – all of these small-to-medium size devices are becoming Internet-ready to reduce the cost of management, enable better repair and control, and offer innovative consumer services like pay-as-you-go energy consumption. But when these systems require multiple functions or must be properly customized for different needs and markets, another CPU chip or virtualization is required to securely run multi-function software stacks with no cross-influence.

For example, M2M module vendors use virtualization to reduce costs by running a modem stack and an application stack to enable their customers to produce applications, migrate legacy code to newer chips and modules, and to maintain different lifecycles, enable independent certification processes, and provide cross-system fault tolerance.

ARM and virtualization make powerful impact on next-gen network servers

As the embedded world grows in power and functionality, it is also important that datacenter technology continues to grow with it in terms of low power and efficiency. For this purpose, ARM-based chips are much more power efficient than their x86 counterparts, and virtualization can still play a role to further optimize these systems.

Researchers today believe that shifting to ARM-based data centers can reduce power consumption by orders of magnitude for data warehouses. In addition, moving to an ARM-based architecture can enable such service providers to custom-tailor and fine-tune their offerings down to the chip and circuit level. This approach can yield hardware/software utilization unachieved by x86-based systems. Given that virtualization is a core element in modern data center technology, this new breed of power-saving server farms will need virtualization to optimize CPU utilization. The sheer amount of energy that can be saved make this a very compelling use case that has the capacity to disrupt the entire server industry.

The future is virtualized

Virtualization technology is already widely implemented in millions of systems, and other virtualization methods continue to be developed. The benefits of new services and cheaper "things," combined with improved security, will make people's everyday lives better. If embedded system developers can conclude anything from the impact virtualization has had on server technology, mobile virtualization is about to transform embedded computing by being a part of every little – and not so little – thing.

Micha Rave is Director, Mobile Virtualization, Product Management at Red Bend Software.

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INDUSTRY STANDARDS TUNE UP TOMORROW'S VEHICLES

RICK FLORES
AUTOSAR

ALAN EWING
Car Connectivity Consortium

JOEL HOFFMANN
GENIVI

HENRY MUYSHONDT
MOST Cooperation

Automotive systems are increasing in complexity as they connect with other consumer devices, assist drivers with safety features, and control more vehicle tasks. To facilitate interoperability and reliability, standards organizations are working with numerous Original Equipment Manufacturers (OEMs), integrators, and each other to develop system- and subsystem-level platforms for the vehicles of the future. *Embedded Computing Design* spoke with AUTOSAR's Rick Flores, Global Lead of Model-based Electrical System and Software Engineering at General Motors; Alan Ewing, President and Executive Director, CCC; GENIVI's Joel Hoffmann, Automotive Strategist at Intel; and Henry Muyshondt, Executive Director, MOST Cooperation about the challenges and strategic and technical considerations of creating standards for the fast-growing automotive electronics industry. Edited excerpts follow.

Q What are the key technology drivers in the automotive industry today?

FLORES, AUTOSAR: Over the last few decades, electronics and software have become increasingly important for automotive applications, as they drive approximately 90 percent of all innovations and account for up to 40 percent of a vehicle's development costs. Current examples of technology drivers in the automotive Electric/Electronic (E/E) architecture are functional safety, Ethernet-TCP/IP communication, multicore, security, and new diagnostics regulations.

MUYSHONDT, MOST: One of the key drivers for automotive electronics is the need to better integrate various domains in the vehicle, such as infotainment, driver assist, navigation, and communications outside the vehicle. This drives the need for communications standards between these domains, and also drives up the need for higher bandwidth as more data is transferred within the vehicle and to the world outside the car.

The challenge is that these systems are typically developed by totally different groups within a car maker's organization, and those groups have different problems that they are trying to solve. The other challenge is finding a technology that fits a broad range of functions. In the case of video, an infotainment system requires higher and higher video resolution and wireless connections to the cloud, while a camera system has more critical latency and determinism requirements. It is necessary to have standardized interfaces to allow the independent development of various domains, while at the same time allowing those domains to easily transfer information between them.

HOFFMANN, GENIVI: The growing expectation of always being connected with the same level of personalization that drivers enjoy on their smartphones and other consumer electronics is one of the key technology drivers in this area. This requires seamless transitions between home, office, and car with contacts or entertainment choices immediately accessible. As a complement to this, automakers, insurance companies, and others look at this notion of "always connected" as a great opportunity to gather data about the car and its drivers to proactively deliver useful and actionable information to the driver.

The greatest challenge facing automakers and their software suppliers is the exponential growth in the amount of software required to meet the growing demands of drivers. IVI systems are stretching to over 50 million lines of code and automakers simply cannot continue their historically slow software development and delivery practices.

EWING, CCC: Driver distraction guidelines have been one of the most interesting things we've worked on in the CCC, and also one of the most challenging. Everybody's a little different, and what's distracting for this group of people is not necessarily distracting for that group. Issues include things like font sizes, complexity of menus, scrolling text, contrast, and how much time it takes to look at the screen and figure out what's going on. The U.S. and EU have guidance for driver distraction, and OEMs are concerned about this because they have liability issues with distracted drivers. The guidelines need to be distilled into test cases for application developers so they know how big their font sizes have to be, how much contrast is needed, and the dimensions of the information. All this is very complex to test and very time consuming to undertake.

Q How do standards approach the lifecycle disparities between consumer and automotive technology, and how do standards benefit manufacturers, developers, and end users alike?

MUYSHONDT, MOST: Automotive systems focus more on being able to distribute information rather than providing static functions; they are the interface between the consumer and their digital world. While the particular kind of information that gets distributed can change more quickly than the vehicle can, the interface to consumer's eyes, ears, and touch does not. Particular instantiations of consumer products change quickly, but larger trends are actually more in tune with the automotive industry. For example, the transition from cassette tapes to CDs, DVDs, and currently mp3/digital music took over a decade each. Car makers have the long-term vision to be able to integrate each technology wave in a timely manner.

The car industry is relatively small in comparison to the consumer industry. It also has much longer lifecycles, which in turn drive much more stringent quality requirements – a typical car platform takes 3-4 years of development; systems used in these cars have to be useful for 15-20 years, and they have to survive in all types of climates for that long. Having a standard that has been developed by the car industry assures that the systems based on it will meet the long lifecycle and quality requirements of the industry.

[Standards] also allow suppliers a common way to communicate between the various subsystems they make for different car makers, without having to develop a new system for each car maker. Consumers benefit from the high quality and long life that these systems provide to them, and also from a lower cost point as development costs are spread over a larger number of vehicles from many car companies.

FLORES, AUTOSAR: In state-of-the-art vehicles, the complexity of the electronics/electronic architecture and the Electronic Control Unit (ECU) software is rapidly increasing, so the use of proprietary solutions becomes less competitive. Uniform and open standards are needed to master this growing complexity.

By relying on standard products available on the market, extensive software reuse and software sharing with different suppliers, standards such as AUTOSAR provide improved development costs and quality. Thus, it is possible to achieve faster time to market for new features, and to integrate software functions from multiple suppliers into a single ECU.

EWING, CCC: With a clear idea of problems and talented engineers and software development folks from throughout the industry, we can sit down and bang through the problems with about 90 percent effective discussion. And with 102 member companies, there's a lot of overlap with other standards groups. We have really good insight into GENIVI, JASPAR, and liaison relationships with the Wi-Fi Alliance, Miracast, and Bluetooth SIG. One of the strengths of a consortium partnered with OEMs and other vendors is you bring in all those visions from your member companies who are putting stuff on the ground, and by doing that you typically are able to find the right path through the maze.

Q What are the standards your organization is currently working on?

FLORES, AUTOSAR: AUTOSAR Release 4.1.1 specifies a TCP/IP protocol suite over Ethernet as a new general communication mechanism. It includes the support for application protocols such as onboard diagnostic communication with software and hardware and service discovery. Additional application protocols will be needed to support automotive use cases, such as support of worldwide harmonization of On-Board Diagnostics (OBD) on Ethernet (ISO 27145), support of upcoming vehicle-to-grid communications protocol ISO 15118, streaming interface, as well as support for safety-related communication over the TCP/IP protocol suite. In addition, concepts are currently being developed, for example, for the configuration of switched systems as well as the efficient handling of large data types in the communication stack of an ECU.

MUYSHONDT, MOST: [MOST] technology includes not only the physical interconnection between devices, but also the necessary network management software and interfaces to control various devices attached to it. It offers a robust optical physical layer that greatly simplifies dealing with electromagnetic interference issues, as well as easier scalability between different speed grades – the same optics and light sources/detectors can be used in 25 Megabit per second (Mbps) to 150 Mbps systems, and the network management software is also the same. There is also an electrical system that uses Unshielded Twisted Pair (UTP) or Shielded Twisted Pair (STP) wiring for more modular design than optical systems, but requires more work to switch between speed grades. A coaxial wire physical layer is also emerging to bridge the gap between optical and UTP solutions.

HOFFMANN, GENIVI: The GENIVI software platforms provide a starting point for producing an IVI development environment that any organization can use to produce a full IVI software platform or individual application. The baselines are actually open source projects hosted at projects.genivi.org, and completely open for use by anyone. They form the basis of a Linux-based automotive software platform that can provide a jump-start to anyone interested in producing IVI software. These baselines represent the collective experience and knowledge of more than 180 GENIVI members, many of whom are leading suppliers of production IVI software in the market today.

EWING, CCC: The CCC's focus is on MirrorLink, which is a technology standard for connecting to and controlling smartphone apps from a vehicle dashboard display or steering wheel controls. It's currently in version 1.1, which supports wireless connectivity using Wi-Fi and Miracast, building on USB 1.0's connectivity.

Everything in MirrorLink is backward compatible, and we're working on version 1.2 to add some refinements to 1.1, like refining Miracast, HSML, and a few other technologies that augment the mirroring of the screen. Discussions for future revisions are in the very, very early days, but after 1.2 it's probably reasonable to say that once a year on average either refinements or something big will be included in an update.

Q How do you address security concerns in your standards?

EWING, CCC: Head units are becoming more and more tightly integrated into the vehicle. That's both a curse and a blessing for us. You get a lot of data access that we can take advantage of, but you have to be really careful. From the smartphone perspective back to the head unit, one of the ways we put up the appropriate guards, roadblocks, caution, firewalls, and so on, is through certifying the device. Only those phone and head units that are certified carry with them information that says, "I am a valid MirrorLink session/device/application, you're a valid MirrorLink head unit, we're allowed to talk and exchange information." For man-in-the-middle attacks, you can never eliminate them, but you can make them so difficult to do that it's impractical, which is what we've done. We have a series of audits that we do on our device manufactures to grant device certifications, and we have a security infrastructure for the app that is banking-quality kind of security.

MUYSHONDT, MOST: The data pipes provided by MOST Technology use data transports that employ industry standard security mechanisms, like AES128 encryption, or various Internet standards like SSL and the like. MOST actually multiplexes several different types of transports, including Ethernet frames and streaming protocols that each have security requirements set by content owners. Commercial video can be protected using Digital

Transport Content Protection (DTCP) or High-bandwidth Digital Content Protection (HDCP).

For Internet traffic, one of the MOST channels – MOST Ethernet Packet (MEP) – can transport Ethernet frames without any need to modify them. Thus all security standards developed for the Internet can be run unmodified to protect data traffic running over the network. The network is transparent to the applications running above it.

FLORES, AUTOSAR: With a new concept group started in 2013, AUTOSAR addresses the increasing demand to make vehicle networks secure and to reduce vulnerability. The activities focus in particular on message authenticity (identification of a trusted sender for messages received over the in-vehicle communication bus), message integrity (detect if a message has been manipulated during transmission), as well as message confidentiality (encryption of data before sending it over the in-vehicle bus for confidentiality and privacy reasons).

Q What features or abilities do you see emerging in automotive embedded systems that will need standardizing?

FLORES, AUTOSAR: Energy efficient technologies have become a key driver in automotive electronics during the last years due to increasing power consumption by new, complex electronic functions, a CO_2-based vehicle tax, and increasing fuel costs.

One of the concepts facing this issue is partial networking. Today, all ECUs in a car are active even if they are not needed. The goal of partial networking is to reduce power consumption of such ECUs by temporarily shutting down groups of them during active bus communication. The concept of pretended networking introduced with release 4.1.1 achieves power saving with an approach that reduces runtime power consumption by increasing the idle time of the MCU. This ECU-local approach allows an easy integration into existing networks. Further aspects to reduce power usage in automotive applications are to be identified and supported.

MUYSHONDT, MOST: The next big thing in terms of networking technology is the integration of sophisticated Advanced Driver Assistance Systems (ADAS), with multiple cameras to see around the vehicle and image recognition for the vehicle to interpret signs, traffic lanes, and other things outside the vehicle. These systems can also serve as a base to develop more autonomous driving functions for vehicles.

ADAS systems will provide a second set of eyes to watch for lane departures, signs on the road, speed limits, cars ahead, people or other objects, etc. Parking will become simpler. The car will be fully integrated into the owner's digital world. Standards are needed to integrate cameras and sensors, and also to distribute and use the data that results from all these sensors working together.

HOFFMANN, GENIVI: Features are constantly changing in the IVI space. The lines between infotainment and car safety are beginning to blur with an increasing wealth of driver assistance capabilities. This is an interesting growth path to consider. The management of car and driver information is another area of growth and is related to an interest in cloud technologies and the Internet of Things (IoT) movement.

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STRATEGIES

Automotive/Infotainment Technology

Q&A OPEN-SOURCE SOFTWARE STEERS AUTOMOTIVE ACQUISITIONS

Mentor Graphics recently acquired MontaVista's automotive division to boost its automotive and infotainment offerings. *Embedded Computing Design* spoke with Andrew Patterson, Business Development Director of Mentor Graphics' Embedded Software Division about the acquisition and Mentor's role in the automotive space.

ANDREW PATTERSON
Mentor Graphics

Q The acquisition of the MontaVista automotive division last year placed Mentor Graphics squarely into the automotive space. What prompted this move and how did the Automotive Technology Platform factor into the deal?

The MontaVista Automotive Division had already established a business around transforming open source Linux into a production-ready operating system for in-vehicle use. The MontaVista Automotive Technology Platform (ATP) was a GENIVI-compliant Linux distribution that had been ported onto popular SoC platforms such as the Freescale i.MX6 and Renesas R-Car H1 and taken all the way through production. With three OEMs already in production with the MontaVista ATP they have become the de facto market leader in the new trend of using open source operating systems for automotive. Mentor already had its own Mentor Embedded Linux offering and this too was gradually gaining acceptance in the automotive marketplace. By merging the MontaVista Automotive Division into the Mentor Graphics Embedded Software organization, it was possible to bring the best parts of both teams and Linux distributions together. The combined effort, now called the Mentor Embedded Automotive Technology Platform (ATP), is based on Yocto 1.5, maintains GENIVI compliance, and has a full supporting design environment and silicon foundry ecosystem behind it.

Q What are the main challenges facing IVI/automotive system developers today, and what puts Mentor Graphics in a prime position to offer more complete system solutions?

There are several challenges facing IVI designers today, which in many ways are the same challenges the automotive industry faces as a whole. These include reducing cost and increasing the rate of innovation while maintaining and improving quality. Also, carmakers are coming to terms with the strong influence of consumer electronics, and the requirement to innovate at a rate more usually associated with smart devices like tablets and smartphones. Additional challenges include:

- Switching to open source software instead of using commercially available licensed products. This can help to reduce costs, and even share components between OEMs where they are non-differentiating.
- Integrating 3rd-party stack applications, such as multimedia players, navigation, smartphone integration, multi-screen displays, in-vehicle cameras, Advanced Driver Assistance Systems (ADAS), and silicon integration.
- Resolving licensing and copy-left requirements. When using open source software, the terms of the license have to be preserved for downstream users. The end-user has the right to further modify and redistribute the source code, so OEMs and Tier 1s are required to consider this obligation when making use of open source components.

Mentor's focus has been to provide a complete platform that can be further adapted to suit the needs of specific OEMs and Tier 1s. Mentor helps to solve the more difficult integration problems such as Board Support Package (BSP) development, optimization of graphics layers and inclusion of Graphics Processing Units (GPUs), providing innovative software architectures including multiple domains which allows for ECU component count reduction, and the inclusion of Android and AUTOSAR subsystems.

Q What are Mentor Graphics' major focus areas going forward?

The further expansion deeper into automotive infotainment, instrument clusters, and telematics is a natural progression for Mentor. In fact, the combined MontaVista and Mentor Embedded organizations already have around ten new Tier 1s and OEMs in preparation for production.

Mentor Graphics has been carefully aligning its technologies into key vertical markets, where electronics and software innovation are prime enablers. Examples include Automotive, Home Automation/Smart Energy, Medical, and Telecommunications. As these markets grow, new revenue streams become available and Mentor has chosen to differentiate itself by focusing on certain areas of these new markets. Examples include "enabling connectivity" where Mentor has adapted its Nucleus RTOS and Linux platforms to fully make use of connectivity technologies such as Wi-Fi, NFC, and Bluetooth.

Mentor Graphics www.mentor.com @mentor_graphics

Reduce Security Risks and Uncover New Revenue Streams for Internet-Connected Devices

Do you know what products, versions and features your customers value in your products?

Are you able to diagnose and debug application issues on remote devices?

Do you handle a lot of support calls related to outdated versions of your products?

Do your products require frequent or critical updates?

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Learn how device manufacturers prepare for security issues and increase revenue with answers to these questions.
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E-CAST:

On The Road To Space-Age Vehicles: Developing for the Convergence of Consumer Electronics and In-Vehicle Entertainment

Presented by: Polarion, IBM, Vector Software, Mentor Graphics

The advances in IVI and advanced driver assistance technology encompasses a wide variety of connectivity, graphics, and sensor technologies. It's critical to start with a strong software foundation and utilize a development environment in order to bring meld these technologies into a safer, more integrated automotive environment.

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WHITE PAPER:

ACCELERATING AUTOMOTIVE SOFTWARE DELIVERY

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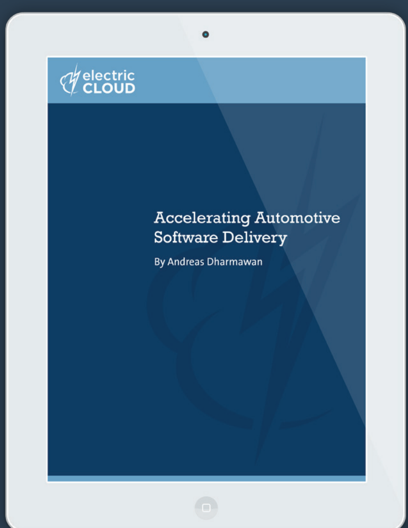

http://opsy.st/autosoftware

E-CAST:

Baby you can drive my car: Developing automotive electronics

Presented by: Freescale, Micron, Perforce Software, Qt by Digia

The average midrange car has over a dozen microprocessors in it. High-end models have over 100. Those systems need to be ultra-reliable and re-usable, they need to be tough and robust, and they need to be cheap. How can a developer possibly meet all those goals at once?

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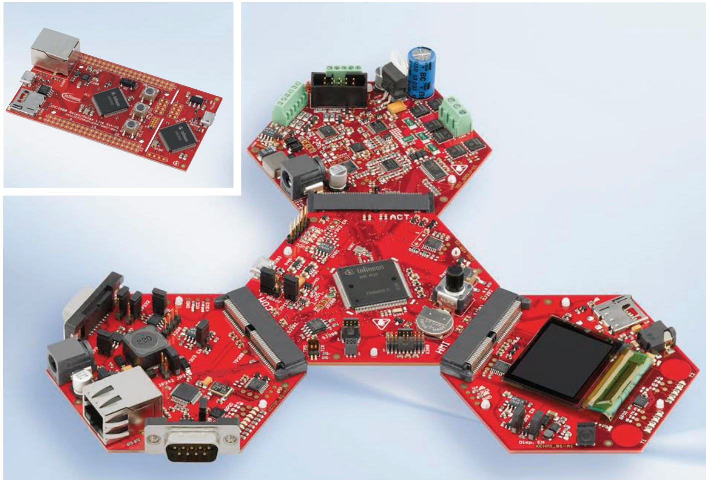
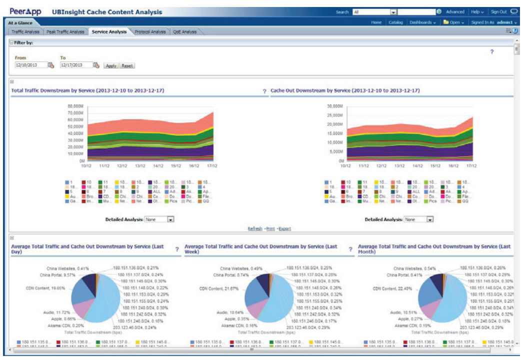


ARM-based microcontroller development hits mark with tools, kits

The next step in microcontroller development is here: By combining software application development with constraint logic programming familiar in the FPGA world, Infineon has provided evaluation platforms, development environment, and libraries that enable greater power efficiency, connectivity, and accelerate time to market. The XMC4500 Relax and Relax Lite Kits feature an ARM Cortex-M4F CPU at 120 MHz with 1 MB of flash and 160 KB RAM. Relax Lite provides a complete set of onboard devices and plugs, which enable running USB-based applications that also support the development of Human Machine Interfaces (HMIs) with buttons and LEDs. The Relax Kit adds Ethernet connectivity. For additional actuator and sensor control options, the XMC4000 Application Kit is available. The application kit provides a number of add-on options and plug-in boards. These kits are also supported by DAVE – a fully functional development and configuration environment that includes compilers, debuggers, and application libraries, all within the Eclipse environment familiar to mainstream embedded programmers.

Infineon | www.infineon.com
www.embedded-computing.com/p9916798



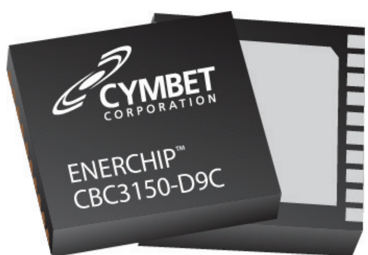
PeerApp embedded UltraBand transparent caching alleviates network bottlenecks, optimizes content delivery

Network operators are facing serious network congestion with the average household now using more than five devices to download network content. Popular multimedia downloads coupled with automatic software updates threaten to cause widespread network quality deterioration. PeerApp has developed the UltraBand Series, an embedded software solution to alleviate congestion by combining traffic inspection and caching of popular multimedia videos and applications that can be deployed in multiple edge locations of the network. As traffic flow content trends upward, UltraBand recognizes this and caches the content so subsequent requests can be served by UltraBand instead of back at the originating server. This results in a 4-10x delivery speed increase on average, while actually reducing upstream network load.

PeerApp | www.peerapp.com
www.embedded-computing.com/p9916802

Cymbet EnerChip solid-state batteries smaller, longer lasting han traditional alternatives

Batteries are a critical component of mobile embedded devices. They need to be light and small, but also last a long time in order for devices to be useful. EnerChip is a thin-film rechargeable Solid-state Smart Battery (SSB) package with a Surface Mount Technology (SMT) component produced using semiconductor fabrication materials, tools, and processes. EnerChips are up to 10 times smaller than non-rechargeable coin cell batteries, last up to three times longer, and are designed to last throughout the useful lifetime of embedded products. The EnerChip product line includes bare die, solid-state battery with and without integrated power management, and evaluation kits to accelerate development.



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> JamaicaVM Embedded and Realtime Technology for IoT, M2M, Industry 4.0, Aviation, Medical Devices, Robotics, and other embedded systems.

Our Jamaica-IoT product offers solutions for requirements of the M2M/IoT/Industry 4.0 market, enabling secure device connectivity for configuration, provisioning, monitoring and control. Critical features include:

- *Managed, secure, signature-verified application and component downloads and updates*
- *Increased software assurance through API-granular access control property lists*
- *Validated client for U.S. DISA certified military-grade open-standards based, scalable messaging infrastructure*
- *Platform of combined international standard APIs for local communications, device messaging protocols, and managed application execution, in a portable, CPU and operating system independent platform*
- *Reduced software development lifecycle and increase code reuse through use of committee standard, industry standard, 3rd party, and customer specific class APIs*
- *JamaicaVM's hard realtime performance and open standards-based APIs for realtime and embedded programming*

aicas realtime

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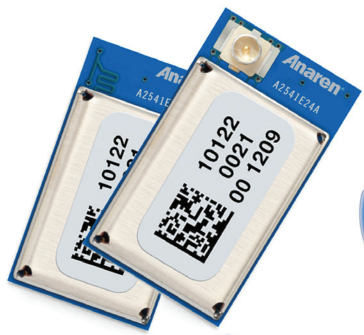

AIR Anaren Integrated Radio

AIR modules now feature: Bluetooth SMART

Developed by RF technology powerhouse Anaren, Inc. – in concert with Texas Instruments as part of TI's Design Network – Anaren Integrated Radio (AIR) modules are an easy, elegant, and cost-effective way to implement low-power RF capability. Each AIR module incorporates a proven TI low-power RF transceiver chip or SOC and is compatible with all TI-approved software stacks. AIR modules offer excellent performance, tiny footprints, ease-of-use, and pre-established compliance with applicable regulatory standards (including FCC, IC, and ETSI). And because AIR module are self-contained – OEMs using them to add RF functionality save the time and costs associated with developing your own radio solution.

NEW AIR module with *Bluetooth®* Smart technology enables embedded applications to connect to millions of *Bluetooth* Smart Ready phones and tablets – in as little as 90 days. This new, *Bluetooth*-based embedded communication solution includes:

- A2541x24x AIR module (based on TI's ultra-low-power SimpleLink™ CC2541 wireless MCU)
- Anaren's new B-Smart BoosterPack kit, compatible with TI LaunchPad development kits and other popular micro-controller (MCU) platforms
- "Em-hub" web portal from Anaren's software ally Emmoco (Austin, TX) that vastly simplifies development of the embedded wireless-communication function

Other advantages of communicating via *Bluetooth* Smart include: low-power consumption, which makes the protocol ideal for largely inactive or 'sleeping' controls or even remote sensors powered by a coin cell battery; local communication, without a connection to a network router or cellular tower; and the confidence that stems from adopting a proven and universally accepted communications standard.

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Concurrent Technologies
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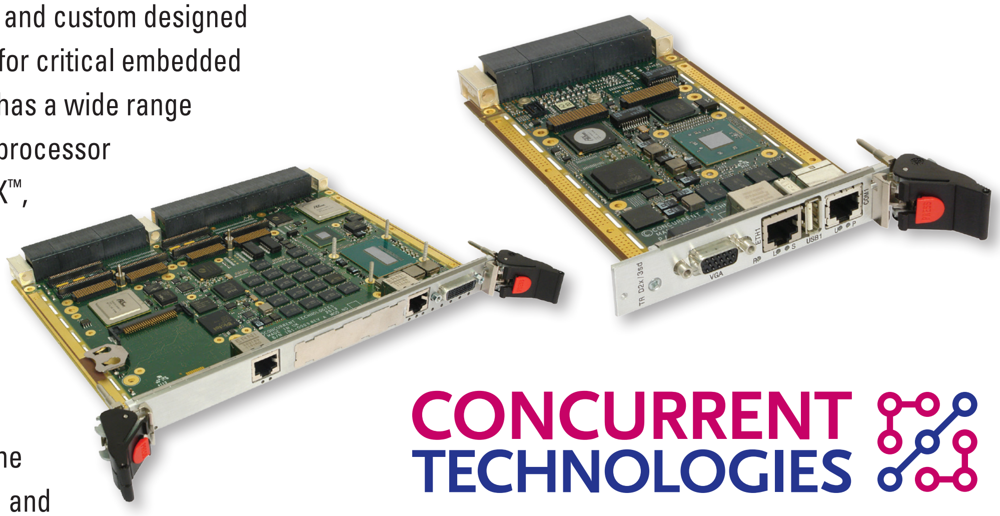
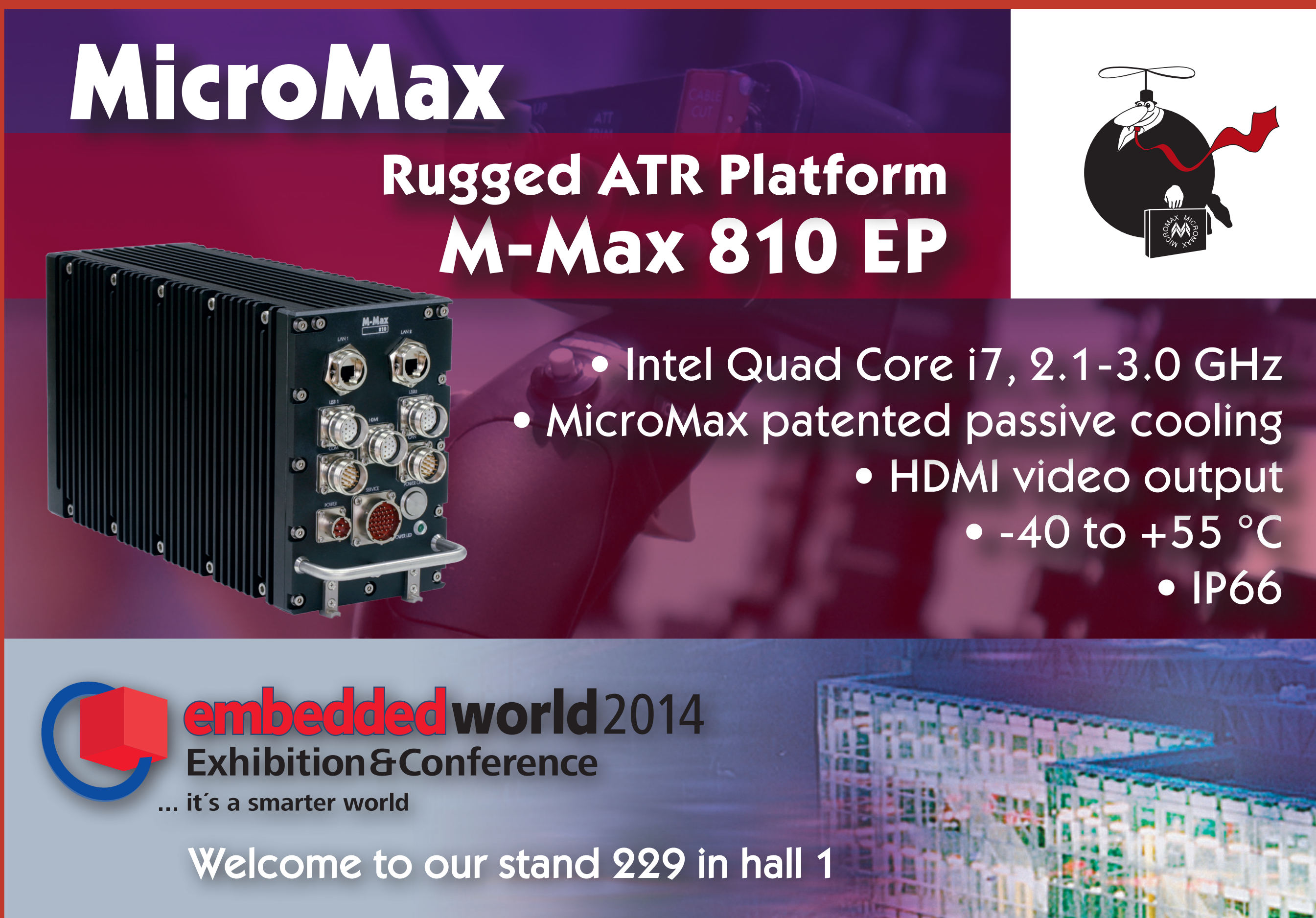
Concurrent Technologies, headquartered in the United Kingdom, specializes in the design and manufacture of commercial-off-the-shelf and custom designed industrial computer boards for critical embedded applications. The company has a wide range of high-performance Intel® processor based VME, VXS™, OpenVPX™, CompactPCI® and AdvancedMC™ products, which are complemented by an extensive offering of PMC (PCI Mezzanine Card) and XMC (Express Mezzanine Card) products. Commercial and ruggedized variants available.

"Concurrent Technologies' latest products feature the high-performance 4th Generation Intel® Core™ i7 processor or the low-power 22nm Intel® Atom™ processor.



CONCURRENT TECHNOLOGIES

Visit us at Embedded World: Hall 1, Stand 1-211



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Qt helps companies create innovative user interfaces for devices that require unique interfaces tailored for their target audience in industries where hardware is no longer the only focus. This ranges from HMI, simple push button controls for factory workers and other industrial uses, to some of the flashiest and most impressive interfaces to help device manufacturers compete in the fast-paced world of intuitive and comprehensive UIs.

A Complete & Flexible Embedded Development Framework

Qt supports embedded developers with a modular library of over 700 proven C++ classes with Qt. These classes offer more than just GUI design. By offering classes for XML, networking, IPC, SVG, threading, SQL, internationalization and multimedia, Qt provides a complete application framework that enables developers to focus on their key competencies and product differentiators rather than the basics.

Qt digia

Qt Enterprise Embedded

Qt Enterprise Embedded is a solution that does not only provide you with the verbose Qt libraries, but a powerful development environment that gets you up-to-speed and productive with the application and UI creation in no time with one-click deployment to the actual device. The included Boot to Qt Software Stack provides you with a ready-made solution for selecting and setting up the suitable software stack for your target device.

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WDL SYSTEMS

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ADLINK MXE-5400, Powerful 4th Generation Intel® Core™ i7 Processor-Based Fanless Embedded Computer

ADLINK TECHNOLOGY INC.

WDL Systems proudly distributes the latest ADLINK™ products such as the new Matrix MXE-5400 series of rugged designed quad-core fanless computers featuring the latest 4th generation Intel® Core™ i7-4700EQ (codename: Haswell), delivering outstanding processor performance with minimum power consumption. Intel's Quick Sync Technology and Core IPG equip the MXE-5400 with a market-leading performance boost in image/video related applications.

With the implementation of Intel® vPro™ (iAMT™ 9.0, TXT, TPM 1.2, Intel VT) technology and ADLINK's proprietary SEMA™ (Smart Embedded Management Agent) tool, the MXE-5400 maximizes manageability and security for a world of applications. Together, SEMA and vPro provide efficient remote monitoring of system activity and health in real time; system control over a robust secured channel; and fully manageable complete utilization of system resources.

The MXE-5400 series accommodates rich I/O interfaces in a compact system size, offering versatile connection to a wide range of applications. Dual mini PCIe slots and USIM socket empower the MXE-5400 to act as a communications hub for a variety of wireless connections, such as BT/WiFi and 3G. One PCIe slot is configurable to a mini SATA interface, cooperating with internal SATA storage to deliver RAID 0/1/5 functionality.

Leveraging proprietary mechanical engineering, the MXE-5400 series continues to offer all the popular features of the Matrix E series, including cable-free construction, wide operating temperature ranges, and 5 Grms vibration resistance. The entire ADLINK Matrix line undergoes rigorous testing for operational verification.

Combining superior processor performance, security and manageability, unsurpassed wireless capability, and rich I/O, in a compact and robust package, the ADLINK MXE-5400 is an ideal choice for a wide range of applications supporting intelligent transportation, in-vehicle multimedia, surveillance and factory automation applications. **Visit www.adlinktech.com/matrix for more info on the ADLINK MXE-5400.**

FEATURES

- *Equipped with 4th generation Intel® Core™ i7-4700EQ processor*
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- *Intel® vPro™ technology for security and manageability (iAMT™ 9.0, TPM 1.2, TXT, Intel® VT™)*
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- *2x SATA-III (6.0 Gb/s) ports, 2x mPCIe slots (w/1 mSATA SSD support)*
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WDL Systems distributes the latest technology for all embedded requirements and markets including Military, Medical, Academic, POS, Development and Factory Automation. WDL Systems' website provides online ordering, product information, and technical support.

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Computer on Module	ADLINK, Kontron, IST Group, SECO
Digital Signage/Panel PCs	DIT, Kontron, ICOP, VIA
Displays	DIT, Kontron, Matrix Orbital
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Industrial DRAM	InnoDisk, Swissbit
Industrial Keyboards	DIT
Machine Vision	ADLINK, Arvoo
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Mobile Computers	ARBOR, ADLINK
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Power Solutions	Kontron, OceanServer, Tri-M Technologies
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Software	Datalight
SSD	InnoDisk, Swissbit

Complete Vendor List:

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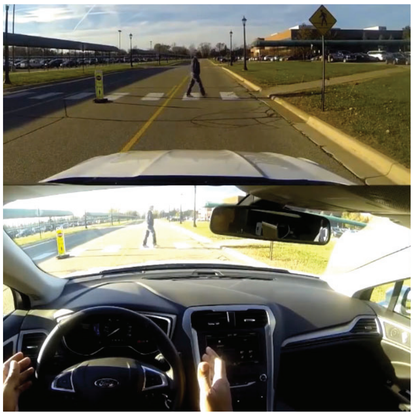
VIDEO

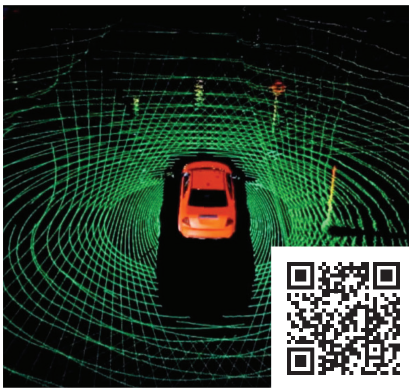
AUTOMATED FORD FUSION HYBRID RESEARCH VEHICLE

By Ford Motor Company

Ford's research vehicle integrates systems for sensing the world around the car to enable enhanced driving safety. Vehicles of the future will be able to avoid traffic congestion and collisions, and be aware of 360 degrees around themselves to improve human driver awareness.

http://opsy.st/ECDFeb14Video
video.opensystemsmedia.com





E-CAST

CONNECTED MEDICAL DEVICES IN THE INTERNET OF THINGS

Presented by: RTI

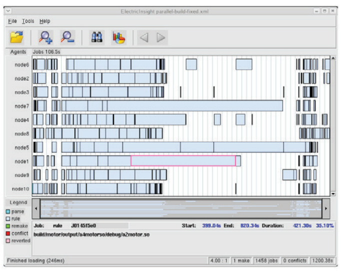
The Internet of Things is changing medicine today through advanced networking technology. It's critical for this technology to be able to find the right data, deliver high-fidelity waveforms, integrate large hospital systems, ensure EMR accuracy, and guard sensitive information.

http://ecast.opensystemsmedia.com/448

WHITE PAPER

A SCALABLE SOFTWARE BUILD ACCELERATOR

By Electric Cloud



For organizations that depend on software innovation, a slow software build process can be a bottleneck for the entire company. Slow build times not only impact engineering efficiency, but they can affect product quality and company agility. New tools can speed up build times and provide graphical insight into the performance and structure of builds at a level impossible with existing tools.

http://opsy.st/ECDFeb14WhitePaper

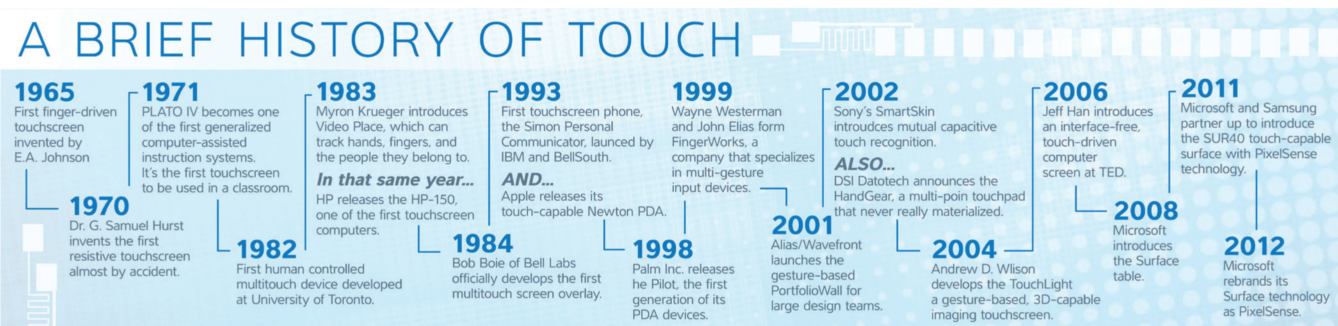
INFOGRAPHIC

50 YEARS OF TOUCHSCREENS

By Atmel Corporation

The earliest origins of touchscreens can be traced back to the 1940s, but they didn't become viable until the 1960s. Atmel traces the development highlights of touchscreen technology over the past five decades in the infographic below. Read more about the history of touchscreens:

http://opsy.st/ECDFeb14Touch



AMD

What you don't see
IS AS IMPRESSIVE AS
WHAT YOU DO

Technology with a human touch.

More and more customers are not only requiring better graphics, more display options and interactivity, but are also demanding higher reliability and long-term availability from systems being deployed. AMD understands these challenges in the embedded market and has developed solutions that combine eye-catching graphics performance with a high-value feature set So, whether your application requires basic 2D or 3D graphics and HD video on multiple displays, AMD Embedded Solutions can help deliver the performance, features and scalability to meet your needs.

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