Event Report: Embedded World 2016

News

Embedded World 2016 took place in Nuremberg from 23 to 25 February. It attracted more than 30,000 trade visitors this year and offered an update on the developments in embedded computing as it grows into the opportunities presented by Industry 4.0 and the Internet of things (IoT).

Insight

- The industrial embedded computing world is a fragmented set of market segments, typically with slow development cycles and a lot of technical complexity and customisation involved in each project. Although the overall market is large, few players are realising economies of scale.

- There are big opportunities taking shape from the trends in Industry 4.0, the Internet of things and virtualisation. These all depend on embedded devices being fully connected to networks and providing operational data. Addressing these opportunities will usher in greater use of standard components.

- Expectations are changing in the market thanks to the rise of smartphones and the maker movement. These are fuelling pressures to speed up development and remove cost from systems. They are also helping drive a trend toward better graphical user interfaces, more visual use of data and more use of video in the embedded world.

- The growth of the Internet of things will open up a number of new technology options in the embedded computing market, including low-power wide-area cellular networks, more use of cloud services, and the use of analytics in most systems.

- There will be a long-running tension between the drive to build using cheaper, standardised systems and a natural caution about using new technology. It is likely that brand-new system developments and disruptive players will provide the best near-term opportunities for players trying to break into the embedded computing market.

Analysis

Embedded World is a long-standing trade show for the industrial use of embedded computing. It is traditionally more focused on the "trade" than the "show" and is technical rather than glitzy.

In addition to the regular exhibitors, there were many players new to the area looking to seize the growth opportunities stemming from the twin buzzwords of Industry 4.0 and the Internet of things. Industry 4.0 is all about having industrial machines connected and providing operational data in real time, enabling smarter and more rapid decision-making either autonomously by intelligent machines or by people. Mostly the new players were IT and telecom suppliers interested in expanding into the industrial world. The show itself is embracing this expansion with the wonderfully meaningless slogan, "we are the IoT".

The overwhelming impression from the show is of a fragmented set of market segments that depend on a high degree of customisation to get what they need. The fragmentation is true at nearly all levels of the technology stack with, for example, 30 different versions of Ethernet in the area — all different from the Ethernet used in IT networks — plus a large

number of chipset suppliers, operating systems, communications and input/output (I/O) options, software development kits (SDKs) and so on.

Some of the suppliers at the show estimate that customisation is about 40 percent of their business; it is used to deliver exactly what customers need in features, protocols and certifications. This is largely driven by the breadth of use cases, which range from military vehicles and nuclear power stations, through traffic-light controls and production lines, to video surveillance and small sensors used in smart buildings. Across these there is a thicket of regulations and certifications that vary both by sector and by country.

Customisation is also driven by a focus on customers' operations, where the embedded computers work, rather than by serving the IT department. Operations technology is largely vertical, while IT is largely horizontal. The distinction between them is a major aspect of the embedded computing market and of the opportunity for the Internet of things within it.

As a result, there are many linkages between suppliers as they work together in different combinations on various projects in the segments they serve. The market was described to us by one exhibitor as a "fairly small family" in which most people know each other.

The area is also characterised by long, slow cycles. One supplier at the show described how a customer had just decided which chipset to use after 12 months of assessment, and can now start to consider other aspects of the system it is planning. The normal guarantee for product availability and support in this area is a minimum of 10 years.

The embedded computing market is really hundreds of smaller specialist markets. As a result, the only companies reaping any economies of scale are at the lower levels of the technology stack: chipsets, microcontrollers and some of the operating systems. STMicroelectronics announced at the show that it has shipped 1.5 billion STM32 microcontrollers since their launch in 2004. Although fragmentation is high, overall the area is large: one supplier estimated that there are 25 billion industrial machines in use worldwide.

Growth Opportunity Depends on Economies of Scale

The first aspect of the growth opportunity comes from the embedded world's fragmentation and slowness. The second part concerns the large new opportunities with Industry 4.0, the Internet of things and virtualisation, in which a much higher level of connectedness will exist. A common thread between the two aspects is economies of scale.

Many end-user organisations are frustrated by the slow speed of the embedded world, with long decision cycles and supply times often measured in weeks. Also, because of the fragmentation and complexity there is a great need for advice, for specialist software tools, for a high level of testing as well as dealing with the many different certification schemes. This means that companies may not be able to compete as they would like to, and that there is considerable overhead cost carried by many industries.

If it were possible to use more standard system components that benefits from economies of scale in their development, supply and support, there would be an opportunity to do things better, faster or cheaper — or all three of these.

Industry 4.0 and the Internet of things are two of the bigger hype terms in the industrial area. There is overlap between the phrases and — without entering into a semantic debate about them — the net result is that many more existing industrial machines will be connected. One exhibitor at the event estimated that about 1 billion of the 25 billion existing machines are connected to a network today, so there is a long way to go. There is also a large opportunity with the Internet of things to connect many new sensors and machines, expanding the addressable market.

Virtualisation is a third hype area, which involves running instances of controller software in containers on standard servers rather than on custom or specialist hardware within the machine itself. This should drive cost of ownership down significantly.

As devices are increasingly connected, it will become more important to use standardised systems and protocols to ensure interoperability, both at the device level and for the data they generate. Maximising this opportunity will depend on low cost of connections, and this points back to economies of scale.

Major Trends at Embedded World 2016

The key trends at the show this year relevant for the Internet of things are highlighted below. Several of them are taking place in the embedded computing market independently of Industry 4.0 and the Internet of things, and address current customer concerns. Security was one of these, with no specific developments to highlight, but there was strong positioning in the area from companies such as Kaspersky. Others trends are about addressing broader opportunities.

Lower Barriers to Entry and Lower Cost

Semiconductor supplier Renesas Electronics had three main themes behind its presence at the show: speed up the time to market, cut the cost of ownership and reduce barriers to entry. These nicely echo the way expectations are changing.

Generally, microcontroller prices are falling. One supplier mentioned that in 2016 it is shipping a device for $29 that cost $49 12 months ago. The effect of this is that customers are becoming less inclined to develop their own hardware.

The maker movement has raised expectations about how quickly and cheaply it is possible to carry out development work and prototyping. The Raspberry Pi single-board computer was mentioned as a major factor in this, and some companies have started to use them as development boards for proofs of concept. Janz Tec has taken this further and launched an updated version of its industrial emPC-A/RPI system based on the Raspberry Pi 2 but on its own circuit board, with a 24 V supply rather than 5 V, more I/O options and a robust casing (see Figure 1). It launched the original as an experiment a year ago and has been surprised by the levels of interest.

Figure 1. Janz Tec emPC-A/RPI
Source: Janz Tec

Imagination Technologies showed its Creator Ci40 developer kit, launched at International CES 2016, which provides "IoT in a box" including basic hardware units, open-source software frameworks, network capabilities and connectors to cloud services (see Figure 2).

Figure 2. Imagination Technologies Creator Ci40
Source: Imagination Technologies

In a similar vein Keolabs launched its IoTize module, an add-on unit that connects to the debug port of an embedded controller and provides a connection to cloud services without needing to interfere with the original hardware or firmware (see Figure 3). The module can be configured by adding chips to offer further connection and security options.

Figure 3. Keolabs IoTize module
Source: Keolabs

Speed and Time to Market

Several of the moves to reduce barriers to entry also help accelerate time to market, of course, but there were some notable moves that focused specifically on this aspect.

Since mid-2015, when Dell launched its first industrial gateway device, it has positioned itself in the industrial Internet of things as a company that can help speed up several aspects of the market by using the scale it enjoys in IT. At Embedded World 2016 it launched its first two embedded PCs, the Embedded Box PC 3000 and 5000 series, offering guaranteed 10-year availability, rugged cases, a range of I/O options, fanless design and extended operation in harsh environments (see Figure 4).

Figure 4. Dell Embedded Box PC 3000 and 5000
Source: Dell

Central to Dell's position is the view that it offers "operations technology on the outside, IT on the inside", with the benefits of dealing with a very large IT supplier, including financing options, next-day delivery worldwide of spare parts, and telephone support. Dell is using these elements to reduce the total cost of ownership, rather than just competing on price.

New Operating System Options

The operating system landscape at the Embedded World show was complicated, with a good showing from QNX, several flavours of Linux, Windows Embedded and the new Windows 10 Embedded, a number of proprietary real-time operating systems as well as runtimes such as Qt that enable software developers to work across these options more easily.

There was a strong presence at the show from Android as a further option for embedded computing. It meets an increasing need for graphics-rich applications, plus growing demand for touch-screen user interfaces.

Android's strength here was surprising as some enterprises will not consider Android phones for their staff, describing it as "toxic" on security. There are two main aspects to its use in embedded computing. The first is that customers see the development effort that has gone into Android, including its security, as already beyond what is available in some operating systems for embedded use. Many of the systems are used behind a corporate firewall, so security is perceived as less of a problem than with mobile phones. In this context, Android is therefore not seen as a bad option. This is the scale discussion playing out again: Google's investment in Android is more than a match for what embedded players can do themselves. The second aspect is that most customers already employ Android developers to create apps for their own customers, so it is easier and cheaper for them to write apps for their internal systems.

We are concerned, though, that the full implications of Android have not been worked out in this market, with Android fragmentation and updates as major stumbling blocks. Android updates raise a particular problem: Google has not yet set up a secure and managed update process itself, so Android users in the embedded market are dependent on others in the supply chain to manage the process for them, or they have to set up secure processes themselves to stay up to date. One software house that supplies Android-based embedded systems told us it has ended up with a different version of Android for each of its customers, and is generally not loading Android updates as they come through. This is not a good outcome.

At the other end of the scale was MicroEJ, a rebranding of IS2T, a Java operating system that works in only 28KB of memory and competes against some of the smaller real-time systems. MicroEJ has existed for 10 years, but is now expanding rapidly from its traditional customers in France and Germany. At International CES 2016 it launched a customer software store for embedded applications as well as the MicroEJ Studio SDK, and it is now trying to expand its developer community quickly with the US as the first target. Its main focus areas are manufacturers of smartwatches and other wearable devices, and home automation devices.

New Communications Options

Although there is a broad set of communications options used in embedded systems, with many specialist versions of IT standards that have been adopted in specific areas, there are also new communications options being launched with the Internet of things as one of the key drivers. Three stood out at the show.

Deutsche Telekom was pushing narrowband IoT (NB-IoT), due to be renamed as LTE category M2 by 3GPP Release 13. The standard is one of several low-power, low-bandwidth, wide area communications options being offered by network operators. It typically sends 85 bytes twice per day, which is suitable for some uses such as smart meters.

The advantages claimed for this technology are that it has much lower power consumption than cellular modules, so devices can have batteries lasting for five years; it has a 20 dB improvement in link budget compared with cellular modules, so offers a more robust radio link and provides better coverage; the low data volumes mean that it is sensible to send all the data straight to a cloud server, which simplifies customers' system architecture by removing the need for local gateways; and it uses licensed spectrum, and so can be guaranteed not to create or suffer radio interference.

Also available were two other low-power wide-area options. Sigfox was being shown on several stands. Sigfox is backed by several players including Telefonica and Intel, and is expanding its coverage in various countries quickly, trying to build a large network before other cellular options become fully available. LoRa, a competing technology being used by Orange and Swisscom among others, was also visible on several stands.

Mesh networking was a notable theme in communications options. ZigBee has been used in the embedded world for a long time, but notable at the show were stands at which Thread and pre-standard Bluetooth mesh networks were being demonstrated, as well as other proprietary mesh networking systems. There is renewed interest in mesh networking thanks to the Thread and Bluetooth standardisation efforts, which promise overall technical improvements in robustness and security, as well as substantial economies of scale.

Consolidation of Technologies

In the spirit of looking for economies of scale there are already some moves under way to consolidate technology options. One good example is the launch of M2.Com, a new standard for sensor modules built on the existing M.2 connector standard. It aims to combine several general wireless connectivity options with some built-in computing powered by a microcontroller unit and a range of sensors (see Figure 5).

Figure 5. M2.Com architecture
Source: Advantech

Another example is the IEEE Time-Sensitive Networking set of standards, which aims to unify the different Ethernet options in use for deterministic and real-time networking. This effort is now being combined with the higher-level protocol standardisation in the Open Platform Communications Unified Architecture (OPC UA), which is used in machine-to-machine communications. The latter is being enhanced to make it suitable for use in multicast and real-time communications, bringing the catchy new acronym OPC UA Pub/Sub.

One method of consolidation is by adoption of a de facto solution, rather than a formally standardised approach. This has happened successfully in Web servers with LAMP — a combination of Linux, Apache, MySQL and PHP — but there is no equivalent configuration for

the Internet of things in the embedded world yet. One key missing element is a de facto database option for devices at the network edge, although it is clear that the volume of data generated by IoT systems will need this.

One product gaining momentum as a database for the Internet of things is McObject eXtremeDB, which runs in 150 KB and meets ACID criteria, meaning its operations can be guaranteed in terms of atomicity, consistency, isolation and durability. It is used in devices as small as a GoPro or set-top box and — thanks to the level of code optimisation — is also finding a good market at the other end of the spectrum in corporate servers for high-speed algorithmic trading in the banking sector. At the show McObject was pushing its new version 7.0, which incorporates improved transaction logging for faster processing and more reliable recovery options, as well as implementing secure socket layer for better security.

McObject said that most of its new customers in the embedded world are companies that have written their own data-handling software for microcontrollers and have later realised that they needed a professional database system. The Internet of things will drive this further.

Displays, Cameras and Graphics

The Internet of things is one factor pushing the embedded computing world into using more visual information. This is for two main reasons. Firstly the volume of data and the range of sources mean that users will need dashboards to be able to take in the information quickly. Secondly, there is growing demand for camera-based systems for surveillance, security applications like iris scanning, image recognition such as correctly finished items on a production line, high-speed bar code scanning and so on.

This is fuelling demand for higher-specification displays, with increasing use of colour and touch screens in industrial settings, and for graphics software.

It is also boosting demand for industrial cameras, with 360-degree camera technology emerging at the show as an important new category. For example, Socionext, a semiconductor joint venture between Fujitsu and Panasonic, was showing its 360-degree wrap-around system for automotive use (see Figure 6).

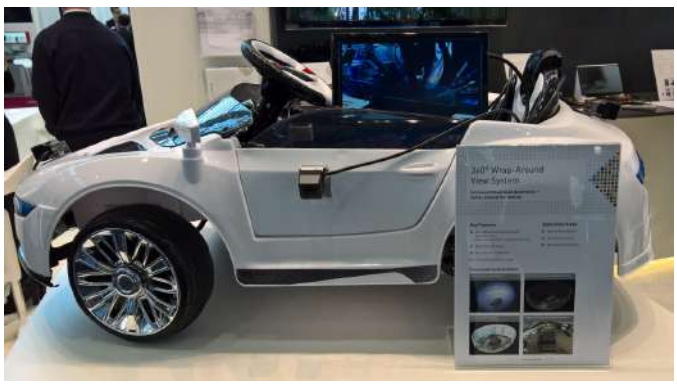

Figure 6. Socionext 360-Degree Wrap-Around View System
Source: CCS Insight

Cloud

Another relatively new area for the Embedded World event is cloud service providers and there were several at the show. Most prominent, and among the most-committed to the industrial Internet of things opportunity, was Cumulocity, which used the show to expand its reach with the developer community. Developers can connect their devices to the Cumulocity cloud by putting a small software agent on the device, and there is also the option to pass data through Cumulocity's cloud to another service, with the benefit of having only a single set of device connectors. At Mobile World Congress 2016 Cumulocity announced

release 7.0 of its platform, bringing integration with Jasper Technologies' SIM management platform, as well as support for several low-power wide-area systems including Sigfox, LoRa and, in a future launch, LTE category M2.

Analytics

Although Internet of things systems are often thought of in terms of how the things are connected, the real interest lies in the data they generate. Analytics will quickly become a key element, and there were many companies highlighting different aspects of their analytics capabilities at Embedded World 2016.

One significant trend is the rise of analytics at the chipset level. This is useful in applications that make heavy use of graphics, such as object recognition in video and machine vision. Nvidia showed its Jetson TX1, which is aimed at enabling deep-learning systems in the Internet of things, being used in robots and live camera feeds (see Figure 7). Connect Tech used the show to launch its Astro Carrier for Jetson TX1 carrier board for developers.

Figure 7. Nvidia Jetson TX1 display at Embedded World 2016
Source: CCS Insight

MathWorks, owners of analytics software Matlab, was exhibiting its Simulink product, which carries out systems simulation and runtime analysis then puts the control code into machines, and its ThingSpeak open-source server, with which it aims to make the area of analytics more approachable for people who are less well-versed in it.

This is a useful effort from MathWorks, but data analytics is a complex and specialist field. The tools available reflect this, needing considerable learning to use, and people who are skilled in the area are in short supply. For these reasons we expect the vast majority of analytics in the Internet of things over the coming years will be fairly simple, perhaps based on a typical activity profile with thresholds for alerts.

Improving Maturity of the Supply Chain

As the embedded computing market moves towards Industry 4.0 and the Internet of things, the supply side of the market is becoming more complicated, and roles are changing.

Embedded computing distributor Arrow described to us how it has changed from being a large-scale component distributor to having a major role in guiding customers through their decision-making processes and advising them on technology choices. Arrow has been working with Qualcomm to introduce a range of modules based on its Snapdragon 410, 500 and 820 chips. For Qualcomm this means guaranteeing supply for 10 years, something it has not had to do since its early days of serving military markets.

The day before Embedded World 2016, Intel held an event for members of its Internet of Things Solutions Alliance, at which attendance was up 50 percent over 2015, highlighting growing interest in the new opportunities. One of the main issues raised was that large systems integrators are not yet well set up for serving opportunities in the Internet of things, so companies further along the supply chain are having to invest significant time in making sure integrators are fully equipped to do this. The good news was that most of the new attendees at Intel's event came from the systems integrator group.

In a similar vein, ARM announced a deal with HP in which HP will act as a distribution, integration and solution provider for ARM's mbed IoT ecosystem. This is a large and important move owing to HP's size and strength in enterprise cloud services and its role as a systems integrator.

Some players are taking the view that the supply chain for the Internet of things is too complicated for most customers to navigate, and are providing highly packaged products instead. An interesting example was London-based start-up Hanhaa with its Parcelive system for tracking parcels and monitoring the conditions they experience (see Figure 8). Hanhaa has completely closed the system in the interests of making it reliable and easy to use. It does not even provide an on/off switch; the only thing its customers have to work out is how to use the data it provides.

Figure 8. Hanhaa Parcelive
Source: CCS Insight

Conclusions

Suppliers in the embedded computing area are fond of pointing out that the Internet of things is nothing more than a neat new label for something they have been doing since the early 1990s, and to a large extent that is true. However, the current opportunity offered by the industrial Internet of things is a big expansion of what is being done in embedded computing, and the huge potential only exists because cost structures have changed since the early 1990s thanks to economies of scale in the Internet, in hardware and in software.

To address the opportunity fully, suppliers will have to find ways to use those economies of scale and take cost, complexity and customisation out of embedded computing systems.

There are many large IT and telecom companies looking to help exploit the opportunity. Generally they hope to speed up the pace of adoption and change, but are not finding it easy to navigate the embedded computing area and become broadly accepted as suppliers. They recognise that there are specific features and certifications needed in different segments, but the scale that is their strength is also a weakness when it comes to implementing different variations and working with small order quantities.

Equally there are strong forces resisting rapid change — mostly for very good reasons. For example, it is extremely important that the embedded computing systems in aeroplanes are known to be highly reliable. Many segments will not wish to be the first to implement a new approach to embedded systems.

This tension will characterise the market for some years. It will mean that brand-new Internet of things projects are some of the most likely areas for adoption of new approaches based on standardised hardware and software, and that companies trying disruptive business models will be some of the most interesting potential customers.