The Three Phases of Device Connectivity: Networking's New Frontier

White Paper

Abstract

The world of computing is in the early stages of an extraordinary but quietly pervasive information technology (IT) revolution. This "quiet revolution" is evolving in three distinct but overlapping phases, each representing a significant step in utility and sophistication.

The advances of personal computers and the Internet have laid the groundwork for this revolution and the rapidly emerging era of intelligent, networked devices. Just as computers evolved from mainframes to minis to PCs – to our current era of laptop and handheld devices – so, too, are electronic devices of every sort being infused with the power of compact computing intelligence. In this post-PC era, billions of electronic devices will work invisibly, collaborating with each other and with people. This world of connected devices will offer new levels of customer service, product maintenance and support though enhanced remote monitoring and control.

But where can this post-PC era of computing and networking technology go from here? How can it increase companies' competitiveness and profitability while enhancing their customers' (and individuals') quality of life? Digi's vision is that within ten years' time, practically every electronic device that does computing, measurement, test control or display will be networked and connected through the Internet and a Local Area or Wireless Network.

Additionally, this paper will outline the key issues OEMs will face as they move through this paradigm: competitive landscape; enhancing product functionality; technology and component issues; and insight into how computing's recent history offers a window into the future of device networking.

Getting Connected: A Quick Look Back

Currently, data communications consists of personal computers, handheld wireless devices and servers networked and broadly connected via LANs, Wide Area Network (WANs), and the Internet. These networks are used primarily for communications between individuals and for unstructured information access. We take this simple access for granted, but getting to this point wasn't easy. It required significant investments in the Internet backbone, along with the purchase of PCs and networking hardware and software within individual companies. Standards didn't really exist, so vendors attempted, with some tactical success, to promote proprietary technologies, while "standards" proposed by independent bodies failed to find broad market acceptance.

As a result, there were many false starts, incompatible alternatives, complexity and frustration in making connectivity work. Today there are some clear winners in the standards arena. Because of its low cost and wide acceptance, 10/100 Ethernet has become a de facto standard. Similarly, TCP/IP and the Internet are the common protocols for connection and data transmission.

So, where will connectivity proceed from this point? At present, most connectivity is limited to computers: mainframes, PCs, PDAs, etc. The vast majority of computers used for business are networked with one another via a LAN, such as an Ethernet network, or the Internet. It is, therefore, reasonable to base any analysis of the future of computing on the existing model of Ethernet/Internet networking.

The next wave of connectivity is leading to productivity improvements and rich rewards in the form of return on investment (ROI) for OEMs – and is coming in the form of networked electronic devices such as digital copiers, pointof- sale (POS) equipment, remotely monitored and managed industrial control and building security systems, and so on.

Why Connected?

But why connect devices in the first place? Quite simply, to save people (a.k.a. "end users") time, and improve productivity and quality of life. Today much attention is being paid to cell phones, PDAs, set-top boxes and "Internet appliances" – devices that allow individuals to access the Internet – in general. All of these applications are examples of people doing things faster and better as an individual, and as a part of a business group.

For businesses such as OEMs of electronic products and their customers, networked devices offer increased functionality, services, and therefore possibilities for increased sales and revenue. Quietly and pervasively, these devices are revolutionizing business approaches. Further, these connected electronic products allow managers using networked devices to access and act upon data critical to decision-making, presenting new and unheard of opportunities for productivity, cost savings and ROI.

What's more, there is another class of device being connected: electronic products that run in factories, retail stores, medical facilities, homes, office buildings, and so on. Most of this networking activity is to other devices and servers, not humans. We call these "invisible" devices, in contrast to more interactive applications such as mobile phones and PDAs. Commercial and industrial applications are leading the revolution of networked intelligent products. These devices are either being produced and shipped right now, or are on the drawing boards in design departments across practically every industry, illustrating how companies are entering into new phases of computing and networking.

For OEMs witnessing this quietly pervasive computing revolution, questions begin to arise: where is this technology revolution headed? How is device networking going to evolve, and what kind of technology is going to be needed for companies' success? Also, what are the pitfalls and obstacles that must be avoided for OEMs to be ready and able to stay ahead of their competition?

The Phases of Intelligent Networked Device Evolution

Most electronic products today are not networked. But we have seen, based on our experience with OEMs of now-networked electronic devices, that the evolution of these electronic products will occur in stages, as end customers successfully build increasing functionality to an increasingly receptive consumer base. Notably, applications today will bear little resemblance to those that will be delivered over the next five years, in terms of functionality and performance. At present we see only a fraction of the ultimate device functionality that will be delivered during the next few years. This is why it is imperative for OEMs and end customers to understand the evolution we outline below and make the best, most informed technology choices available to them, as there is little time available to retract a missed step. The winning OEMs will be those who made the right technology choices, and lost little or no time as a result of bad technology choices made along the way.

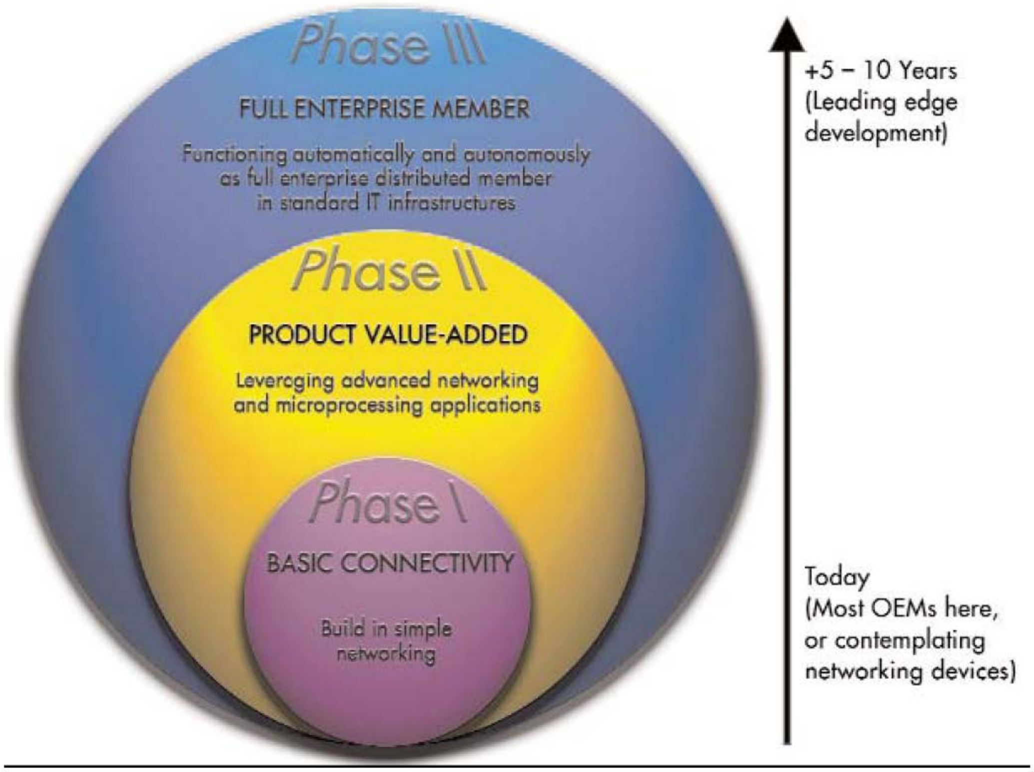

Figure 1 – The Three Phases of Device Connectivity

The "Three Phases of the Intelligent Networked Device Evolution" can be summed up as follows:

- Phase One: Basic Connectivity
- Phase Two: Value-Added Network Functionality
- Phase Three: Full Enterprise Membership

To enter the first evolutionary stage, Basic Connectivity, an OEM equips their products, such as printers, motor controls, security cameras etc., with essential networking functionality, such as Ethernet 10/100 and basic Internet. Examining their current competitive landscapes, many OEMs of electronic products attempt to do this quickly and with as little complexity as possible. Most companies are in or are contemplating this stage.

In Phase Two, the Value Add stage, OEMs couple the intelligence of a microprocessor with networking services, which enables data collection and distribution from collaborating devices to enhance the functionality of their products. The installation and management of devices becomes more complex as OEMs and their product developers wrestle with the engineering and network integration involved in this kind of design, and as technology rapidly develops. "Smart" applications and automated service features are added, which can command higher prices and establish stronger competitive positions for all companies involved – OEM and end customer.

The basic trend that begins to occur is inter-device communications and data sharing. Devices begin to become more intelligent and deliver more benefits and product value. This phase is slowly beginning now, as some "early adopter" OEMs build this functionality into their already-connected products, but will pick up pace during the next one to three years.

Phase Three, the Enterprise phase, is where networked devices become fully participatory and autonomous members of the business operation. Devices become equipped with the necessary networking communications, data and intelligence to make local decisions based on shared information with other devices. In order for this to happen, MIS systems and devices will pass information seamlessly and automatically – as cooperating partners – without human intervention. This means vital productivity improvements and significant ROI for businesses, and we see hints of this autonomous functionality in a handful of device applications today, such as in Industrial Automation.

These three phases will parallel the history of the PC, which moved from a stand-alone device, to a networked machine for printer sharing, and finally to being an integral node of collaborative networks of people and services.

The Impact of Intelligent Networked Devices for OEMs and Their Customers

Why is this important? First, clear market drivers exist for manufacturers of electronic products. The Internet is bringing a new generation of value-added services for customer relationship management, sales and support that will enable OEMs to form stronger links with their customers, while strengthening competitive barriers. OEMs must recognize device networking in many industries is happening quickly, and they must keep pace or be left behind.

As this computing and networking revolution unfolds, the technology employed and deployed will require OEMs to make business-critical decisions about which company they partner with on the supplier side in three key areas: hardware, software and support.

For example, looking at the increase in processing power and decrease in cost of personal computers over the past ten years, one sees that the same processing technology that powers a desktop computer is now being "embedded" in everyday devices. Now, instead of intelligence only co centrated into big, multi-purpose machines (such as PCs), it is being distributed to single-function products such as thermostats, security cameras, industrial sensors, motors and much more.

The important issue for OEMs is what the critical success factors are to obtain and stay current with networking technologies and their evolution. If OEMs have to redo significant parts of the evolving platform because an inadequate technology was selected, it can be very costly and the timeto- market deficit encountered may ultimately be the cause of a low success rate. This issue will be dealt with in this paper using recommendations of the best, most appropriate technology needed for each phase.

Lastly, OEMs of electronic products now more than ever must look to their suppliers not just as vendors offering components, but as technology partners critical to their success in the market. Many factors must be considered. What is a supplier's technology roadmap? Are standards and protocols being supplied universal or proprietary? Are a vendor's hardware and/or software platforms easily upgradeable? Are you as an OEM being provided a stopgap solution for the near term, without a long-term plan for future product upgrades?

Phases One: Basic Connectivity

Today, Ethernet is ubiquitous as the networking infrastructure already in place in commercial and corporate offices. Additionally, it is important to note that while home or consumer networking receives the lion's share of media attention, it is in the area of what Digi terms "Device-to-Business" (D2B) connectivity where OEMs are learning the ins and outs of device networking, and yielding significant productivity improvements and ROI. For example, when office workers connect their PCs to a local printer via a LAN, they are sharing the benefits of first-phase Basic Connectivity device networking. That office printer is now networked via Ethernet and its resources shared by many individuals, versus having one person at a time connected to the device by a single PC-to-device cable, in order to print a document.

Typically, the device applications delivered in Phase One will be the same as the product provided without the Ethernet and Internet connection, i.e., the office printer described above. The main purpose is to link the device into a stronger, more open networking structure so advanced services can commence; such as improved device installation and management, etc. as explained below.

But this is only the beginning. Basic device installation and management can be significantly improved via basic connectivity through the innovative use of Web screens. An MIS person does not need to be physically present at a device's location to access, for example, the special software on a PC necessary to install and configure a device. Today, one can remotely install and configure a device from anywhere, as Web browser tools are well understood and available. Web browsers also enable users to get over the hurdles of learning how to use a new interface, and how to connect to it. Therefore, installation using the Web becomes an easy thing to do.

OEMs seeking to build Ethernet/Internet connectivity into their products have some basic but important decisions to make about the processing hardware and networking software necessary to enter into this first phase of computing. The essential technology elements of basic connectivity are:

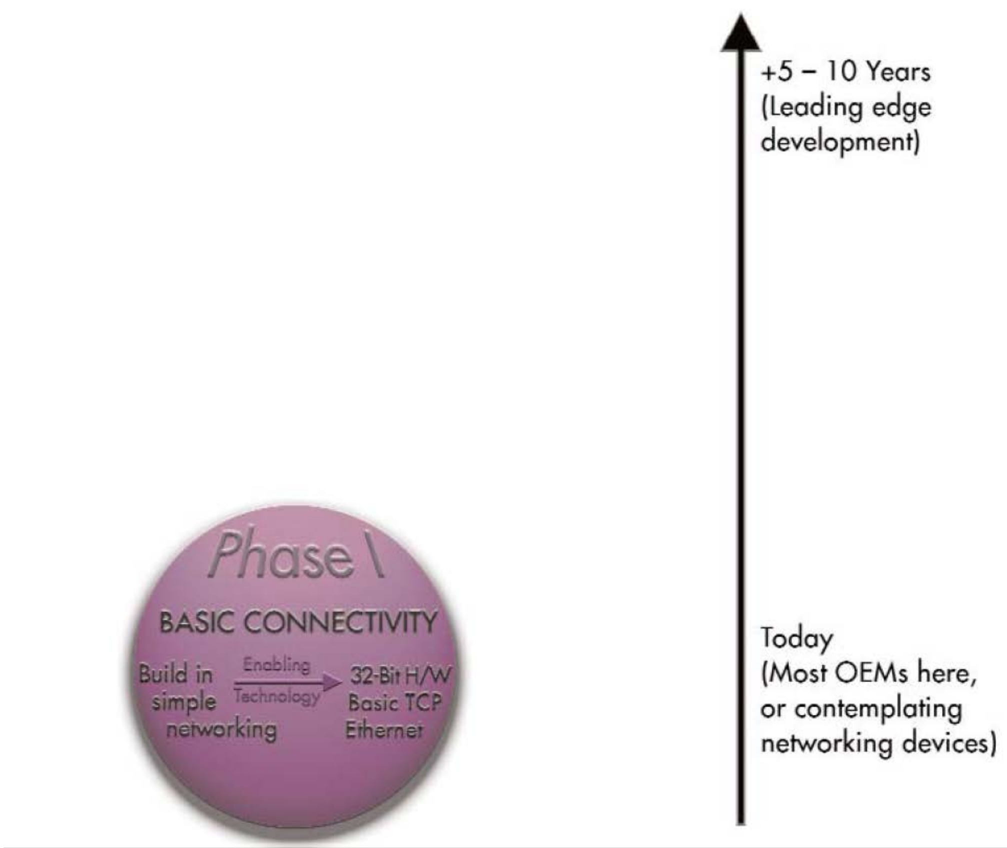

Figure 2 – In the first phase of device connectivity, many OEMs of electronic products attempt to connect their productsquickly and with as little complexity as possible.

Hardware

- A 32-bit microprocessor to support the address space and performance for the future. Microprocessors are typically grouped by the width of their data bus 8, 16, 32, 64, etc. In general, the wider the data bus the more performance and therefore the higher the cost.
- A 10/100 Ethernet Media Access Controller (MAC) to attach to most popular networks. 10/100 means 10 or 100 megabits per second. While 10BaseT moves data quickly enough for many applications, it costs more to attach to 100BaseT networks, which now predominate the commercial/corporate arena.
- A 10/100 Ethernet Physical Interface (PHY)
- Sufficient memory to support today's application, with space held in reserve for product improvements
- Enough Direct Memory Access hardware to support the data rates needed
- Flash memory for downloading across the network
- Enough RAM to hold variables, pointers and data buffers

Software

- A Real-Time Operating System (RTOS) with the capability to support new applications quickly and reliably
- A Transmission Control Protocol/Internet Protocol (TCP/IP) stack that includes sockets interface, for ease in porting applications
- A Hypertext Transfer Protocol (HTTP) server with a set of tools to help generate dynamic data for HTML screens
- A simple way to acquire an IP address, like Dynamic Host Configuration Protocol (DHCP)
- A method to establish an Ethernet address
- A way to download new code over the network
- A File Transfer Protocol (FTP) client and server for data transfer

It is important to note that the Phase One computing requirements are not typically complex and can lead many OEMs to select a low-power, inexpensive 8 or 16-bit processor, and/or a non-standard, proprietary or non-universal networking technology for networking. This approach, while arguably cost-effective in the short-term, may in fact be very costly in the long-term. Why? As an OEM improves or upgrades their product, as valueadded services and functionality are added, an OEM will require real computing power typically achieved through a 32-bit hardware platform that can not only quickly and reliably transfer data, but can also handle a robust RTOS and full set of networking protocols and applications. From a performance perspective, 32-bit microprocessors will be the foundation for all subsequent phases, and therefore it is critical for OEMs to design with the scalability and performance of the hardware platform from the beginning. If the Phase One basic platform has to be redesigned to achieve Phase Two functionality, much valuable market time and engineering resource capacity will be wasted.

Phases Two: Value-Add (Here's Where it Gets Interesting...)

To add quantifiable value to a device, there must be closer integration of the application and the networking software. If during the first connectivity phase an external box is employed (see Sidebar) it will be very difficult to add further value and networking capabilities without significantly changing the device. To add real value, the application will need access to internal data and provide access to that data to the outside world using a network. For example, in order to aid remote diagnostics certain internal information about the device will need to be exposed in order for a remote site to diagnose the problem.

An OEM may add more functionality – and therefore more value – to a product in many different ways. Value can be added by making something easier to install, or how the device itself is configured and managed. Or, advances in technology could enable an entire new class of functionality, which may not have been possible before.

Systematic, real-time, remote access to an intelligent, networked device, wherever it is, provides a tremendous solution to the needs of businesses today. Ethernet/Internet networking will enable four (4) major installation and operational functions to be radically improved.

1. Easier remote or local product installation
2. Applications expansion made possible because network services enable instantaneous access to databases and other collaborating device data
3. Data transfers to distributed hosts for automating processes and automatic product monitoring
4. Remote device management, diagnostics and repair

From the standpoint of installation and maintenance, an OEM now has the possibility of enabling its products to be supported from any place that can access the web. This gives an OEM's customer – in this case, let's use the example of measurement device on a factory floor – the capability to monitor, manage and diagnose that device remotely, from anywhere in the world. As we will examine in the Phase Three section of this paper, this has great advantages not just to the end user but also to the OEM. This capability enables OEMs to offer expanded services to their customers and opens new revenue opportunities.

Adding new, significant product functionality is made possible due to the availability of the high-speed medium Ethernet, which can run as high as 100 megabits per second. Users are able to access information much faster and in much larger sets than ever before.

An example of such value-added connectivity is demonstrated in a networked retail point-of-sale (POS) system, in this case in a fast food restaurant. A customer purchases a standard meal at a cash register/POS display, and through the use of this networked payment terminal/display unit, the customer is presented with the following options: the customer has $1.25 change due, and automatically the POS terminal presents the person with image displays of what additional items that $1.25 could purchase. For example, an ice cream, a soft drink, french fries, etc. Networking the POS system via an Ethernet backbone to a centralized database enables this functionality, allowing real-time calculations for hundreds of products, much more quickly than if a human attempted the same tasks. And here lies opportunities to sell more products at the point of transaction.

Another example is in the building security and control industry, where Ethernet-enabled cameras or sensors monitor doors, corridors and/or secured rooms, sending emails, pages, or other types of notifications when an

Tech Focus: The "Ethernet Box"

For those OEMs looking to network-enable legacy products, a popular approach may be to use an external "Ethernet box" which can provide simple serial-to-Ethernet functionality; that is to say, add connectivity to a pre-installed legacy product as quickly as possible, with some web-based configuration as a starting point. In this scenario, companies will buy this solution for an installed base of devices and for shipping products because it is low risk, entails little development cost and allows fast time-to-market. Others will incorporate an Ethernet-to-serial board into a product, orredesign a product controller with an Ethernet- to-serial bridge approach. A key factor for those companies taking this near-term route is that while allowing OEMs to build connectivity into devices quickly, there is no avenue for companies to add Phase Two value-added functionality into their products.

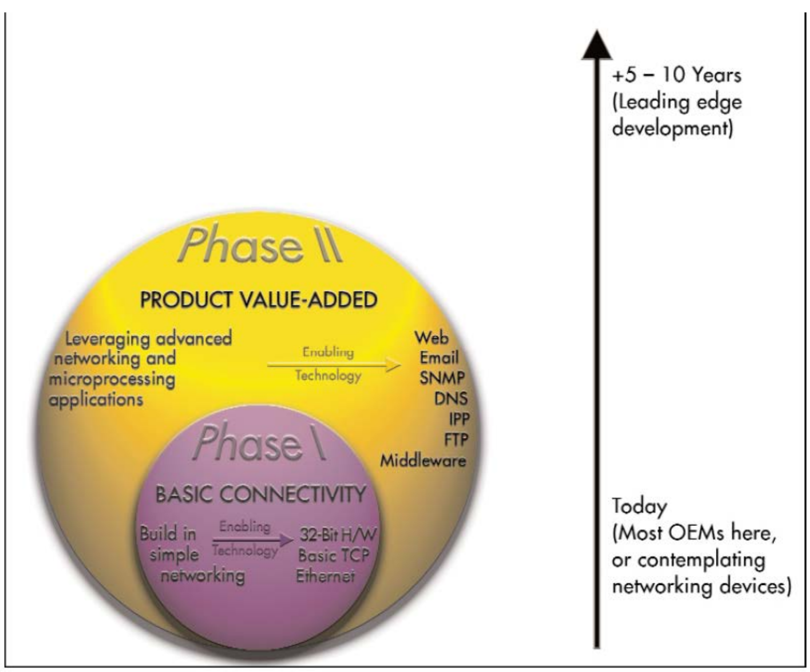

Figure 3 – In Phase Two, value-added services and functions are builtinto electronic products, including remote management, monitoring, diagnostics and upgrade capabilities.

intruder is spotted, or an unusual temperature is detected or an alarm condition is detected.
Naturally, Phase Two begins after experience is gained with Phase One products and basic functionality. Many companies are now planning – and a few are developing – such products, but according to Digi's estimates, large scale Phase Two development will not commence for two to five years. However, most of the necessary technology is in already in place.

Note that the 32-bit hardware platform is required to handle the basic connectivity as we described above, while possessing the processing power and data throughput capabilities to handle Phase Two device workloads.

Following is a list of the necessary technologies for Phase Two computing and networking.

Hardware

- A processing platform that allows scalability, from Phase One through Phase Three
- A 32-bit microprocessor to support the address space and performance for the future
- Integration of more I/O - USB, PCI
- Lower cost, for cost sensitive lower performance devices – $8-10 for 10-20 MIPS (millions of instructions per second)
- High Performance 75-100 MIPS CPUs for most other applications: note, some will require 150-200+ MIPS, but this may force a separate hardware/software platform for lower performance applications

Software

- Email protocols such as Simple Mail Transfer Protocol (SMTP) and Post Office Protocol (POP3) for sending and receiving messages.
- Point-to-Point Protocol (PPP) for remote serial connections
- Simple Network Management Protocol (SNMP) for network management
- A web client for attaching to servers
- Multicasting
- Domain Name Server (DNS) for resolving network names
- LDAP interface for locating email address and resources
- Auto IP for the temporarily assigning an IP if DHCP is unavailable
- WINS support, for resolving names with logical entities

Phases Three: Devices As Enterprise Members

Phase Three, or the Enterprise stage of connectivity, is the last currently foreseeable stage of this paradigm, but in fact represents the beginning of a new generation and evolution of devices and automation services. At present there are few models of Phase Three applications, but there are glimpses into this potential future.

Perhaps the best way to describe Phase Three is to describe it as devices talking to other devices without human intervention; devices making decisions and providing online information to back end systems, changing the way business is done. No one can completely or accurately describe what innovations tomorrow's imagination will bring, but we can make educated guesses based on experience and insight. There will most likely be a whole new set of technology services provided. These services will most likely include online diagnostics, predictive maintenance, dynamic loading of new functions, ordering of supplies, rescheduling of operations, etc.

Devices Interfacing with MIS Systems

Based on history, one of the first initiatives MIS departments will implement is control over the protocols this new breed of devices will employ and are employing, control over their utilization on the corporate network, and which brands can be purchased and deployed.

Therefore, OEMs must realize that the networked electronic products they manufacture must be designed to open standards and for interoperability; otherwise, they will not be allowed on corporate or commercial networks. Some likely interfaces that must be taken into consideration are DCOM, CORBA, .NET and XML with SOAP. Digi will implement whatever is needed over time but is starting with XML and SOAP because they fit very well into an embedded environment, and also work well into MIS systems.

The Enterprise Phase of Device Networking: Helping OEMs Sell Products

With device networking, OEMs must not only think of how to add more features to a product, but also consider at a basic level what networking protocols their devices will support. An OEM must adopt an "interoperability" strategy to ensure they

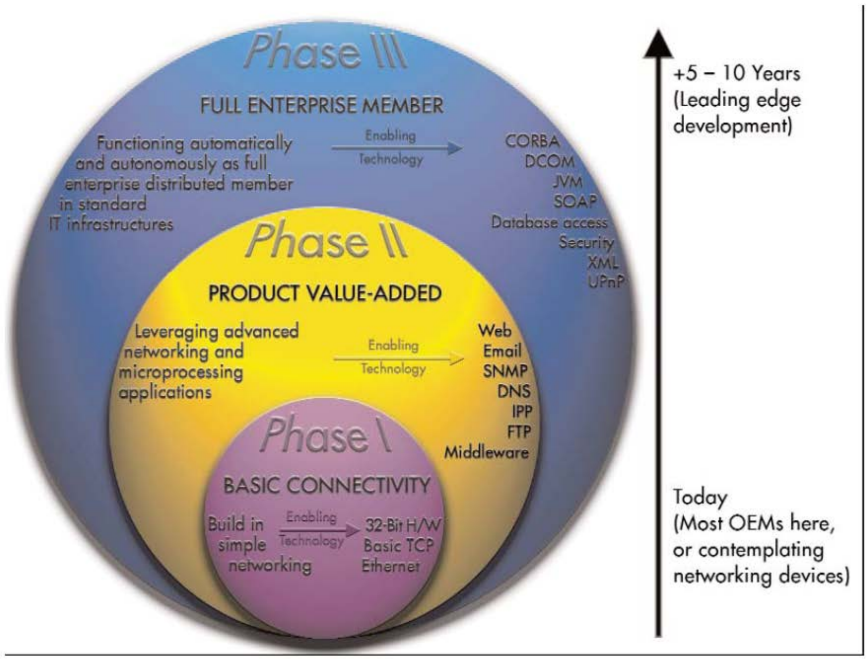

Figure 5 – Phase 3: Enterprise

will be able to sell their products in large volume. Thus, if an OEM plans on designing a network-attached device, careful consideration must be placed on choosing a supplier that provides and deploys universal standards and protocols.

Project managers and engineers at OEMs must ask themselves how aware their vendors are of the networking standards that are in place today, and whether existing or potential suppliers have any insight about which standards will be in place – or driven out of the market – in the future. At Digi, we have worked hard at mapping our technology with customers' and the industry's current and future needs in mind. Most important, we are doing this according to a product offering and roadmap that allows our customers to evolve smoothly through these three phases. Based on extensive work with hundreds of customers, we provide all of the necessary protocols and applications needed to add value in the near future, and we will have all of the new functionality, such as distributed processing, that will be required by MIS for the enterprise environment.

Distributed Intelligence

As mainframes, minis and PCs were introduced, processing – that is to say, where the computing jobs or tasks were executed – shifted to where it would be more useful. These jobs or tasks were distributed – from one central mainframe to several minicomputers, then to hundreds of PCs. In each case the decision-making moved closer to the user, putting processing closer to the user, and having more communications between the computing systems.

The same shift is happening in the device world. Ultimately, not only will devices be much closer to the decision-making source, but also have the ability to speak to each other. This will require these devices to be designed with some form of device-to-device communications system. Digi believes this will happen according to some form of peer-to-peer communications model that will also support communications to the various server structures. Publisher/ Subscriber capability, for example, is one approach that offers this functionality today.

Speaking the Language of Phase Three Device Networking

Devices are going to have to be able to speak some common language, given that the thousands or potentially millions of devices will be manufactured by a wide variety of OEMs, and these devices will also have to communicate with centralized computer systems.

Due to its flexibility and small size, Extensible Markup Language (XML) is ideally positioned to become the foundation for data exchange. Indeed, XML's rapid adoption by data-intensive application developers proves this point. By being able to define data structure, type and content, as well as carrying those definitions with the data, XML will allow a device to interchange data with other devices and the enterprise.

With time, schemas will be developed for managing data, databases, control applications, workflow applications, etc. These schemas, and the flexibility of XML, will allow for more innovative forms of industrial automation and control. For example, cameras will be employed to capture images, extract data from those images, compare it with information in a database, and take appropriate actions, like sounding an alarm or automatically closing a door, thereby eliminating human intervention. Inventories will be captured automatically, and processes will be automatically monitored and controlled with greater accuracy and efficiency under such a model. What's more, these functions will take place in real time.

The other function that devices will have to be able to do is cause each other to perform some form of action. In the past, this has been called remote log-ins. They've been called remote procedure calls. But it's just some form of communications between two cooperating partners.

In order to make distributed processing a reality at the device level, there must be a way for devices to "advertise" their services, as well as deliver results. A leading candidate technology for this is Simple Object Access Protocol (SOAP), which allows a device to define objects that are, in turn, made available to other devices or for computers to call. SOAP runs on top of XML, which makes it a relatively small means for accomplishing the equivalent of remote procedure calls.

With the ability to see how devices can be installed, interchange data, and even cooperate in accomplishing an objective, one must still be able to have a central repository for these devices and attributes such that they can be accessed remotely, namely by a directory. LDAP (Lightweight Directory Access Protocol), which has been defined as a way to access such information and is supported by most, if not all, operating systems. It is relatively small and efficient, making it a good fit for networks.

At the Enterprise level, once devices begin communicating in this manner, and once systems are established that provide the necessary algorithms for inter-device communication, centralized control is no longer necessary. Automated local control and communication then enable even greater efficiencies to be built into these systems. Instead of one massive control program, users have a series of small, distributed programs allowing programming changes to be isolated and made only where they are needed. And with decisionmaking driven down to the device level – the source of the information – the system becomes more configurable, scalable and real time. Following is a list of required technology.

Hardware

Note the 32-bit processor's flexibility in handling data and services running on this type of platform. In short, an 8 or 16-bit hardware offering simply cannot run these services, or handle the two-way data transfer on any kind of busy network. These are important factors for OEMs to consider, especially when dealing with how to constantly upgrade and improve their products for competitive purposes.

- 32-bit processor; any less will not do the job.
- Integration of memory onto SOCs will decrease cost and improve performance.
- Smallest footprint and power consumption will be important in order to make the technology available to the broadest range of applications. Some devices will have to be small and low-powered by their very nature.
- Emergence of many application-oriented SOCs will make some applications possible, which prior technological and financial obstacles prevented. These applications, however, will need to be very high volume with well-understood needs to justify the cost of development, which can be in the millions of dollars. Hence the need for a commercially available, integrated device networking platform with all the necessary hardware and software available in one package.
- Total system cost will remain important. There is a real possibility that some devices will be sold on a subscription basis where money is made on services, not the sale of the device.

Software

- XML Parser and development tools
- Support for SOAP
- Linkage between Web Screens, SNMP and XML
- Peer-to-Peer software such as Publisher/Subscriber for coordination of execution
- Java Virtual Machine (JVM) to allow new applications to be downloaded and executed seamlessly
- Security to protect the devices from attack
- An open architecture that allows various technologies access to the data structures. Change is the only certainty, and software must account for an environment that will change at an accelerating pace. Data and data structures will need to be exposed to a broad range of technologies.
- Interfaces to MIS Middleware like CORBA, DCOM and .Net will need to be considered as their popularity in the embedded

world develops. At this time CORBA and DCOM appear far too complex for the embedded world and .NET is too new to judge its viability. As indicated above, Digi believes that XML and SOAP will become very important technologies.

Bumps in the Road Ahead?

There are three major obstacles to further progress in the device networking movement:

- Cost
- Complexity
- Competitive Pressure

Cost

OEMs keep a close watch on bill of materials (BOM) costs – how much the sum of all product parts cost.To be fully competitive OEMs need to see full networking hardware and software products available on a scale of $6 to $25 per device, depending on the microchip and software requirements, and whether a platform is configured for Ethernet or wireless networking. Today, using standard components, the price is in the $40 to $100 range.

Development costs, component costs, and ongoing design support costs potentially can add up to a hefty sum. At present, most networked, device level products sell for less than $1000 and have a BOM cost

Tech Focus: "Device Security"

As Phase Three emerges the role played by devices, particularly devices used in distributed environments are going to become critical to the day-to-day operation of many enterprises. Leaving these devices exposed to potential accidental changes, to sabotage, or to eavesdropping will eventually become too great a risk for most businesses. But, as OEMs examine such risk, they will have to make a determination: at what price do they want security? Typical security applications are very large and require a tremendous amount of computing horsepower to execute the calculations.

Thus, an OEM will have to look at companies that are well versed in security as it impacts devices. For example, an OEM needs to view security in terms of preventing people from accidentally or on purposely changing something in the device, and find ways to protect pieces of data; but not necessarily all data. Standards like IP-SEC and SSL are very secure but require royalties, vast amount of horsepower, and large amount of memory and very complex key distribution systems.

This Phase Three networking also presents some unique challenges, especially in the areas of BOM (bill of materials) costs: specifically, the security breach risk versus the BOM cost. Or, even more precisely, the cost of the probability of breach versus BOMs costs.

Companies like Digi will be investing in security applications that provide authentication and access control, to make sure that only company-approved individuals can gain entry into these devices, and we will do that using challenge protocols, encrypted passwords, and other techniques to protect unauthorized access to the unit. Digi will also be providing paths where data can be selectively encrypted by applications, to secure both privacy and intrusion of data from the outside. And this will be done in a way that it will work over either Ethernet or wireless connections. Of particular note regarding Phase Three is that the hardware and software have to be tightly integrated, and it will be very difficult to tell the hardware from the software.

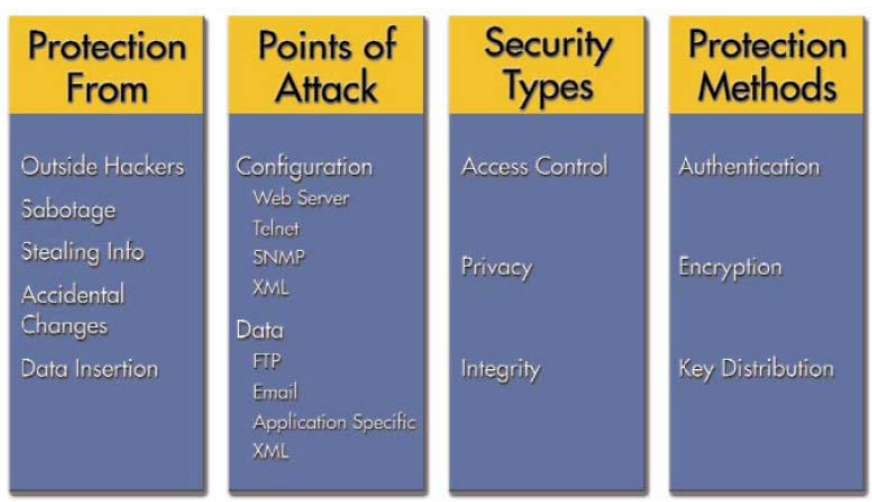

Figure 6 – Phase Three networking also presents some unique security challenges, as devices used in distributed environments are going to become critical to the day-to-day operation of many enterprises. Digi is already examining the technology requirements and tradeoffs OEMs will face.

in the $75-250 range. Here, the basic question that arises is how can OEMs achieve reduced BOM costs, while adding intelligence and networking to their electronic products?

The answer to this question is an OEM should select vendors who supply 32-bit integrated hardware and standards-based, royalty-free software capable of delivering their customers increased functionality, usefulness and value.

Complexity

Because most companies that design these socalled “invisible” embedded devices are not network-centric, there is a need for a product that’s as easy as plugging in an electrical product in a wall outlet, as opposed to requiring networking engineers. The issue gets more difficult due to:

- Increasing rate of change in networking technology and protocols. The base keeps changing and it’s difficult to keep up with.

- A “distributed intelligence” and decisionmaking paradigm that is changing from centralized control to distributed control, at the device itself. New application software and concepts are needed.

- A general lack of availability of competent networking engineers as employees orconsultants for most device manufacturers. Nothing can happen without these engineers.

- Hardware and complex software are much more difficult to develop and debug. Project delays are frequent: according to a recent study by CMP Media, 57% of embedded design projects finish 3.8 months behind schedule, which represents significant monetary and engineering capacity losses.

Now, it becomes clear how OEMs can leverage their vendors’ technology and expertise, to avoid the pitfalls involved with device networking. Selecting components that provide real integration and more value-added services can solve most of the issues described above. The key issue for OEMs of electronic products is to determine whether or not it makes sense to design their own solutions in-house, attempt networking integration on their own, or buy a scalable hardware/software platform “out of the box,” so they can apply their engineering resources to the unique application at hand. This brings up one of the greatest issues an OEM faces: competitive pressure.

Competitive Pressure

The third obstacle, competitive pressure, is also referred to as time-to-market. The impact of increasing complexity is a substantial slowdown in a design team’s ability to get an innovative product off the drawing board and out to market. The solution has to be found in substantial development simplification, even in light of the above complexity issues. Development simplification can only come from device OEMs starting with a production-ready base of integrated hardware design, and all system and networking software operational and ready for the OEMs specific application development.

A new breed of networked microprocessor solution has to merge the processing hardware and networking software necessary to engineer their products for future success, while delivering increased value to their customers.

Digi Vision

Digi has detailed a vision of the evolution of device networking and what the success criteria and technology elements are for OEMs to develop their products from simple connectivity, to integration in large IT infrastructures. We have explained how and why network connectivity and local, distributed device intelligence are the innovation drivers for electronic products. OEMs today face serious issues in selecting the right technologies and partners, and false starts, project delays and technology obstacles can put an OEM behind competition costing time and money that may be difficult – or impossible – to recoup. The need for networked microprocessing platforms will evolve quickly over the next five years, so it is critical that OEMs focus key engineering talent on unique product applications, versus attempting to keep design staffs constantly up to speed with ever-evolving networking technology – a near impossible task for most OEMs.

Summary

The market for intelligent, networked devices is rapidly expanding. The adoption rate for these connected electronic products – while small today – will become significantly greater in the commercial and corporate sectors, and in the near-term OEMs can capitalize on advances in computing and networking technology to add more functionality, services and value to their products.

As device networking evolves in three distinct phases, Basic Connectivity, Value-Add and Enterprise Connectivity, OEMs have great opportunities for success. However, OEMs must choose vendors who offer the most compelling products, support and technology to help keep their products innovative, feature-rich and competitive – for the next five to ten years.

Likewise, companies that deploy intelligent, networked devices in their businesses can achieve incredible productivity gains and ROI. The benefits for OEMs and their customers are practically limitless. And as we have outlined above, we have some insight into how widely networked devices of all kinds will be utilized over the next decade.

Contact a Digi expert and get started today

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