Introduction

In the year 2020, the world will be more connected, wireless networks will connect more machines than people and Machine-to-Machine (M2M) technology will help us to be more energy and cost efficient, safer and more secure. This is the era of connected intelligence.

The number of mobile connections is forecast by the GSM association to grow to 50 billion by the end of the decade. There will be several trillion wirelessly connected things, according to the Wireless World Research Forum. This increased use of mobile and M2M technology will deliver as much as $100 billion of annual savings thanks to material and energy efficiency savings (smart2020.org). The social and economic benefits are clear.

Many M2M solutions, usually single-purpose services, are already and will continue to be deployed. Ease of use and scalability will be better achieved by employing an M2M gateway. This article will demonstrate how Freescale’s portfolio of QorIQ communication processors can provide the performance and flexibility needed to create an M2M gateway for trusted and connected intelligence.

Why M2M Gateways?

M2M is a new opportunity helping us to be safer and more secure as well as cost and energy efficient. M2M can also be used for revenue generation and customer retention. It is good for business. Figure 1 demonstrates a broad range of sectors which represent a diverse set of connection challenges and variable conditions “on the ground.” A multi-purpose M2M gateway offers several comprehensive advantages over a “silo” approach and is likely to prevail in many cases.

M2M gateways offer the following key advantages:
- Can be applied and scaled to multiple settings—home, industrial, office, public, retail
- Avoids duplication of equipment
- A local intelligent node turns raw data into useful information
- A secure node bridges broadband WAN and local wireless connections
- A hub for cross-sector service and application convergence, or “joined up thinking”
Stand-alone machines connect directly to a wireless broadband network.

M2M gateways bridge one or more locally networked devices to a wired or wireless broadband connection. The local network can be wired or wireless.

The M2M gateway will host various applications and networking stacks, running on virtual machines on one or more CPU cores.

A trusted software platform is key to preventing theft of data, functionality and of product uniqueness.

Challenges in Designing M2M Network Solutions

A QorIQ M2M gateway module of the kind shown in Figure 2 can be implemented in a credit-card-sized footprint. The design supports a variety of wired and wireless connectivity options and delivers the computing performance required to help alleviate some of the key challenges faced by M2M service providers:

- **Scale:** Wherever you have clustering of M2M devices of sufficient scale, you have the potential to overload the cellular network. This could be anything from buses parked at a garage at the end of the working day to packages arriving at a distribution center. They don’t have to be data-hungry devices; a localized peak in signaling traffic alone might be enough to cause failure at a cell level. Use of a gateway can alleviate signaling (and data) congestion.

- **Security:** M2M device deployment will be widespread and they will often appear in fairly public places. As such, they will be susceptible to both physical and network intrusion. Recent publicity around the growth of malware attacks directed against smart phones is testament to this.

- **Data deluge:** Even if only transmitting small amounts of data once a day, millions of such devices will generate a mass of data—not all of it necessarily useful. Service providers may prefer that only useful data is transmitted, which is where a gateway performing some sensor or algorithmic translation can help by filtering out unnecessary data.

- **Distributed intelligence:** An intermittent connection, the need for filtering of data or for autonomous operation at a local level requires local storage and processing of data.

- **The “rebound” effect:** Increased deployment of M2M technology must not cancel out the original cost and energy efficiency benefits. Low-power and cost-effective nodes are the key factors. A gateway can help with scaling, bridging between low-energy wireless networks and mainstream infrastructure.
Freescale’s M2M Gateway Solutions

The QorIQ processors for M2M applications range from single-, dual- and quad-core processors designed on 45 nm technology for low-power implementation. A rich set of integrated I/O controller options help minimize component count and module footprint. Built using high-performance Power Architecture® cores, QorIQ platforms enable a new era of networking innovation where reliability, security and quality of service for every connection matters.

Below are some of the key QorIQ processor features which address each of the above-mentioned challenges in designing M2M platform solutions:

- **Connectivity:** Multiple PCI Express®, RS232, USB, SPI and I²C controllers allow direct connection to ZigBee®, Wi-Fi® and 2.5G/3G modem chipset ports or to local wired and wireless sensor networks.

- **Security:** Trusted boot platform and integrated security engine have single pass encryption/message authentication for common security protocols (IPsec, SSL etc). Trust architecture platform helps protect against software intrusion and software cloning by incorporating advanced end-to-end code signing and intrusion-prevention capabilities. For more details please refer to the article, “Trust Architecture: Freescale’s Security Solution for Industrial Control Systems” in the Beyond Bits: Power Architecture edition.

- **Packet processing:** Multiple 10/100/1000 Ethernet ports support advanced packet parsing, flow control and quality of service features, as well as IEEE® 1588 time stamping and are ideal for managing the data path traffic between the LAN and WAN interfaces.

- **Local storage:** USB, SATA or SD/ MMC interfaces provide options for local storage—which is key for local data analysis filtering and decision making.

- **Advanced energy management:** This feature provides power-saving modes for managing energy consumption in both dynamic and static power modes, which includes the traditional nap, doze plus jog (dynamic frequency scaling) and packet lossless deep-sleep modes.

M2M at Home

Regulation on power dissipation of home-based networking equipment is now common, and for good reason. There is more that can be done. Energy savings made as a result of effective home automation can be enhanced by bundling functionality and services onto a single M2M-enabled digital home gateway which can support IPTV, broadband wireless, media storage and distribution, medical and home automation and more (see Figure 3). A virtualized software platform can allow different service providers or utilities to run concurrently on the same box without interference. Visualization and control can be achieved by connecting via smartphone, TV, tablet or netbook. Freescale’s M2M at-home solutions using QorIQ processors provide an excellent price/performance blend while simultaneously supporting a rich mix of networking capabilities for home area networks. For more details please refer to the “Networked Smart Gateways for Energy Management and Control” article in the Beyond Bits: Power Architecture Edition.
M2M for Commerce

Deployment of digital signage and self-service kiosks and checkouts is growing rapidly. The addition of sensors and short-range wireless to digital signs has turned them from screens into interactive displays, providing stimulus for advertisers who can now target and connect with new customers. Near field communication (NFC) technology allows users to interact with advertisements via their smart phones, while sensor technology can be used to identify demographics (and in the future, the mood) of passers-by and react accordingly. Due to its connectivity and high-performance features, general purpose applications can add digital signage capabilities on QorIQ processors with no additional hardware expense. For further details refer to the “Digital Signage: A Sign of the Times” article in the Beyond Bits: Power Architecture Edition.

M2M in Health Care

An aging population, increase in monitored illnesses like diabetes and heart disease and insurance mandates around hospital stays and visits have led to an increase in home-based health monitoring. This thought is now being matched by the onset of portable devices which monitor patients away from a hospital or doctor’s office. The added comfort of the patient is matched by cost savings for health care providers and insurers.

Devices that monitor a patient’s vital signs at home can operate as a direct M2M device, via a gateway of the type mentioned in the previous M2M at Home section, or a dedicated telehealth hub (see Figure 4). In either case, measured data such as blood pressure, heart rate, body temperature, respiratory rate, blood glucose and cholesterol can be accumulated, processed and, if desired, sent periodically to the health care provider. Freescale’s M2M in health care solutions using QorIQ processors enable encrypted communication through trust architecture which helps provide a secure link between patient and doctor ensuring that private information does not get stolen.

M2M for Infrastructure

Much of our transport, civic and industrial infrastructure (road, rail, tunnels, bridges, waterways and pipelines) asset base is monitored and maintained using very labor-intensive processes. M2M technology has real potential to provide more cost-effective autonomous techniques to help with remote monitoring and preventive maintenance. While their needs often differ, they face one common problem—the cost involved in clean-up operations and insurance payouts after subsidence, land-slip or breached canal embankments is usually huge. While open spaces lend themselves well to using wireless technologies, it is not uncommon to find fiber laid along the lengths of rail-track, roadways, canals etc., that could form part of the solution infrastructure (see Figure 5). QorIQ processors’ key features such as connectivity, storage and packet processing, make them an ideal choice for transport M2M gateways for infrastructure.
M2M in Buildings

Buildings represent another area where energy efficiencies can be made. In offices, hotels or campuses, it is reasonable to suggest that people do not have the same motivations as they do at home to conserve energy. The potential for M2M to automate is magnified for buildings because the goal is not only to save energy but also to implement security (see Figure 6). CCTV and secure access systems like card swipe, card proximity or something more advanced like iris scanning, have an increasing role to play in securing our towns and cities.

Figure 6: M2M in Buildings

New buildings constructed with glass and steel as well as old stone constructions often suffer from poor in-building wireless coverage. It is not unreasonable then to devise in-building M2M networks which combine wireless with (for example) Ethernet, daisy-chained perhaps, to save on cable costs. Freescale’s QorIQ processors with their advanced energy management and security features, along with strong support for various industrial networking protocols, make them an ideal solution for building M2M gateways in buildings.

Conclusion

While the particulars of each use case may vary, the rationale for using M2M is consistent: Safety, security, power and cost savings.

Freescale’s QorIQ solutions are ideal for each of these applications. The potent combination of advanced packet processing, energy management and integrated I/O flexibility with trusted boot will allow developers and integrators to quickly deploy wired and wireless M2M systems they can trust. When considering the volume of M2M nodes and gateways which will be deployed, often in reasonably accessible places, trust and security are vital. As can be seen in the “Trust Architecture: Freescale’s Security Solution for Industrial Control Systems” and “Industries Made Safe: PXS Series by Freescale” articles in Beyond Bits: Power Architecture Edition, Freescale’s Power Architecture processors and controllers provide the optimum solution for trusted and connected intelligence.
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