Machine-to-Machine: Reinventing Embedded Devices for Smart Services

By Intel® Corporation

Machine-to-machine (M2M) technology is quietly reshaping the way we live, though most people don't realize it's even happening. And that's the way it should be.

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In a modern home, why should average consumers have to know how their new washer and dryer maintain themselves or alert the manufacturer for a service call? All is done automatically. But the question we should be asking is... Are today's connected devices fully enabled for the rise of new embedded smart services? That is, services that can add new value over time, evolve to new uses, or become an integral part of your everyday home life. The answer today is likely not. This is because current devices, like consumer appliance white goods for example, can't be easily upgraded in the field to host future services, like downloading new wash cycle options, sending maintenance information, or even sending promotion information to the active display – all tied into the modern 'smart' home infrastructure.

A change is underway... Embedded design is being challenged to change forever. Although it was never hip to be a fixed function embedded device, it will soon be out of vogue and mediocre. Imagine sending an email to someone every day and never hearing back. Many of today's dumb devices will generate the same frustration in the coming years. Just as the demand for information services catapulted the Internet, the same factors are driving the embedded Internet and requiring smarter devices to play a larger role in delivering intelligent services. This also enables financial gain for innovators and services providers utilizing the 'smart' devices of the future for ever increasingly smart services.

Connecting the "Internet of Things"

One of the great enablers for the Internet is the proven path to market for entrepreneurs creating an application. Language and protocol standards are in place enabling applications to run on any server and eliminating the need to build and certify a hardware platform because of the standardized hardware and software environment (HTTP, APIs, standard PC peripherals, etc). In comparison, the value chain for the "Internet of Things" is highly fragmented and proprietary today. Deploying a new service on a typical set of embedded devices requires the coordination of many hardware, software, supply chain, and service provider players. This is complex, costly and difficult for a services innovator who only desires to write and run the applications creating the tangible value.

The pace of innovation in the machine-to-machine trend hinges on the availability of standards-based platforms that let developers do what they do best, write and deploy new services, instead of designing devices and worrying about the complexity of them working together. As a result of this ideal state, these platforms must have computing and connectivity headroom and flexibility to take on new workloads in support of next generation service models, otherwise they'll be relegated to fixed-function, non-intelligent embedded devices, which is the condition of current deployments. Essentially, machine-to-machine is a service driven concept that requires devices to be extensible and act as an open platform for future services.

Knowing this, a new generation of smart devices should have the following characteristics;

1. Be simple to develop on and deploy
2. Have ample and scalable processing power
3. Have adequate application and data storage memory
4. Support on-demand connectivity and adequate bandwidth
5. Be fully and dynamically secure and self-managed
6. Be integrated with network cloud-based intelligence

The justification of smarter devices cost is made possible by quicker time to market, readiness and scalability for new services, maintainability, and a longer productive lifecycle.

Revenue streams

The revenue generating potential of a service typically tracks the computing and connectivity capability of the device, as illustrated by the services pyramid in Figure 1. Devices collecting basic information and sending it over low bandwidth radio represent the largest unit volume, but typically the lowest ARPD (average revenue per device). A popular "smart grid" example is a home energy management system

that exchanges information with the utilities company via a wireless service, estimated to cost a few dollars per month.

Moving up the pyramid, smarter devices will allow homeowners to automate their premises for convenience and security, to do things such as control doors, lights and appliances; remotely adjust thermostats; and view home surveillance video in the house or remotely on smart phones and laptops. Even more capable devices with cameras and GPS systems will enable car rental and trucking companies to keep close track of vehicles to bill per use, improve safety, assist during breakdowns, and closely monitor schedules.

At the top of the pyramid, devices that aggregate information or control data, perform rich analytics, or support real-time video monitoring will provide higher revenue streams. Each of these smart service classes have new revenue potential for the developers and service providers.

Reinventing embedded devices

Vehicle navigation is an application that has really taken off, and now a machine-to-machine service model using voice recognition is emerging. Imagine being on vacation and speaking into your rental car's GPS, "Navigate to the museum with the Body World exhibit".

The question is; what's the most cost effective way to deploy this service? In the embedded smart device or on a data center server? Here is a summary;

Let's first take a look at the Device:

Perform voice recognition on the GPS device, which requires a more capable feature set,

- **Consumer impact:** One-time additional cost of $20-50 to buy a voice recognition capable GPS device

Now on the Server: Continuously stream audio over 3G or 4G to a datacenter server, which incurs extra wireless data charges,

- **Consumer impact:** Pay for hosted wireless GPS services, up to $10 per month extra, which can easily cost tens or hundreds of dollars annually.

In this example, consumers who pay extra for a more capable device are making a good investment, with a short payback period. On the other hand, consumers using devices which rely on a cloud server to perform voice recognition must pay the high cost of a constantly active radio channel. It's a fine balance.

Equipment manufacturers who build extensible devices with more computing capability incur slightly higher BOM costs, but they will offer greater value to consumers and service providers in the emerging machine-to-machine markets.

Hitting a stride

Sufficient device capability that is cost and power efficient along with easy software deployment in standardized platforms is needed. This includes computing performance, connectivity, IO, and memory. Lack of this capability is what stands in the way of making smart services effectively and efficiently work. A wider assortment of services – media, consumer convenience services, security, energy management, and more – are coming together as emerging M2M offerings provide revenue upside for the industry. Today, connected devices generally lack the computing power and headroom needed for new services that are raising the bar with respect to intelligent decision making, data translation, and network bandwidth. It would also be a challenge to get a large number of independent software vendors (ISVs) and partners to write applications (think App Store) for some of the esoteric processors found in these devices.

With this in mind, we at Intel are working hard to create smarter devices that are services-ready, extensible, and standardized. There are countless scenarios where innovators of 'smart' services will be enabled by smarter and smarter standards-based devices allowing an ever spiraling realm of possibilities. The call-to-action for the industry is to reinvent embedded devices using standards-based technologies that are simple, extensible, flexible, and integrate seamlessly with the existing infrastructure, thereby speeding up deployment and time-to-money. As the M2M trend continues to evolve, embedded design will need to emphasize highly adaptable devices, thus enabling the industry to more easily seize new opportunities.

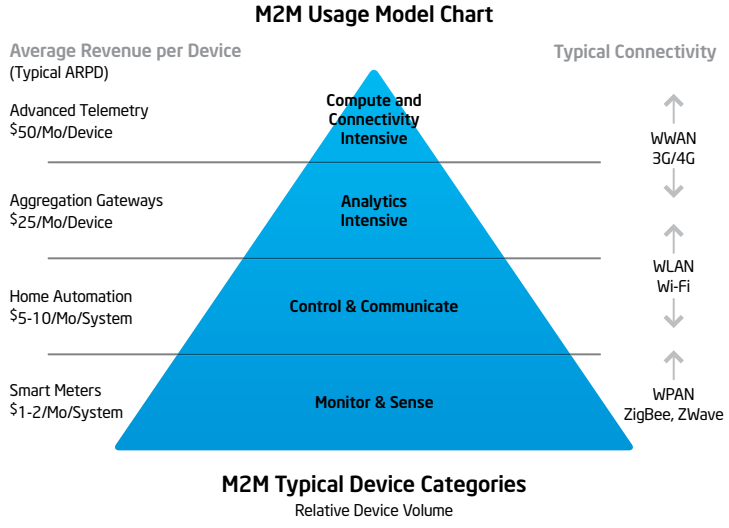

Figure 1: Connected Services Gateway Block Diagram

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