Connected Things

Bits Versus Electrons

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By Bob Frankston

The power of the Internet comes from our ability to build connected applications. We use the term "Internet of Things" (IoT) to extend this concept beyond computation to include the objects in the physical world. This is not a new idea—we have been embedding computers in devices for many years. What is new about the IoT is the potential for making these capabilities available as resources for consumers (or at least, prosumers) as well as entrepreneurs to create their own solutions.

HELLO, MY NAME IS...

The idea that we can take the power of software and apply it to the physical world—to things—is exciting. The term the "Internet of Things" has been popularized by the radio-frequency identification (RFID) effort to tag physical objects so that they are visible to software. This is sort of like a name tag (Figure 1) on objects. Unlike the bar codes on groceries and other products, the RFID can be a unique identifier that enables applications such as tracking merchandise through a warehouse.

QR codes (Figure 2) represent an interesting alternative to RFIDs, and there is no need for a clearinghouse or licensing. They also have other advantages in that they are visible, unlike RFIDs, and can be read even if the "thing" is hidden.

I'M WATCHING YOU

Computer vision allows software to read the same text that humans do. We see this with the technology used to collect payments. Highway toll booths have increasingly been replaced by active and passive tags that allow for remote sensing of the car's payment identifier to automatically charge the driver's account. For a few months, I did not know that my son's tag was not working because the toll cameras simply read the license plate.

While each application is reasonable in itself, the ready availability of all of this information has major implications for public policy both in terms of privacy and the ability to limit nonconformity.

While full treatment of the issue is beyond the scope of this column, we do need to think about limiting the disclosure of information. For example, my car has detailed information about what is going on in the engine, and it can provide that information in an encrypted form so that it is only available to those who are authorized to access that information.

GATHERERS

The technology of RFIDs was embraced because entrepreneurs could make money by managing the database of identifiers, licensing the technology, and building applications such as supply chain management. With the IoT, we create opportunities for everyone to create new solutions and businesses.

One reason that big data and smart cities get so much press is that they give vendors something to sell in the form of gear for networking and computing and in the form of knowledge derived from such information.

Thus, a provider can sell products and services such as a traffic management system. That idea is not entirely new, as ideas such as coordinating traffic lights were available long ago, and the centralized processing of data by giant brains (Figure 3) is an old idea with factor analysis being a term for analyzing data.

What is new is that we have myriad new sources of data as well as a common medium—the Internet—that we can use to connect the sensors to processing sites. We can also build smarter devices that can be controlled remotely.

HELLO my name is

Lamp #218128

FIGURE 1. The RFID effort to tag physical objects is much like a name tag.

FIGURE 2. QR codes offer an alternative to RFID.

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This my October 2014 IEEE CE Column. You should read this article on the IEEE Site (here). My previous column *is available as http://rmf.vc/IEEECE201407*.

Internet of …

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Purpose Built

Wearable devices represent another source of data that can be monetized. While there is money to be made by selling devices such as wearable sports monitors and smart watches, the value comes from being part of a larger eco system.

However we lose much of the synergy that comes from the "Internet of …" aspect when the devices are tied too much to the particular purpose and scenarios. We see this when a smart phone becomes the gatekeeper for smart devices rather than merely an enabler. While the idea of being able to unlock my door using a smartphone seems exciting it isn't much more than a substitute for carrying a key. I'm still dependent upon a particular physical device being directly connected to the door.

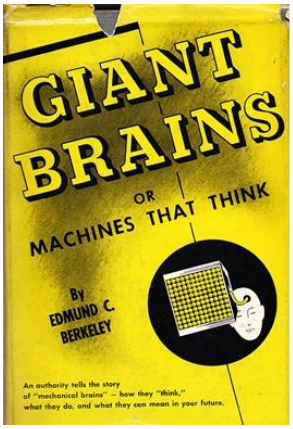
Building smarts for a particular app is a very powerful and attractive idea in the short term but it tends to limit the long term value of a platform to that initial purpose. It makes it difficult for others to contribute value and to get benefit from the applications they create.

When Steve Wozniak designed the Apple][it was a very open system and anyone could create their own solutions with the computer as a building block. While the original Apple was just a board, the second version was packaged so I could add value in software. That made the Apple a great building block.

Much of the focus of IoT devices has been on traditional embedded systems building blocks with the addition of radios such as Wi-Fi for wider connectivity and Bluetooth for local connectivity.

This is also familiar ground for traditional consumer electronics companies that build valuable hardware. With unbundling much value shifts from the devices to the applications and that creates an incentive to keep control.

Cloudy Thinking



Functions like unlocking a door are just that, functions, and shouldn't be tied to a particular device like a smart phone. If I'm in my car I shouldn't have to bring my personal smart phone just to run an application.

We have some sense that applications are independent of the particular device when we talk about running applications in the cloud. But it is also important to recognize that the computing device in the car can also run applications safely using the same kind of approach we use for the cloud.

The cloud is just a fancy word for what we used to call timesharing – the ability to have apps share hardware without having to be trusted or trust each other. We need to be able to use local computing platforms without being tethered to a distant cloud if for no other reason than reliability, resilience and control. You don't want to have to have connectivity to an external service merely to open your doors or turn on your lights.

Building Blocks

The secret sauce of the Internet is that everything gets normalized to IP packets apart from the application. This means we're not limited to the original purpose and can discover what is possible and then, if we choose, share our discoveries or sell services.

If we are to realize the Internet-like potential of things we need building blocks that enable us to use our software skills to remake the world. We need a Remaker movement akin to the Maker movement for hardware.

A first step is to understand the value of open interfaces even if the devices themselves may be closed and that openness starts at home.

The Nest Thermostat is a marvel of engineering but it only controls one parameter at one point in the house. Imagine if we had access to air ducts and had sensors around the house and could treat HVAC as a system. This is just what a startup, EcoVent, is doing.

Rather than trying to figure that out we can allow a cycle of experimenting and learning without having to first justify the value. Innovation is driven by little bits of data and simple applications. These simple applications have been sufficient to generate interest even if we had no idea of the later world-changing potential.

We can see one example in email. In the early 1980's committees spent years developing a standard for email only to find it quickly eclipsed by SMTP which was good enough for the job and only took a weekend to implement. Fortunately the US Government dropped its requirement that contractors use X.400.

One attractive feature of X.400 is that it was far more secure and trustworthy. Or so it seemed. As we see with spoofing Caller-ID such assurances are often illusionary or, worse, they create naive and brittle dependencies which only increase our vulnerability.

Resources and Public Goods

We need to think about information as a resource or public good apart from each narrow application. Location (or, colloquially, GPS) information is a good example. Today it is available only if we have line-of-site to a satellite. It should be available as a resource anywhere in the same way we should assume connectivity (as in Wi-Fi) everywhere. (See my July 2014 for more on what I'm calling Borderless Connectivity).

It is important for resources to be very simple as with IP. The success of USB for power is another example. It was a very simple 5 volt power supply readily available without having a special cable or adaptor for each device. It was quickly accepted and it was only after that acceptance that the new symmetric USB Type-C connector was developed to address the awkwardness of the micro-USB connector.

If we are to honor the "Internet" in "Internet of Things" we need to appreciate the nature of resources of public goods. Instead of building products limited to one manufacturer we need to think of the larger possibilities.

Perhaps governments can take the lead by doing less governing and more guidance. For example instead of designing a new public safety system (including E911 in the US) it could provide an example of open interfaces and support research in how to safely use the common infrastructure. There is an important precedent in the US Interstate (Defense) Highway System sponsored by Al Gore Sr. and President Eisenhower to get synergy in meeting both civilian and military needs.

The FCC is in the midst of a so-called IP Transition but IP is fundamentally a different concept from telecommunications. And we need a fundamentally different organization. Just as the Interstate Commerce Commission (the ICC) was replaced by the Department of Transportation perhaps we need a Department of Connected Resources.

Instead of sponsoring a transition it would assure the availability of borderless connectivity. I use the word "borderless" as a contrast with traditional networks which have borders around them. This makes connectivity only available if a provider approves of the application.

And instead of treating the copper-based phone system as a backup power supply it can sponsor efforts to build a resilient power grid rather than simply a distribution system. Companies like Elecyr are already building such systems. Imagine being able to move power between two points depending on the need.

A Deeper Understanding

As engineers we have a responsibility to understand what it takes to implement the services that people expect. The web is just an application that takes advantage of the Internet's connectivity. Navigation relies on a functioning GPS system and mapping technologies.

Engineers also have a responsibility to recognize that the technology exists in the context of markets and (financial) motivations. The fact that the Internet's connectivity isn't tied to a particular application makes uses like the web possible even if they were not reasons for building the infrastructure.

In the same way, we need to look beyond the excitement of an Internet of Things and work to provide the resources that we can build on, both in terms of technology and as products whose business models allow the bounty to be shared rather than limited to a single purpose.