

Empowering People ... and Their Things

Column: Bits versus Electrons

Empowering People ... and Their Things

Bob Frankston

EMPOWERING

■ **OVER THE LAST** year, many of us have discovered that the Internet offers abundant capacity for causal video calls and streamed video. This happened because we have pooled the available networking capacity and turned it into a common packet medium. Yet when it comes to connected devices, we deny ourselves opportunity by treating each path as special. We lose synergy by asking for a special Internet of Things.

I am empowered to innovate because I have the skills to use software to create my own solutions and to program around limitations. I also can choose to create solutions that match available opportunities.

Ambient Connectivity—the ability to assume connectivity everywhere, would be transformative. It would provide a resource that empowers people to think beyond the web and deploy medical monitors that work anywhere. They could implement crop monitoring without depending on a provider making a profit.

The key is to recognize that the value of connectivity is on the whole. Once we pool our resources and pay for a common infrastructure it becomes a resource for innovation. We will quickly

find that we already have an Internet of Things and do not need a special network for each purpose.

In this column, I will look at how we can step back from a complexity of seeing each network and applications as a special case and, instead, viewing it as a common infrastructure—an abundant commons.

PREFACE

In my previous column, I cited an article from IEEE CE Magazine. It showed many ways to take advantage of connectivity on farms and in villages. Applications ranged from tracking crops and livestock to accessing community services and the rest of the Internet. They can be implemented using existing Internet Protocols to overlay disparate facilities.

The hard part is making the connection between the two endpoints. This chart (see Figure 1) from the article brings the problem into sharp relief. Navigating the paths and assuring that the right services are available is daunting.

It is difficult to justify the investment in a special infrastructure for each purpose in each place. If the applications were already implemented, perhaps the value would be apparent.

PUBLIC PACKET INFRASTRUCTURE

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Preface

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Communication Technology	Standard/governing bodies	Frequency	Range (approximately)	Data rate	Topology
Bluetooth	IEEE 802.15.1	2.4 GHz	1-100 m	1Mb/s	Point-to-point
Z-Wave	-	900MHz	100m	9.6-100 kb/s	Star, cluster, mesh
ZigBee	IEEE 802.15.4	2.4 GHz	10-20 m	25 kb/s	Mesh
LoRaWAN	LoRa Alliance	867-869 MHz	2-5 km	290 b/s-50 kb/s	star
WiFi	IEEE 802.11 (a/b/g/n)	2.4 GHz, 3.6 GHz, 4.9 GHz, 5 GHz	100 m	1-54 Mb/s	Star
RFID	ISO, EPCglobal	125-134 kHz, 13.56 MHz, 860-960 MHz, 2.45 GHz	2 m	100 kbps	Point-to-point
6LoWPAN	IETF	915 MHz	30 m	250 Kbps	Star, mesh
NFC	ISO 18092	13.56MHz	<0.2 m	106, 212 or 424 kbits	Mesh
UBW	IEEE 802.15.3	2400MHz	10-30 m	11-55Mbps	Star

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A Public Packet Infrastructure (PPI)

The solution is to go back to the powerful idea that gave us the Internet – separating the relationships from the endpoints from the complexity of the path between. In simpler terms, this means that I can focus on my applications without being dependent on subscriptions, performance promises, or particular of each network.

The availability of open infrastructure, or what I call a Public Packet Infrastructure, creates a resource that enables individuals to implement and share their innovations.

10/20/2021 11:35

Digital Object Identifier 10.1109/MCE.2021.3095702

Date of publication 30 July 2021; date of current version 6 October 2021.

November/December 2021

Published by the IEEE Consumer Technology Society

2162-2248 © 2021 IEEE

53

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It also reduces the cost of the infrastructure since all applications can share the costs.

Opportunity starts at home

In my columns, I often write about projects I do within my own home. There are an increasing number of devices with open interfaces that allow me to implement solutions in software. As I wrote in my previous column, I can rapidly iterate and learn by doing.

My devices all share the common facilities, mostly Wi-Fi within my house. If I want to install a new light, I just find a power source (or use batteries). I don't need to run a wire to control the light – I simply give the bulb a name. I can then use that name to send it a message from a virtual button in an app, or I can tell Alexa (or another app) the name of the bulb. I don't have to think about the path the bits take – whether I use radios (as with Wi-Fi) or a wired connection.

In practice, the technologies don't work perfectly, but any effort I put into improving Wi-Fi benefits all my applications. If I want to control the lights from outside my house, I may need to carefully adjust port forwarding rules and add my own software. What is important is that my applications and smart devices get the benefit of the improved infrastructure. Because the application is not dependent upon the particulars of each network, the apps can continue to function without needing any change to take advantage of improved reach and capacity. When we depend on particular properties of a network, such as low latency, we limit our choice of underlying facilities.

In my own applications, I take advantage of all the Internet technology, but I'm not limited by it since I can implement my own capabilities to fill in the gaps as long as I'm within my house where I have control. All the devices share a single connection to the larger world. Even if I lose connectivity to the larger world, my local devices continue to work. At least those that, unlike Alexa (similar services such as Google Home), are entirely local.

I can also get some of this benefit outside my house if I use my phone as a hotspot. The phone isn't a general solution since it only works for my applications. A PPI (Public Packet Infrastructure) builds on this idea and makes connectivity available to all without having to maintain a special hotspot.

The Abundance of the Commons

Today our communications networks are digital – no matter what we are sending and receiving, it's all represented as ones and zeros. Those bits are grouped into packets. This has been true for more than half a century.

The powerful idea that enabled the Internet is that we can treat all packets the same, whether they are time-sensitive voice packets or an email message. It doesn't matter if we are connecting to a website or we're connecting devices, AKA things.

Letting go of the idea that each packet needs special treatment is difficult but liberating. The surprising lesson of Voice over IP is that even the most sensitive application can be implemented outside the network. The result is that today, we can casually do video conferencing at no premium cost. This is the power of being able to use software to create our own solutions – the synergy that comes from sharing the common facilities.

Just as I can implement my own home network, a farmer can provide common connectivity for all the devices on a farm. To be very careful about terminology, these locally owned facilities leverage Internet technology but aren't technically the Internet. To keep things simple, we can think of all this as part of the larger concept of Internet connectivity.

If there are two farms and one has a field far away, they can share the connectivity rather than having to each build parallel facilities. That's the power of not having to worry about whose wires or radios we're using. Each farmer gets more capacity than would be available with two separate facilities. Another fine point – notice that I'm using the word facilities – the networking is done using the facilities. Networking is done as an app rather than as a billable service.

This ability to share connectivity works just as well in a village. Rather than having each household operate its own networks, it makes more sense to pool their resources and hire professional staff to operate the facilities, just like the community hires professionals to maintain streets and other facilities.

We can then assume connectivity for schools, healthcare, environment monitor and much more. There is also a bonus in that livestock that wander can be tracked using any available connectivity. In parts of India where tracking elephants is important, simple radios can allow them to be tracked as they roam over a larger area.

Open Connectivity

When you add a smart device to your home network, you don't worry about the monthly subscription for each additional lightbulb. When you have connectivity on a farm, you don't have a monthly fee for each crop monitor or each sheep. You just connect the device, and you're done.

Imagine being able to take your medical monitor with you without having to worry about a subscription or pairing it with the right phone. It just works —It doesn't take a high-speed network, but it does require being able to assume connectivity.

The facilities become a resource, just like a path in a village is a resource. The value isn't in a given wire or a given brick on a path. The value is in the whole. When you walk down the street, you shouldn't have to negotiate with each access point.

And, given that the community is pooling the resources, there is no need to prevent people from connectivity just to charge a monthly fee. The community is the owner.

This is very liberating. It allows the focus to shift to taking advantage of the opportunities, and it creates a virtuous cycle as it encourages investment in shared capacity and the increased capacity leads to more opportunity. This is why we have VoIP – it took advantage of the capacity for the web, which is fortunate. Before VoIP was a thing, it would've been hard to explain why we need to provide special capacity.

That's the real value in open connectivity or what I call a Public Packet Infrastructure. A PPI is a market-based approach – the value is in the whole, so we come together to pay for the whole.

Leaving the Village

You connect your home network with the larger world by buying a “fat pipe”, AKA a broadband connection shared by all the devices on your home network. In the same way, the village or farm coops pool their resources to pay for a high-capacity connection to the Internet.

The economic benefits of sharing a fat pipe are compelling – far less than the cost of individual subscriptions and without limiting the capacity of individual connections. This is in addition to the benefits of open connectivity for innovation and the day-to-day functioning of the community.

The facility approach repeats at scale since adjacent communities can interconnect their facilities to create a larger whole and increase the pool of resources to pay for further connectivity while having no cost within the growing reach of the shared connectivity.

The key is to understand the power of shared infrastructure and the compelling advantage of being able to use any available connectivity rather than demanding special facilities for each application.

It's all Consumer Technology

It's appropriate for this column to appear in the IEEE Consumer Technology Magazineⁱⁱⁱ. By enabling people to innovate using the readily available computing devices and open connectivity, consumer technology comes to the fore. Software enables individuals to act as creators in solving their own problems. The community can then benefit when those solutions are shared with others.

We already have the Internet for things. We just need to recognize it.

ⁱ <https://rmf.vc/IEEEBetaLife>

ⁱⁱ Internet-of-Things-Enabled Smart Villages (<https://doi.org/10.1109/MCE.2020.3013244>).

ⁱⁱⁱ Yes, I know it's still called the Consumer Electronics Magazine but that will change.