2018 ACE SCHOOL & RUS SYMPOSIUM
TERMINUS
CONNECTING POINTS OF OPPORTUNITY

The Internet of Things

Interfaces and Aggregation

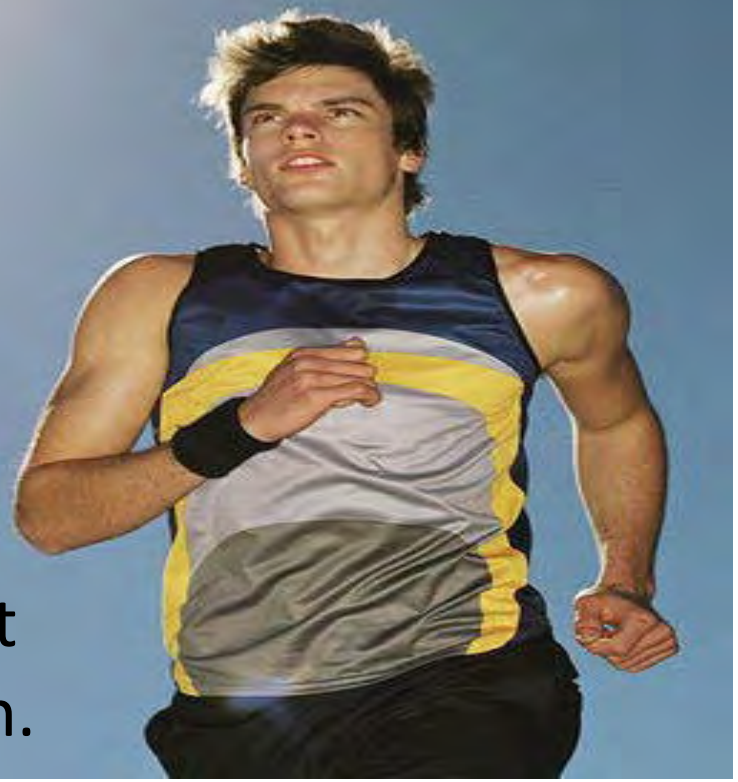
- David Hunt, Mid-State Consultants, Inc.

Association of Communication Engineers
ACE

Internet of….what things?

- Almost everything that can be automated, collect data, analyze – or that can trigger other events for analyzing data and doing things.
- Anything a machine or sensor can do that someone might want to hook to the Internet or a stand-alone network.
- Just plain goofy stuff – but the promise is there for good stuff!

- Electronic tattoos that monitor vitals.
- Contact lenses that read blood sugar.
- Water bottles that detect hydration from our touch.



Taking care of ourselves has become a global networking activity. In an IoT world, Data from sensors will inform everything from wellness to critical care.

It's way beyond fitness tracking.

But do I care?

- Does it really make my life easier and more fun?
  - *How much will it cost?*

Home Automation and Security Markers

Biggest factors are complexity and cost?

NFV significantly lowers costs and complexity?

What are my (service provider) complexities and costs?

- Initially, your subscribers will hook up via existing networks – and protocols.
- Subsequently, they will want you to help manage it.
- *If you're going to manage it:*
  - *You should make a buck.*
  - *You should limit your liability.*
  - *What else can you then offer?*
  - *But what will it cost you, and your network?*

Do I really want all these things on my network, and on the Net?

- Mindset: your network, and the Internet, are tools.
  - That tool is going to have to change, no matter what.
  - It might be faster, easier, and cheaper than alternatives
- It might happen all around me whether I want in or not, so let's consider using those tools.

Which will affect the network?

- All of them might –
- Some apps will require big bandwidth
- Some apps will require fast response
- Some apps will need new control protocols
- Some apps will run over the cellular network, or their aggregated traffic will, or –
- Some apps will need to be cheap
- Some apps may just flat-out need new, dedicated networks?

What Interfaces?

It depends on the type of traffic –

Locally processed and decisions are made locally, or

Aggregated and shipped upstream to …?

or direct to the cloud to be processed.

- There are different interfaces and protocol options, all optimized for different things – or vendors?
- They may all need to work together?

Shortcut protocols for IoT

- When sensors are cheap, work well, and last a long time, using a specific portion of IPv6 addressing can maximize the speed and reduce the power needed.

- Translating locally from a smaller protocol to aggregated IPv6 packets could help?

Which Protocols and Interfaces will be in the home?

- Almost all types, but not all apps
- The health-related ones?
- The ones that can make life simpler, smoother, faster, and more profitable?
- The cheapest ones?
- The ones that are the most fun?

The Digital Living Network Alliance (DLNA) framework provides media interoperability

DLNA storage locally and accessing the cloud

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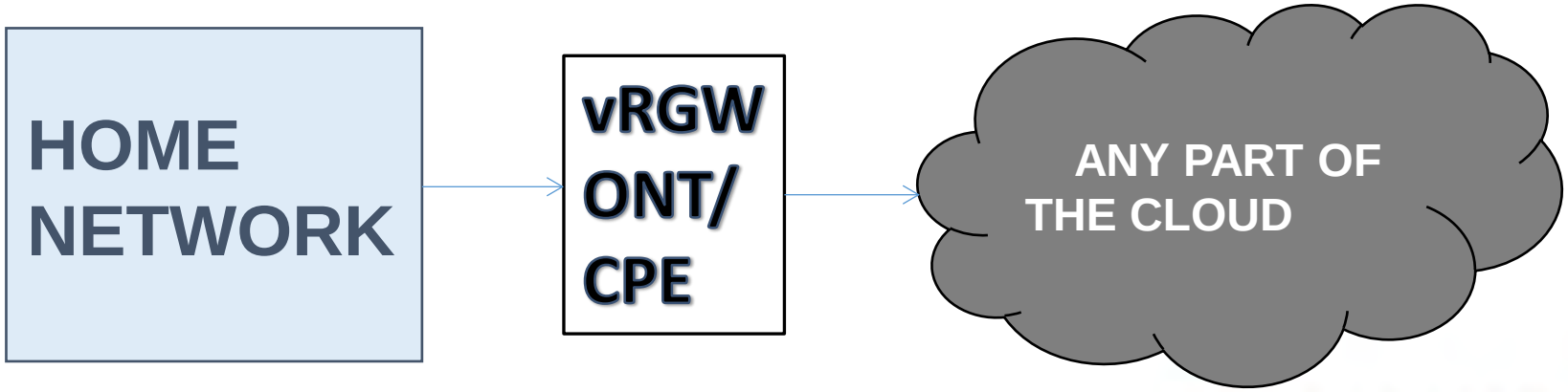
The Residential Gateway Enables More

- The vRGW (Virtual Residential Gateway) extends the home LAN into the service provider's network value-added services
- Your home network can smoothly include functions and apps from anywhere?
- *What happens when the "gateway" fails?*



Management and value

1. Apps and Services. This ‘Value Area’ is going to be very competitive.

2. Access. Your Network can be the best (or only) option.

3. Control. Good management of the network-and good support of any issues- may be the value that sets you apart from competitors.

The needs – and my part

- An IoT with home automation, health sensors, and cars connected to the Internet.
- Consumer-Services providers will be involved, to sell the apps, some specialty hardware, and some data collection and analysis.
- You get a ‘piece of the action’, or at least a fee for bandwidth and for QoS guarantees (the Open Internet rules made, and could still make, subscriber SLAs a little dicey).

The other players want -

- Hobbyists can use a Raspberry Pi CPU and build their own IoT. This can be started for about $50.
- Who’s going to provide the monitoring and management of the app? ANYBODY
- Who manages the basic network?

YOU CAN!

Ok, Which ones will just be inside the home, mostly?

- The ones that aggregate through apps on a smartphone – or a smart home
- The ones that can allow health data to be simply, cheaply, quickly collected
- Home automation and Home security – including Cybersecurity?
- The ones that collect data elsewhere and report back to you?
- The ones that your utility providers use to save money
- *The ones the government mandates?*
  - *Advanced 911, parole observations – health evaluations, - gun control?*

New Innovations

- One vendor just sent me an invitation to a show where “engineering experts will demonstrate our innovative 24 GHz and 60 GHz radar sensor system solutions for smart home applications including presence detection and occupancy tracking with voice interaction as well as best in class technologies for 5G mmW communications.”

What if I don’t want any IoT in my home?

- Your choice – mostly.
- The proposed ‘army of cheap sensors’ could enter your home on products you never expected – a cereal box that talks to your cupboard inventory system and your refrigerator?
  - And to your health monitoring app, of course.
    - *Your health and life insurance companies will want to know?*
    - *But if the insurance company will give me a really good deal I might be willing to let them know what I eat and what I do.*
- *Your refrigerator could be your best friend – and it could rat you out.*
- *Be aware of devices that have cameras, do interactive voice, etc.*

So what else?

- IoT is a broad topic – it could encompass "*any*thing" and "*every*thing"
- It will provide tools we will benefit from
- There will be 'defensive' IoT apps and devices to block other sensors
  - *If they gather data from you, they have to pay you for it?*
    - *Or at least get your permission and potentially give you something of value in return*

The Protocols

- How do they interface, how is their data aggregated, how do they report back to you?
- Several options for wireless
- Several options for wireline
- Hybrid combos of wireless and wireline

Wireless Interfaces

- The cheap apps – or at least the apps that depend on lots of cheap sensors – need simple wireless protocols
  - Some need long range, some just short range – and low power consumption
    - Some need batteries that can last a long time – or solar chargers
  - Some only send little packet bursts a few times a day, some are just waiting for input
- The big bandwidth ones need serious connections
  - 4G LTE for long range
  - 5G High Frequencies for big bandwidth
    - These interfaces can be pretty expensive
    - Unless you have a local box that is aggregating data from a bunch of sensors
    - Your smartphone could be a serious data aggregator? *Or it already is?*

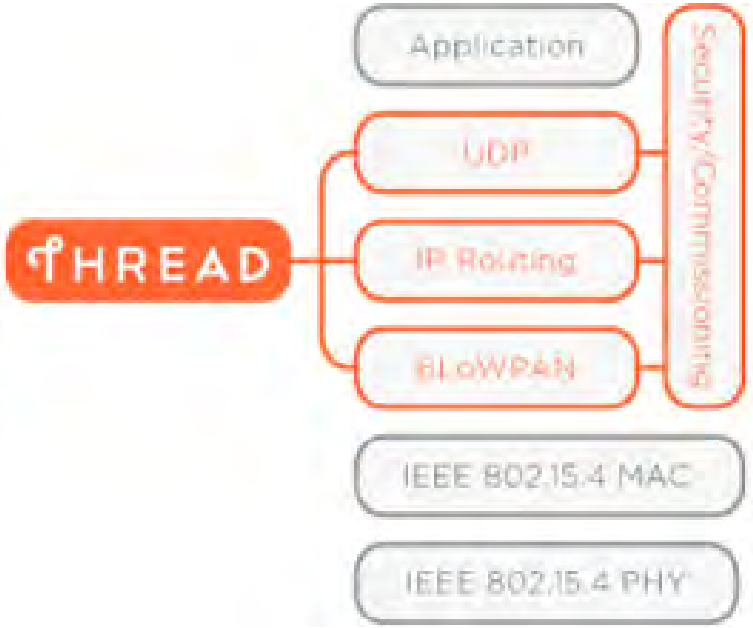
Like What? Examples

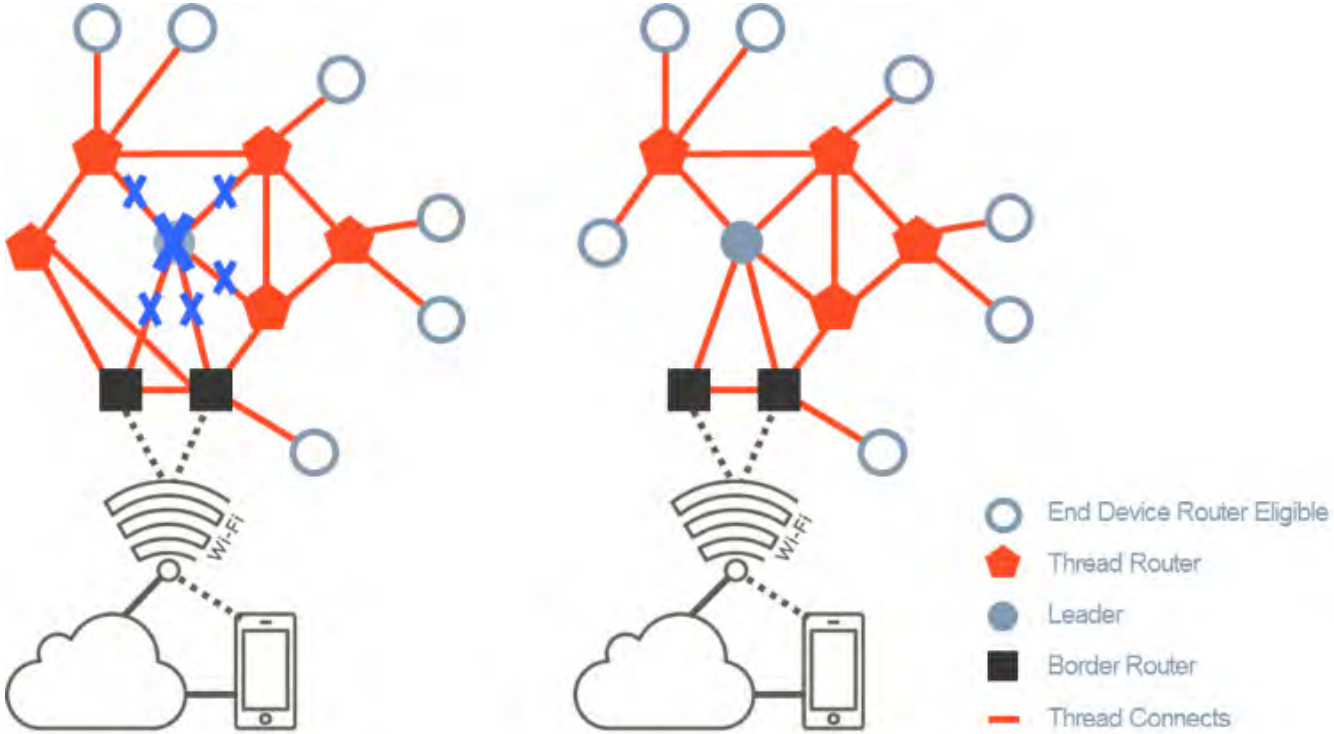
- I don't have a FitBit or an Apple Watch because it is too expensive (and invasive, annoying) for what little utility I think it would provide me. It's a novelty. But,…
  - Like all Apple products, the newer ones are getting better – and cheaper
  - All the protocols and net operator interactions are invisible to the user?
- When the cost and annoyance factor are less than the utility, the usability should be simple?
  - *Every properly developed technology is indistinguishable from magic….*

Simple Wireless Protocols

	Wi-Fi	WeMo	Bluetooth LE	Z-Wave	ZigBee	Thread	Android Things 1.0
First Launched	1997		2010	2003	2003	2015	2015
	IEEE	Belkin Product	IEEE Now Bluetooth SIG	ITU-T	IEEE	IEEE	IEEE
Standard	802.11	Wi-Fi	802.15.1 Now SIG	G.9959	802.15.4	802.15.4 6LoWPAN IPv6	802.15.4 Bluetooth Low Energy & Wi-Fi
Max. No. Devices		Router Dependent	32,000	232	Dozens	250	250-300
Data Rate		Router Dependent		9.6-100 kbps	40-250 kbps		
Frequency Bands	2.4 / 5 GHz 60 GHz	2.4 GHz	2.4 GHz	908.42/916 Mhz (U.S.)	915/2.46 GHz	2.4 GHz	2.4 GHz
Typical Range	100 m 66 feet indoors	100 feet	Class 3 – 3' Class 2 – 16'-33' Class 1 – 66'-98'	30-100 m 30' Recommended	10-100 m 35 feet Typical	10-100 m 100 feet theoretical	10-100 m 100 feet theoretical
Bandwidth	6 Gbs?		1-2 Mbs	40-100 kbs	40-250 kbs	250 kbs	250 kbs
Architecture	Star	Star	Scatternet Master-Slave	Mesh	Star, Tree & Mesh	Mesh with no single point of failure with at least 2 Border Routers	Mesh
Need Hub?		No	Yes	Yes	Yes	Border Routers	

Thread Protocols





(courtesy of Thread Group © 2015)

Wireline Interfaces

- The cheapest apps might be the ones that use existing infrastructure
  - There are several protocols that communicate over home power wiring
  - An interface from your home Internet connection to your power meter – paid for by the power company? Or by Amazon? Or the water company or your home insurance or health insurance…
  - Like the cheap wireless sensors, some only send little packet bursts a few times a day, some are just waiting for input
  - I don't really want demand-based AC power pricing, but if they gave me a big discount for running my dishwasher at night (during summer) I might do it.
- The big bandwidth ones need serious connections
  - Some apps, like video monitoring, will basically need FTTP

Simple Wireline Protocols

Protocol	*Transport*	*Messaging*	*LowPower and Lossy*	*Compute Resources*	*Security*	*Users*	*Arch.*
CoAP	UDP	Rqst/Rspnse	Excellent	10Ks/RAM Flash	Medium-Optional	Utility Field area Networks	Tree
Continua HDP	UDP	Pub/Subsrb Rqst/Rspnse	Fair	10Ks/RAM Flash	None	Medical	Star
DDS	UDP	Pub/Subsrb Rqst/Rspnse	Poor	100Ks/RAM Flash +++	High-Optional	Military	Bus
DPWS	TCP		Fair	100Ks/RAM Flash ++	High - Optional	Web Servers	Client Server
HTTP/REST	TCP	Rqst/Rspnse	Fair	10Ks/RAM Flash	Low-Optional	Smart Energy Phase 2	Client Server
MQTT	TCP	Pub/Subsrb Rqst/Rspnse	Good	10Ks/RAM Flash	Medium-Optional	IoT Msging	Tree
SNMP	UDP	Rqst/Rspnse	Fair	10Ks/RAM Flash	High-Optional	Network Monitoring	Client Server
UPnP		Pub/Subscrb Rqst/Rspnse	Good	10Ks/RAM Flash	None	Consumer	P2P Client Server
XMPP	TCP	Pub/Subsrb Rqst/Rspnse	Fair	10Ks/RAM Flash	High-Mandatory	Rmt Mgmt White Gds	Client Server
ZeroMQ	UDP	Pub/Subscrb Rqst/Rspnse	Fair	10Ks/RAM Flash	High - Optional	CERN	P2P

Where is the data processed?

- In the home?
- In the nearest router/ CO / ‘IP Space’?
- In the cloud – or a local version of someone’s cloud app?
  - Edge IP is getting a lot of discussion in the network, and it can mean many things.
  - Perhaps you have no reason to route the traffic until there are choices to be made – Edge Ethernet can do most of the same things, and already exists to some degree – but this presentation isn’t about layer 2 versus layer 3
  - But Cisco, who tried to use the phrase, “Internet of Everything” would love for every telco to deploy routers all the way to the home. Is there any reason for it? Probably not yet. [MPLS has missed it’s big chance?]

Aggregation

- There aren't many smart home apps yet – except for the ones that do home security and now home automation – and smartgrid apps.
  - Probably already an outdated statement
    - In 2005, there were 6 products using Z-Wave, by 2012, 600 products
    - As of April 18, 2018 there were over 2,400 interoperable Z-Wave products
- The smartphone is really the driver of these?
- Smart TVs could be a big driver?
- But, aggregation can be expensive, and needs good control from upstream systems.

Satellite Apps?

- If I want sensors out in the sticks, could a bunch of sensors (or whatever) report back to a device that would aggregate traffic and 'talk' to the satellite just once in a while?
- Really remote location apps could be the drivers for cheaper aggregation devices
- A home Wi-Fi AP that can automatically aggregate / store IoT data and report upstream?

IPv6

- IP version 6 was seen as critical a few years ago (at least by some), but there have been some really good tricks to extend the capabilities of IPv4. Some of these little tricks and techniques will help low-cost IoT apps get rolling in the marketplace.
- But, IPv6 is slowly becoming more common, and it provides enough address space that, at least in theory, every user (or every home, etc.) could essentially have their own IPv4-sized Internet.
- Do we need it? Not yet. But if all the projections for 50 billion connected devices are at all accurate, we will at least need something.
- Most Residential will get a /64 1 IPv6 subnet is: 18,446,744,073,709,551,616 and it's pronounced like this: eighteen quintillion, four hundred forty six quadrillion, seven hundred forty four trillion, seventy three billion, seven hundred nine million, five hundred fifty one thousand, six hundred sixteen

New addressing protocols?

- What if your home aggregation device more-or-less automatically set up its own addressing scheme with all your IoT interconnected devices?
- Simple, small addressing packets tightly connected to one device.
- Low power, really low bandwidth, low cost sensors.

Which Lock Do You Prefer?

-

And what about security?

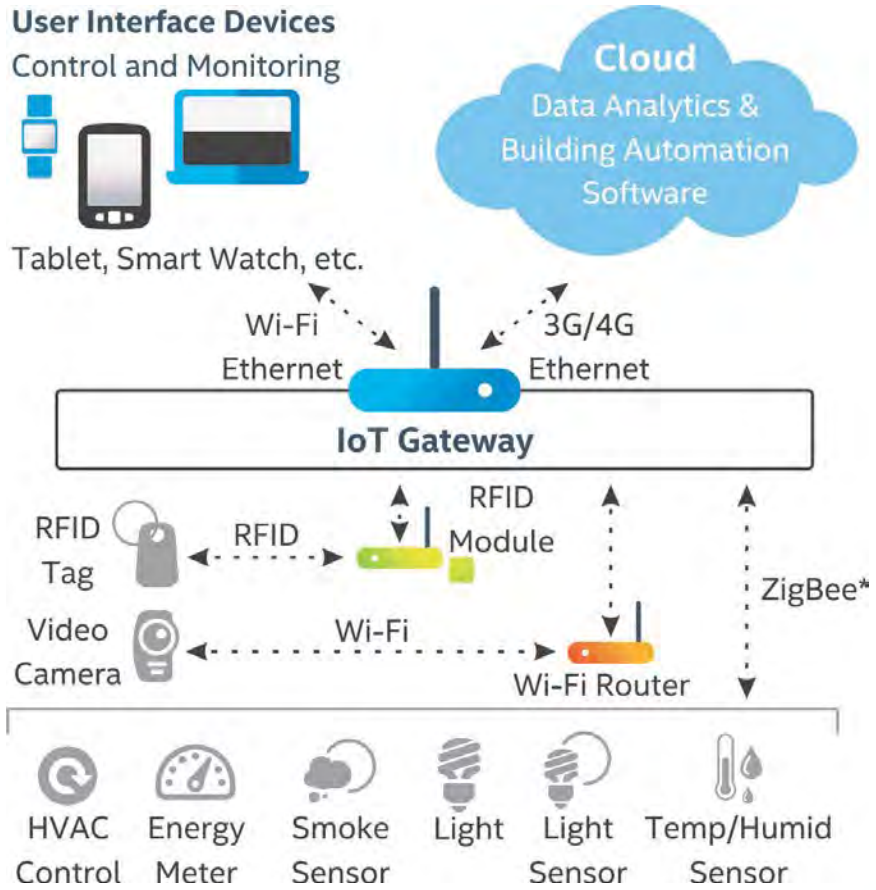
- Could anyone hack into these simple little protocols?
- If they are just simple little apps that turn on my lights and sprinklers and tell me when my milk is expiring, perhaps I don’t care much.
- *But if that provided a back door into my health apps that affected my health insurance*
- *What I don’t know can hurt me!*

From Integration Testing Vendor Intertek

- **Interoperability & Compatibility**
  Many connected IoT solutions are installed into ecosystems and environments using wireless products sourced from different OEMs and connected over multiple protocols. Without a guarantee that connected products are designed to work together – or that third-party elements will not be introduced into the ecosystem -- great risk is introduced to your solution.

  Intertek's team of connected world test engineers are trained to evaluate factory-installed and aftermarket off-the-shelf "smart" / connected IoT products for performance, interoperability and claims. Intertek engineers can install and integrate any combination of products and networks in our labs to validate seamless operation.

Do I Want To Be That Connected?



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Take-Aways

- Customer requirements and interest will drive adoption, not the network provider in most cases
  - Will you really be able to sell an IoT enabled lock to someone who doesn't even lock their front door?
- Customer ability or inability to manage will drive revenue options
- Standards Based (customers will drive if network owners don't)
- Security may not be important to consumer until a breach occurs

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