IEEE Consumer Electronics Society

Future Insights 2020+
The Internet of Things

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Distinguished Lecturer IEEE Consumer Electronics Society

IEEE
Advancing Technology
for Humanity

Who am I?

- Professional Volunteer (Electronic & ICT Engineer)
  - Member Board of Governors, IEEE Consumer Electronics Society
  - Editor-in-Chief, IEEE Consumer Electronics Magazine
- Day Job(s):
  - University vice-Dean (2005-2012) & Statutory Lecturer
  - Entreprenneur, Inventor & Technologist
  - Industry Consultant

Where am I?

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  - pcor00@gmail.com
- Google Scholar (search ‘Peter Corcoran’)
- LinkedIn:
  - http://www.linkedin.com/in/cregg
- Twitter & Facebook
  - I don’t use these very much …

Today’s Talk

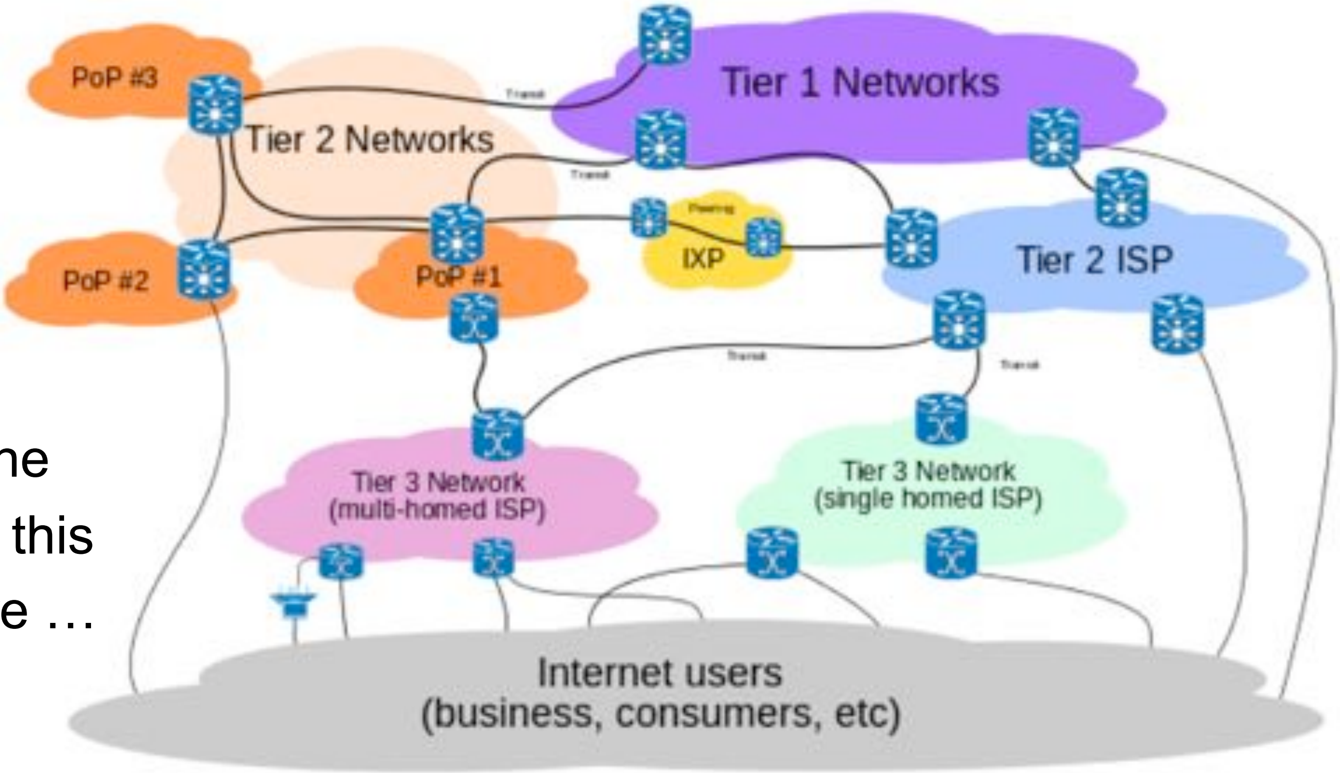
- 1. What is the Internet Anyway?
- 2. What is the Cloud?
- 3. Mobile Data & Smartphones ***(the first ‘Things’)***
- 4. The Internet of Things - Should I care?
- 5. The IoT Today – Some Examples
- 6. Where the Internet & Things are Heading …
  - Data Growth
  - Energy Consumption
  - The Dark-Web & Cyber Security

The Internet is Broken, Daddy … ☹☹☹

1. WHAT IS THIS ‘INTERNET’ THING ANYWAY … ?

The ‘Internet’ is NOT the ‘Web’ …

Note that Vint Cerf & Tim Berners-Lee agree on this!



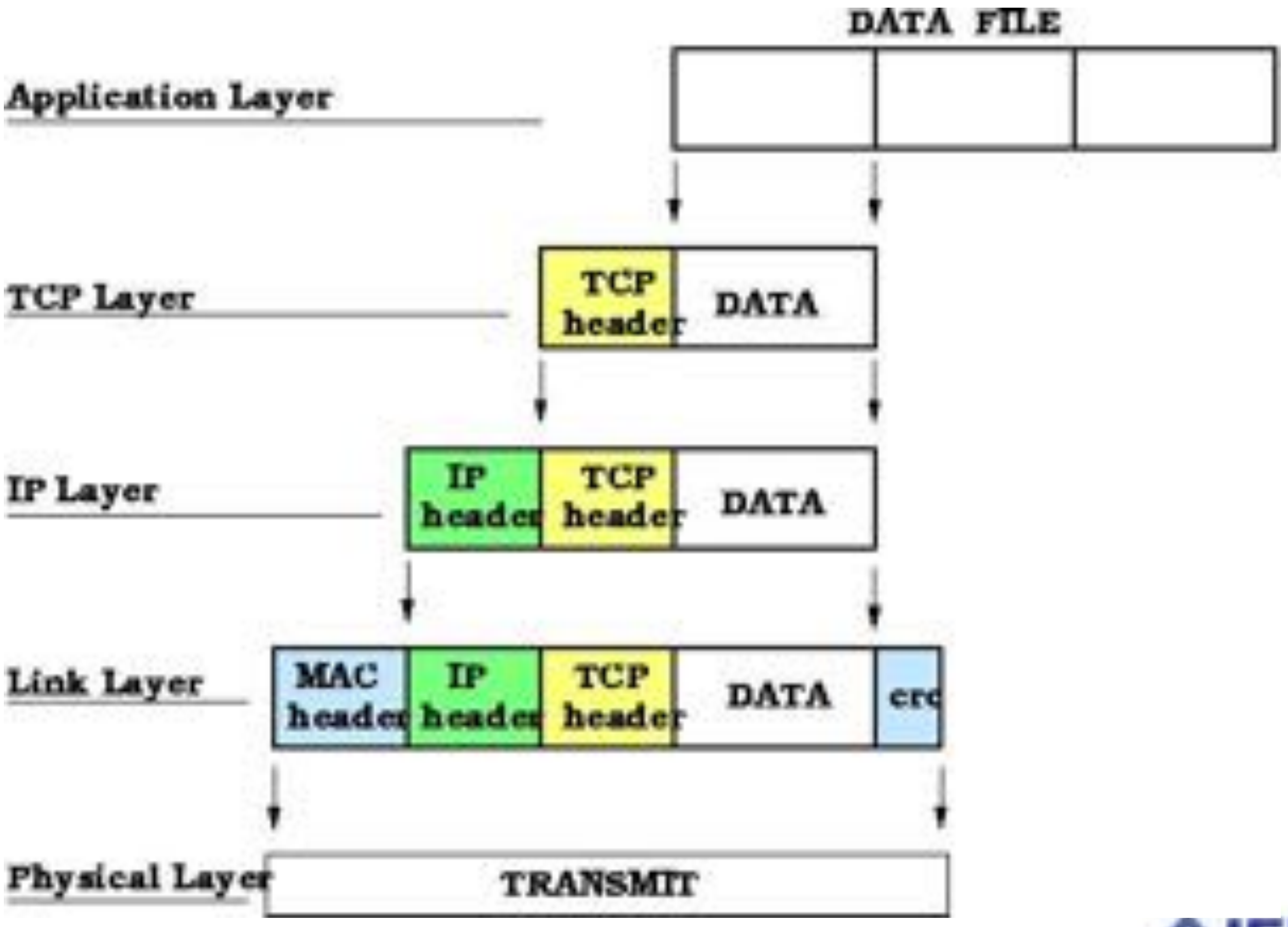
We are on the periphery of this Infrastructure …

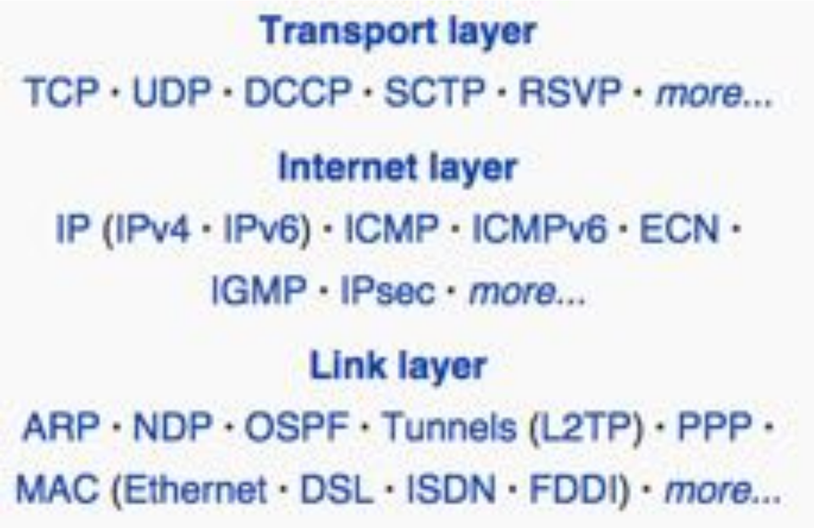
A LAYERED NETWORK OF NETWORKS

TCP/IP is a Military Technology –

designed to operate in uncertain environments with built-in redundancy & robustness …

Concept: TCP/IP Protocol Stack





Transport layer

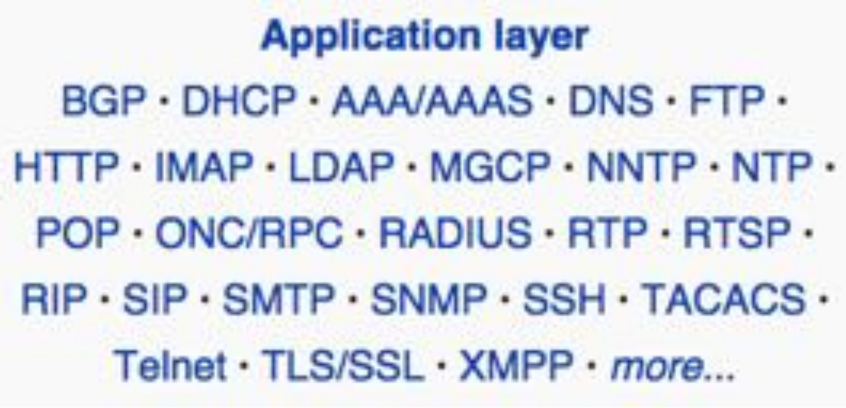
TCP · UDP · DCCP · SCTP · RSVP · *more...*

Internet layer

IP (IPv4 · IPv6) · ICMP · ICMPv6 · ECN · IGMP · IPsec · *more...*

Link layer

ARP · NDP · OSPF · Tunnels (L2TP) · PPP · MAC (Ethernet · DSL · ISDN · FDDI) · *more...*



Application layer

BGP · DHCP · AAA/AAAS · DNS · FTP · HTTP · IMAP · LDAP · MGCP · NNTP · NTP · POP · ONC/RPC · RADIUS · RTP · RTSP · RIP · SIP · SMTP · SNMP · SSH · TACACS · Telnet · TLS/SSL · XMPP · *more...*

Do you recognize any of the above?

GLUED TOGETHER BY A SUITE OF TCP/IP PROTOCOLS

The 1nd main point for today!

- Computers aren’t much use any more without the network ….
- …. And the network is TCP/IP

The Internet is Broken …

2. WHAT IS ‘THE CLOUD’?

Concept from 1960s!

Douglas Parkhill - *The Challenge of the Computer Utility* (1966).

- Almost all the modern-day characteristics of cloud computing were thoroughly explored in **Douglas Parkhill's 1966 book, *The Challenge of the Computer Utility*.** Parkhill was the first to draw a comparison to the electricity industry and the use of public, private, government and community forms, elastic provisioning and the illusion of infinite supply.
- The first scholarly use of the term cloud computing was in a 1997 lecture by Ramnath Chellappa. He defined the term cloud as a computing paradigm where "… ***the boundaries of computing will be determined by economic rationale rather than technical limits***".
- 1999 - Salesforce.com pioneered the concept of delivering enterprise applications via a simple website. This made it possible for software firms to deliver **applications** over the internet.
- 2002 – 2006: post dot-com bubble, **Amazon** played a key role by modernizing their data centers to handle the huge surges in network traffic at Xmas. Afterwards the company realized that surplus computing capacity could become a new business for them.

A Corporate Conspiracy … ?

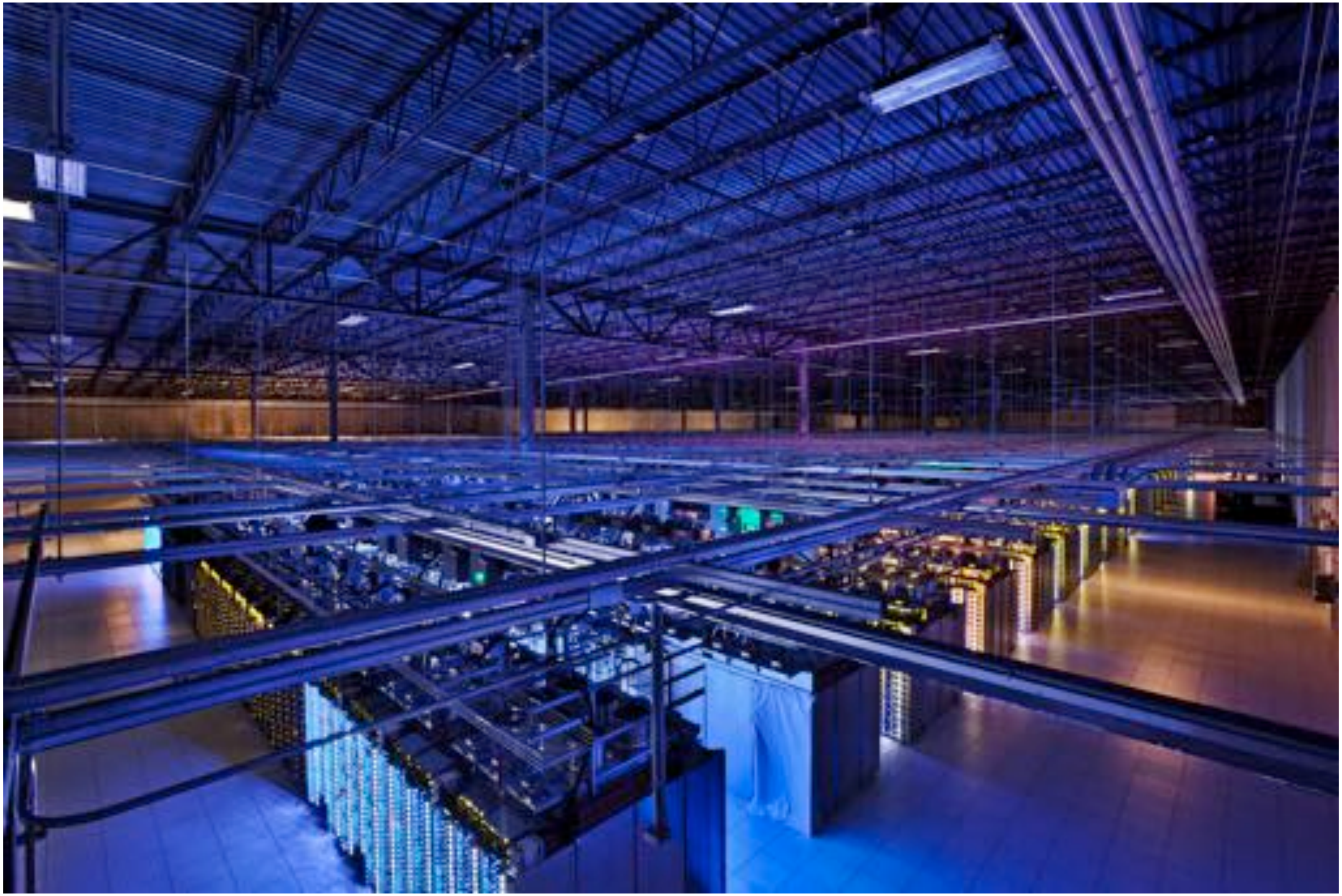
Some Links:

- Cisco – VNI (Visual Networking Index)
  - http://www.cisco.com/c/en/us/solutions/service-provider/visual-networking-index-vni/index.html
- IEEE Cloud Computing
  - http://cloudcomputing.ieee.org/
  - http://en.wikipedia.org/wiki/IEEE_Cloud_Computing

A View Inside 'The Cloud'

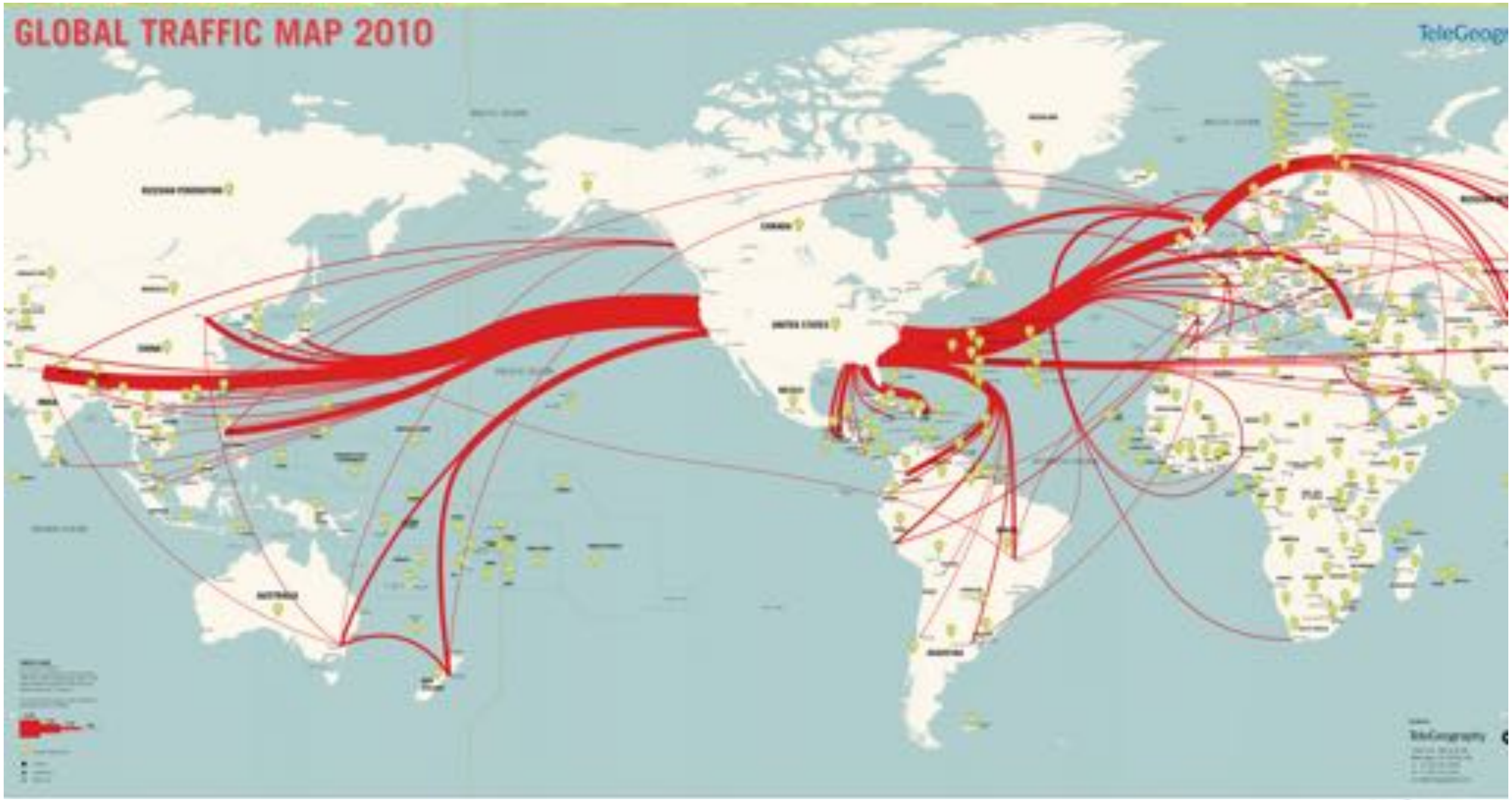
An Occasional Engineer is Seen …

Inside Google



An Outside View

The US is World’s Internet HUB (2010 Data)



But what does the cloud mean for me …. ?

Example #1 – Online E-Mail

- Gmail (2004)
  - A radical re-thinking of the e-mail service; there were some key user advantages to managing e-mail on a Web server:
    - Access to e-mail from ANY Web browser;
    - No mail client compatibility issues;
    - Management & Admin all “in the cloud”
  - Large storage allowance means you don’t have to clean your inbox; Google says you’ll never have to delete any e-mail, EVER!
  - Of course Google loves to mine all the data associated with your e-mail!

GMAIL

Example #2 – Online Storage

- Dropbox (2008), Google Drive (2007), iCloud (2011), many others …
  - Software sits on your computer but everything is duplicated at a remote data center;
  - Enables sharing of data between different users;
  - The models facilitates sharing of data between laptop/desktop and mobile devices;
  - You can (almost) forget about data backup as this is part of the 'service' …

Dropbox

Drive iCloud

Example #4 – Online Applications

- Youtube (2005)
  - User generated video storage; free service!
  - Lots of controversy around copyright and related issues but acquired by Google in 2006 providing 'deep pockets' to resolve teething problems …
  - Continues to grow and build services with a focus around user-video;
  - Video is THE underlying growth content driving network infrastructure;
  - My kids watch more youtube than regular TV …
  - Many things are best explained in video clip:
    - Minecraft Tutorials; Game Walkthroughs; How-To tutorials for DIY, repair and assembly tasks;

youtube

The 2nd main point for today!

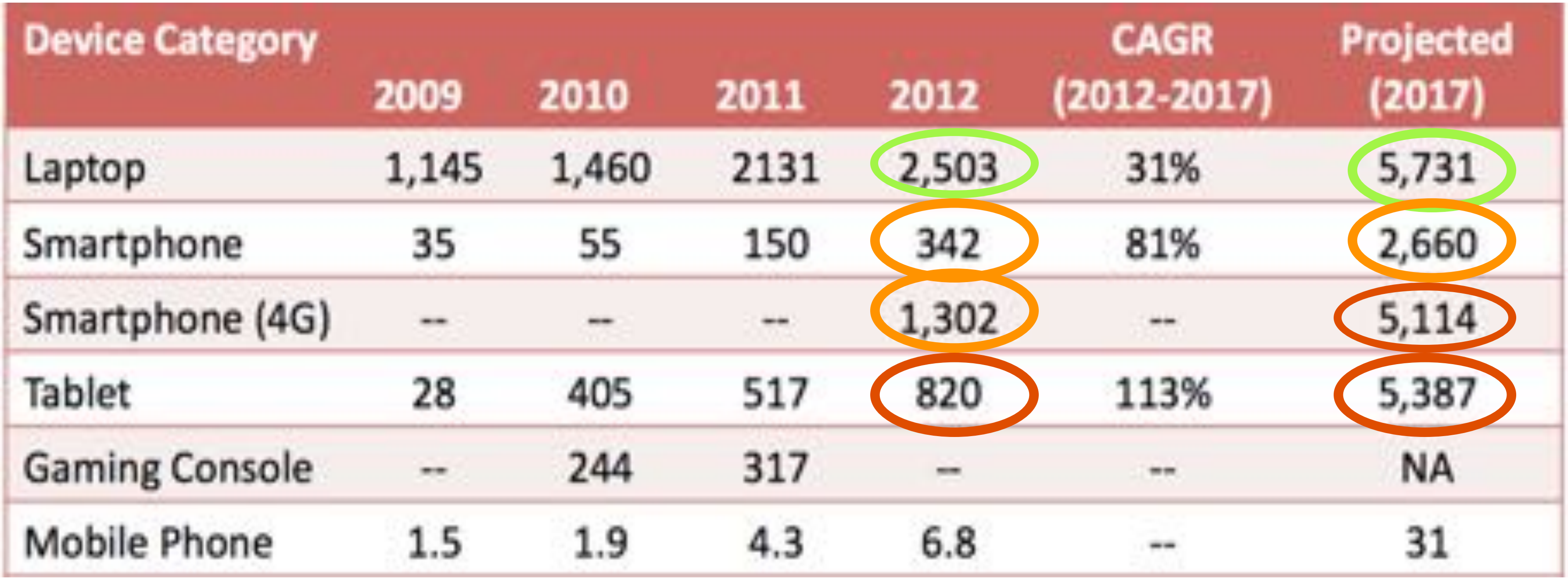
- Computers aren’t much use any more without the network ….
- … the data **just left the computer** and moved to the network as well!

3. MOBILE DATA & SMART-PHONES

Why are Thin Client Important?

- Phenomenal Growth rate in Smartphones & Tablets in last few years
- Changing fundamental use patterns of CE-ICT
    - Many consumers now view TV/Movies on ‘small screen’;
    - New Media – youtube, facebook, Netflix, etc …
    - New Services – grocery shopping, games, social networks
- Tablets bring ICT from Desktop into Living Room
- Disruptive Technology!

(Table courtesy Cisco VNI)



Device Category	2009	2010	2011	2012	CAGR (2012-2017)	Projected (2017)
Laptop	1,145	1,460	2131	2,503	31%	5,731
Smartphone	35	55	150	342	81%	2,660
Smartphone (4G)	--	--	--	1,302	--	5,114
Tablet	28	405	517	820	113%	5,387
Gaming Console	--	244	317	--	--	NA
Mobile Phone	1.5	1.9	4.3	6.8	--	31

Data use in MB per month; note the CAGR rates of 81% and 113% for smartphones & tablets;

Tablets will consumer as much “Network Data” as Laptops by 2017 – 2x the consumption of today’s laptops; but there will be a lot more tablets & smartphones …

Thin Clients like Smartphones will drive Data Consumption … and Production! (via Pictures, Videos, etc) …

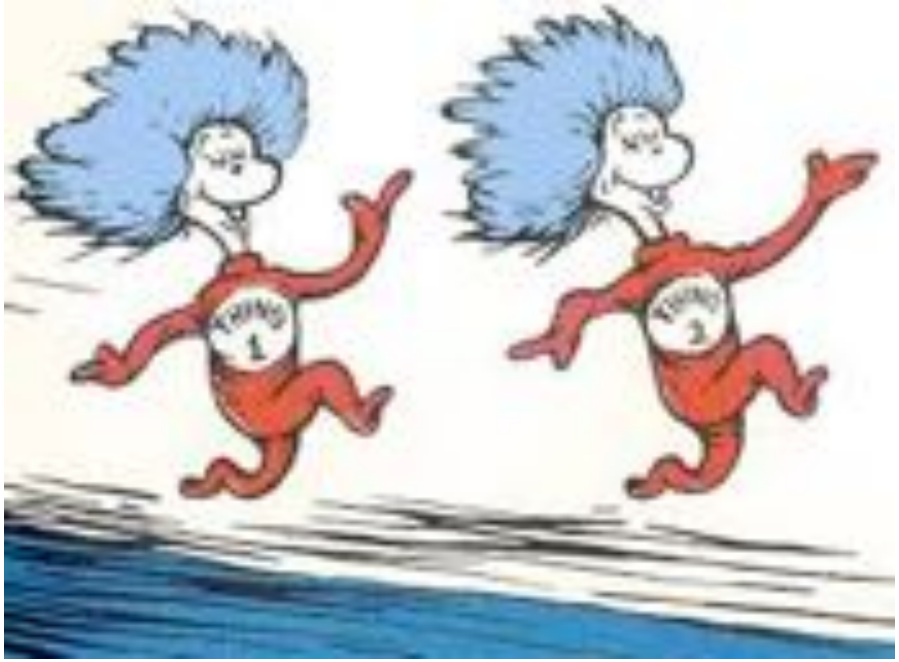
Growth in Numbers = Big Growth in Data Traffic …

- Today (2012) -
  - c. 600 Million Laptops
- Tomorrow (2017) –
  - c. 2,000 Million tablets (+ c. 1000 Million Laptops)
  - c. 4,000 Million smart-phones (conservative?)
- TV Panels are also becoming “connected”:
  - Smart TV
  - Add-on connectivity: Boxee, Apple-TV, many others …

The 3rd main point for today!

- Exponential Growth as …
  the user **becomes the Data!**

The “Things” are coming …



4. THE INTERNET OF THINGS –

What is it and why Should I care?

What The Phrase Means

Kevin Ashton coined ***"Internet of Things"*** phrase to describe a system where the Internet is connected to the physical world via ubiquitous sensors

The term "Internet of Things" was first documented by British visionary, Kevin Ashton, in 1999.

Corcoran & Desbonnet genuinely built an IoT … in 1997 & 1998!
(i) "Browser Style Interfaces to a Home Automation Network"
(ii) "Mapping home-network appliances to TCP/IP sockets using a three-tiered home gateway architecture")

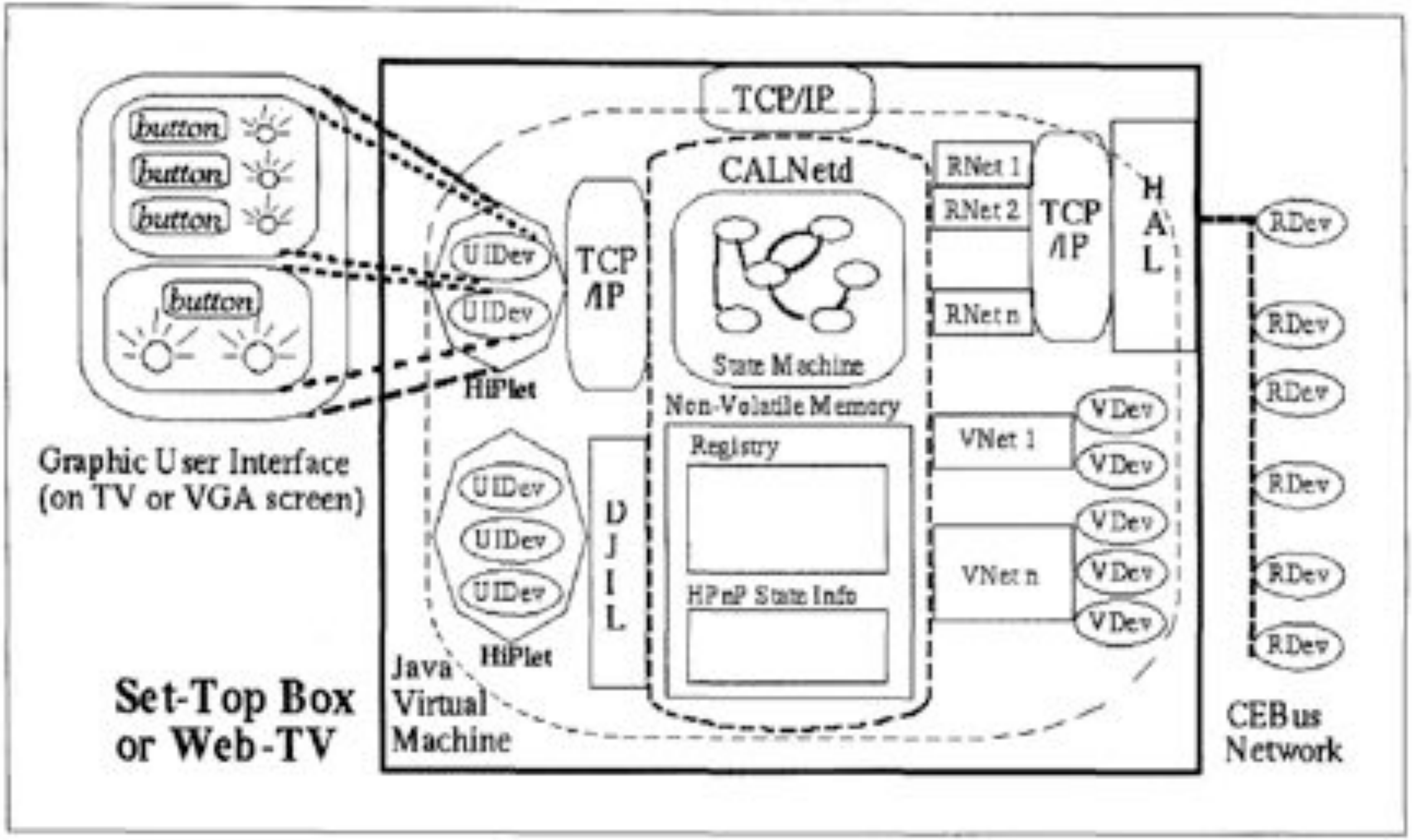
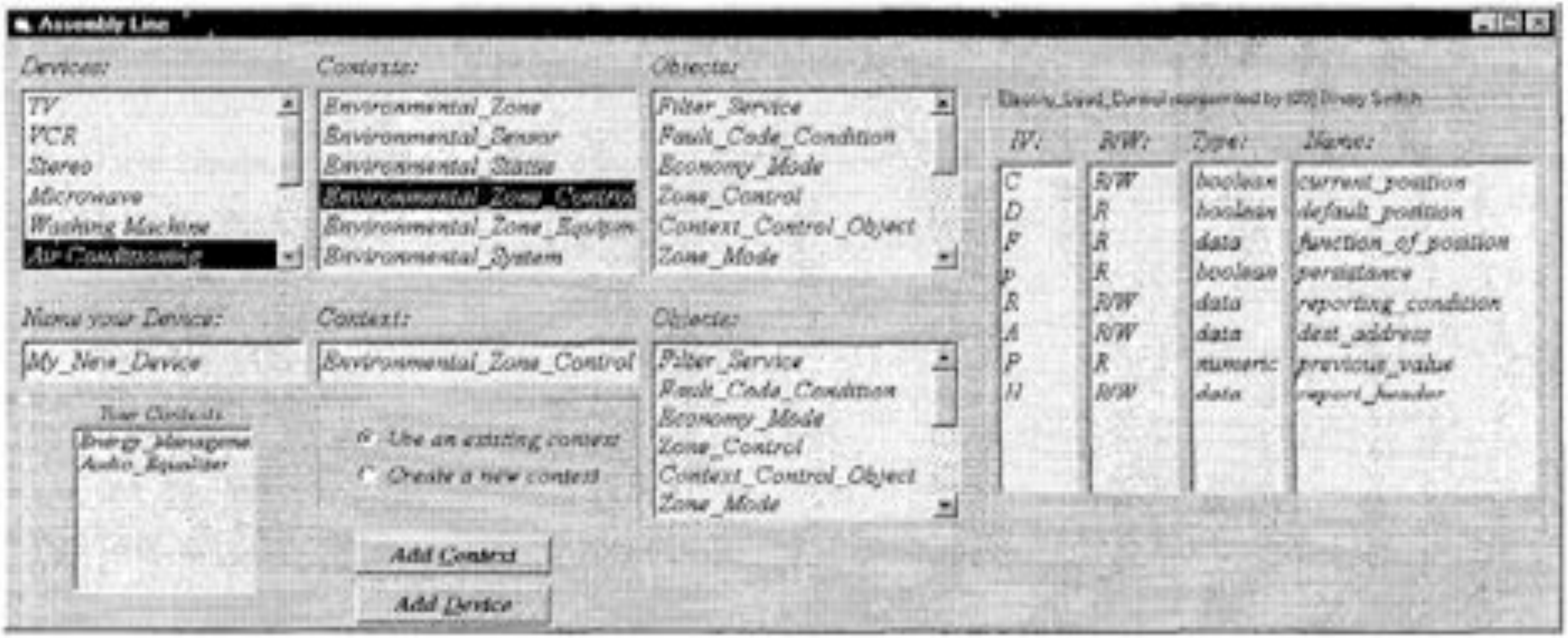


Fig: 2 Details of Internal System Architecture and UI Elements.

What an 'object infrastructure' looks like – nearly 20 years ago!

("Browser Style Interfaces to a Home Automation Network")



Devices:
- TV
- VCR
- Stereo
- Microwave
- Washing Machine
- Air Conditioning

Contexts:
- Environmental_Zone
- Environmental_Sensor
- Environmental_Status
- Environmental_Zone_Control
- Environmental_Zone_Equipm
- Environmental_System

Objects:
- Filter_Service
- Fault_Code_Condition
- Economy_Mode
- Zone_Control
- Context_Control_Object
- Zone_Mode

Name your Device: My_New_Device

Context: Environmental_Zone_Control

Objects:
- Filter_Service
- Fault_Code_Condition
- Economy_Mode
- Zone_Control
- Context_Control_Object
- Zone_Mode

Your Contexts:
- Energy_Manageme
- Audio_Equaliser

● Use an existing context

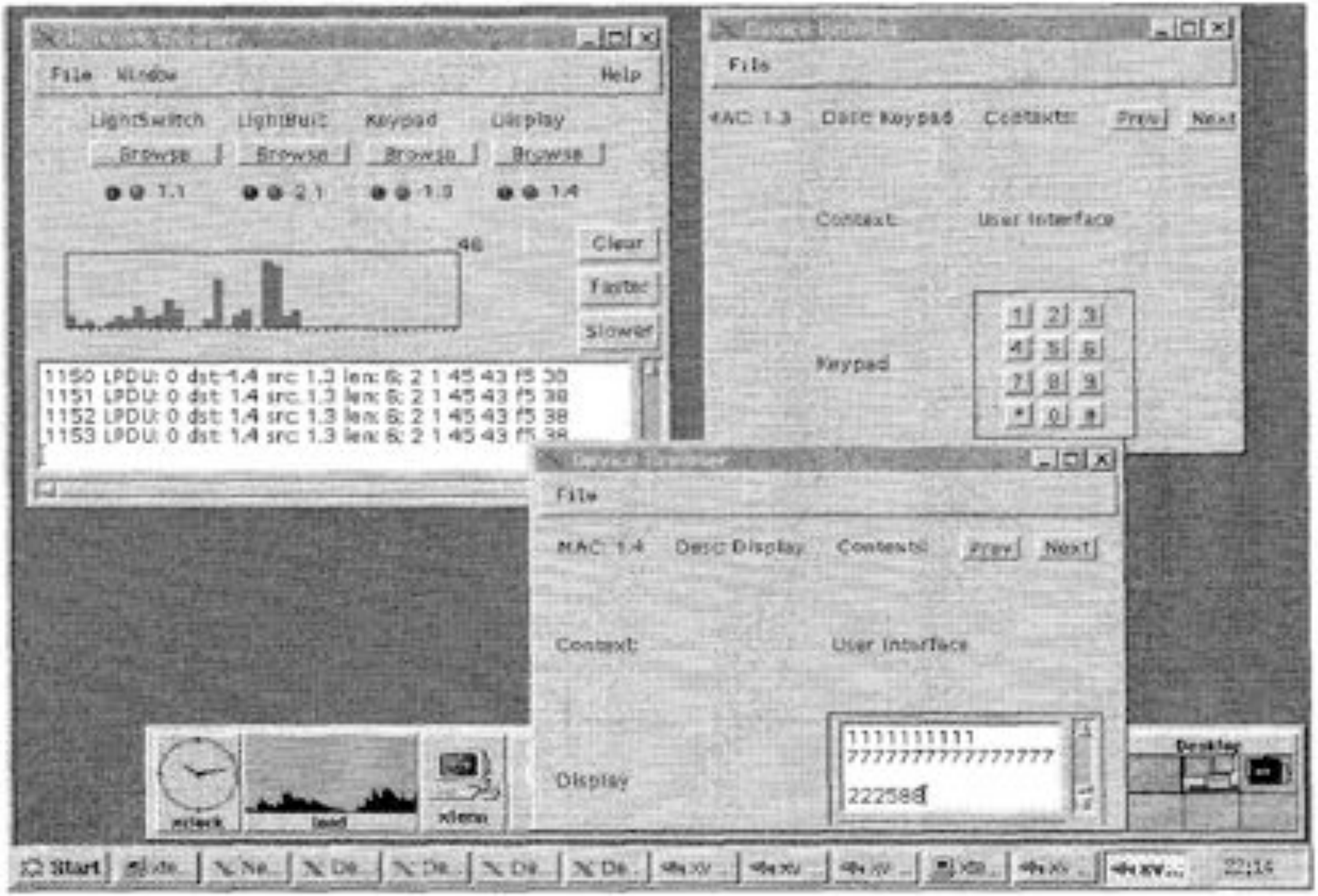
○ Create a new context

[illegible]

IV:	R/W:	Type:	Name:
C	R/W	boolean	current_position
D	R	boolean	default_position
F	R	data	function_of_position
p	R	boolean	persistance
R	R/W	data	reporting_condition
A	R/W	data	dest_address
P	R	numeric	previous_value
H	R/W	data	report_header

Fig: 4 *An Enhanced Device Browser can provide very detailed access to the CAL Object Structure of Appliances connected to a Home Automation Network.*

And on a Workstation Terminal … *("Browser Style Interfaces to a Home Automation Network")* **…** each window links to a device!



```
1150 LPDU: 0 dst 1.4 src 1.3 len: 6: 2 1 45 43 f5 38
1151 LPDU: 0 dst 1.4 src 1.3 len: 6: 2 1 45 43 f5 38
1152 LPDU: 0 dst 1.4 src 1.3 len: 6: 2 1 45 43 f5 38
1153 LPDU: 0 dst 1.4 src 1.3 len: 6: 2 1 45 43 f5 38
```

MAC: 1.3 Desc: Keypad Contexts:

MAC: 1.4 Desc: Display Contexts:

```
1111111111
7777777777777777
222588
```

Fig: 8 The Device Browser described in 3.3 is shown with two single-context HiPlets, A Keypad and a Display.

How Ubiquitous?

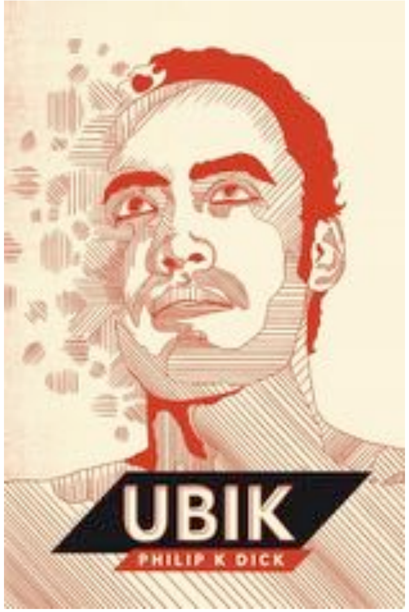
Gartner: “IoT Installed Base Will Grow to ***26 Billion Units*** By 2020.” *That number is likely too low.*

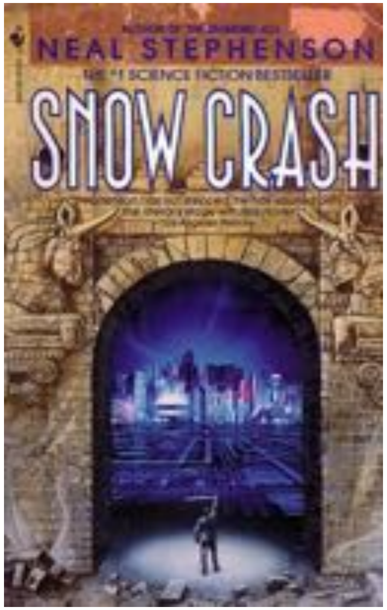
- Every mobile
- Every auto

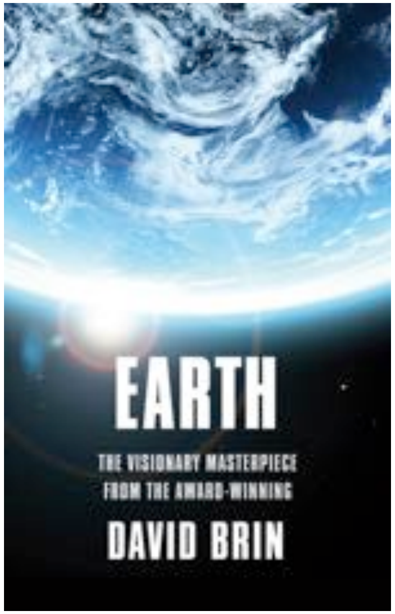
- Every door
- Every room

- Every part, on every parts list

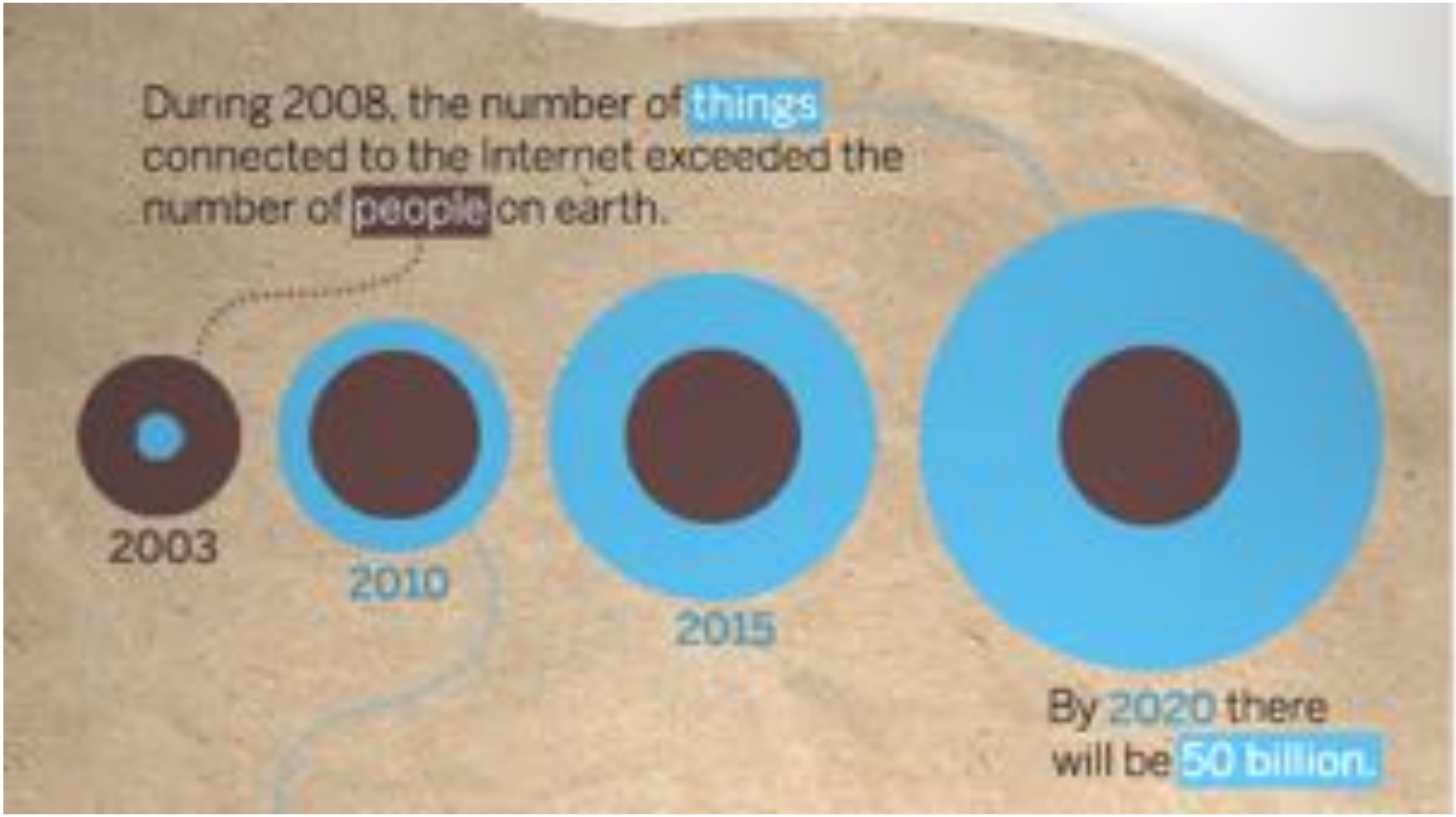
- Wearables cheaper than water





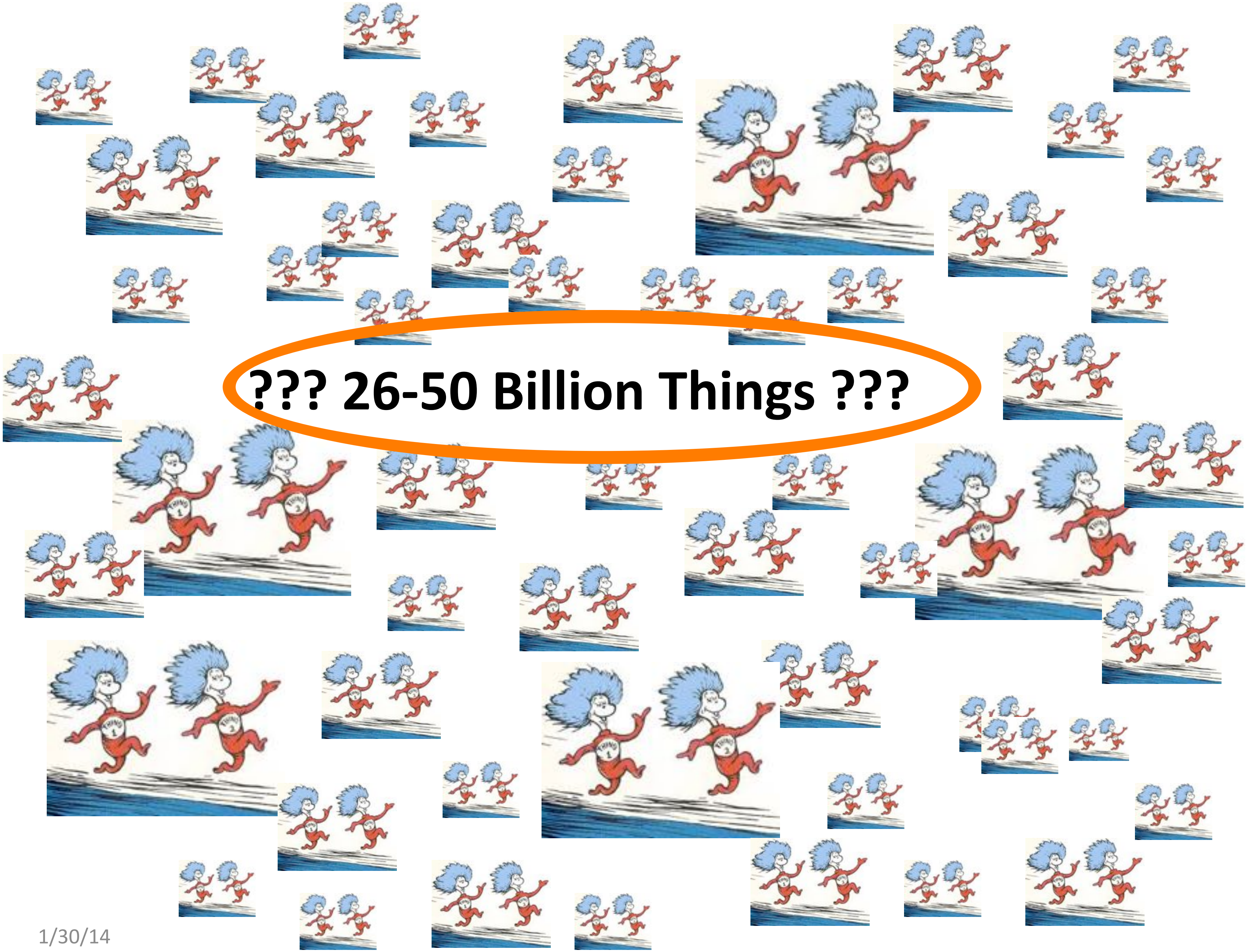


“Thing” connected to the internet



Sources: Cisco IBSG, Jim Cicconi, AT&T , Steve Leibson, Computer History Museum, CNN, University of Michigan, Fraunhofer

Image Courtesy: : CISCO



??? 26-50 Billion Things ???

The 4th main point for today!

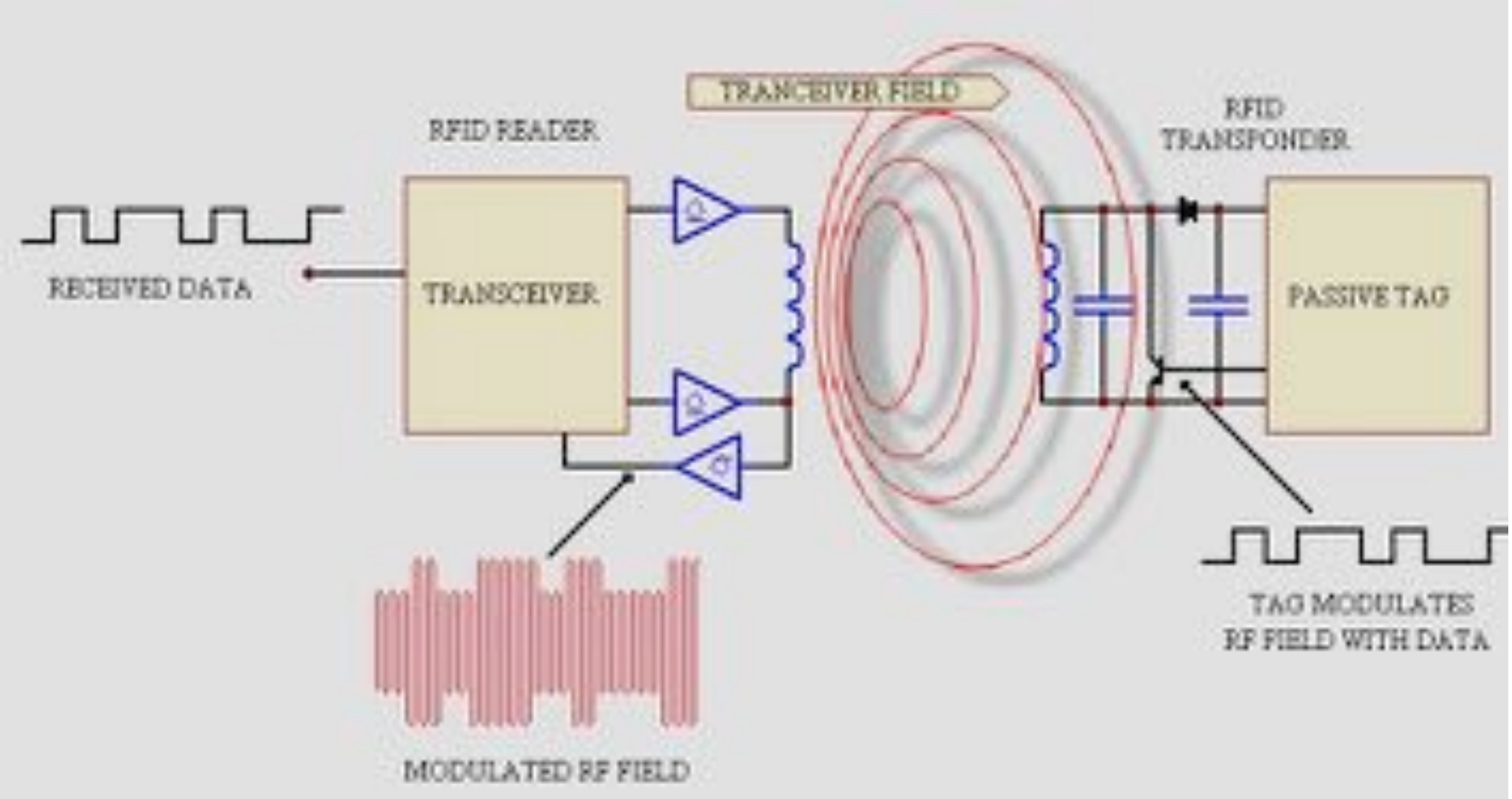
Hang onto your Hat!

We saw 3-4 Billion Smartphones would create a lot of DATA, but …

IoT is going to be a LOT **BIGGER!**

INTERNET OF THINGS TODAY? – SOME EXAMPLES

1. RFID – *Identification* for Things



One Application of IoT/RFID

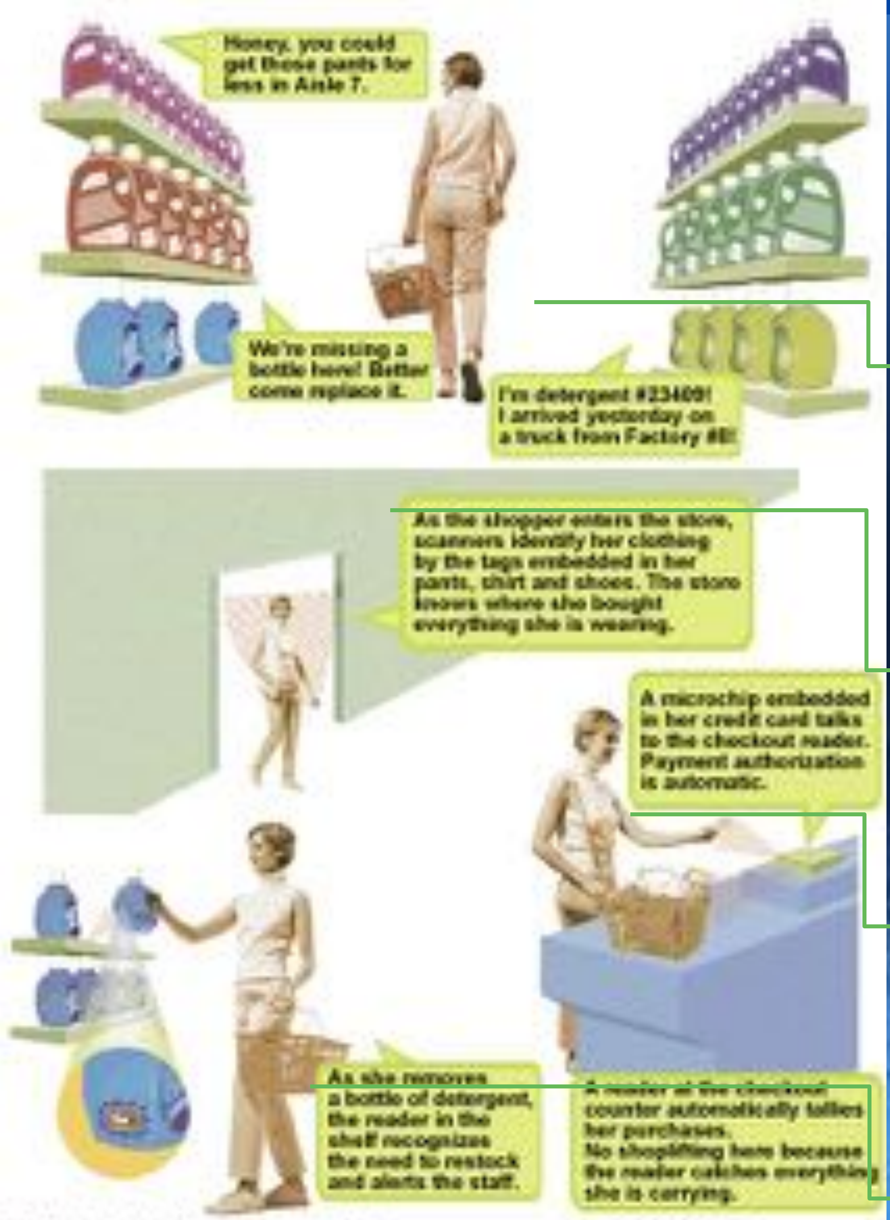

Honey, you could get those pants for less in Aisle 7.
We're missing a bottle here! Better come replace it.
I'm detergent #23409! I arrived yesterday on a truck from Factory #8!
As the shopper enters the store, scanners identify her clothing by the tags embedded in her pants, shirt and shoes. The store knows where she bought everything she is wearing.
A microchip embedded in her credit card talks to the checkout reader. Payment authorization is automatic.
As she removes a bottle of detergent, the reader in the shelf recognizes the need to restock and alerts the staff.
A reader at the checkout counter automatically tallies her purchases. No shoplifting here because the reader catches everything she is carrying.

Illustration by Lisa Knouse Braiman for Forbes

Scenario: shopping!

(2) When shopping in the market, the goods will introduce themselves.

(1) When entering the doors, scanners will identify the tags on her clothing.

(4) When paying for the goods, the microchip of the credit card will communicate with checkout reader.

(3) When moving the goods, the reader will tell the staff to put a new one.

Bad
Good
Impacts

GOOD-BAD ©-CANSTOCK PHOTO/STUARTMILES. CHIP COURTESY OF FREEIMAGES.COM/[illegible]

Protect Yourself from RFID

Fend off frightening tracking tech.

By Katherine Albrecht and Liz McIntyre

A CREEPY NEW SPYING TECHNOLOGY CALLED RADIO-FREQUENCY IDENTIFIcation (RFID) is starting to show up on products you buy at stores like Walmart, and it could be used to track your every move. RFID uses tiny microchips hooked up to miniature antennas to track items from a distance. This chip and antenna combination is called an RFID tag. Each tag contains an ID number that uniquely identifies the item to which it is attached. It is like a Social Security number for things. RFID tags are tracked by RFID reading devices. These readers gather information from the tags via radio waves, similar to the radio waves that allow you to listen to your favorite FM radio station. RFID radio waves, like FM radio waves, travel invisibly through solid objects such as purses, backpacks, wallets, and shopping bags.

HOW DO RFID SYSTEMS KEEP TRACK OF ITEMS?

RFID readers collect and process information from matching RFID tags whenever they are in reading range. Since each tag contains a unique ID number and is associated with a specific item, it is possible to link items to specific customers at checkout. This makes it possible to track customers using tagged items, like shoes, as a proxy. There are some preliminary plans to watch the tags at all times, long after purchase and anywhere in the world, through a developing infrastructure known as the Internet of Things.

RFID tags are easy to hide. They can be sandwiched in price labels, hidden within the soles of shoes, printed on boxes, and even woven right into fabric and clothing labels [1]. Right now, you might have one in a store loyalty card or credit card and not know it! Most RFID tags get their power from the reader device, so they do not need batteries. With no parts to wear out, they can beam tracking information to RFID readers indefinitely. The readers can also be hidden, and we have seen plans to embed them in floors, doorways, ceiling tiles, and store

CHIP IMAGE COURTESY OF WIKIMEDIA COMMONS/[illegible]. EYE IMAGE LICENSED BY GRAPHIC STOCK.

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Date of publication: 9 April 2015

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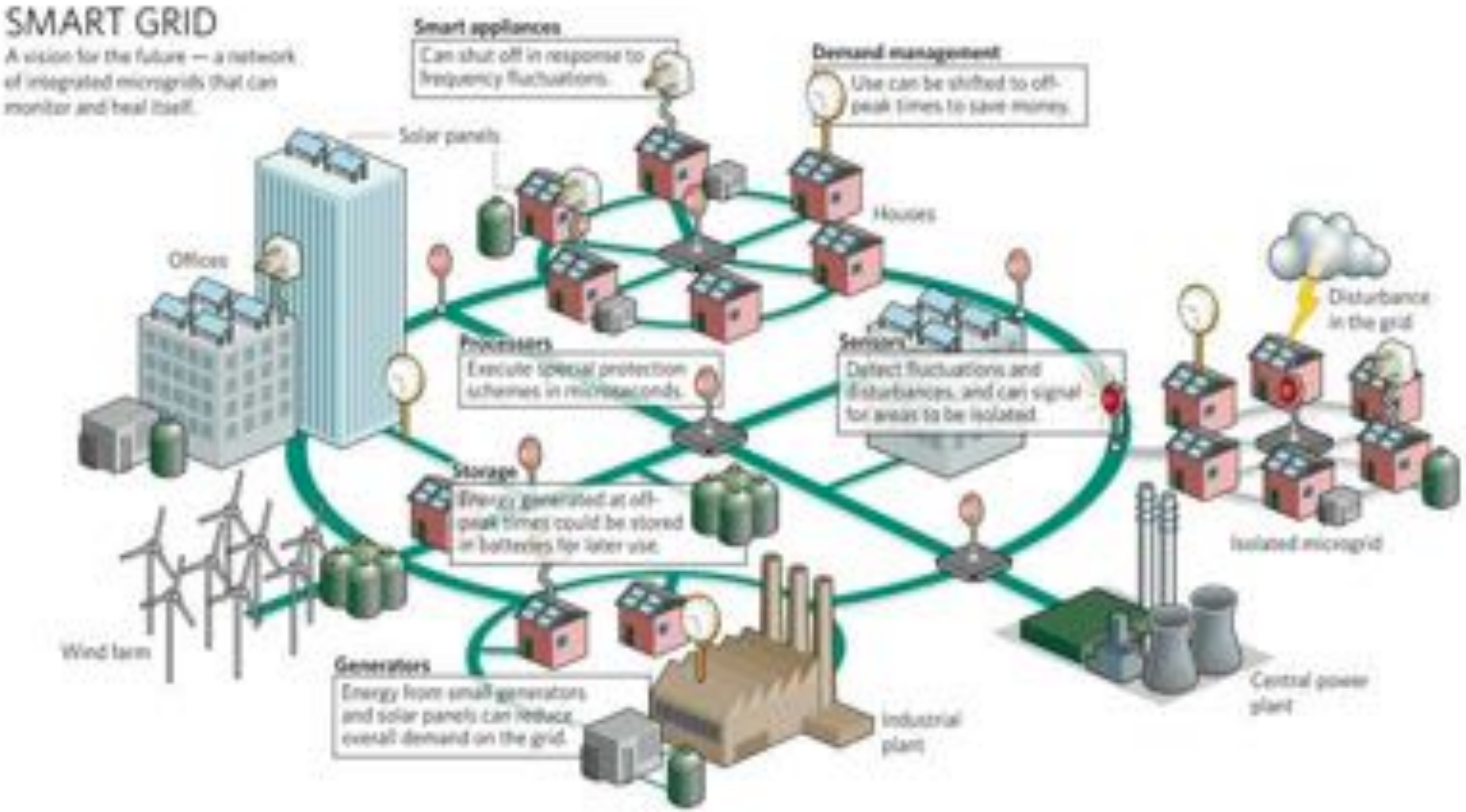
IEEE Consumer Electronics Magazine

April Issue

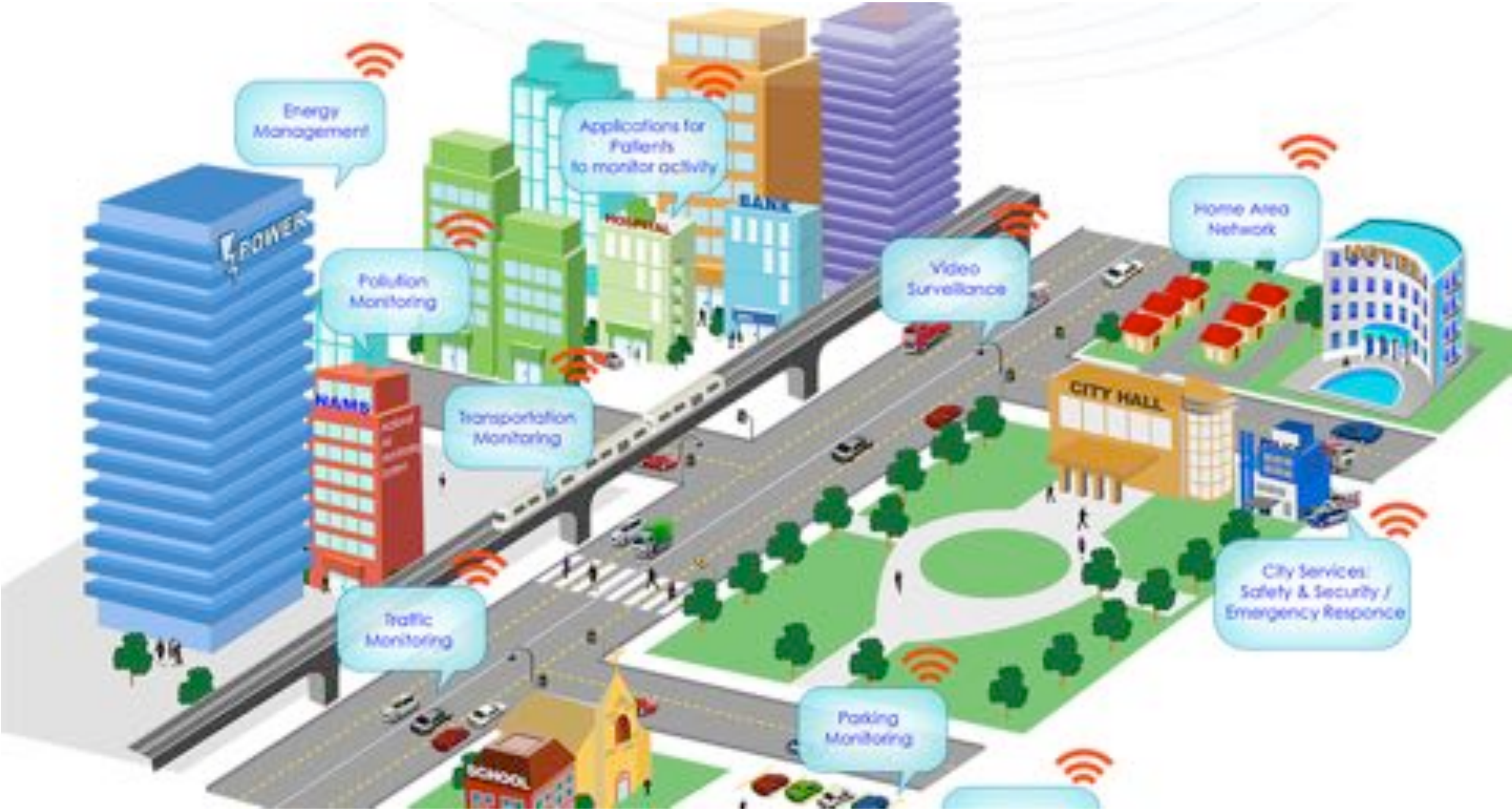
2. Machine-to-Machine (M2)

M2M #1 – The SmartGrid

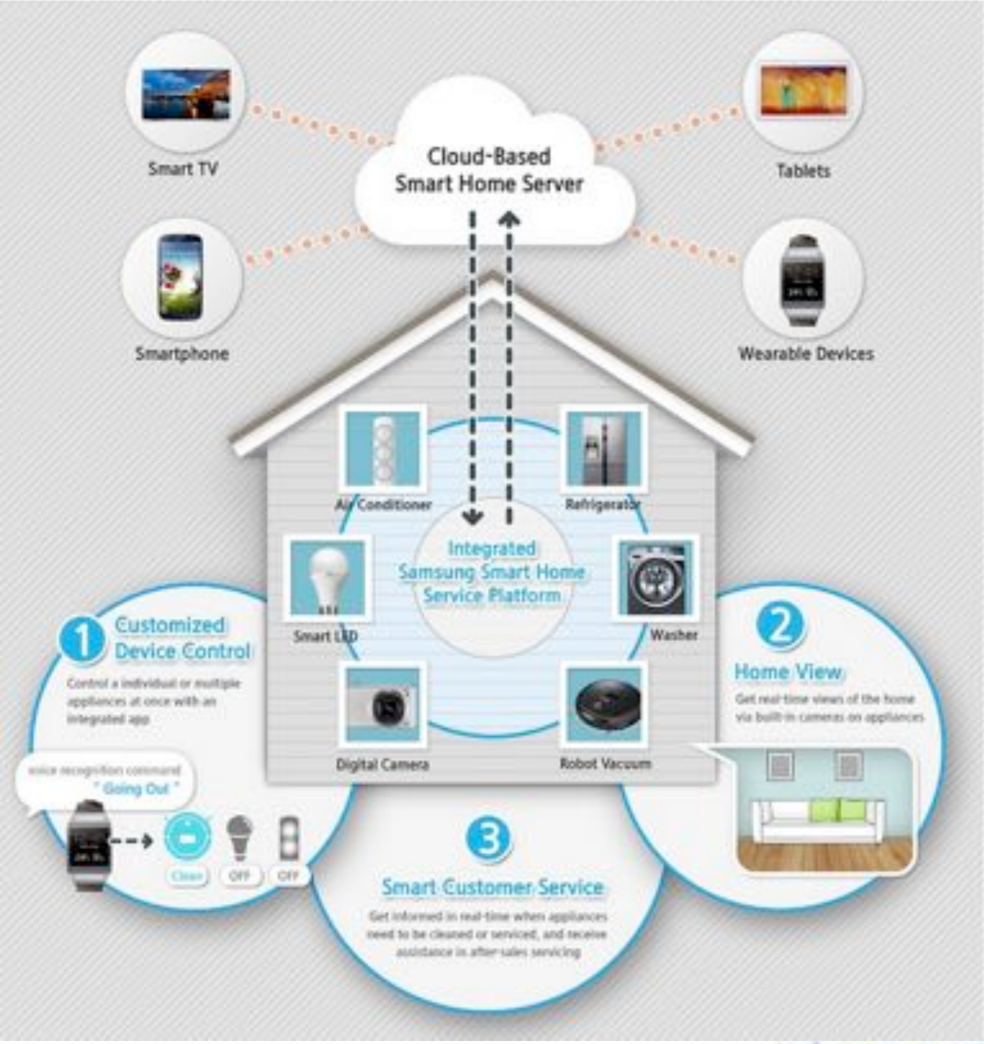

SMART GRID
A vision for the future — a network of integrated microgrids that can monitor and heal itself.
Smart appliances
Can shut off in response to frequency fluctuations.
Demand management
Use can be shifted to off-peak times to save money.
Solar panels
Houses
Offices
Disturbance in the grid
Processors
Execute special protection schemes in microseconds.
Sensors
Detect fluctuations and disturbances, and can signal for areas to be isolated.
Storage
Energy generated at off-peak times could be stored in batteries for later use.
Isolated microgrid
Wind farm
Generators
Energy from small generators and solar panels can reduce overall demand on the grid.
Industrial plant
Central power plant

M2M #2 – Smart Factories

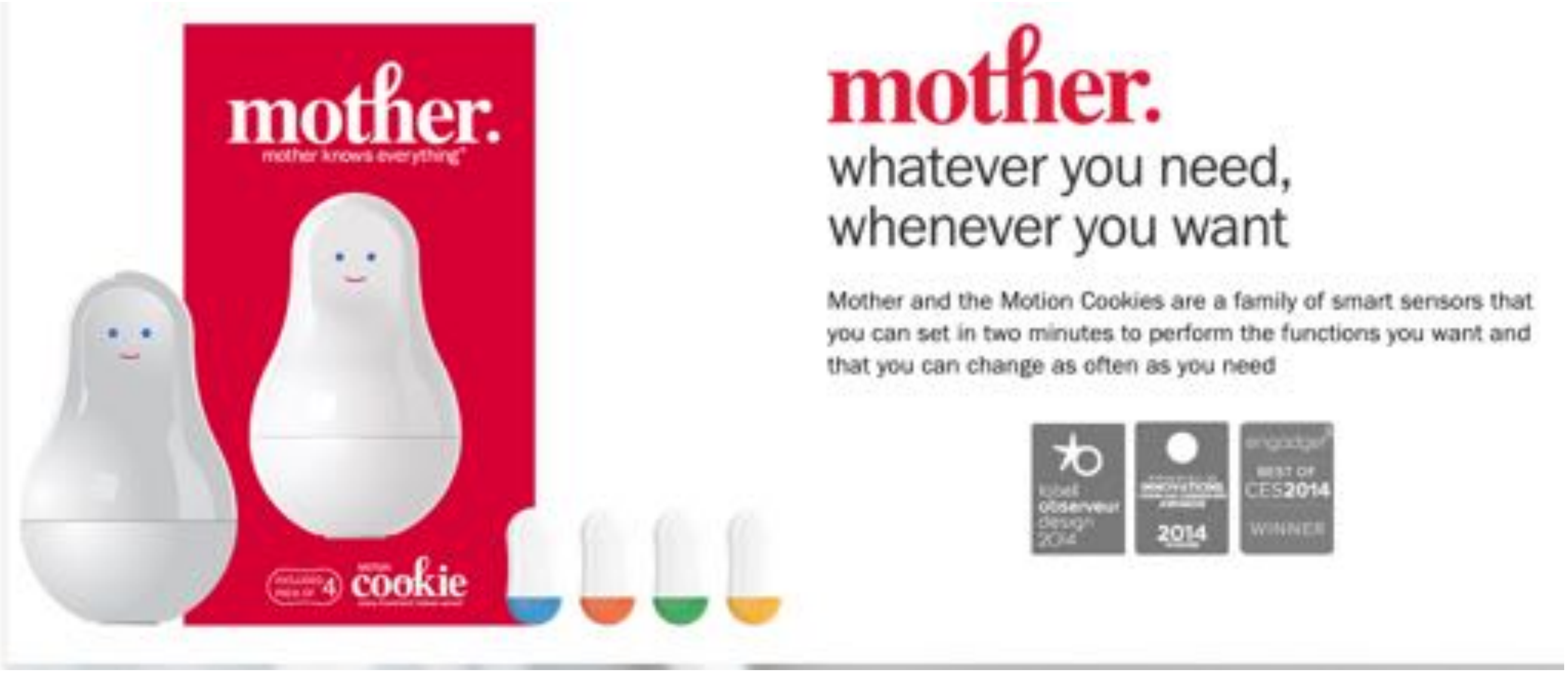
M2M #3- Smart Cities



3. Smart-TV & Home Networks



Meet Mother *(The scary side of IoT!)*

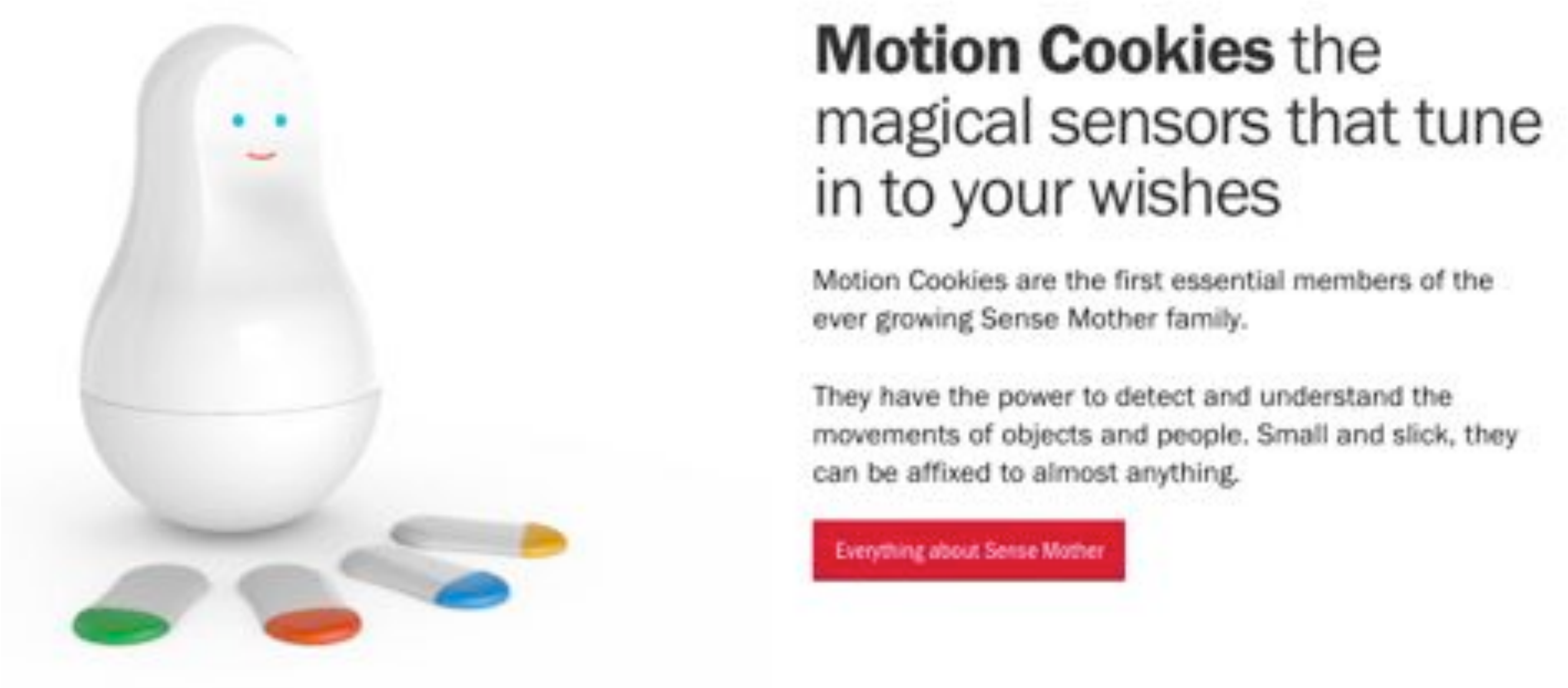


mother.

whatever you need,
whenever you want

Mother and the Motion Cookies are a family of smart sensors that you can set in two minutes to perform the functions you want and that you can change as often as you need

… and the Motion Cookies …

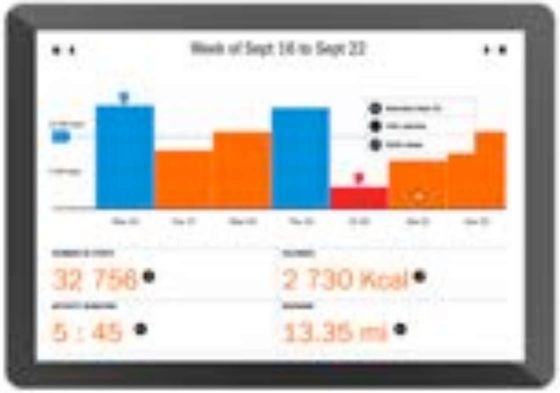


Motion Cookies the magical sensors that tune in to your wishes

Motion Cookies are the first essential members of the ever growing Sense Mother family.

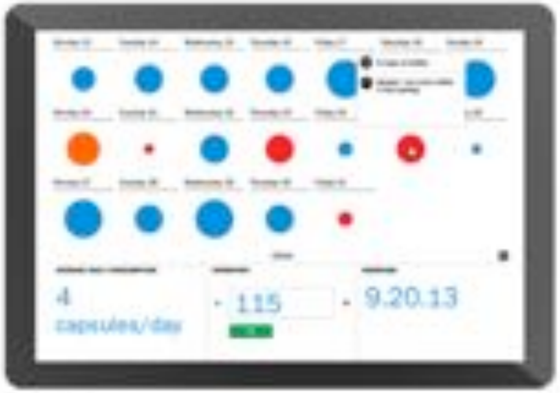
They have the power to detect and understand the movements of objects and people. Small and slick, they can be affixed to almost anything.

Silly, but claims to solve problems



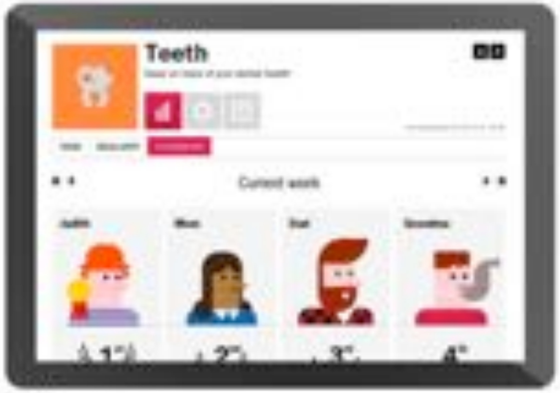
Walk

Are you active enough to stay fit? Monitor the number of steps you make, the distances you walk, the calories you burn.



Espresso

How many espresso coffees do you brew? Do you drink too many of them in the evening? Get notified before you run out of capsules.



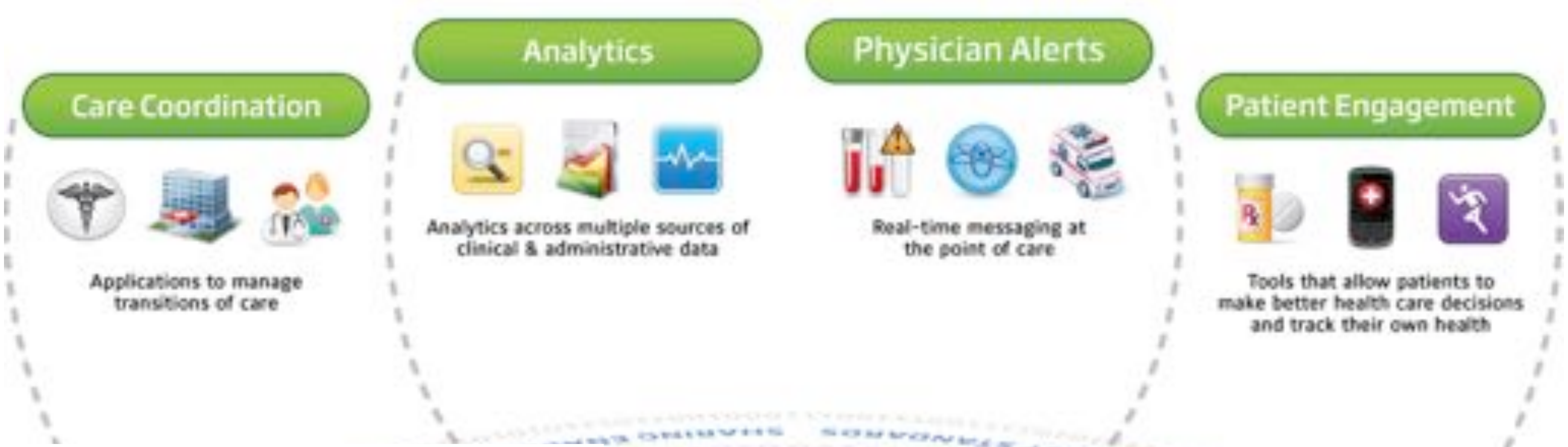
Teeth

Do you really brush your teeth better than your children? Accept the challenge and see who sets the example.

Door

Monitor the access to your home. Get an alert when unusual activity is detected while you are away.

4. Healthcare & Connected Capabilities



Care Coordination

Applications to manage transitions of care

Analytics

Analytics across multiple sources of clinical & administrative data

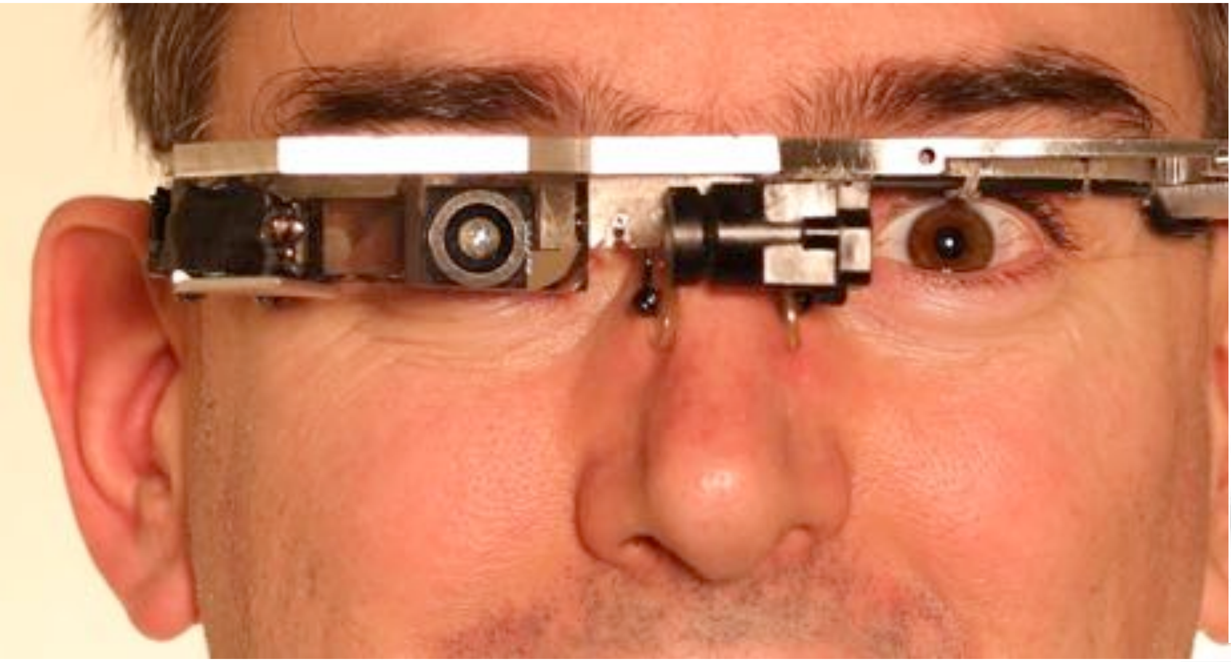
Physician Alerts

Real-time messaging at the point of care

Patient Engagement

Tools that allow patients to make better health care decisions and track their own health

Wearable Technologies?



Too Extreme?

INTERNET OF THINGS
SOME FUTURE CONCERNS

But if every “thing” is Connected …

- What about Privacy?
  - Google Glass can detect your passwords & PIN
- Personal Security?
  - NEST smart thermostat can be hacked so people know when you are home – Blackhat 2014
- Home Security Cameras
  - recently a Russian Website put up video access to 1000’s of Chinese home security cameras …
  - default passwords so no hacking!

A GUIDE TO THE CE INNERVERSE

IEEE Consumer Electronics MAGAZINE

VOL. 4, NO. 2, April 2015

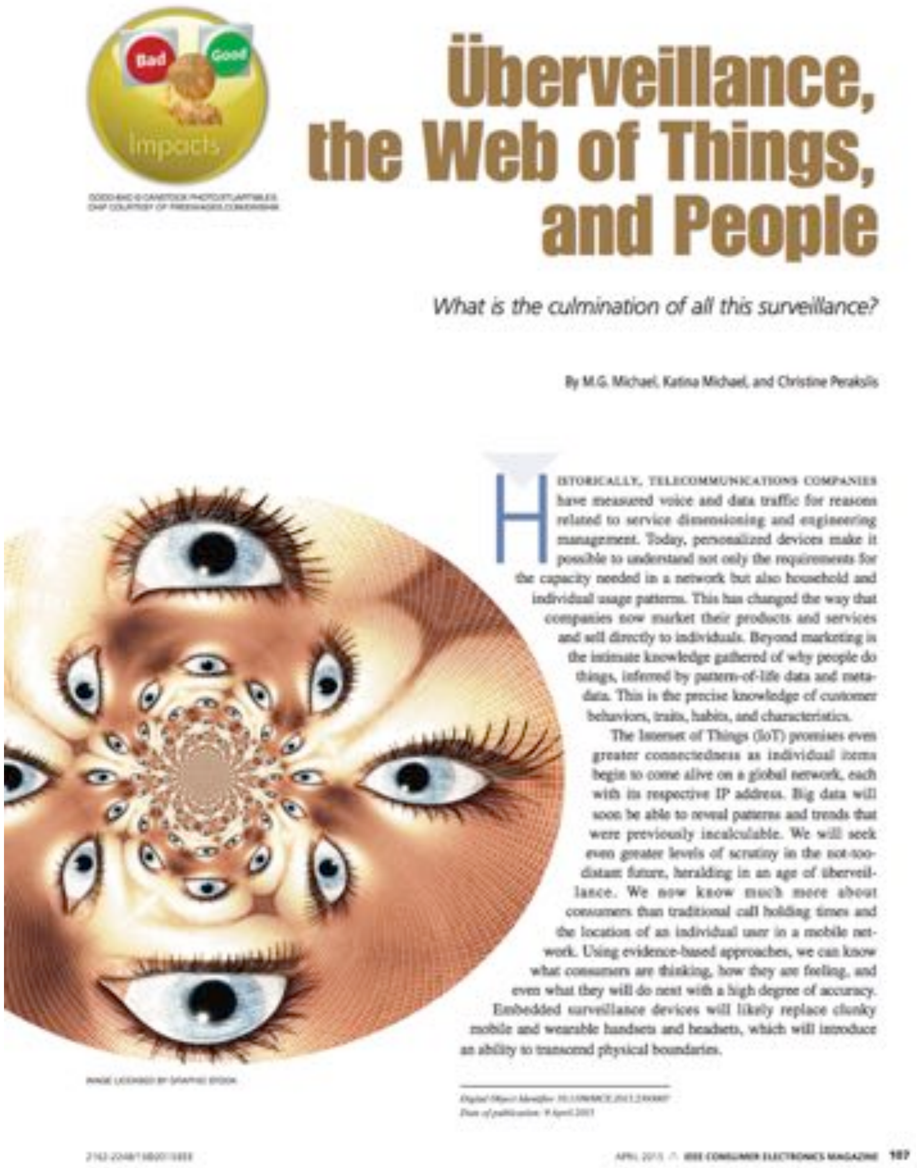
"Little Brother" Is Watching

Welcome to the Age of Sousveillance

IEEE Consumer Electronics Magazine

April 2015 Issue –

Welcome to the Age of Sousveillance …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Good
Impacts

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Überveillance, the Web of Things, and People

What is the culmination of all this surveillance?

By M.G. Michael, Katina Michael, and Christine Perakslis

HISTORICALLY, TELECOMMUNICATIONS COMPANIES have measured voice and data traffic for reasons related to service dimensioning and engineering management. Today, personalized devices make it possible to understand not only the requirements for the capacity needed in a network but also household and individual usage patterns. This has changed the way that companies now market their products and services and sell directly to individuals. Beyond marketing is the intimate knowledge gathered of why people do things, inferred by pattern-of-life data and metadata. This is the precise knowledge of customer behaviors, traits, habits, and characteristics.

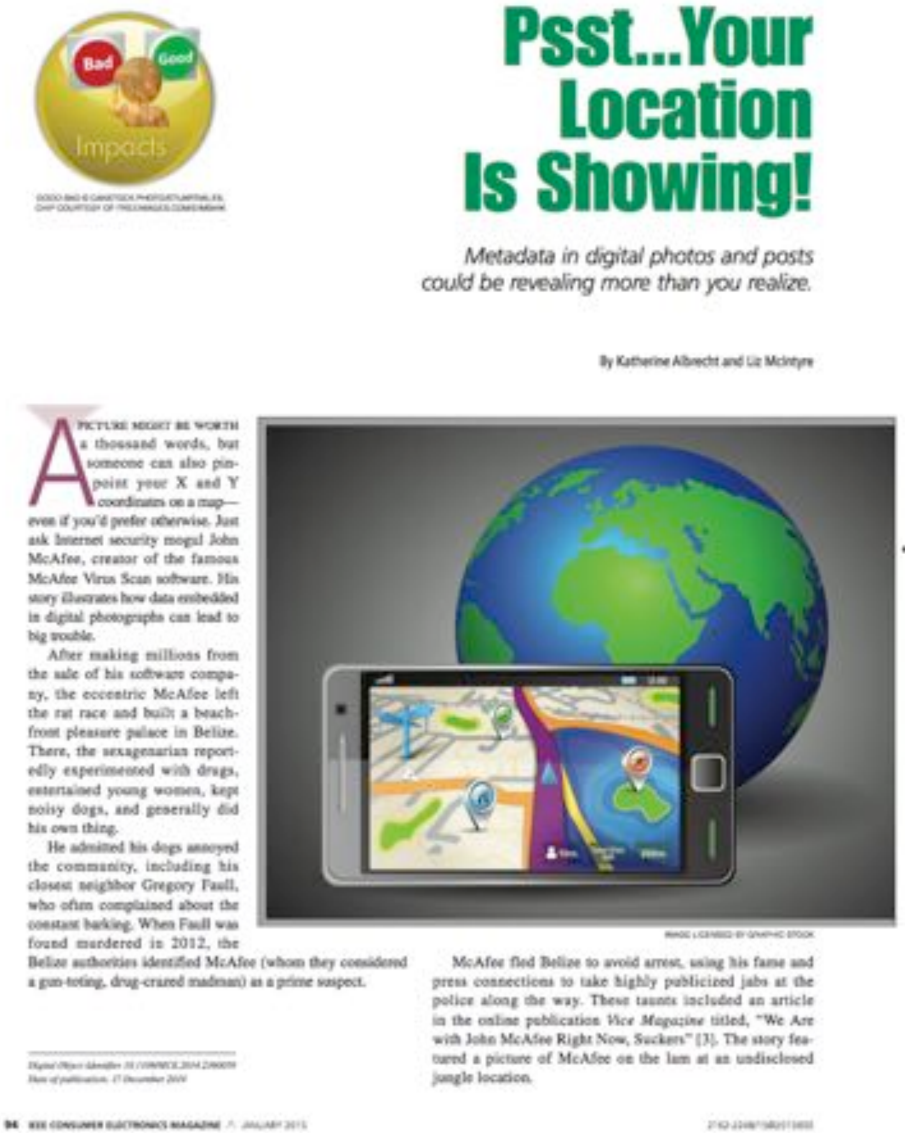
The Internet of Things (IoT) promises even greater connectedness as individual items begin to come alive on a global network, each with its respective IP address. Big data will soon be able to reveal patterns and trends that were previously incalculable. We will seek even greater levels of scrutiny in the not-too-distant future, heralding in an age of überveillance. We now know much more about consumers than traditional call holding times and the location of an individual user in a mobile network. Using evidence-based approaches, we can know what consumers are thinking, how they are feeling, and even what they will do next with a high degree of accuracy. Embedded surveillance devices will likely replace clunky mobile and wearable handsets and headsets, which will introduce an ability to transcend physical boundaries.

IMAGE LICENSED BY GRAPHIC STOCK

Digital Object Identifier 10.1109/MCE.2015.[illegible]
Date of publication: 9 April 2015

2162-2248/15©2015IEEE

APRIL 2015 ∧ IEEE CONSUMER ELECTRONICS MAGAZINE 107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Psst...Your Location Is Showing!

Metadata in digital photos and posts could be revealing more than you realize.

By Katherine Albrecht and Liz McIntyre

A PICTURE MIGHT BE WORTH a thousand words, but someone can also pinpoint your X and Y coordinates on a map—even if you'd prefer otherwise. Just ask Internet security mogul John McAfee, creator of the famous McAfee Virus Scan software. His story illustrates how data embedded in digital photographs can lead to big trouble.

After making millions from the sale of his software company, the eccentric McAfee left the rat race and built a beachfront pleasure palace in Belize. There, the sexagenarian reportedly experimented with drugs, entertained young women, kept noisy dogs, and generally did his own thing.

He admitted his dogs annoyed the community, including his closest neighbor Gregory Faull, who often complained about the constant barking. When Faull was found murdered in 2012, the Belize authorities identified McAfee (whom they considered a gun-toting, drug-crazed madman) as a prime suspect.

IMAGE LICENSED BY GRAPHIC STOCK

McAfee fled Belize to avoid arrest, using his fame and press connections to take highly publicized jabs at the police along the way. These taunts included an article in the online publication *Vice Magazine* titled, "We Are with John McAfee Right Now, Suckers" [3]. The story featured a picture of McAfee on the lam at an undisclosed jungle location.

Digital Object Identifier 10.1109/MCE.2014.[illegible]
Date of publication: 17 December 2014

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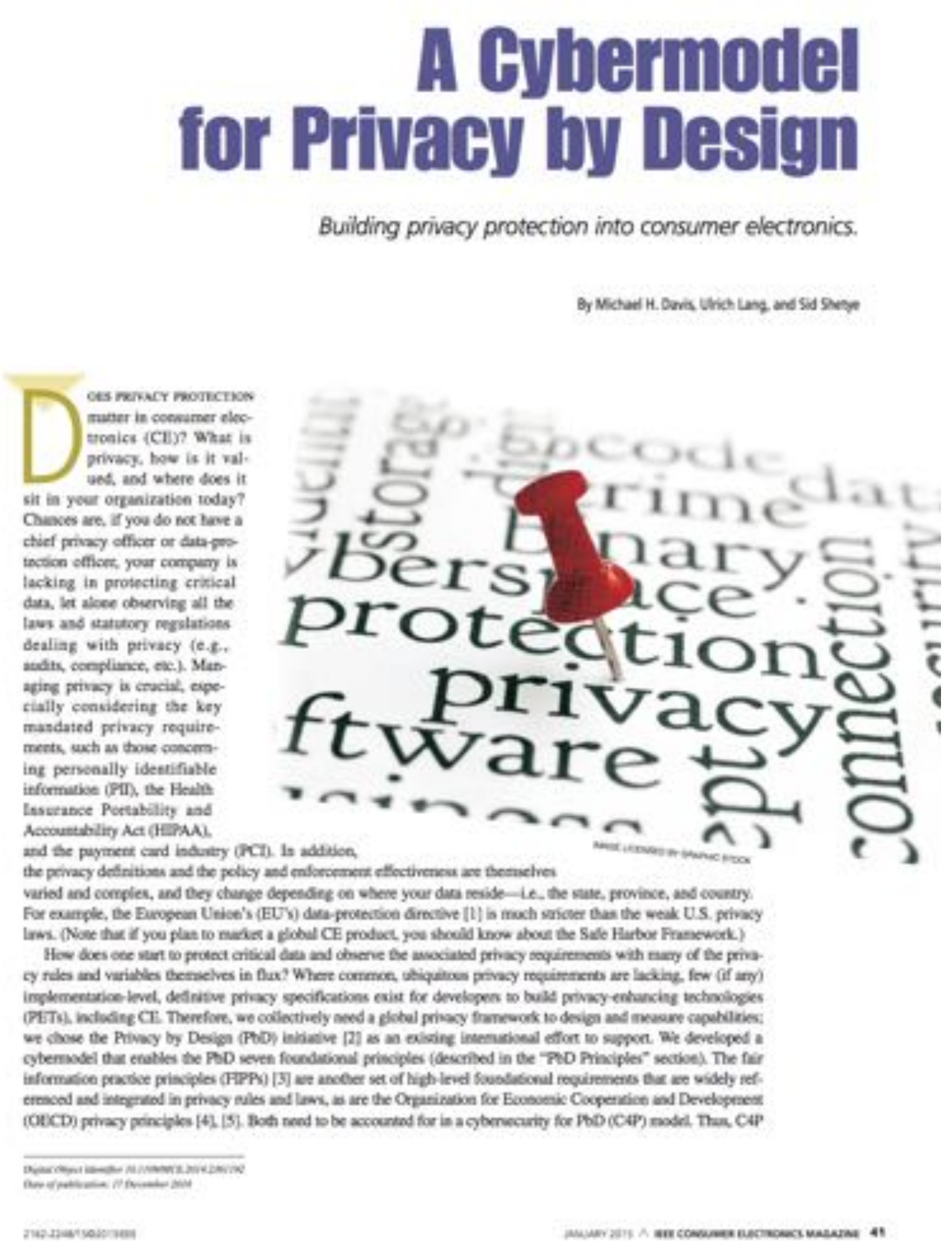
2162-2248/15©2015IEEE



A Cybermodel for Privacy by Design

Building privacy protection into consumer electronics.

By Michael H. Davis, Ulrich Lang, and Sid Shetye

IMAGE LICENSED BY GRAPHIC STOCK

DOES PRIVACY PROTECTION matter in consumer electronics (CE)? What is privacy, how is it valued, and where does it sit in your organization today? Chances are, if you do not have a chief privacy officer or data-protection officer, your company is lacking in protecting critical data, let alone observing all the laws and statutory regulations dealing with privacy (e.g., audits, compliance, etc.). Managing privacy is crucial, especially considering the key mandated privacy requirements, such as those concerning personally identifiable information (PII), the Health Insurance Portability and Accountability Act (HIPAA), and the payment card industry (PCI). In addition, the privacy definitions and the policy and enforcement effectiveness are themselves varied and complex, and they change depending on where your data reside—i.e., the state, province, and country. For example, the European Union's (EU's) data-protection directive [1] is much stricter than the weak U.S. privacy laws. (Note that if you plan to market a global CE product, you should know about the Safe Harbor Framework.)

How does one start to protect critical data and observe the associated privacy requirements with many of the privacy rules and variables themselves in flux? Where common, ubiquitous privacy requirements are lacking, few (if any) implementation-level, definitive privacy specifications exist for developers to build privacy-enhancing technologies (PETs), including CE. Therefore, we collectively need a global privacy framework to design and measure capabilities; we chose the Privacy by Design (PbD) initiative [2] as an existing international effort to support. We developed a cybermodel that enables the PbD seven foundational principles (described in the "PbD Principles" section). The fair information practice principles (FIPPs) [3] are another set of high-level foundational requirements that are widely referenced and integrated in privacy rules and laws, as are the Organization for Economic Cooperation and Development (OECD) privacy principles [4], [5]. Both need to be accounted for in a cybersecurity for PbD (C4P) model. Thus, C4P

Digital Object Identifier 10.1109/MCE.2014.2361192
Date of publication: 17 December 2014

2162-2248/15©2015IEEE

IEEE Consumer Electronics Magazine

Jan 2015 Issue –

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??? Questions ???