The Vision for the Internet of Things



CS525T Fall 2015

Internet of Things (IoT)





Cisco Commercial





A Few IoT Facts

- . The phrase 'Internet of Things' was first used in 1999.
- First Article about IoT in 2004 from MIT researchers called IO (Internet 0).
- Why it is important to our future?
 Optimistic prediction: 7 trillion wireless devices for
 7 billion people by 2020

Does it exist now? Some say - Yes !!





Birth of IoT?

Figure 1. The Internet of Things Was "Born" Between 2008 and 2009



Source: Cisco IBSG, April 2011



A Few More IoT Facts

• "In the second quarter of 2010 AT&T and Verizon announced that non-human objects - interconnected devices - came online in greater numbers than human subscribers. The Internet of Things is here, penetrating society quietly and efficiently" (Oxford, 2011).

 "Engineers who have been preparing this technology have estimated that over 20% of the non-video traffic of the Net will come from Internet of Thing sensors in just a few years." (Vasseur & Dunkel, 2010).



One Vision of the Internet of Things

The IoT includes many objects (preferably smart objects) connected and communicating effectively with people on the Internet to help solve the problems of the world.

"IoT can make a significant difference in closing the poverty gap."



Fight Poverty?

- Try to reduce the difference in price of water between
 Dharavi and Warden
 Road in Mumbai.
- Price disparities are due to the high cost of delivering utilities.

Example: in India



Source: The Wall Street Journal, 2009.



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Thought Provoking Quotes

From IEEE Computer Magazine:

"To reach ambient intelligence, these things must understand the user's context." Roggin et al.

"After the World Wide Web and universal mobile accessibility, the IoT represents the most potentially disruptive technology revolution of our lifetime." Feki et al.

"The IoT is an inherently democratic phenomenon, with many smarts, loosely coupled, each contributing as they can to a greater whole." Kortuem et al. (from the Open University)

Senior Analyst at Forester Research:

"We should push sensor-laden devices – and not use of them – to enhance, not outsource, our cognitive experience." Epps



Smart Grid





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Smart Utility Networks (SUNs)





Smart Homes





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A Smart Light (Philips' Hue)

- Tunable light, 16 million colors
- Activated by smart phone or over Zigbee wireless
- . Can serve as alarm clock
- Can synch colors to movies or possibly music



Philips never anticipated the demand sold out in 3 months at Apple stores!



Wifi Connected Goal Light

"Budweiser Embraces the Internet of Things With In-Home Automatic Hockey Goal Light" - wired.com





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Smart Corks



The RFID read-write tags embedded into the corks use <u>Philips'</u> <u>ISO 15693</u> I-Code SLI 13.56 MHz <u>chip</u> with 1,024 bits of <u>memory</u>.



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More Smarts

- Smart bathroom cabinet for medicine
- Smart refrigerator
- . Smart traffic
- Smart history (in museums)
- . Smart health (RFID in running shoes)
- Smart buying (Near Field Communication)
 - Use smart phone to make payments





Enabling Technologies

- . Technologies needed:
 - RFID
 - Power for Sensors*
 - Mobile and Smart phones
 - Nanoscience and Miniaturization
 - Smart Objects (intelligence) and Robotics
 - M2M (Machine-to- Machine) communication
 - Standardization* of communication, protocols, security
 - IPv6*, 6LoWPAN, Zigbee
- . Others
 - Big Data
 - The Cloud



Miniaturization





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IoT Issues



- Privacy, security and trust concerns
 - Social network blunders
- Big Brother security cameras, police state









Reaction to Coke Commercial

. One Perspective

"Coke commercial about security cameras was so cool. Let's look at the world a little differently. Going to drink a coke in honor."

- Another Perspective

"Ad full of hidden security-cam moments: Coke proudly proclaims itself Official Soft Drink Of The Security State."



Multi-dimensional Change





IoT Players

- Involves industry governments– academia cooperation
- EU countries Great Britain
- Scandinavia Countries in the lead
 - Finland by 2017
 - Norway, Sweden*
 - Contiki protocol platform, Cooja simulator
- Claim China* and India heavily committed to IoT.
- * The Walmart connection {RFID}



Corporate IoT Players

- Cisco
- . IBM
- Philips
- Walmart
- Nokia (Finland)
- Google announces Brillo as IoT OS!

"Europe's biggest chip maker, STMicroelectronics, and the world's third-largest chip maker, Texas Instruments, are to use the tiny Mist operating system developed by Sweden's Thingsquare for use by devices on the "Internet of things". It should make it easier to connect anything from streetlights to thermostats."

- March 13,2013 Wall Street Journal 'Tech Europe'



Research Themes







Figure 4 – The Internet of Things – from idea to market



One Network to Connect Them All

Internet-O allows myriad devices to intercommunicate and interoperate: pill bottles can order refills from the pharmacy; light switches and thermostats can talk to lightbulbs and heaters; people can check on their homes from their offices. Existing technologies already allow many of these functions, but Internet-O provides a single consistent standard. It can handle information sent through the AC power line, over a wireless connection or even engraved on a metal key, and it seamlessly integrates with the local and global computer networks. Devices can be configured by interacting with them rather than by typing on computers.



IP header

UDP header ----

Summary

- . There is more than one vision for the Internet of Things.
- Much "buzz" now but when will it be a reality.
- Interoperability is essential and requires standards agreements.
- Many opportunities and challenges
- As a new area, IoT research is not well-established.

