Internet of Things
2017/2018

An overview

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John Carpenter, 1982
Guiding questions

• What makes up the Internet of Things?
  – Working definition
  – Scope

• What are examples?
Some definitions of IoT (march 2015)

- **Whatis.com:** a scenario in which objects, animals or people are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. IoT has evolved from the convergence of wireless technologies, micro-electromechanical systems (MEMS) and the Internet.

- **Wikipedia:** … is the network of physical objects or "things" embedded with electronics, software, sensors and connectivity to enable it to achieve greater value and service by exchanging data with the manufacturer, operator and/or other connected devices. Each thing is uniquely identifiable through its embedded computing system but is able to interoperate within the existing Internet infrastructure.

- **Techopedia:** … is a computing concept that describes a future where everyday physical objects will be connected to the Internet and be able to identify themselves to other devices.
Some definitions of IoT (march 2015)

- **IERC:**

  A dynamic global network infrastructure
  
  with self configuring capabilities
  
  based on standard and interoperable communication protocols
  
  where physical and virtual “things”
  
  have identities, physical attributes, and virtual personalities
  
  use intelligent interfaces,
  
  and are seamlessly integrated
  
  into the information network.
So,

• IoT: identifiable *devices* (attached to objects) and *interconnected networks*

• Didn’t we call this the Internet?

• Yes, but these are devices
  – with limited functions
    • not useful by themselves
  – connected to low capacity networks
    • limited data per device
  – without proper UI
  – in large numbers
    (>> 1/human)
  – that interact with the real world

Laptops, desktops, phones, 1-1 electronics
~B

Internet ‘Core’, Web, Data, Compute Servers
~M

Single function devices, sensors, actuators, M2M, 1-many electronics, ~100B

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Scope

- Literature mentions converging elements:
  - Internet, IP protocols, connectivity
  - Wireless Sensor Networks
    - low resource communication standards
  - Semantics
    - smartness, reasoning

Scope

• Literature mentions converging elements:
  – Internet, IP protocols, connectivity
  – Wireless Sensor Networks
    • low resource communication standards
  – Semantics
    • smartness, reasoning
• In addition:
  – Cyber Physical Systems
    • tight integration of communication, computation, physical world
  – Cloud Computing
    • build powerful services and applications on top of massive amounts of data
    • ... collected through the embedded devices

What makes up the IoT?

- ‘Things’ are *constrained* devices. Constraints pertain to
  - memory: static background (flash) and dynamic (RAM)
  - processing power: #instructions / second
  - available energy
  - accessibility, uptime (duty cycling)
- ‘Things’ are connected into *constrained* networks (typically deriving from node constraints). Network constraints pertain to
  - low bitrate
  - duty cycle limits [may not use network more than x%]
  - high packet loss, and variability
  - asymmetric links
  - small packet size
  - limited group communication primitives
- But then, united with ‘regular’ Internet services and fast networks
These ‘regular’ Internet Services…

• Deal with large amounts of data
  – storage
    • storage clouds
  – transport towards storage and delivery (e.g. media, data-applications)
    • Content Delivery Networks
    • Software Defined Networking
    • Network Function Virtualization

• Support processing
  – data analysis
    • cloud processing
  – applications must run somewhere
    • coordination platform
    • compute services

In summary

- IoT stands for the vision of the Internet of tomorrow
  - extending network communication to billions of endpoints
  - reaching into the physical world, gathering incredible amounts of detailed information about states and events
    - (processes, objects, people, environment)
  - expanding processing and storage capacities to analyze such data
  - enhancing coordination and algorithms to use this knowledge as soon as possible in feedback cycles and new applications
  - thus connecting the physical and the Internet worlds
  - simplifying and standardizing – commoditizing – the corresponding technologies
Some Things and Application domains

- Consumer & Home
- Smart Infrastructure
- Security & Surveillance
- Healthcare
- Transportation
- Retail
- Industrial
- Others

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Application domains and functions

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