Internet of Things
2017/2018

An overview

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Guiding questions

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

• How to understand IoT?
Some definitions of IoT (Oct 2017)

• **Whatatis.com:** is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.

• **Wikipedia:** … is the network of physical devices, vehicles, and other items embedded with electronics, software, sensors, actuators, and network connectivity which enable these objects to collect and exchange data….. Each thing is uniquely identifiable through its embedded computing system but is able to interoperate within the existing Internet infrastructure. Experts estimate that the IoT will consist of about 30 billion objects by 2020

• **Techopedia:** … is a computing concept that describes the idea of everyday physical objects being connected to the internet and being able to identify themselves to other devices.
Some definitions of IoT (Oct 2017)

• Stephen Haller, SAP Research:

“A world where physical objects are seamlessly integrated into the information network, and where the physical objects can become active participants in business processes. Services are available to interact with these 'smart objects' over the Internet, query and change their state and any information associated with them, taking into account security and privacy issues.”

• ITU-T Studygroup 13

A global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving interoperable information and communication technologies
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
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
- May in turn serve things

In summary

• IoT stands for the vision of the Internet of tomorrow
  
  – extending (Inter)network communication to billions of endpoints
  – enabling devices of all form factors to exchange information using standard protocols and data formats
  – 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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retrieved from bensontao.com, March 2015
Technology roadmap: The Internet of Things

- **Supply-Chain Helpers**
  - RFID tags for facilitating routing, inventorying, and loss prevention

- **Vertical-Market Applications**
  - Surveillance, security, healthcare, transport, food safety, document management

- **Ubiquitous Positioning**
  - Locating people and everyday objects

- **Physical-World Web**
  - Teleoperation and telepresence: Ability to monitor and control distant objects

- **Software agents and advanced sensor fusion**

- **Source:** SRI Consulting Business Intelligence

**Technology Reach**
- Cost reduction leading to diffusion into 2nd wave of applications
- Demand for expedited logistics

**Time**
- 2000
- 2010
- 2020
Understanding IoT systems

• domains
  – home
  – mobile / outdoor (fields, ad-hoc)
  – office
  – industry
  – public (city)

• architecture, layered and deployment view
  – devices, things
  – functionality placement alternatives
  – data and control flow

• communication stack, protocols

• lifecycles
  – devices
  – services
  – applications

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The IoT Architectural Framework, Design Issues and Application Domain, Gordana Gardasˇevic et al.

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14-Nov-17
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