Research Directions for IoT

Internet of Things

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What is IoT?

- Break the “Internet of Things” into:
  - Things —> Devices
    computers, light switches, door locks, phones, cars, health monitoring appliances, etc.
  - Internet —> connected to the Internet
- collaboration of uniquely identifiable objects (“things”) that exchange services using the Internet, to implement certain services
  - Any thing, any time, any place
- IoT Enablers: WSN and RFID

IoT Services and Potentials

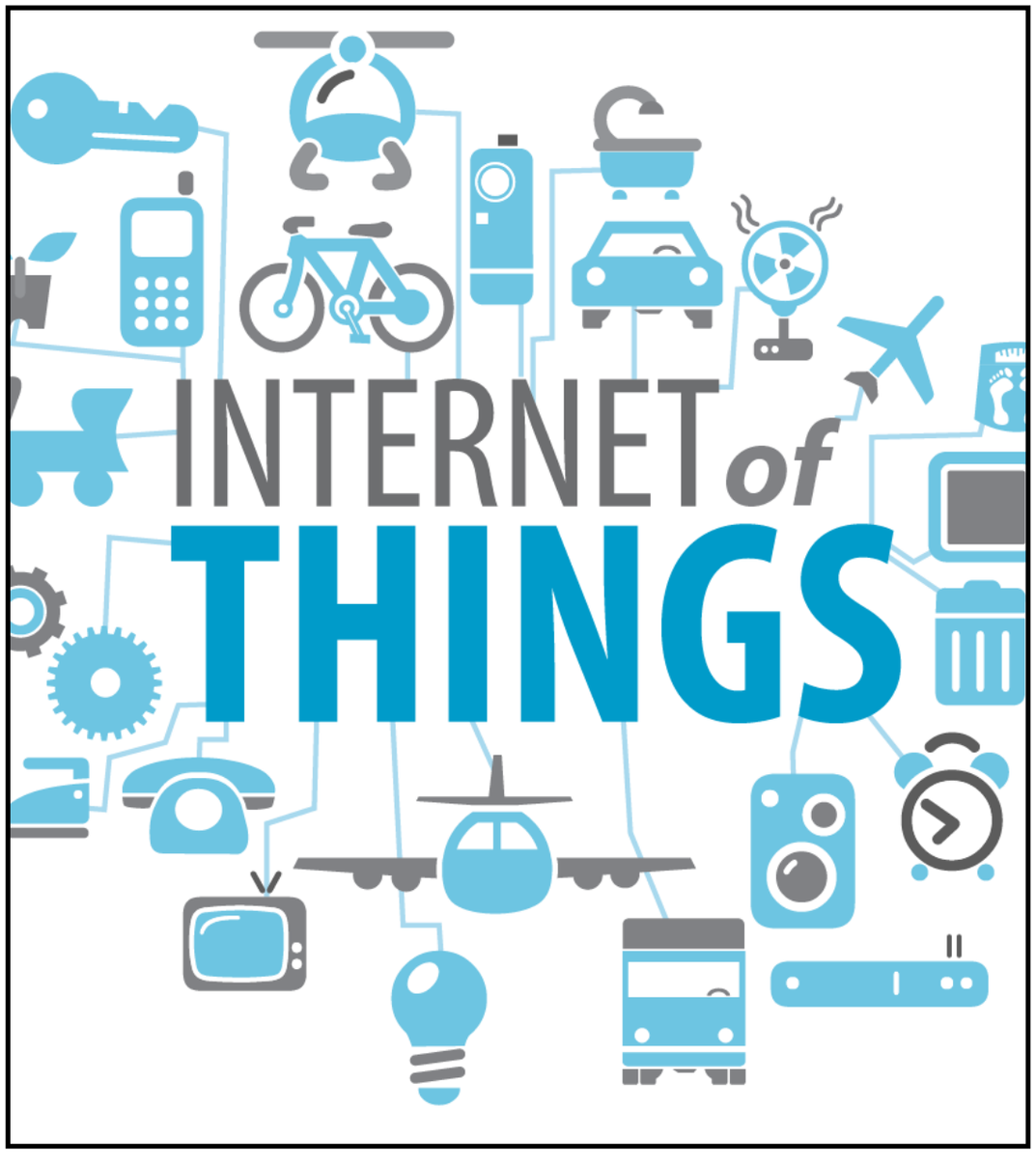
- Cities will be overwhelmed with sensing and actuation, many embedded in “things” -> smart world
- Detecting traffic congestion
- Smart car & taxi
- Monitoring patient’s blood pressure (remote medicine)
- Reading, controlling, and programming power meters (home & factory)

IoT Services, cont.

- biometrics such as voice or retinas to access to buildings, ATMs, etc.
- Automatically ordering food
- predicting an impending medical problem that should be addressed early to avoid it

- Remotely controlling light and temperature in home

- And more!



IoT is great, but…

- Analysts predict that the IoT will comprise up to 26 billion interconnected devices by 2020, a 30-fold increase from 2009 [1]

- There are many research challenges that need to be addressed

- Actually, these challenges makes us rich and famous

IoT Research Challenges

- Security
- Privacy
- Scalability
- Robustness
- Openness

Security

- Small and weak devices
- Physical access of devices to actuator and sensor
- Openness of the system
- Failure —> can be used by attackers
  - IoT must be able to continue to operate in the presence of, and to recover effectively from, security attacks
- today's security solutions require heavy computations and large memory requirements

Privacy

- Users' data is privacy sensitive
  - e.g. patient's habits, camera readings, residency presence information
- Location privacy
- Support of aggregating requests e.g. average, maximum, or minimum of specified sensing data
- Privacy domains

Scalability

- Naming
- Big data -> collection, use, storing
- Maintainability (support)
- Communication
- Security
- Heterogeneity
- Architecture —> dependencies

Robustness

- Mobility (relocalization)
- Clock synchronization (consistent sleep/ wake-up)
- power levels for communication
- run time assurances
  - Fire alarm system
- Self-maintainability, self-repair

Openness

- cars communicating to/controlling each other to avoid collisions
- physiological data uploaded to doctors
- model of the system is constantly changing
- unified communications interfaces needed.

(Internet of Things) IoT Research

- collaboration of **uniquely identifiable** objects (“**things**”) that exchange services using the **Internet**, to implement certain services
  - Any thing, any time, any place
- Sensors, cameras, actuators, robots, etc/
- Irrigation, Smart Home, Smart City, Transportation,
  - Automatically ordering food
  - Remotely controlling light and temperature in home

References

- [1] www.gartner.com/newsroom/id/2636073

- [2] Stankovic, John. "Research directions for the internet of things." Internet of Things Journal, IEEE 1.1 (2014): 3-9.

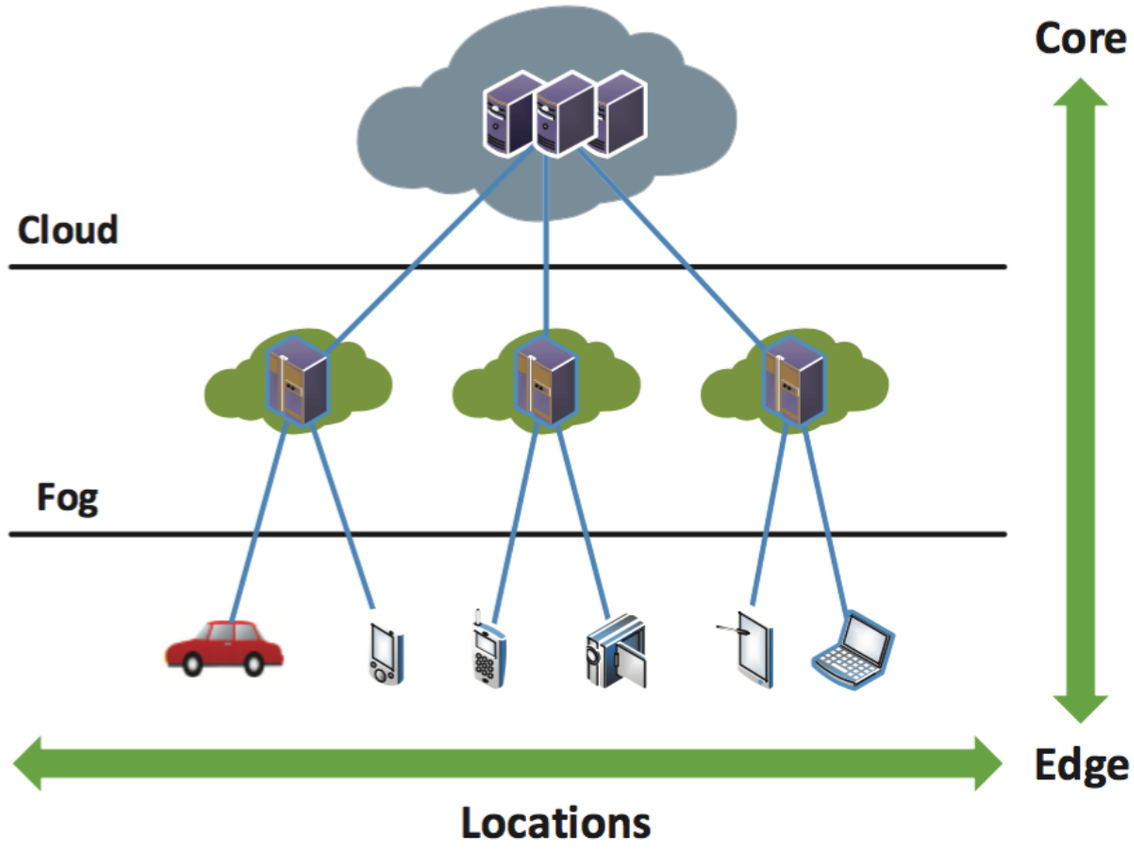
- [3] A. Yousefpour, Z. J. Haas, “A Privacy Scheme for Monitoring Devices in the Internet of Things”, submitted to 2nd EAI International Conference on Safety and Security in Internet of Things, Roma, Italy, October 2015

Fog Computing Research

- "Fog computing is a horizontal architecture that distributes resources and services of **computing**, **storage**, **control** and **networking functions** [closer to user], anywhere along the **continuum** from **Cloud to Things**

- Fog Computing provides low latency, location awareness, and improves quality-of-services (QoS) for streaming and real time applications

- Introduced by CISCO



Fog Computing Examples

- Fog computing puts cloud closer to the user for better quality of service
- Fog computing brings low latency, location awareness, wide-spread geographical distribution, mobility, etc.

USE CASE	INDUSTRY
Traffic Management	Smart Cities
Visual Security & Surveillance	Safety / Smart Cities
Real-time Subsurface Imaging	Energy / Environment
High-Scale Drone Package Delivery	Supply Chain / Transportation

Thank you!

Questions?