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Introduction: IoT Networking- Part I

Dr. Sudip Misra

Professor

Department of Computer Science and Engineering

Indian Institute of Technology Kharagpur

Email: smisra@sit.iitkgp.ernet.in

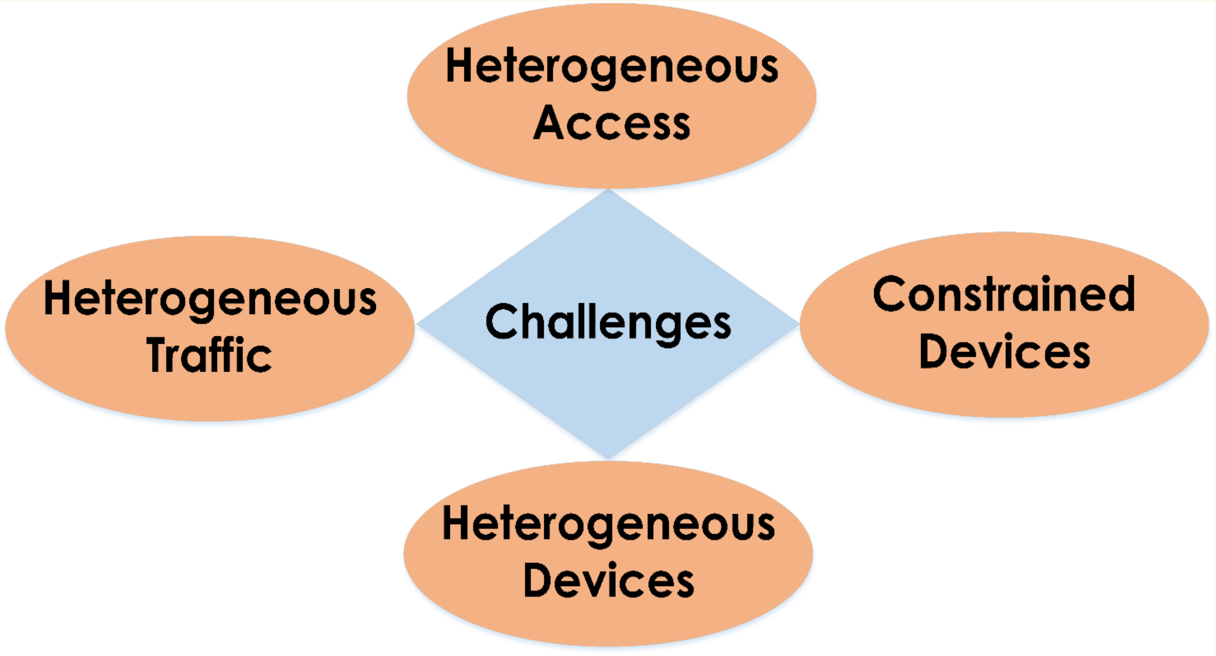
Website: http://cse.iitkgp.ac.in/~smisra/

Research Lab: cse.iitkgp.ac.in/~smisra/swan/

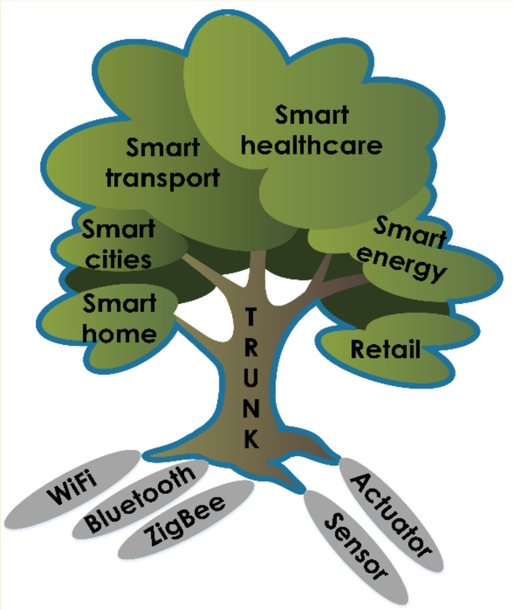
Introduction

- Characteristics of IoT devices
  - Low processing power
  - Small in size
  - Energy constraints
- Networks of IoT devices
  - Low throughput
  - High packet loss
  - Tiny (useful) payload size
  - Frequent topology change
- Classical Internet is not meant for constrained IoT devices.

Introduction



Introduction



- Analogy
  - Roots - Communication Protocol and device technologies
  - Trunk- Architectural Reference Model (ARM)
  - Leaves – IoT Applications
- Goal
  - To select a minimal set of **roots** and propose a potential **trunk** that enables the creation of a maximal set of the **leaves**.

Source: FhG, I. M. L., et al. "Internet of things-architecture iot-a deliverable d1. 3–updated reference model for iot v1. 5."

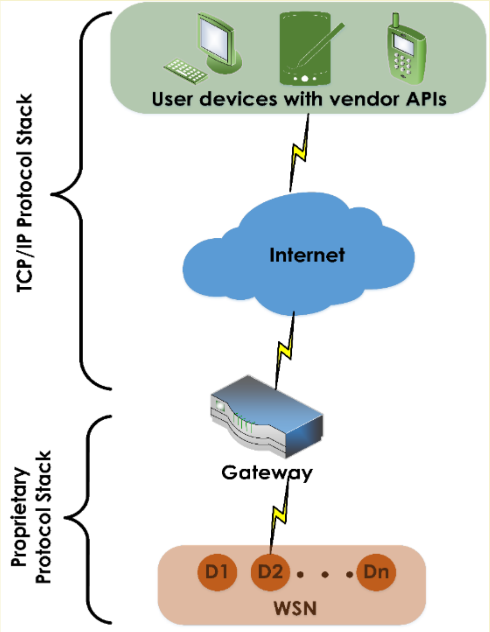
Enabling Classical Internet for IoT Devices

- Proprietary non-IP based solution
  - Vendor specific gateways
  - Vendor specific APIs
- Internet Engineering Task Force (IETF) IP based solution
  - Three work groups
    - IPv6 over Low power Wireless Personal Area Networks (6LoWPAN)
    - Routing Over Low power and Lossy networks (ROLL)
    - Constrained RESTful Environments (CoRE)

Source: I. Ishaq, et al. , "IETF standardization in the field of the internet of things (IoT): a survey", J. of Sens. and Act. Netw. 2, vol. 2 (2013): 235-287.

Proprietary non-IP based solution

- Drawbacks
  - **Limited flexibility to end users**: vendor specific APIs
  - **Interoperability**: vendor specific sensors and gateways
  - **Limited last-mile connectivity**



Source: I. Ishaq, et al. , "IETF standardization in the field of the internet of things (IoT): a survey", J. of Sens. and Act. Netw. 2, vol. 2 (2013): 235-287.

IETF IP based solution

- Three work groups
  - IPv6 over Low power Wireless Personal Area Networks (6LoWPAN)
    - By header compression and encapsulation it allows IPv6 packets to transmit and receive over IEEE 802.15.4 based networks.
  - Routing Over Low power and Lossy networks (ROLL)
    - New routing protocol optimized for saving storage and energy.
  - Constrained RESTful Environments (CoRE)
    - Extend the Integration of the IoT devices from network to service level.

Constrained RESTful Environments (CoRE)

CoRE

- Provides a platform for applications meant for constrained IoT devices.
- This framework views sensor and actuator resources as web resources.
- The framework is limited to applications which
  - Monitor basic sensors
  - Supervise actuators
- CoAP includes a mechanism for service discovery.

CoRE: Service Discovery

- IoT devices (act as mini web servers) register their resources to **Resource Directory (RD)** using **Registration Interface (RI)**.
- RD, a logical network node, stores the information about a specific set of IoT devices.
- RI supports Representational State Transfer (REST) based protocol such as HTTP (and CoAP- optimized for IoT).
- IoT client uses **Lookup interface** for discovery of IoT devices.

IoT Network QoS

IoT Network QoS

- Quality-of-service (QoS) of IoT network is the ability to guarantee intended service to IoT applications through controlling the heterogeneous traffic generated by IoT devices.
- QoS policies for IoT Network includes
  - Resource utilization
  - Data timeliness
  - Data availability
  - Data delivery

Source: Rayes, A., & Salam, S. (2016), "Internet of Things from hype to reality: the road to digitization", Springer.

Resource utilization

- Requires control on the storage and bandwidth for data reception and transmission.
- QoS policies for resource utilization:
  - **Resource limit policy**
    - Controls the amount of message buffering
    - Useful for memory constrained IoT devices
  - **Time filter policy**
    - Controls the data sampling rate (interarrival time) to avoid buffer overflow
    - Controls network bandwidth, memory, and processing power

Source: Rayes, A., & Salam, S. (2016), "Internet of Things from hype to reality: the road to digitization", Springer.

Data timeliness

- Measure of the **freshness** of particular information at the receiver end
- Important in case of healthcare, industrial and military applications
- Data timeliness policies for IoT network include
  - **Deadline policy**
    - Provides maximum interarrival time of data
    - Drops the stale data; notify the missed deadline to the application end
  - **Latency budget policy**
    - Latency budget is the maximum time difference between the data transmission and reception from source end to the receiver end.
    - Provides priority to applications having higher urgency

Source: Rayes, A., & Salam, S. (2016), "Internet of Things from hype to reality: the road to digitization", Springer.

Data availability

- Measure of the amount of valid data provided by the sender/producer to receiver/consumer
- QoS policies for data availability in IoT network include
  - **Durability policy**
    - Controls the degree of data persistence transmitted by the sender
    - Data persistence ensures the availability of the data to the receiver even after sender is unavailable
  - **Lifespan policy**
    - Controls the duration for which transmitted data is valid
  - **History policy**
    - Controls the number of previous data instances available for the receiver.

Source: Rayes, A., & Salam, S. (2016), "Internet of Things from hype to reality: the road to digitization", Springer.

Data delivery

- Measure of successful reception of reliable data from sender to receiver
- QoS policies for data delivery include
  - **Reliability policy**
    - Controls the reliability level associated with the data distribution
  - **Transport priority**
    - Allows transmission of data according to its priority level

Source: Rayes, A., & Salam, S. (2016), "Internet of Things from hype to reality: the road to digitization", Springer.

Thank You!!