The Internet of Things - An Overview
IoT Domain

- **Individual**
  - Smart Living
  - Personal electronics, wearables, smart homes, connected cars

- **Industrial**
  - Improves business efficiency
  - Smart factory, buildings, machines, retail

- **Infrastructure**
  - Smart communities, cities,
  - Intelligent transportation systems
  - Public safety,
  - Smart education
  - Healthcare

- Some applications span multiple domain

- Technology driving business decision
  - Break down barriers of vertical markets
4A’s and 4S’s

- The 4A’s
  - Automated Remote Provisioning and Management - Sensing and Control
  - Augmented Reality
  - Awareness of Context and Location - aka Cognition
  - Analyze and Take Action - aka Big Data

- The 4S’s
  - Simplicity - as in the Internet protocols
  - Security
  - Smart - Intelligent actionable items
  - Scalable

- The current version of the Internet provides some of these but not all
- Our goal - how to incorporate these new attributes to the Internet
IoT Landscape

- IoT is not new, goes back to early 1990s
- Fixed function systems to generic architecture
- Key enabler are abstractions
  - Services (Cloud based processing and storage)
  - Gateway / Aggregation (Ubiquitous wireless infrastructure) - THIS COURSE
  - Sensing (Plethora of systems - RFID, ZigBee, Z-Wave, NFC, etc)
Building Blocks - Sensing

- Sensors for data acquisition
  - Static, Mobile, Wearable
- RFID tags, MEMS, iBeacon, Bluetooth
  - Higher reliability at much lower costs
- ZigBee vs Z-wave - Key differences in RF
  - Both support mesh topology
- 6LoWPAN - IPv6 over Low-Power Wireless Personal Area Network.
- Spurious data communication
- Energy Harvesting
- EECS 700 - The Internet of Things - first offering Spring 2016
  - Android Sensor Programming
Building Blocks - Gateway

- Migrate IPv4 to IPv6 to address large number of devices.
- Heterogeneity of connection - Wireless, PLC
  - Smart grid and smart meters.
- Topology - Infrastructure-based, mesh, other.
  - Depends on application
  - Small cells, V2X (X = Infrastructure, vehicles, anything)
- Host-centric network to Information-centric based networks (ICN)
- Network virtualization - resource sharing
- Spectrum rules
  - Dynamic spectrum access - 802.22, 802.11af
    - Whitespaces - unused or low utilization bands - atmospheric radar, tv band
    - Geographical variation.
- Pretty much everything we studied in this course
Building Blocks - Service

- From cloud to Fog or cloudlets
  - Personal cloud
  - Challenge is in maintaining consistency of data and services, SAN
  - Virtualization and resource sharing
  - Software Defined Networking
    - Network function Virtualization

- Datacenter scale networking

- Infrastructure as a Service (IaaS)
  - Anything as a service (XaaS)
  - Google fi
  - OTT services
Bitcoin as a IoT Service

- **What is it?**
  - Method for transferring money, electronically and anonymously that is cryptographically secure
  - Peer to peer transaction. No need for financial institution or decentralized
  - Bitcoin is a unit that maps to real world dollar value (not a fixed mapping)
  - One can exchange Dollar with Bitcoins in Bitcoin exchange akin to buying stock
  - Open to all, no access control. Open source code base
  - Identity is a bunch of Hex numbers, which is her public key

Transaction using Apps on mobile devices
Bitcoin Nuts and Bolts

• Distributed system
  ○ Validation done by other nodes in the network (how?)
  ○ Transaction recorded in global ledger (how?)
  ○ Alice applies Digital Signature to the transaction and broadcast to the Bitcoin P2P network
  ○ Bob receives and checks for Integrity and Identity
  ○ Prevent double spending - copy transactions

• Enforced by Bitcoin miners
  ○ Take all transaction and create a transaction block (Cryptographic Hash)
  ○ Using a key called Proof-of-Work

• Mining
  ○ Anybody can be a miner
  ○ Receives the transaction and creates a blockchain along with Proof of work
  ○ Proof-of-work takes a lot of time to compute and it has to be done before someone else adds another transaction the blockchain. So essentially it is a race.