Topics of Presentation

- What is IoT/IoT?
- IoT Supporting Technologies
- IoT Applications
- IIoT Applications
- Challenges and Opportunities
- IoT/IoT-based Technology Strategies
What is IoT (Internet of Things)?

- IoT includes: “Internet” & “Things”
  - Things:
    - Physical things or Virtual things
    - Products, Services, places, etc
  - Network connected things (devices) with sensors and/or actuators communicating with one another without human in the loop
  - Served as a main conduit between the physical and digital applications.

What is IoT (Internet of Things)?

- IoT includes: “Internet” & “Things”
  - States of Things – our most interested data & info
    - Motion info: location, position, in-motion (how fast, direction), proximity
    - Environment info: temperature, humidity, pressure, light
    - Heath monitoring devices: heart rate, blood pressure, step detector and counter, face gesture, and body fall
    - Power and machines: current, voltage, power, power factor, service time, problems
**What is IIoT (Industrial Internet of Things)?**

- **IIoT ≈ IoT** applications in smart factory manufacturing setting for
  - Continuous improvement
  - Reduced unplanned downtime
  - Greater asset availability and reliability

- Harnessing the existing **sensor data, machine-to-machine (M2M)** communication and **automation** technologies

- Incorporating technologies
  - Machine learning
  - Big data analytic

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**IoT Supporting Technologies**

- **State of Things**
  - Raw data, aggregated data (info)
  - Big data, Analytic

- **Volume**

- **Velocity**

- **Variety**

- **Veracity**

- Optimized decision making and action
**IoT Nodes**

- IoT nodes = Smart devices
  - Sensors, Analog electronics & Signal processing,
    Embedded processor, Communication Units,
    Programs

**IoT/IIoT Enabling Technologies and Supporting Infrastructures**

- Sensors technologies
- Micro-electronics subsystems
- Embedded computing subsystems
- Wired/wireless communications and Internet
- Distributed computing systems
- Cloud computing services
- Database, Datacenter
- Big data and analytic
IoT/IIoT Enabling Technologies and Supporting Infrastructures

IoT-A
Sensor Node

State/Condition/Event

IoT-B
IoT-C
IoT-D
IoT-E
IoT-F
IoT-G

Data Gateway

IoT Data Store

Cloud Services
IoT Platform & App Servers

IoT Datacenter

IoT Connected Things

- Connected Things
  - Shoes, Clothing
  - Health monitoring devices
  - Home appliances
  - HVAC system
  - Cars, buses, trucks
  - Power sources, switches & power panels
  - etc
IoT Applications

- Personal Health IoT
- Smart Home
- Financial services
- Retail and service IoT
  - Customer Services, Buying behaviors, Retention
- Manufacturing IoT
- Smart Transportation
  - Connected vehicles
  - Autonomous

IoT Applications

- Smart Infrastructure Monitoring
- Smart Energy Management IoT
- IoT for Smart Grid – renewable energy resources + traditional power generation
- Smart Building
- Smart and Sustainable Cities
Smart Infrastructure Monitoring

Personal Health IoT

- **IoT** –
  - Connected devices: hand-held devices, wearable devices, tablet, smartphones
  - Body sensor network, mobile gateway, cloud services
  - Mobile health/medical app

- **Applications**
  - Intelligent personal health assistant
  - Monitoring Patients and Medical Devices in Real-Time
Healthcare IoT

- IoT in Healthcare Architecture
- IoT endpoint:
  - sensors
  - Smart and connect medical devices
  - Little data
- Gateways/Smartphone
- Cloud Services
  - Big data and Data analytics

Smart Building IoT

- IoT (sensors) – Real-time building operational and security data gathering
  - Temperature, Humidity, Light, Air Quality, Weight, Force, Sound, Motion, Fluid Flow
  - Building operational data: Lighting, HVAC, Water, Parking, Energy, Access and Security
  - Occupancy monitor, Fitness trackers, Elevator, Waste, Fire Safety
Smart Building IoT

- Data Analytics and Real-time Management & Control to Improve
  - Building automation and operations
    - Improved serviceability and reduce the risk of downtime
    - Optimized comfort and reducing energy costs
  - Security
    - Risk management: act or react to people and other machines in a nonintrusive manner

Smart Building IoT

- Building AI & Learning
  - Sense, Tuning/Learning
  - Anticipate, Act/Respond, Adapt
What is IIoT (Industrial Internet of Things)?

- IIoT ≈ IoT applications in smart factory manufacturing setting
- More operation data management
  - Manufacturing systems, machines and devices
  - Throughput, cycle time, lead time, availability, uptime
  - Production quality, defects and rework
  - Maintenance logs, technician notes
- Data analytic
  - Spot trends, streamline processes
  - Optimize assets
  - Predictive maintenance

IIoT Knowledgebase

- Industrial Internet of Things: How big is the opportunity? Accenture, 30:31 minutes, Jan. 21, 2015, https://www.youtube.com/watch?v=MqiD46_IGbU
- Industrial Internet of Things Deeper Dive, Rockwell Automation, 19:36 min, April 6, 2016, https://www.youtube.com/watch?v=27k9clbmjhE
Industry 4.0

- A German initiative which promotes Intelligent Factory
  - Computerization of the manufacturing industry
  - Communications and IT system automate production in a smart way creating connected intelligent factory
- Industry 4.0 also referred to as the 4th Industrial revolution

Industry 4.0 Examples

- The Fourth Industrial Revolution, https://www.youtube.com/watch?v=HPRURtORnjs, 5:34 minutes, Nov. 2013, Siemens
- Bosch plant in Blaichach, Germany, 3:37 minutes, April 20, 2015, https://www.youtube.com/watch?v=GKhSTjraHlU
- EN | Future Production with Industry 4.0 - by Bosch Global, 4:28 min, June 29, 2016, https://www.youtube.com/watch?v=ISk64bJ35yM
**IoT Challenges**

- IoT - open global standardization and implementation at various levels
- Interoperability of software and protocols
  - Platform, Connectivity
- Data control and access
- Data Security
- Privacy
- Regulation

**IoT Opportunities**

- **Bain** predicts that by 2020 annual revenues could exceed $470 B for the IoT vendors selling hardware, software and comprehensive solutions.¹

- **McKinsey** estimates the total IoT market size in 2015 was up to $900 M, growing to $3.7 B in 2020 attaining a 32.6% CAGR (Compound Annual Growth Rate).¹
**IoT Opportunities**

<table>
<thead>
<tr>
<th>Company</th>
<th>Forecasts and/or Market Estimates</th>
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<td>Bain &amp; Company²</td>
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</table>
| Gartner                    | * Estimate that 4 billion connected things will be in use in the consumer sector in 2016, and will reach 13.5 billion in 2020 *
|                             | * The IoT will support total services spending of $235 billion in 2016, up 22 percent from 2015                                                                    |

¹Roundup of Internet of Things Forecasts and Market Estimates, 2016, Louis Columbus, Nov. 27, 2016,  

**IoT Technology Management Strategies**

- Balancing old and new technical constraints
- Building your technology portfolio
- Lesson learned from the disruptive technology histories, Technology S curve, Technology Lifecycle
- Planning innovative IoT technology development
  - Making sure the end product/services enhanced by additional IoT technology and components
  - Explore opportunity for further inventive enhancement
Disk Storage Technology S-Curve Examples

- Previous …
- USB Flash Drive
- Portable Hard Drive
- Storage Area Network (SNA)
- Cloud storage

IoT Technology S Curve
Thank You!
Questions?