Security of the Internet of Things (IoT), Hardware Security: Part 1

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References

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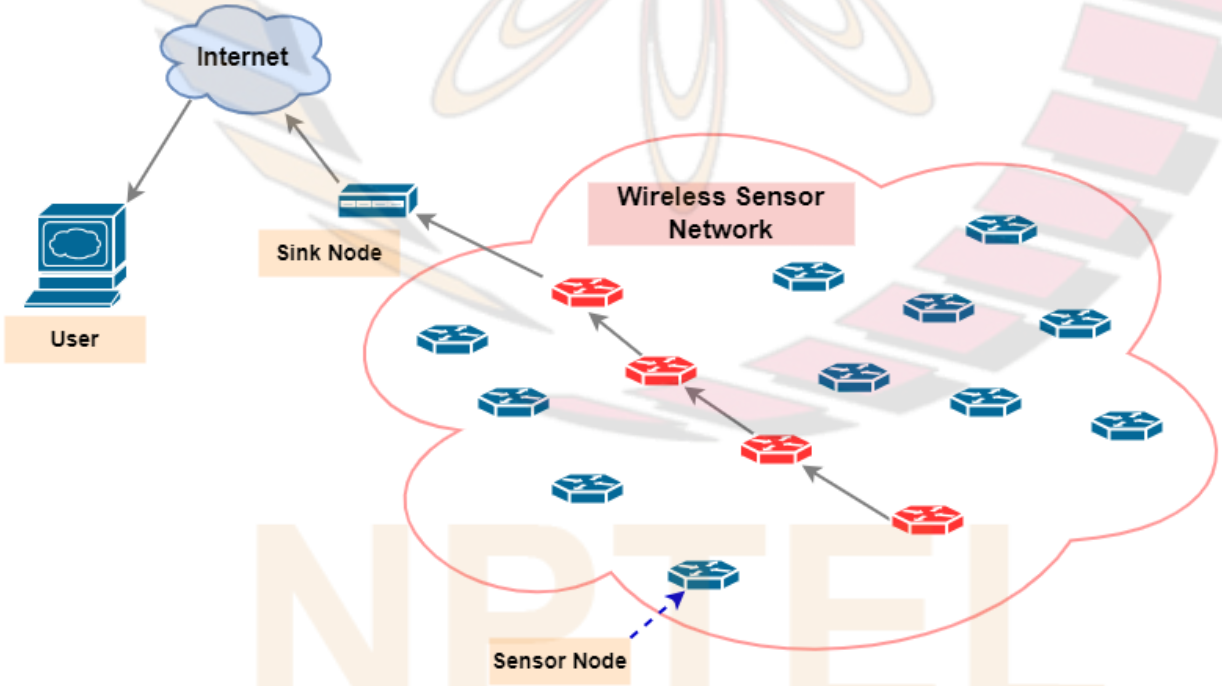
Introduction

- IoT is an emerging and promising technology with a variety of applications
- Different aspects of IoT being extensively researched upon
- IoT is extension of Internet connectivity to resource-constrained devices (e.g., sensors, actuators) and everyday objects
- Allows remote monitoring and control of such devices
  - often called "*IoT nodes*"
- IoT nodes also communicate among themselves with minimal or no human intervention
  - called "*Machine-to-Machine*" (M2M) communications

Applications of IoT

- Precision Agriculture
  - ❑sensors deployed at multiple points in a farm
  - ❑they monitor soil moisture/ composition, temperature, humidity, etc.
  - ❑measurements from sensors can be monitored remotely; used to control irrigation/ fertilizing



Applications of IoT (contd.)

- Agricultural and Environmental IoT Use Cases:
  - ❑ Smart irrigation and fertilization techniques to improve yield
  - ❑ Livestock health and asset tracking
  - ❑ Preventative maintenance on remote farming equipment
  - ❑ Drone-based land surveys
  - ❑ Robotic farming
  - ❑ Sensors floated at various altitudes in atmosphere to sense temperature, air quality, etc.
  - ❑ Volcanic and fault line monitoring

Applications of IoT (contd.)

- Smart Healthcare
  - Sensor devices are attached to patient's body
  - They collect medical data and vital signs (e.g., blood pressure, body temperature, cholesterol level, heart rate, etc.) from patient
  - Enables automatic diagnosis of conditions, tracking of progress
  - Anomalies can be indicated directly to healthcare provider, without significant human involvement
- Smart Healthcare Use Cases:
  - In-home patient care
  - Dementia and elderly care and tracking
  - Patient fall indicators

Applications of IoT (contd.)

- Smart Home
  - Automatic lighting system senses presence of human beings and switches on the lights only in specific areas of house accordingly
  - Automatic control of heating and air conditioning, e.g., to avoid heating or cooling an empty home
  - Smart appliances can be remotely switched ON or OFF over Internet
  - Security: e.g., motion sensors to sense intrusion by burglars, transmission of alerts to home owner's smartphone
  - Home automation for elderly and disabled: making it easier for the elderly and disabled to remain at home, safely and comfortably (instead of being moved to a healthcare facility)

Applications of IoT (contd.)

- Infrastructure/ Machine Monitoring and Preventive Maintenance
  - ❑sensors fixed to machines in factory, walls of buildings, bridges, etc., which sense vibration patterns/ acoustics
  - ❑send alerts when maintenance needed
- Industrial Automation
  - ❑Safety systems such as thermal sensing, pressure sensing, and gas leaks

Applications of IoT (contd.)

- Wildfire Control
  - sensors equipped with thermometers and GPS dropped from airplane into forest
  - collectively produce “temperature map” of forest to assist firefighters

Applications of IoT (contd.)

- Consumer IoT
  - **Smart home gadgetry**: Smart irrigation, smart garage doors, smart locks, smart lights, smart thermostats, smart security, Alexa assistants, smart set-top boxes
  - **Wearables**: Health and movement trackers, smart clothing/ wearables
  - **Pets**: Pet location systems, smart kennel doors
- Retail, finance, and marketing IoT use cases
  - Targeted advertising, such as locating known or potential customers by proximity and providing sales information
  - Asset tracking, such as inventory control, loss control, and supply chain optimizations
  - Cold storage monitoring, such as analysis of cold storage of perishable inventory
  - Beaconing systems within entertainment venues, conferences, concerts, amusement parks, and museums

Applications of IoT (contd.)

- Intelligent Transportation and Logistics Systems
  - ❑Fleet tracking and location awareness
  - ❑Municipal vehicle planning, routing and monitoring (snow removal, waste disposal)
  - ❑Railcar identification and tracking
  - ❑Asset and package tracking within fleets
  - ❑Preventative maintenance of vehicles on the road

Applications of IoT (contd.)

- Smart Cities
  - Pollution control and regulatory analysis through environmental sensing
  - Microclimate weather predictions using citywide sensor networks
  - Efficiency gains and improved costs through waste management service on demand
  - Improved traffic flow and fuel economy through smart traffic light control and patterning
  - Energy efficiency of city lighting by switching lights on demand
  - Smart snow plowing based on real-time road demand, weather conditions, and nearby plows
  - Smart irrigation of parks and public spaces, depending on weather and current usage
  - Smart cameras to watch for crime
  - Smart parking lots to automatically find best parking spaces on demand
  - Bridge, street, and infrastructure wear and usage monitors to improve longevity and service

Applications of IoT (contd.)

- Government and Military IoT Use Cases
  - ❑Terror threat analysis through IoT device pattern analysis and beacons
  - ❑Swarm sensors through drones
  - ❑Sensor networks deployed on the battlefield to monitor threats
  - ❑Government asset tracking systems
  - ❑Real-time military personnel tracking and location services
  - ❑Sensors to monitor hostile environments
  - ❑Water level monitoring to measure dam and flood containment

Components of IoT-Enabled Things

- Fig. shows key components of an IoT-enabled device
- **Sensor**:
  - ❑ Measures some parameter of a physical, chemical, or biological entity and delivers an electrical signal proportional to the observed characteristic
  - ❑ Sensor output is typically input to a microcontroller or other management element
- **Actuator**:
  - ❑ Receives an electronic signal from a controller and responds by interacting with its environment to produce an effect on some parameter of a physical, chemical, or biological entity
- **Microcontroller**
- **Transceiver**:
  - ❑ Contains the electronics needed to transmit and receive data
  - ❑ Most IoT devices contain a wireless transceiver, which communicates using Wi-Fi, ZigBee, etc.
- **Power Supply**:
  - ❑ Typically, this is a battery