Embedded Systems

Introduction to the Wireless Sensor Network and Internet of Things

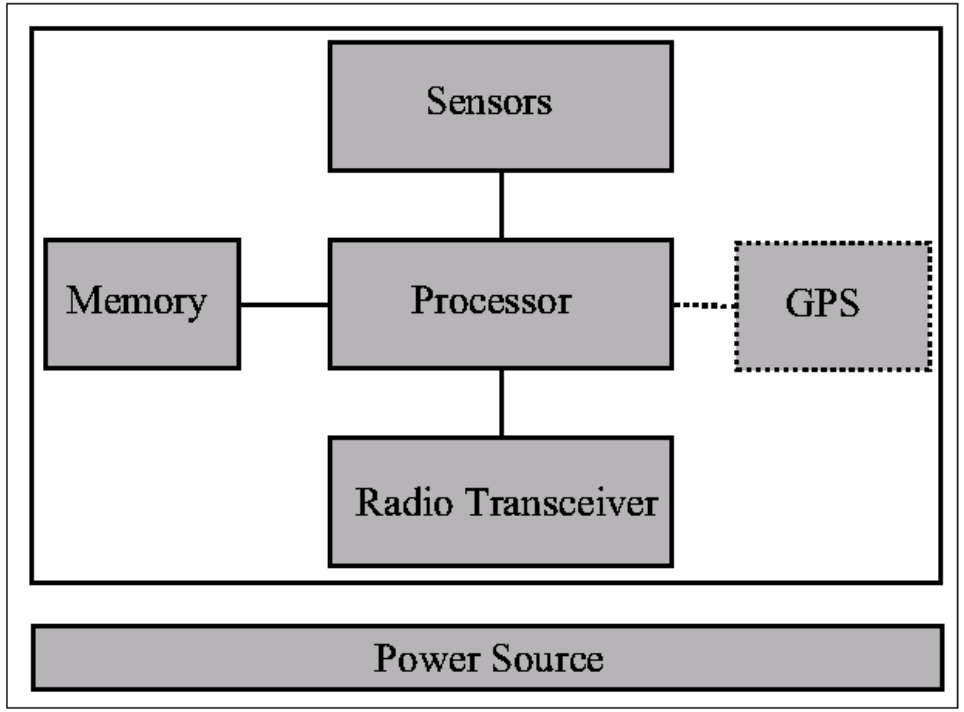
Outline

- Introduction to Wireless Sensor Network
- Introduction to the Internet of Things
- An application .. Home Automation

Wireless Sensor Network

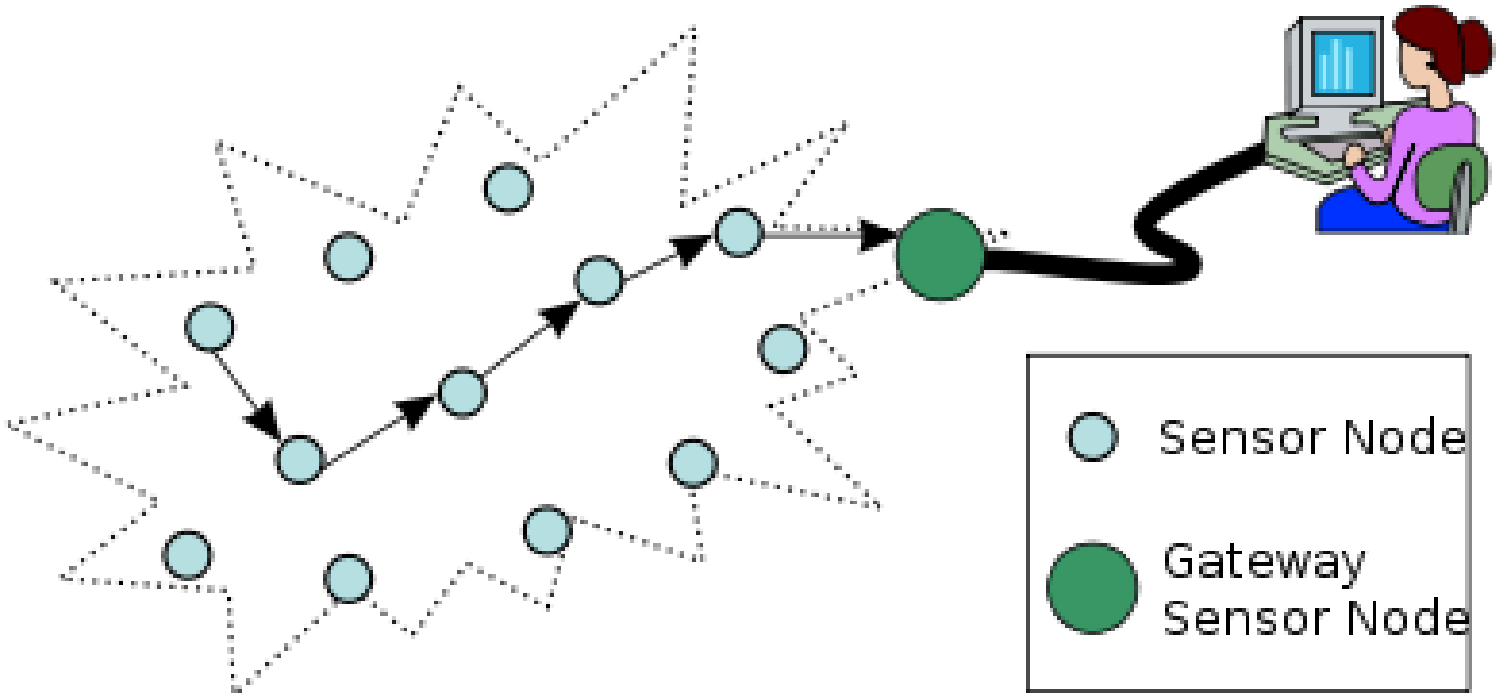
Wireless Sensor Network

- WSN
  - A group of specialized transducers with a communications infrastructure for monitoring and recording conditions at different locations.
  - Consists of multiple detection stations called sensor nodes, each is equipped with a transducer, microcomputer, transceiver and power source.
- Applications
  - Automotive and avaiation
  - Home automation – smart home
  - Video surveillance
  - Traffic monitoring
  - Medical device monitoring
  - Monitoring of weather conditions
  - Air traffic control
  - Robot control



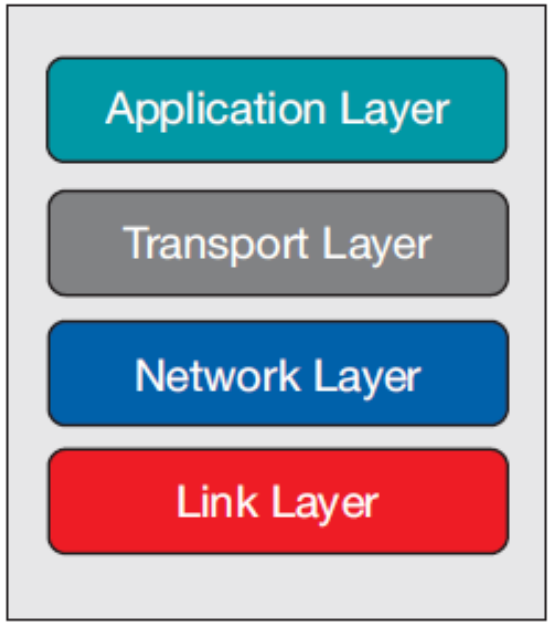
Wireless Sensor Network

- WSN incorporates multiple of issues:
  - Deployment
  - Localization
  - Time Synchronization
  - Wireless Link
  - Medium Access
  - Power Management
  - Routing
  - QoS

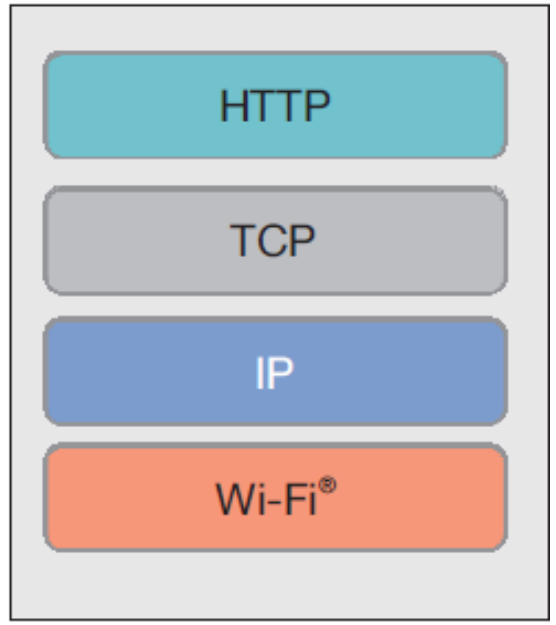


Wireless Link

- Communication protocols
  - Set of rules and standards to format data and control data exchange
- Link layer:
  - Conversion of bits to radio signals
- Network layer
  - Addresses and routing
- Transport layer
  - Generates communication sessions
- Application layer:
  - Data formatting



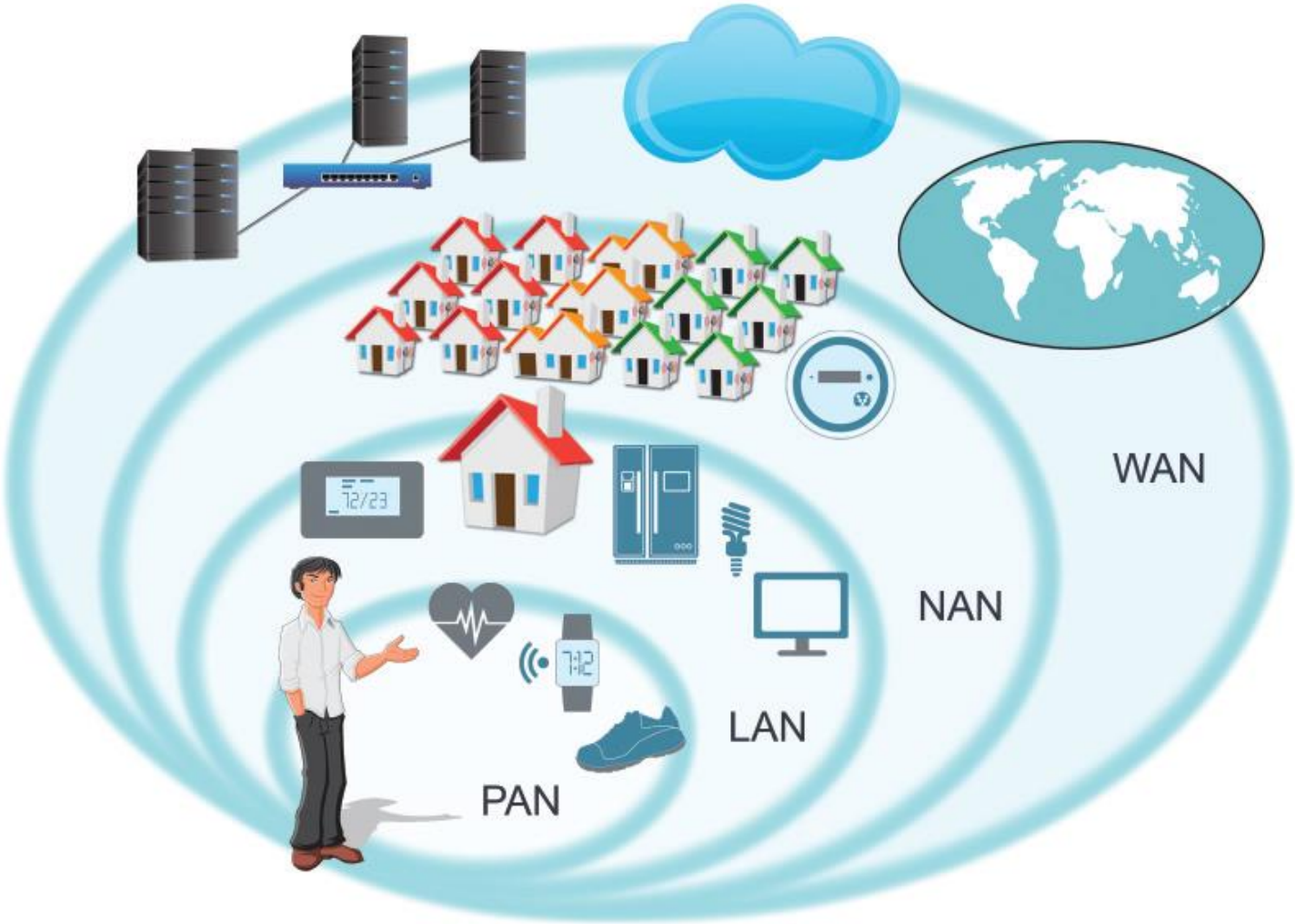
The OSI network model



The TCP/IP protocol stack

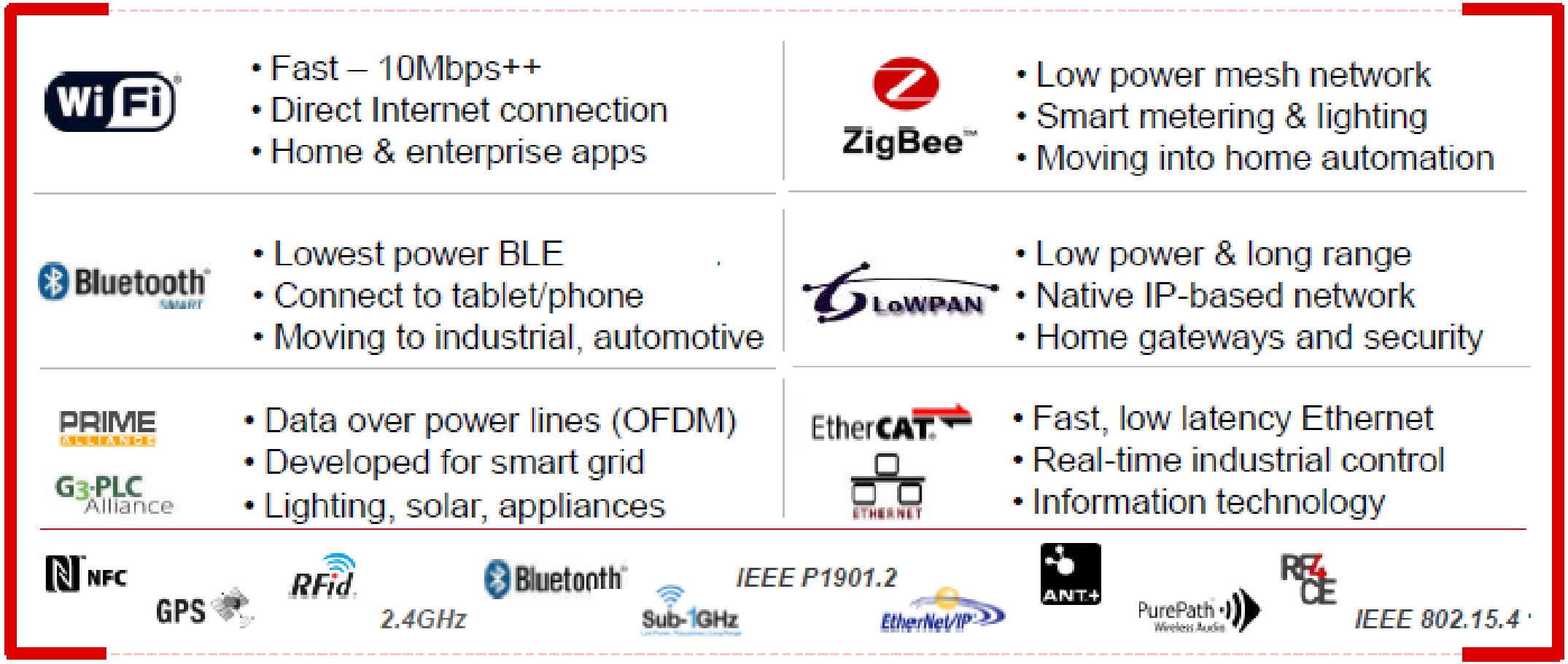
Wireless Link

- Range
  - Personal Area Network
  - Local Area Network
  - Neighborhood Area Network
  - Wide Area Network



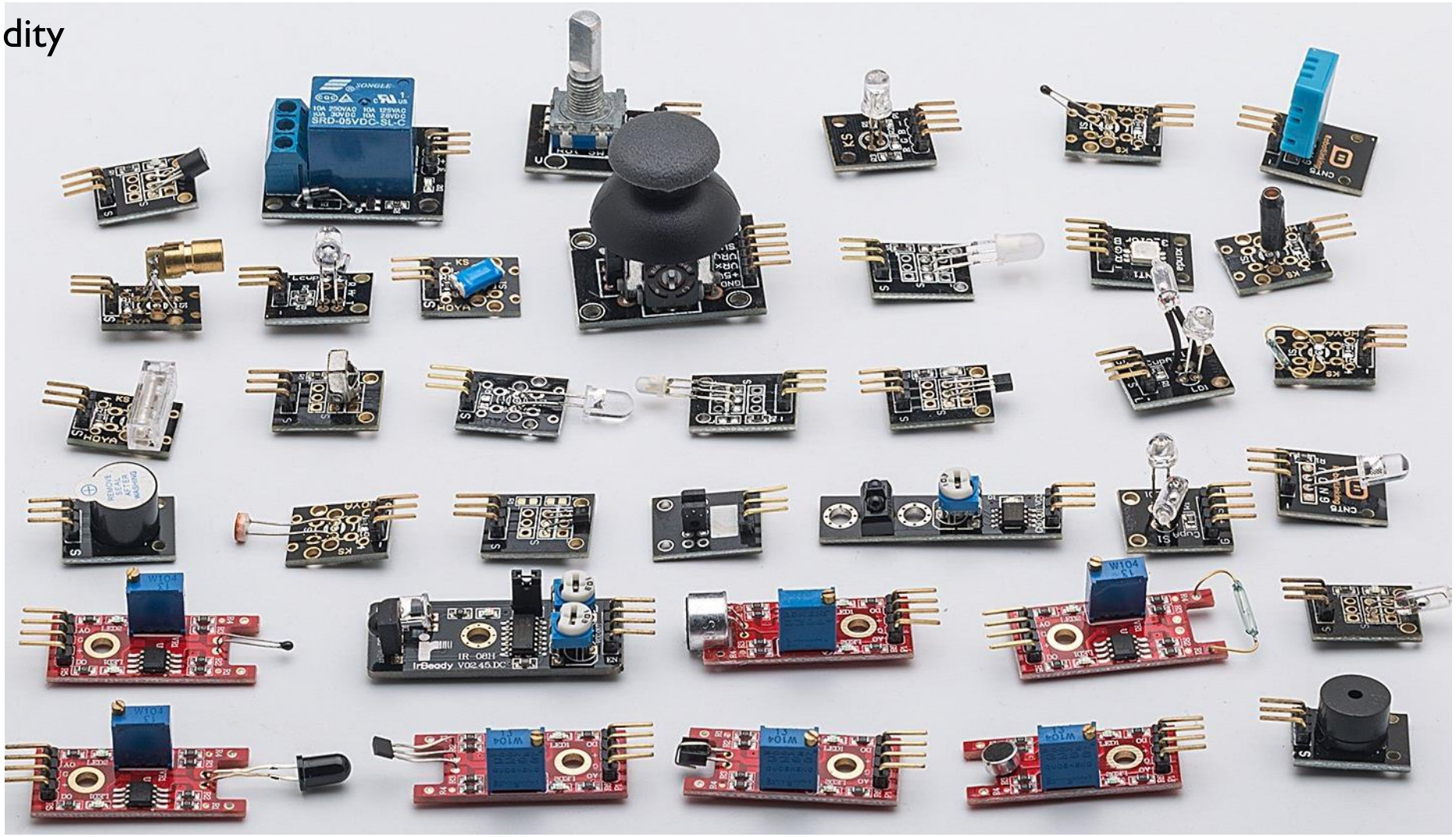
Wireless connectivity

- Varity of options



Sensors?

- Temperature and humidity
- Light
- Angle
- Infrared
- Tilt
- Force
- Acceleration
- Sound
- Vibration
- Capacitance
- Barometric pressure
- Magnets
- Gases
- Flame and smoke
- ….

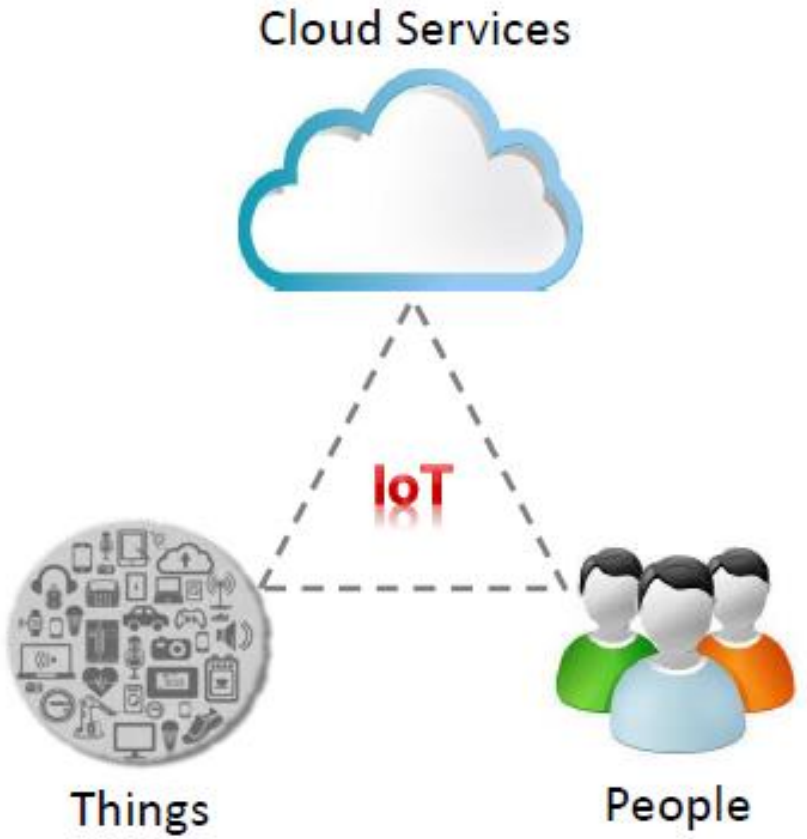


Internet of Things

Internet of Things

- "The network of physical objects or 'things' embedded with electronics, software, sensors, and network connectivity, which enables these objects to collect and exchange data."
- denotes the connectivity of devices, systems and services that goes beyond the traditional machine to machine communications
  - Mesh networks, point to point, near field, sonar, …

- Simplified definition:
  - People and ‘things’ gets connected via cloud services



Internet of Things

- Iot fields of interest:

Wearables
- Entertainment
- Fitness
- Smart watch
- Location and tracking

Building & Home Automation
- Access control
- Light & temp control
- Energy optimization
- Predictive maintenance
- Connected appliances

Smart Cities
- Residential E-meters
- Smart street lights
- Pipeline leak detection
- Traffic control
- Surveillance cameras
- Centralized and integrated system control

Smart Manufacturing
- Flow optimization
- Real time inventory
- Asset tracking
- Employee safety
- Predictive maintenance
- Firmware updates

Health Care
- Remote monitoring
- Ambulance telemetry
- Drugs tracking
- Hospital asset tracking
- Access control
- Predictive maintenance

Automotive
- Infotainment
- Wire replacement
- Telemetry
- Predictive maintenance
- C2C and C2I

Internet of Things

- IoT fields of study:
  - Sensing a complex environment
    - Occupancy
    - Triangualization
  - Connectivity
    - No one standard fits all
  - Security
    - Hackers ??!
  - Complexity
    - Not everyone's an expert !
  - Power
    - Should run for years !
  - Operating environment
    - How to run in a not-so-friendly environment ?

Internet of Things

- IoT targets not only professional engineers, but whoever has the sense of design.
  - Cheap boards and platforms are available, starting < 10$
  - Simple programming and configurations tools
    - Python
    - Scratch
    - Lua
  - Fully integrated developing environment
  - Huge community

Python

- Script language
  - Code syntax is checked at runtime
  - Code is interpreted, not compiled (sort of)

```
# import modules used here -- sys is a very standard one
import sys

# Gather our code in a main() function
def main():
    print repeat('Yay', False)
    print repeat('Woo Hoo', True)

# Defines a "repeat" function that takes 2 arguments.
def repeat(s, exclaim):
    """Returns the string s repeated 3 times.
    If exclaim is true, add exclamation marks.
    """

    result = s * 3
    if exclaim:
        result = result + '!!!'
    return result

# Standard boilerplate to call the main() function to begin the program
if __name__ == '__main__':
    main()
```

Comment

Comment at the end of line

Call a function

Function definition

Variable assignment

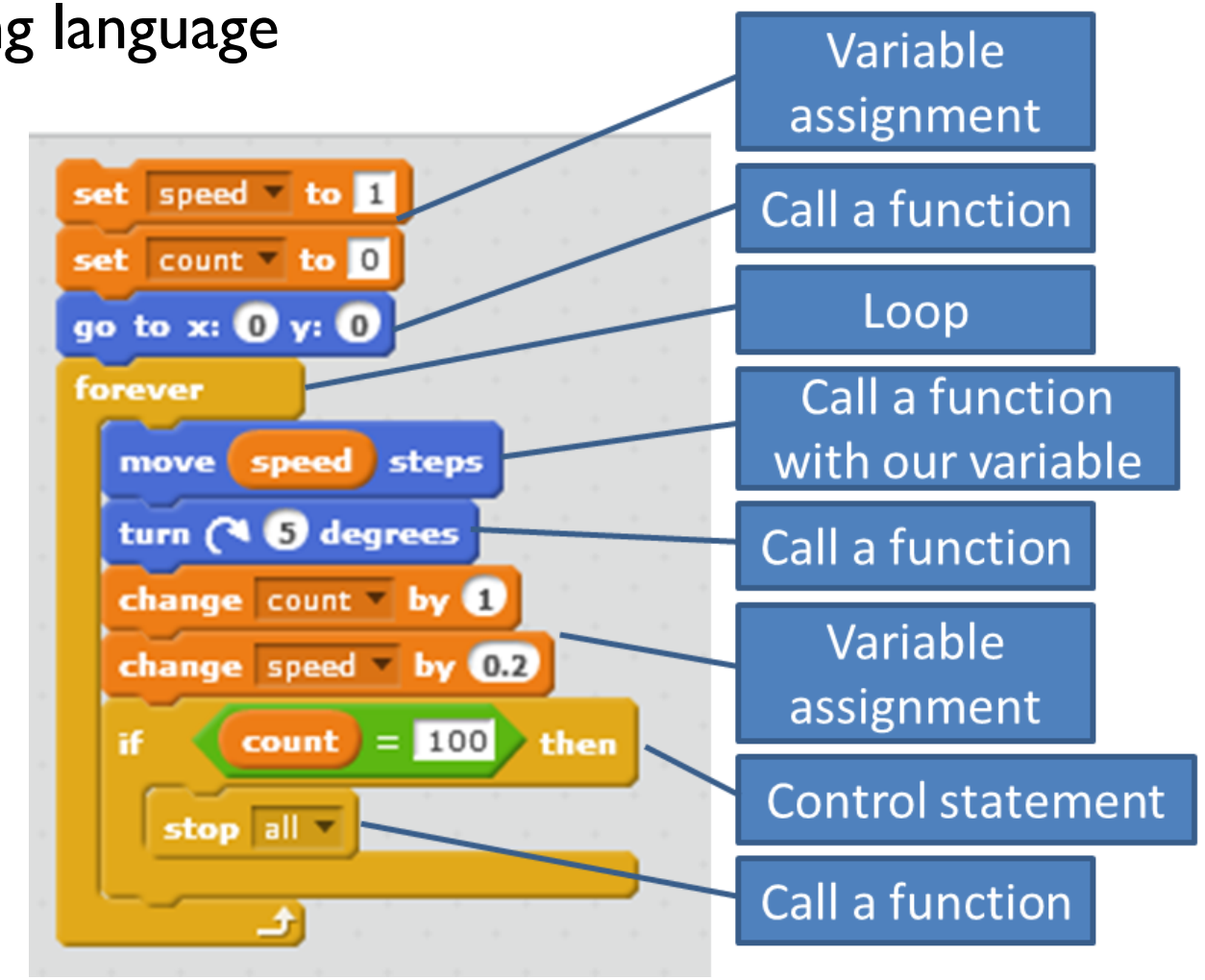
Control statement

Variable assignment

Return result from the function

Scratch

- Visual programming language



IoT Example

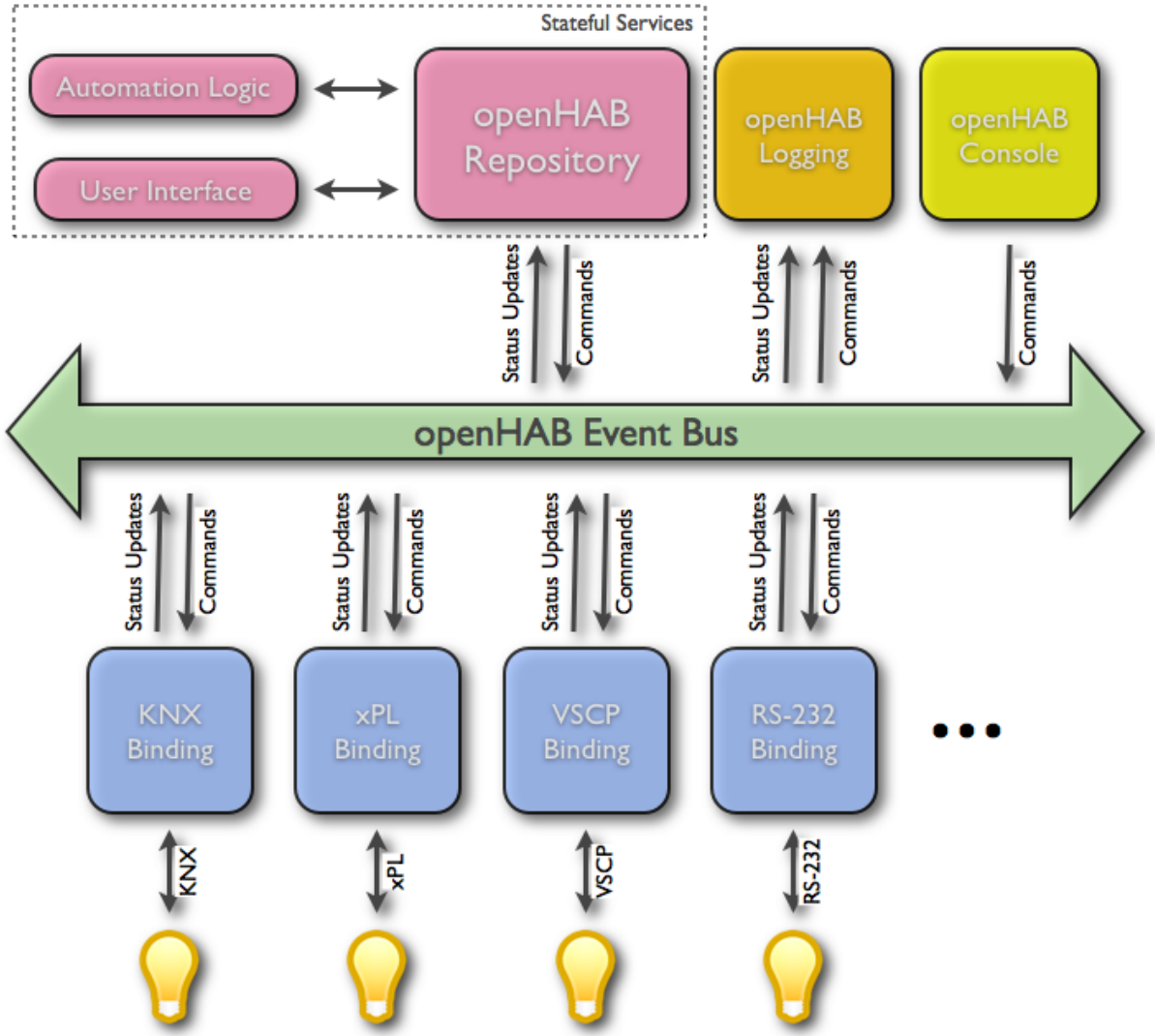
Home Automation

Home Automation

- Automatic centralized control of a home's lighting, HVAC (heating, ventilation and air conditioning), appliances, security locks of gates and doors and other systems
- Large, profitable market !
- Basic idea:
  - Sensors in advert places around home
  - Sensors communicates wirelessly with centralized control center
  - Control center takes actions according to a given rules
  - Home owner configures the control center, and gets notifications !

Home Automation

- openHAB
  - Open Home Automation Bus, open-source home automation framework
  - Runs on Windows, Linux, Raspberry Pi and BeagleBone



???

- Supposed to be a demo with Wifi module attached to a sensor, but both are fried !
- Questions ?