SNJB's KBJ College of Engineering

Chandwad–423101 (Nashik)

Department
of
Information Technology

Subject : Internet of Things (IOT) of BE 2015 Pattern

Unit 3
SMART OBJECTS:
THE “THINGS” IN IoT

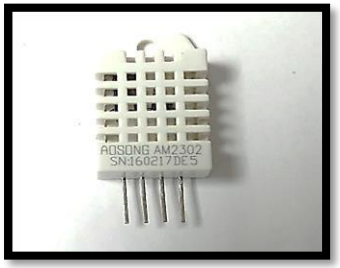
Sensors

- Characteristic of any device or material to detect presence of particular physical quantity
- Output of sensor is signal, which is converted to human readable form
- Performs some function of input by sensing or feeling physical changes in the characteristic of a system in response to stimuli

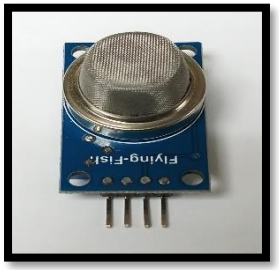
Sensors

- Input: Physical parameter or stimuli
  - Example: Temperature, light, gas, pressure, and sound
- Output: Response to stimuli

Sensors



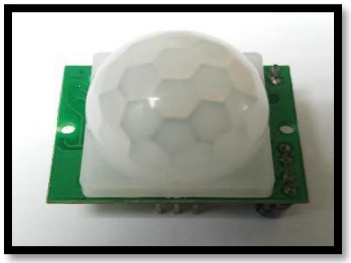
Temperature and Humidity sensor – DH22



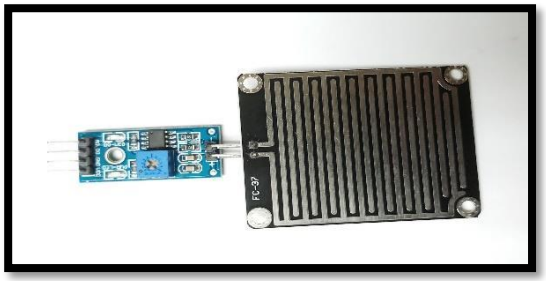
Gas (LPG, CH4, and CO) detector sensor - MQ-5

Ultrasonic sensor - HC-SR04

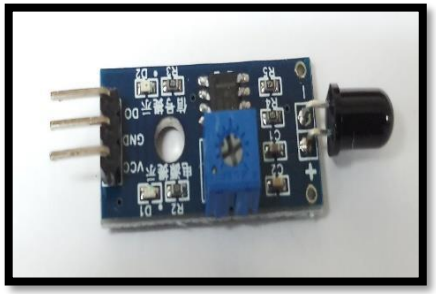
CMOS Camera



PIR Sensor

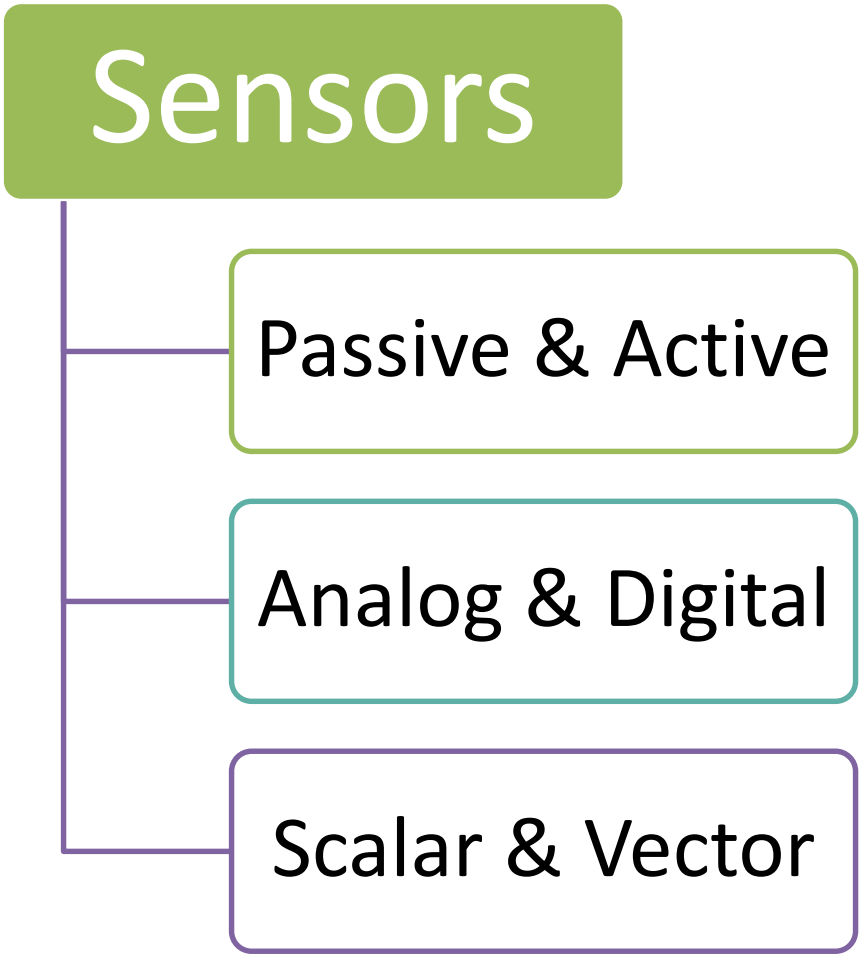


Rain Detector Sensor



Fire Detector Sensor

Classification



Passive Sensor

- Cannot independently sense the input
- Example:
  - Accelerometer
  - Soil Moisture
  - Water-level and
  - Temperature Sensors

Active Sensor

- Independently sense the input
- Example:
  - Radar
  - Sounder and
  - Laser Altimeter Sensors

Analog Sensor

- The response or output of the sensor is some continuous function of its input parameter
- Example:
  - Temperature sensor
  - LDR
  - Analog Pressure Sensor and
  - Analog Hall Effect/Magnetic Sensor

Digital Sensor

- Responses in binary nature
- Designs to overcome the disadvantages of analog sensors
- Along with the analog sensor it also comprises of extra electronics for bit conversion
- Example:
  - Passive Infrared (PIR) Sensor and
  - Digital Temperature Sensor (DS1620)

Scalar Sensor

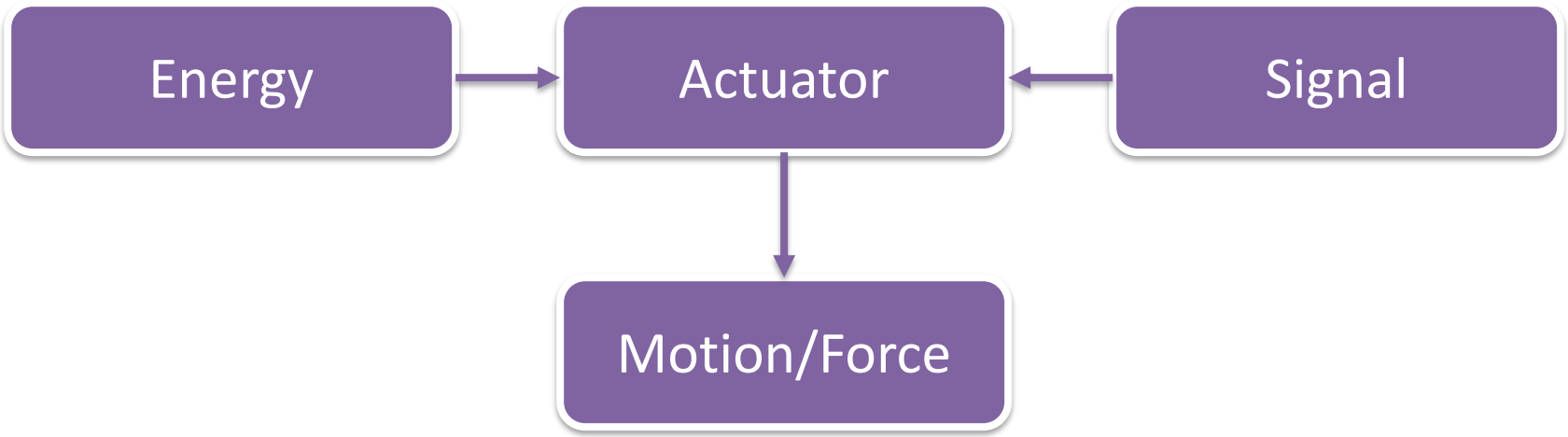
- Detects the input parameter only based on its magnitude
- Response of the sensor is a function of magnitude of the input parameter
- Not affected by direction of input parameter
- Example: Temperature, Gas, Strain, Color and Smoke Sensors

Vector Sensor

- Response of sensor depends on magnitude of direction and orientation of input parameter
- Example :
  - Accelerometer
  - Gyroscope
  - Magnetic Field
  - Motion Detector Sensors

Actuator

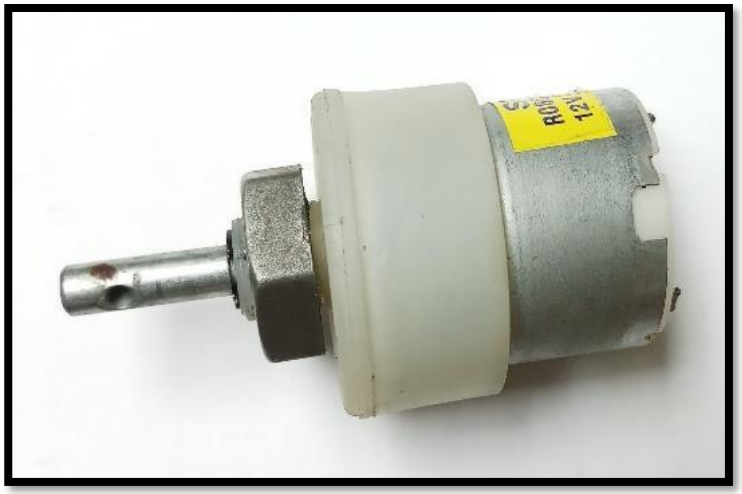
- Part of system that deals with the control action required (mechanical action)
- Mechanical or electro-mechanical devices



Actuator

- A control signal is input to an actuator and an energy source is necessary for its operation
- Available in both micro and macro scales
- Example:
  - Electric Motor,
  - Solenoid,
  - Hard Drive Stepper Motor
  - Comb Drive
  - Hydraulic Cylinder,
  - Piezoelectric Actuator
  - Pneumatic Actuator

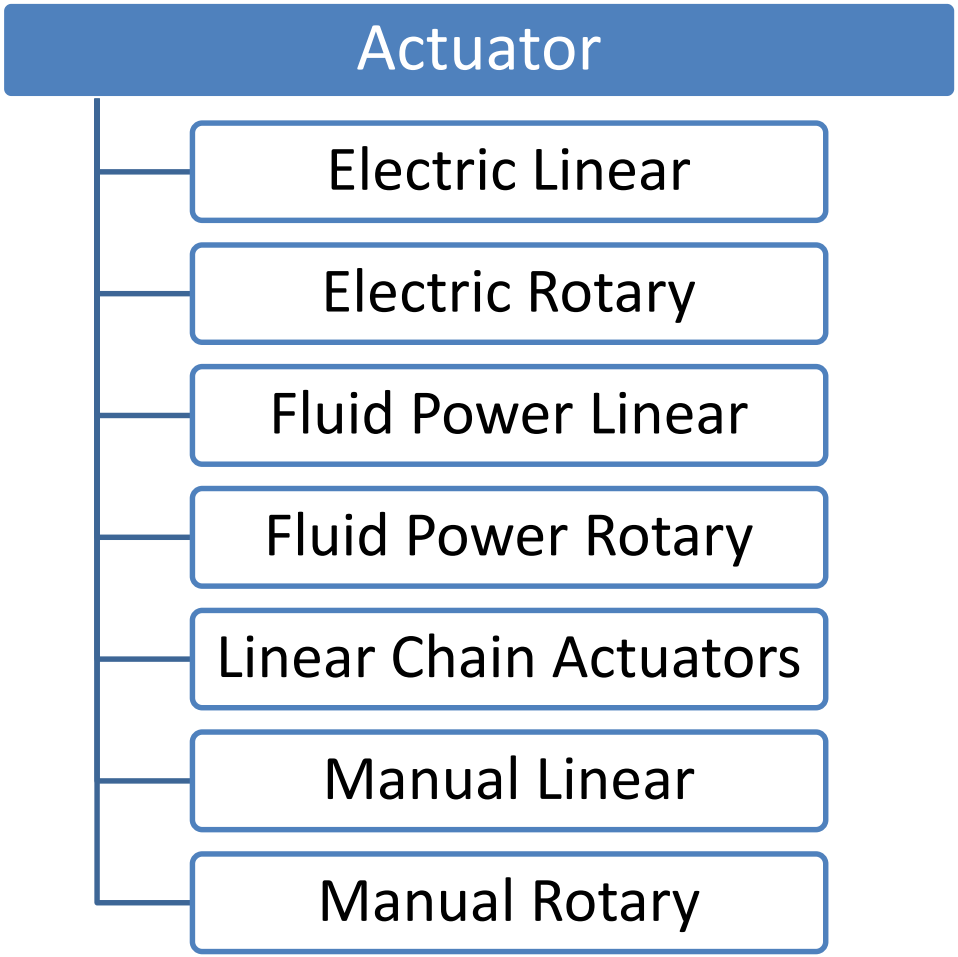
Actuator



DC Motor

Relay

Classification



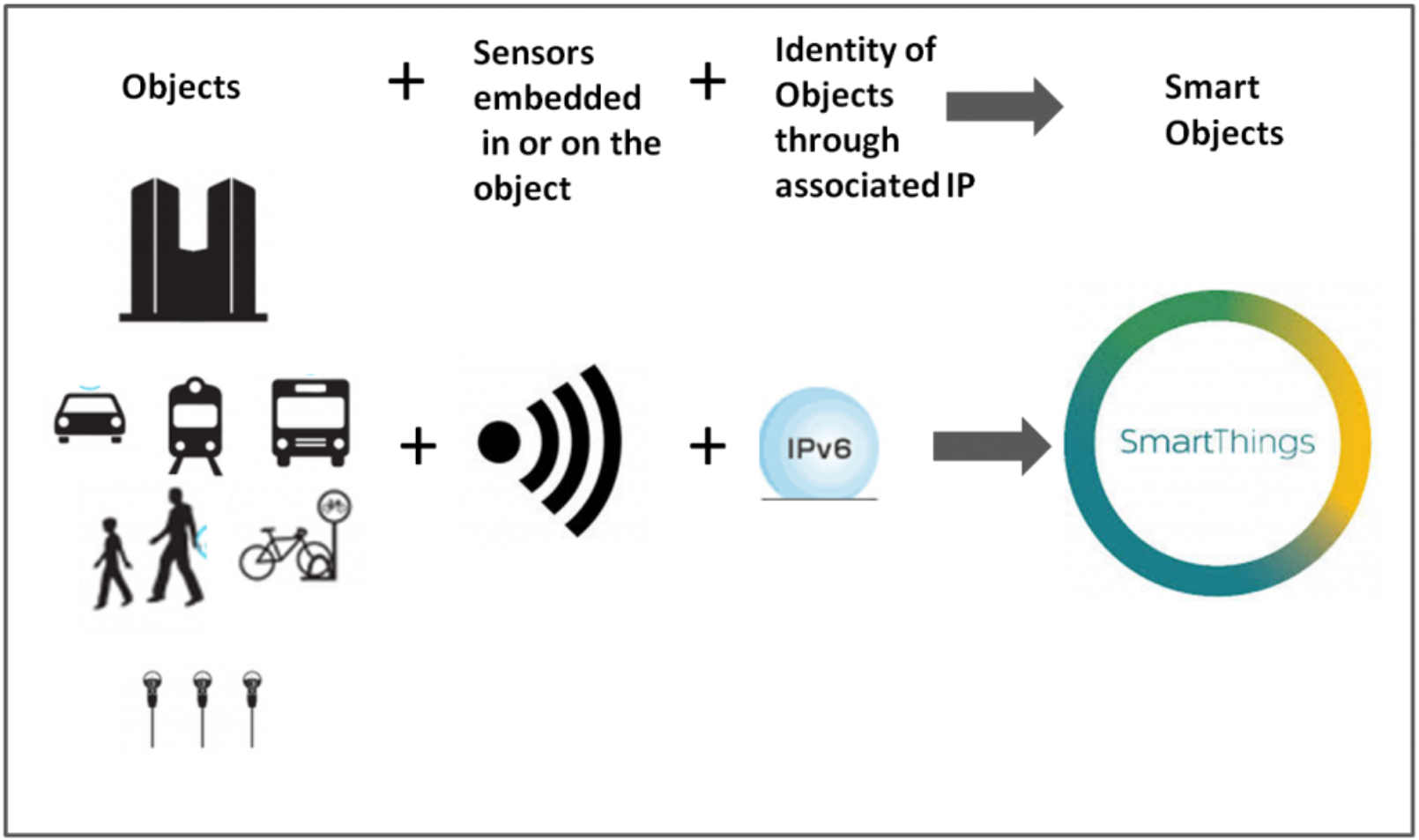
Smart Objects

- A smart object is defined by IPSO (Internet Protocol for Smart Objects) as
  - An intelligent (RFID) tag
  - A sensor
  - An actuator
  - An embedded device
  - Any combination of the above features to form a more complex entity

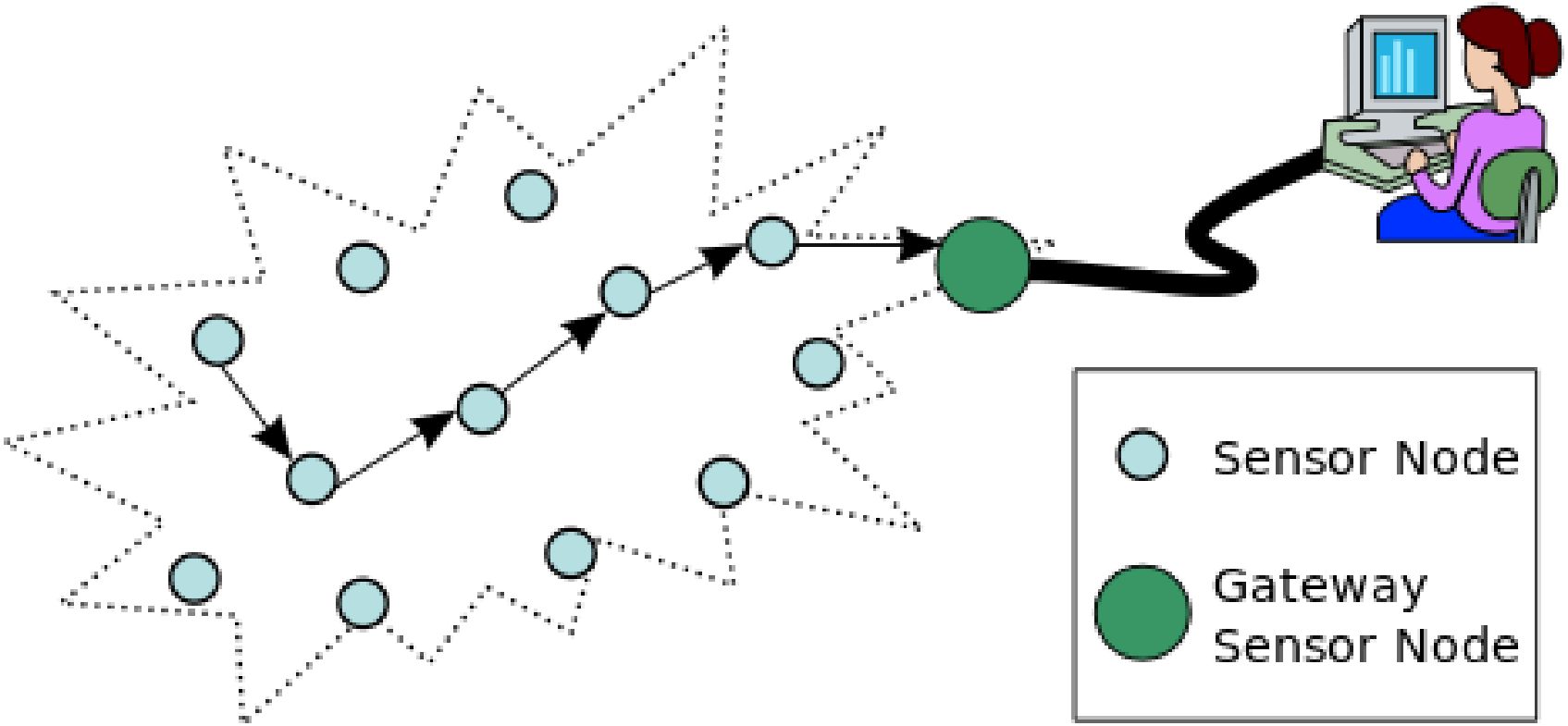
Smart Objects

- An object that enhances interaction with not only people but also with other smart objects
- Also known as smart connected products or smart connected things (SCoT)
- They are products, assets and other things embedded with processors, sensors, software and connectivity

Smart Objects



Sensor Networks



IoT Access Technologies

- IEEE 802.15.4
- IEEE 802.15.4g and 802.15.4e
- IEEE 1901.2a
- LoRaWAN

IEEE 802.15.4

- Provides framework for lower layers (MAC and PHY) for wireless PAN
- PHY defines frequency band, transmission power, and modulation scheme of the link
- MAC defines issues such as medium access and flow control (frames)
- Used for low power, low cost and low speed communication between devices (< ~75m)

Features of IEEE 802.15.4

- Nature of transmission is line of sight
- Standard range of transmission - 10 to 75m
- Transmission of data uses CSMA-CA (carrier sense multiple access with collision avoidance)
- Star and peer-to-peer network topology is included

IEEE 802.15.4

Version	Feature
802.15.4 - 2003	Basic version. The modulation schemes and data rates were fixed for different frequency band – 868, 915 MHz, and 2.4 GHz.
802.15.4 - 2006	Also known as 802.15.4b. Provides higher data rate even on the lower frequency bands. In the 868 MHz, the data transmission rate is up to 100 kb/s while in 915 MHz, the data transmission rate is up to 250 kb/s. Uses OQPSK for all the frequency bands.
802.15.4 a	Increases range capability. Defines two new physical layers – Direct Sequence ultra-wideband (UWB) – 249.6 - 749.6 MHz (sub-gigahertz band), 3.1 - 4.8 GHz (low band), and 6 - 10 GHz (high band). Chirp spread spectrum (CSS) approach in ISM band at 2.4 GHz.
802.15.4 c	This version provides 780 MHz band in China. It uses either O-QPSK or MPSK (Multiple frequency-shift keying) using data transmission rate 250 kb/s.

IEEE 802.15.4

Version	Feature
802.15.4 d	This version provides 950 MHz band in Japan. It uses either GFSK (Gaussian frequency-shift keying) using data rate 100 kb/s or BPSK using data rate 20 kb/s.
802.15.4e	Defines MAC developments to IEEE 802.15.4 towards ISA SP100.11a application (industrial applications).
802.15.4f	Defines fresh PHYs for 433 MHz frequency band (RFID applications), 2.4 GHz frequency band and UWB.
802.15.4g	Defines fresh PHYs for smart utility networks for 902 - 928 MHz band (smart grid applications, majorly for the energy industry).

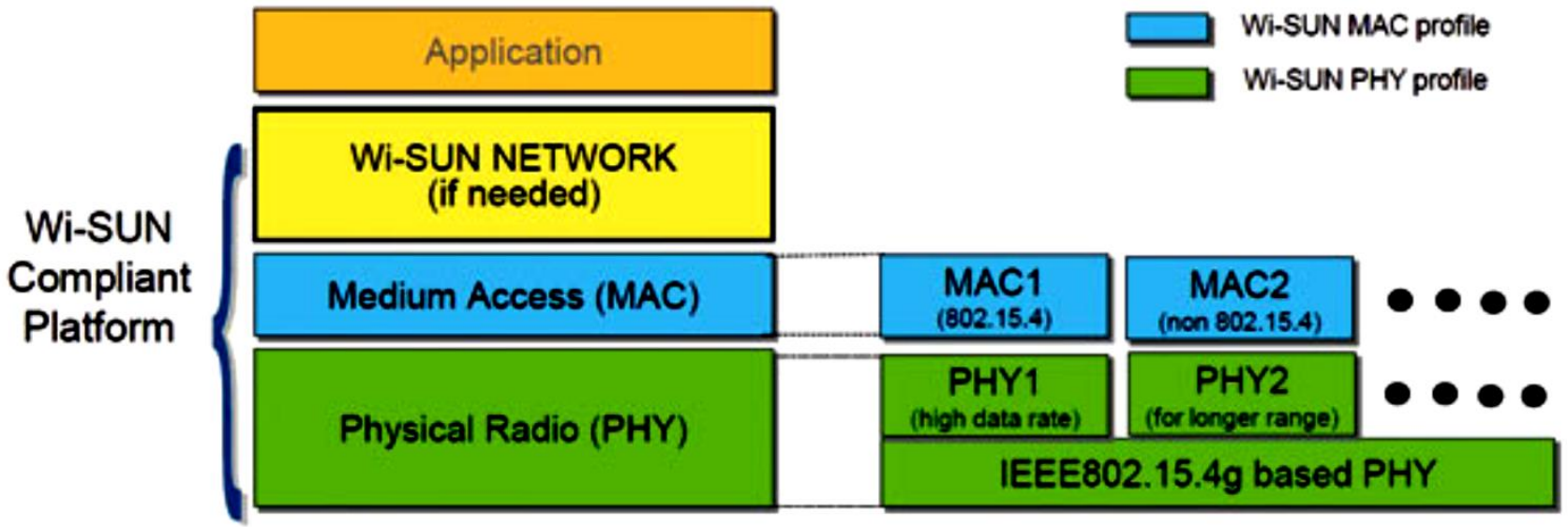
IEEE 802.15.4g

- IPv6 based Wireless Smart Utility Network (Wi-SUN) based on IEEE 802.15.4g
- Also known as Smart Utility Networks (SUN), was approved by IEEE in March, 2012
- Initially Japan focused, now expanding globally (US, South East Asia, India, Europe)
- Target smart utility use cases: Gas metering; demand/response; distribution automation

IEEE 802.15.4g

- PHY layer based on 4g but specification will be categorized based on use cases
- Frequency: 868 MHz (EU), 915 MHz (USA), 2.4 GHz ISM bands (worldwide)
- MAC may be based on or not based on 802.15.4. Application dependent

IEEE 802.15.4g



IEEE 802.15.4e

- Chartered to define a MAC amendment to the existing standard 802.15.4-2006
- MAC Amendment for Industrial Applications
- Intent of this amendment is to enhance and add functionality to the 802.15.4-2006 MAC to
  - better support the industrial markets
  - Permit compatibility with modifications being proposed within the Chinese WPAN

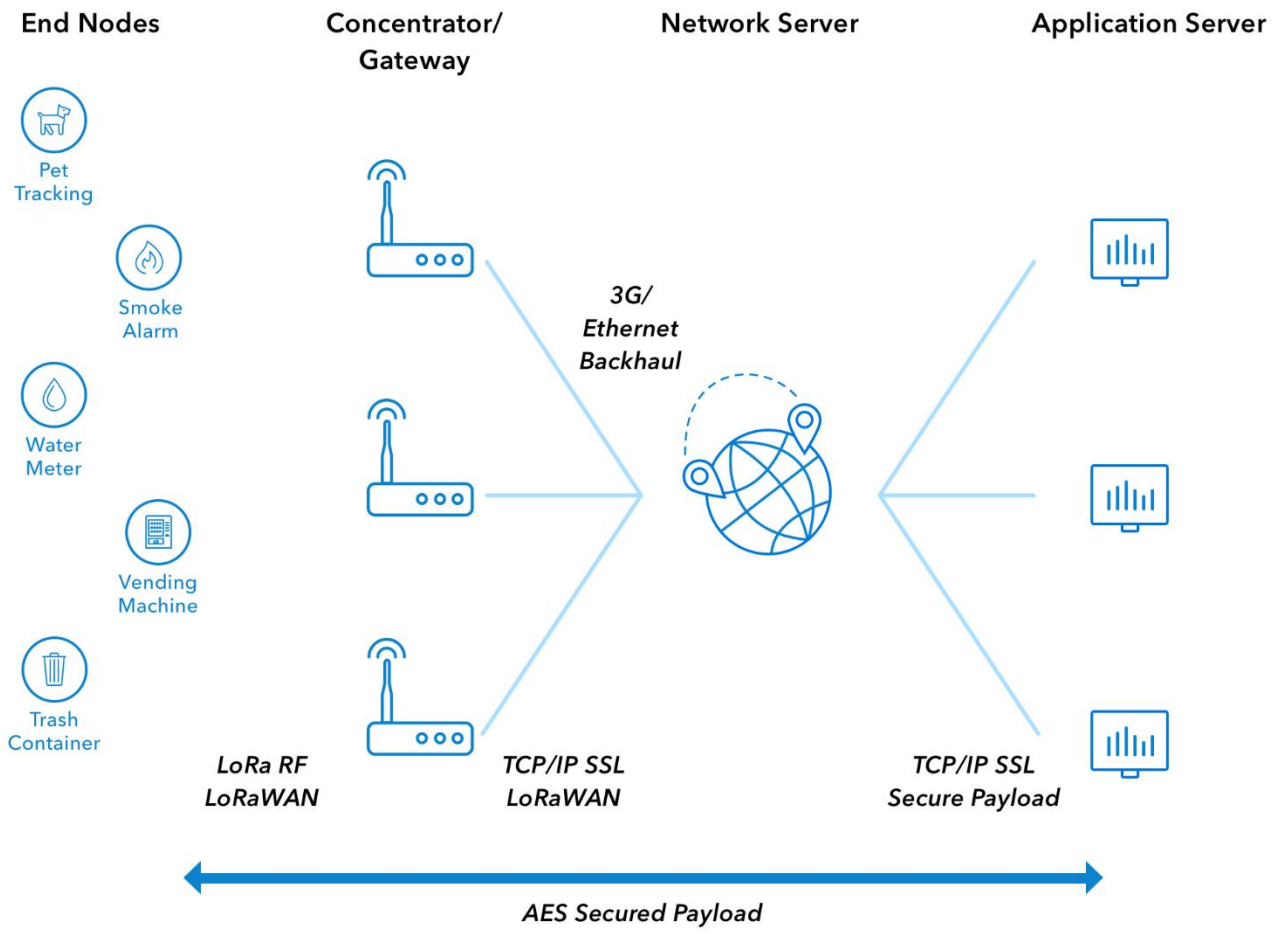
IEEE 1901.2a

- For Low-Frequency (less than 500 kHz) Narrowband Power Line Communications
- Designed for Smart Grid Applications
- Supports indoor and outdoor communications over low voltage & medium-voltage power line

LoRaWAN

- Media access control (MAC) protocol for wide area networks
- Designed to allow low-powered devices to communicate with Internet-connected applications over long range wireless connections
- Can be mapped to the second and third layer of the OSI model

LoRaWAN


End Nodes
Concentrator/ Gateway
Network Server
Application Server
Pet Tracking
Smoke Alarm
Water Meter
Vending Machine
Trash Container
3G/ Ethernet Backhaul
LoRa RF LoRaWAN
TCP/IP SSL LoRaWAN
TCP/IP SSL Secure Payload
AES Secured Payload