Low Power Wide Area Network

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LPWAN

- LPWAN has two network topologies:
  - Direct device connectivity (base station)
  - Indirect device connectivity through an LPWAN gateway

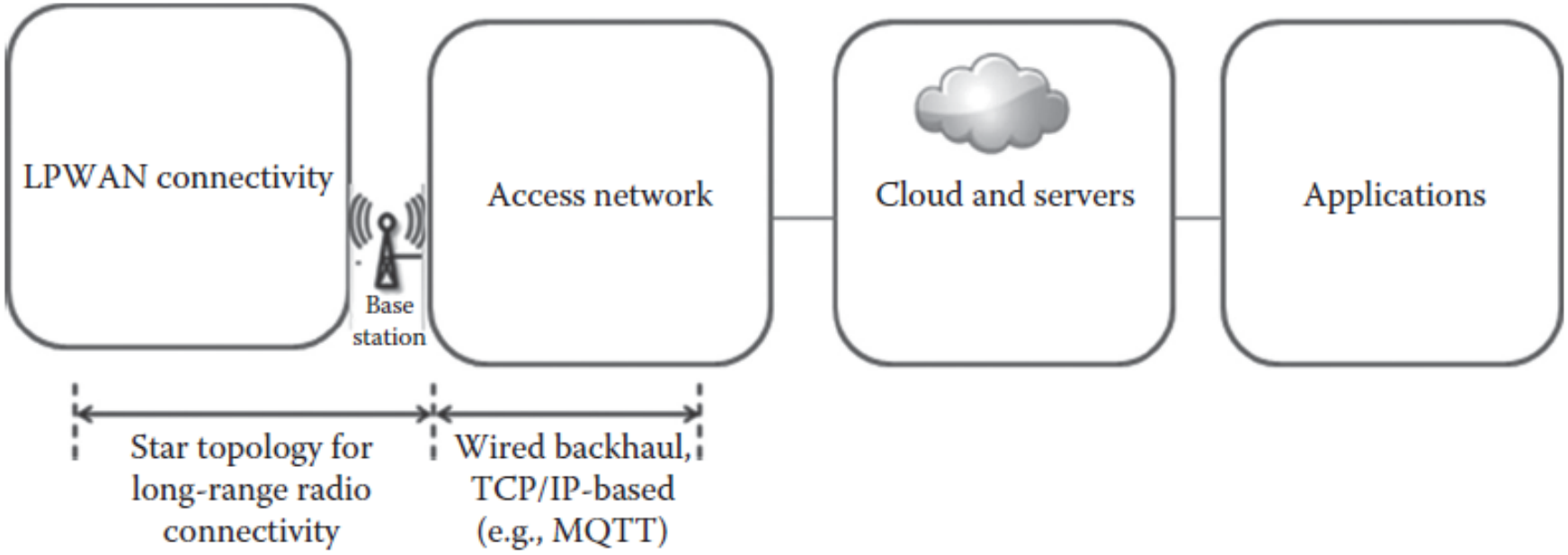
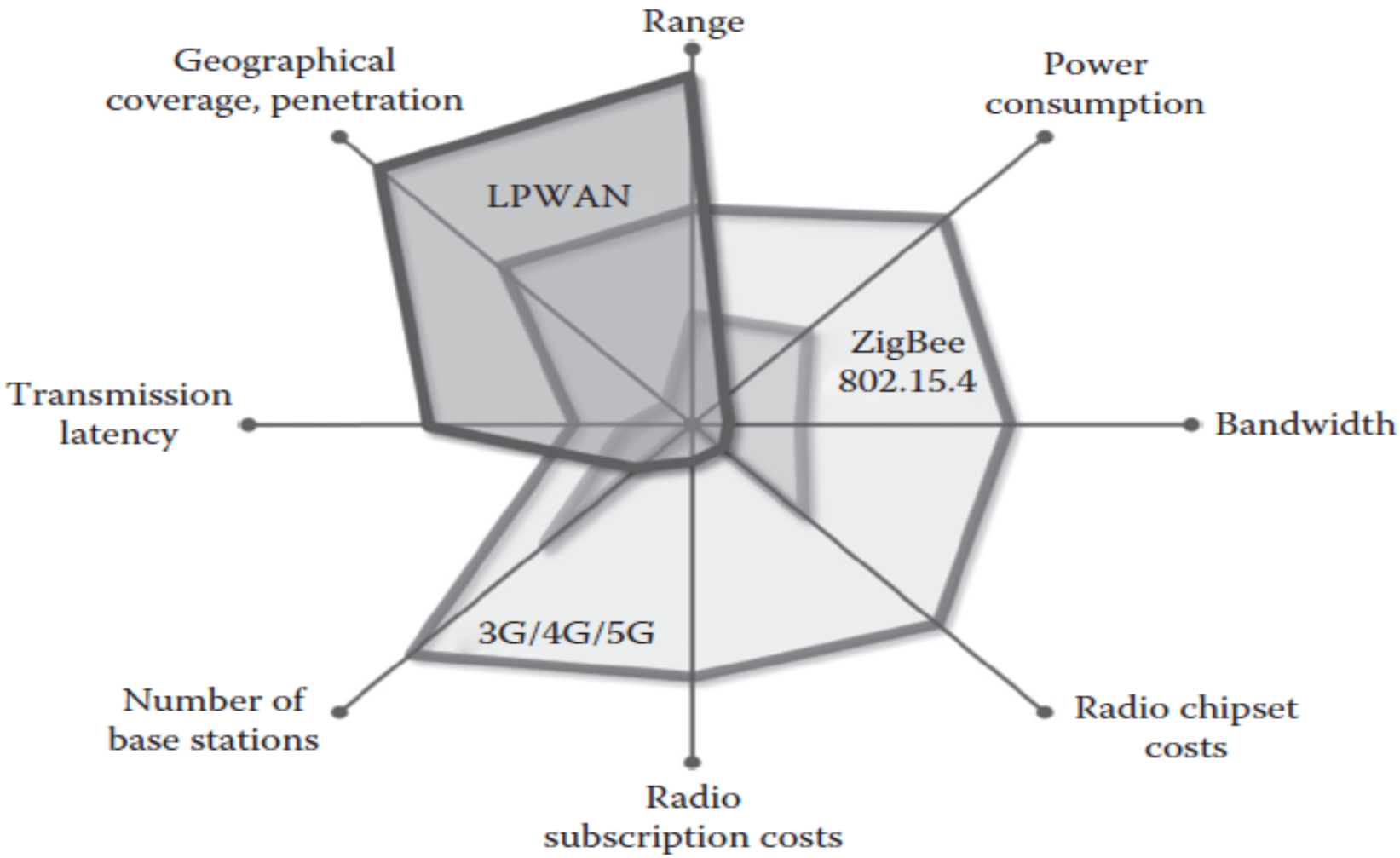


Figure 2.12 Direct device connectivity topology of LPWAN.

LPWAN



Requirements of LPWAN technologies.

Sigfox

- Sigfox does not support bidirectional Networks
- 15 bytes of traffic at a time with an average of only 10 messages per day
- 868 or 915 MHz frequency bands
- Binary phase shift keying (BPSK)

Wightless

- *Weightless is an open LPWAN*
- Weightless-P
  - bidirectional communication
  - narrow band modulation
  - 100 uW power consumption in an idle state
- Weightless-N
  - One way communication
  - star network
  - ultra narrow band
  - Sub-GHz spectrum
  - differential binary phase shift keying
  - 128-bit AES algorithm

- Weightless-W
  - runs in the unused TV spectrum
  - 1 Kbit/s to 10 Mbit/s
  - Multicast
  - ultra secure 128-bit encryption and authentication model
  - range is about 5 km in indoor

NWave

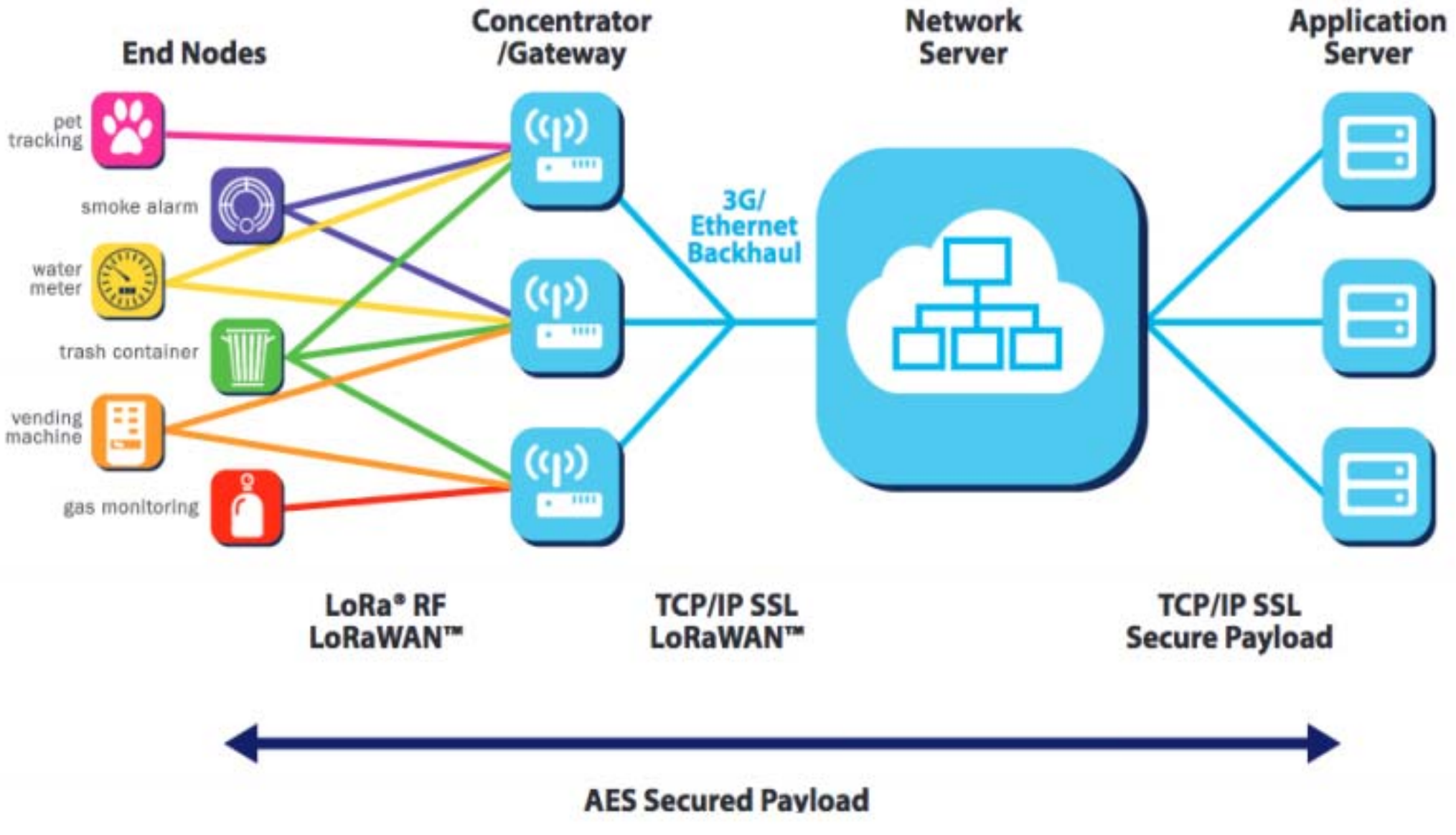
- NWave operates in UNB radio spectrum
- Runs in sub-1 GHz ISM bands
- Star topology

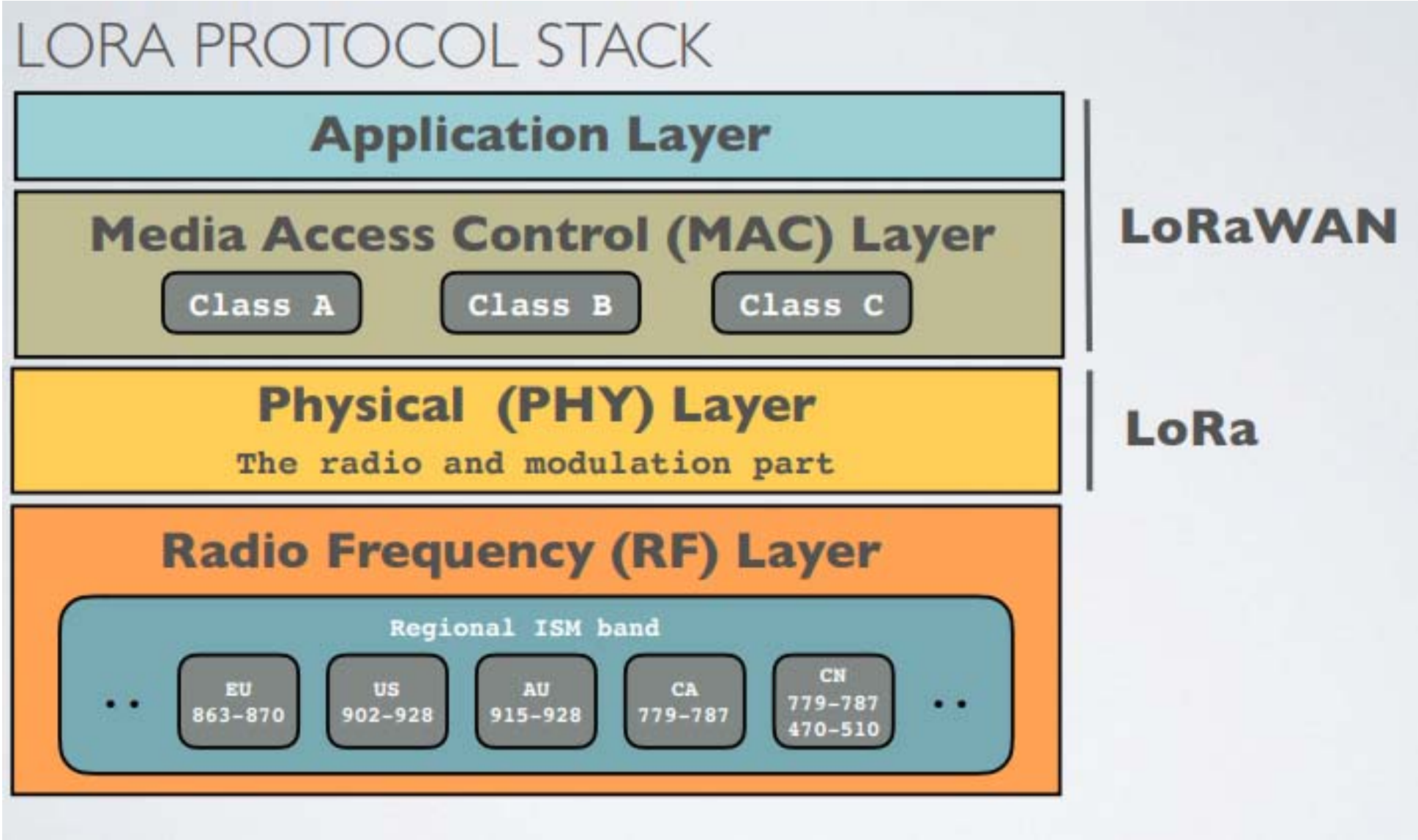
LoRa

- LoRa is an acronym for Long Range and it is a wireless technology where a low powered sender transmit small data packages (0.3 kbps to 5.5 kbps) to a receiver over a long distance
- A LoRa end node consists of 2 parts:
  - A radio module with antenna.
  - A microprocessor to process for example the sensor data.
  - Battery powered
- A LoRa Device+sensor = Mote

- LoRa gateway consists of 2 parts:
  - A radio module with antenna
  - A microprocessor to process the data
- Multiple gateways can receive data from the same end node
- bi-directional communication, multicast addressing groups to make efficient use of spectrum during tasks such as Firmware Over-The-Air (FOTA) upgrades
- Chirp Spread Spectrum Modulation - is a spread spectrum technique that uses wideband linear frequency modulated chirp pulses to encode information

LoRa WAN


End Nodes
Concentrator /Gateway
Network Server
Application Server
pet tracking
smoke alarm
water meter
trash container
vending machine
gas monitoring
3G/ Ethernet Backhaul
LoRa® RF LoRaWAN™
TCP/IP SSL LoRaWAN™
TCP/IP SSL Secure Payload
AES Secured Payload


LORA PROTOCOL STACK
Application Layer
Media Access Control (MAC) Layer
Class A
Class B
Class C
LoRaWAN
Physical (PHY) Layer
The radio and modulation part
LoRa
Radio Frequency (RF) Layer
Regional ISM band
EU
863-870
US
902-928
AU
915-928
CA
779-787
CN
779-787
470-510

CLASS A (ALL)

- Class A - Lowest power, bi-directional end-devices:
- The default class which must be supported by all LoRaWAN end-devices, class A communication is always initiated by the end-device and is fully asynchronous. Each uplink transmission can be sent at any time and is followed by two short downlink windows,

CLASS - B (Beacon)

- Class B – Bi-directional end-devices with deterministic downlink latency
- In addition to the class A initiated receive windows, class B devices are synchronised to the network using periodic beacons, and open downlink ‘ping slots’ at scheduled times. This provides the network the ability to send downlink communications with a deterministic latency,

CLASS – C (Continous)

- Class C – Lowest latency, bi-directional end-devices
- In addition to the class A structure of uplink followed by two downlink windows, class C further reduces latency on the downlink by keeping the receiver of the end-device open at all times that the device is not transmitting (half duplex)
- battery powered devices, temporary mode switching between classes A & C is possible, and is useful for intermittent tasks such as firmware over-the-air updates.

- The **frequency** band for **LoRa** Technology in **India** is 865 MHz to 867 MHz

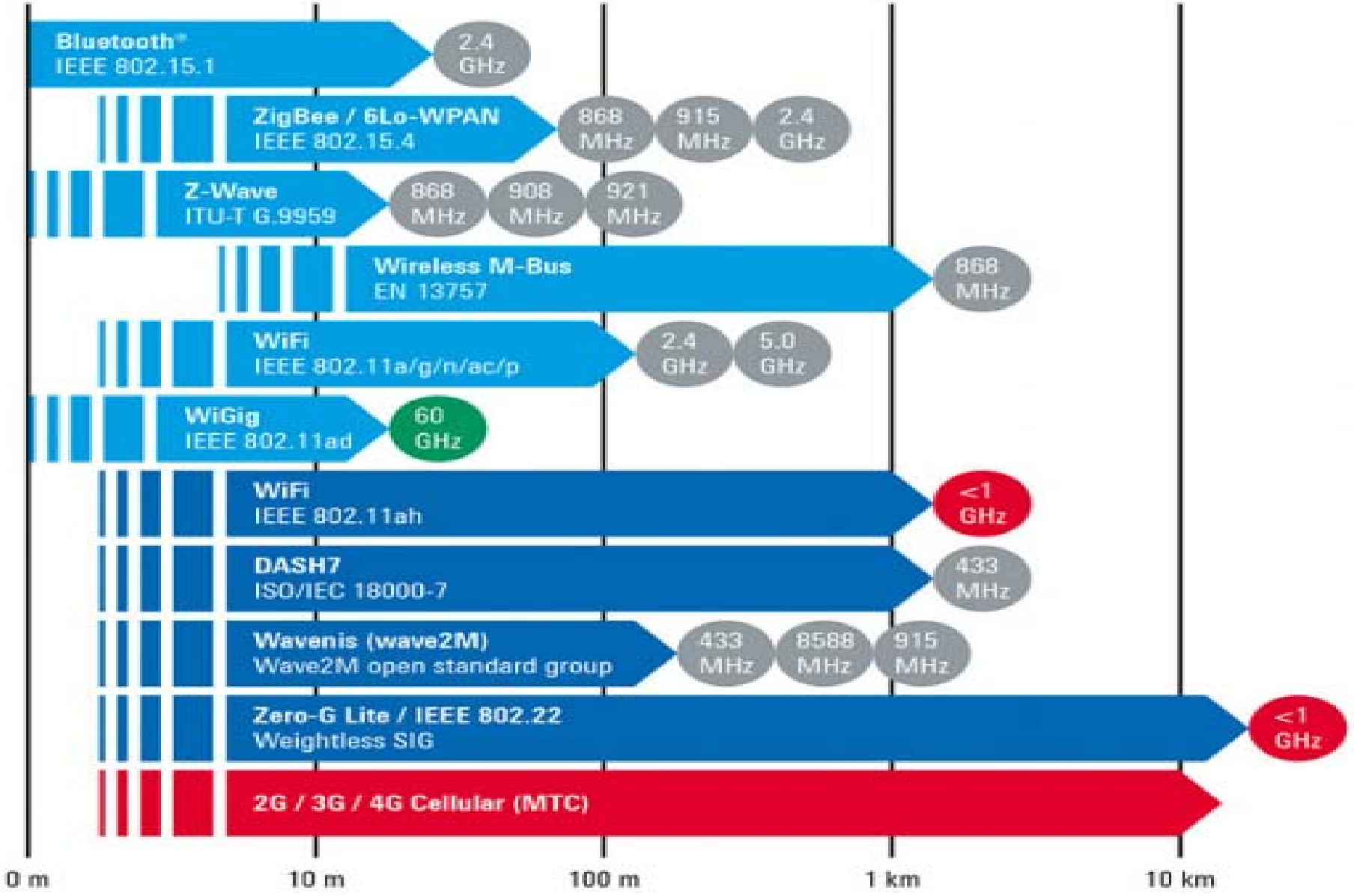
Govt Notification:

- G.S.R.36 (E).- In exercise of the powers conferred by sections 4 and 7 of the Indian Telegraph Act, 1885 (13 of 1885) and sections 4 and 10 of the Indian Wireless Telegraphy Act, 1933 (17 of 1933), the Central Government hereby makes the following rules, to amend the “Use of low power Equipment in the frequency band 865 – 867 MHz for (RFID) Radio Frequency Identification Devices (Exemption from Licensing Requirement) Rules, 2005.” namely:-

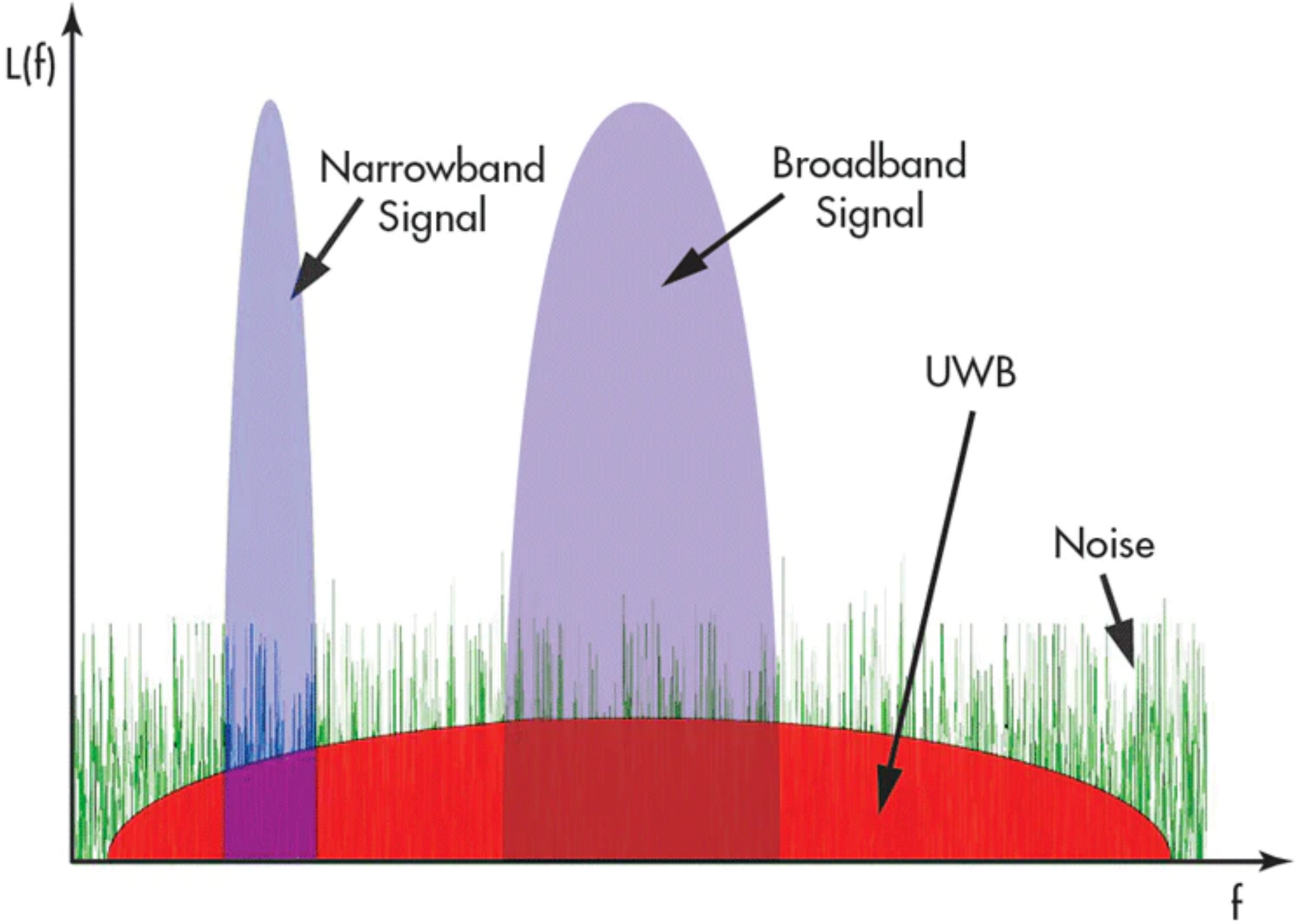
1. (1) These rules may be called the Use of low power Equipment in the frequency band 865 – 867 MHz for (RFID) Radio Frequency Identification Devices (Exemption from Licensing Requirement) Amendment Rules, 2006.

Region	LoRa Frequency Band	LoRa Channel Frequency
EU	863 to 870 MHz	868.10 Mhz (used by Gateway to listen) 868.30 MHz (used by Gateway to listen) 868.50 MHz (used by Gateway to listen) 864.10 MHz (used by End device to transmit Join Request) 864.30 MHz (used by End device to transmit Join Request) 864.50 MHz (used by End device to transmit Join Request) 868.10 MHz (used by End device to transmit Join Request) 868.30 MHz (used by End device to transmit Join Request) 868.50 MHz (used by End device to transmit Join Request)
US	902 to 928 MHz	902.3 MHz to 914.9 MHz spaced at 200KHz (Upstream-64 channels) 903 MHz to 914.2 MHz spaced at 1.6 MHz apart (Upstream- 8 channels) 923.3 MHz to 927.5 MHz spaced at 600KHz apart (Downstream- 8 channels)
China	779 to 787 MHz	779.5 MHz (Default channel) 779.7 MHz (Default channel) 779.9 MHz (Default channel) 779.5 MHz (Used by ED to transmit Join Request) 779.7 MHz (Used by ED to transmit Join Request) 779.9 MHz (Used by ED to transmit Join Request) 780.5 MHz (Used by ED to transmit Join Request) 780.7 MHz (Used by ED to transmit Join Request) 780.9 MHz (Used by ED to transmit Join Request)

Frequency bands by different technologies



Src: https://www.raviyp.com/868-mhz-frequency-is-not-license-free-in-india-lora-in-india/


L(f)
Narrowband Signal
Broadband Signal
UWB
Noise
f