LPWAN - LoRa

Trends in Electronics and Communication

- **Exponential Growth in Electronics, Communication, and Computing: Giving birth to ICT Technologies**

- **With the advancements in hardware, software and networks, electronic devices are getting:**
  - **Miniaturized**
  - **More and more intelligent**
  - **More and more smarter**
  - **With the capabilities of performing any given task**

Low Power Wide Area Networks (LPWAN):

Traditional Cellular

Long Range
Higher data rates
Low battery life
High Cost

LPWAN (3-5B in 2022)

Long Range
Low data rates
Long battery life
Low Cost

Local Area Network

Short Range
High data rates
Low battery life
Medium Cost

Personal Area Network

Very Short Range
Low data rates
Good battery life
Low Cost

Popularity of Low Power Wide Area Network

- Long Range
- Low Power
- Low Data Rate

LPWAN is becoming popular day-by-day

Important Requirements of LPWANs:

- Network architecture
- Communication range
- Battery lifetime or low power
- Robustness to interference
- Network capacity (maximum number of nodes in a network)
- Network security
- One-way vs two-way communication
- Variety of applications served

Introduction to LoRa:

2013
- Launch of first LoRa radio by Semtech

2014
- First mobile network operator trials

2015
- Launch of LoRa Alliance: 130 members in 6 months
- Multiple sensors, gateways, modules available
- Public, private, viral network deployments worldwide

2016
- Over 400 LoRa Alliance members today
- Over 100 regions with deployments or trials
- Low power geolocation introduced
- Comcast announces US LoRaWAN network trial

Chirp Spread Spectrum:

- Many legacy wireless systems us FSK as it is efficient for achieving low power
- LoRa:
  - Uses Chirp Spread Spectrum (CSS) modulation:
    - To maintain low power level like FSK
    - Also significantly increases communication range
- Though CSS is used for military applications because its long range and robustness to interference
  - LoRa is first low power implementation for commercial applications

Key Features of LoRa:

Long Range	• 30 - 50 km outdoor • Deep indoor coverage
Low Power	• 10 – 20 years lifetime • >10 x vs cellular M2M
Multi Usage	• Scalable Capacity • Multi Tenant | Public/Private
Physical Layer	• CSS • Spreading Factor
Sensitivity	• High sensitivity
ISM Band	• License free
Low Cost	• Minimal Infrastructure • Low Cost End Nodes | Open Source Software

Differentiators and Benefits:

True Location

- Outdoor
- Lesser Battery Impact

Bidirectional

- Over the air updates
- Acknowledgements
- Security key exchange

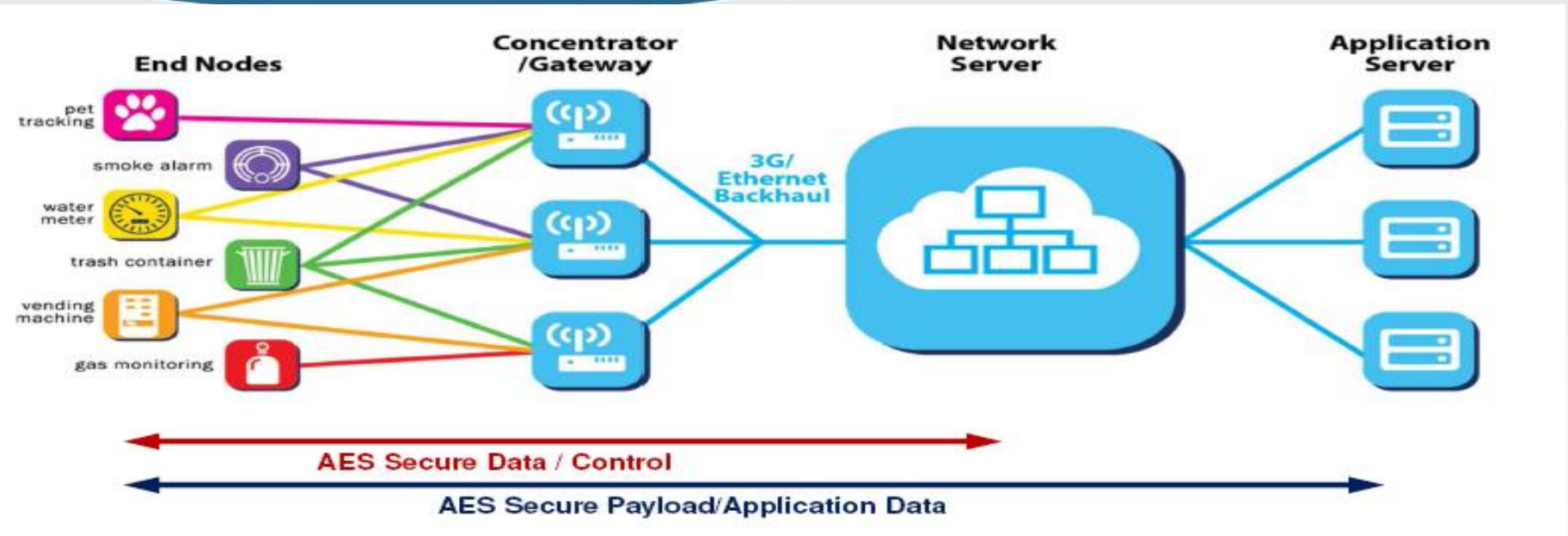
LoRaWAN

- Interoperable
- Global support
- Roaming

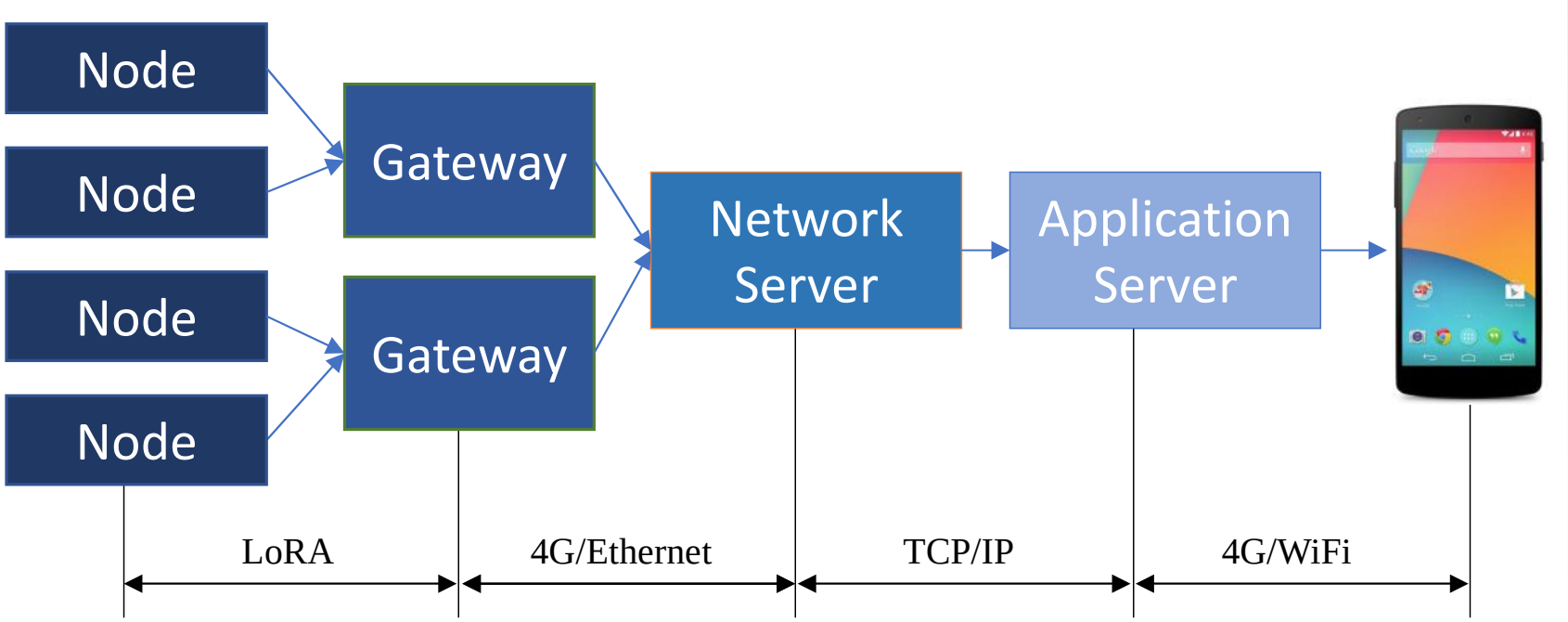
Security

- End to end encryption
- Secure element ready

LoRaWAN Network:

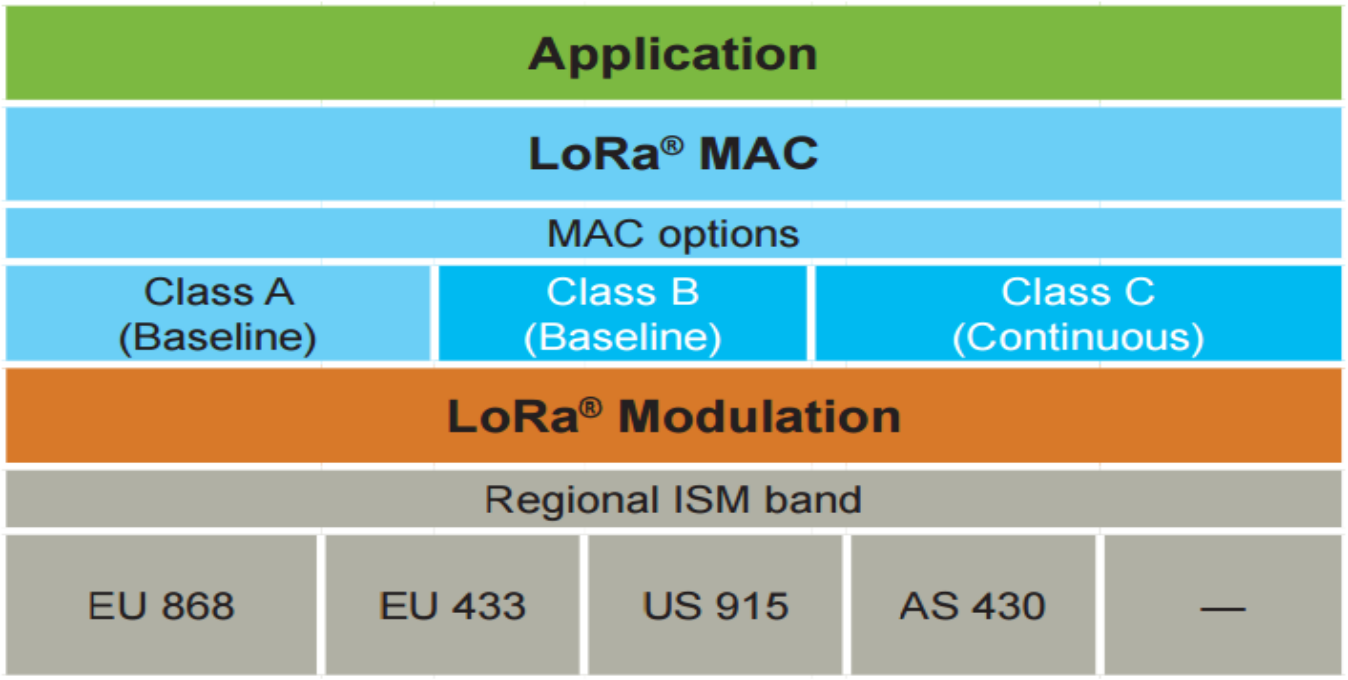


Overview of LoRa

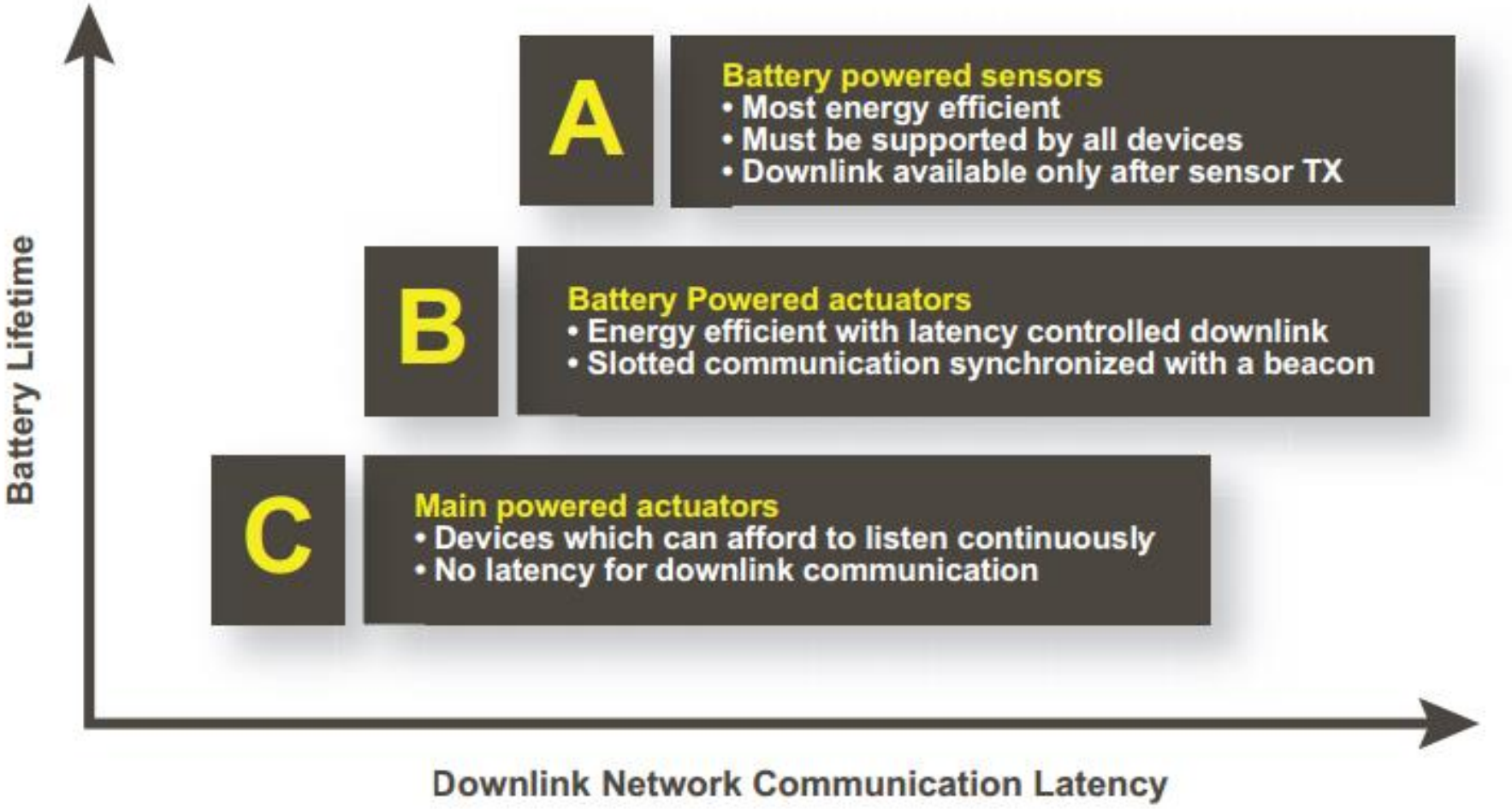


LoRaWAN:

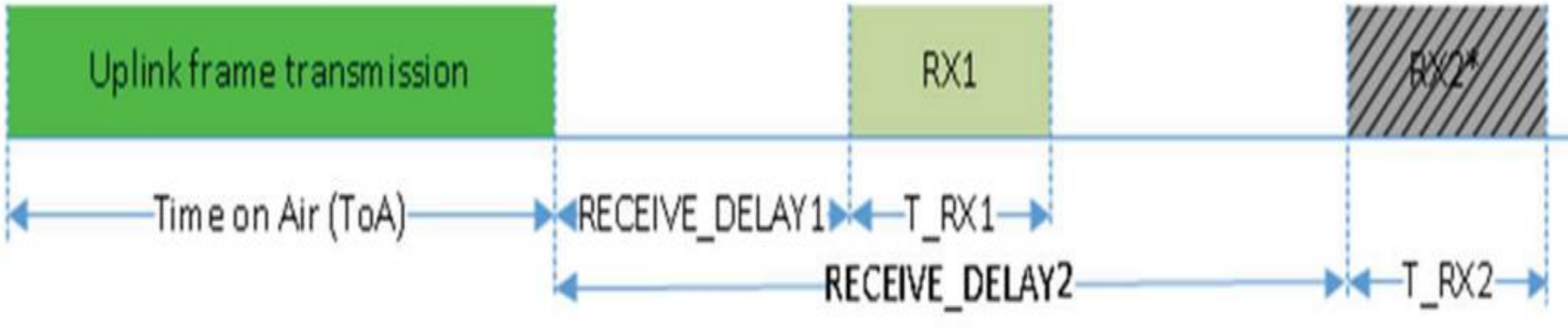
- LoRa: Physical Layer
- LoRaWAN: MAC, Network and Application built on LoRa
  - Battery Life Time, Network Capacity, QoS, Security



Three Classes of End Devices



LoRaWAN Frame (Class A Transmission):



* RX2 does not need to be present if reply is received in RX1

LoRaWAN Network Providers:

- Senet
  - Commercial network
- The Things Network (TTN)
  - Crowdsourced
  - No licensed spectrum required…!!

LoRa Specifications:

	Europe	North America	China	Korea	Japan	India
Frequency band	867-869MHz	902-928MHz	470-510MHz	920-925MHz	920-925MHz	865-867MHz
Channels	10	64 + 8 +8	In definition by Technical Committee	In definition by Technical Committee	In definition by Technical Committee	In definition by Technical Committee
Channel BW Up	125/250kHz	125/500kHz				
Channel BW Dn	125kHz	500kHz				
TX Power Up	+14dBm	+20dBm typ (+30dBm allowed)				
TX Power Dn	+14dBm	+27dBm				
SF Up	7-12	7-10				
Data rate	250bps- 50kbps	980bps-21.9kpbs				
Link Budget Up	155dB	154dB				
Link Budget Dn	155dB	157dB				

Comparison of LPWAN Technologies

MICROCHIP

Technology Comparison: IoT

Technology	802.11ah	WLAN	ZigBee	LTEM	Sigfox & other UNB	LoRa®
Sensitivity	-106 dBm	-92 dBm	-100 dBm	-117 dBm	-126 dBm	-136 dBm
Link Budget	126 dB	112 dB	108 dB	147 dB	146 dB	150 dB
Range (I=Indoor, O=Outdoor)	O: 700m I: 100m	O: 200m I: 30m	O: 150m I: 30m	2km urban 20km rural	2km urban 20km rural	5km urban 15km rural
Data rate	100 kbps	6 Mbps	250 kbps	1 Mbps	600 bps	300 bps to 10 kbps
Tx current consumption	300 mA 20 dBm	350 mA 20 dBm	35 mA 8 dBm	800 mA 30 dBm	120 mA 20 dBm	39 - 124 mA 14 - 20 dBm
Standby current	NC	NC	0.003mA	3.5mA	0.001mA	0.001mA
RX current	50 mA	70 mA	26 mA	50 mA	10mA	14 mA
Battery ife 2000mAh				18 months	90 months	105 months
Localization	no	<1m	no	200m	no	10m
Interference Immunity	moderate	moderate	bad	moderate	bad	good

LoRaWAN – TTN

- The Things Network
- Provides backend
  - Network Server
  - Application Server and integration
  - Device registration

LoRaWAN – Node Example 1

- Wistrio LoRa Tracker
  - Low cost (for the features) ~USD70
    - GPS
    - Temp/Humidity/Pressure/Gas
    - 3 axis accelerometer
    - GPIO
    - Battery input
    - Battery charging circuit
    - AT command set

LoRaWAN – Node Example 2

- LoPy
  - Low cost ~US35
    - Python-based microcontroller
  - Boots directly into Python interpreter
  - Versions support WiFi/BT plus LoRa/Sigfox

LoRa Use Cases

Agriculture with LoRa

- Animal health monitoring
- Crop yield
- Water conservation

Asset management with LoRa

- Utilization Of Resources
- Asset tracking and monitoring
- Energy and land use

LoRa Use Cases

Smart City with LoRa

- Energy conservation
- City or neighborhood coverage
- Operational efficiency

Smart Buildings with LoRa

- Deep indoor penetration
- Safety and security
- Operational efficiency

Conclusion

- LoRa enables the Internet of Things
- Provides outdoor and deep indoor connectivity
- Very low cost of ownership with private or nationwide networks
- Scalable architecture future proof for capacity & interference
- Strong ecosystem of partners and applications