LoRa

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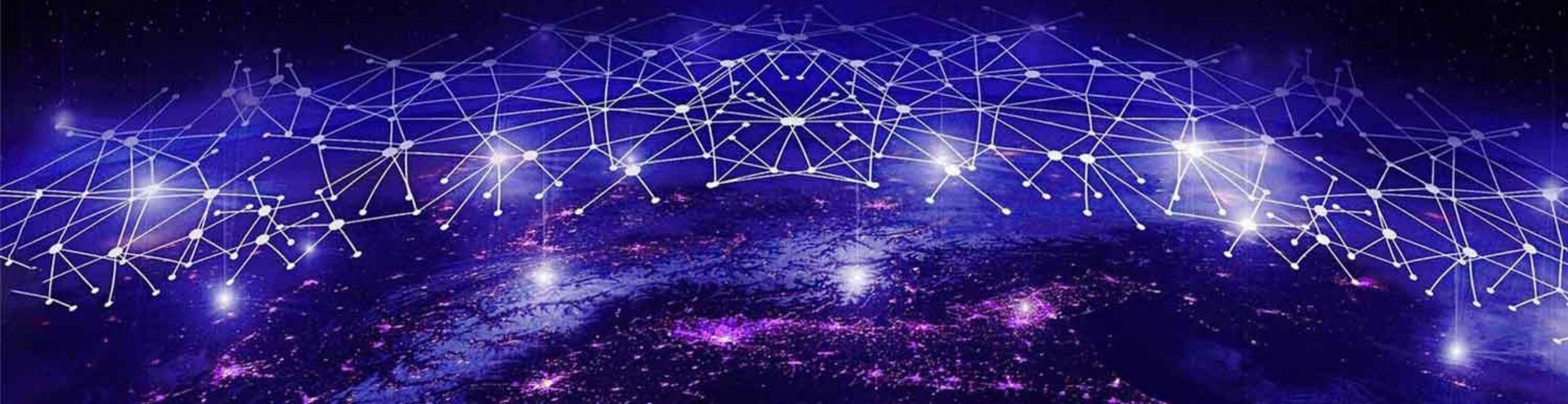
01 What is LoRa

02 LoRa’s physical layer

03 LoRaWAN link layer

04 LoRaBlink an idea



What is LoRa

What is LoRa

Expected around 75 billion IoT devices
By 2025

Need for LPWAN
low-power wide-area network

Two types of technologies, Non-cellular-based technologies
Sigfox and LoRaWAN®

Cellular-based technologies
LTE-M and NB-IoT

70%

According to the report of Exploding Topics in 2024, around 70% of all devices around the globe are IoT devices, reaching a total of 30 billion, with an increase of 14% in 2022 and it will not stop any time soon.

What is LoRa

Smart Cities

- Street lighting
- Smart parking
- Waste management
- Water level and flood management

What is LoRa

Smart Buildings

- Temperature and Humidity Monitoring
- Room Occupancy
- Motion Detection
- Smart Water Metering
- Fire, flood, CO/CO2 level Monitoring

What is LoRa

Logistics and Transportation Management

- monitoring packages and vehicles
- NFS payments

What is LoRa

Smart Healthcare

- Hospital Patients
- Seniors Care Residents
- High Performing Athletes

What is LoRa

Others

- Public Safety
- Space Utilization
- Smart Environment
- Smart Agriculture

LoRa Alliance

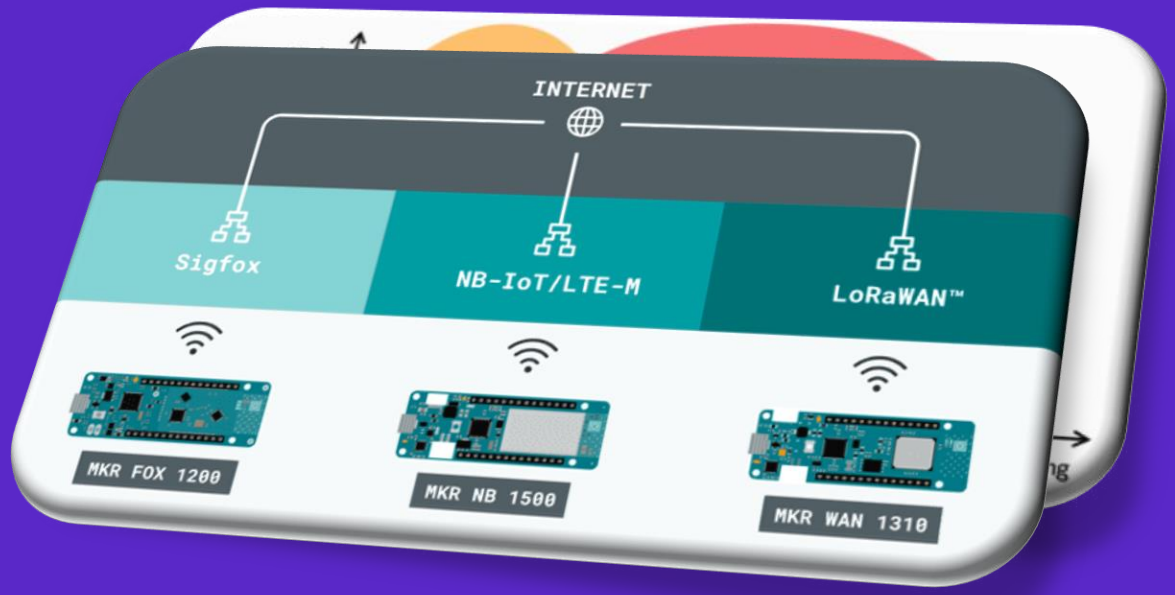
- Open
- Non-profit association

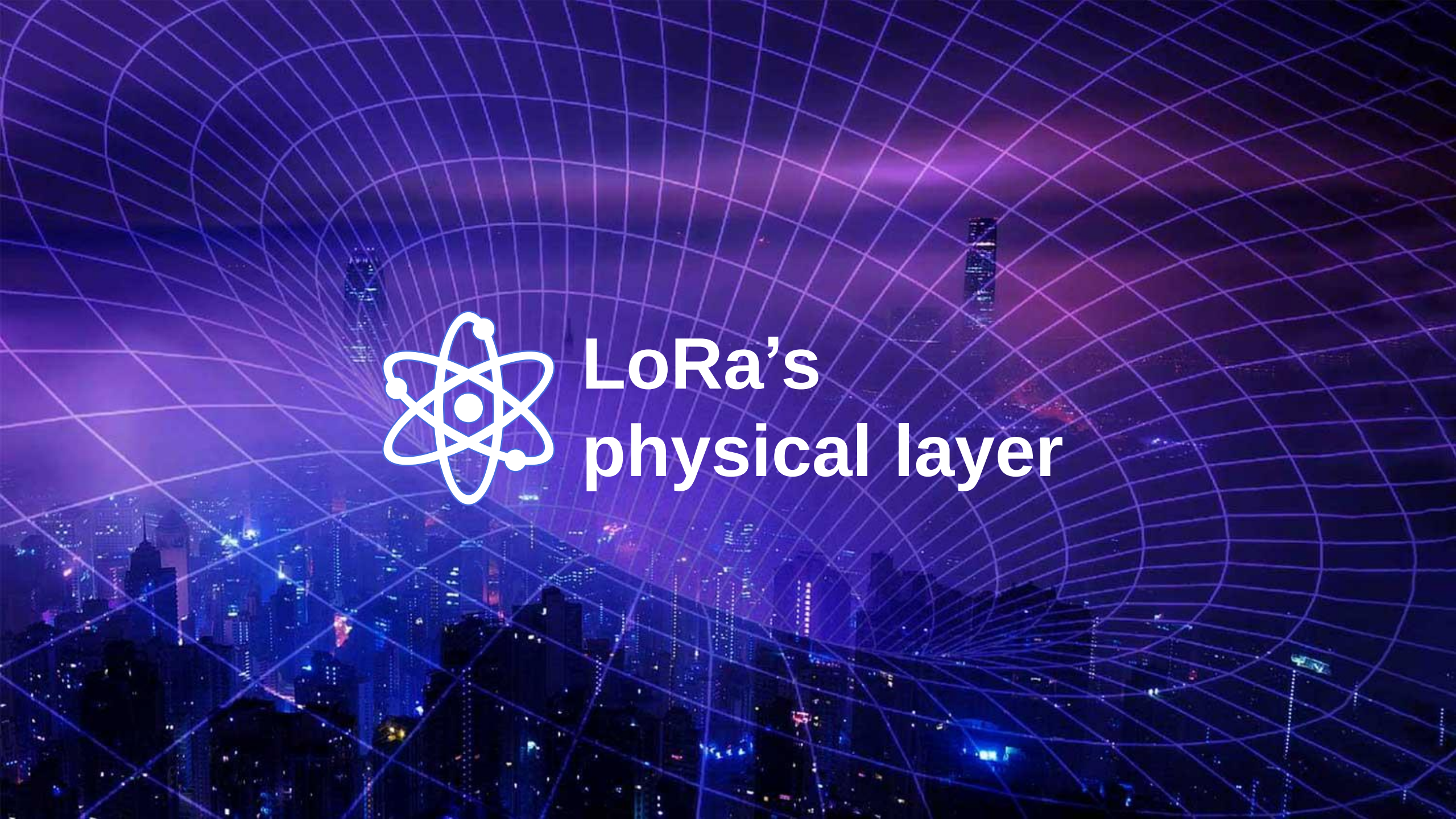
LoRa

- Small packets
- Long ranges

LPWAN Modules

- MKR FOX 1200, BN 1500, WAN 1310




LoRa’s
physical layer

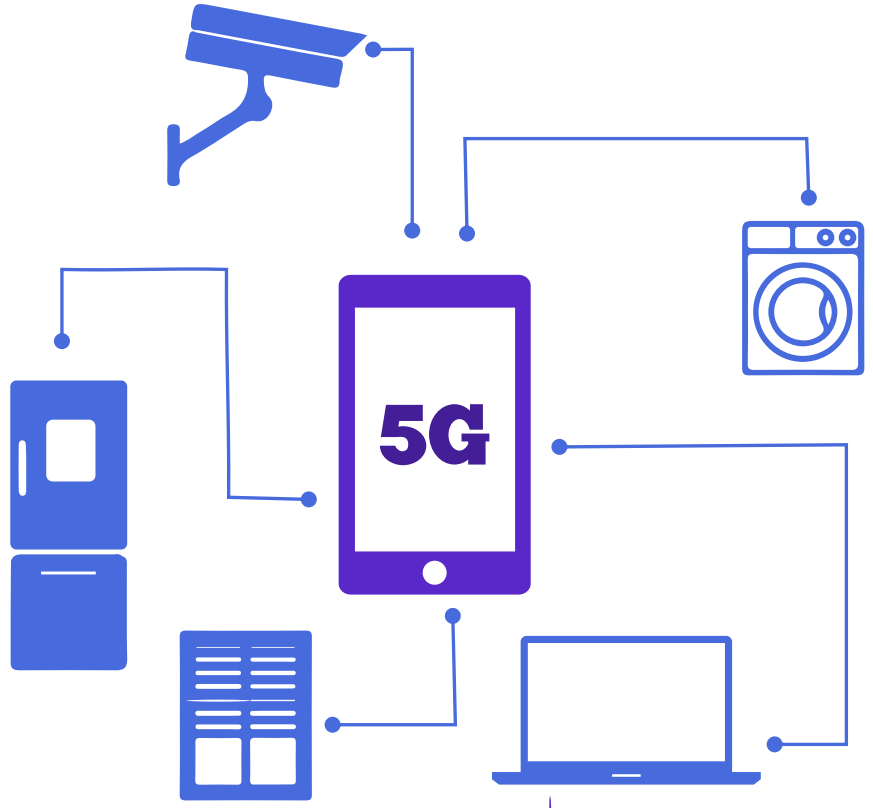
LoRa PHY

LoRa PHY

- Chirp Spread Spectrum (CSS)
- Frequency Shift Keying (FSK)

Benefits

- Resiliance, robustness
- Simple, low power consumption
- Long-range, linear frequency modulation



LoRa PHY

Frequency Shift – Chirp Spread Spectrum (FS-CSS)

Signal form:

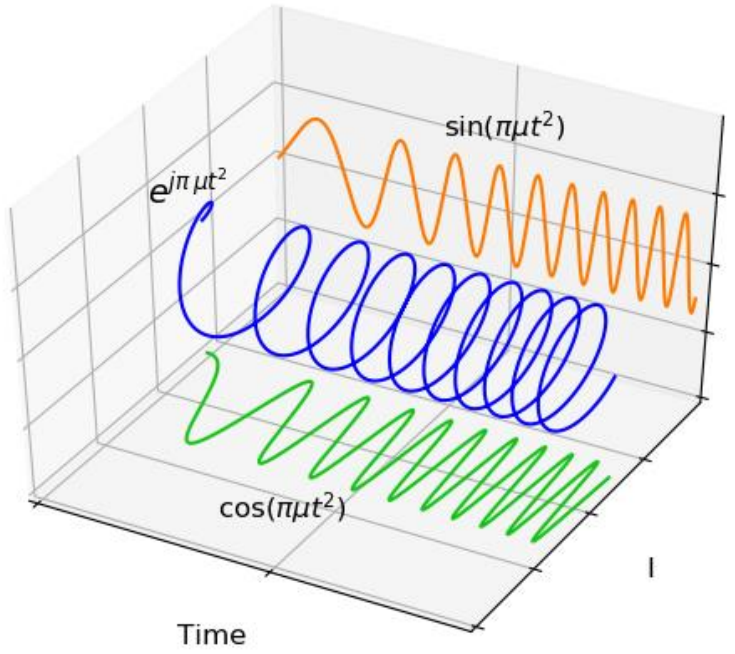
$$x(t) = e^{j\pi\mu t^2}$$

The complex function used by LoRa:

$$x(t) = e^{j(\pi\mu t^2 + 2\pi f t + \theta)}$$

Three changeable parameters:

- Phase θ
- Frequency ω = 2πf
- Chirp rate μ



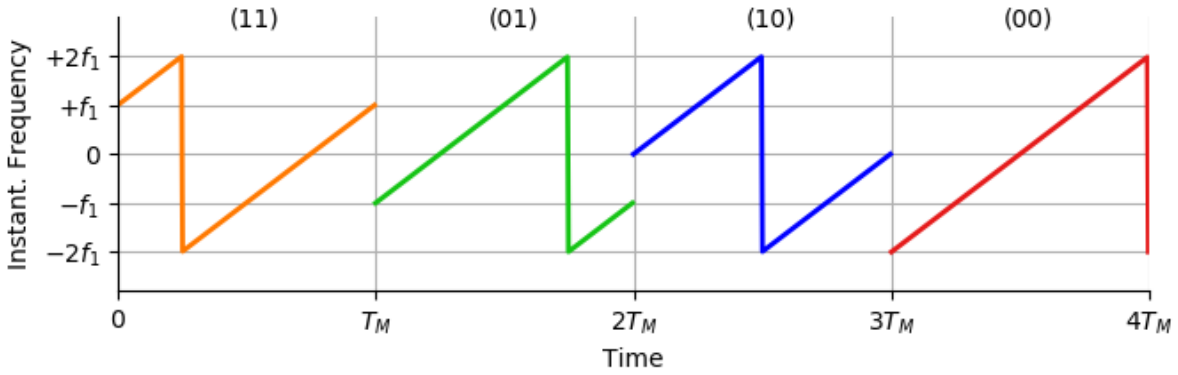
LoRa PHY

Use of frequency for modulation

$$f_m = m f_1 \quad , \quad f_1 = \frac{B}{M}$$

Protocol specifications:

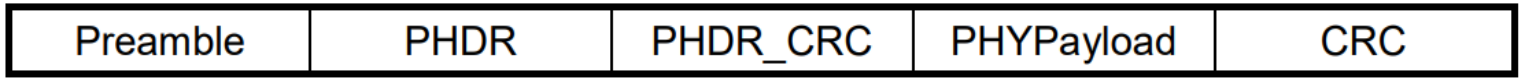
- Carrier Frequency
- Bandwidth
- Symbol Rate
- Chirp Rate
- Chip Rate



LoRa PHY

Two types of packets

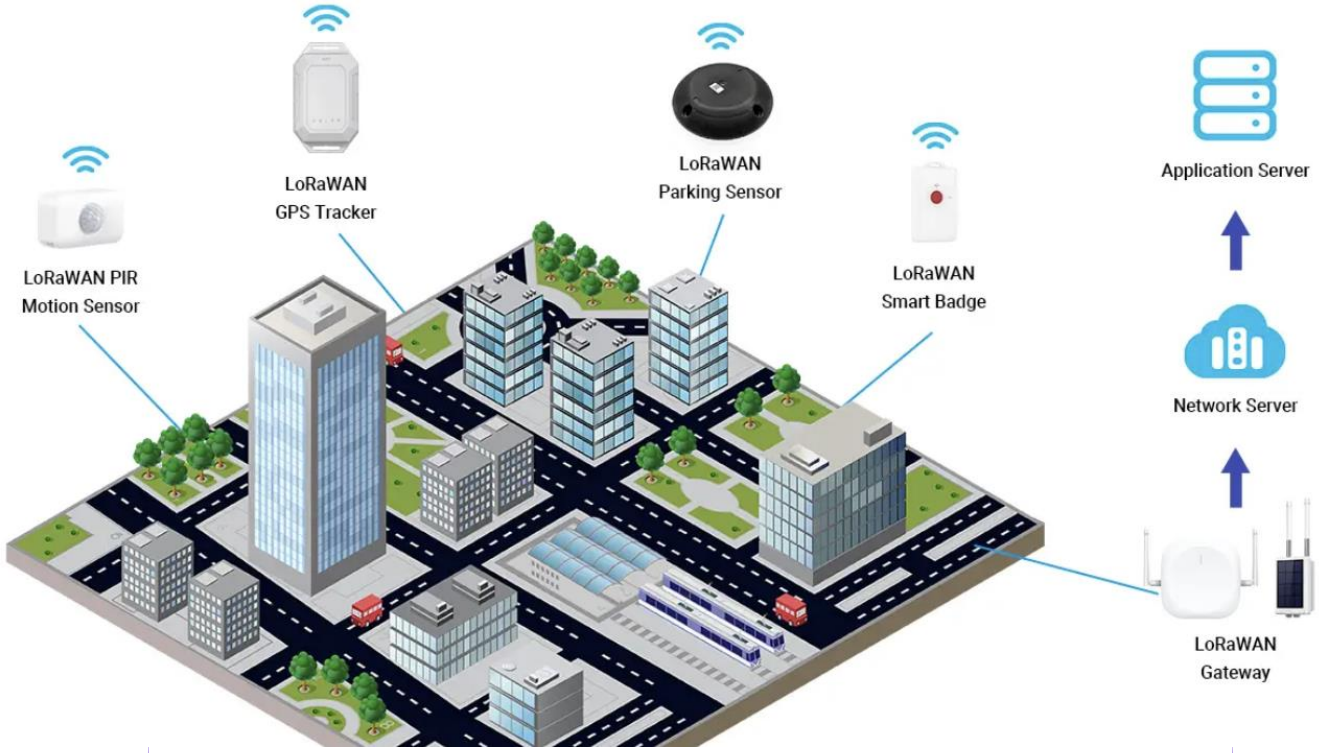
1. **explicit**



2. **implicit**

LoRaWAN link layer

LoRaWAN



Range from 3km to 15km

LoRaWAN architecture:

- Endpoint
- Gateway
- Network server
- Application server

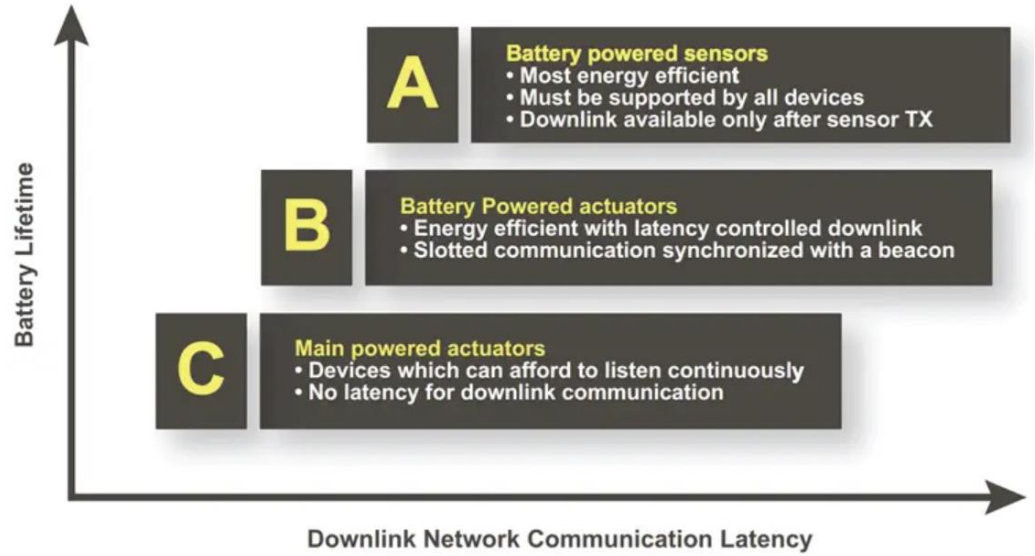
LoRaWAN

LoRaWAN device classes

- Class A
  Lowest power
  Short downlink receives windows

- Class B
  Downlink windows in scheduled times

- Class C
  Minimum delay
  Always receiving



MOKOSmart LoRaWAN sensors

LoRaWAN PIR Motion Sensor

LoRaWAN Temperature Humidity Sensor

LoRaWAN GPS Tracker

LoRaWAN Panic Button

LoRaWAN Smart Badge

LoRaWAN Parking Sensor

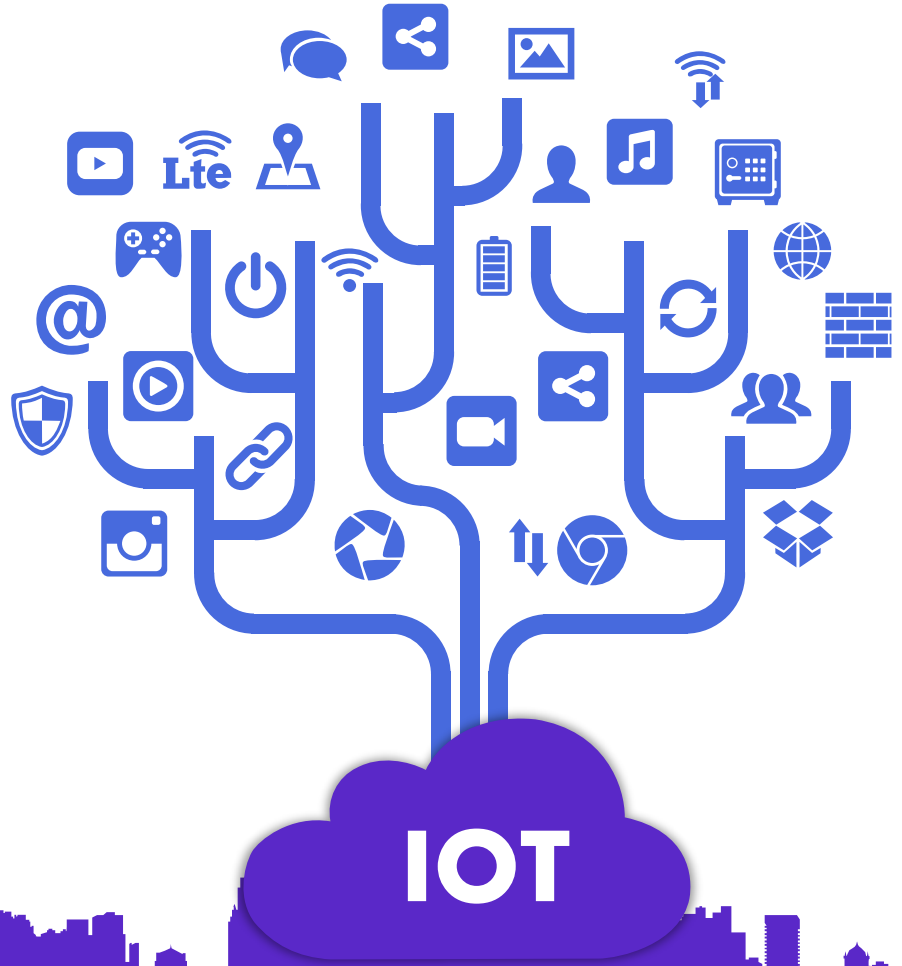
LoRaBlink

LoRaBlink

Goals:

- Multi-Hop
- Low-Energy
- Resilience
- Low-Latency

Slotted channel access
Optional Ack
Possible relaying



LoRaBlink

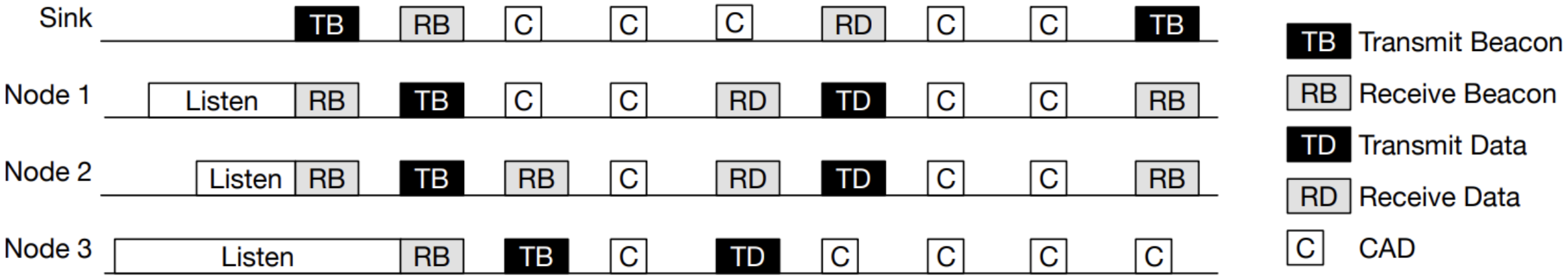
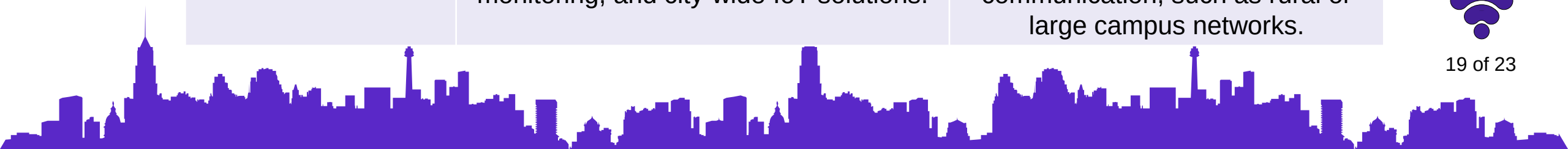
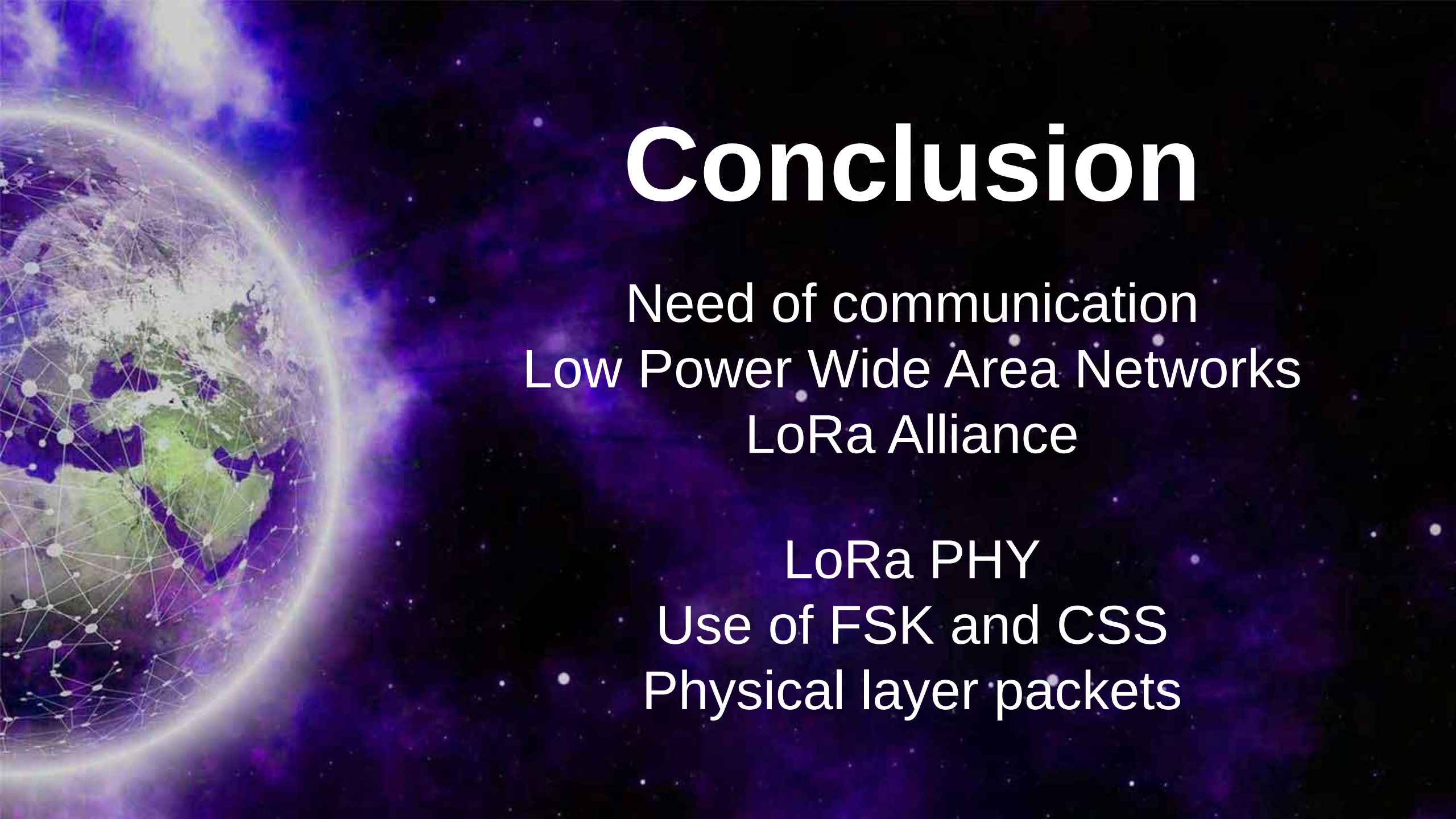


Figure 4. LoRaBlink: Protocol example using a 4 node network.

LoRaBlink

Feature/Aspect	LoRaWAN	LoRaBlink
Topology	Star topology where all nodes communicate directly with the gateway.	Multi-hop communication supporting data relaying via nodes.
Routing	Gateway-based centralized communication; no routing between nodes.	Decentralized; integrates MAC and routing for multi-hop communication.
Unique Features Used	Uses LoRa's physical layer features like long range and low power, but focused on single-hop communication.	Exploits LoRa features like concurrent transmissions and carrier activity detection for robust multi-hop communication.
Applications	Meter reading, environmental monitoring, and city-wide IoT solutions.	IoT deployments in challenging environments requiring multi-hop communication, such as rural or large campus networks.





Conclusion

Need of communication
Low Power Wide Area Networks
LoRa Alliance

LoRa PHY
Use of FSK and CSS
Physical layer packets

Conclusion

LoRaWAN
Different classes
LoRaWAN gadgets

LoRaBlink
Add multihop
Sinks and Beacons

recsourses

IoT for all

Arduino101

The things network

Wireless pi

LoRaBlink

THANK YOU