IoT Access Technologies

- Topics addressed for each IoT access technology:
- **Standardization and alliances:**
  - The standards bodies that maintain the protocols for a technology
- **Physical layer:**
  - The wired or wireless methods and relevant frequencies
- **MAC layer:**
  - Considerations at the Media Access Control (MAC) layer, which bridges the physical layer with data link control
- **Topology:**
  - The topologies supported by the technology
- **Security:**
  - Security aspects of the technology
- **Competitive technologies:**
  - Other technologies that are similar and may be suitable alternatives to the given technology

IoT Access Technologies: LoRaWAN

- **Standardization and Alliances**
- LoRa was developed by a French company named Cycleo, Later, Cycleo was acquired by Semtech.
- Optimized for long-range, two-way communications and low power consumption
- Technology evolved from Layer 1 to a broader scope through the creation of the LoRa Alliance.
- The LoRa Alliance quickly achieved industry support and currently has hundreds of members.
- The LoRa Alliance uses the term LoRaWAN to refer to its architecture and its specifications that describe end-to-end LoRaWAN communications and protocols.

IoT Access Technologies: LoRaWAN

- **Standardization and Alliances**
- LoRa Alliance handles the MAC layer and regional frequency bands.

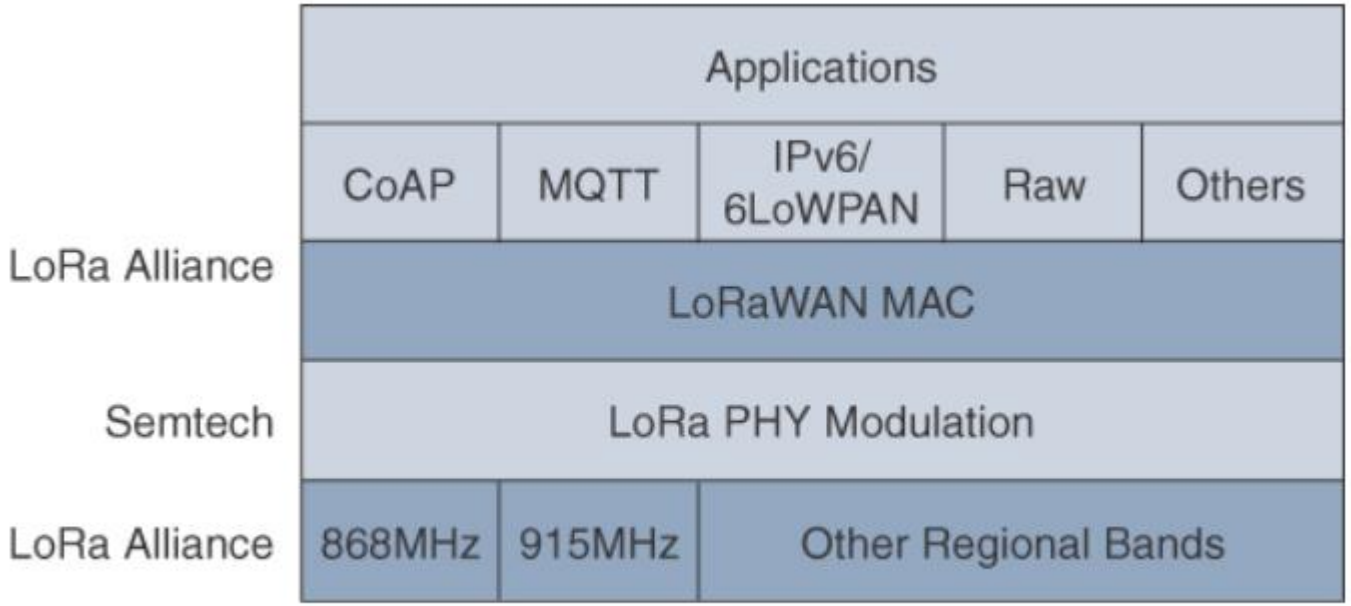


Figure 4-15 *LoRaWAN Layers*

IoT Access Technologies: LoRaWAN

- **Physical Layer**
- Semtech LoRa modulation is based on chirp spread spectrum modulation, which trades a lower data rate for receiver sensitivity to significantly increase the communication distance.
- it allows demodulation below the noise floor, offers robustness to noise and interference, and manages a single channel occupation by different spreading factors.
- LoRaWAN 1.0.2 regional specifications describe the use of the main unlicensed sub-GHz frequency bands of 433 MHz, 779–787 MHz, 863–870 MHz and 902–928 MHz, as well as regional profiles for a subset of the 902–928 MHz bandwidth.

IoT Access Technologies: LoRaWAN

- **Physical Layer**
- A LoRa gateway is deployed as the center hub of a star network architecture.
- serve as a transparent bridge relaying data between endpoints, and the endpoints use a single-hop wireless connection to communicate with one or many gateways.
- The data rate in LoRaWAN depends on
  - Frequency bands and
  - Adaptive data rate (ADR).
- ADR is an algorithm that manages the data rate and radio signal for each endpoint.
- It ensures that packets are delivered at the best data rate possible and that network performance is both optimal and scalable.

IoT Access Technologies: LoRaWAN

- **Physical Layer**
- An important feature of LoRa is its ability to handle various data rates via the spreading factor.
- SF(spreading factor) provides slower transmission rates but achieves a higher reliability at longer distances.

IoT Access Technologies: LoRaWAN

- **MAC Layer**
- The LoRaWAN specification documents three classes of LoRaWAN devices:
- **Class A:**
  - Optimized for battery-powered nodes, it allows bidirectional communications, where a given node is able to receive downstream traffic after transmitting. Always on sleep mode, awakened by real time clock
  - Two receive windows are available after each transmission.
- **Class B:**
  - A Class B node or endpoint should get additional receive windows compared to Class A, but gateways must be synchronized through a beaconing process. Always on sleep mode, awakened by GPS clock
- **Class C:**
  - This class is particularly adapted for powered nodes. This classification enables a node to be continuously listening keeping its receive window open when not transmitting. Always active

IoT Access Technologies: LoRaWAN

- **MAC Layer**
- composed of a MAC Frame
- 1-byte MAC header,
- a variable-byte MAC payload, and
- a MIC that is 4 bytes in length.

Total Bytes - 1 - 4 (bytes)

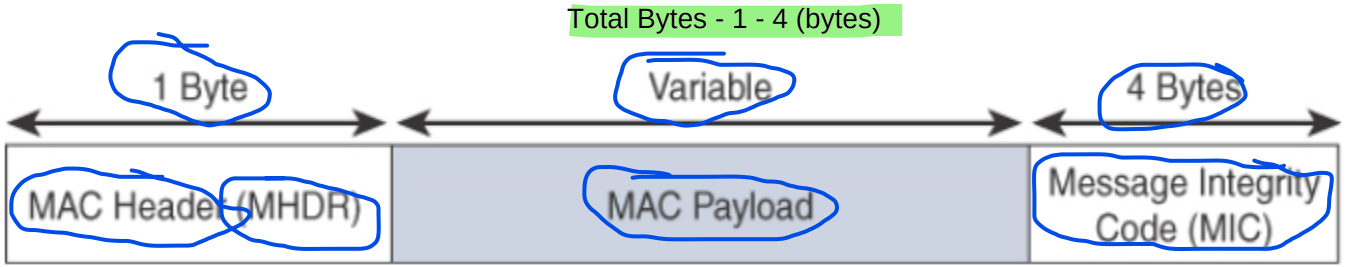


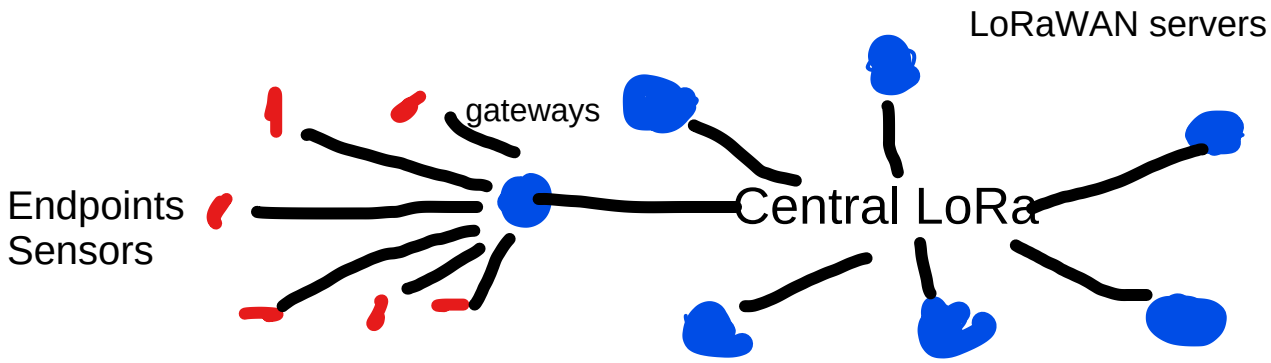
Figure 4-16 *High-Level LoRaWAN MAC Frame Format*

IoT Access Technologies: LoRaWAN

- **MAC Layer**
- 1.0.x LoRaWAN utilizes six MAC message types.
- LoRaWAN devices use join request and join accept messages for over-the-air (OTA) activation and joining the network.
- The other message types are unconfirmed data up/down and confirmed data up/down.
- Uplink messages are sent from endpoints to the network server and are relayed by one or more LoRaWAN gateways.
- Downlink messages flow from the network server to a single endpoint and are relayed by only a single gateway.

IoT Access Technologies: LoRaWAN

- **Topology**
- “star of stars” topology.
- the infrastructure consists of endpoints exchanging packets through gateways acting as bridges, with a central LoRaWAN network server.
- Gateways connect to the backend network using standard IP connections, and endpoints communicate directly with one or more gateways.



IoT Access Technologies: LoRaWAN

- **Topology**
- LoRaWAN gateways act as bridges that relay between endpoints and the network servers.
- Multiple gateways can receive and transport the same packets.
- When duplicate packets are received, de-duplication is a function of the network server.

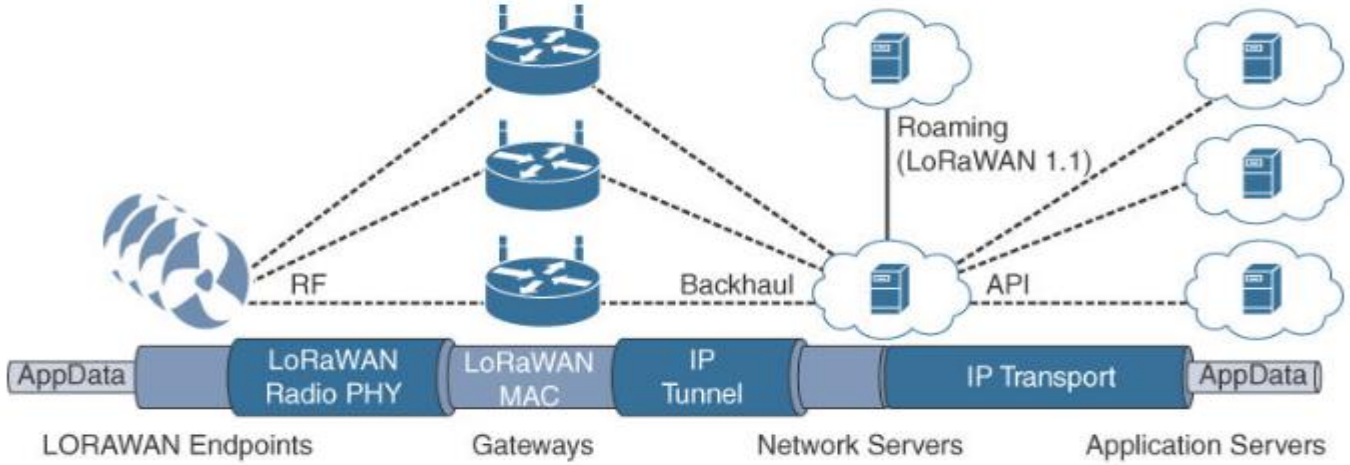


Figure 4-17 *LoRaWAN Architecture*

IoT Access Technologies: LoRaWAN

- **Topology**
- Network server manages the data rate and radio frequency (RF) of each endpoint through the adaptive data rate (ADR) algorithm.
- Forwards application data to the application servers.

IoT Access Technologies: LoRaWAN

- **Security**
- LoRaWAN endpoints must implement two layers of security, protecting communications and data privacy across the network.
- The first layer, called “network security” but applied at the MAC layer, guarantees the authentication of the endpoints by the LoRaWAN network server.
- It protects LoRaWAN packets by performing encryption based on AES.
- The second layer is an application session key (AppSKey), which performs encryption and decryption functions between the endpoint and its application server.

IoT Access Technologies: LoRaWAN

- The term LoRa refers to the PHY layer, and LoRaWAN focuses on the architecture, the MAC layer, and a unified, single standard for seamless interoperability.
- LoRaWAN is managed by the LoRa Alliance, an industry organization.
- The PHY and MAC layers allow LoRaWAN to cover longer distances with a data rate that can change depending on various factors.
- The LoRaWAN architecture depends on gateways to bridge endpoints to network servers.
- From a security perspective, LoRaWAN offers AES authentication and encryption at two separate layers.