IoT access technologies

IoT access technology involves following points:

1. **Standardization and Alliances**

   The organizations and bodies that develop, maintain, and promote the standards and protocols for the technology.

Standardization ensures that devices and systems from different manufacturers can work together seamlessly.

Alliances often drive the adoption and evolution of these standards.

2. Physical Layer

>> The physical communication medium (wired or wireless) and relevant frequencies used by the technology to transmit data.

>> The physical layer determines key characteristics such as transmission range, power consumption, and data rate.

For example, low-power wide-area networks (LPWANs) are designed for long-range communication with minimal power usage.

3. MAC Layer

>> The Media Access Control (MAC) layer manages how data packets are placed on the network medium and coordinates access to the physical transmission medium.

>> The MAC layer is crucial for efficient data transmission, collision avoidance, and maintaining data integrity.

>> It acts as a bridge between the physical layer and the higher data link layer, ensuring reliable communication.

4. Topology

>> The network layout or structure supported by the technology, such as star, bus, mesh, or point-to-point topologies.

>>Network topology affects scalability, reliability, and complexity.

>> For instance, a mesh topology can enhance network robustness and range by allowing multiple paths for data to travel, while a star topology simplifies network management.

5. Security

>> The security mechanisms and protocols implemented by the technology to protect data and devices.

>> Security is critical to protect sensitive data, prevent unauthorized access, and ensure the integrity and availability of the network.

>> Common security measures include encryption, authentication, and secure key management.

802.15.4 Revision

Overview:

The IEEE 802.15.4 specification provides a foundation for various industry standards and products by offering robust PHY and MAC layers.

The **PHY layer** supports speeds up to 250 kbps, varying with modulation and frequency.
The **MAC layer** manages device association, communication reliability, security, and network topology formation.

Topologies Supported:

Star Topology: Simple setup with a central coordinator.
Peer-to-Peer Topology: Direct device-to-device communication.
Mesh Topology: Extends coverage by allowing nodes to relay messages through intermediaries.

Security Features:
AES encryption ensures secure data transmission and integrity.
Frame format modifications accommodate security enhancements.

802.15.4e and 802.15.4g

- **IEEE 802.15.4g and 802.15.4e:**

  Integration and Adoption: IEEE 802.15.4g and 802.15.4e are amendments to the IEEE 802.15.4 standard, now part of IEEE 802.15. They have been successfully deployed and support millions of endpoints.

- These amendments improve upon the original standard by addressing issues like latency and multipath fading.

  Focus Areas:

  IEEE 802.15.4g: Enhances the Physical (PHY) layer, introducing features for better performance in various deployment scenarios, particularly in smart grids and smart cities.

  IEEE 802.15.4e: Targets the Medium Access Control (MAC) layer, aiming to reduce latency and improve reliability.

IEEE 1901.2a

Overview: IEEE 1901.2a-2013 is an update to the IEEE 1901.2 specification, focusing on Narrowband Power Line Communication (NB-PLC). This standard operates over the same power lines used for electricity, offering low power, long-range communication with resistance to interference.

Use Cases:

- **Smart Metering**: Automates utility meter readings.
- **Distribution Automation**: Monitors and controls power grid devices.
- **Public Lighting**: Manages city and street lighting.
- **Electric Vehicle Charging**: Facilitates communication for EV charging stations.
- **Microgrids**: Supports local energy grids.
- **Renewable Energy**: Integrates with solar, wind, hydroelectric, and geothermal systems.

Technical Specifications: IEEE 1901.2a supports frequency bands from 3 to 500 kHz, and data rates can reach up to 500 kbps.

The standard includes robust modulation and coding techniques like ROBO, DBPSK, DQPSK, D8PSK, and optionally 16QAM.

Comparison to IEEE 802.15.4g/e: While IEEE 802.15.4g/e focus on wireless communication, IEEE 1901.2a provides a dual-PHY approach for wired connections.

IEEE 1901.2a supports a more extensive range of modulations and tone maps, offering dynamic data throughput based on channel conditions.

It also implements MAC payload segmentation for efficient data handling.

Feature	IEEE 1901.2 (NB-PLC)	IEEE 802.15.4 (LR-WPAN)
Medium	Wired (power lines, ≤500 kHz)	Wireless (ISM bands, 868/915/2.4 GHz)
Typical Use	Smart grids, metering, grid automation	Wireless sensor networks, home automation, IoT
Topology	Mesh over power infrastructure	Star, peer-to-peer, mesh (via upper layers)
Data Rates	Up to ~500 kbps	Up to 250 kbps (2.4 GHz), lower in sub-GHz
Modulation	OFDM (DBPSK, DQPSK, D8PSK, optional 16QAM)	DSSS, hopping methods, etc.
MAC Features	Based on 802.15.4e, includes segmentation, Information Elements, AES security	CSMA/CA, beacon/superframe, slots, AES-128
Security	AES + IEEE 802.15.9 key management	AES-128 encryption, MAC-layer security