Application of IoT protocols in surface water pollution monitoring systems

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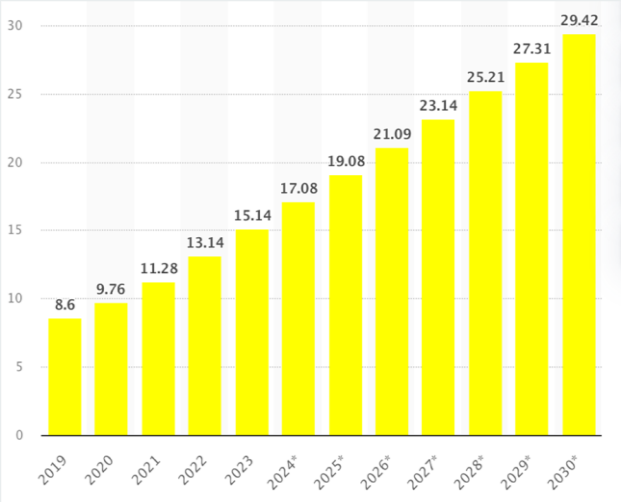
Why does water pollution monitoring matter?

- According to the World Health Organization, in 2020, nearly 30% of the global population (2 billion people) did not have access to a safely managed drinking water.
- Contaminated water can have economic repercussions, affecting industries that rely on clean water, such as agriculture, fisheries, and tourism.
- Regular monitoring ensures that water sources comply with local, national, and international water quality standards.
- Regular updates on water quality can raise community awareness about the importance of clean water and encourage public participation in conservation efforts.

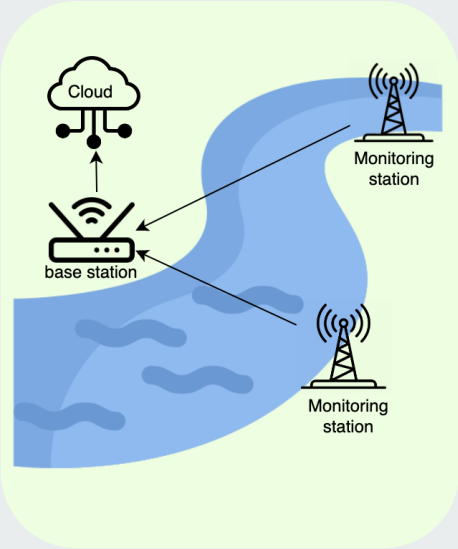
IoT technologies in water pollution monitoring systems

- The cost of measurements is much lower compared to the use of on-site specialists
- Easy integration of IoT technologies into other information systems
- Ability to quickly respond to sudden water pollution
- Affordable sensors, microcontrollers and and other required equipment



Main requirements to data transmission protocols in surface water monitoring systems

1. Transmission distance over 1000 meters
2. Energy efficiency allowing 1+ year of autonomous power supply



LoRa

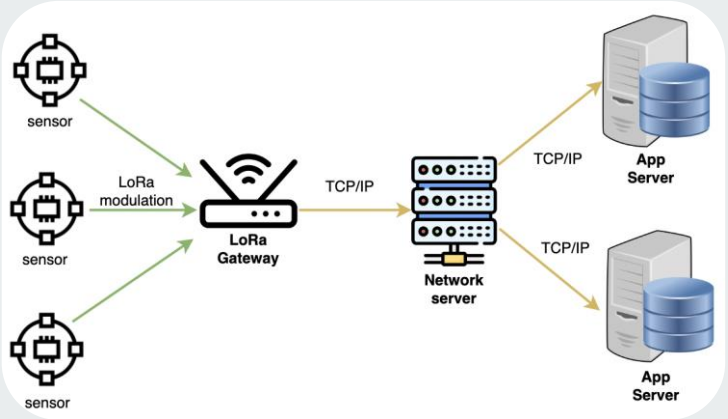
Open radio protocol operating on unlicensed frequencies, designed as a specialized solution for IoT networks.

Strength:

- Low power consumption (simple devices can operate up to 10 years powered by a 1.5 V battery)
- High signal penetration
- Long data transmission range (over 10 km)

Weaknesses:

- Low data transmission speed - ranging from 0.018 to 37.5 kbps



Zigbee

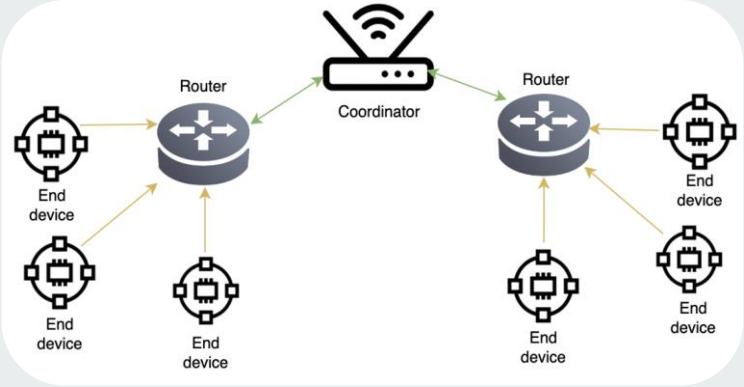
Wireless network technology that implements the open radio standard IEEE 802.15.4[28] and is supported by the Connectivity Standard Alliance

Strength:

- Efficient energy consumption
- High resilience of the network achieved through distributed topologies - star network, tree network, and mesh network
- Data transfer speed can reach up to 250 kbps

Weaknesses:

- Short transmission distances (up to 200 meters)



NB-IoT or Narrowband Internet of Things

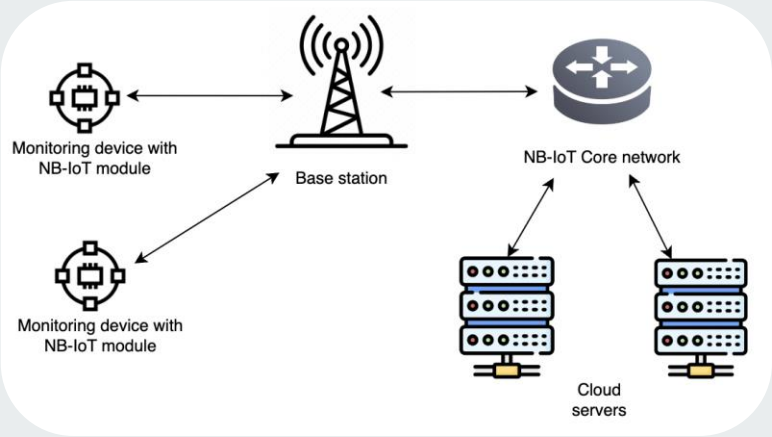
Low-power wide-area (LPWA) protocol developed to enable lightweight communication in IoT networks

Strength:

- Ability to work in cellular networks
- Good resistance to radio interference
- Low energy consumption allowing operation for years from a single power source
- Excellent penetration capabilities

Weaknesses:

- Data transfer speed is up to 26 kbs
- Monthly or annual service fee



BLE (Bluetooth Low Energy)

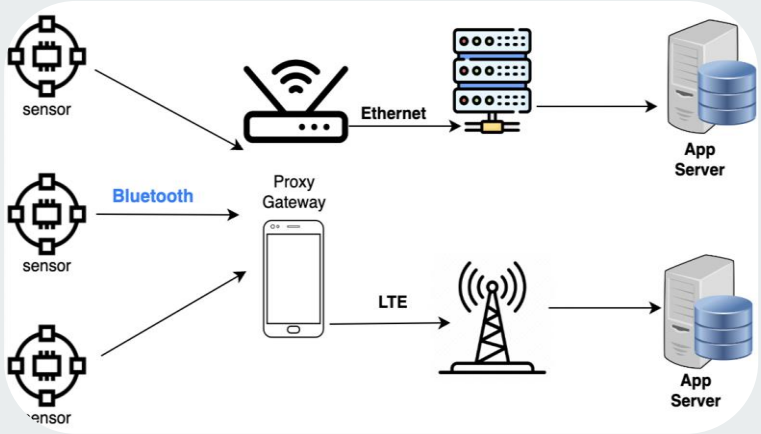
Wireless personal area network technology, which operates on 2.4 GHz, is designed and marketed by the Bluetooth Special Interest Group

Strength:

- Has FEC (Forward Error Correction) data-recovery mechanisms which helps to deliver data on long distances
- AFH (Adaptive Frequency Hopping) allows to dynamically change transmission frequency to avoid interference
- Transmission speed up to 500 kbit/sec
- Optimized power usage, allowing devices to run for months or even years on small coin-cell batteries

Weaknesses:

- Transmission distance limit is about 1000 meters



Which protocol is better for water pollution monitoring systems ?

Protocol name	Energy efficiency	Maximum transmission radius	Transmission speed
Zigbee	moderate	200m	250 kbit/s
WiFi	low	150m	300 mbit/s
LoRa	high	10 km	35 kbit/s
NB-IoT	moderate	Limited by cellular coverage	60 kbit/s
BLE	moderate	1km	500 kbit/s