Session: IoT Protocol

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Internet of Things Protocols

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Agenda

- Communication Standards
- Communication Models
- Data Exchange Formats
- Communication Patterns

Why we need Communication Standards?

Communication Standards

- Different systems have different operating conditions
- They have certain limitations i.e. processing power, memory etc
- To transfer data reliably among systems and connection topologies, they must agree to follow common standards, protocols
- To follow a common standard, both the systems should have the bare minimum hardware and software stacks
- RFC 7452

Deploying IoT Device

Basic questions to consider before deploying-

- Does it continuously or intermittently powered?
- How to maintain the device once it is in the field?
- Term of device life
- Internet connection

Security Considerations

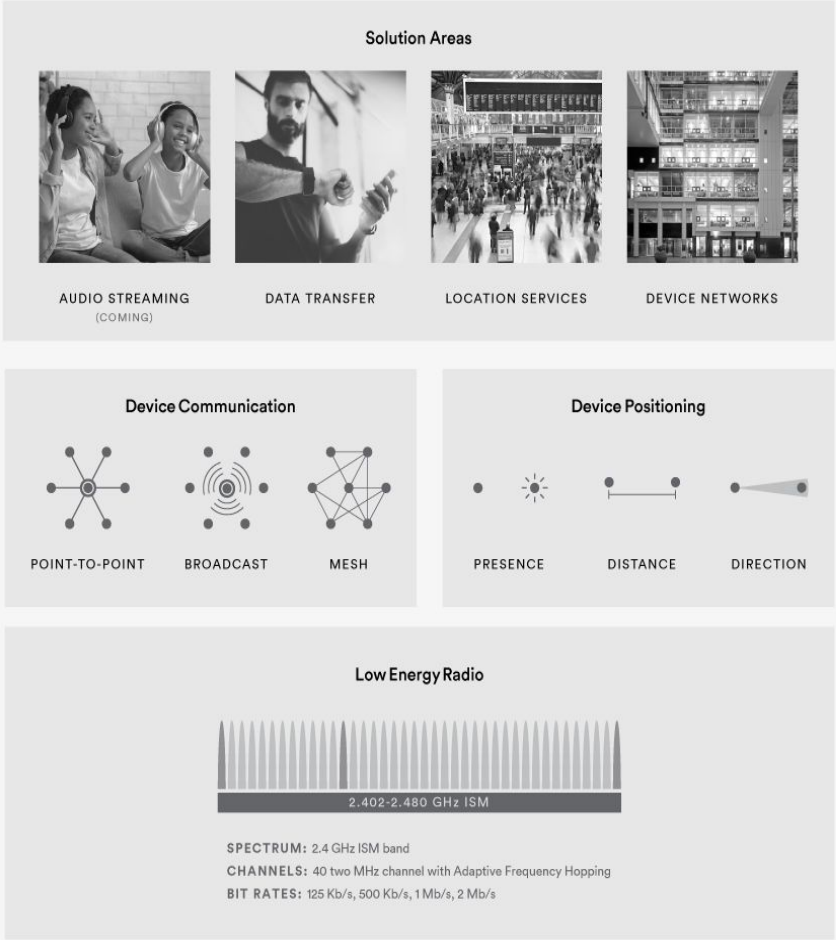
- A trust for smart object needs to be build, generally it is done by some credential
- A single device compromise should not result into distributed attack
- For life span of device, some updates to be pushed
- Generation of random numbers on devices to secure eg. PUF

IoT Communication Standards

- Low-power, short range networks, tend to only need small batteries and are usually inexpensive to operate -
  - Wireless Fidelity (IEEE 802.11)
  - Bluetooth
  - Zigbee
    - An IEEE 802.15.4-based specification for a suite of high-level communication protocols used to create personal area networks with small, low-power digital radios
  - NFC
  - Z-Wave
    - A mesh network using low-energy radio waves to communicate from appliance to appliance

Bluetooth Low Energy

- Range varies upto 100 mts
- Data rates available 125 kbit/s, 500 kbit/s, 1 Mbit/s, 2 Mbit/s
- Supports Advertising & Discovery mode
- Uses Generic Attributes Profiles for devices - Heart Rate Profile etc
- AES 128 bit encryption
- Very low power consumptions



IoT Communication Standards

- Low-power wide area Networks (LPWAN), require minimal power, and are used for a majority of IoT devices. Common examples of LPWANs are -
  - 5G IoT
  - LoRaWAN
    - It is a cloud-based medium access control (MAC) layer protocol, but acts mainly as a network layer protocol for managing communication between LPWAN gateways and end-node device
  - Sigfox
  - NB-IoT
    - It uses a subset of the LTE standard, but limits the bandwidth to a single narrow-band of 200kHz

Gartner Insights

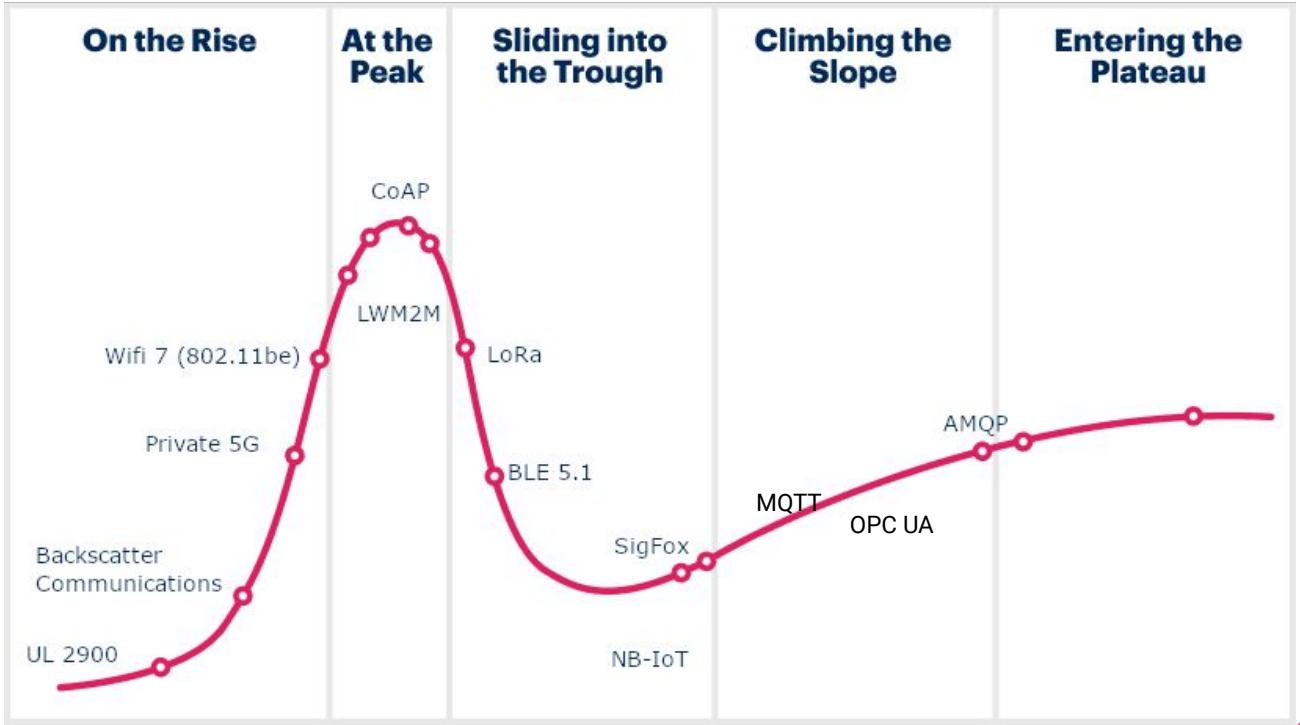


Chart 1: Hype Cycle, IoT Standards & Protocols, 2020

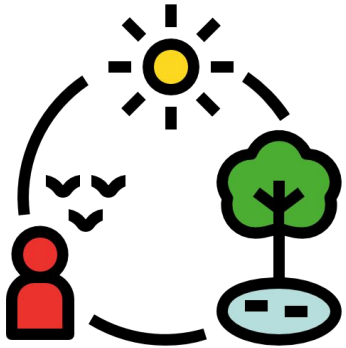
IoT Ecosystem

Device Layer
Consists of smart devices, actuators, gateways that interconnects with network

Data Layer
It plays a crucial role, all the insights after analysis comes from data

Business Layer
The outcome that helps to take decisions that brings profits and comfort for users

User Layer
Interaction of people with devices and services

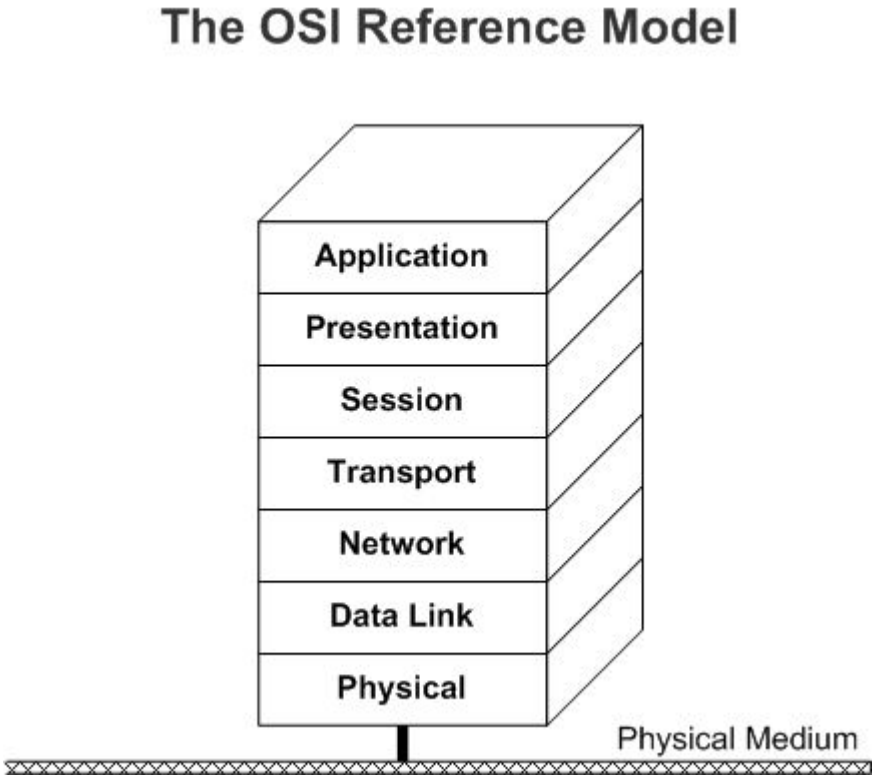


Device Communication

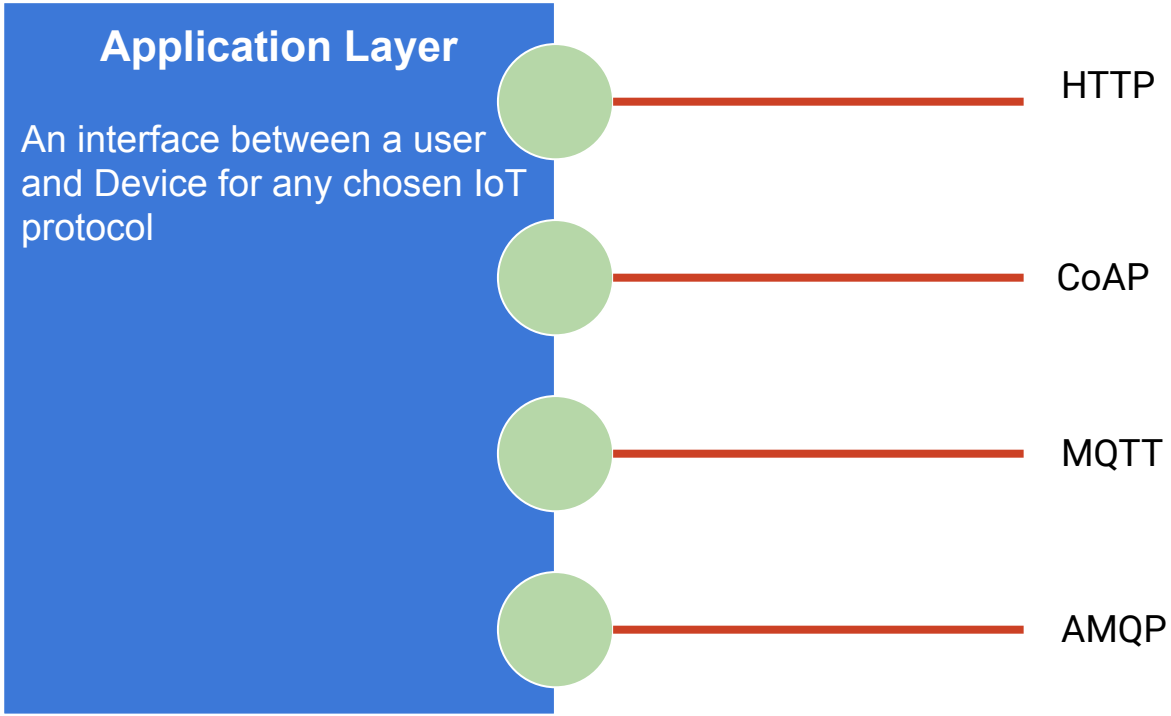
- IoT solution needs devices to communicate using some standard protocols- IoT Protocols
- Internet Protocol (IP) helps define rules to send data to internet
- Protocols make sure the data from one or all sensors reaches its destination either another sensor, different service or gateways
- Many protocols available for use, it’s important to know how to select the right one

How to calculate and arrive at the right protocol?

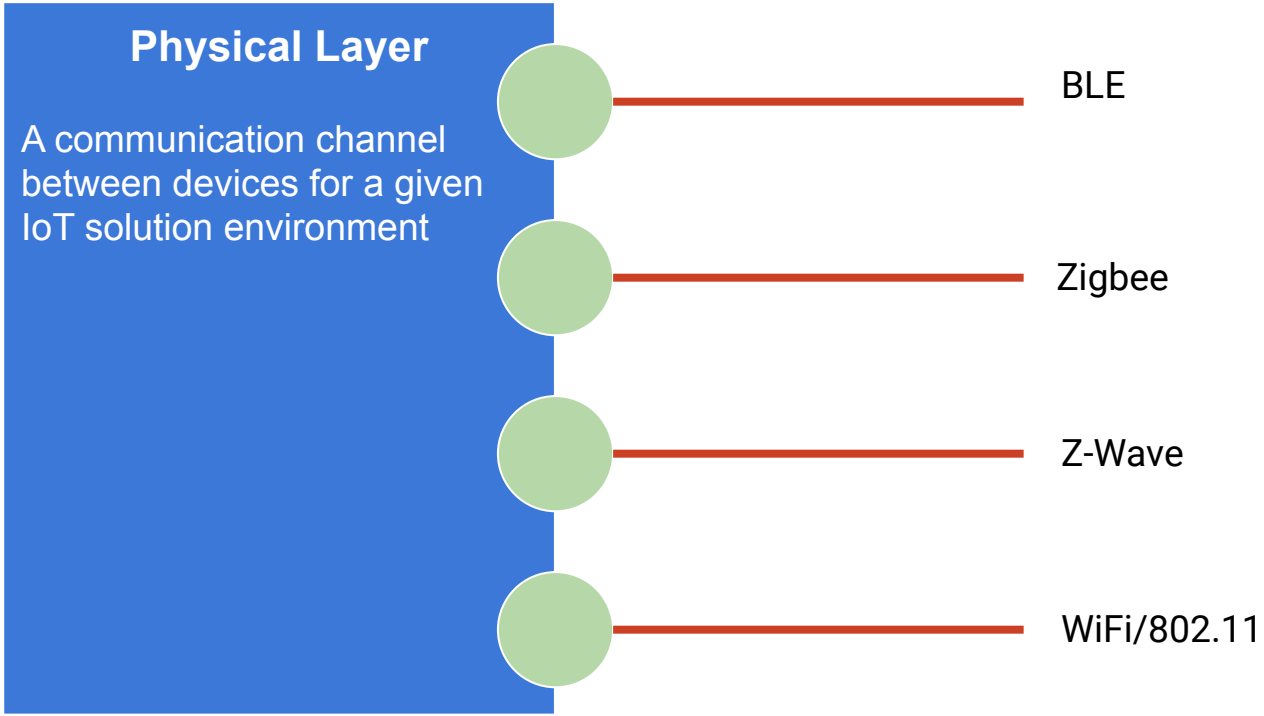
Network Architecture



Protocols Position in Network Arch



Protocols Position in Network Arch

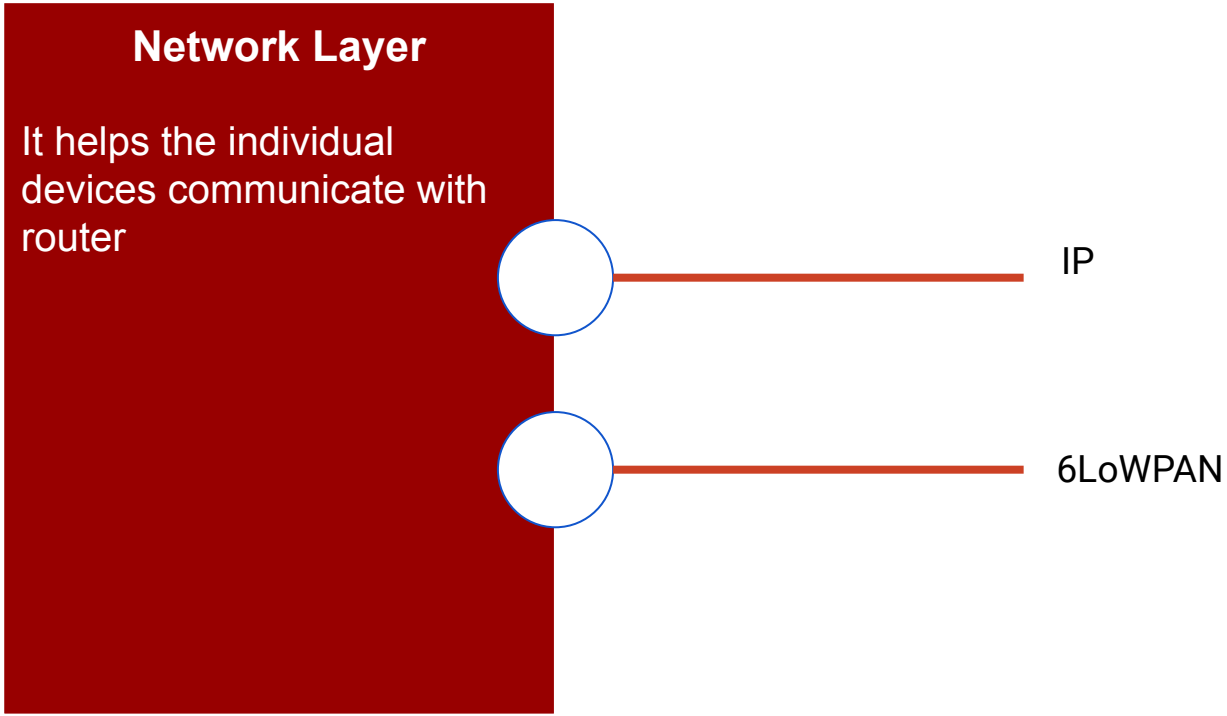


Protocols Position in Network Arch

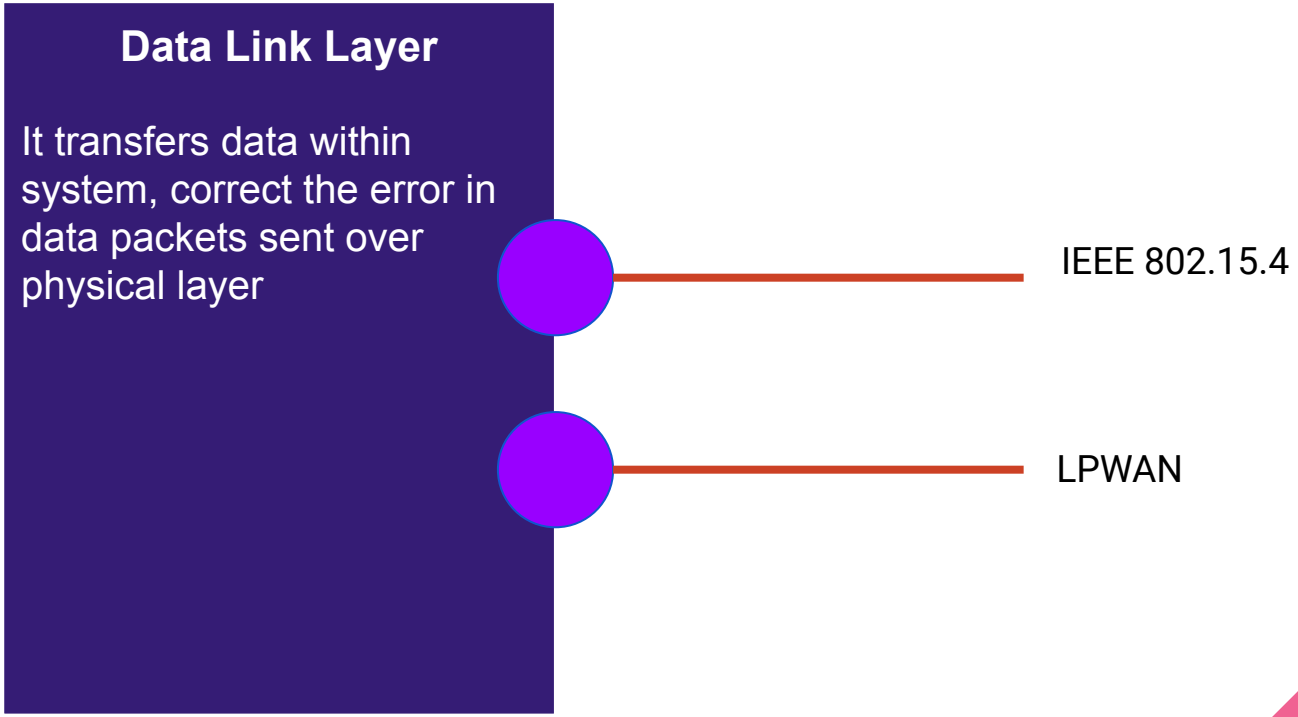
Transport Layer

It enables and safeguards the communication of the data as it moves through different layers

Protocols Position in Network Arch



Protocols Position in Network Arch



Communication Models

- Depending on the IoT solution, the devices can implement one of the ideal model for communication to cloud, to other devices-
  - Request - Response
  - Publish - Subscribe
  - Peer - Peer

Request Response Model

- Server hosts services and client consumes those services
- Client sends Request and Server sends the response
- Protocols that support this type of model
  - HTTP
  - CoAP

Publish Subscribe Model

- Publisher send data for a topic, to a message broker, which takes care of sending the data to only subscribers to that topic
- Protocols supporting this type of model
  - AMQP
  - MQTT

Peer to Peer Model (P2P)

- The connection is a direct communication infrastructure between two peers/devices
- They have equal permissions and rights
- Protocols that support this-
  - BLE
  - AMQP
  - WebRTC

Data Exchange Formats

Most IoT devices are used for telemetry. The send raw data and using one of the communication model transmits it to the destination.

Renowned Formats

- eXtensible Markup Language (XML)
- JavaScript Object Notation (JSON)

Lesser Known

- Concise Binary Object Representation (CBOR)

Obvious Choice!

JSON

- RFC 8259
- Stores data in ‘name-value’ pair
- Supports
  - Strings
  - Arrays
  - Numbers
  - Objects
  - Boolean
  - Null

Example:

```
{
        “Session”: “IoT protocols”,
        “Location”: {
                “Building”: “Cdac”,
                “Class”: 5
        },
        “Students”: [
                {“name”: “Ram”,
                  “Age”: 16,
                },
                { “name”: “Shyam”,
                        “Age”: 18,
                }]
}
```

XML

- RFC 5364
- Predefined tags or Custom tags
- Tags will follow a rules defined in Document Type Definition (DTD) files or Schema

```
<?xml version="1.0" encoding= "utf-8">
 <LinearLayout
        android:name="">
        <TextView
              android:name="">
        </TextView>
 </LinearLayout>
```

Committing to Data

To make any IoT solution a huge success, you should implement a data-driven culture that makes the following as core aspects-

- Data Collection
- Data Access
- Data Privacy
- Data Security

Communication Patterns

The data transfer can happen in a repeated pattern. This is helpful to recognise them and build solution around it

- Telemetry
  - Sending stats to remote system, regularly irrespective if it fails
- Notifications
  - Remote system will explicitly listens
- Status
  - Resource is known
- Inquiry
  - Checking if a resource with certain condition is available

References

- Hype cycle for IoT Standards and Protocols, 2020: Hype Cycle for IoT Standards and Protocols, 2020 (gartner.com)
- Azure IoT Protocols: https://azure.microsoft.com/en-us/overview/internet-of-things-iot/iot-technology-protocols/
- BSON documents: https://www.mongodb.com/basics/bson
- RFC 7452 : https://datatracker.ietf.org/doc/html/rfc7452

Thank You.
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