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NPTEL ONLINE CERTIFICATION COURSES

Introduction:

IoT Networking - Part 2

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Requirements of IoT Network

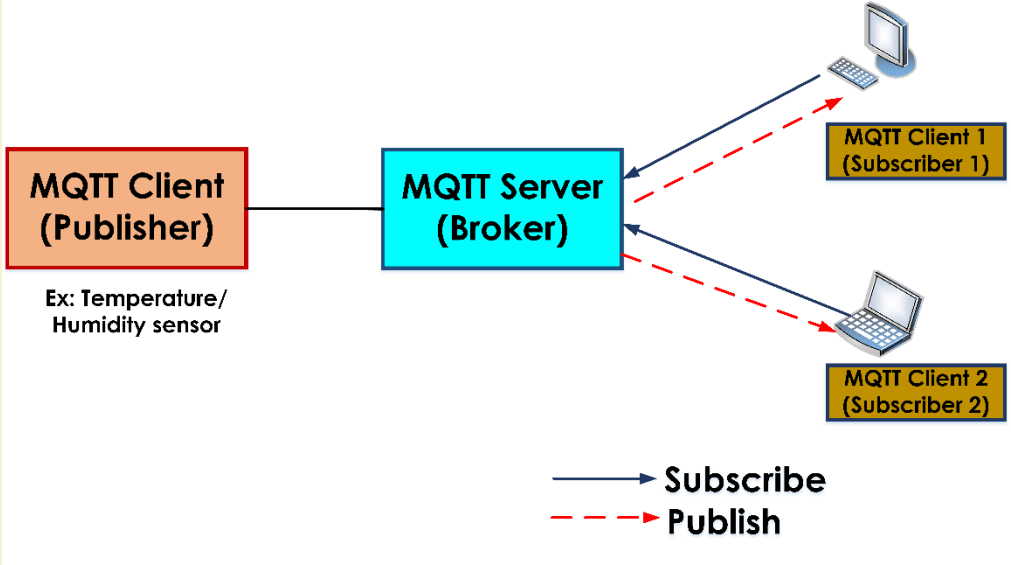
- Coverage
- High throughput
- Low latency
- Ultra reliability
- High power efficiency

MQTT

MQTT

- Message Queue Telemetry Transport
- Introduced by IBM and standardized by Organization for the Advancement of Structured Information Standards (OASIS) in 2013
- Works on Publish/Subscribe framework on top of TCP/IP architecture
- Advantages
  - Reliable, Lightweight, and cost-effective protocol

MQTT Publish/Subscribe Framework



Source: Hanes, D, et al. (2017), "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", Cisco Press.

MQTT QoS

- QoS of MQTT protocol is maintained for two transactions
  - First transaction: Publishing client → MQTT Server
  - Second transaction: MQTT Server → Subscribing Client

- Client on each transaction sets the QoS level
  - For the first transaction, publishing client sets the QoS level
  - For second transaction, client subscriber sets the QoS level

Source: Hanes, D, et al. (2017), "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", Cisco Press.

MQTT QoS Levels

- Supports 3-level of QoS
- **QoS 0:**
  - Also known as “at most once” delivery
  - Best effort and unacknowledged data service
  - Publisher transmits the message one time to server and server transmits it once to subscriber
  - No retry is performed

Source: Hanes, D, et al. (2017), "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", Cisco Press.

MQTT QoS Levels

- **QoS 1:**
  - Also known as “at least once” delivery
  - Message delivery between the publisher, server and then between server and subscribers occurs at least once.
  - Retry is performed until acknowledgement of message is recieved
- **QoS 2:**
  - Also known as “exactly once” delivery
  - This QoS level is used when neither packet loss or duplication of message is allowed
  - Retry is performed until the message is delivered exactly once

CoAP

CoAP

- Constrained Application Protocol
- CoAP was designed by IETF Constrained RESTful Environment (CoRE) working group to enable application with lightweight RESTful (HTTP) interface
- Works on Request/Response framework based on the UDP architecture, including Datagram Transport Layer Security (DTLS) secure transport protocol

Source: Hanes, D, et al. (2017), "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", Cisco Press.

CoAP

- CoAP defines four types of messages
  - CON: Conformable
  - NON: Non-conformable
  - RST: Reset
  - ACK: Acknowledgement
- For conformable type message, the recipient must explicitly either acknowledge or reject the message.
- In case of non-conformable type message, the recipient sends reset message if it can't process the message.

Source: Hanes, D, et al. (2017), "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", Cisco Press.

CoAP

- Utilizes GET, PUT, OBSERVE, PUSH, and DELETE messages requests to retrieve, create, initiate, update, and delete subscription respectively.
- Supports caching capabilities to improve the response time and reduce bandwidth consumption.
- Uses IP multicast to support data requests sent to a group of devices.
- Specialized for machine-to-machine (M2M) communication.

Source: Hanes, D, et al. (2017), "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", Cisco Press.

XMPP

XMPP

- Extensible Messaging and Presence Protocol
- Supports Publish/Subscribe messaging framework on top of TCP protocol
- The communication protocol is based on Extensive Markup Language (XML).
- Uses Datagram Transport Layer Security (DTLS) secure transport protocol

Source: Rayes, A., & Salam, S. (2016), "Internet of Things from hype to reality: the road to digitization", Springer.

XMPP

- XMPP model is decentralized, no central server is required.
- Advantages of XMPP
  - Interoperability: Supports interoperability between heterogeneous networks
  - Extensibility: Supports privacy lists, multi-user chat, and publish/subscribe chat status notifications
  - Flexibility: Supports customized markup language defined by different organizations according to their needs

Source: H. Wang et. al., "A Lightweight XMPP Publish/Subscribe Scheme for Resource-Constrained IoT Devices," IEEE Access, vol. 5, pp. 16393-16405, 2017.

AMQP

AMQP

- Advance Message Queuing Protocol
- Optimized for financial applications
- Binary message-oriented protocol on top of TCP
- Supports Publish/Subscribe framework for both
  - Point-to-point (P2P)
  - Multipoint communication

Source: Rayes, A., & Salam, S. (2016), "Internet of Things from hype to reality: the road to digitization", Springer.

AMQP

- Uses token-based mechanism for flow control
  - Ensures no buffer overflow at the receiving end
- Message delivery guarantee services:
  - At least once: Guarantees message delivery but may do so multiple times
  - At most once: Each message is delivered once or never
  - Exactly once: No message drop and delivered once one

Source: Rayes, A., & Salam, S. (2016), "Internet of Things from hype to reality: the road to digitization", Springer.

IEEE 1888

IEEE 1888

- Energy-efficient network control protocol
- Defines a generalized data exchange protocol between network components over the IPv4/v6-based network.
- Universal Resource Identifiers (URIs) based data identification
- Applications: Environmental monitoring, energy saving, and central management systems.

Source: Rayes, A., & Salam, S. (2016), "Internet of Things from hype to reality: the road to digitization", Springer.

DDS RTPS

DDS RTPS

- Distributed Data Service Real Time Publish and Subscribe
- Supports Publish/Subscribe framework and on top of UDP transport layer protocol.
- Data-centric and binary protocol
- Data is termed as “topics”.
- The users/listeners may subscribe to their particular topic of interest

Source: Rayes, A., & Salam, S. (2016), "Internet of Things from hype to reality: the road to digitization", Springer.

DDS RTPS

- A single topic may have multiple speakers of different priorities
- Supports enlisted QoS for data distribution
  - Data persistence
  - Delivery deadline
  - Reliability
  - Data freshness
- Applications: Military, Industrial, and healthcare monitoring

Source: Rayes, A., & Salam, S. (2016), "Internet of Things from hype to reality: the road to digitization", Springer.

Thank You!!