MQTT & CoAP

Background

- **Polling Model:**
  - Applications send queries to sensor nodes to retrieve information.
  - Problem?
  - When an event of interest occurs, in order to react in real-time, the sensor nodes have to be queried continuously.
    - Waste of resources such as energy, processing and bandwidth.

Background

- **Publish/Subscribe Model**
  - Entities:
    - Publisher: generate events
    - Subscriber: express interest in events
  - Subscription:
    - Register interest in the event
  - Advantages:
    - Decouple in time: publishers and scubscribers do not need to be actively participating in the interaction at the same time
    - Decouple in space: publishers and subscribers do not need to know each other
    - Publishers and subscribers can produce or consume events in an asynchronous way.

Publication Discipline

- Activation: when there is a pending confirmation of a publication message, and a new publication is generated

- MQTT-S publication discipline:
  - Discard the new publication message

- CoAP publication discipline:
  - Discard the old publication message

- An **inappropriate** fixed RTO will result in a higher probability of a new publication message being generated while the RTO is active. Therefore, the publication discipline will discard the publication message (Old or New).

MQTT-S

- Extension of the Message Queuing Telemetry Transport (MQTT) Optimized for WSN.

➡ Components:

    ➡ Broker node:

        ➡ responsible for managing subscriptions as well as storing and sending publications to corresponding WSN subscriber nodes.
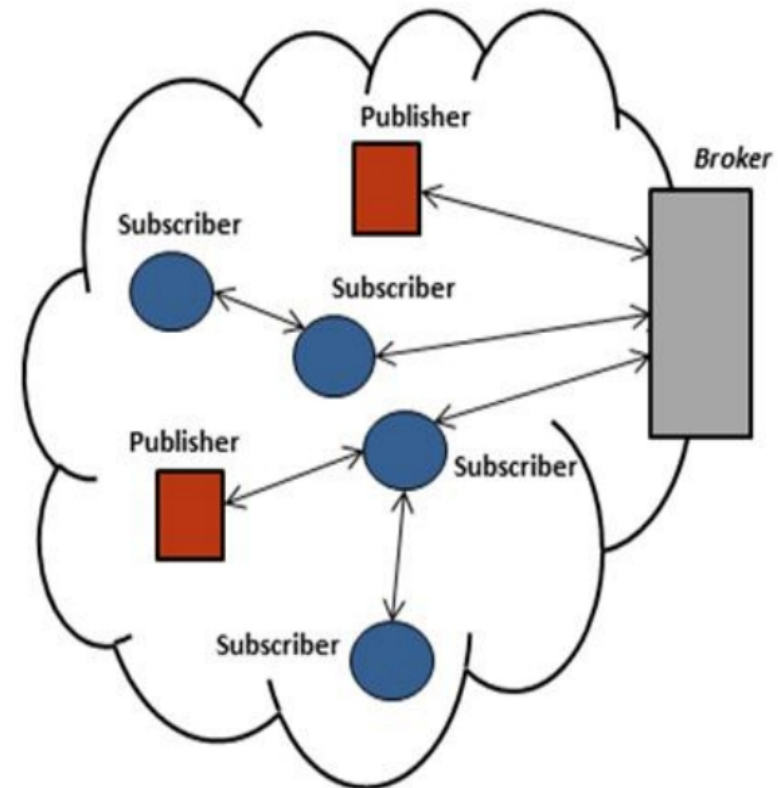
    ➡ Publisher nodes:

        ➡ generate event

    ➡ Subscriber nodes:

        ➡ express interest in events

    ➡ Relay nodes:

        ➡ for multi-hop scenario.

MQTT-S

- Reliability:
  - QoS Level 0 (QoS0)
    - Offers a best-effort delivery service, no retransmission or Acknowledgements.
  - QoS Level 1 (QoS1)
    - Allows the retransmission of messages until Acked
    - Does not prevent duplicate reception
  - QoS Level 2 (QoS2)
    - Ensures the reception of message
    - Ensures to deliver only once to the destination by four message handshake.
  - Parameters for QoS1 and QoS2:
    - Fixed RTO: 10-15 seconds.
    - Retransmission number: 3-5

MQTT-S

- Publication Discipline:
  - "stop and wait" mechanism for the transmissions of publication messages with QoS1 and QoS2.
  - A publisher node has to wait for the termination of its publication message flow with the broker node before it can start a new one.
  - If more than one publications are generated, publication discipline is needed.
  - Activity 1: Queue the new publication messages
    - Drawback: cost more source
  - Activity 2: Drop the new publication messages
    - Always attempts to retransmit the old publication message till receive the ACK.
    - Called 'Persistent mode' discipline

CoAP

- Characteristics:
  - RESTful (Representational State Transfer)
  - Resources are identified by Universal Resource Identifiers (URI)
  - UDP based
- Model:
  - Client/server interaction model
    - Request messages initiate a transaction with a server, which may send a response to the client with a matching transaction ID
    - Polling based: not suitable for requiring information in real-time in order to react when an event of interest occurs.
  - Publish/subscribe interaction model
    - A.k.a: Observer Model
    - A publisher node can send publications to a subscriber node (observer) about a event that the subscriber is interested in receiving .
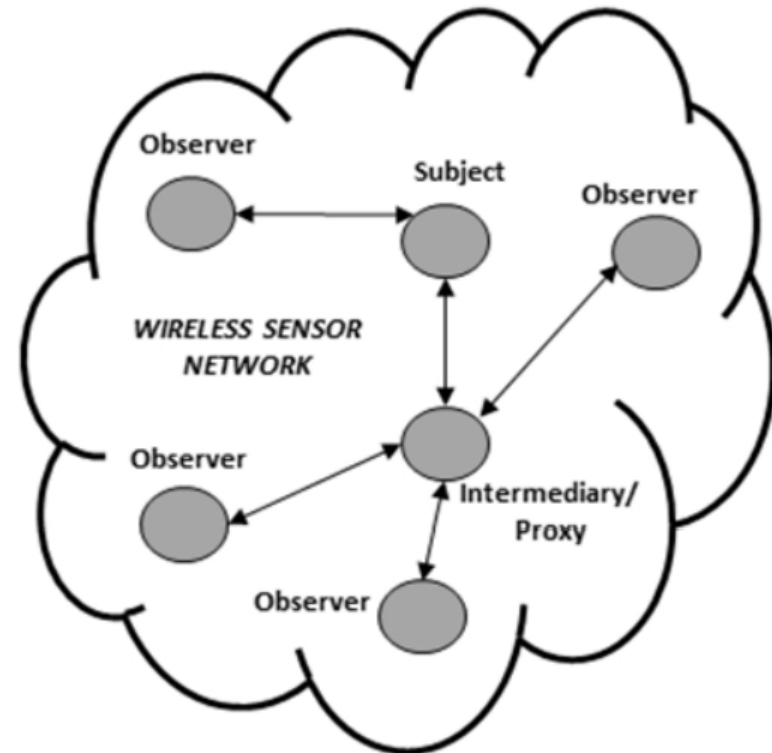
CoAP

– Publish/subscribe interaction model

- A subscriber constantly to observe the events by registering its interest in the event (GET request to the publisher node).

  ➡ Subscription Action:

    ➡ Publisher node establishes an observation relationship between the subscriber and the event.

    ➡ The publisher notifies each subscriber node that has an observation relationship with the event.

  ➡ Observer Model:

    ➡ High scalability

    ➡ Use caches and proxy nodes that multiplex the interest of multiple subscribers in the same event into a single association

CoAP

- Reliability:
  - Non-Confirmable (NON) message:
    - Correspond to MQTT-S QoS 0
    - No ACK to messages
  - Confirmable (CON) message:
    - Correspond to MQTT-S QoS 1
    - ACK messages received
    - Fixed RTO
      - Random number between and ACK TIMEOUT constant and an ACK TIMEOUT multiplied by ACK-RANDOM-FACTOR
      - UnACKed messages within RTO are retransmitted
      - RTO is doubled (Exponential back-off mechanism)
    - MAX_RETRANSMIT: Maximum retransmission numbers

Protocol Constants	Value
ACK_TIMEOUT	2 s
MAX_RETRANSMIT	4
ACK_RANDOM_FACTOR	1.5

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