Messaging for IoT (MQTT)

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HTTP

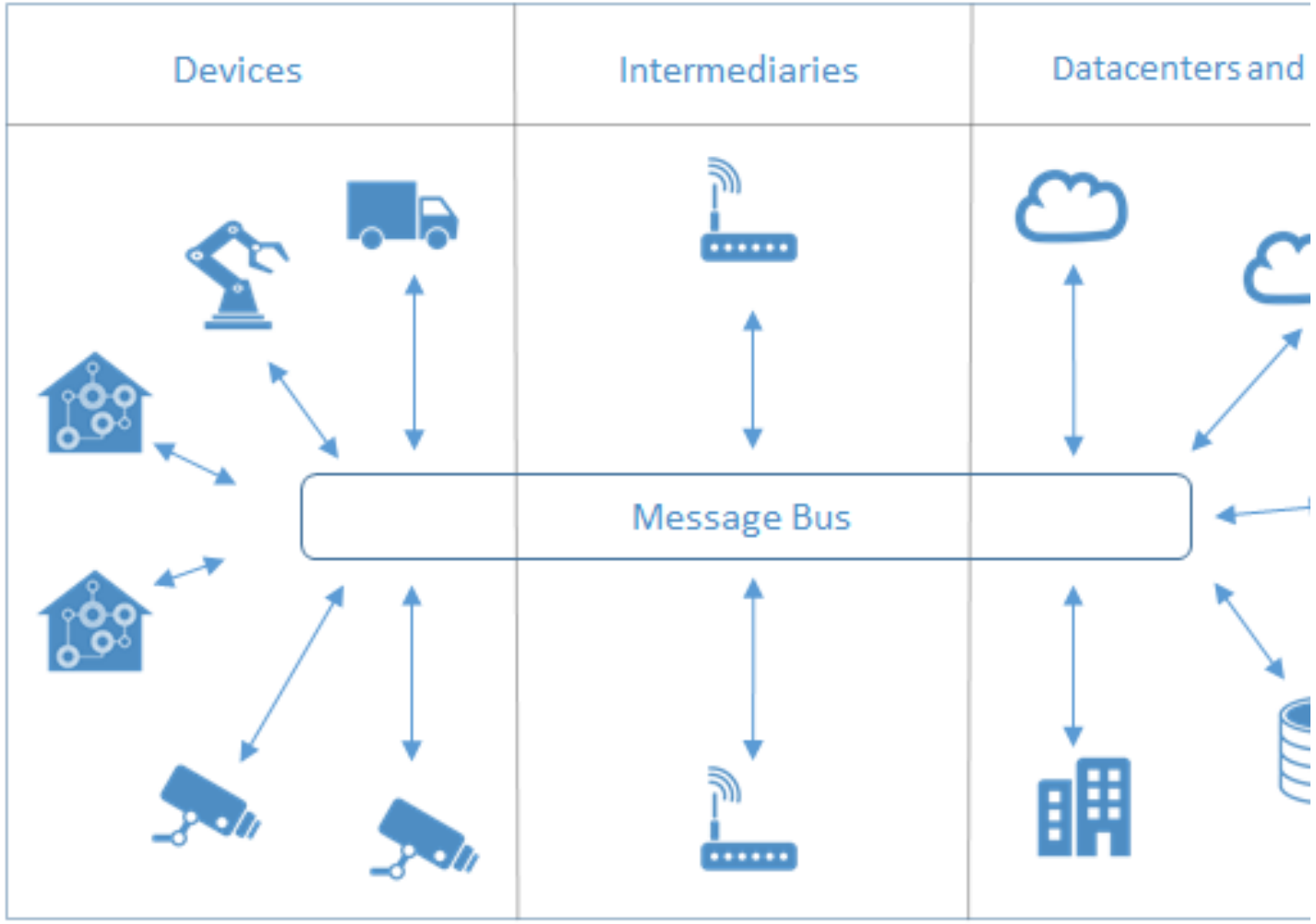
- HTTP is a key protocol for distributed/web applications.
  - Simple request/response model
  - Supports REST
- Excellent protocol for requesting data from a known source
- Internet of Things has some extra requirements
  - Emitting data from one thing to many
  - Event-orientated – reacting to events when they happen.
  - Large volumes of small data
  - Constrained devices/things.
  - Unreliable infrastructure

Mobile Comms

- Issues with
  - data charges
  - Power consumption
  - Security
  - Reliability (unreliable connections)
  - Scalability

Messaging Requirements for IoT

- Lightweight for constrained devices
  - Low bandwidth
  - Low code base and computational footprint
- Scalable
- Reliable
- Open accepted standard
- Interoperable



IoT with Messaging

MQTT

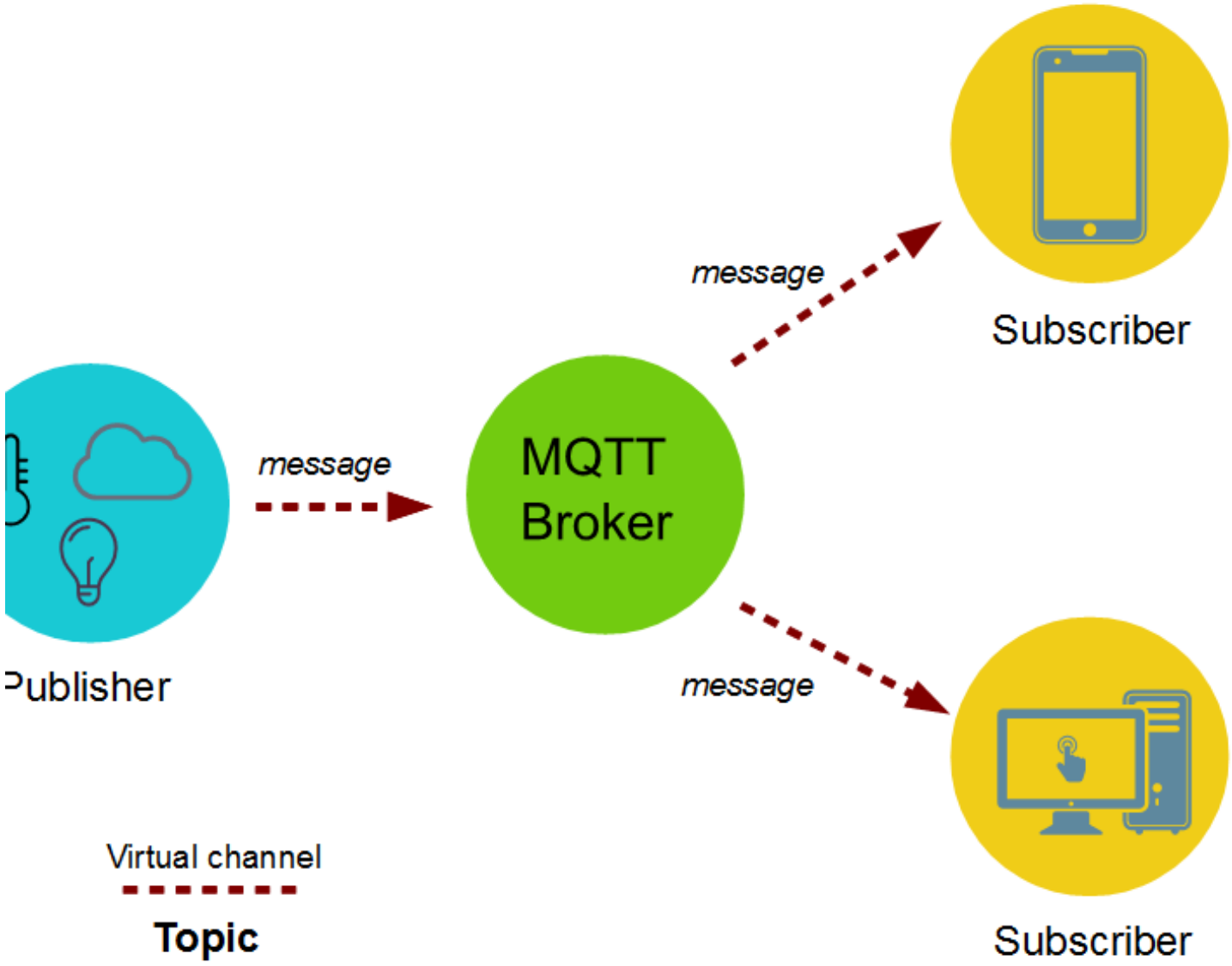
- MQ Telemetry Transport (MQTT)
- Telemetry
  - Remote measurements
- Created by IBM
  - from message queueing (MQ) architecture used by IBM for service oriented networks.
  - **There are no queues in MQTT.**
- Telemetry data goes from devices to a server or broker.
  - Uses a publish/subscribe mechanism.
- Lightweight both in bandwidth and code footprint

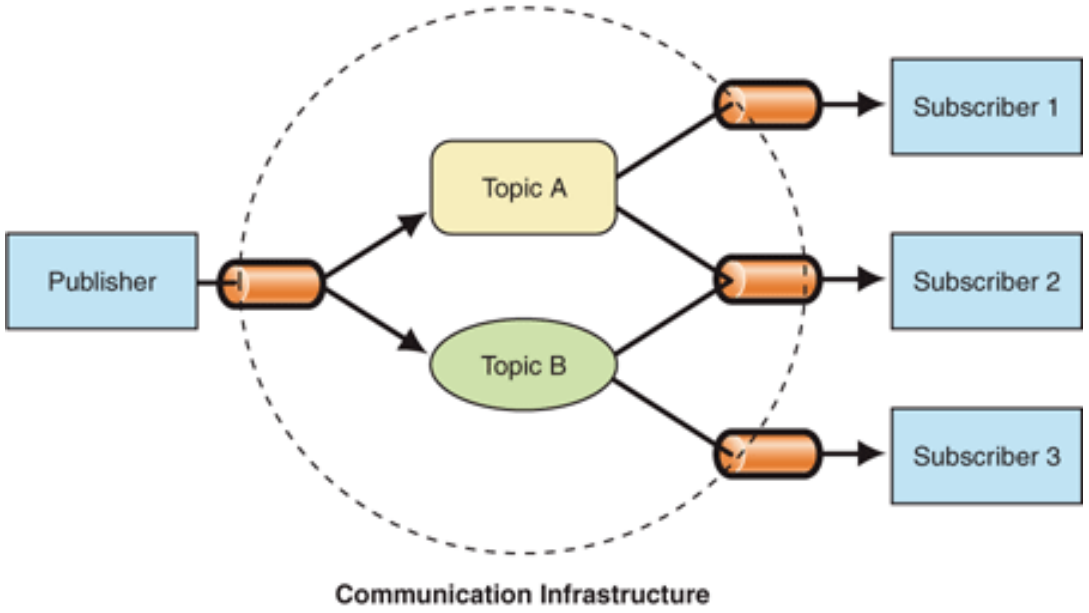
MQTT is Open Source

- Lots of implementations:
    - Mosquitto
    - Micro broker
    - Really small message broker (RSMB): C
    - Cloud services

MQTT – publish subscribe

- **Topics/Subscriptions:** Messages are published to topics.
  - Clients can subscribe to a topic or a set of related topics
- **Publish/Subscribe**: Clients can subscribe to topics or publish to topics.





Publish Subscribe

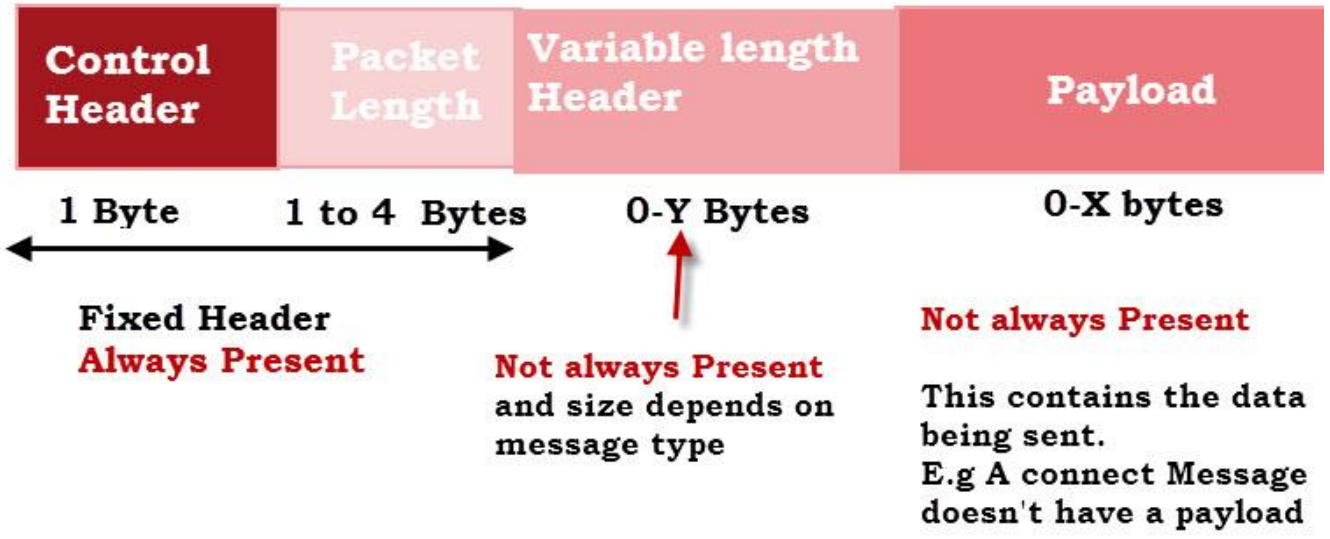
- A Publish Subscribe messaging protocol allowing a message to be published once
- Many things can receive the message
- The messaging service, or “broker”, provides decoupling between the producer and consumer(s)
- A producer sends (publishes) a message (publication) on a topic (subject)
- A consumer subscribes (makes a subscription) for messages on a topic (subject)
- A message server / broker matches publications to subscriptions
  - If no matches the message is discarded
  - If one or more matches the message is delivered to each matching subscriber/consumer

Publish Subscribe characteristics

- A published messages may be retained
  - A publisher can mark a message as “retained”
  - The broker / server remembers the last known good message of a retained topic
  - The broker / server gives the last known good message to new subscribers
- A Subscription can be durable or non-durable
  - Durable: messages forwarded to subscriber immediately, If subscriber not connected, message is stored and forwarded when connected
  - Non-Durable: subscription only active when subscriber is connected to the server / broker

MQTT Characteristics

- MQTT protocol compresses to small number of bytes
  - Smallest packet size 2 bytes
  - Supports always-connected and sometimes connected
  - Provides Session awareness
    - Configurable keep alive providing granular session awareness
    - “Last will and testament” enable applications to know when a client goes offline abnormally
    - Typically utilises TCP based networks e.g. Webscokets
    - Tested on many networks – vsat, gprs, 2G….



MQTT Standard Packet Structure

MQTT Characteristics

- Three quality of service levels:
  - 0 = At most once (Best effort, No Ack),
  - 1 = At least once (Acked, retransmitted if ack not received),
  - 2 = Exactly once [Request to send (Publish), Clear-to-send(Pubrec), message (Pubrel), ack (Pubcomp)]
- Retained Messages
  - Server keeps messages even after sending it to all subscribers. New subscribers get the retained messages

MQTT vs HTTP

- Push delivery of messages / data / events
  - MQTT – low latency push delivery of messages from client to server and **server to client.** Helps bring an event oriented architecture to the web
  - HTTP – push from client to server but poll from server to client
- Efficient use of network
  - For an M2M project the number of bytes with MQTT was **137130 bytes per device per month**
  - with HTTP the number of bytes was **801000 bytes per device per month**
- Reliable delivery over fragile network
  - MQTT will deliver message to QOS even **across connection breaks**
  - Decoupling and publish subscribe – **one to many delivery**

Characteristics		3G		WiFi	
		HTTPS	***MQTT***	***HTTPS***	***MQTT***
Receive Messages	**Messages / Hour**	1,708	160,278	3,628	263,314
	Percent Battery / Hour	18.43%	16.13%	3.45%	4.23%
	Percent Battery / Message	0.01709	0.00010	0.00095	0.00002
	Messages Received (Note the losses)	240 / 1024	1024 / 1024	524 / 1024	1024 / 1024
Send Messages	**Messages / Hour**	1,926	21,685	5,229	23,184
	Percent Battery / Hour	18.79%	17.80%	5.44%	3.66%
	Percent Battery / Message	0.00975	0.00082	0.00104	0.00016

	MQTT	HTTP
Design	Data centric	Document centric
Pattern	Publish/Subscribe	Request /Response
Complexity	Simple	More Complex
Message Size	Small. Binary with 2B header	Large. ASCII
Service Levels	Three	One
Libraries	30kB C and 100 kB Java	Large
Data Distribution	1 to zero, one, or n	1 to 1 only

http://stephendnicholas.com/archives/1217

Application Example

- Home care monitoring solution
  - Home and patient instrumented with sensors.
    - E.g. door motion, blood pressure, pacemaker/defib.
  - Collected by monitoring service (broker) using MQTT
  - Subscribed by a health care service in the hospital
  - Alerts relations/health care profs. if anything is out-of-order