How Do You Select Which IoT Protocol to Use?

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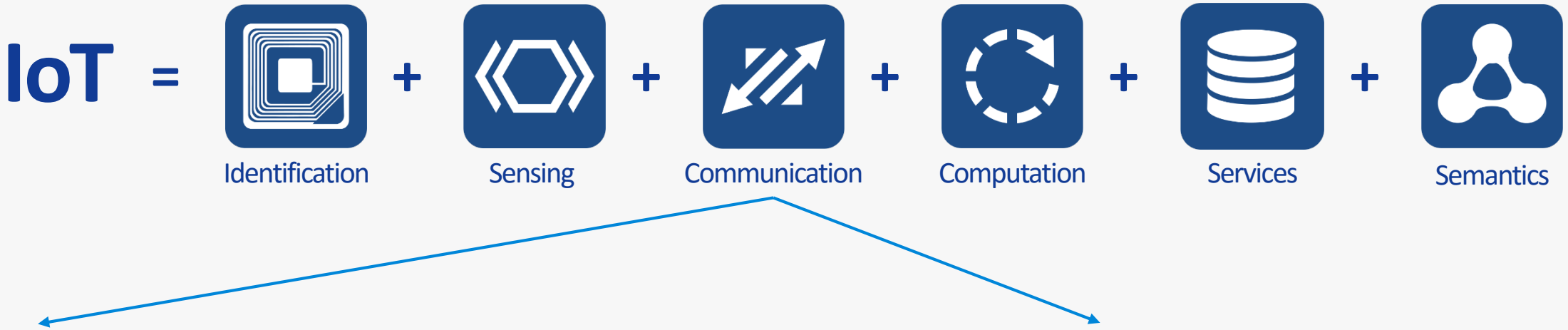
IoT Systems – Consumer vs Industrial

Attribute	Industrial IoT	Human IoT
Market Opportunity	Brownfield (known environment)	Greenfield (unchartered domain)
Product Lifecycle	Until dead or obsolete	Whims of style and/or budget
Solution Integration	Heterogeneous APIs	Vertically integrated
Security	Access	Identity & privacy
Interaction	Autonomous	Reactive
Availability	0.9999 to 0.99999 (4–5 ‘9’s)	0.99 to 0.999 (2–3 ‘9’s)
Access to Internet	Intermittent to independent	Persistent to interrupted
Response to Failure	Resilient, fail-in-place	Retry, replace
Network Topology	Federations of peer-to-peer	Constellations of peripherals
Physical Connectivity	Legacy & purpose-built	Evolving broadband & wireless

Source: Patrick Morehead, Forbes, “Who Wins In The Industrial Internet Of Things (IIoT)?”, October 29 2013

IoT Building Blocks



Application Protocol		DDS	CoAP	AMQP	MQTT	MQTT-SN	XMPP	HTTP REST
Service Discovery		mDNS				DNS-SD		
Infrastructure Protocols	Routing Protocol	RPL						
	Network Layer	6loWPAN					IPv4 / IPv6	
	Link Layer	IEEE 802.15.4						
	Physical / Device Layer	LTE-A		EPCglobal	IEEE 802.15.4		Z-Wave	
Influential Protocols		IEEE 1888.3, IPSec			IEEE 1905.1			

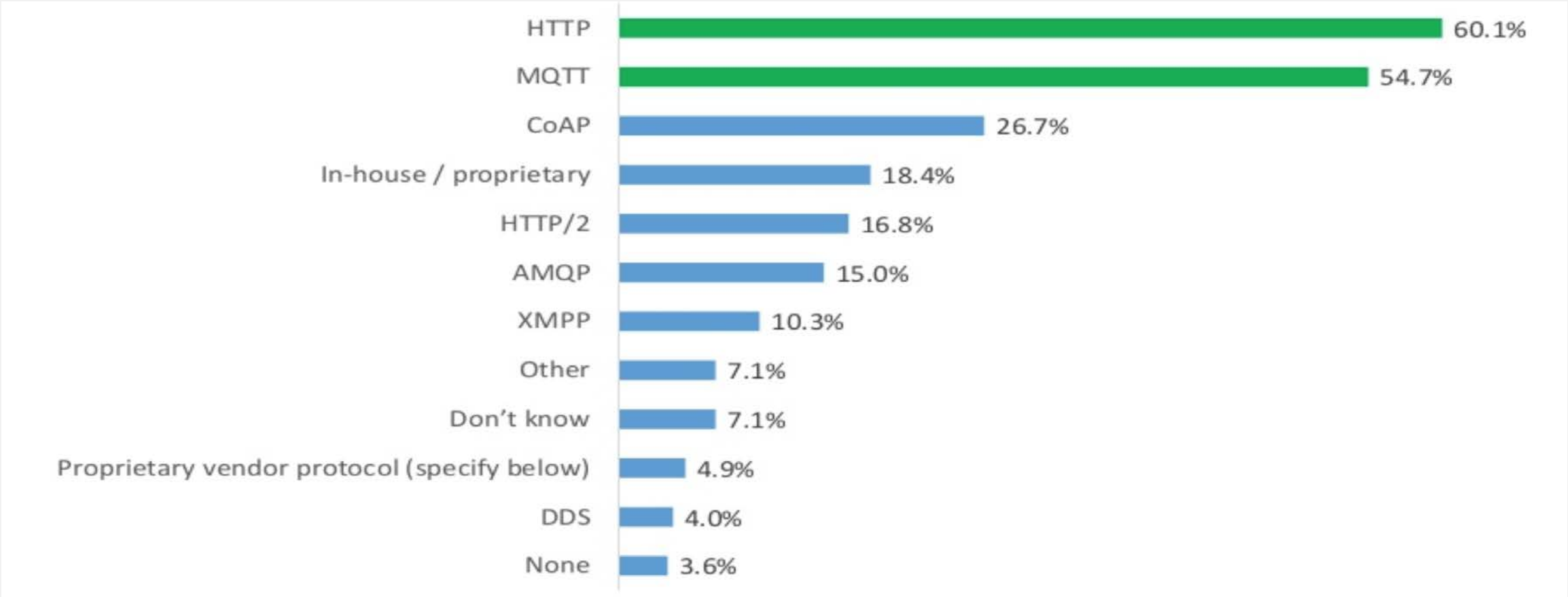
Internet of Things: A Survey on Enabling Technologies, Protocols, and Applications

Ala Al-Fuqaha, Senior Member, IEEE
Mohsen Guizani, Fellow, IEEE
Mehdi Mohammadi, Student Member, IEEE
Mohammed Aledhari, Student Member, IEEE
Moussa Ayyash, Senior Member, IEEE

http://www.slideshare.net/IanSkerrett/iot-developer-survey-2017

Messaging Standards Usage

What messaging protocols do you use for your IoT solution?



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IP Usage

Web Services

- IP family of protocols that can be used to provide services to a device
- Examples: SMS text, e-mail, file sharing, streaming audio, speech to text, social media …

IoT Services

- The availability of back-end services based on IP protocols
  - Differentiating “IoT devices” from “connected devices”:
- Examples: Storage, multiple devices/applications data usage, system analytics and potential for efficiency gain…

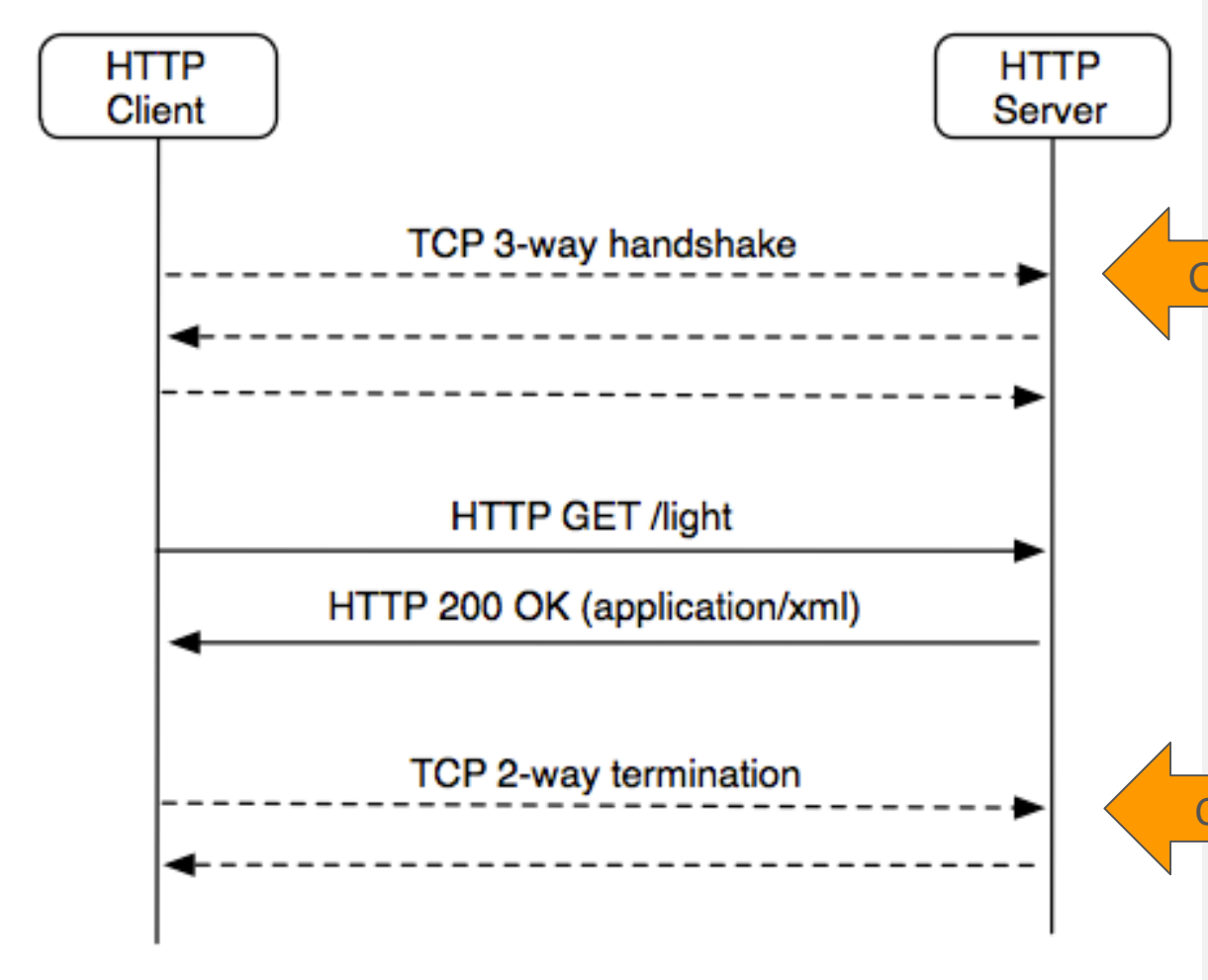
Internet Protocol Types

Request/Response		Publish/Subscribe	
HTTP	Web Services	MQTT	IoT Services
WebSocket	Web Services	CoAP	IoT Services
CoAP	IoT Services	XMPP	

Request/Response

HTTP

HTTP Request



Client opens connection and sends a request message to HTTP server

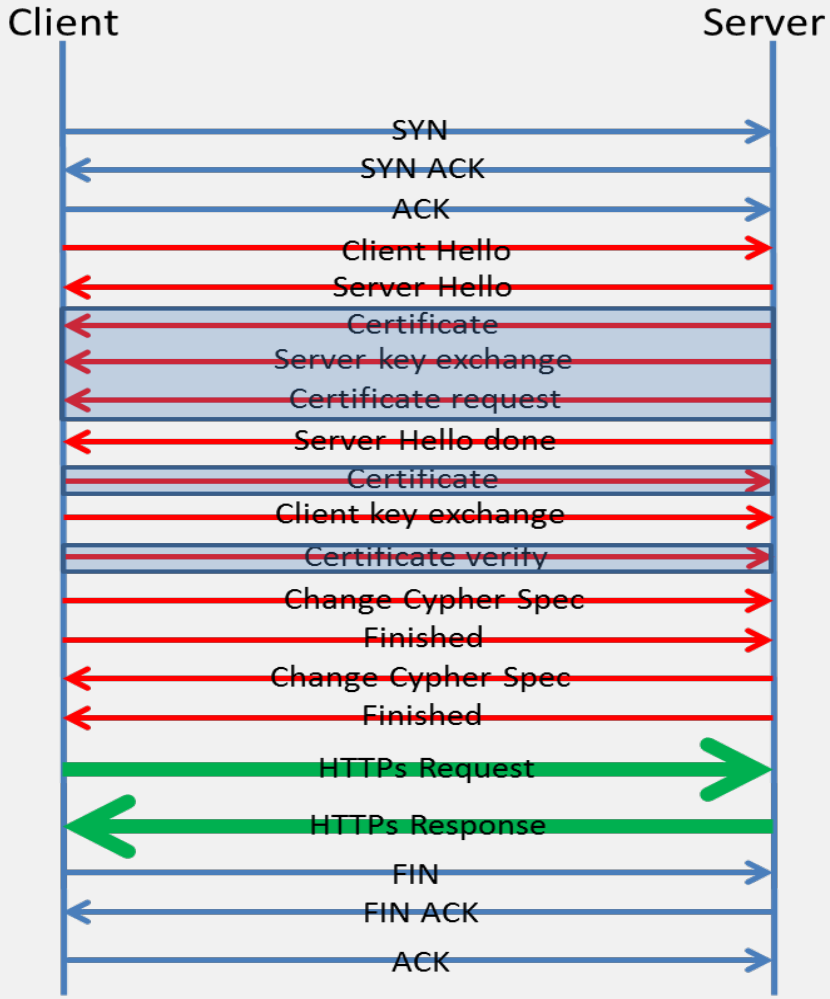
Server returns a response

Client closes the connection

HTTP is ‘stateless’

HTTP and HTTPS

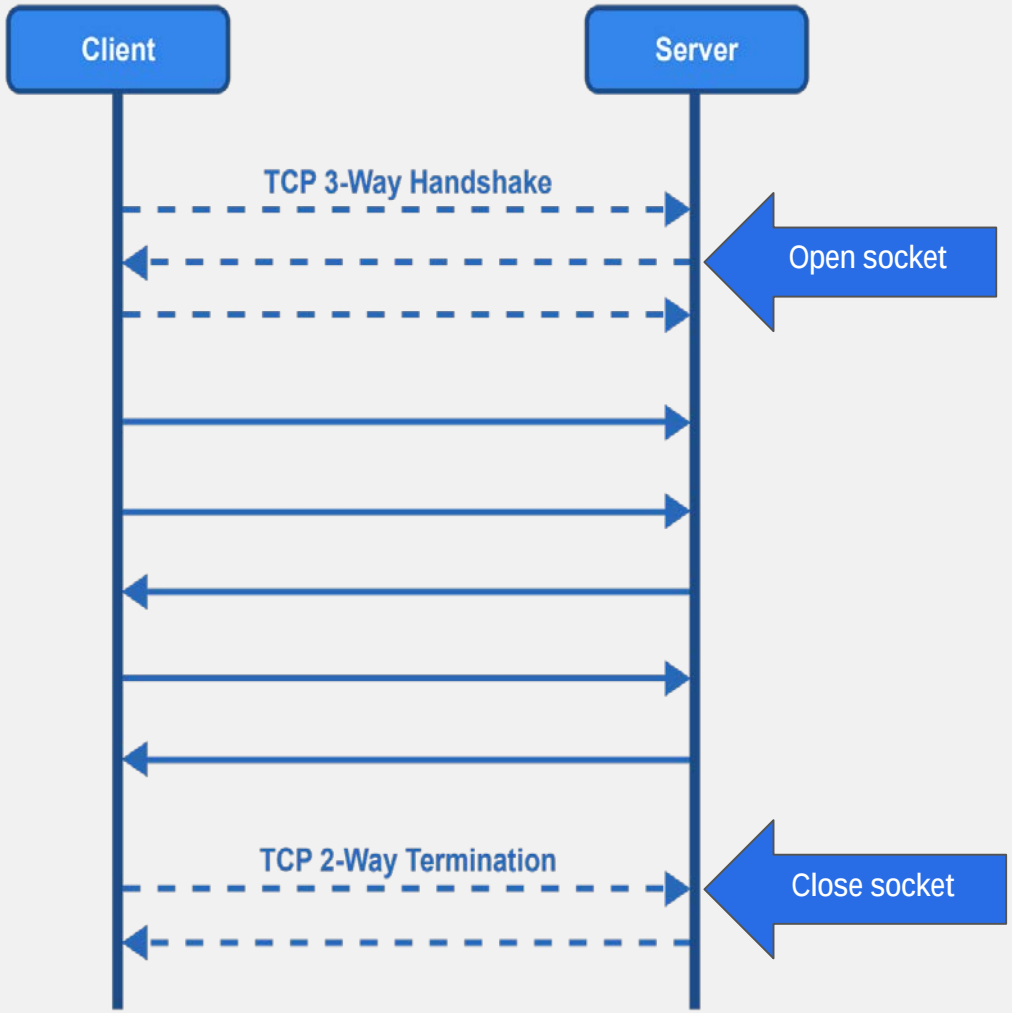
- Typical HTTPS
  - showing the messages, not the number of packets
- Areas in blue are optional
  - bidirectional SSL/TLS
- Connection is initiated by a client
- Client always has to poll the server, server cannot initiate connection: not efficient for an embedded device
- High overhead: Open/Send/Close for every message



Request/Response

Websocket

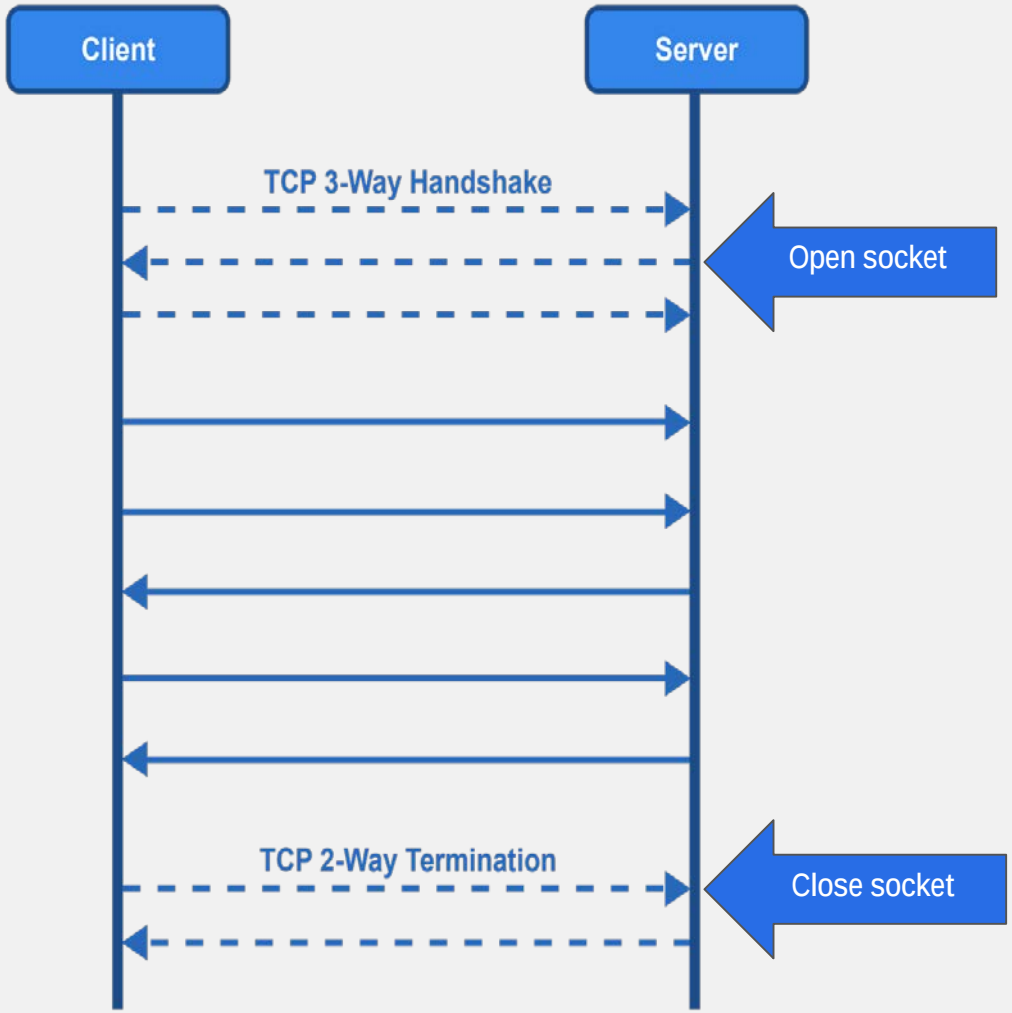
A Websocket Connection



WebSockets are a bi-directional, full-duplex, persistent connections from a client to a server.

Once a WebSocket connection is established the connection stays open until the client or server decides to close this connection.

A Websocket Connection



With this open connection, the client or server can send a message at any given time to the other.

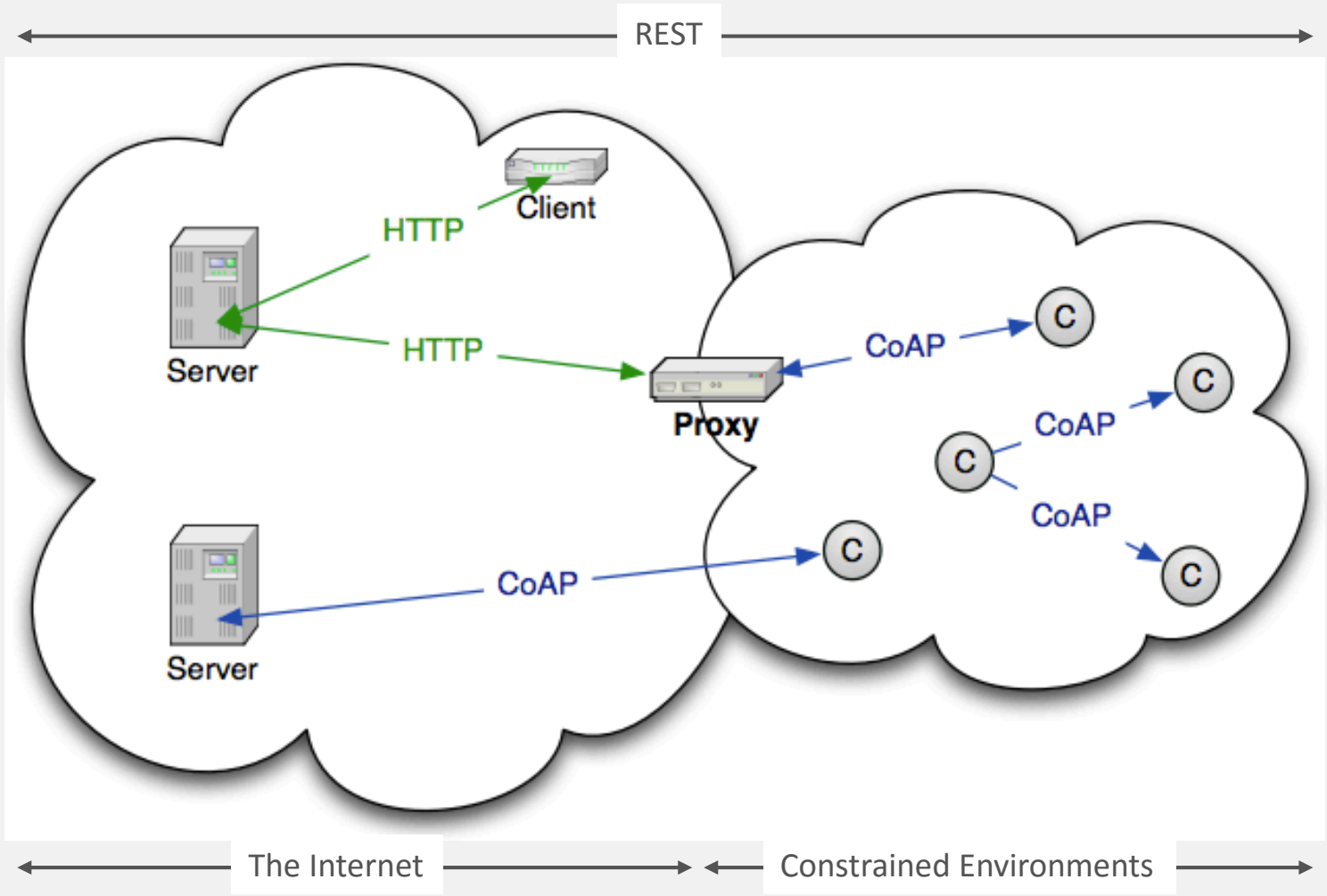
This makes web programming entirely event driven, not (just) user initiated.

It is stateful.

Publish/Subscribe

CoAP

CoAP Architecture



RFC 7252

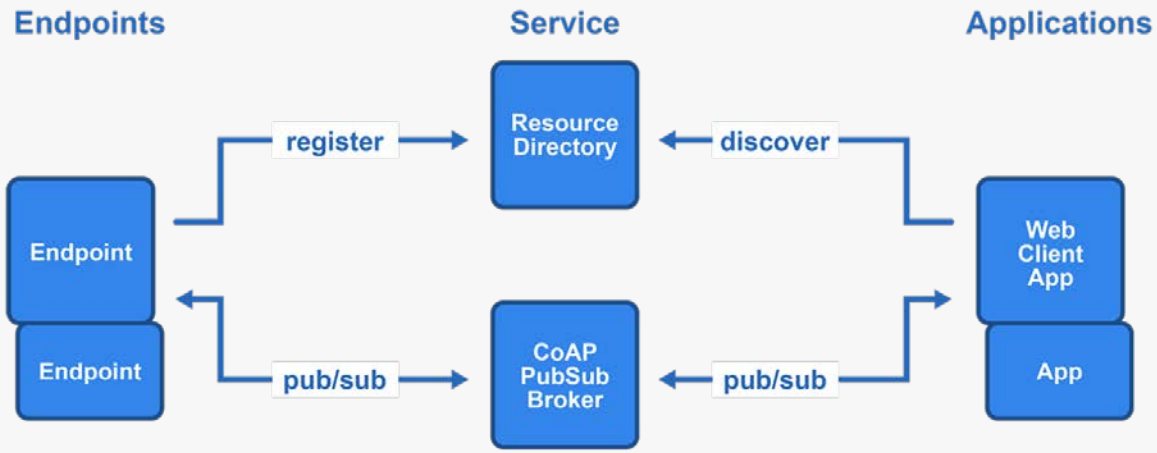
Proxy/Gateway

Constrained device

Publish/Subscribe with CoAP

As of July 2016, the IETF draft defining publish/subscribe and message queuing functionality for CoAP that extends the capabilities for supporting nodes with long breaks in connectivity and/or up-time is in its 5th iteration.

https://datatracker.ietf.org/doc/draft-koster-core-coap-pubsub/



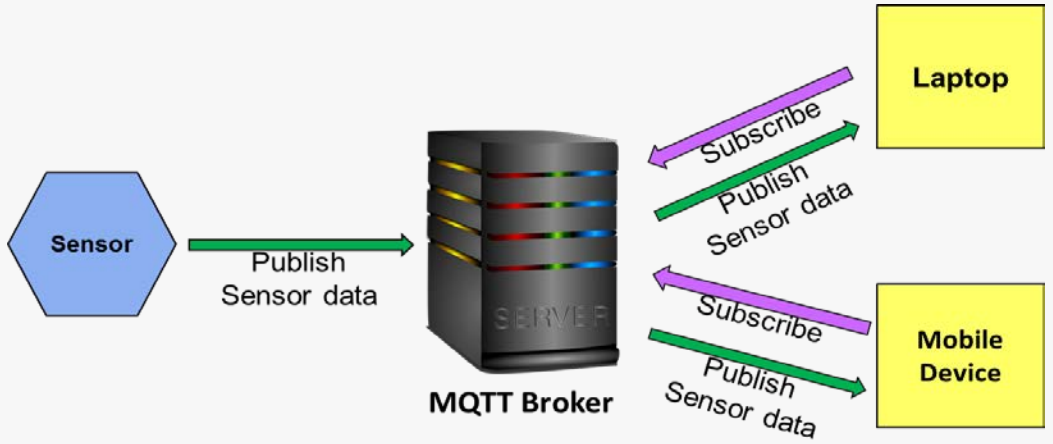
CoAP Publish/Subscribe Architecture

Publish/Subscribe

MQTT

MQTT

- MQTT has a client/server model, where every device is a client and connects to a server, known as a broker, over TCP.
- MQTT is message oriented. Every message is a discrete chunk of data, opaque to the broker.
- Every message is published to an address, known as a topic. Clients may subscribe to multiple topics.
- Every client subscribed to a topic receives every message published to the topic.

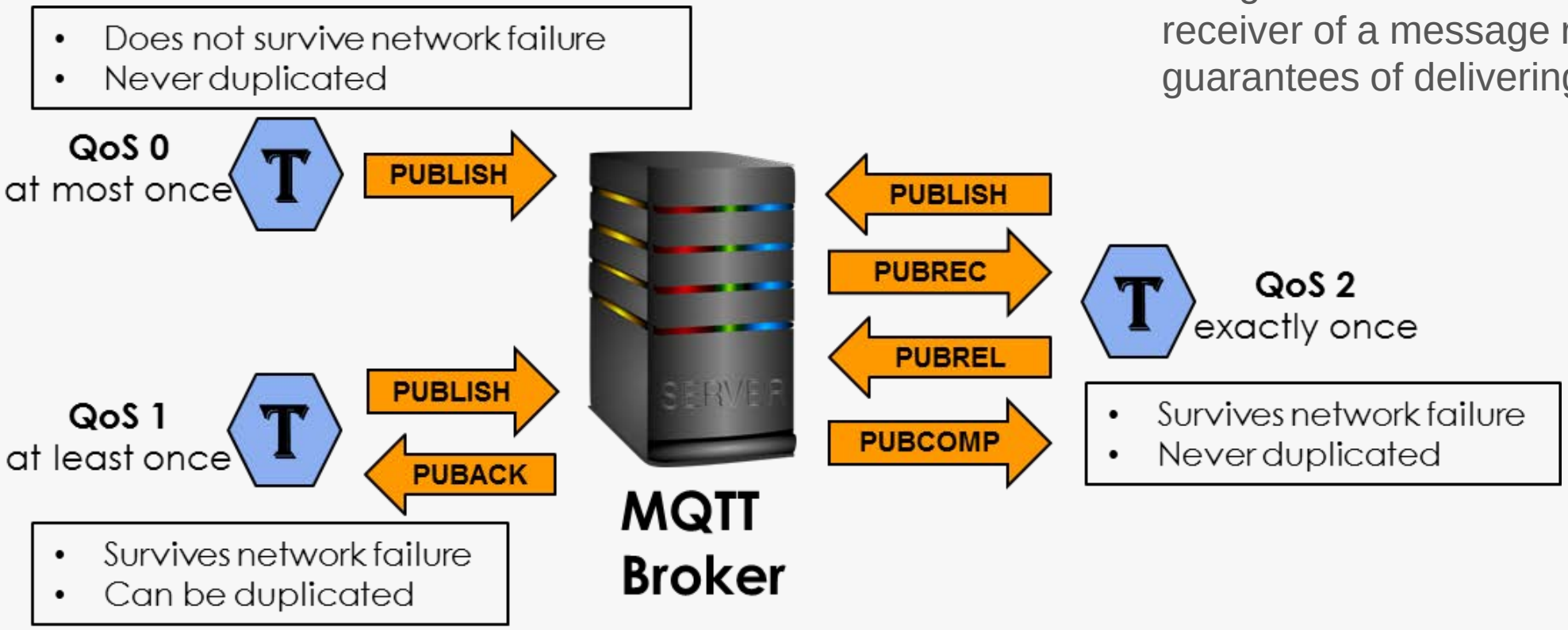


A simple network with three clients and a central broker

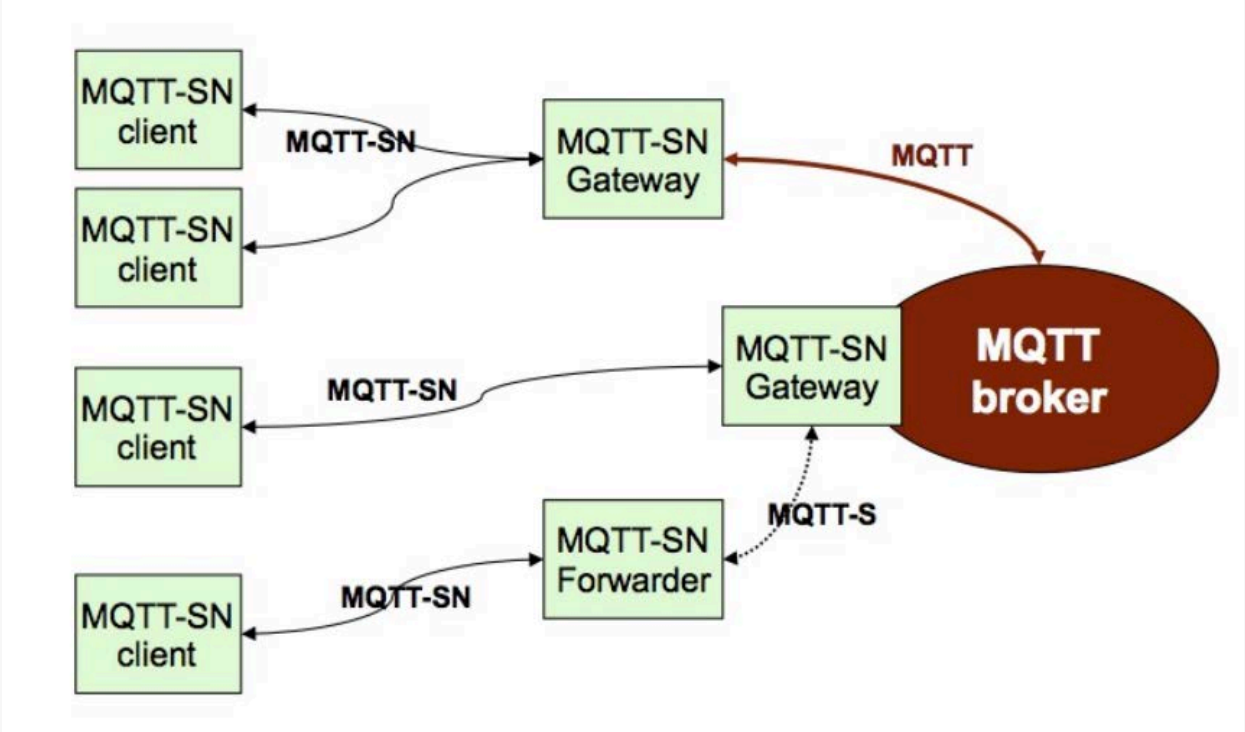
MQTT Quality of Service (QoS)

There are 3 QoS levels in MQTT:

The Quality of Service (QoS) level is an agreement between sender and receiver of a message regarding the guarantees of delivering a message.



MQTT-SN



- MQTT-SN uses UDP instead of TCP
- Client connects to Gateway via MQTT-SN
- Gateway can be integrated into broker/server or can connect via MQTT
  - The main function of the Gateway is to translate between MQTT and MQTT-SN
- Forwader encapsulates MQTT-SN packets and forwards unchanged to the gateway

DDS

DDS is Decentralized

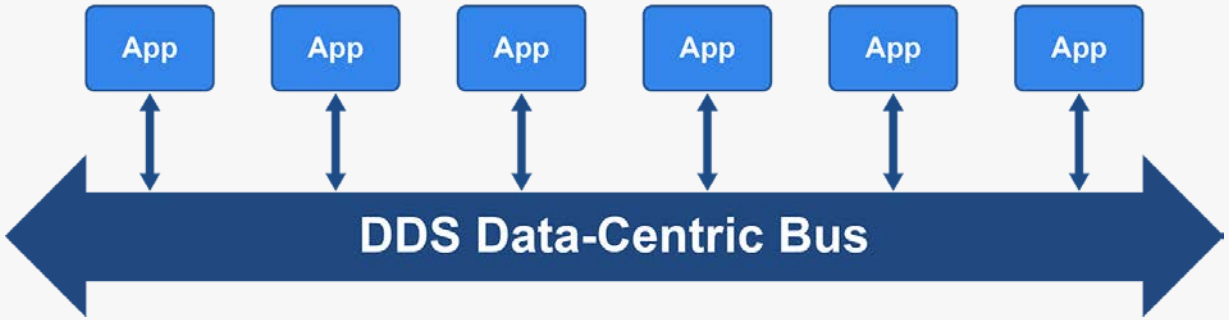
- Is an Object Management Group (OMG) standard
- Introduced in 2004
- Uses a Publish/Subscribe architecture
- Uses network resources efficiently
- Can be deployed without servers or brokers
- Commercial and Open Source versions

Fast
- 100,000's update/sec

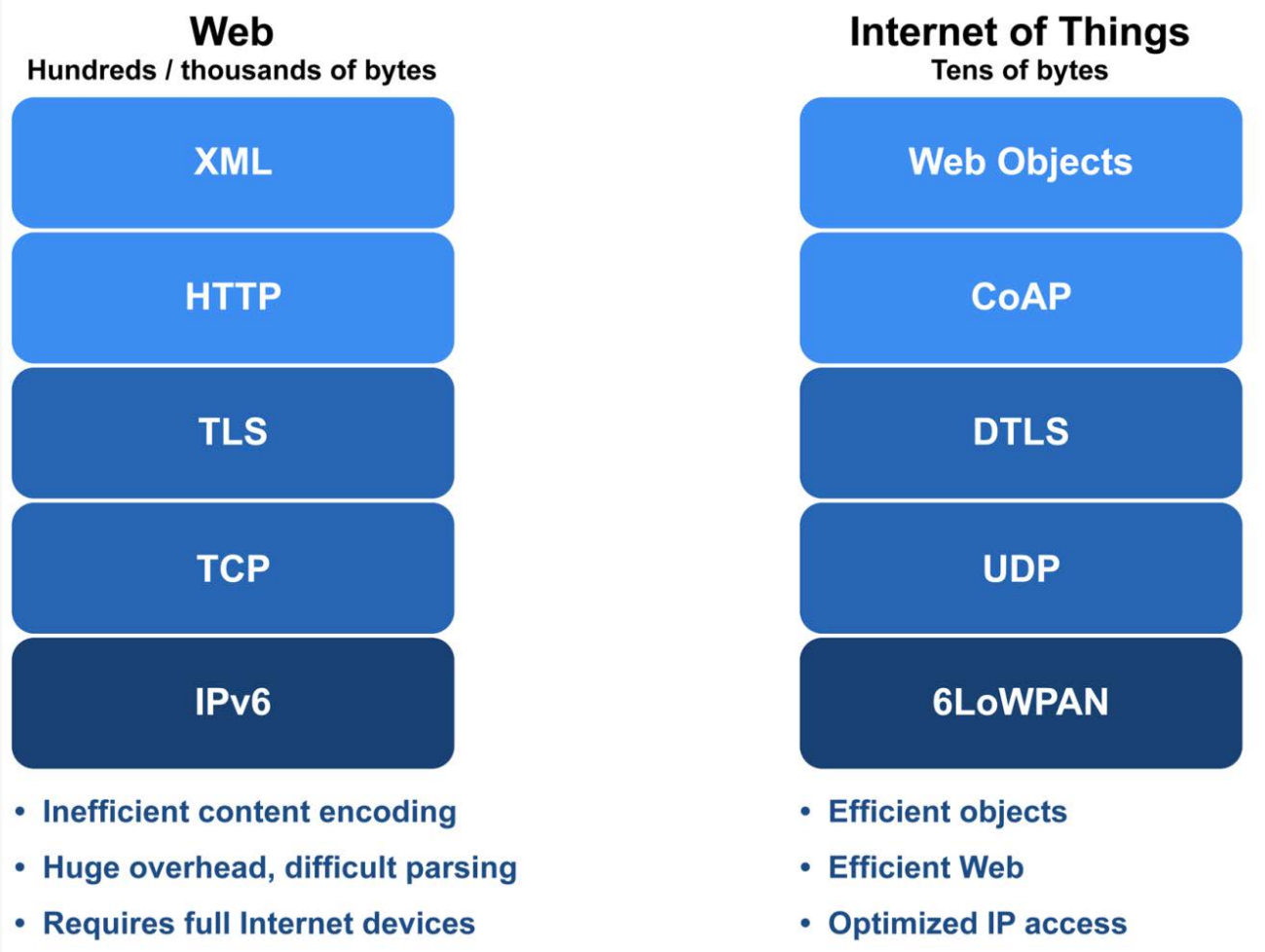
Scalable
- Load independent # apps

Managed with QoS

Reliable
- No single point of failure



Web Versus Dedicated IoT



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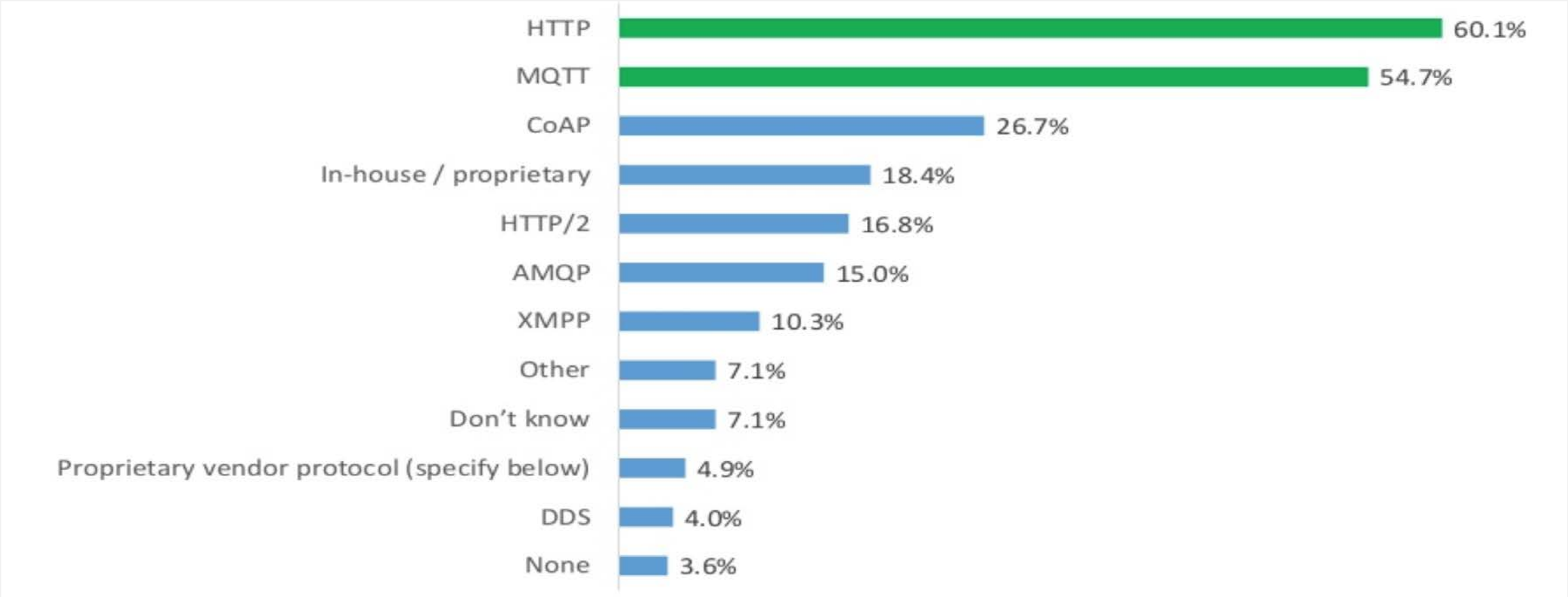

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So, which protocol do I use?

IoT Protocol Choice – It depends on your use case…

- There are 100's if not 1000's of different use cases
  - The needs of your use case will determine the protocol you need to use
- Define your system requirements very precisely, for example
  - What does 'real time' mean in your use case?
  - What is a 'thing' in your system?
  - What hardware resources are available to your 'things'?
- Choose the protocol that satisfies your system requirements
  - How you have defined your system will be critical to your choice of protocol(s)

Thank you.

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