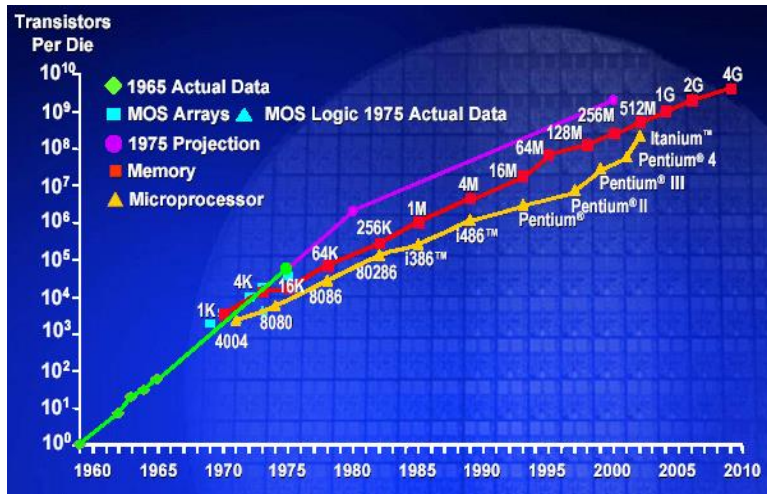


Technology Trends

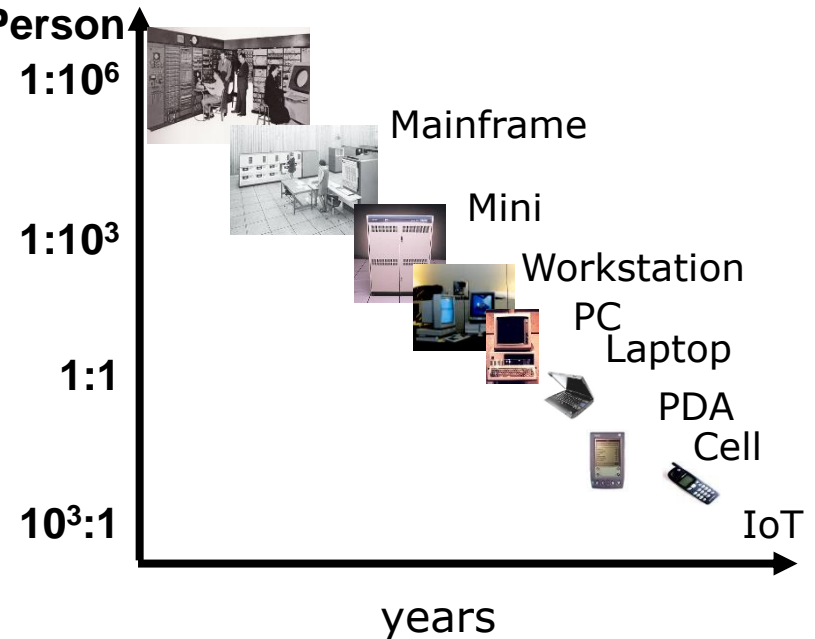
Moore's Law: # transistors on cost-effective chip doubles every 18 months



Today: 1 million transistors per \$

Bell's Law: a new computer class emerges every 10 years

Computers Per Person

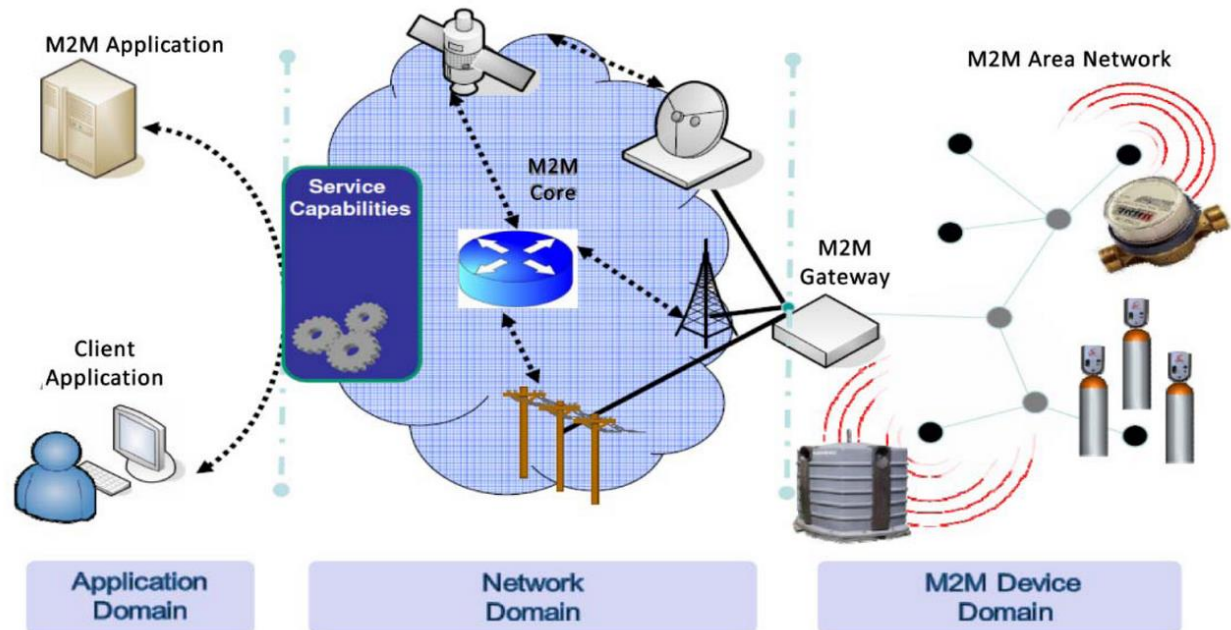


What is IoT?

- The Internet of things (IoT) is the **network** of physical devices, vehicles, home appliances and other items embedded with electronics, software, sensors, actuators, and network connectivity which enables these objects to connect and exchange data. Each thing is uniquely identifiable through its **embedded computing** system but is able to inter-operate within the existing Internet infrastructure.
- Experts estimate that the IoT will consist of about 30 billion objects by 2020. It is also estimated that the global market value of IoT will reach \$7.1 trillion by 2020.

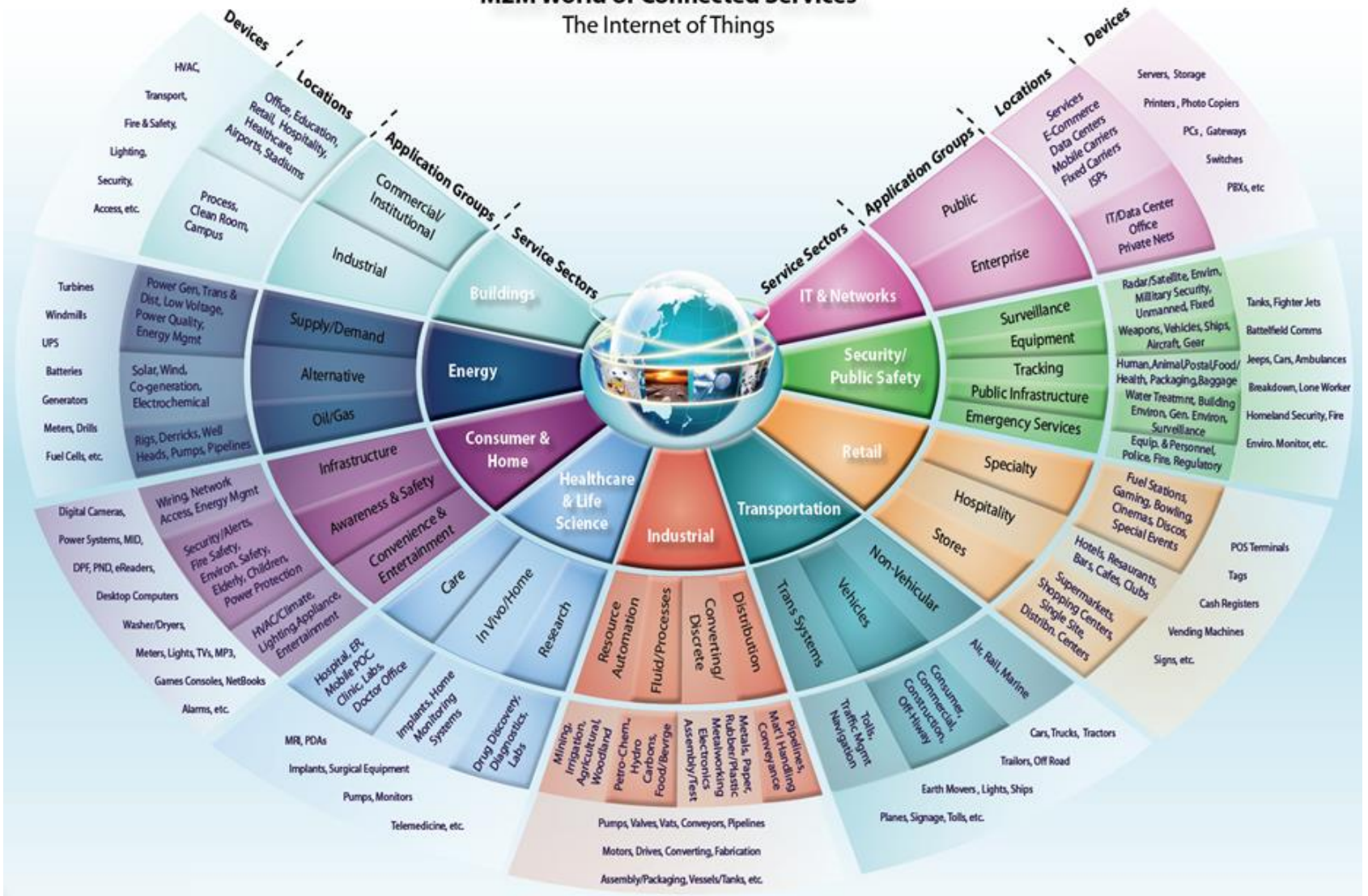
Various Names

- M2M (Machine to Machine)
- “Internet of Everything” (Cisco Systems)
- “World Size Web” (Bruce Schneier)
- “Skynet”



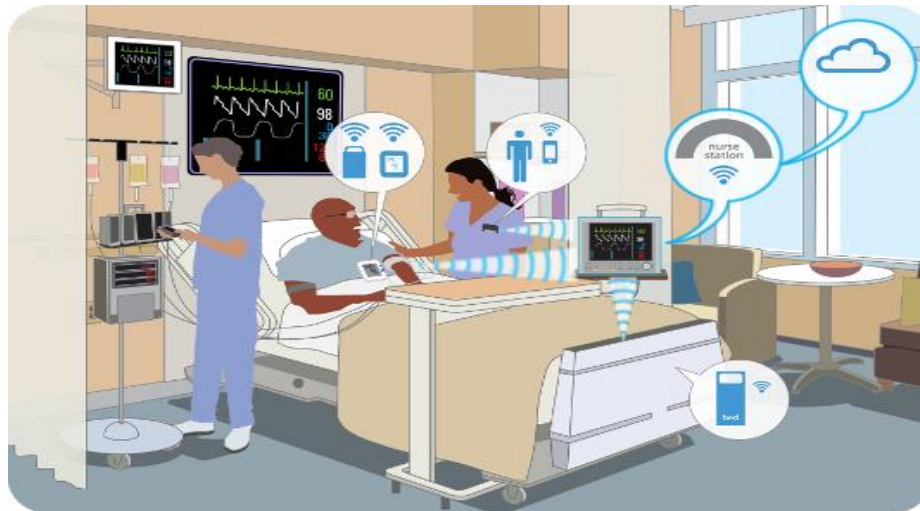
M2M World of Connected Services

The Internet of Things



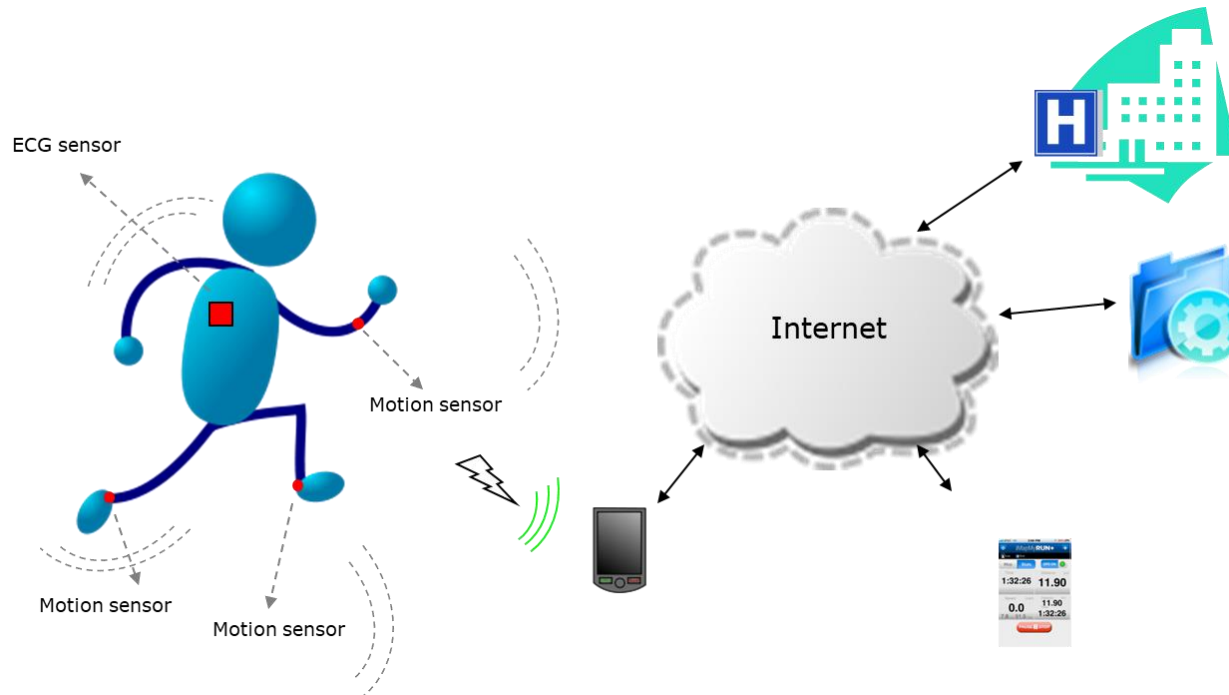
Where is IoT?

■ Everywhere



Trends

- Sensor devices are becoming widely available
- More “Things” are being connected
- People connecting to Things
- Things connecting to Things

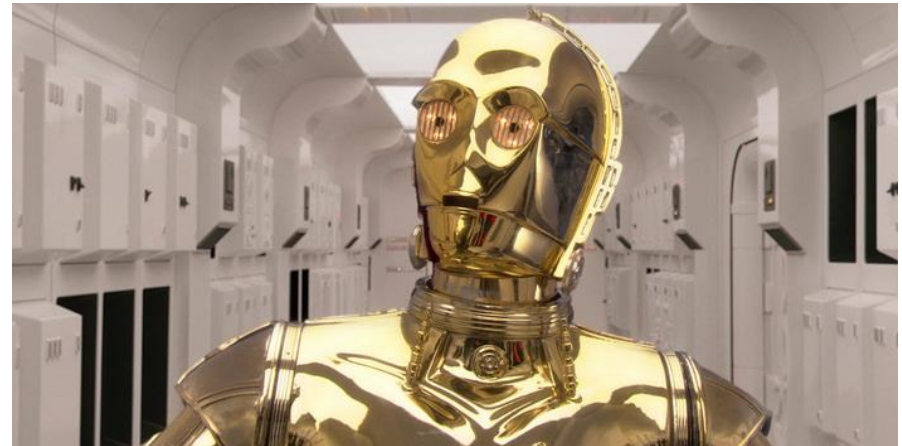


Communication Protocol

- In telecommunication, a communication protocol is a system of rules that allow two or more entities of a communications system to transmit information via any kind of variation of a physical quantity. The protocol defines the rules syntax, semantics and synchronization of communication and possible error recovery methods. Protocols may be implemented by hardware, software, or a combination of both.[1]
- Communicating systems use well-defined formats (protocol) for exchanging various messages.

-Wikipedia

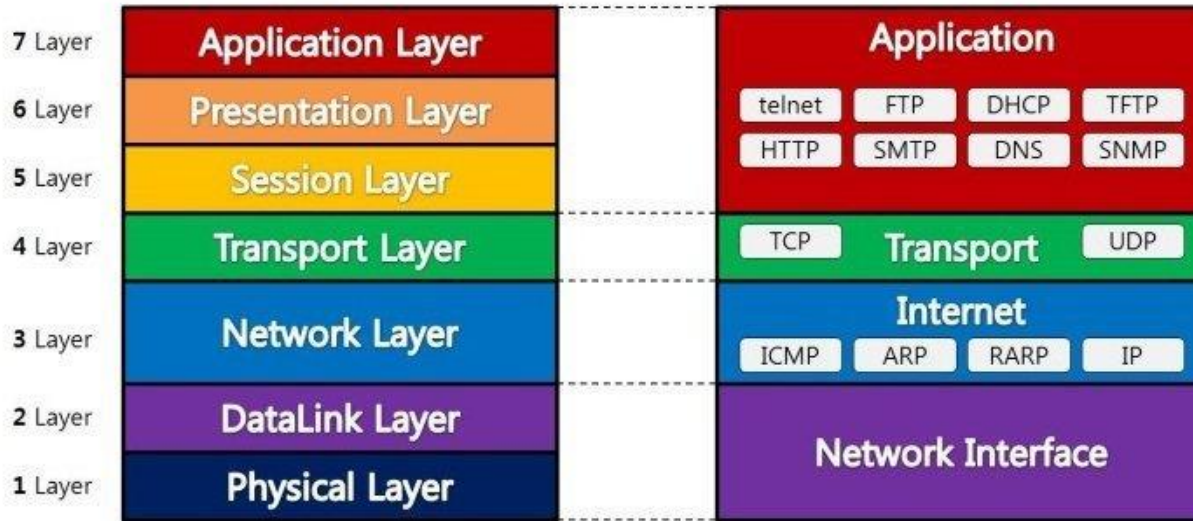
C3PO: Protocol Droid



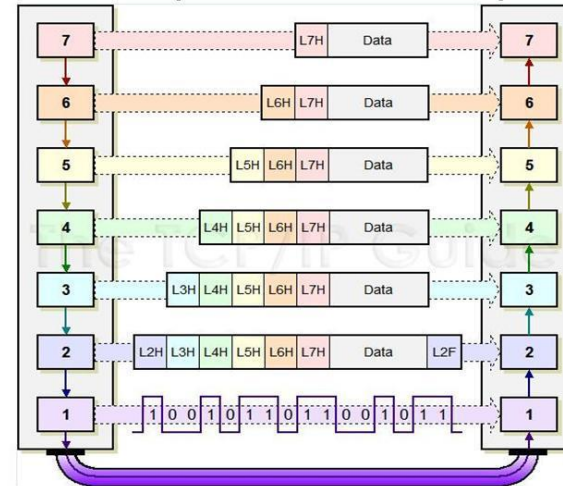
OSI Model (Open Systems Interconnection Model)

OSI 7 Layer Model

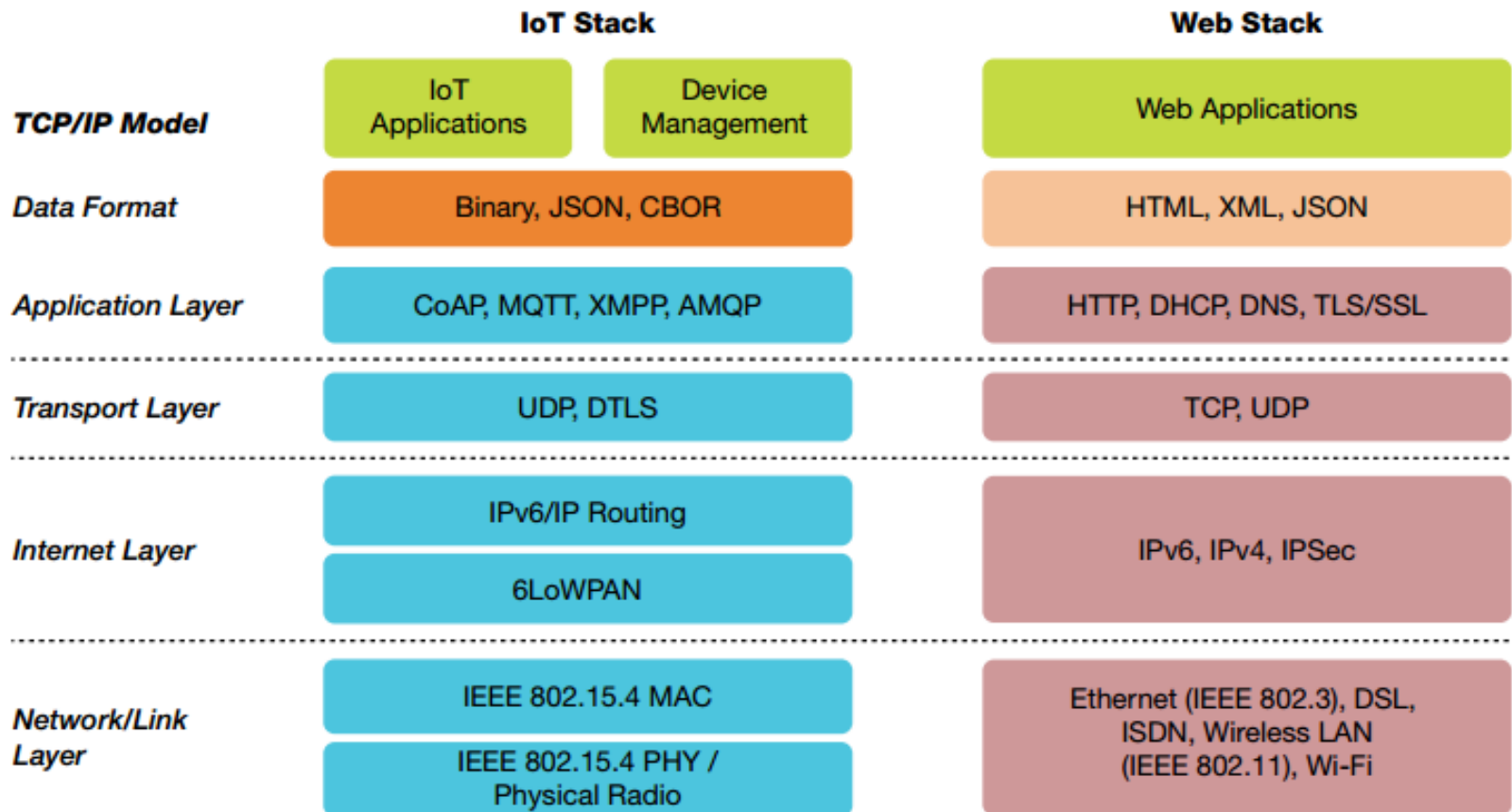
TCP/IP Protocol



Data encapsulation & de-encapsulation



IoT Protocol Stack



Standardization

■ HTTP

- ▶ IETF standard (RFC 2616 is HTTP/1.1)

■ CoAP

- ▶ IETF standard (RFC 7252)

■ MQTT

- ▶ OASIS standard (v3.1.1)

■ AMQP

- ▶ OASIS and ISO 19464 standard (1.0)

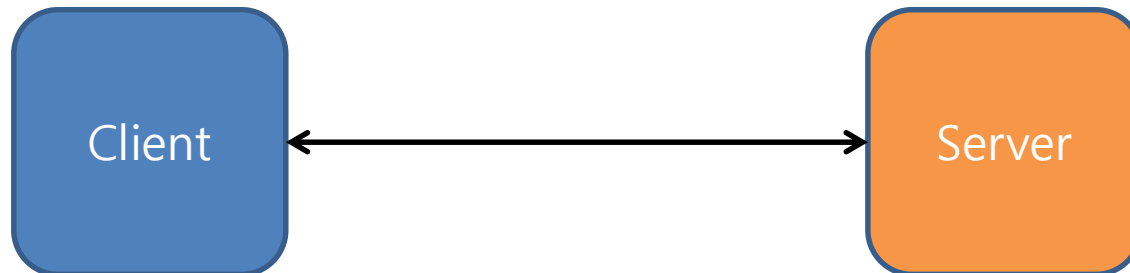
Architecture: HTTP & CoAP

■ Client/Server

- ▶ request/response
 - HTTP : synchronous
 - CoAP : (also) asynchronous

■ HTTP is ASCII based

■ CoAP is binary based

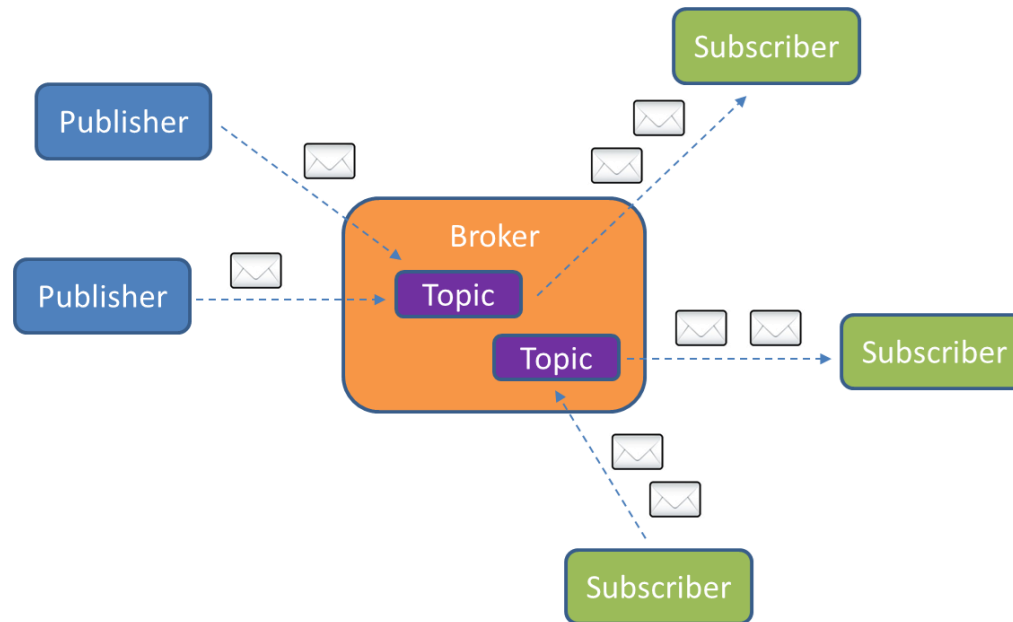


Architecture: MQTT

■ Broker and connected Clients

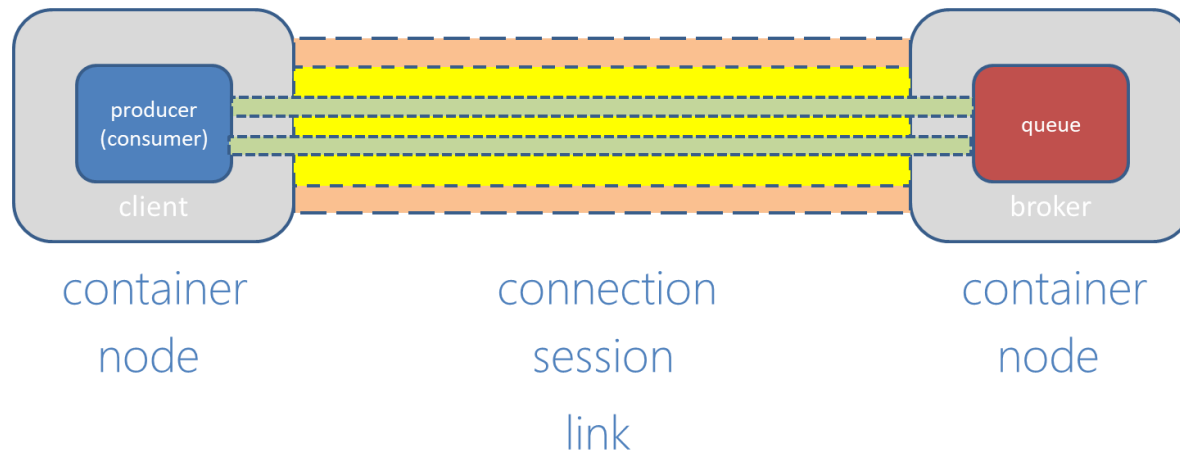
- ▶ broker receives subscriptions from clients on topics
- ▶ broker receives messages and forward them
- ▶ clients subscribe/publish on topics

■ Brokers bridge configuration

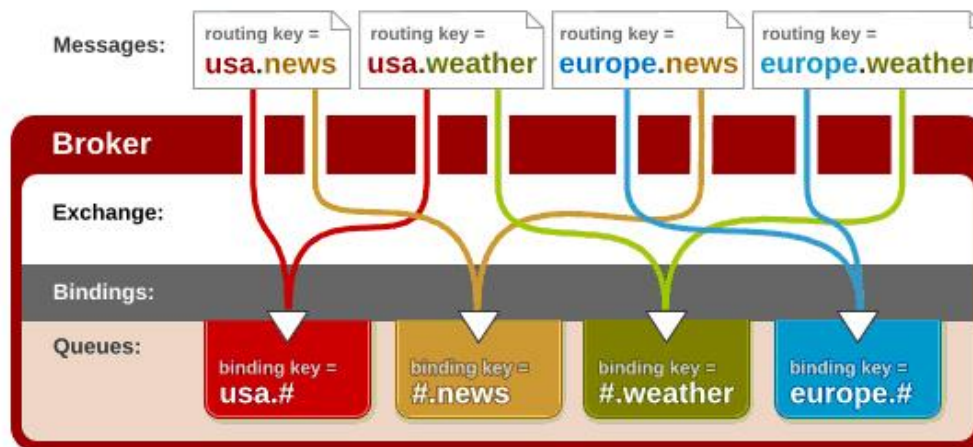


Architecture: AMQP(1.0)

■ Multiplexing frames on sessions and links



Topic Exchange



IoT Communication Patterns



Telemetry

Information flows from device to other systems for conveying status changes in the device



1:N



Inquiries

Requests from devices looking to gather required information or asking to initiate activities



1:N



Commands

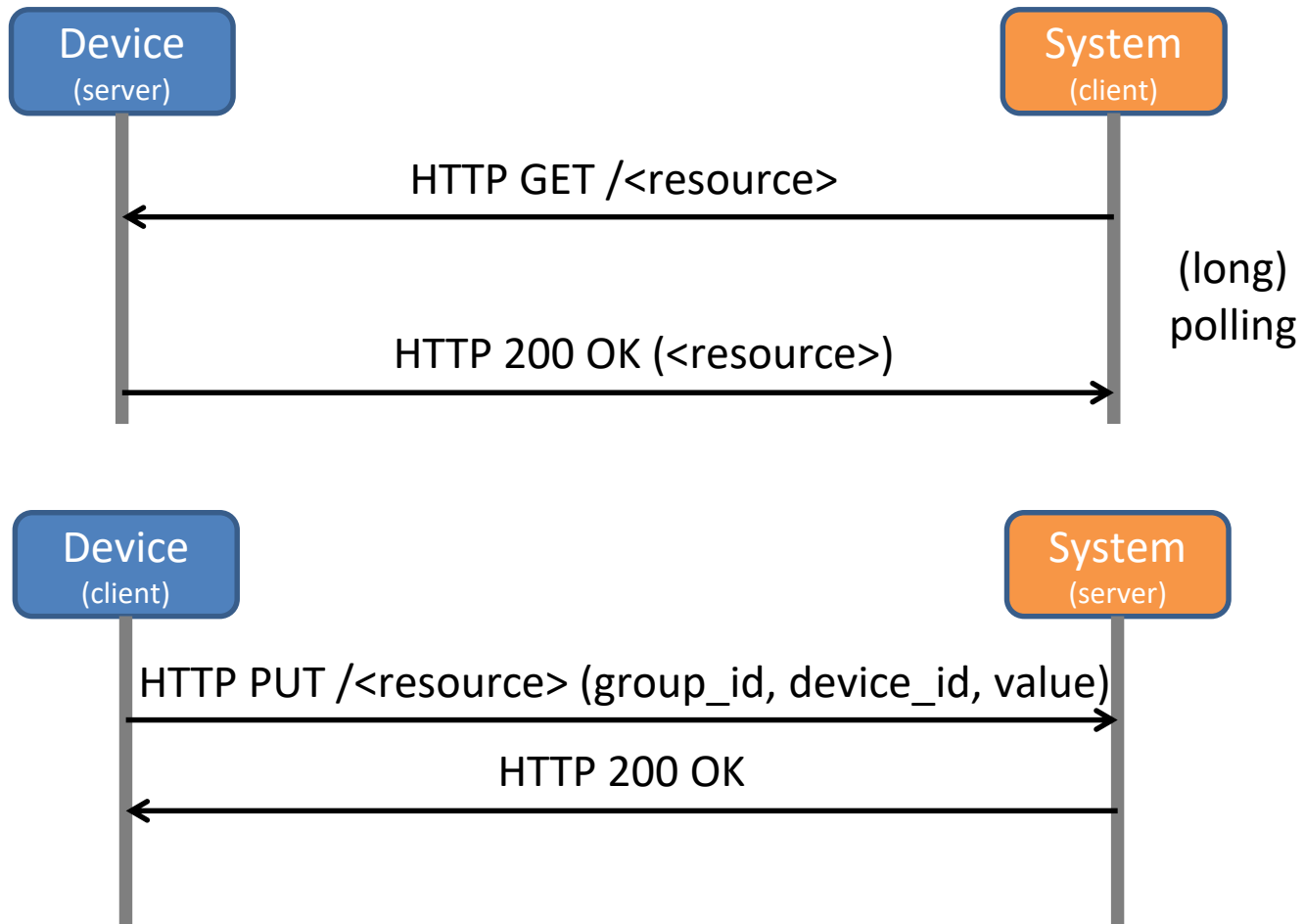
Commands from other systems to a device or a group of devices to perform specific activities



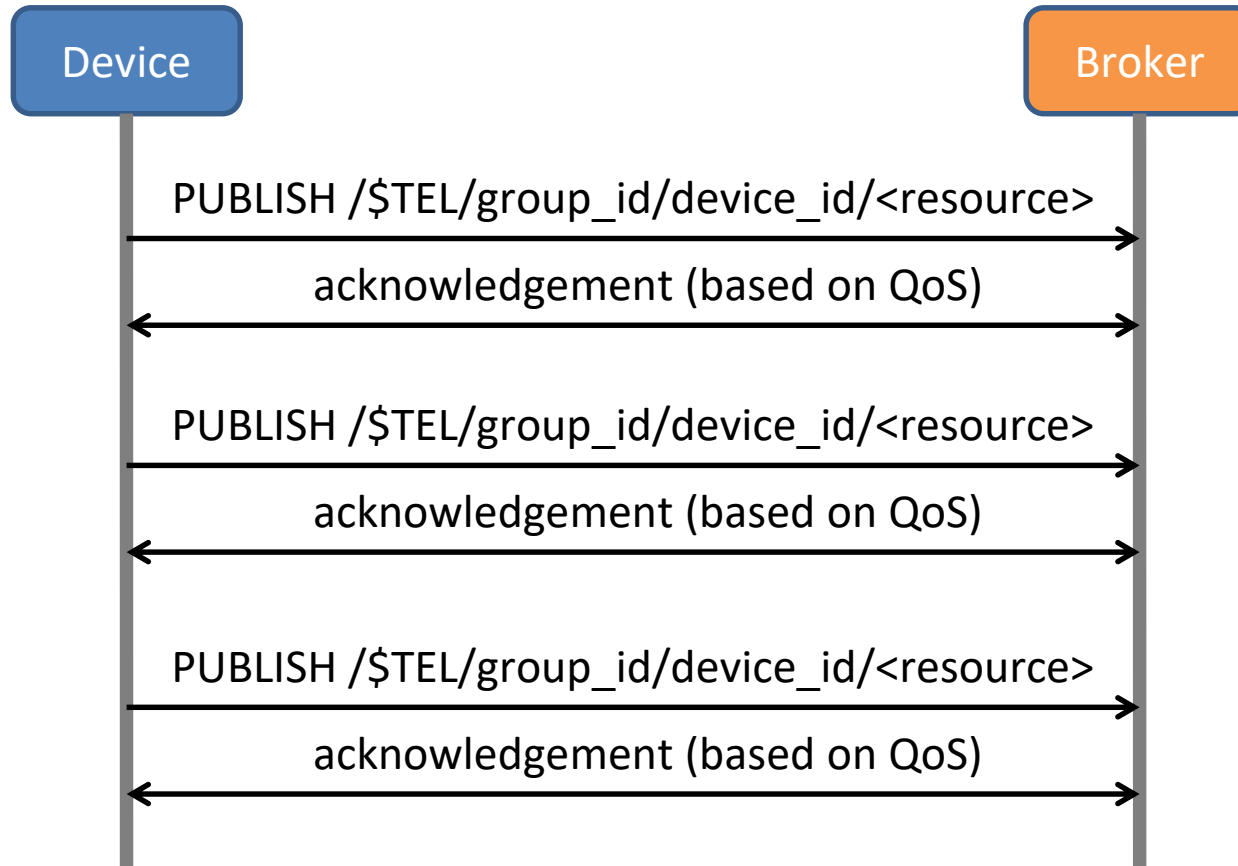
Notifications

Information flows from other systems to a device (-group) for conveying status changes in the world

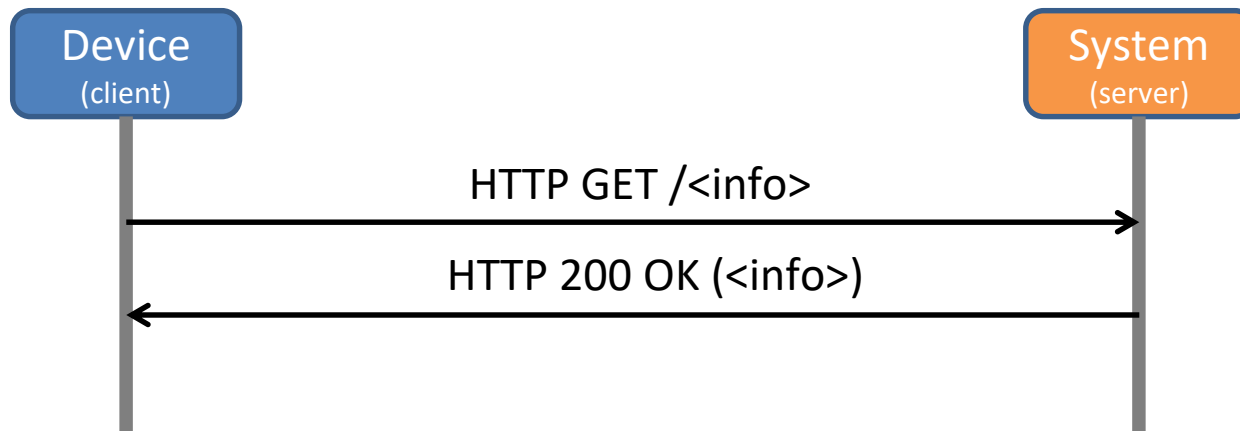
Telemetry: HTTP



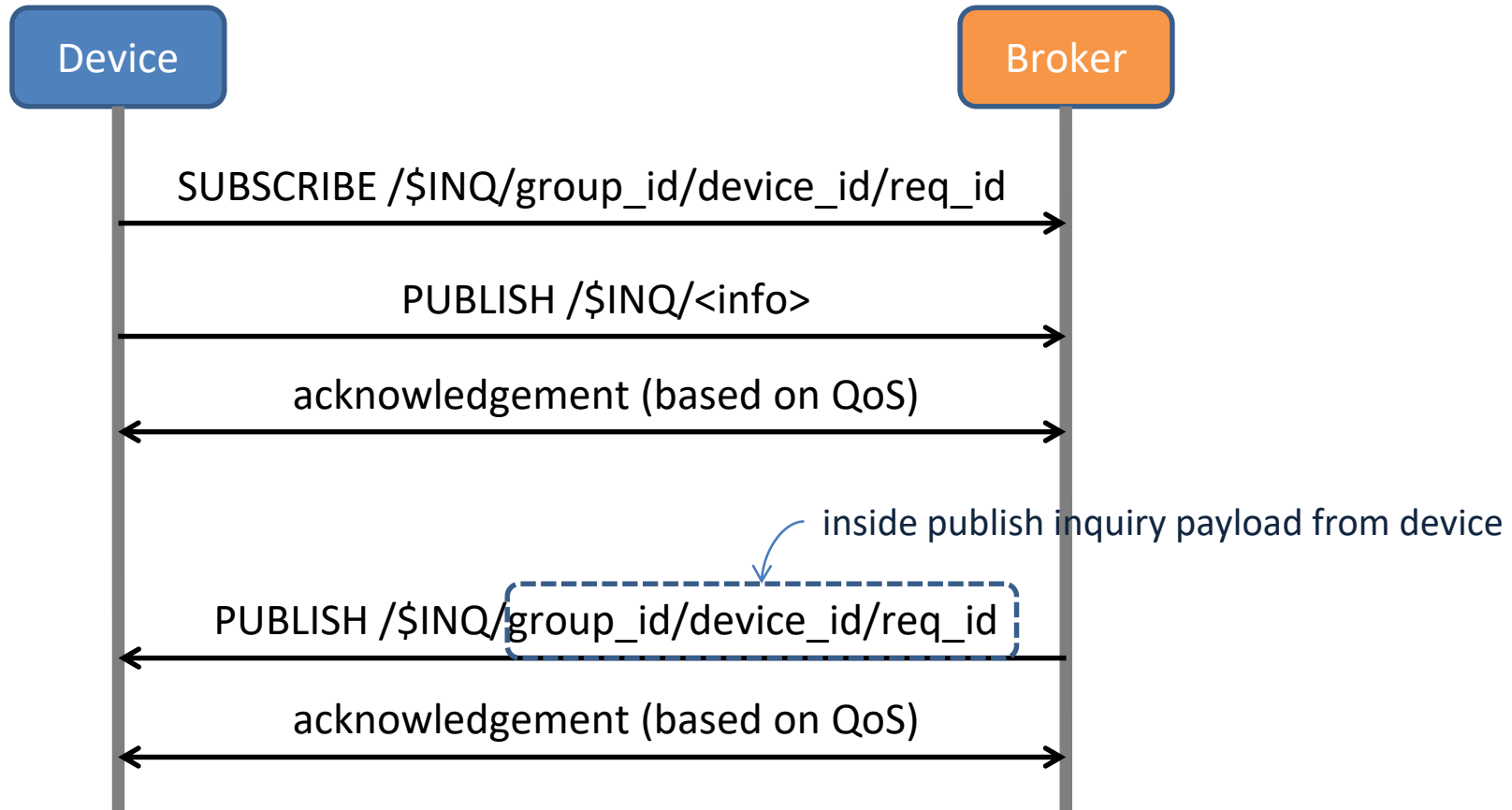
Telemetry: MQTT



Inquiry: HTTP



Inquiry: MQTT



IoT Protocol Conclusion

- protocol choice depends on scenario
- some protocols have more features than other
- a complex system can use more protocols

