Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

CS2031 Telecommunications II

MQTT

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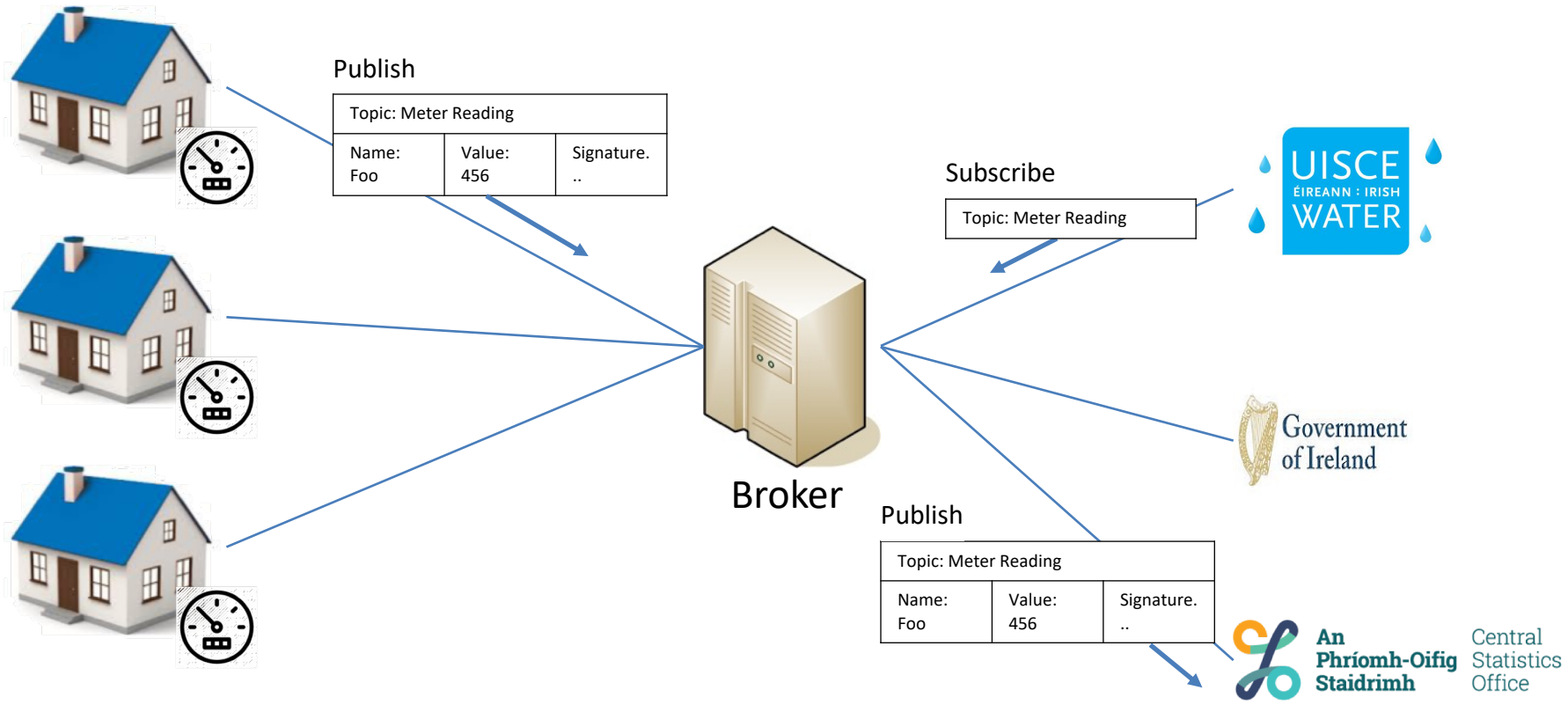
Pub-Sub Killer App

(Irish Water ☺ - Disclaimer: this is not real!)



MQTT Header Format

- General structure of a packet

Figure 2-1 Structure of an MQTT Control Packet

Fixed Header, present in all MQTT Control Packets
Variable Header, present in some MQTT Control Packets
Payload, present in some MQTT Control Packets

- Header for all MQTT packets

Figure 2-2 Fixed Header format

Bit	7	6	5	4	3	2	1	0
byte 1	MQTT Control Packet type				Flags specific to each MQTT Control Packet type			
byte 2…	Remaining Length							

CONNECT Packet

- Protocol Name (clear text - really????)

Figure 3-2 - Protocol Name bytes

	Description	7	6	5	4	3	2	1	0
Protocol Name									
byte 1	Length MSB (0)	0	0	0	0	0	0	0	0
byte 2	Length LSB (4)	0	0	0	0	0	1	0	0
byte 3	'M'	0	1	0	0	1	1	0	1
byte 4	'Q'	0	1	0	1	0	0	0	1
byte 5	'T'	0	1	0	1	0	1	0	0
byte 6	'T'	0	1	0	1	0	1	0	0

- Protocol Version and Connect Flags

Figure 3-3 - Protocol Version byte

	Description	7	6	5	4	3	2	1	0
Protocol Level									
byte 7	Version(5)	0	0	0	0	0	1	0	1

Figure 3-4 - Connect Flag bits

Bit	7	6	5	4	3	2	1	0
	User Name Flag	Password Flag	Will Retain	Will QoS		Will Flag	Clean Start	Reserved
byte 8	X	X	X	X	X	X	X	0

Complete CONNECT Header

Bit	7	6	5	4	3	2	1	0
byte 1	MQTT Control Packet type				Flags specific to each MQTT Control Packet type			
byte 2…	Remaining Length							
Protocol Name								
byte 1	Length MSB (0)				0	0	0	0
byte 2	Length LSB (4)				0	0	1	0	0
byte 3	'M'				0	1	0	0	1	1	0	1
byte 4	'Q'				0	1	0	1	0	0	0	1
byte 5	'T'				0	1	0	1	0	1	0	0
byte 6	'T'				0	1	0	1	0	1	0	0
Protocol Version								
	Description				**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
byte 7	Version (5)				0	0	0	0	0	1	0	1
Connect Flags								
byte 8	User Name Flag (1) Password Flag (1) Will Retain (0) Will QoS (01) Will Flag (1) Clean Start(1) *Reserved* (0)				1	1	0	0	1	1	1	0
Keep Alive								
byte 9	Keep Alive MSB (0)				0	0	0	0	0	0	0	0
byte 10	Keep Alive LSB (10)				0	0	0	0	1	0	1	0
Properties								
byte 11	Length (5)				0	0	0	0	0	1	0	1
byte 12	Session Expiry Interval identifier (17)				0	0	0	1	0	0	0	1
byte 13	Session Expiry Interval (10)				0	0	0	0	0	0	0	0
byte 14					0	0	0	0	0	0	0	0

CONNACK Header

- Connection acknowledgement
  - ack flags and result in 2 bytes
  - plus a variable number of properties

Figure 2-1 Structure of an MQTT Control Packet

Fixed Header, present in all MQTT Control Packets
Variable Header, present in some MQTT Control Packets
Payload, present in some MQTT Control Packets

Figure 3-7 – CONNACK packet Fixed Header

Bit	7	6	5	4	3	2	1	0
byte 1	MQTT Control Packet Type (2)				Reserved			
	0	0	1	0	0	0	0	0
byte 2	Remaining Length							

Bit	7	6	5	4	3	2	1	0
byte 1	Connect Acknowledge Flags							
byte 2	Connect Reason							
	Variable Property information e.g. 0x15 followed by a string indicating the authentication method							

PUBLISH Header

- Connection acknowledgement
  - ack flags and result in 2 bytes
  - plus a variable number of properties

Figure 3-8 – PUBLISH packet Fixed Header

Bit	7	6	5	4	3	2	1	0
byte 1	MQTT Control Packet type (3)				DUP flag	QoS level		RETAIN
	0	0	1	1	X	X	X	X
byte 2…	Remaining Length							

Figure 3-9 - PUBLISH packet Variable Header non-normative example

	Description	7	6	5	4	3	2	1	0
Topic Name									
byte 1	Length MSB (0)	0	0	0	0	0	0	0	0
byte 2	Length LSB (3)	0	0	0	0	0	0	1	1
byte 3	'a' (0x61)	0	1	1	0	0	0	0	1
byte 4	'/' (0x2F)	0	0	1	0	1	1	1	1
byte 5	'b' (0x62)	0	1	1	0	0	0	1	0
Packet Identifier									
byte 6	Packet Identifier MSB (0)	0	0	0	0	0	0	0	0
byte 7	Packet Identifier LSB (10)	0	0	0	0	1	0	1	0
Property Length									
byte 8	No Properties	0	0	0	0	0	0	0	0

Variable Byte Integer

Property Length									
byte 8	No Properties	0	0	0	0	0	0	0	0

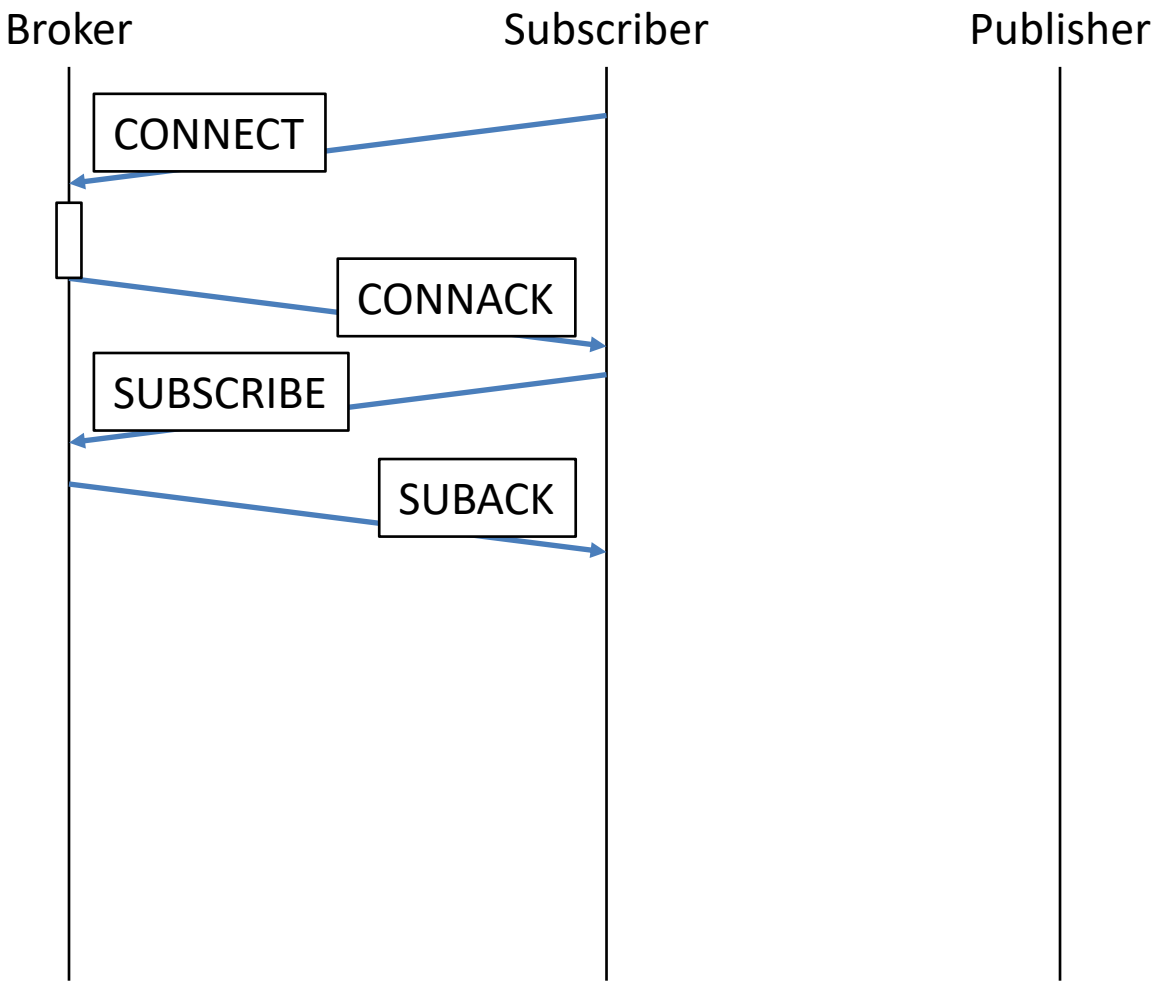
Table 1-1 Size of Variable Byte Integer

Digits	From	To
1	0 (0x00)	127 (0x7F)
2	128 (0x80, 0x01)	16,383 (0xFF, 0x7F)
3	16,384 (0x80, 0x80, 0x01)	2,097,151 (0xFF, 0xFF, 0x7F)
4	2,097,152 (0x80, 0x80, 0x80, 0x01)	268,435,455 (0xFF, 0xFF, 0xFF, 0x7F)

```
multiplier = 1
value = 0
do
        encodedByte = 'next byte from stream'
        value += (encodedByte AND 127) * multiplier
        if (multiplier > 128*128*128)
                throw Error(Malformed Variable Byte Integer)
        multiplier *= 128
while ((encodedByte AND 128) != 0)
```

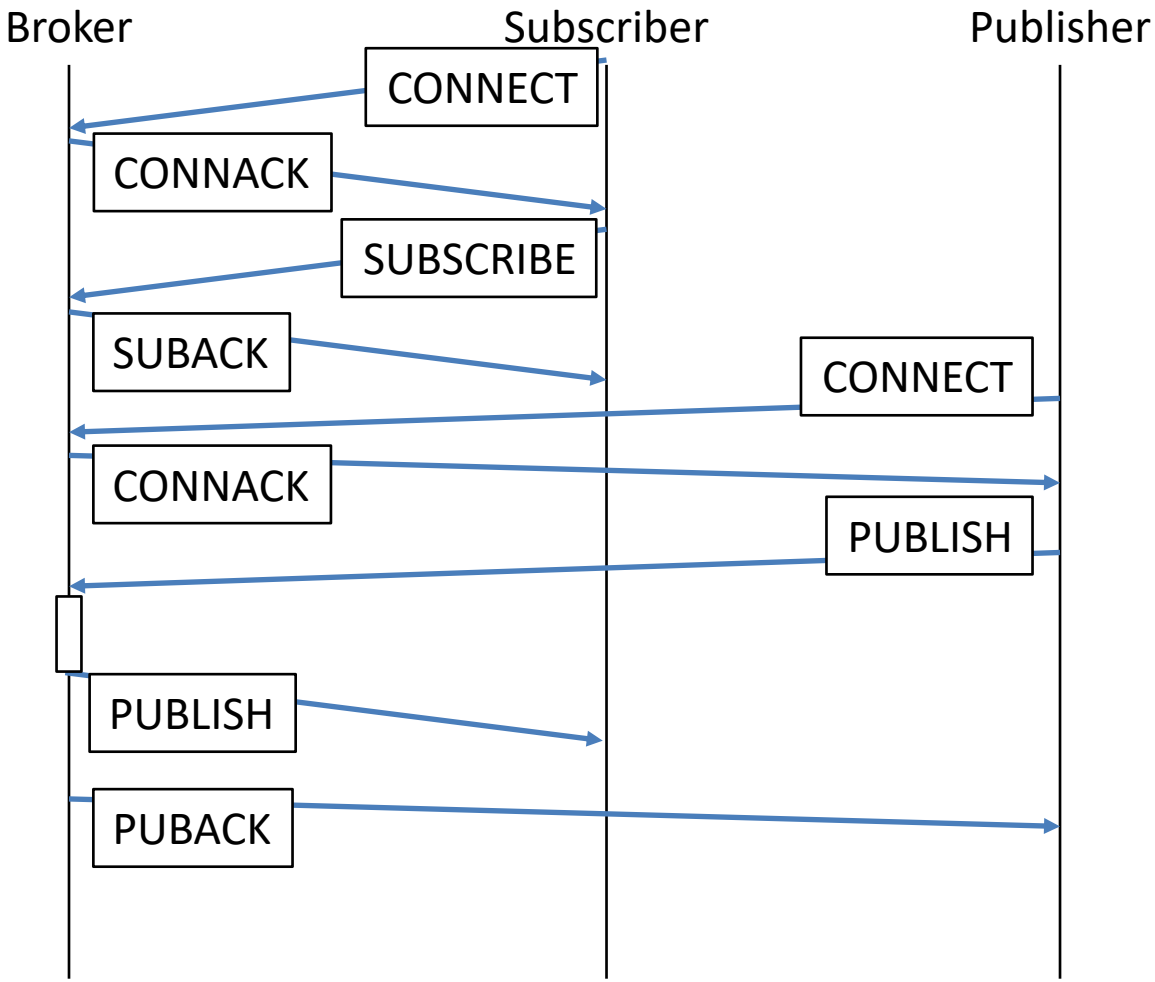
MQTT Sequence Diagram

Connection from Subscriber



MQTT Sequence Diagram

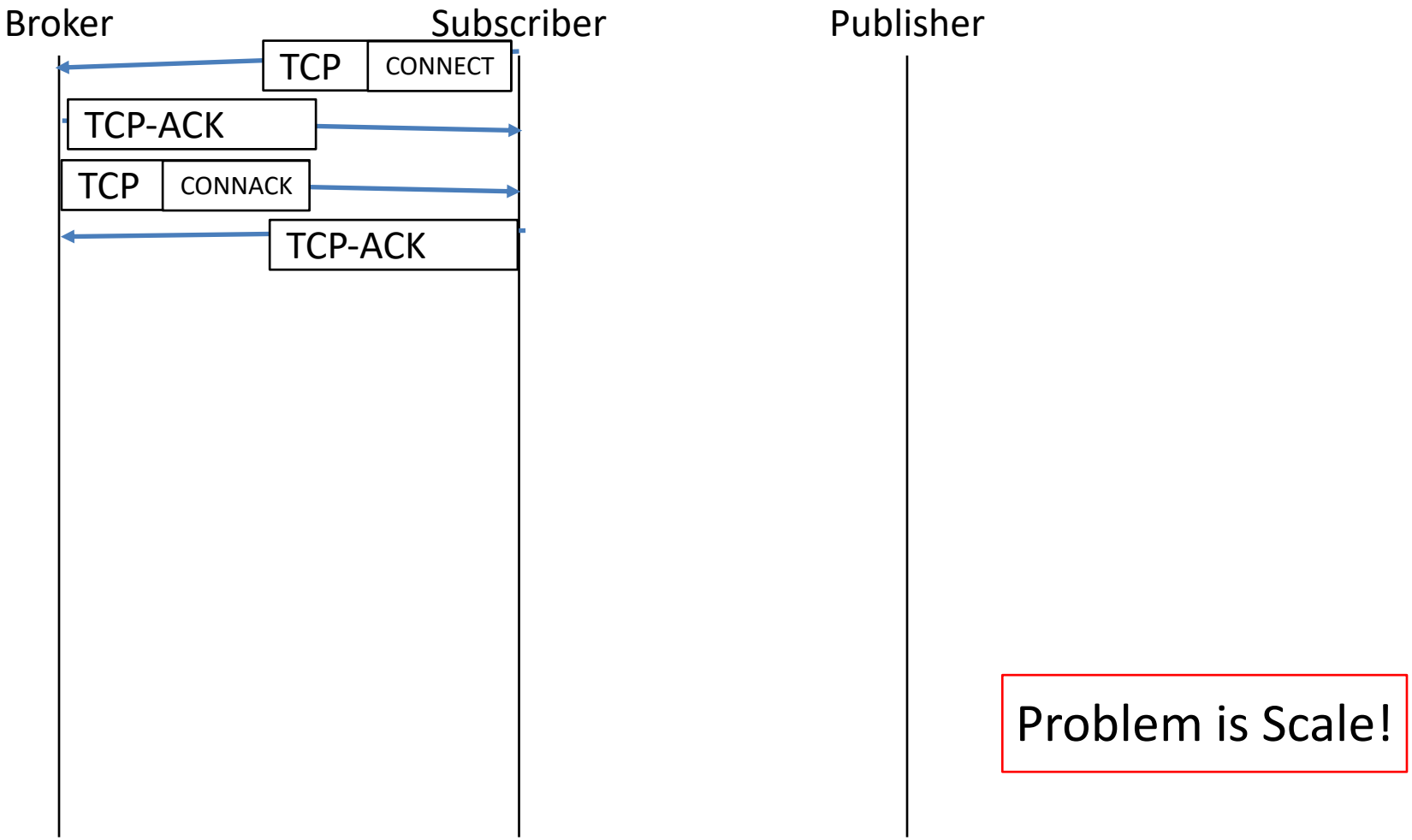
+ Connection from Publisher



Problem is Scale!

Critique on MQTT

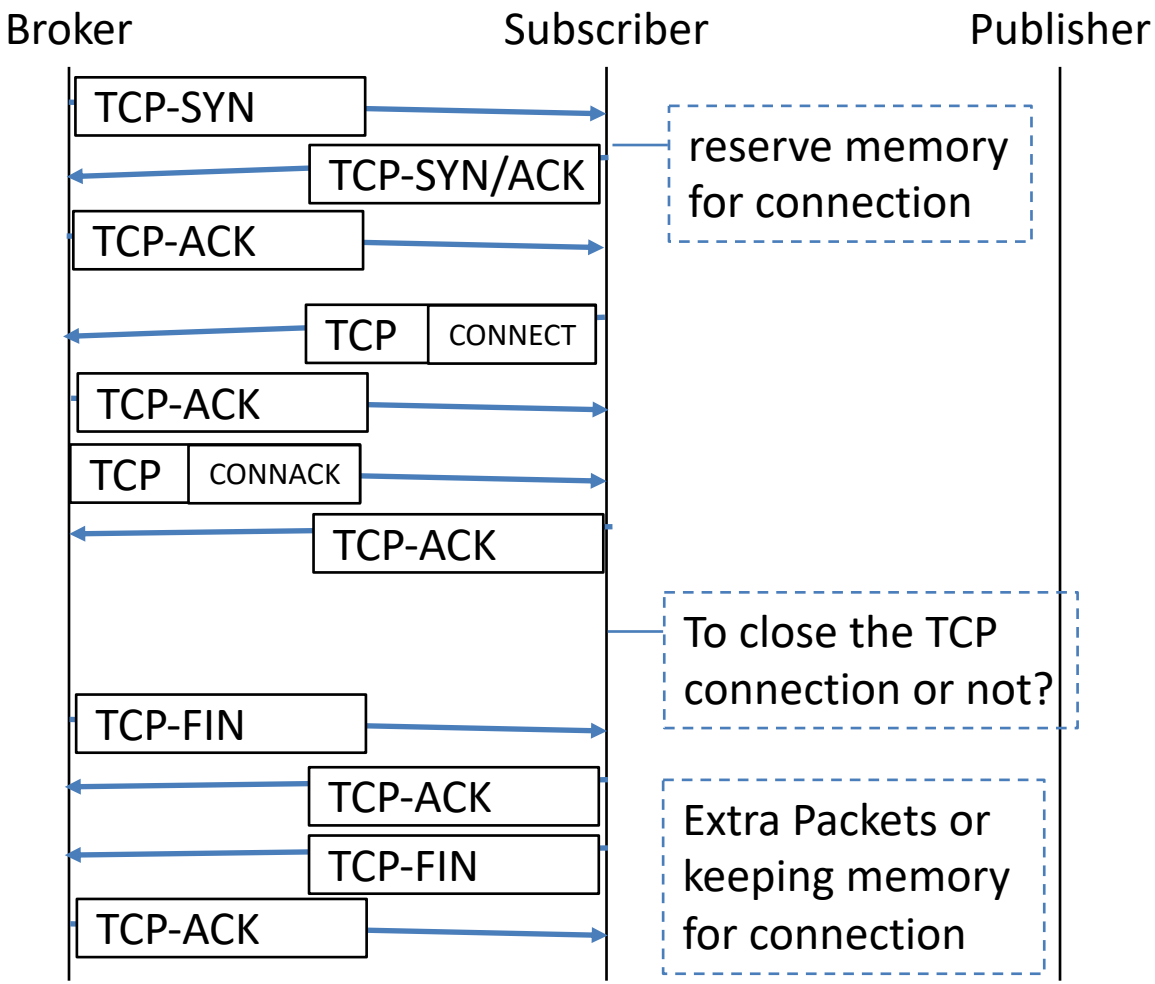
TCP Acknowledgements



Problem is Scale!

Critique on MQTT

+ TCP Connections



Problem is Scale!

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