Event Based Approaches

Oxford University
Software Engineering
Programme
April 2021

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Why Asynchronous?

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Loose coupling

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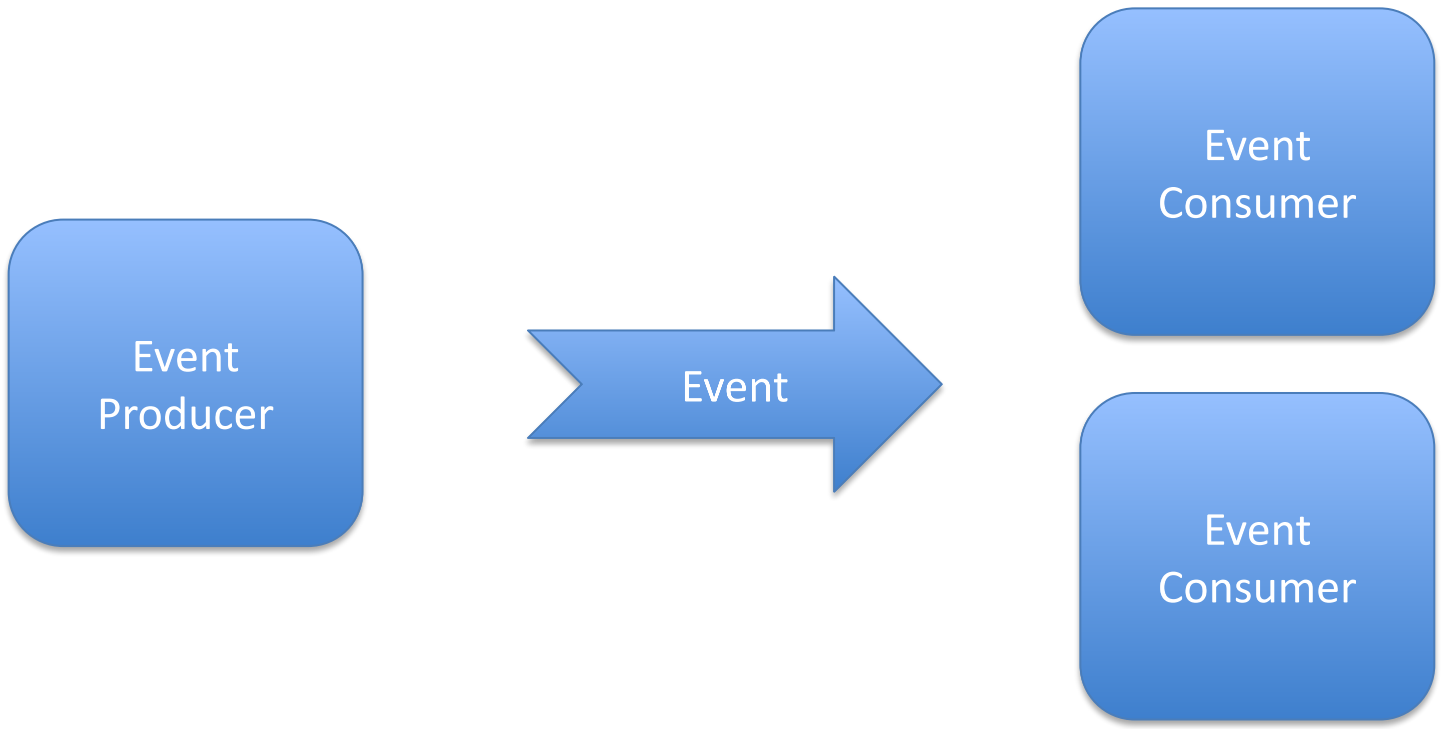
Event Driven Architecture



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Loose coupling in EDA

- Location
  - Logical addresses
- Time
  - Asynchronous, Store/Forward, Replay
- Message
  - JSON, XML, ProtoBuf, etc
- Pattern
  - Pub/Sub, Queue, 1-1, 1-many, many-many, request-reply

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EDA

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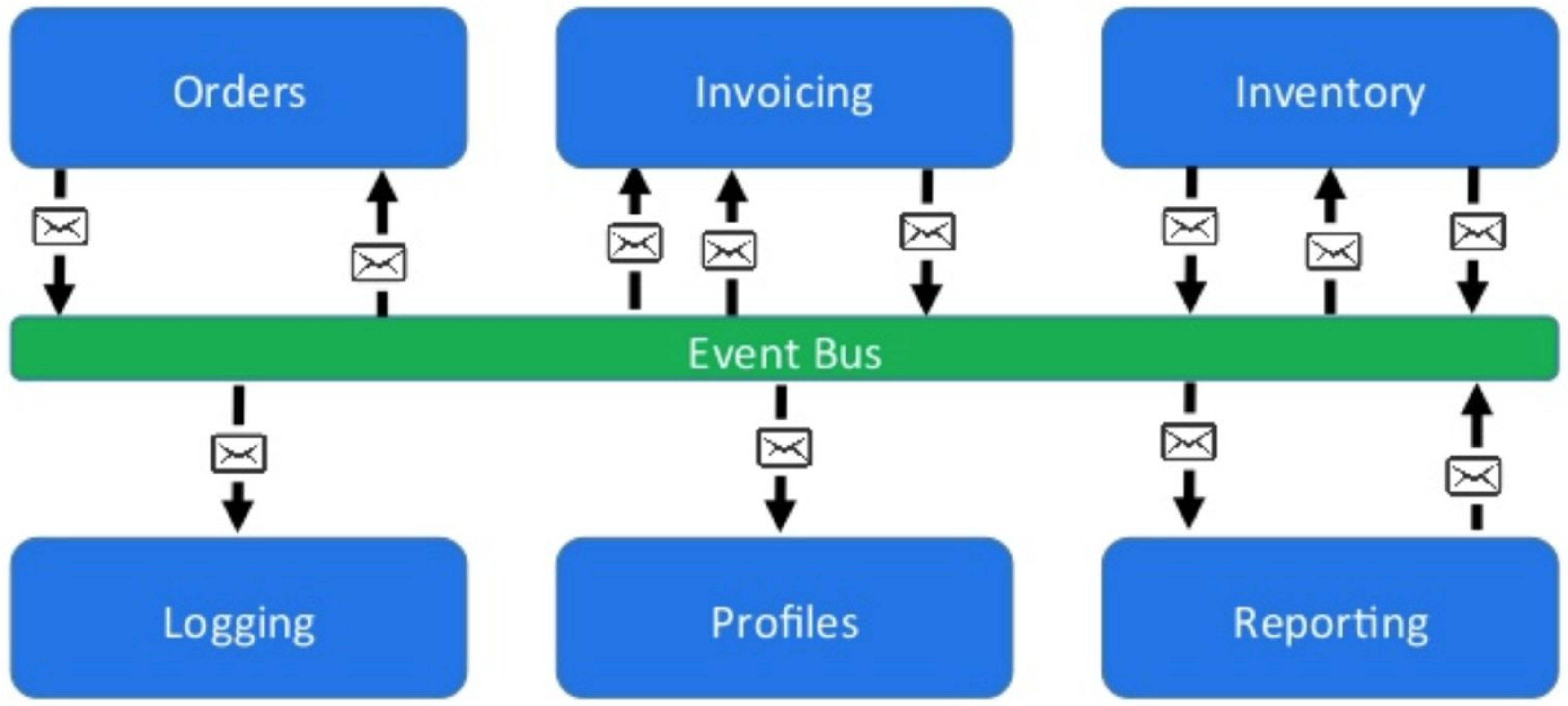
Loose coupling via event bus



https://www.slideshare.net/CentricConsulting/eventdriven-architecture-57613466

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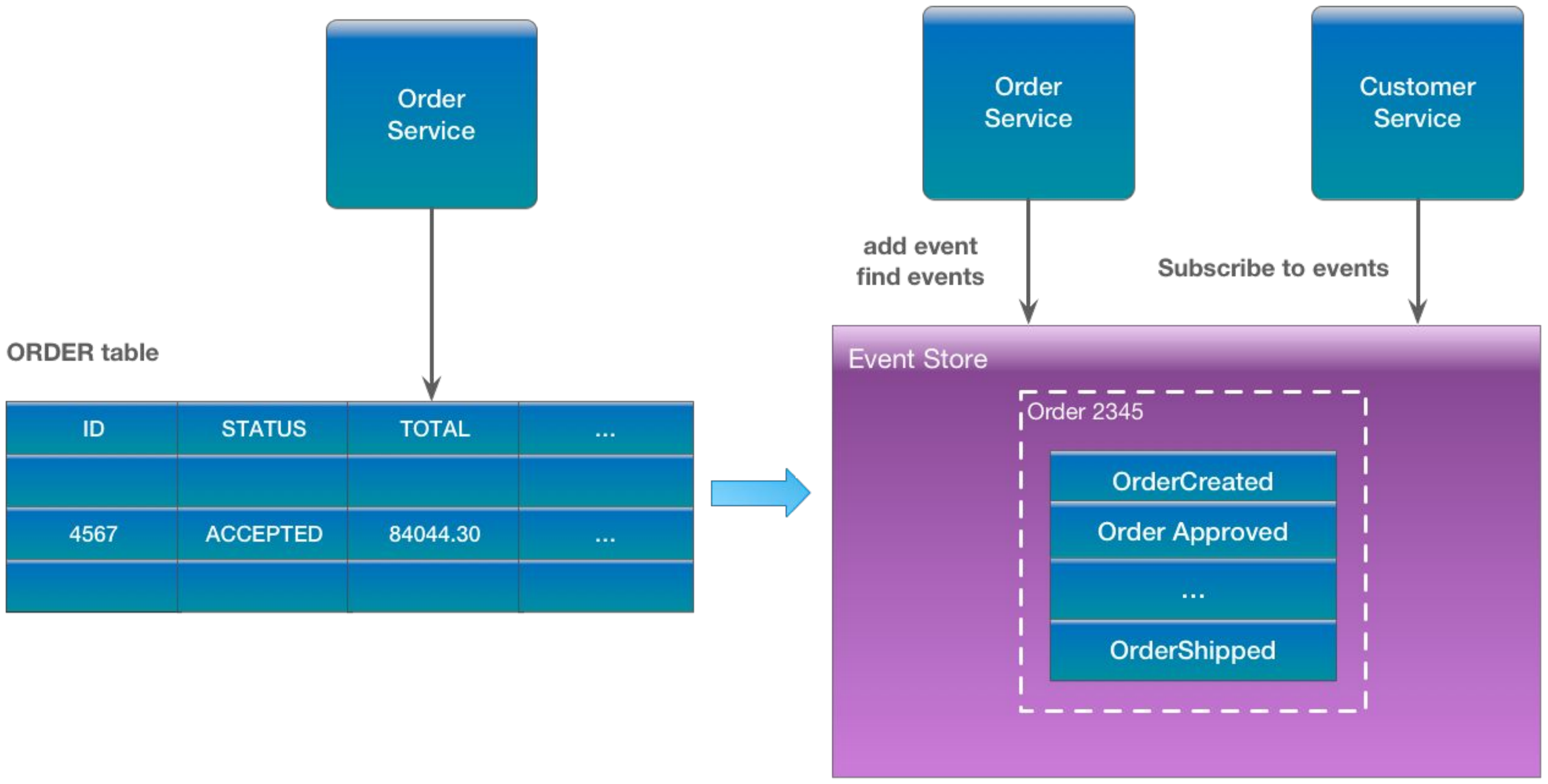
Event Sourcing



https://eventuate.io/whyeventsourcing.html

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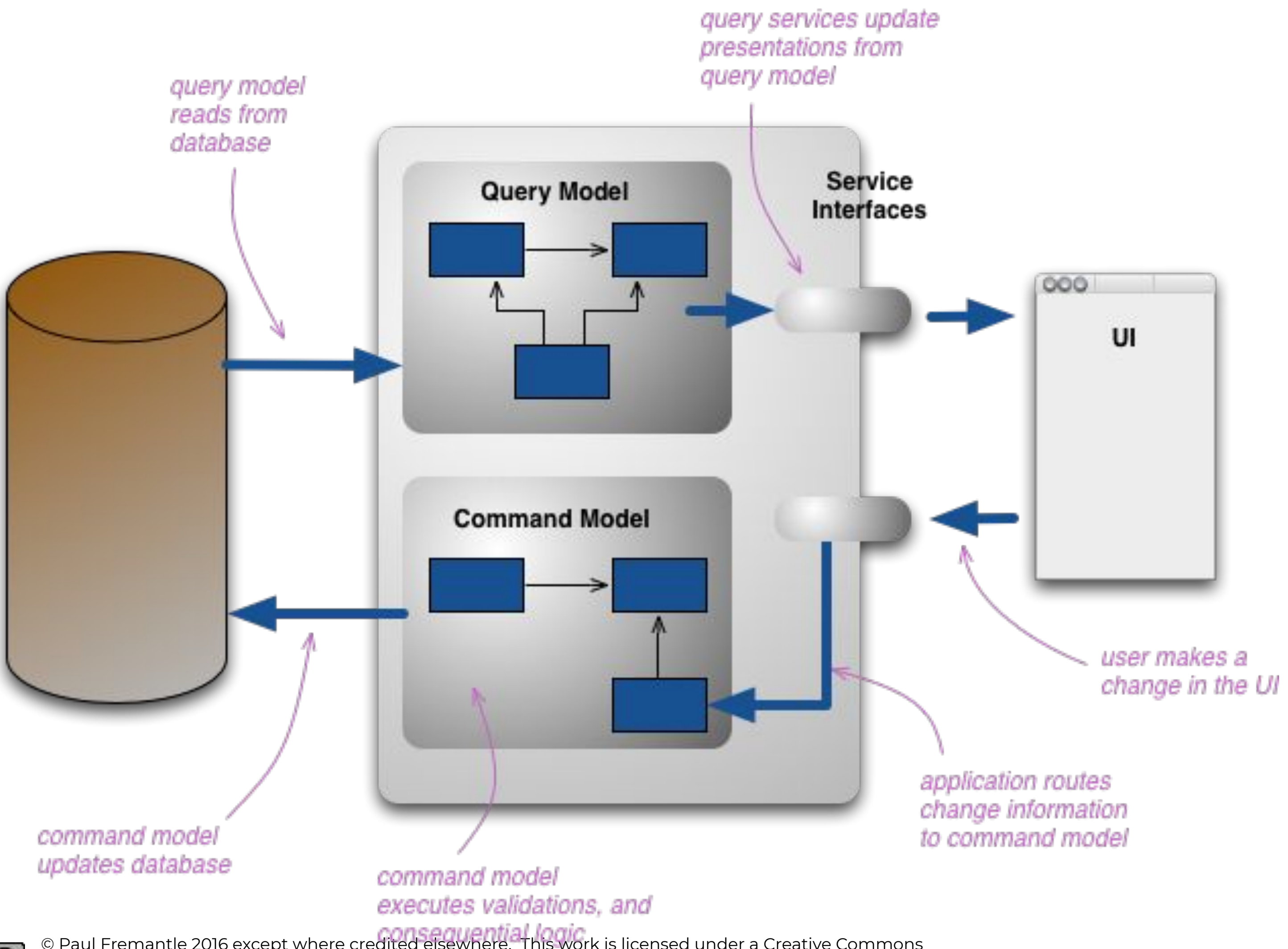
Command Query Responsibility Separation


query model reads from database
query services update presentations from query model
Query Model
Service Interfaces
UI
Command Model
user makes a change in the UI
command model updates database
application routes change information to command model
command model executes validations, and consequential logic

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https://martinfowler.com/bliki/CQRS.html

Message distribution systems

- NATS
- MQTT
- STOMP
- AMQP / RabbitMQ
- Kafka

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NATS

- Simple text based protocol
- Multiple patterns
  - Pure Pub/Sub
  - Request-Reply
  - Queuing
- Clustered servers
  - Distributed queue across clusters
  - Cluster aware clients

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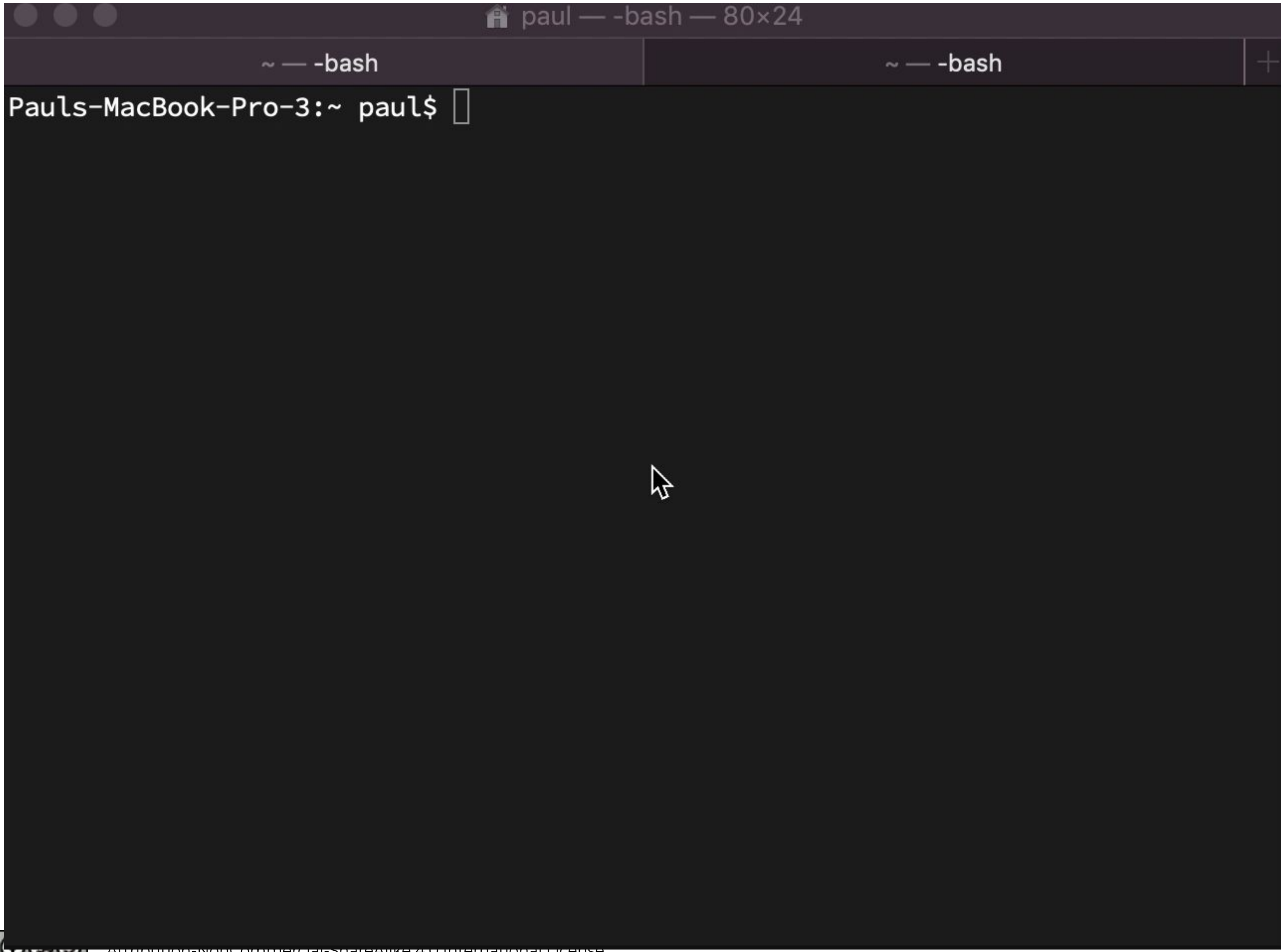
NATS simple demo



```
Pauls-MacBook-Pro-3:~ paul$ 
```

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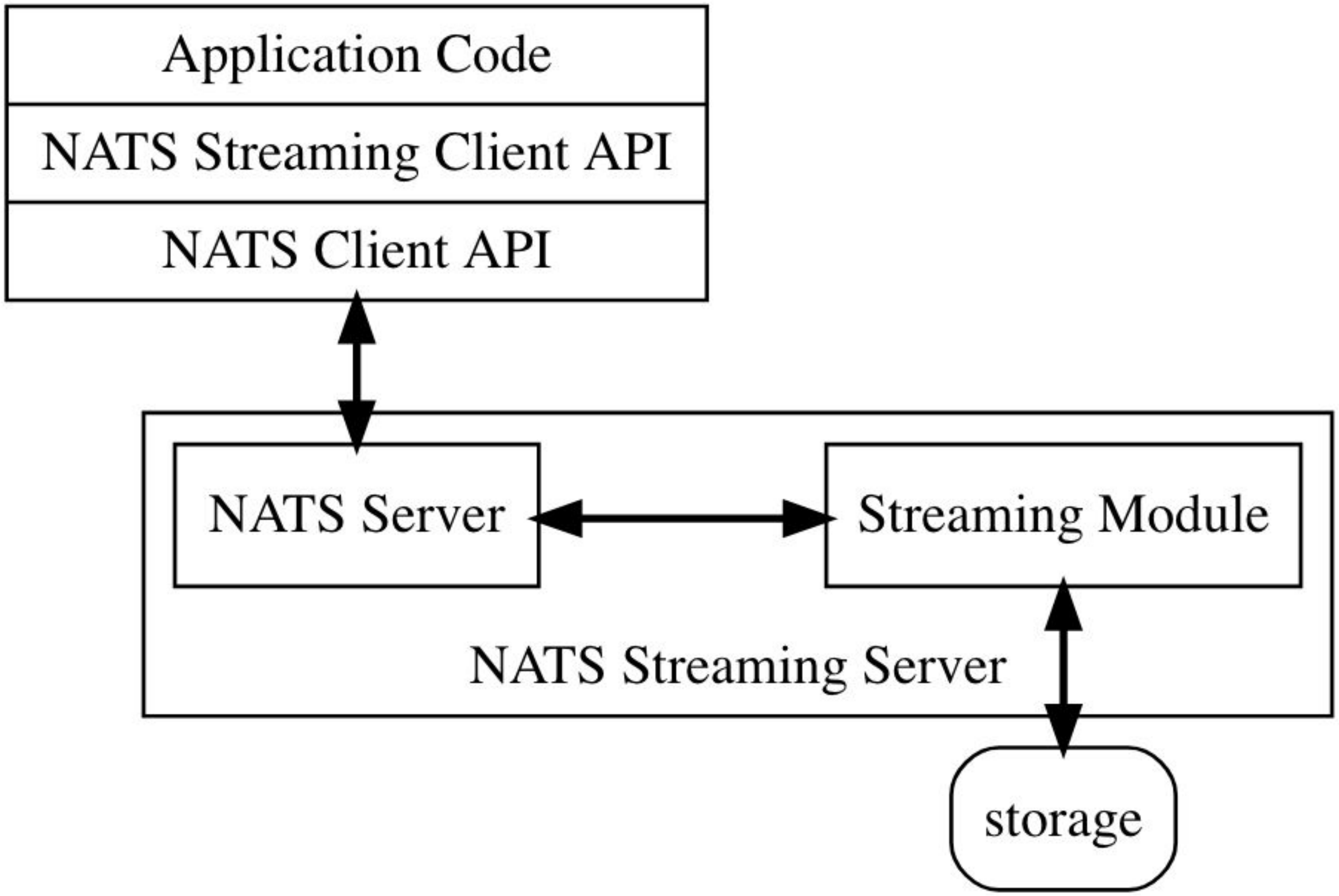
NATS Streaming



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NATS Streaming

- At least once delivery
- Publisher rate limiting
- Subscriber rate limiting
- Message Replay
- Durable Subscriptions

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MQTT

- Very lightweight binary protocol
  - 2-byte overhead
- Widely used in IoT scenarios
- Pub-sub only until MQTT5
- QoS levels
  - Fire and forget QoS0
  - At least once QoS1
  - Exactly once QoS2

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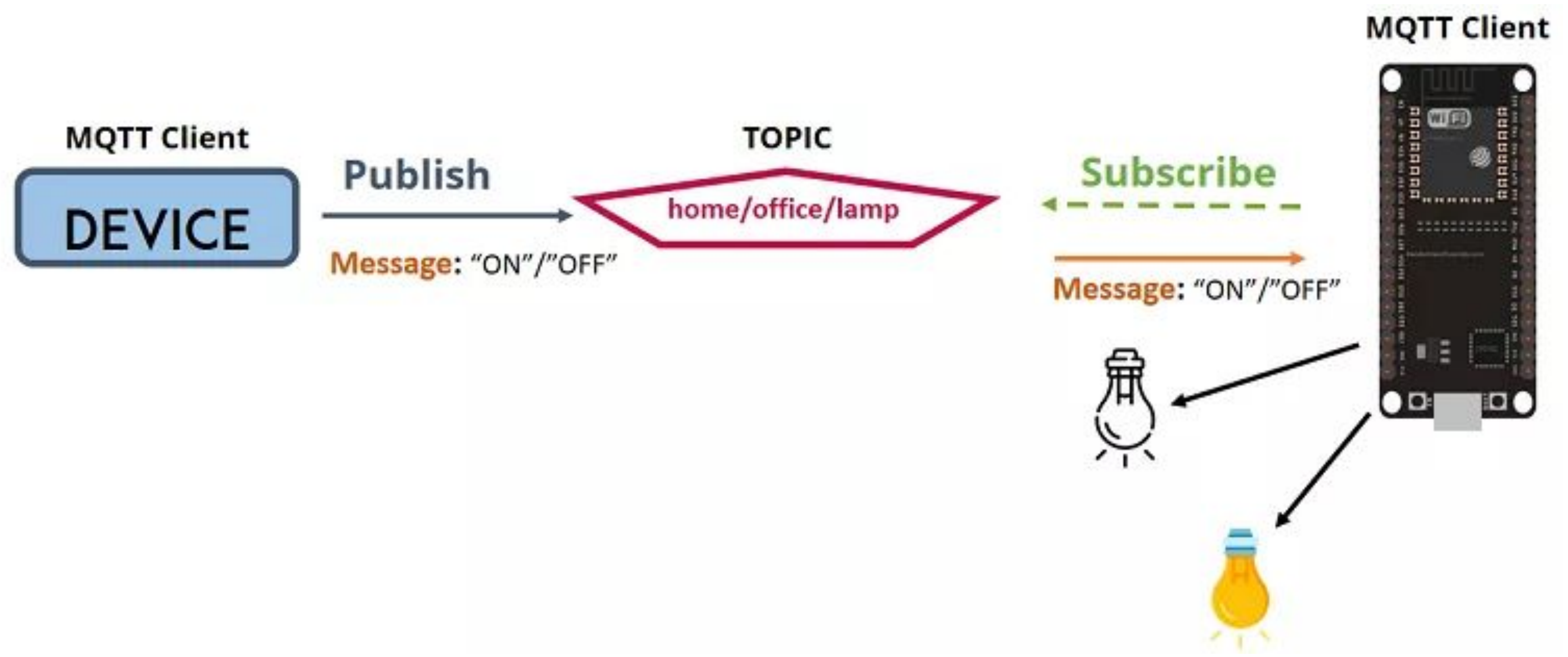
MQTT



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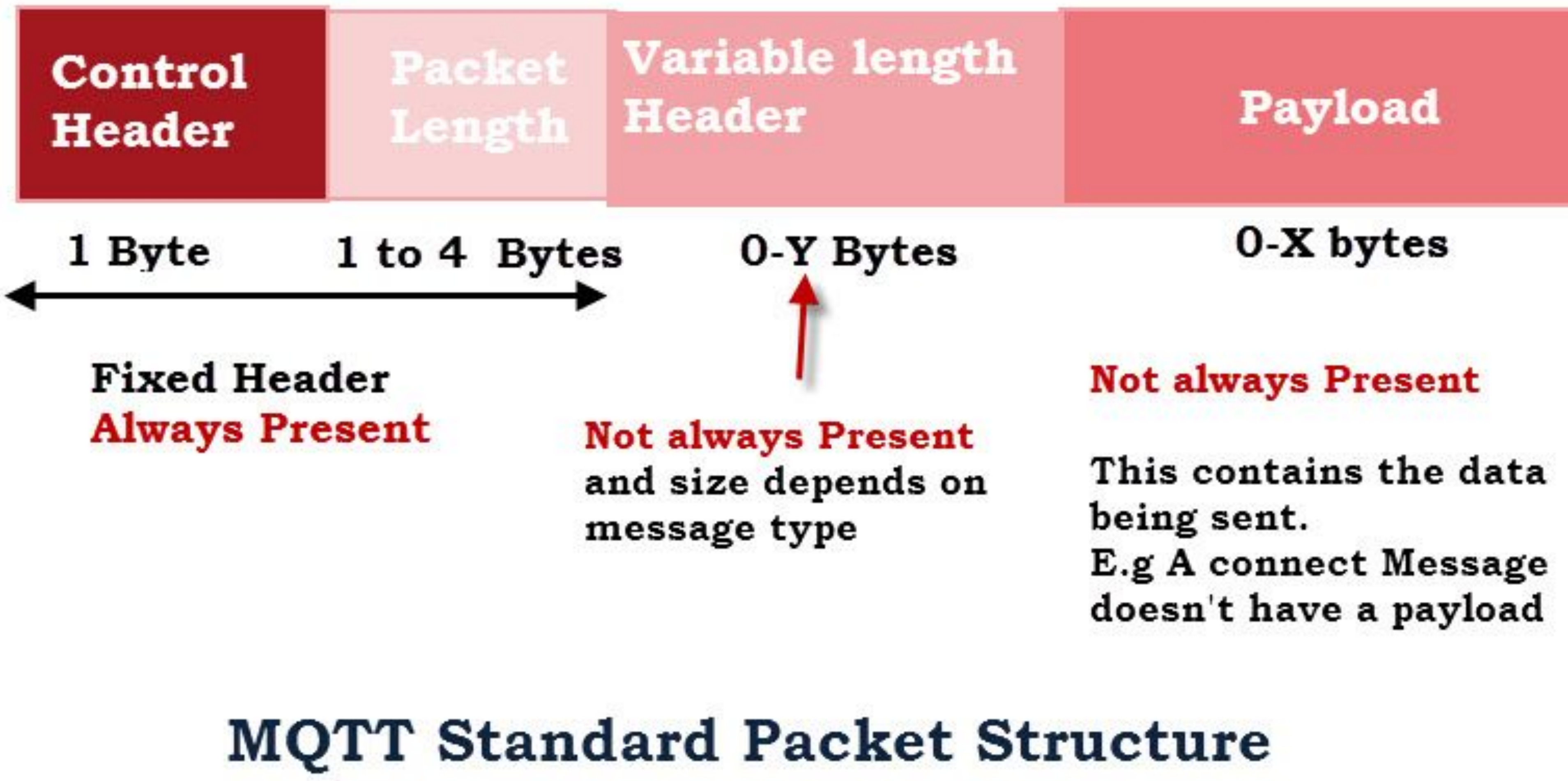
MQTT Packets

http://www.steves-internet-guide.com/mqtt-protocol-messages-overview/



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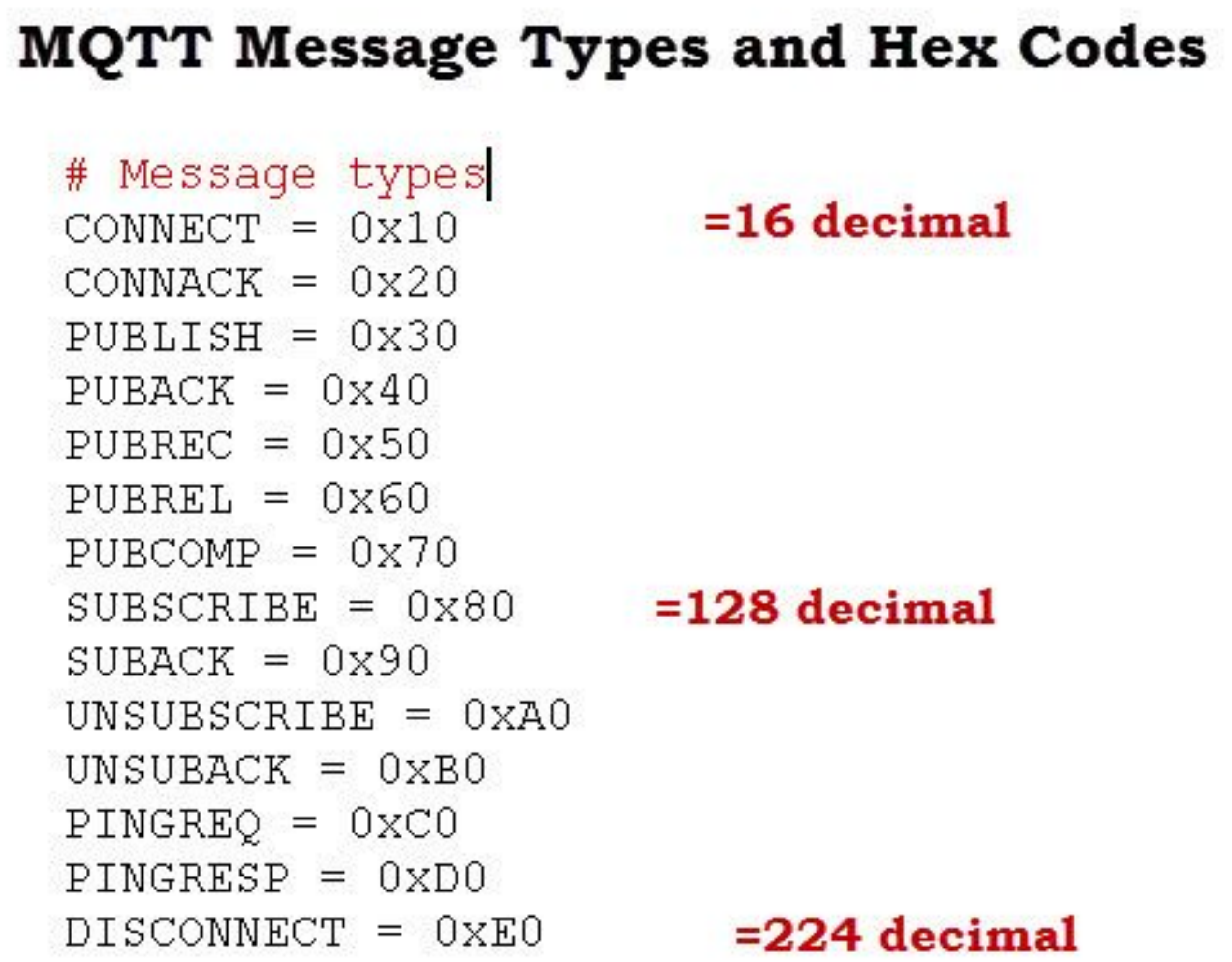

MQTT Message Types and Hex Codes

```
# Message types
CONNECT = 0x10                =16 decimal
CONNACK = 0x20
PUBLISH = 0x30
PUBACK = 0x40
PUBREC = 0x50
PUBREL = 0x60
PUBCOMP = 0x70
SUBSCRIBE = 0x80              =128 decimal
SUBACK = 0x90
UNSUBSCRIBE = 0xA0
UNSUBACK = 0xB0
PINGREQ = 0xC0
PINGRESP = 0xD0
DISCONNECT = 0xE0             =224 decimal
```

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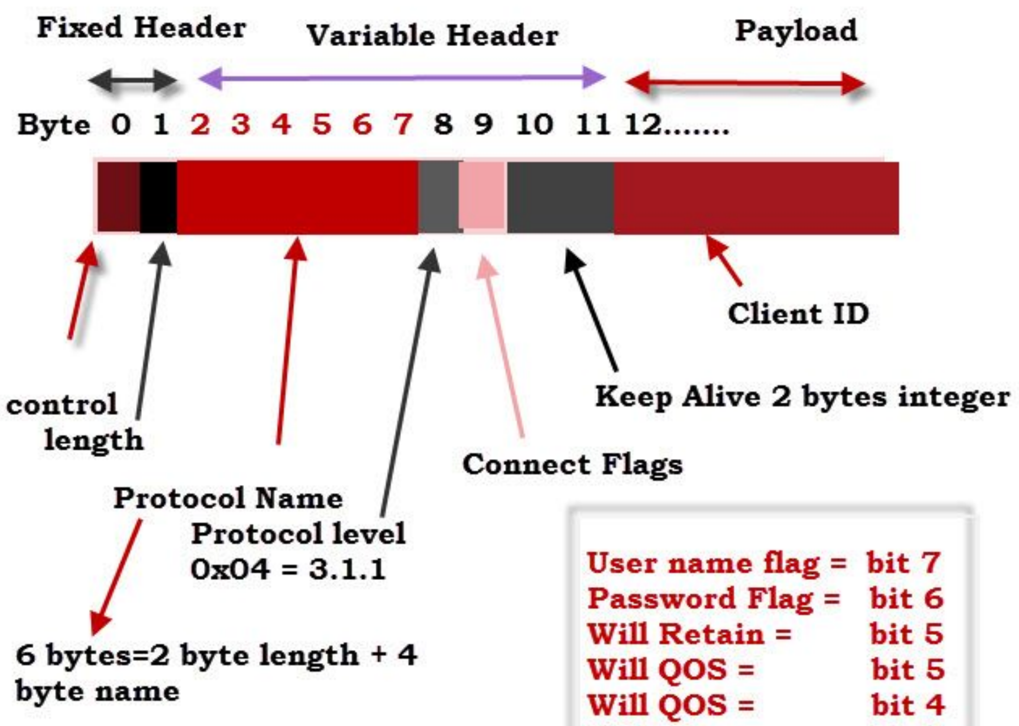
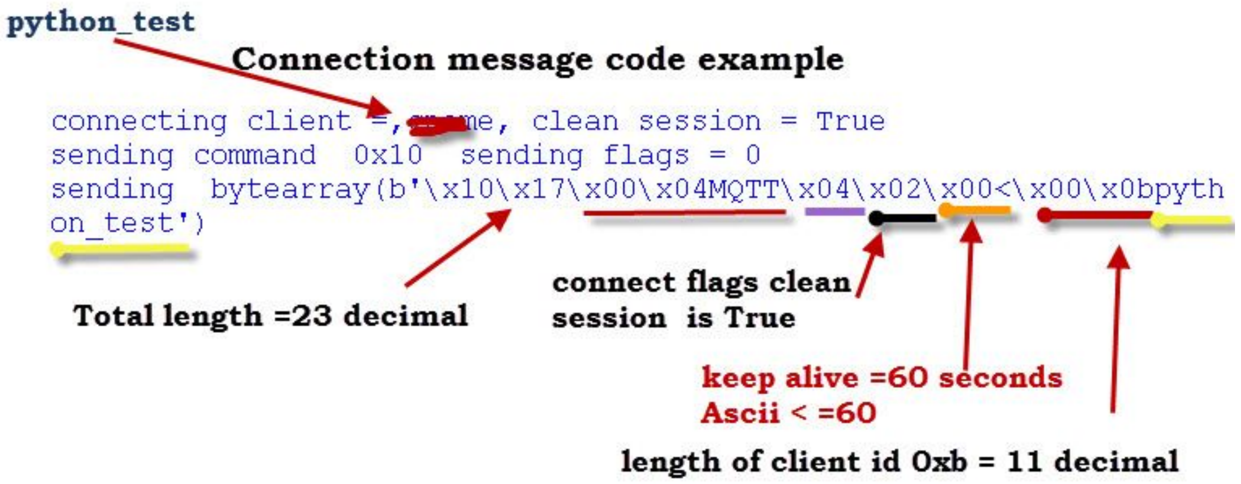
MQTT Connect Message Structure



User name flag =	bit 7
Password Flag =	bit 6
Will Retain =	bit 5
Will QOS =	bit 5
Will QOS =	bit 4
Will Flag =	bit 2
Clean Session =	bit 1
Reserved =	bit 0



python_test

Connection message code example

```
connecting client =,[redacted]e, clean session = True
sending command  0x10  sending flags = 0
sending  bytearray(b'\x10\x17\x00\x04MQTT\x04\x02\x00<\x00\x0bpyth
on_test')
```

Total length =23 decimal
connect flags clean session is True
keep alive =60 seconds
Ascii < =60
length of client id 0xb = 11 decimal

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See ht

AMQP / RabbitMQ

- AMQP is an advanced messaging protocol
  - Designed to meet more enterprise needs
  - Emerged from JP Morgan attempting to decouple from proprietary systems
- Standardised in OASIS
  - Although many implementations prefer 0-91 to 1-00

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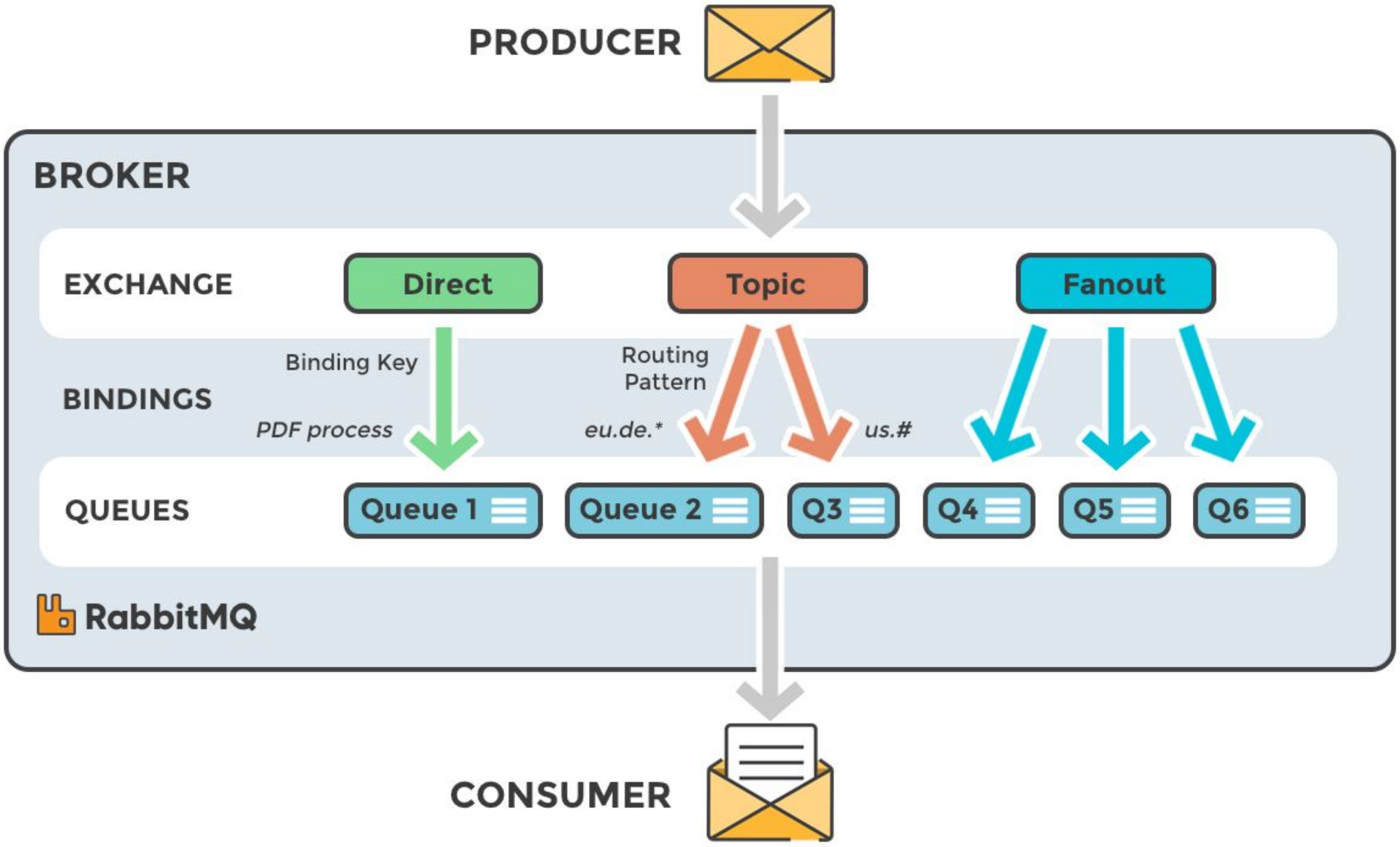

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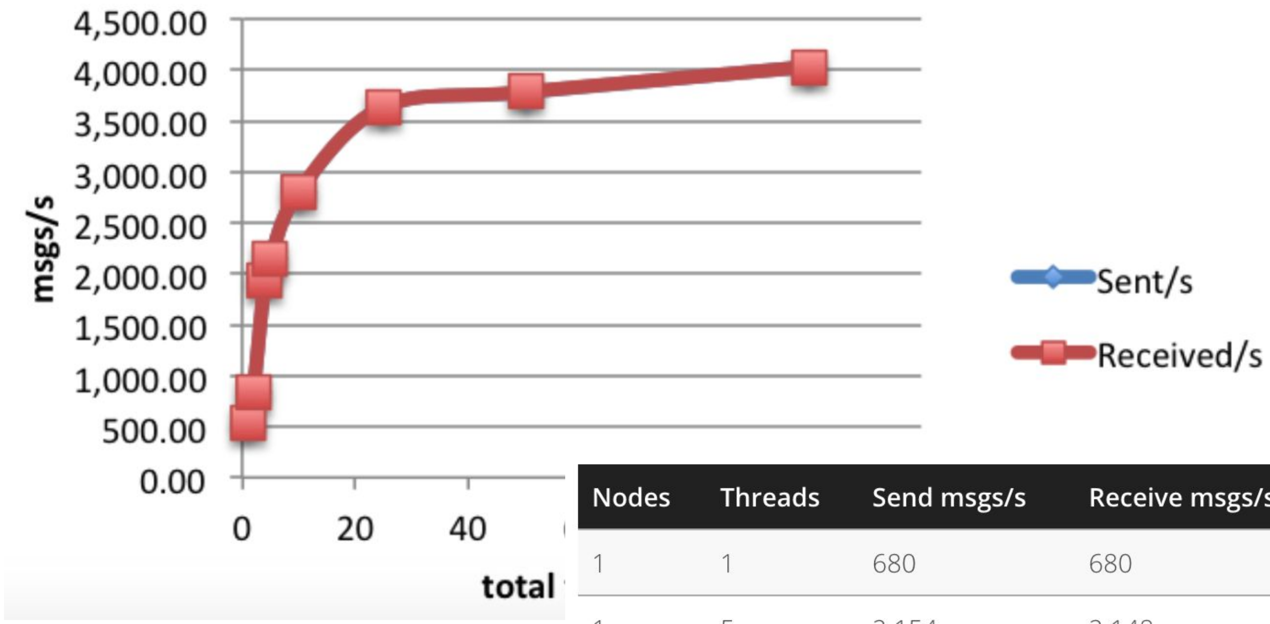
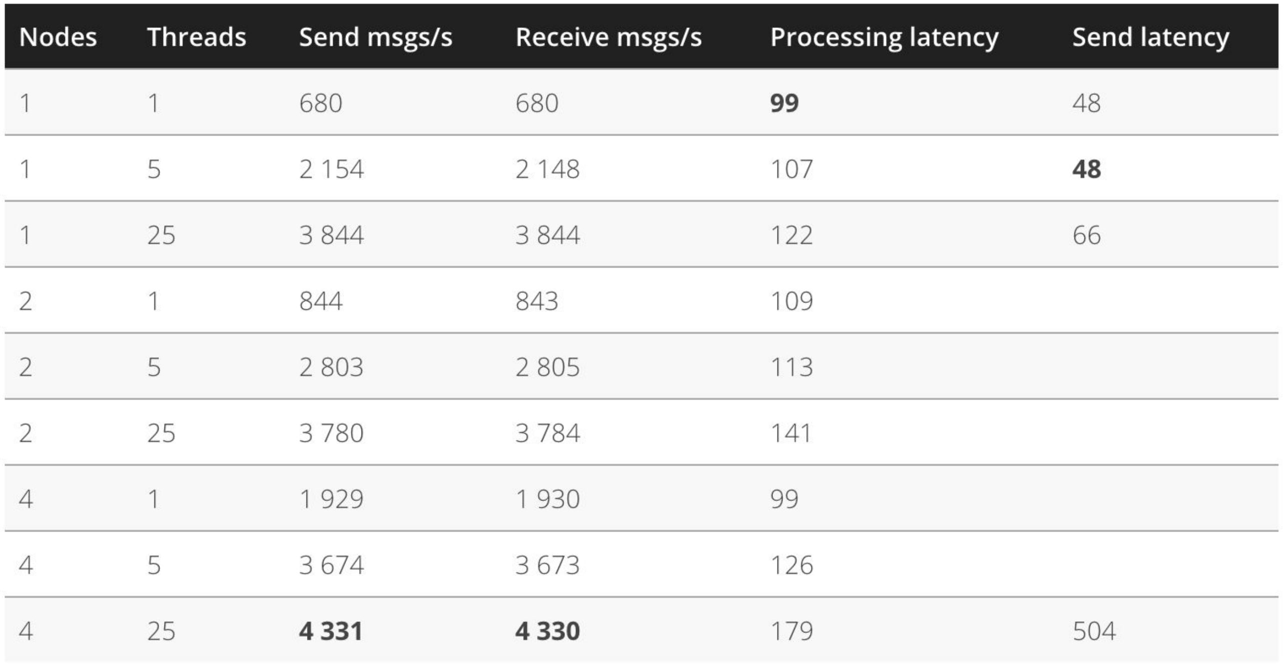
RabbitMQ performance

https://softwaremill.com/mqperf/





Nodes	Threads	Send msgs/s	Receive msgs/s	Processing latency	Send latency
1	1	680	680	**99**	48
1	5	2 154	2 148	107	**48**
1	25	3 844	3 844	122	66
2	1	844	843	109	
2	5	2 803	2 805	113	
2	25	3 780	3 784	141	
4	1	1 929	1 930	99	
4	5	3 674	3 673	126	
4	25	**4 331**	**4 330**	179	504

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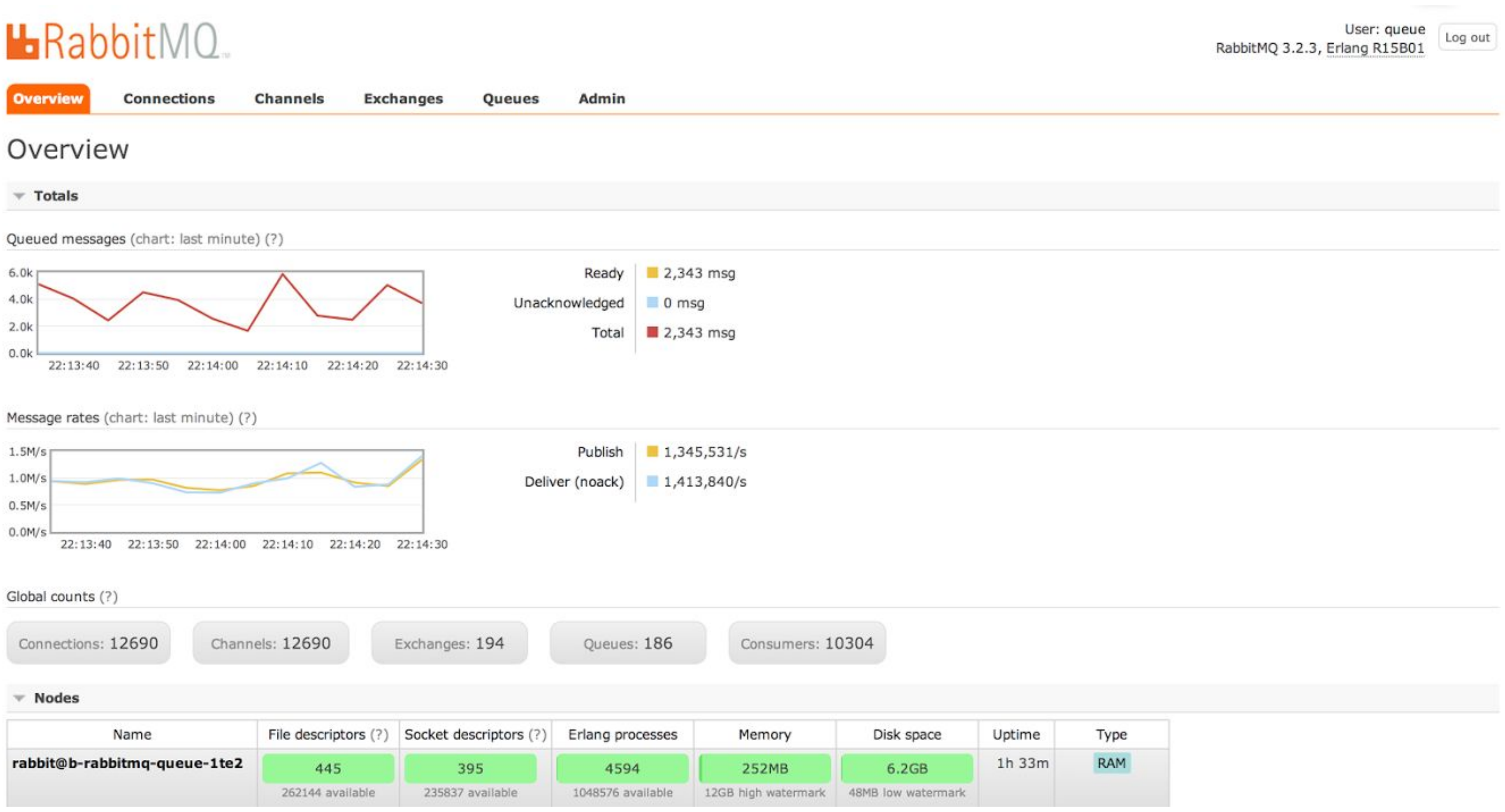
>1m msgs/sec

https://content.pivotal.io/blog/rabbitmq-hits-one-million-messages-per-second-on-google-compute-engine



Overview

Totals

Queued messages (chart: last minute) (?)

Ready	🟨 2,343 msg
Unacknowledged	🟦 0 msg
Total	🟥 2,343 msg

Message rates (chart: last minute) (?)

Publish	🟨 1,345,531/s
Deliver (noack)	🟦 1,413,840/s

Global counts (?)

Connections: 12690 | Channels: 12690 | Exchanges: 194 | Queues: 186 | Consumers: 10304

Nodes

Name	File descriptors (?)	Socket descriptors (?)	Erlang processes	Memory	Disk space	Uptime	Type
rabbit@b-rabbitmq-queue-1te2	445 262144 available	395 235837 available	4594 1048576 available	252MB 12GB high watermark	6.2GB 48MB low watermark	1h 33m	RAM

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ActiveMQ / Artemis

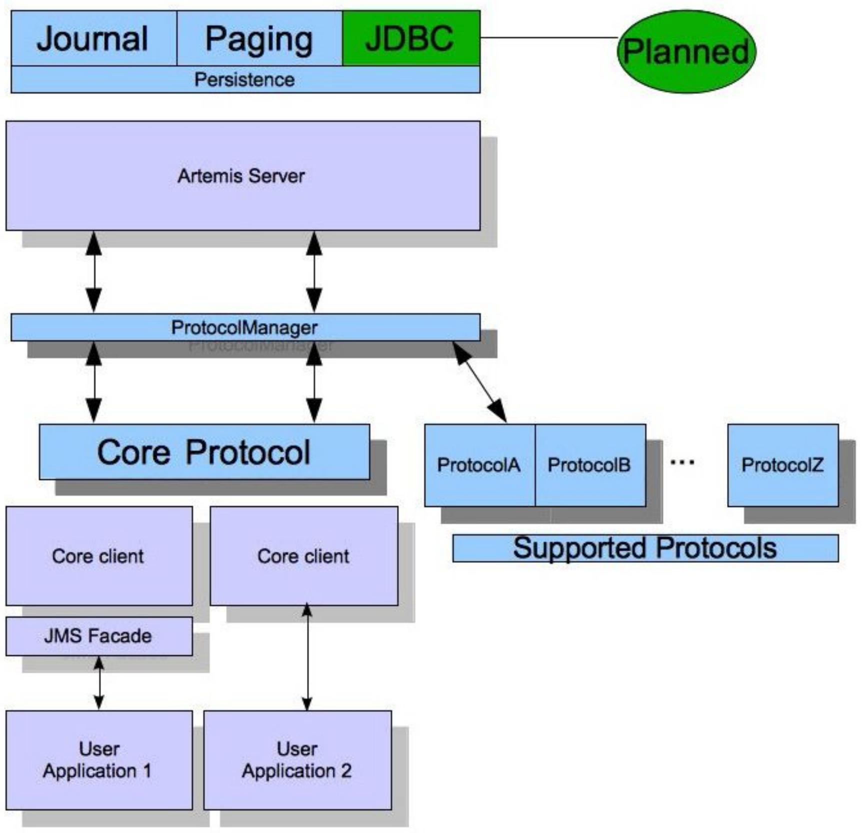

Figure 3.1 Artemis High Level Architecture

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Artemis

- Supports multi-protocols:
  - “JMS”, AMQP, STOMP, OpenWire, MQTT, REST
  - Highly available and clusterable
  - Written in Java

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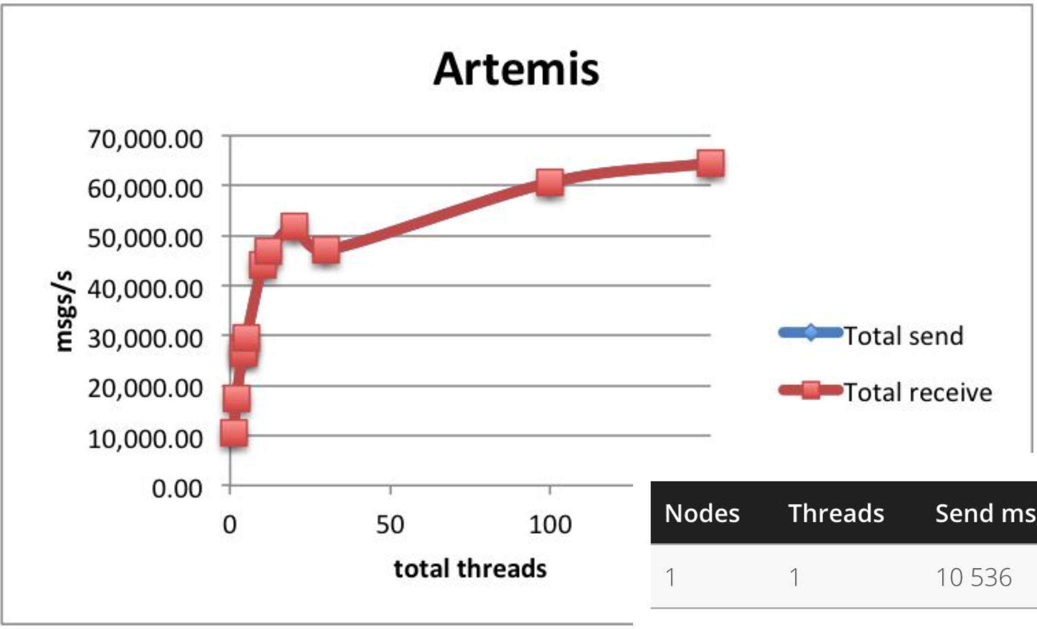
Artemis Performance

https://softwaremill.com/mqperf/



Nodes	Threads	Send msgs/s	Receive msgs/s	Processing latency	Send latency
1	1	10 536	10 536	48	45
1	5	29 476	29 476	48	47
2	1	17 515	17 515	46	46
2	5	44 003	44 003	46	47
4	1	27 197	27 197	47	47
4	5	51 724	51 720	46	47
4	25	60 619	60 619	62	48
6	5	47 078	47 082	**47**	48
6	25	**64 485**	**64 487**	122	**48**

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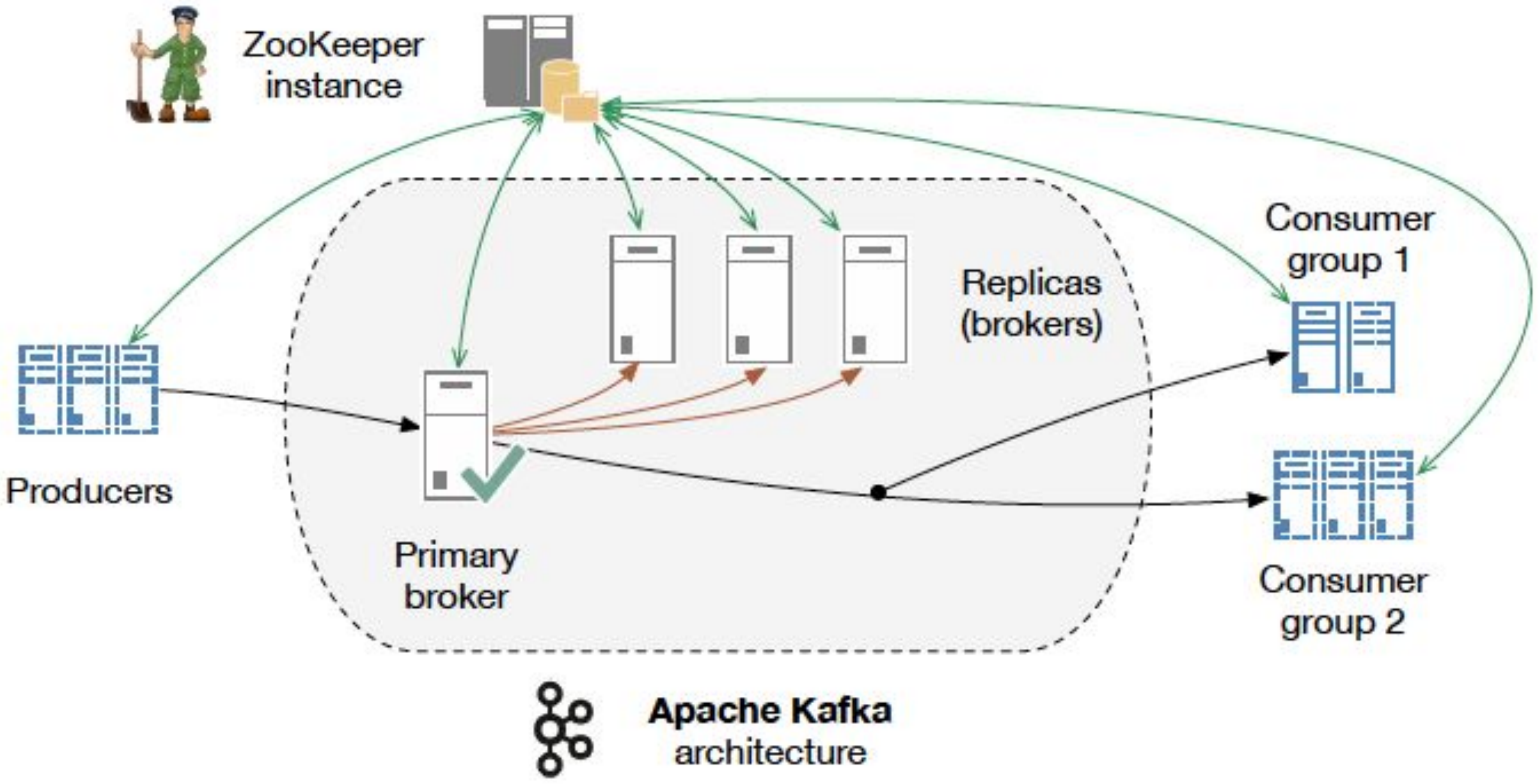
Apache Kafka



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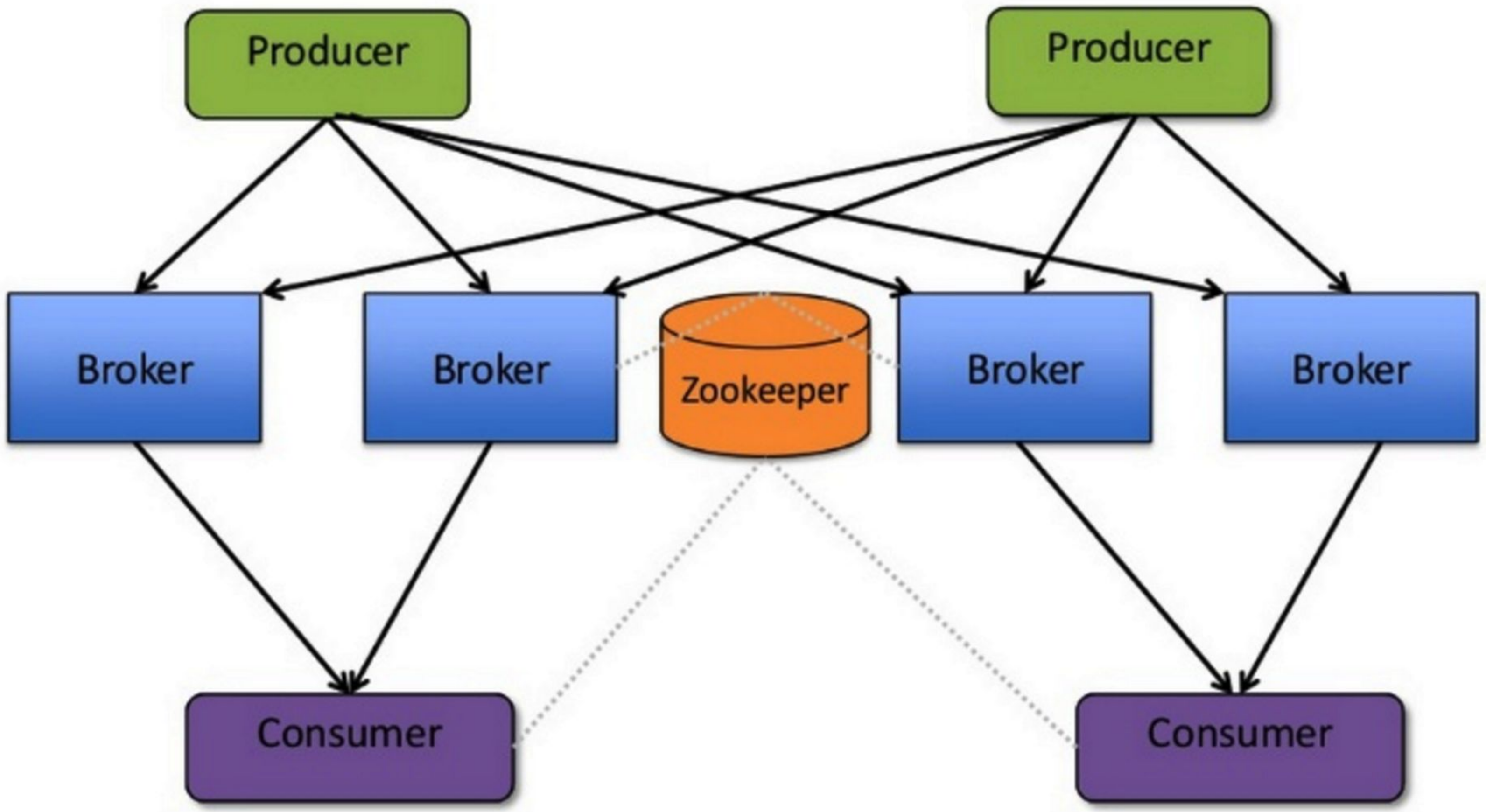
Apache Kafka



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Source: http://www.slideshare.net/charmalloc/

Kafka

- Applying “big data” approaches to messaging:
  - Partitioning
  - Multiple brokers
  - Elastically scalable
  - Supports clusters of co-ordinated consumers
  - Automatic re-election of leaders

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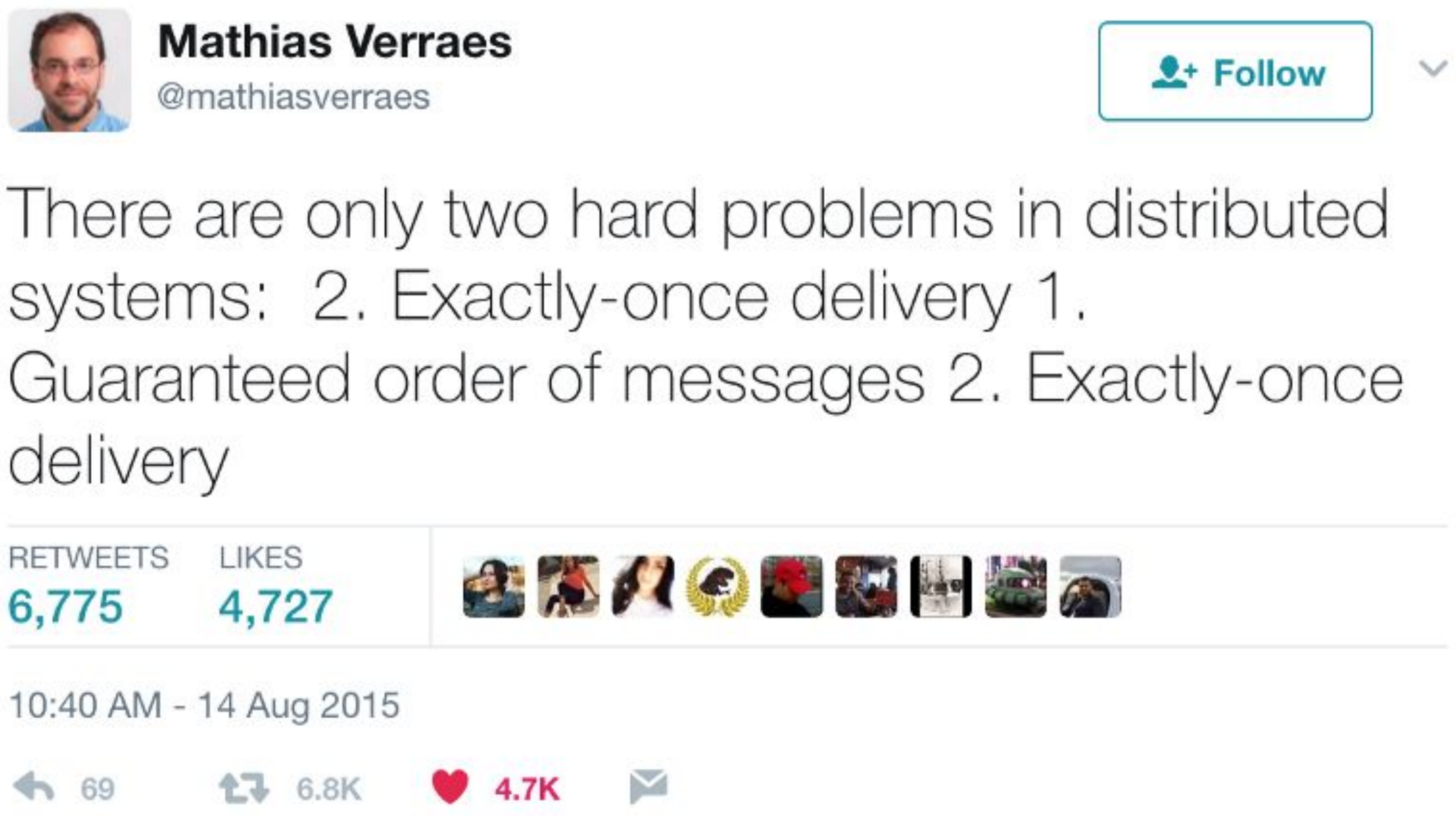
Kafka exactly-once semantics



Mathias Verraes
@mathiasverraes

There are only two hard problems in distributed systems: 2. Exactly-once delivery 1. Guaranteed order of messages 2. Exactly-once delivery

RETWEETS 6,775 LIKES 4,727

10:40 AM - 14 Aug 2015

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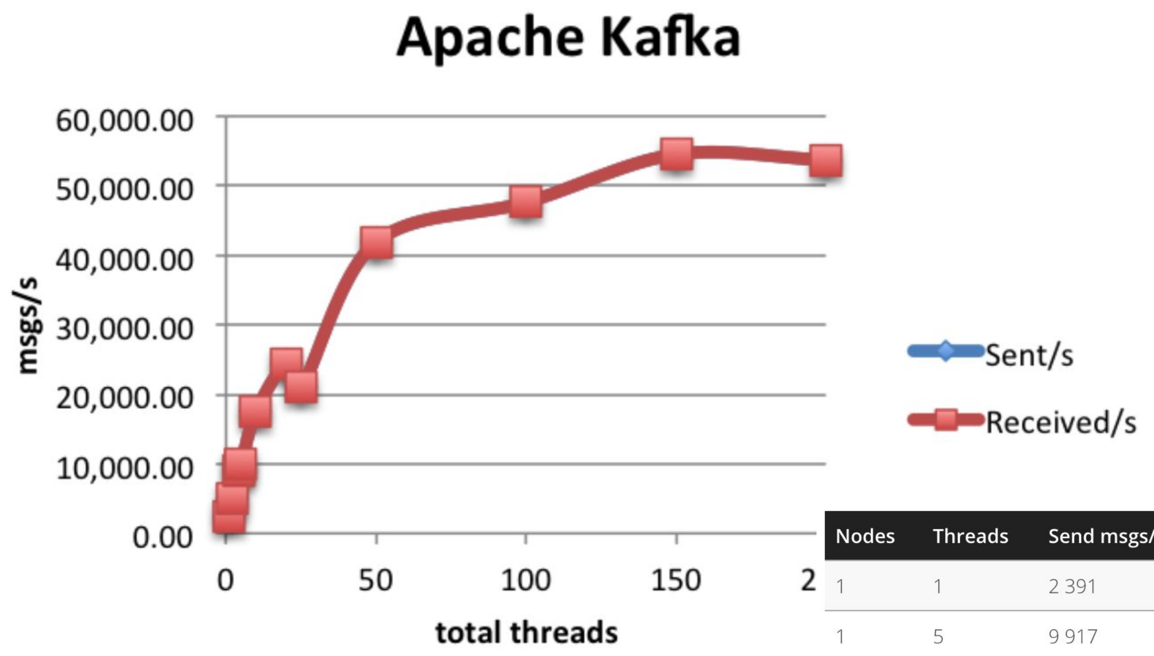
Kafka Performance



Nodes	Threads	Send msgs/s	Receive msgs/s	Processing latency	Send latency
1	1	2 391	2 391	48	48
1	5	9 917	9 917	48	48
1	25	20 982	20 982	46	48
2	1	4 957	4 957	47	
2	5	17 470	17 470	47	
2	25	41 902	41 901	45	48
4	1	9 149	9 149	47	
4	5	24 381	24 381	47	48
4	25	47 617	47 618	47	48
6	25	**54 494**	**54 494**	**47**	**48**
8	25	53 696	53 697	47	48

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Questions?

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