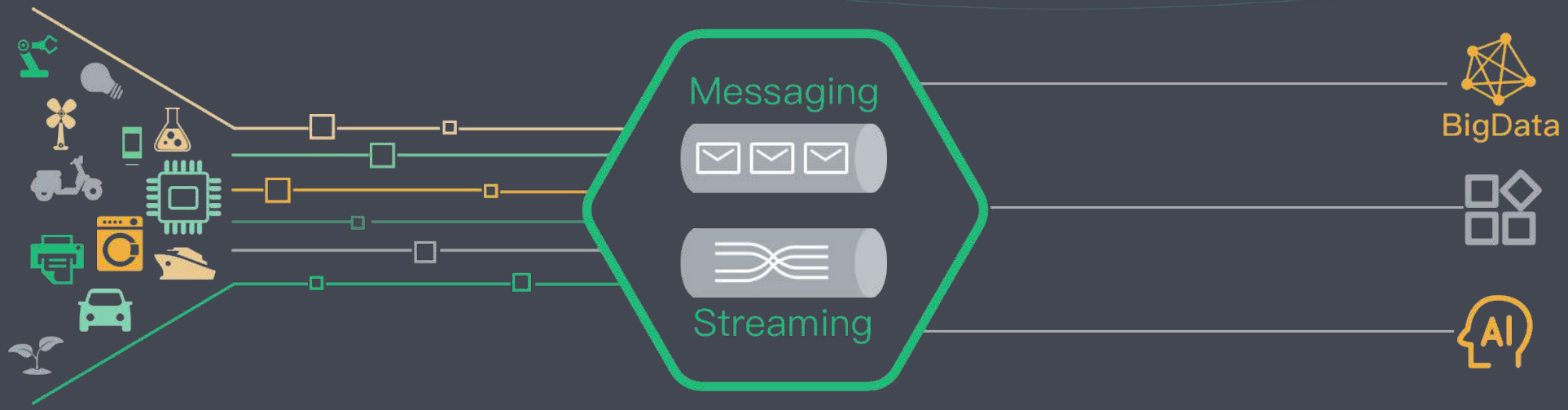
www.emqx.io

Scalable MQTT Messaging Platform for IoT in 5G Era

Zhengyu Pan, EMQ #CodeBEAMSTO



About EMQ — MQTT + Erlang, Aiming at IoT (Short Version)

MQTT

A Protocol for IoT

Light weight messaging protocol for low bandwidth, low-power and unstable network environment of IoT;
Compact message: 1 byte fixed head & 2 byte heartbeat;
Using QoS to guarantee message delivery.

Erlang

High Concurrency & Soft-Realtime

Erlang/OTP platform designed for Telco application, Actor model, preemptive scheduling of lightweight processes, fine-grained GC, fault tolerance, distributed.

About EMQ

Great things start with small beginnings, and we started in a coffeehouse.

Github Star (2019/05/17)

4502

Total Downloads

2M+

Foundations' Membership

OASIS

OASIS MQTT TC

Voting Member

EDGE X FOUNDRY™

Member

Messaging Layer

EMQ

Establish a Foundation focusing on OSS for IoT

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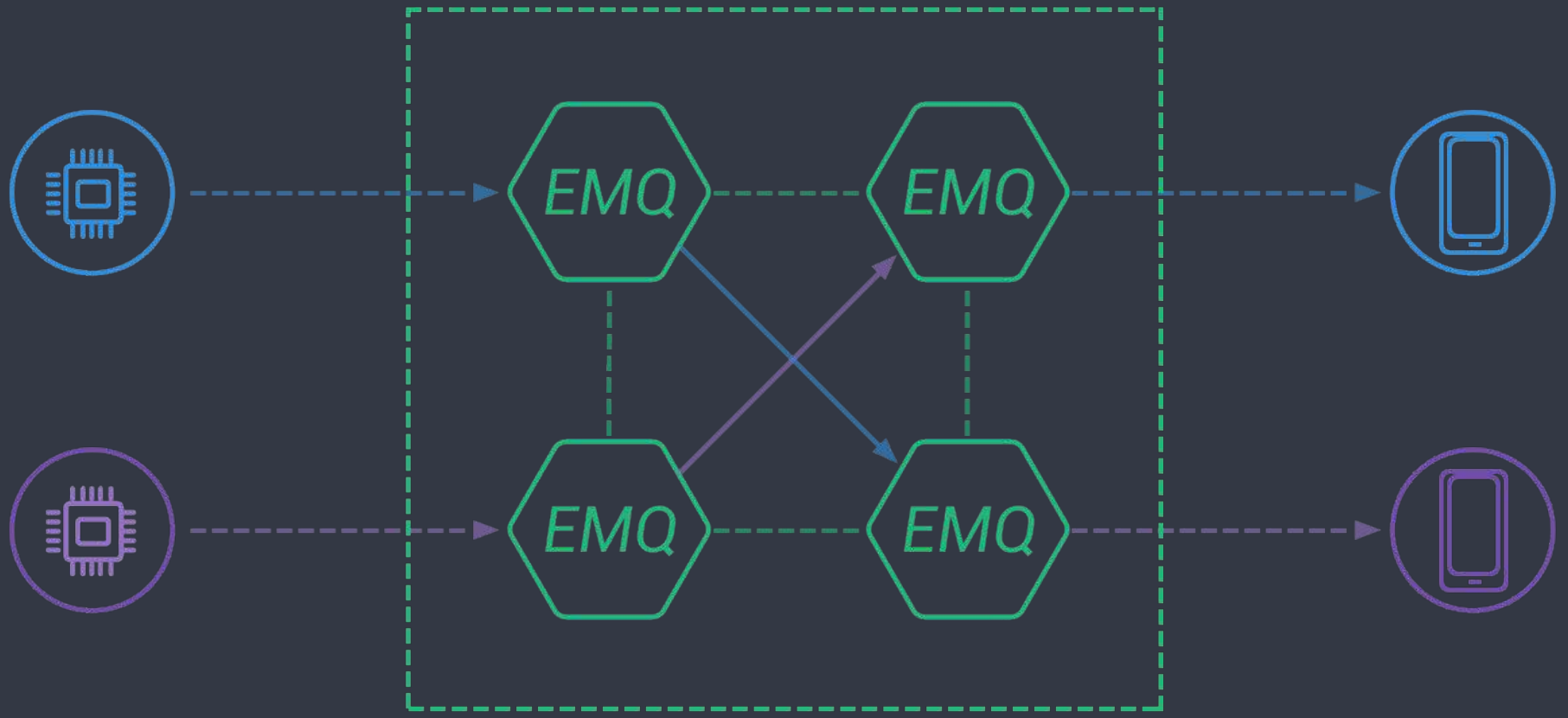
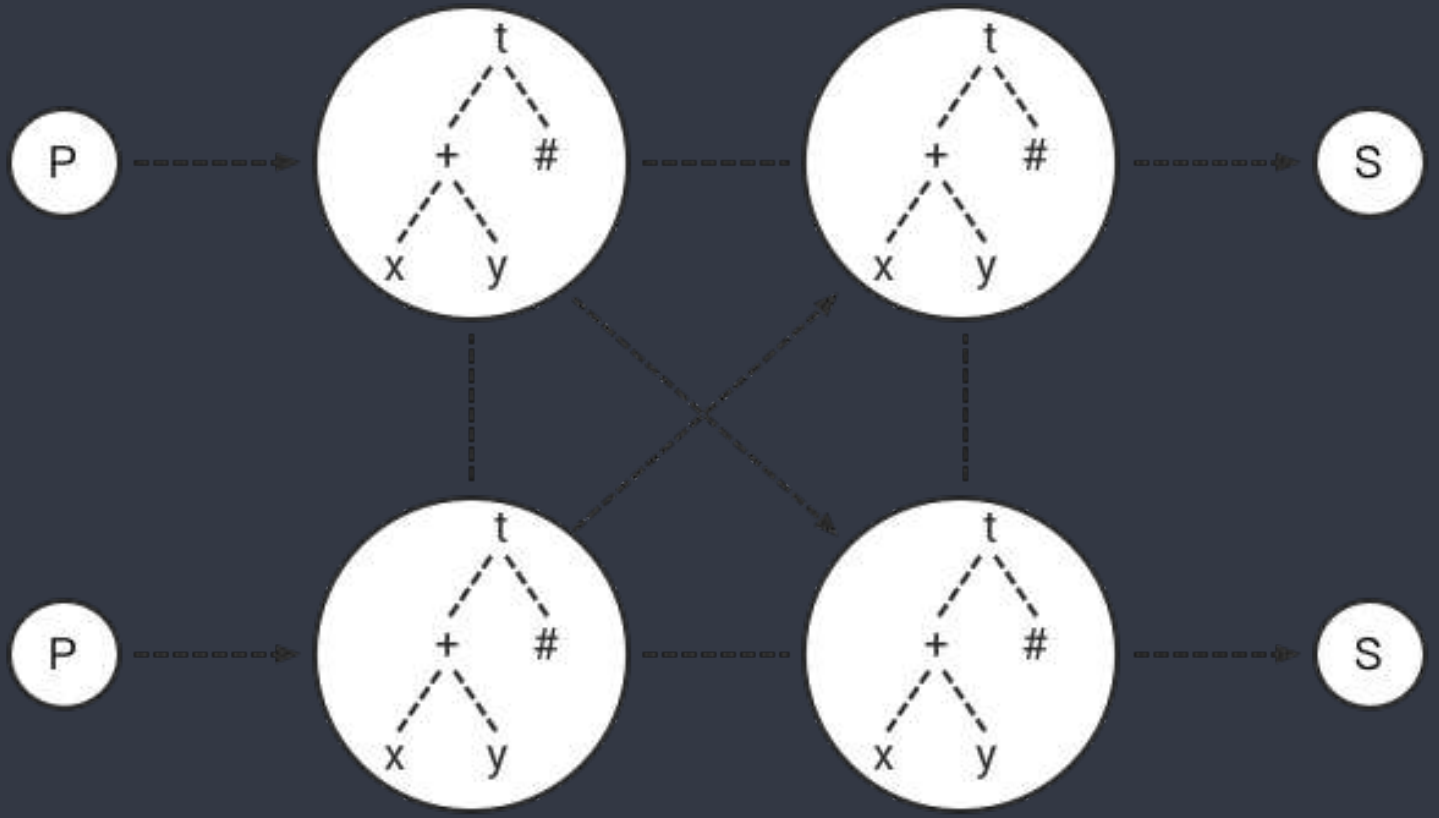
Goals: Massive Scalability, Extensibility, Low Latency, …



Message broker for IoT platform and applications in 5G era

Design: 4 Layers for Handling Messages

- Connection Layer
- Session Layer
- PubSub Layer
- Routing Layer



Design: Connection Layer

Connection Layer handles server socket connection and MQTT protocol decoding:

1. Built on eSockd asynchronous TCP server framework
2. TCP acceptor pool and asynchronous TCP acceptor
3. TCP/SSL, WebSocket/SSL
4. Max connections management
5. Access control against peer address or CIDR
6. Flow control
7. MQTT protocol encoder/decoder
8. MQTT connection keepalive
9. MQTT packet process

Design: Session Layer

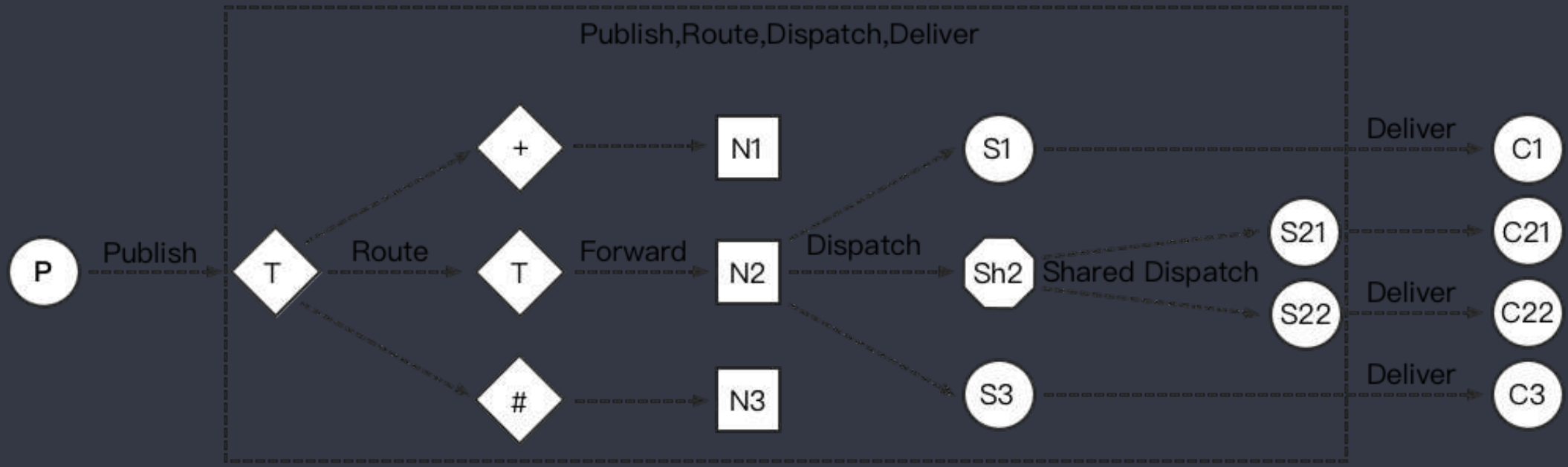
Session layer processes publish and subscribe service of MQTT protocol:

1. Store clients' subscription and implement the QoS of subscriptions.
2. Process the publish and delivery of QoS1/2 messages, retransmit timeout messages and retain offline messages.
3. Manage inflight window and control the message delivery throughput and transmission order.
4. Retain QoS1/2 messages which has been sent but not acknowledged by client.
5. Retain QoS2 messages from client to server, which has not yet received a responding PUBREL message.
6. Retain QoS1/2 offline messages of a persistent session, when the client is disconnected.

Desgin: PubSub Layer

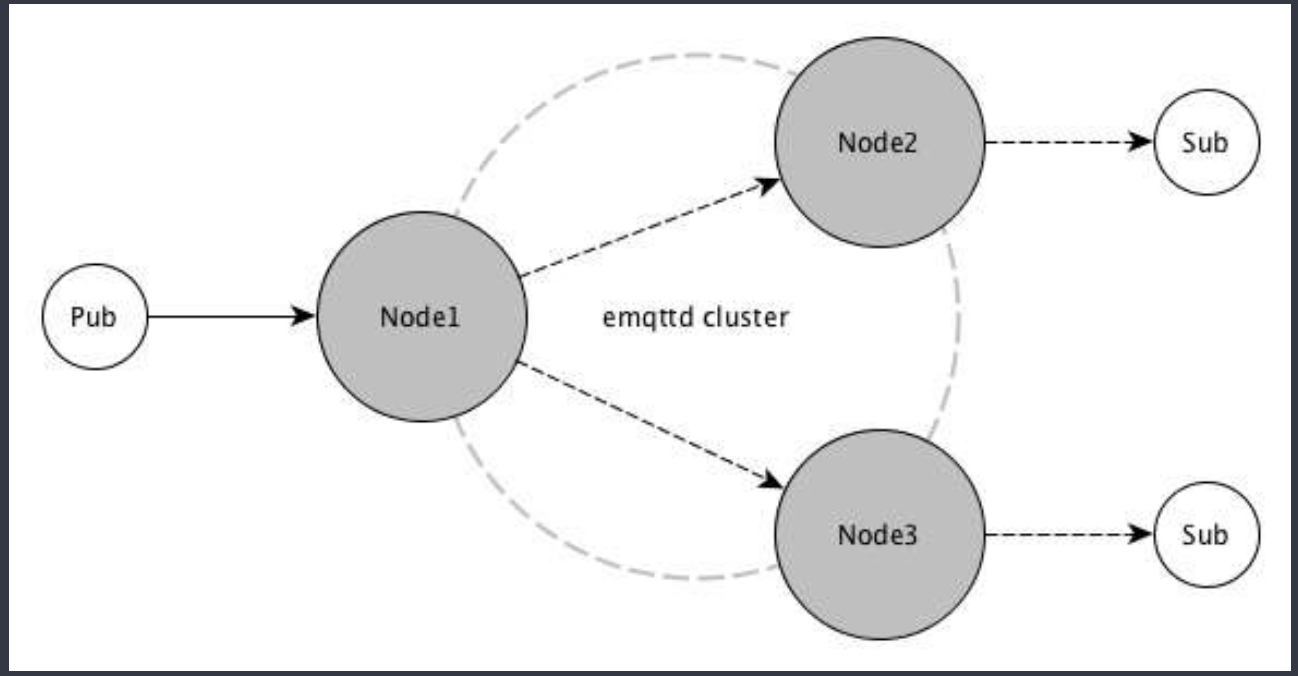
The PubSub layer maintains a subscription table and is responsible to dispatch MQTT messages to subscribers.

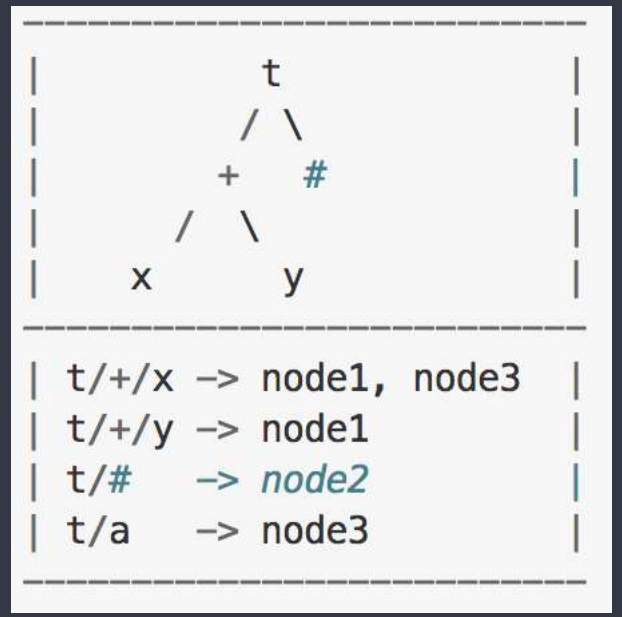
MQTT messages will be dispatched to the subscriber's session, which finally delivers the messages to client.



Design: Routing Layer

The brokers in the cluster route messages by topic trie and route table, deliver messages to MQTT clients by subscriptions.

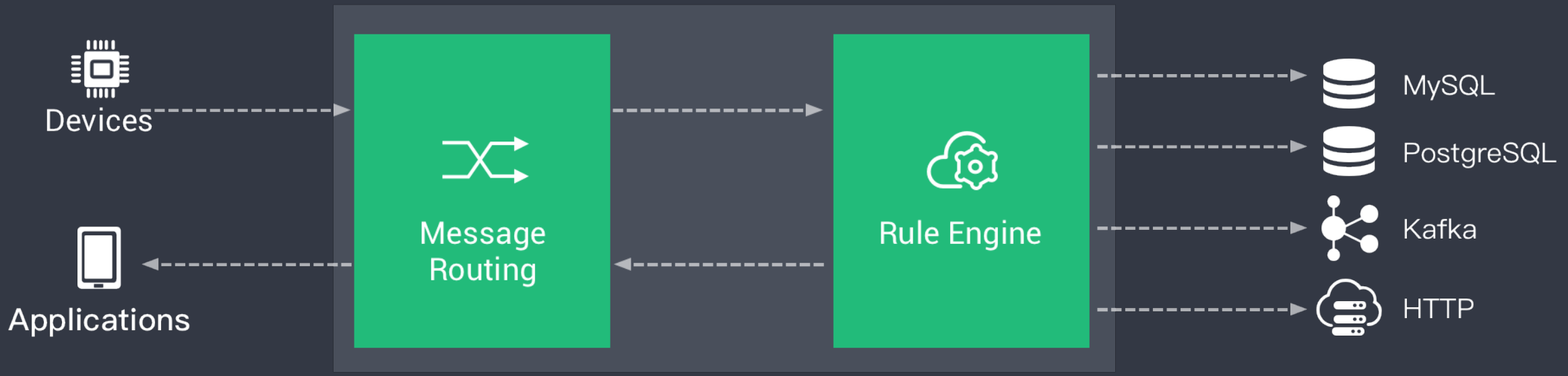




Design: Extensibility

- Through module registration and hook mechanism, EMQ X broker supports user to develop extension plugin to customize server authentication and service functions.
  - ./bin/emqx_ctl plugins load emqx_auth_username
- Plugin development template
  - https://github.com/emqx/emqx-plugin-template
  - Example code: emqx_auth_demo.erl
  - Example code: emqx_acl_demo.erl

Design: SQL Style Rule Engine to help build IoT Hub (Development)




```
{
  "devid": 1,
  "metrics": {
    "x": 9,
    "y": 10
  }
}
```

```
select clientip() as ip, devid,
sqrt(payload.metrics.x) as x,
(payload.metrics.y * 2) as y
from "iot/topic" where x > 0
and y < 100
```

```
{
  "ip":"127.0.0.1",
  "devid": 1,
  "x": 3.0,
  "y": 20
}
```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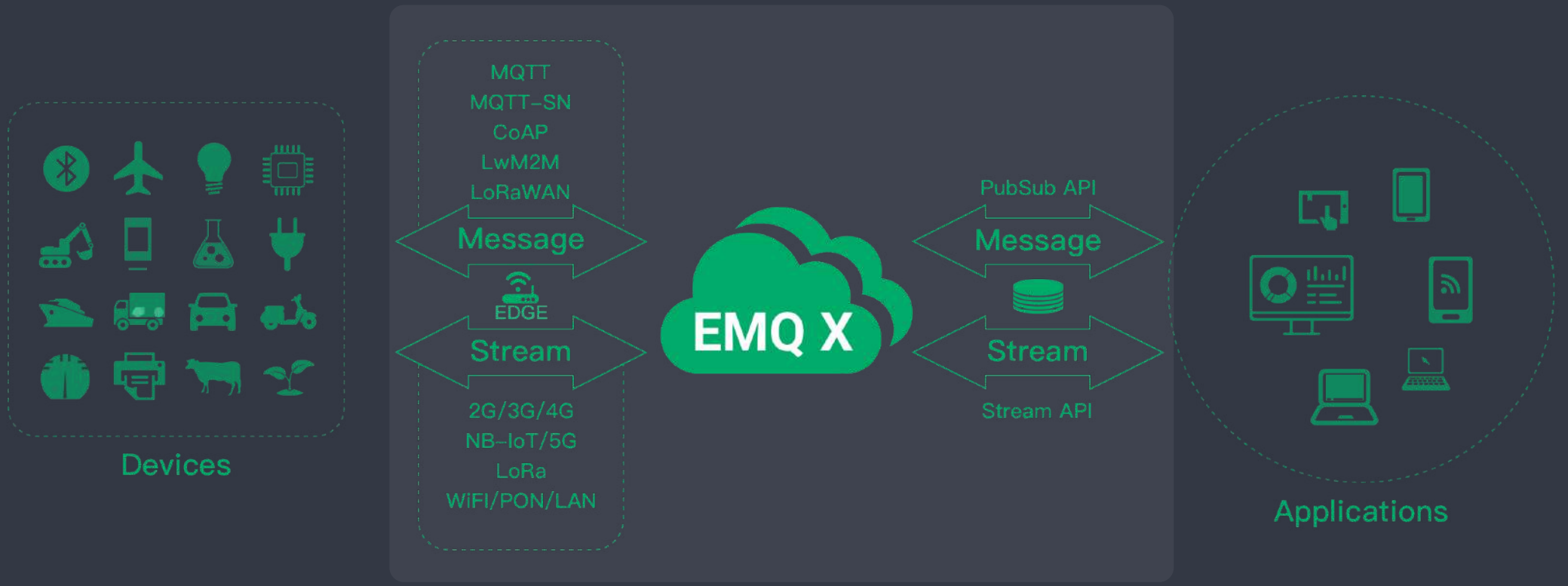
EMQ X – The messaging and streaming engine for IoT in 5G Era



Highlights

- Open Source
- Supports Major IoT protocols
- Compatibility
- Security & Authentication & ACL
- Deploy Anywhere
- High Concurrency
- Soft Real Time
- High Availability
- Distributed, Massive Scalability

Rich Features and Highly Extensible

- Load balancing
  - Proxy Protocol V2
  - X.509 Certificate
  - CoaProxy and DTLS
- Transports
  - MQTT over TCP/SSL/WS/WSS
  - CoAP over UDP/DTLS
- Rate Limiting
  - Incoming Data
  - Incoming Messages
  - Max Connections
  - Connection per second
- Connection Management
- Zone Management

- Protocols
  - MQTT v3.1.1/v5.0
  - MQTT-SN
  - WebSocket/HTTP
  - Stomp
  - CoAP/LwM2M
  - LoraWAN
  - JT/T-808
  - GBT32960
  - Modbus
  - TCP/UDP
  - TLS/DTLS
- Session Management
  - ClientId flapping detect
  - Session takeover or resumption

- Authentication and ACL
  - X.509 Certificate
  - ClientId or Username
  - JWT Token Authentication
  - PKI Authentication
  - HTTP Authentication
  - LDAP Authentication
  - Redis Authentication
  - MySQL Authentication
  - PostgreSQL Authentication
  - MongoDB Authentication
  - CoaProxy and DTLS
- Security Management

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Advanced features with professional support

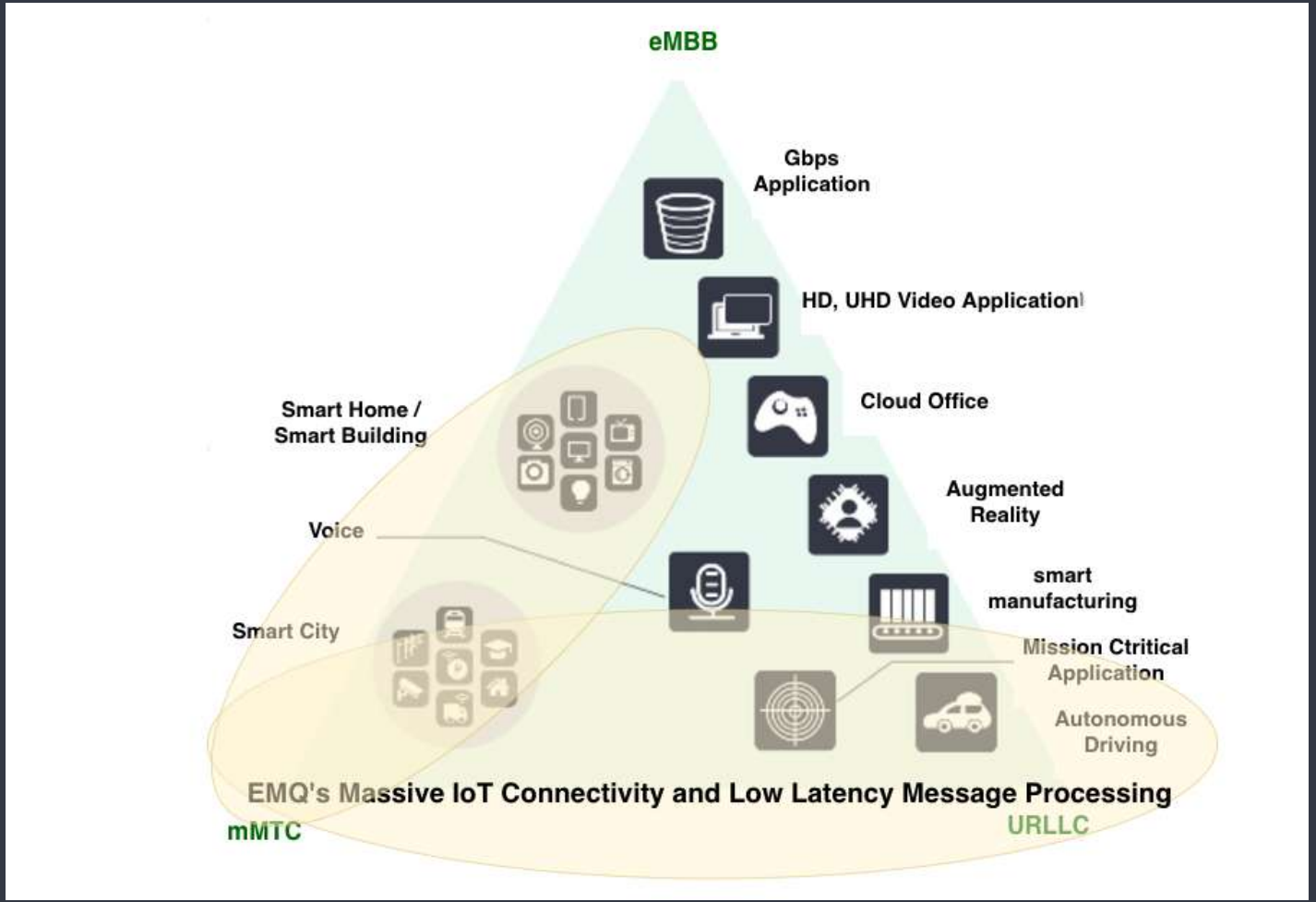
- Shared subscriptions
  - round_robin
  - random
  - hash
  - direct
  - claim
- Rule Engine
- Management and Monitoring
- Backends
  - Redis
  - MySQL
  - PostgreSQL
  - MongoDB
  - Cassandra
  - OpenTSDB
  - InfluxDB
  - Azure Cosmos (TODO)
  - AWS Dynamo (TODO)
- WebHooks
- Bridges
  - Kafka
  - RabbitMQ
  - Pulsar
  - HStream
- Metrics and Stats
- Events and Alarms
- ECC/Dashboard
- Packages, Docker, K8S

What Can 5G Mobile Network Bring to Us?

- Speed is not the only thing:
  - 2 Radio Frequency Ranges (FR 1 & 2) for different Coverage
  - Massive MIMO & Beamforming for better signal
  - Higher cell density (up to 500 times)
  - Evolved NB–IoT
  - Lower Latency (lower than 1 ms)
  - User Plane Function (UPF) allows Data Plane traffic on Edge
  - And more…

EMQ X & 5G

- Use Cases of 5G
  - mMTC – massive Machine Type Communications
  - URLLC – Ultra Reliable Low Latency Communications
  - eMBB – enhanced Mobile Broadband
- EMQ as Message Broker in 5G
  - High Concurrency, connect massive IoT & Mobile devices on Edge and Cloud
  - Reliable Device & Connection Management for Mission Critical Application
  - Millisecond Level Processing Ability



Use Case — IoV, Autonomous Driving

- Autonomous Driving (Driving Formation, Driverless Cars), Level 5 Autonomy:
  - Perception, Path Planning, Real-time location Updates, Coordinated Driving
- Benefits of 5G:
  - High speed network
    - GB level data link
  - Low latency network
    - ~1ms latency
  - Direct Data Communication
    - In 3GPP Rel-14 to 16 C-V2X (Cellular Vehicle to Everything) defined direct communication does not rely on cellular networks or network coverage.

Use Case — Cloud Controlled Manufactory / Robots

- URLLC, Ultra reliable low latency communication
  - Sow case by Huawei & SoftBank in late 2017, Cloud AI controlled Robot Arm played air hockey against human.
- Requirements
  - Massive sensor network
  - High reliability
  - Low Latency
  - Autonomous

Use Case — mMTC (Smart City)

- From millions to billions of devices/sensors
  - 5G's high density small cell enables billions devices in a network
  - Integration with current smart city application based on 4G and WiFi
- Cooperation of heterogeneous applications
  - Energy
  - Utilities
  - Transport
  - Public safety, and etc
- Combined technologies
  - 5G Mobile Network
  - Cloud Computing
  - Edge Computing
  - AI

Thank You

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