KubeCon CloudNativeCon

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China 2024


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Extend Kubernetes to Edge Using Event-Based Transport
Longlong Cao
Meng Yan

Agenda

Background

- Edge Trend
- Kubernetes at the Edge
- CloudEvents

Event Based Transport

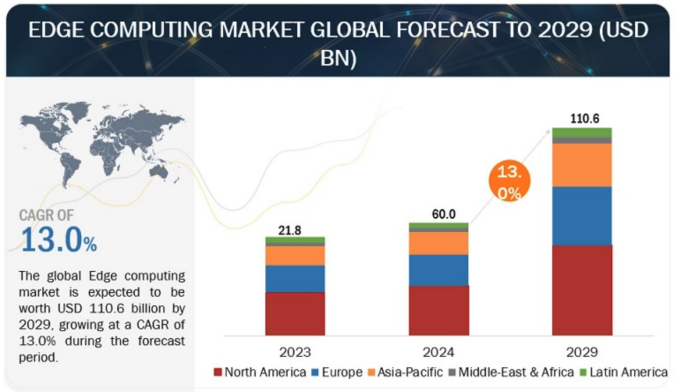
- Introduction
- Challenges & Solutions
- SDK Integration

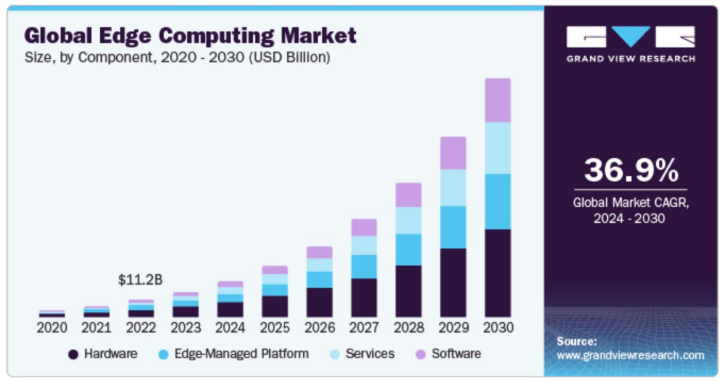
Demo

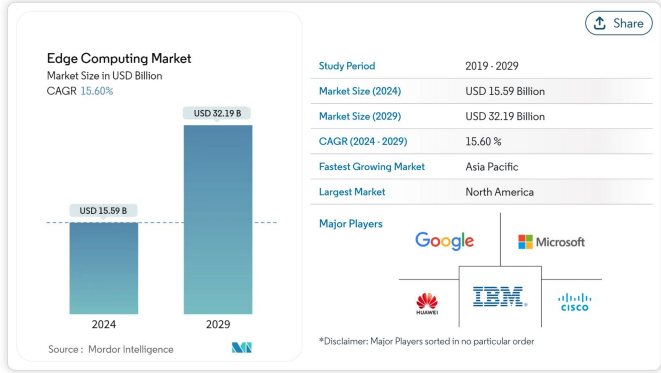
Additional Resources

Background

Edge Trend







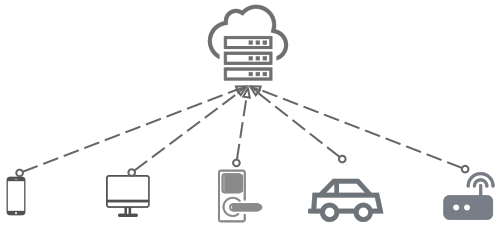
- MarketsandMarkets: “The Edge computing market size is expected to grow from USD 60 billion in 2024 ot 110.6 billion by 2029...”
- Grand View Research: “The global edge computing market size is expected to grow at a compound annual growth rate(CAGR) of 36.9% from 2024 to 2030... ”
- Mordor Intelligence: “Growing at a CAGR of 15.6% during the forecast period(2024-2029); Largest Market is North America; Fastest Growing Market Asia Pacific...”

Kubernetes at the Edge

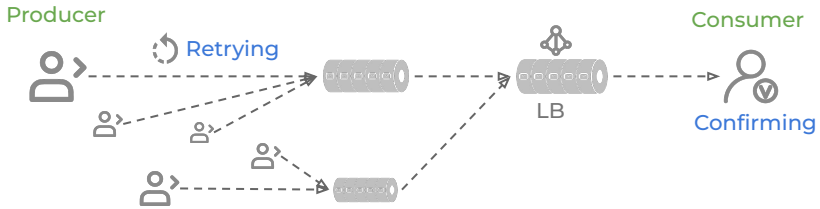
- **Lightweight Kubernetes for Edge**

K3S K3D MicroK8s Raspberry Pi

- **Resource Management on Edge Clusters**
  - Storage for vast edge resources
  - Transmission for Edge data
    - Network instability
    - Flexibility with dynamic scaling
    - Scalability for traffic spikes

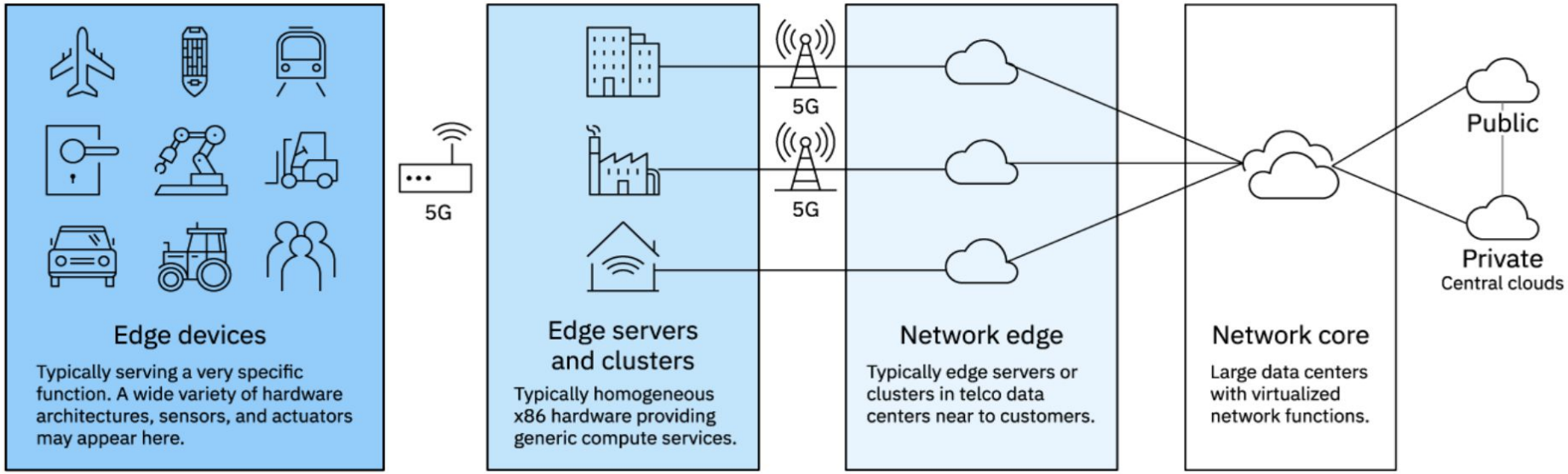


- Message retrying, confirming, and error handling
- Producer and consumer decoupling control-plane and edges
- The LB of transport enhances the system's performance



Background

Event - CloudEvents



IBM developer: Overview of edge computing?

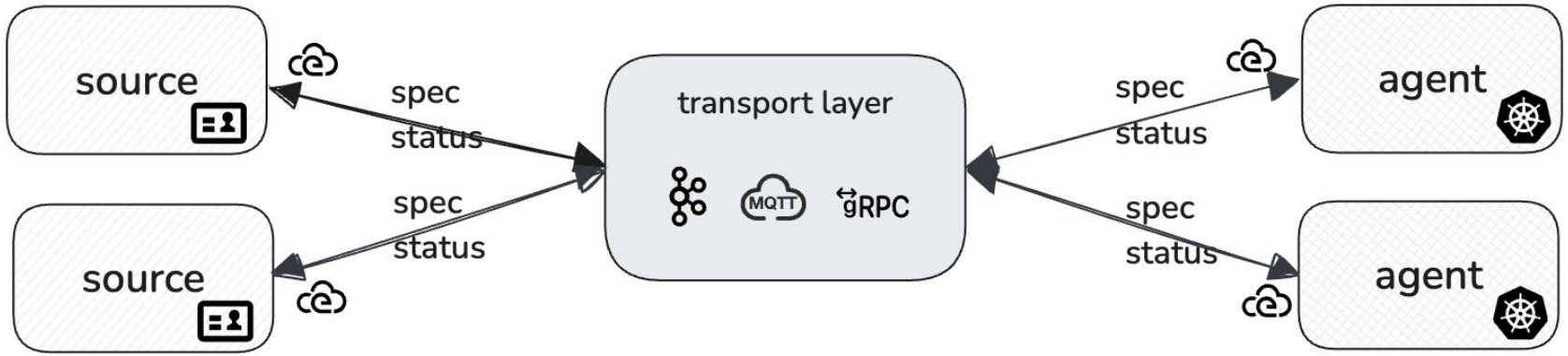
A standard for uniformly describing event data, aiming to simplify event declaration and delivery across various services, platforms and beyond!

E ≠ Business

E ≠ Platform

Event Based Transport

Introduction



Source

- Publishes resource spec & Subscribes to status
- Examples include a controller or a service with DB backend

Transport Layer

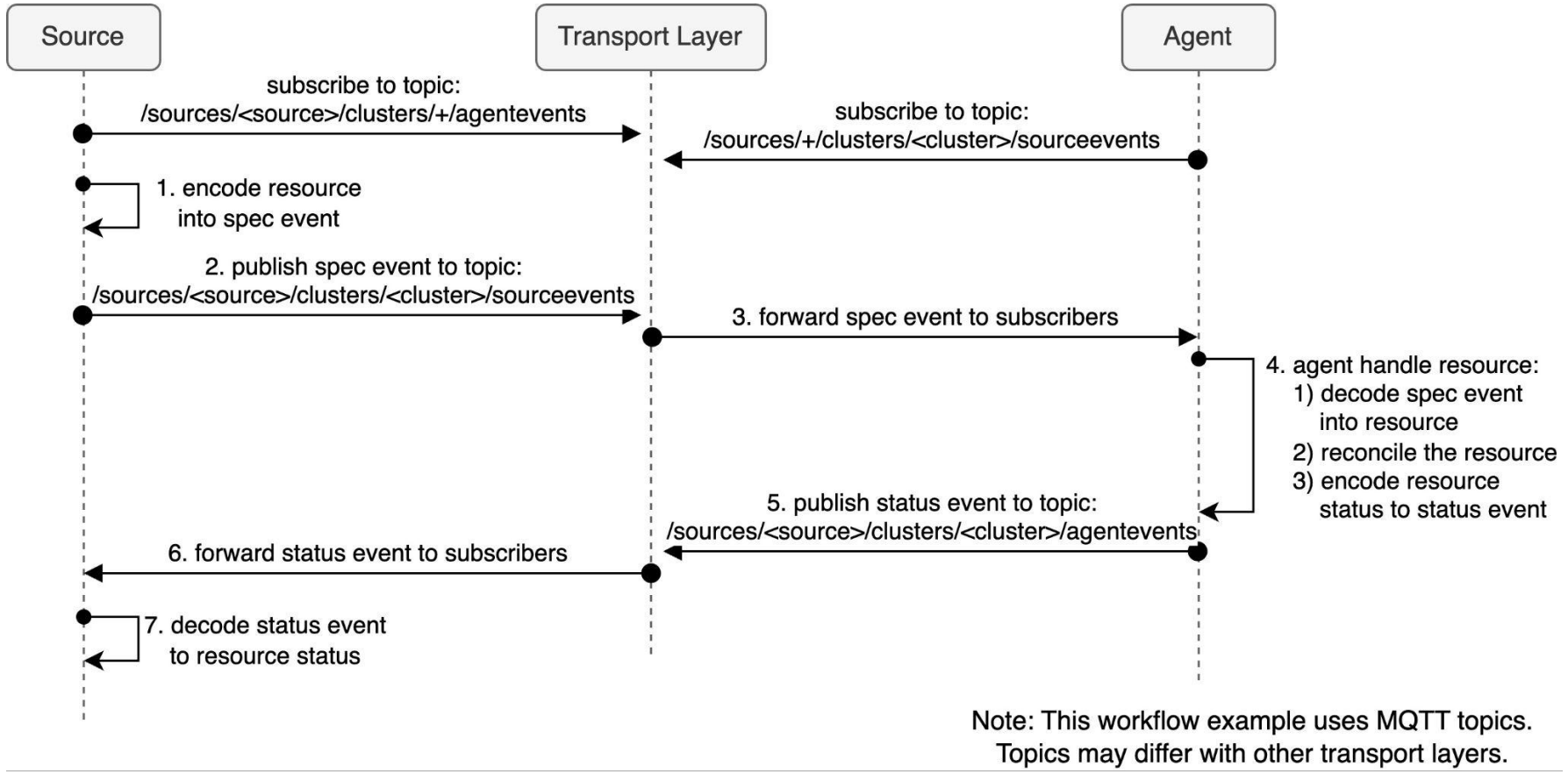
- Event broker between source and agent
- Supports various brokers (e.g., Kafka, MQTT) or custom implementations (e.g., gRPC)

Agent

- Running on Edge clusters
- Subscribes to resource spec & Publishes status
- Reconciles resource at edge cluster

Event Based Transport

Workflow Overview



Note: This workflow example uses MQTT topics.
Topics may differ with other transport layers.

Challenges & Solutions

- **Event Disorder**
  - Resource spec event
    - resource version 
  - Resource status event
    - Sequence ID generated by snow flake 
- **Spec/Status Divergence**
  - Source/Agent restart
  - Network disruption between source/agent and transport layer
    - spec/status resync
      - spec resync event using the cached versions map.
      - status resync event using the stored status hash map.
- **Event Distribution**
  - Consistent hashing

Event Based Transport

SDK Integration

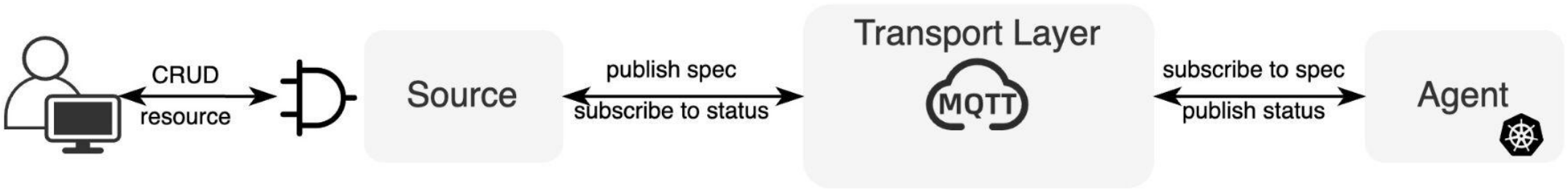
cloudevents/sdk-go

- MQTT Protocol
  - Eclipse Paho
  - Binary, Structured Mode
- Kafka Protocol
  - Confluent Kafka
  - Commit offset asynchronously
  - Replay from a specific point(offset)
  - Wildcard consumption pattern

open-cluster-management/sdk-go

- Generic Cloud Events Client
  - Supports drivers MQTT, Kafka, gRPC
- Work Client with Cloud Events driver
  - Source/Agent manifestwork client

Demo


CRUD
resource
Source
publish spec
subscribe to status
Transport Layer
MQTT
subscribe to spec
publish status
Agent

Additional Resources

- **Documents**
  - Event Based Manifestwork Enhancement
  - CloudEvents Based Client Design
  - CloudEvents Based Client Usage
- **Tools and Libraries**
  - Generic CloudEvents Client
  - Work Client with CloudEvents Driver
- **Real Use Cases**
  - Project Maestro - https://github.com/openshift-online/maestro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Thanks!