KubeEdge Introduction

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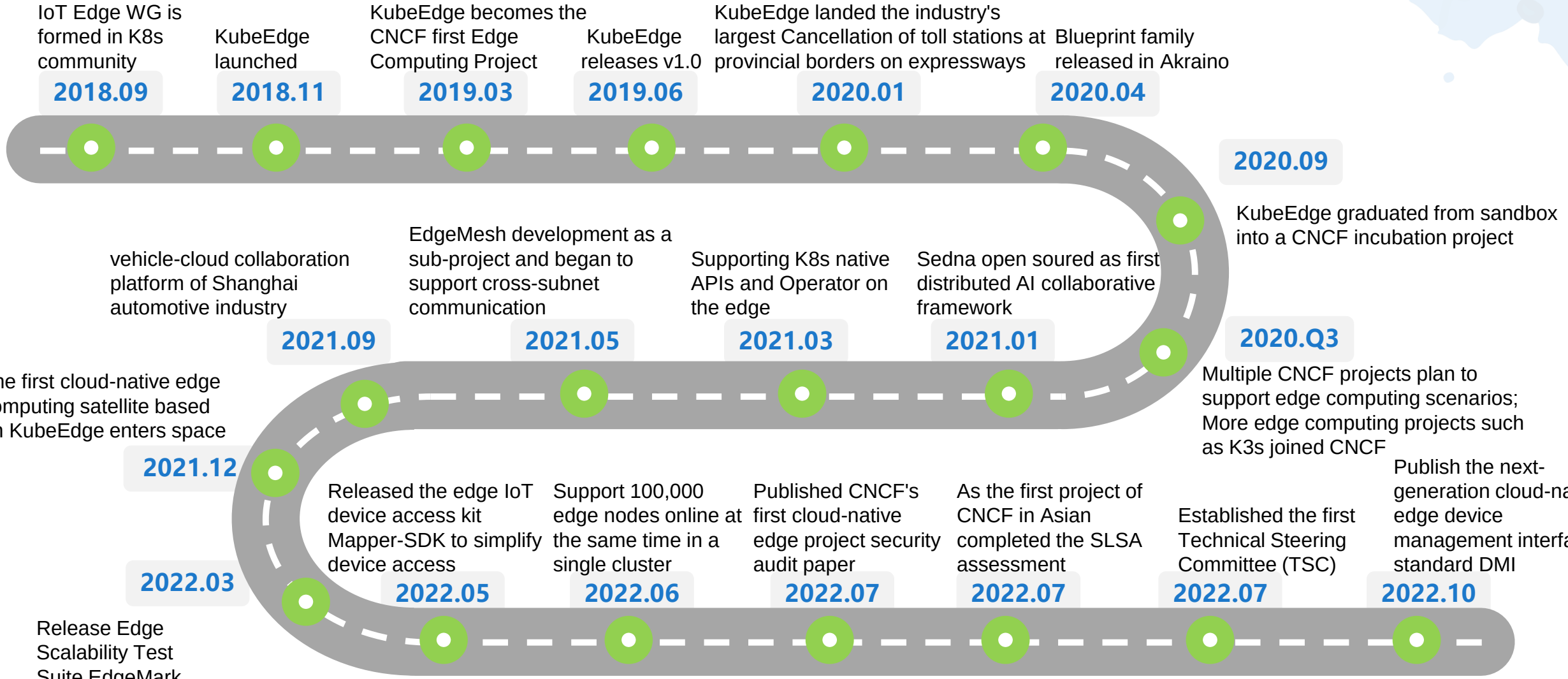
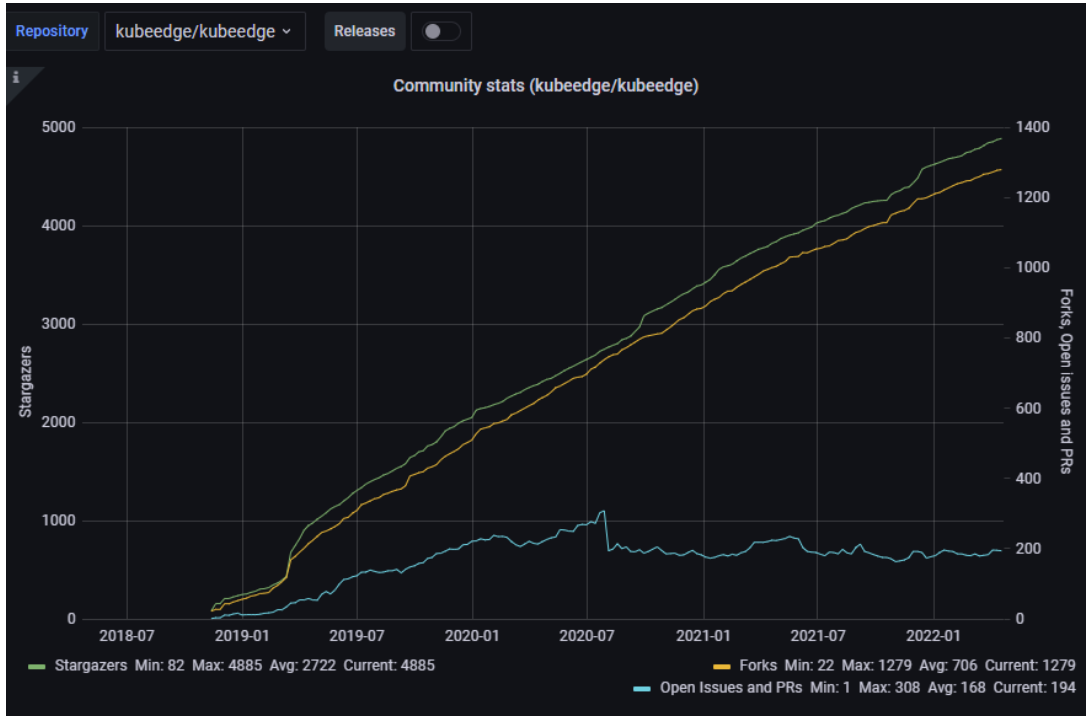
KubeEdge SIG-Security / SIG-Testing Tech Leader

Contents

Our Journey


IoT Edge WG is formed in K8s community
2018.09
KubeEdge launched
2018.11
KubeEdge becomes the CNCF first Edge Computing Project
2019.03
KubeEdge releases v1.0
2019.06
KubeEdge landed the industry's largest Cancellation of toll stations at provincial borders on expressways
2020.01
Blueprint family released in Akraino
2020.04
2020.09
KubeEdge graduated from sandbox into a CNCF incubation project
2020.Q3
Multiple CNCF projects plan to support edge computing scenarios; More edge computing projects such as K3s joined CNCF
Sedna open soured as first distributed AI collaborative framework
2021.01
Supporting K8s native APIs and Operator on the edge
2021.03
EdgeMesh development as a sub-project and began to support cross-subnet communication
2021.05
vehicle-cloud collaboration platform of Shanghai automotive industry
2021.09
The first cloud-native edge computing satellite based on KubeEdge enters space
2021.12
Release Edge Scalability Test Suite EdgeMark
2022.03
Released the edge IoT device access kit Mapper-SDK to simplify device access
2022.05
Support 100,000 edge nodes online at the same time in a single cluster
2022.06
Published CNCF's first cloud-native edge project security audit paper
2022.07
As the first project of CNCF in Asian completed the SLSA assessment
2022.07
Established the first Technical Steering Committee (TSC)
2022.07
Publish the next-generation cloud-native edge device management interface standard DMI
2022.10

Community Growth



Contributors 243

- 5.6k+ Stars
- 1.5k+ Forks
- 950+ Contributors
- 260+ Code Submitters
- 70+ Organizations

KubeEdge Key Features

- Kubernetes Native API at Edge
- Seamless Cloud-Edge Coordination
- Edge Autonomy
- Low Resource Readiness
- Simplified Device Communication
- Cloud View of Global Metrics Data

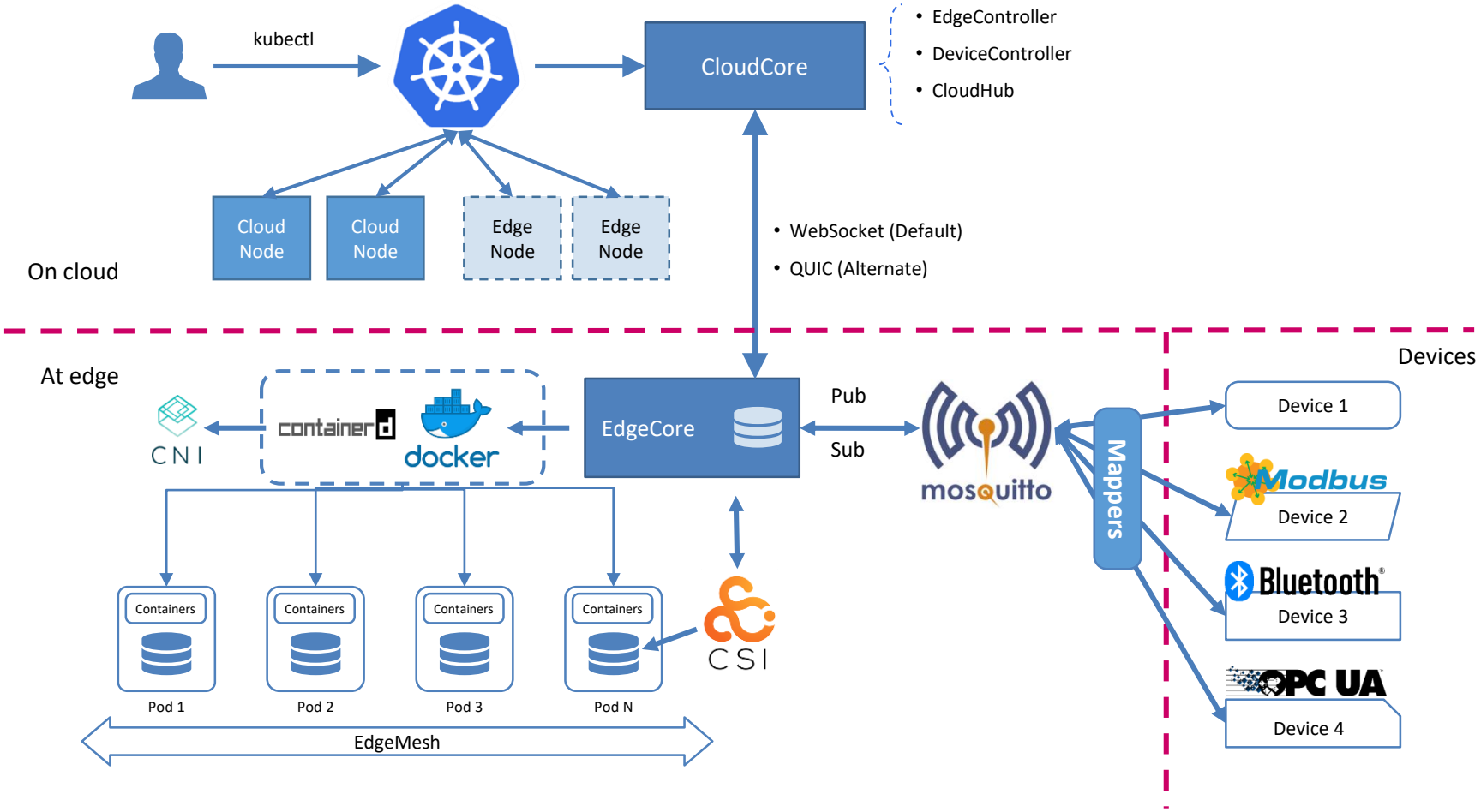
KubeEdge

https://kubeedge.io

What's New

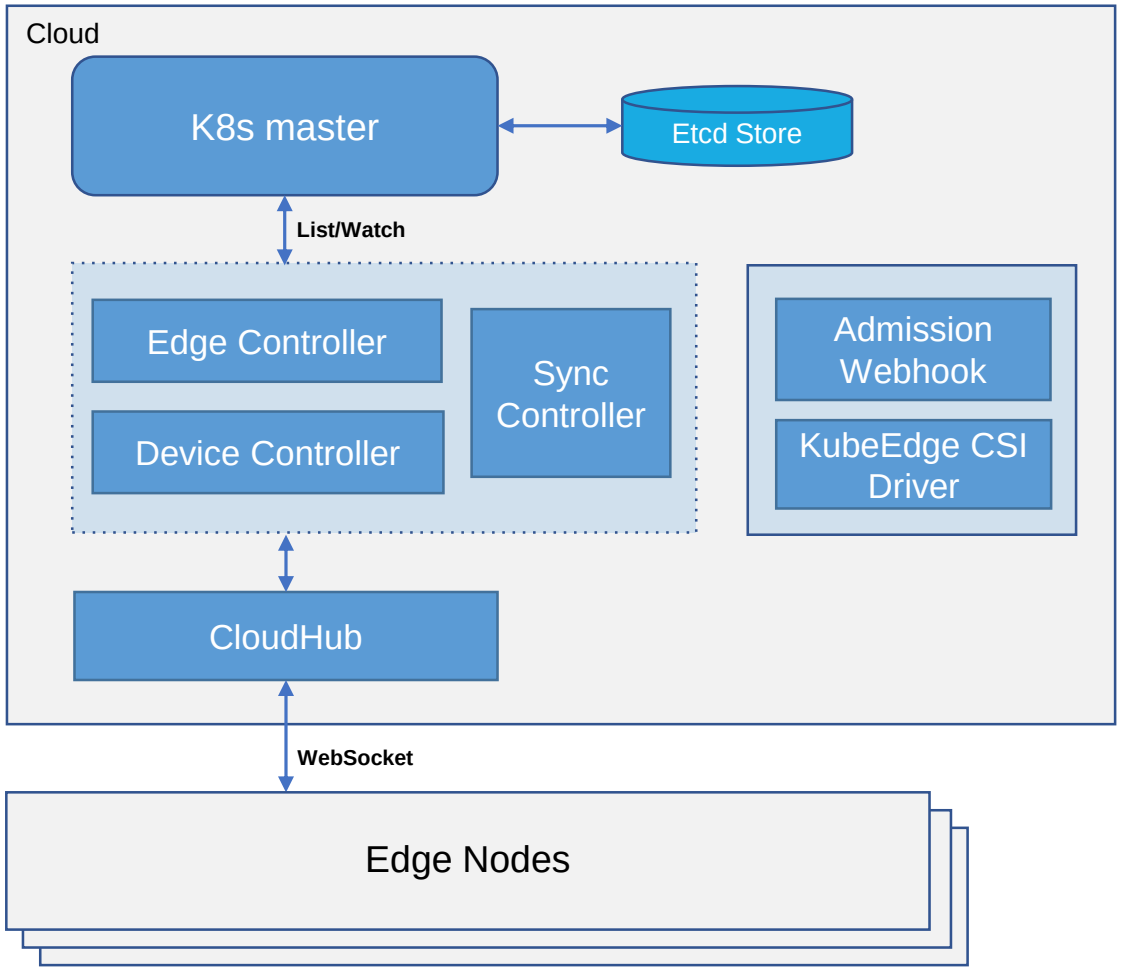
- Active-Active HA Support of CloudCore for Large Scale Cluster
- Mapper Framework updates
- Custom HTTP Request Routing between Cloud and Edge for Applications
- EdgeMesh Architecture Upgrade
- EdgeMesh Cross LAN Communication
- Device Management Interface
- *Support 100,000 Edge Nodes and manage 1,000,000 pods

Architecture



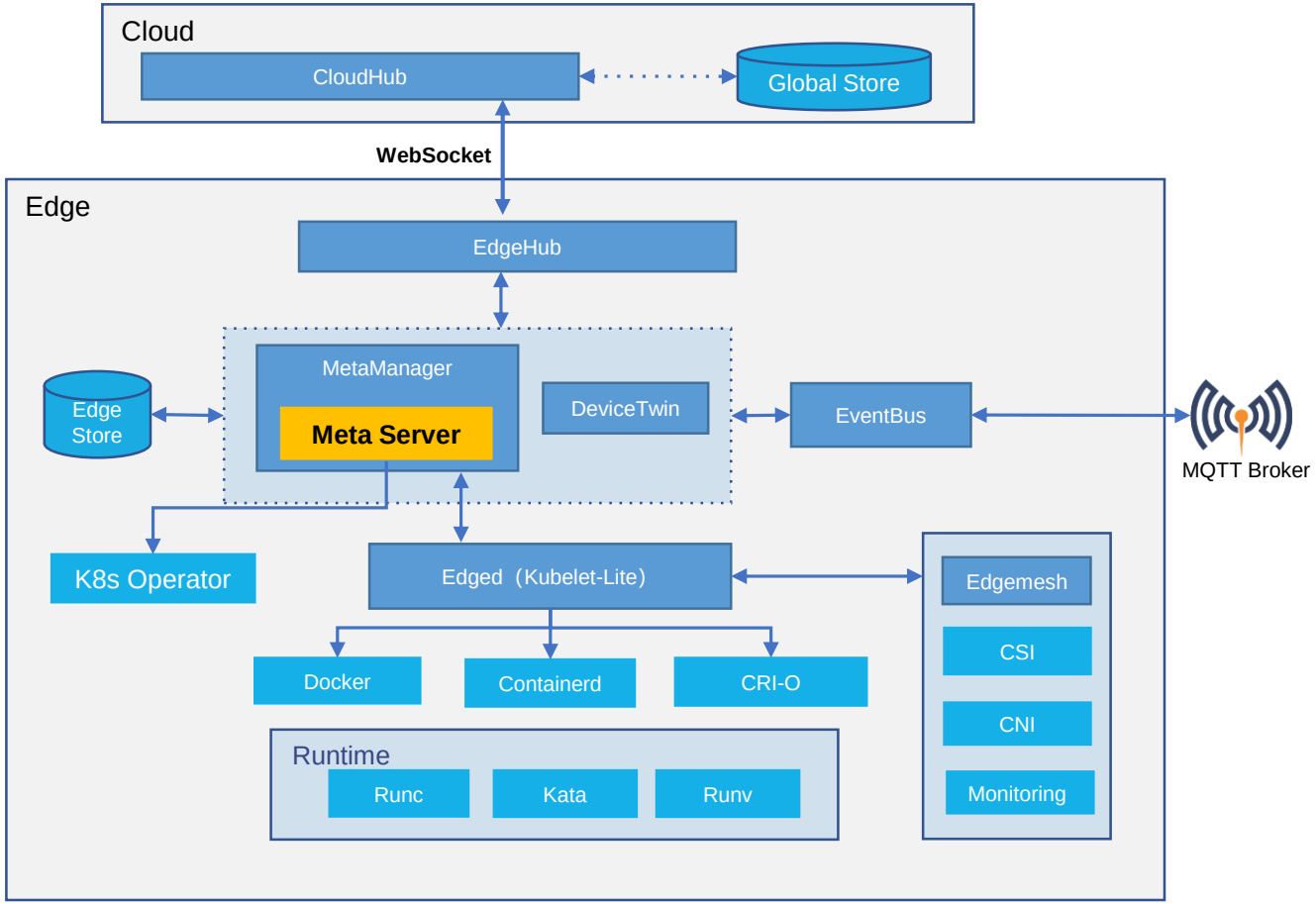
- Native Kube-API at Edge
- Seamless Cloud-Edge Coordination
- Edge Autonomy
- Low Resource Readiness
- Simplified Device Communication
- Cloud View of Global Metrics Data

KubeEdge Component on Cloud



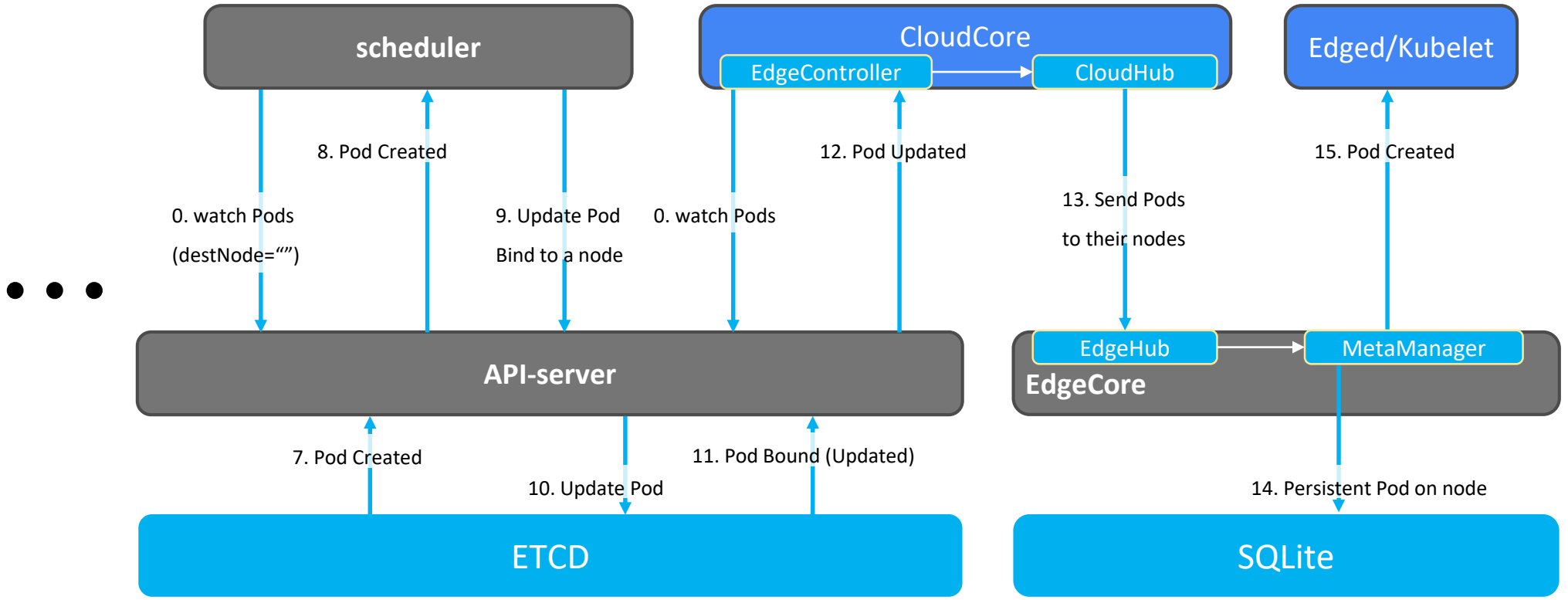
- EdgeController
  - Edge node management
  - Collaboration of app state metadata
- Devices API/DeviceController
  - Access and manage edge devices
  - Collaboration of devices metadata
- Sync Controller
  - Reliability and consistency of data between cloud and edge
- CSI Driver
  - seamless integration of third-party CSI plug-ins
- Admission Webhook
  - Extension API input validation

KubeEdge Component on Edge

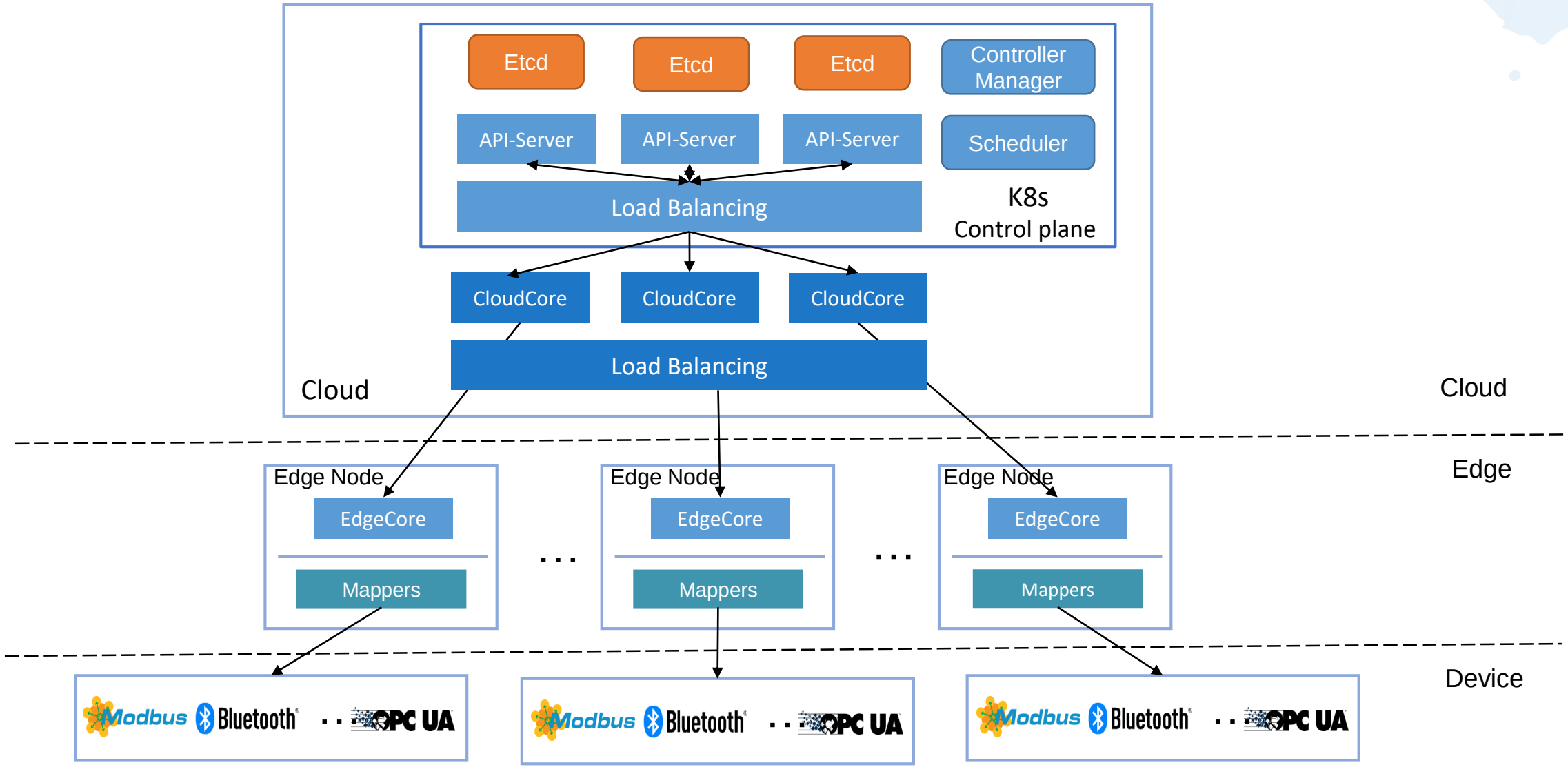


- EdgeHub
  - Messaging over WebSocket / Quic
  - Provide reliable cloud edge information synchronization
- MetaManager
  - Metadata is stored locally and persistently
  - provides reliable K8s native API access
- Edged
  - Kubelet-lite
  - Pod life cycle management
- DeviceTwin
  - Synchronize device information to the cloud
- EventBus
  - MQTT client, Edge devices

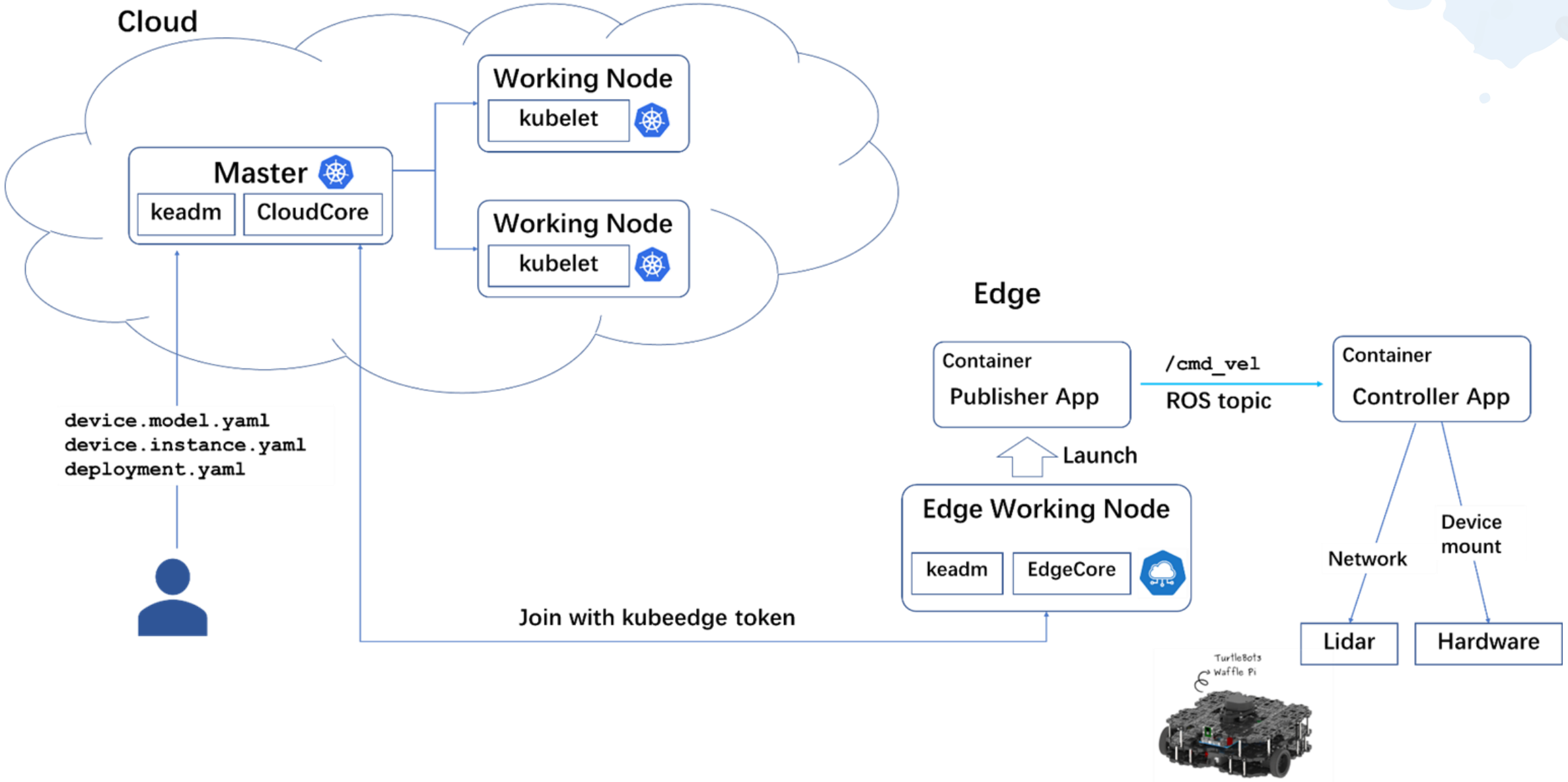
Deploy App to Edge Node



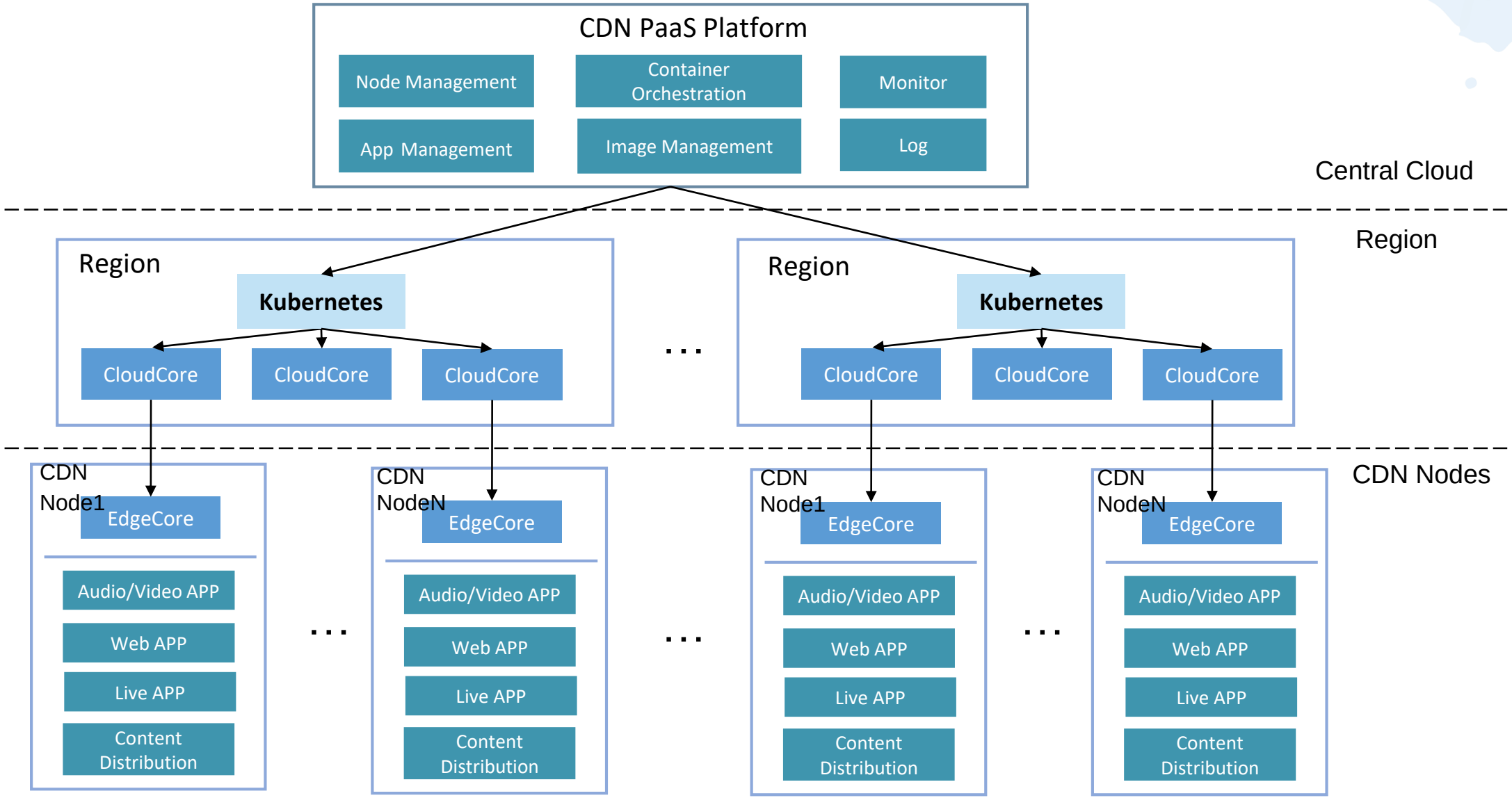
KubeEdge HA Deployment



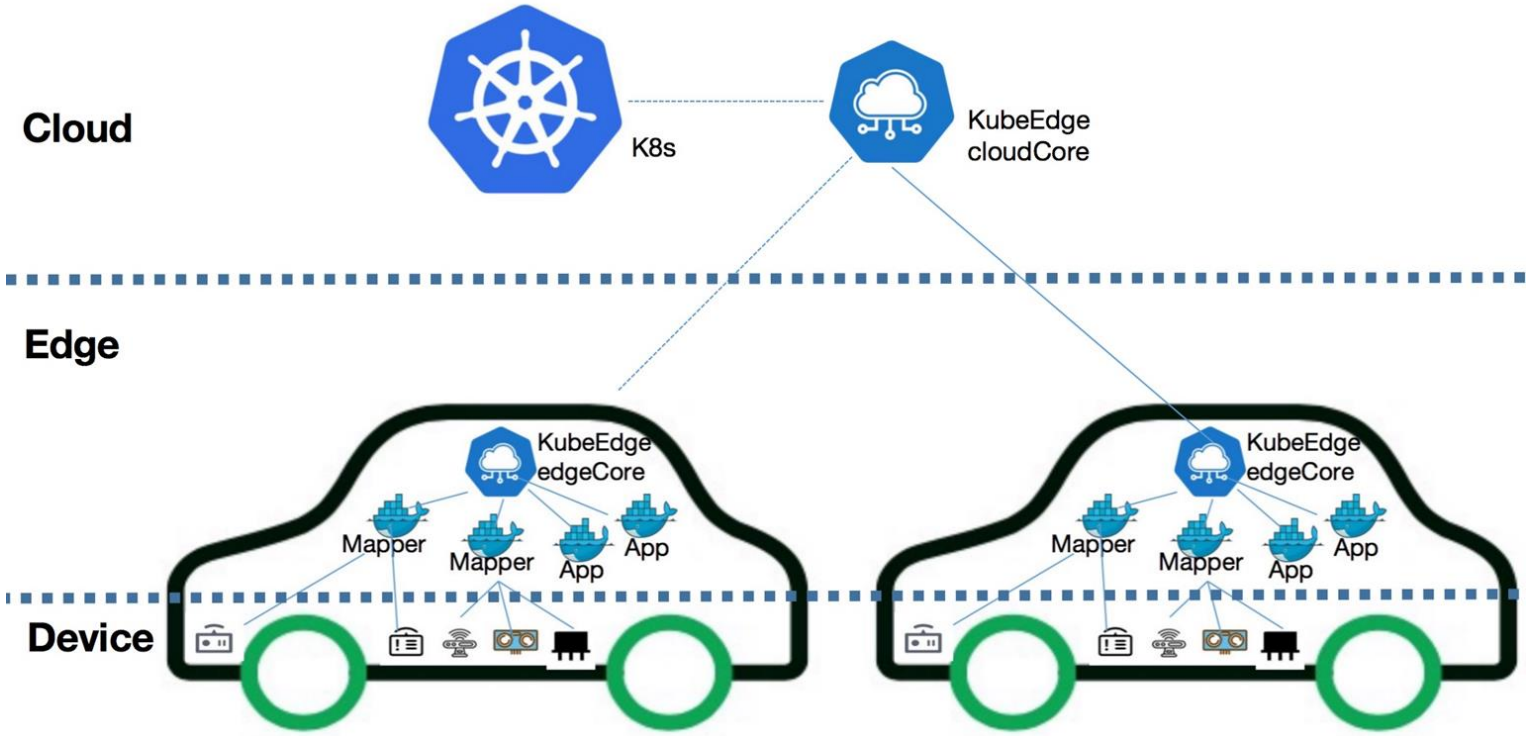
Robotics Deployment



Use Case – Manage Large Scale CDN Nodes

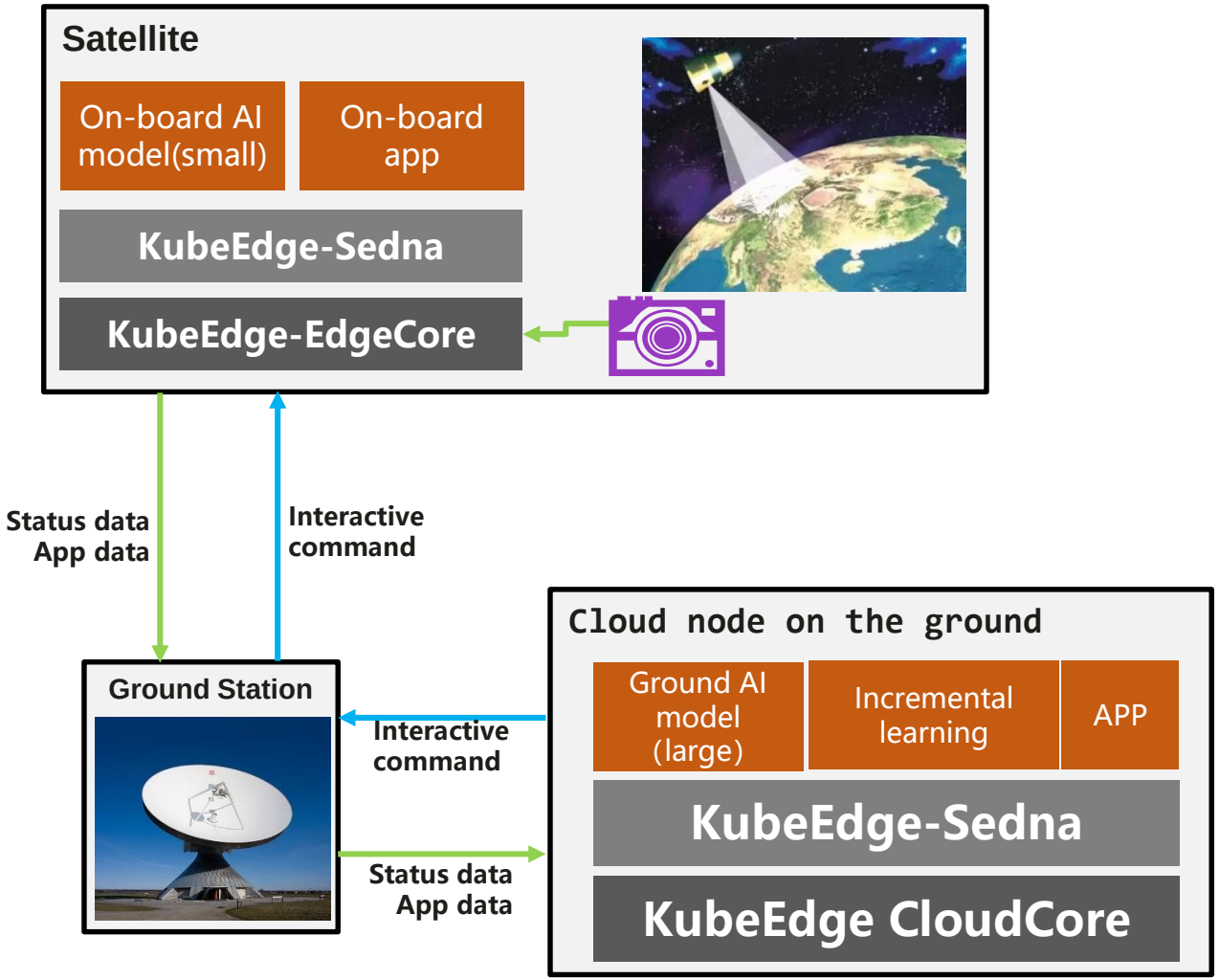


Use Case – vehicle-cloud collaboration platform



- Large scale
  - ✔ Manage 100,000+ vehicles per cluster
  - ✔ Manage million-level devices per cluster
- Light-weighted architecture
- Flexible expansion
  - ✔ Multi-K8s clusters
  - ✔ Customized endpoints rules, channels
- others
  - ✔ Edge autonomy, and other features ...
  - ✔ Stable: CNCF edge computing framework
  - ✔ Very active community and quick response

Cloud-Native Satellite



- Lifecycle Management for edge node and cloud-native applications
- Highly reliable satellite-ground data transmission and synchronization
- Multi-model joint inference, less satellite resource consumption
- Incremental learning, auto tuning, higher model accuracy
- Unified IoT device modeling, easier device access

Partners


arm
SAMSUNG
midokura
EMQ
RAISECOM
兴海物联
orange
China unicom中国联通
创新·改变世界
沃云
Wo Cloud
中国移动
China Mobile
中国电信
CHINA TELECOM
中国南方电网
CHINA SOUTHERN POWER GRID
南方电网深圳数字电网研究院有限公司
ICTNJ
中科南京信息高铁研究院
Nanjing Institute of Information Superbahn


SPANIDEA
ideas to implementation
Infoblox
NEXT LEVEL NETWORKING
inovex
Ci4Rail
FUTUREWEI
Technologies
inspur
精英数智


HUAWEI
HUAWEI CLOUD
DaoCloud
时速云
tenxcloud.com
EasyStack
open cloud computing
KUBESPHERE
谐云科技
HARMONY CLOUD
Click2Cloud
博云
BoCloud


CAICT
中国信息通信研究院
SEL
之江实验室
ZHEJIANG LAB
USTC
1956
1949
FUDAN UNIVERSITY
1905

A more secure project

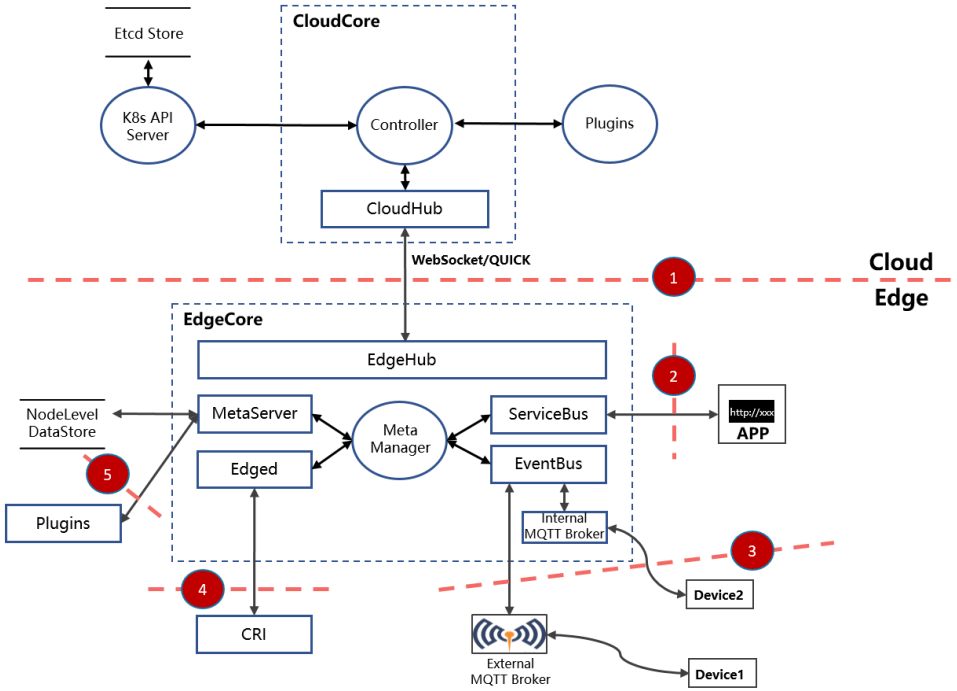
As the first project of CNCF completed the SLSA assessment and reached level 3

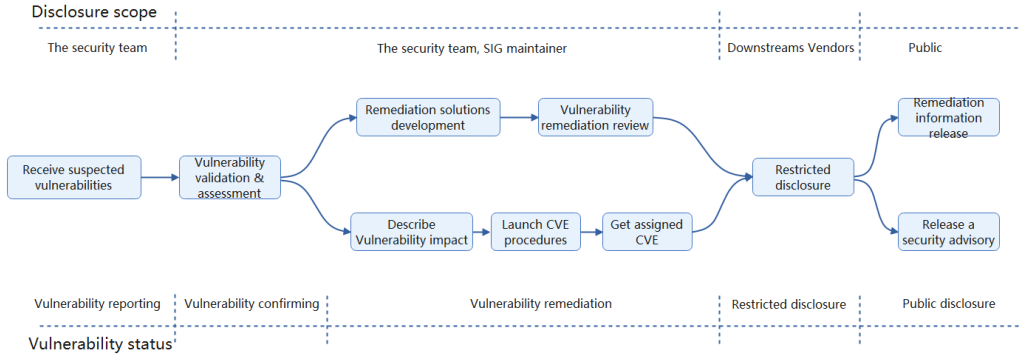
KubeEdge security audit
https://github.com/kubeedge/community/tree/master/sig-security/sig-security-audit/KubeEdge-security-audit-2022.pdf

As one of the first project of CNCF integrated Fuzzing test

https://www.cncf.io/blog/2022/06/28/improving-security-by-fuzzing-the-cncf-landscape/

A more secure project





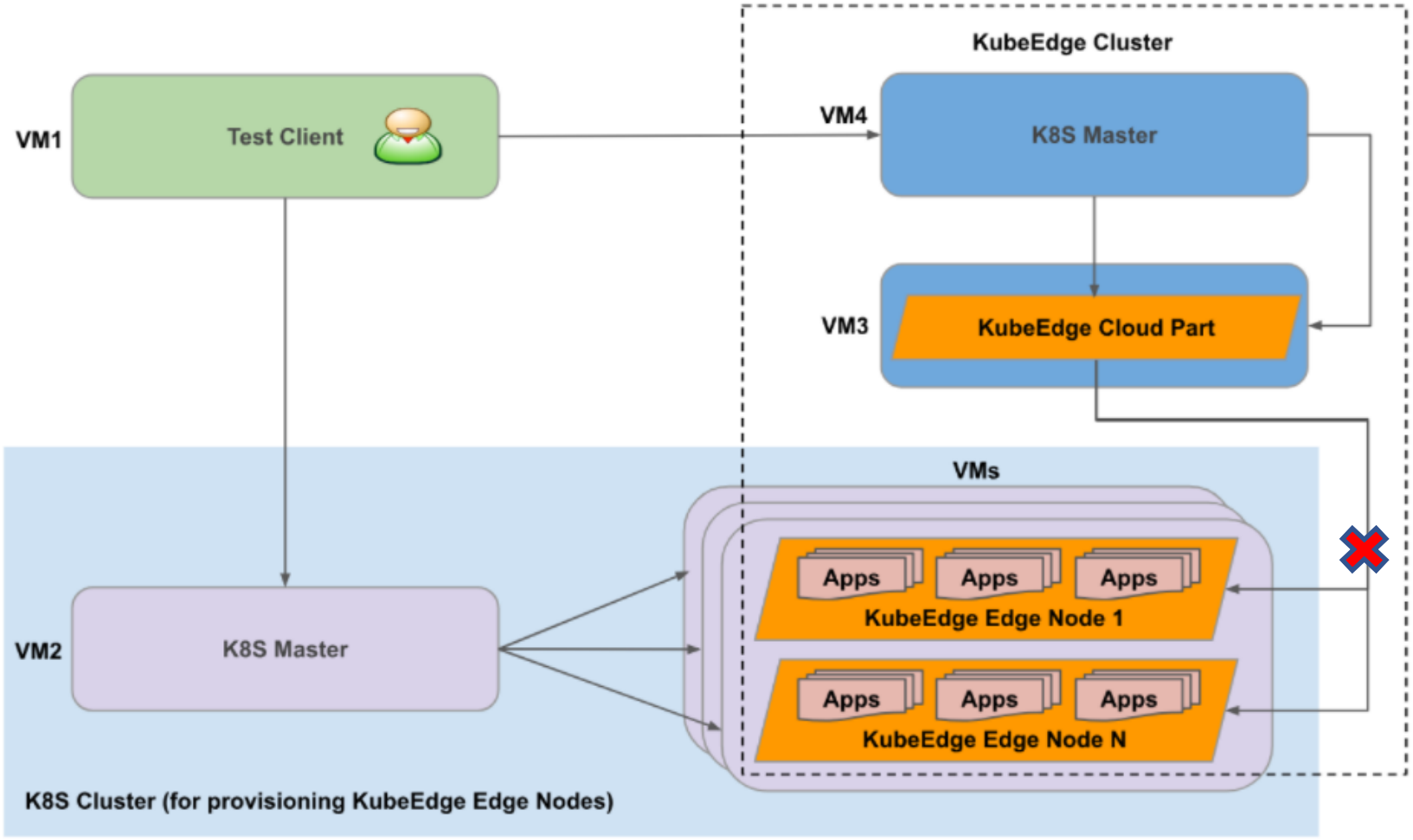
KubeEdge Threat model and security protection analysis paper

https://github.com/kubeedge/community/tree/master/sig-security/sig-security-audit/KubeEdge-threat-model-and-security-protection-analysis.md

KubeEdge community vulnerability management and security policy

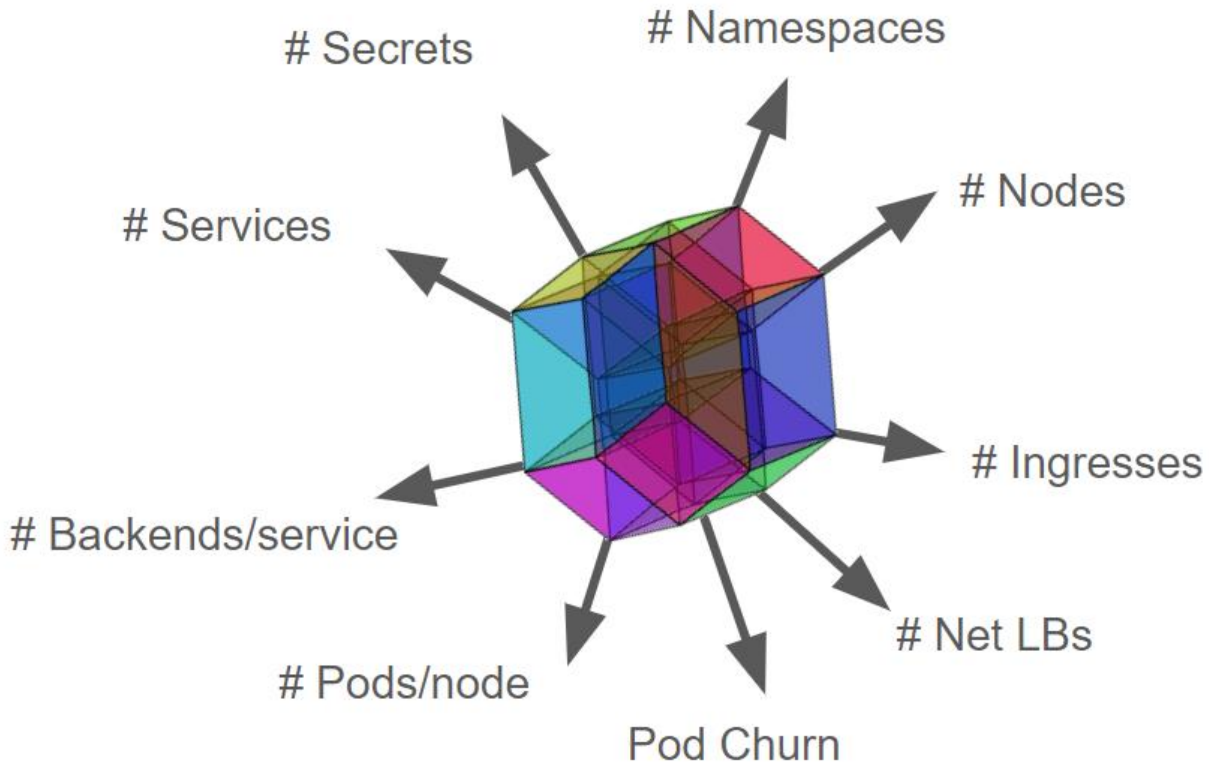
https://github.com/kubeedge/community/blob/master/security-team/SECURITY.md

KubeEdge Performance Tests



- Service Level Objectives Tested
  - Latency
  - Throughput
  - Scalability
  - CPU Usage
  - Memory Usage
- For Unstable Cloud-Edge Network
  - Disconnect the Cloud-Edge Network
  - Network delay simulation
  - Network bandwidth control

Kubernetes Scalability <> #Nodes



From Kubernetes [sig-scalability]

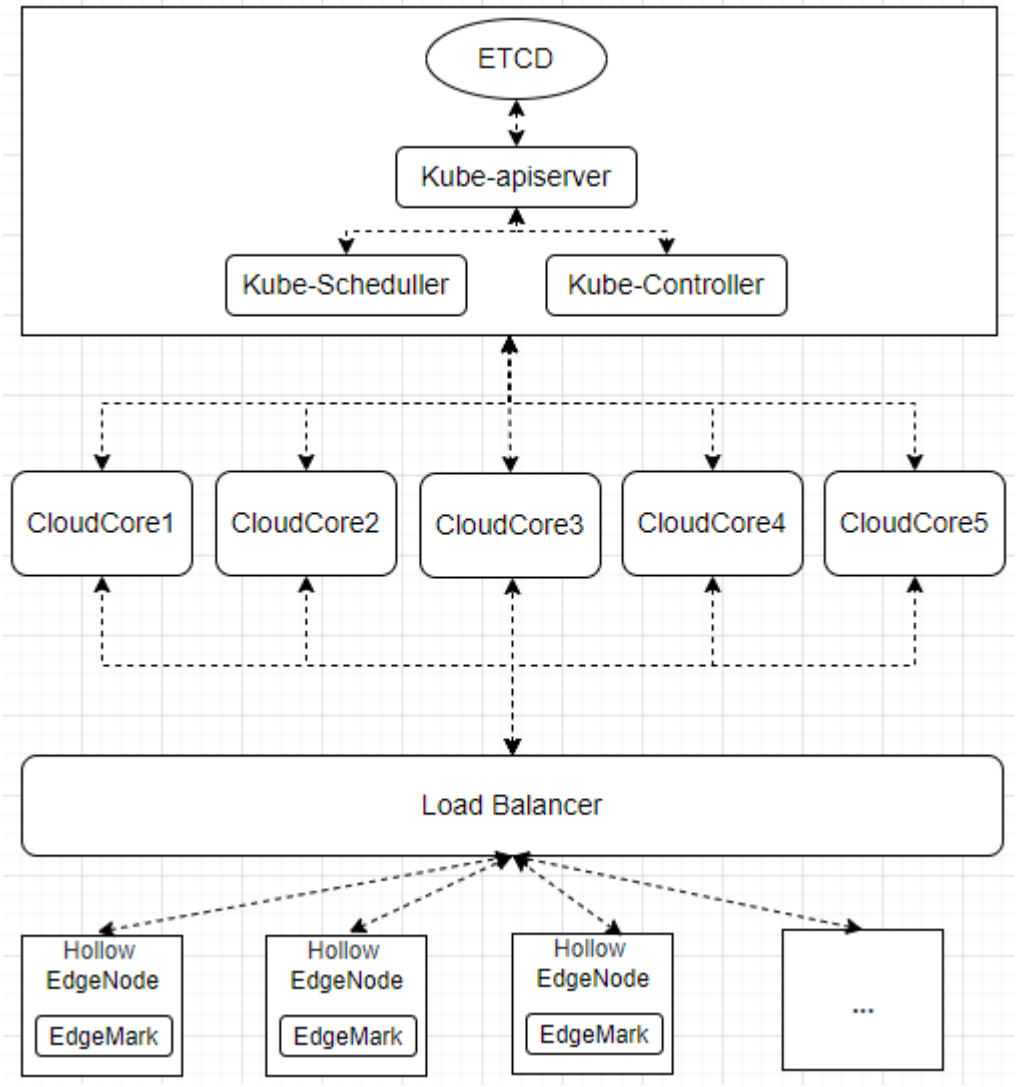
- **Kubernetes Scalability thresholds**

https://github.com/kubernetes/community/blob/master/sig-scalability/configs-and-limits/thresholds.md

- **Kubernetes scalability and performance SLIs/SLO**

https://github.com/kubernetes/community/blob/master/sig-scalability/slos/slos.md

KubeEdge Scalability Tests



- **ClusterLoader2** Kubernetes density test configuration

https://github.com/kubernetes/perf-tests/blob/master/clusterloader2/testing/density/config.yaml

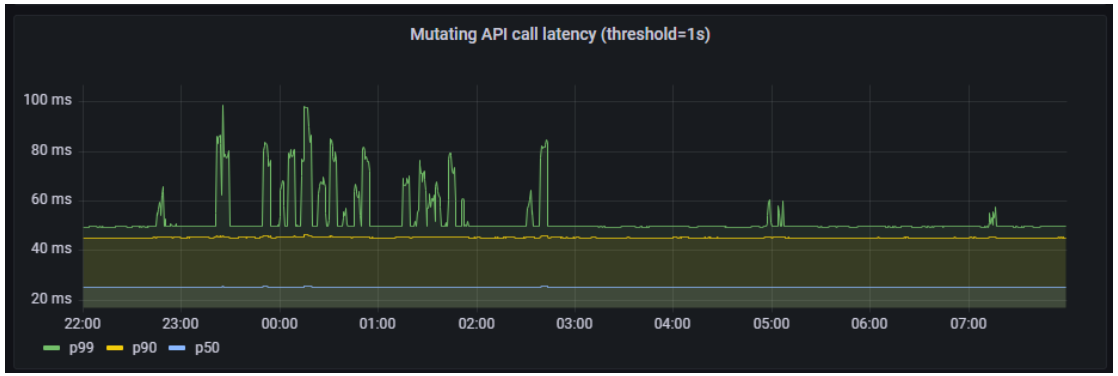
Maximum type	Maximum value
Number of Nodes	100,000
Number of Pods	1,000,000
Number of Pods per node	10
Number of Namespaces	400
Number of Pods per Namespace	2,500

***100,000 Edge Nodes and 1,000,000 pods**

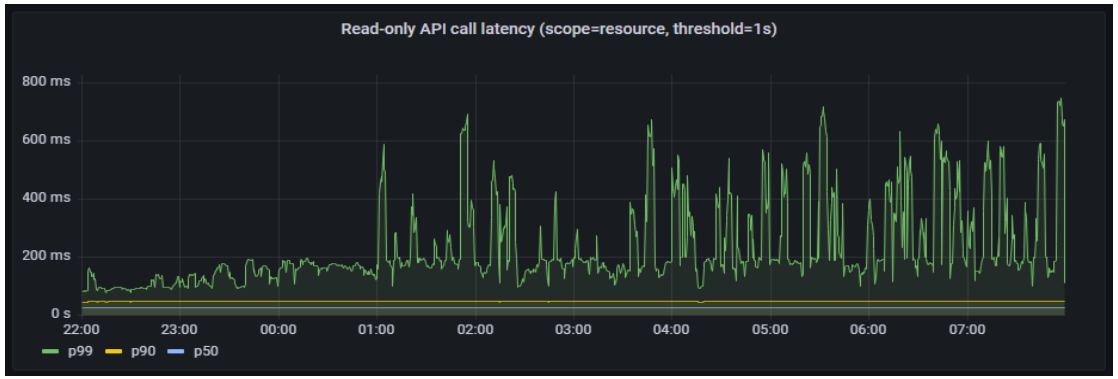
KubeEdge Scalability Tests Results

API Responsiveness Latency

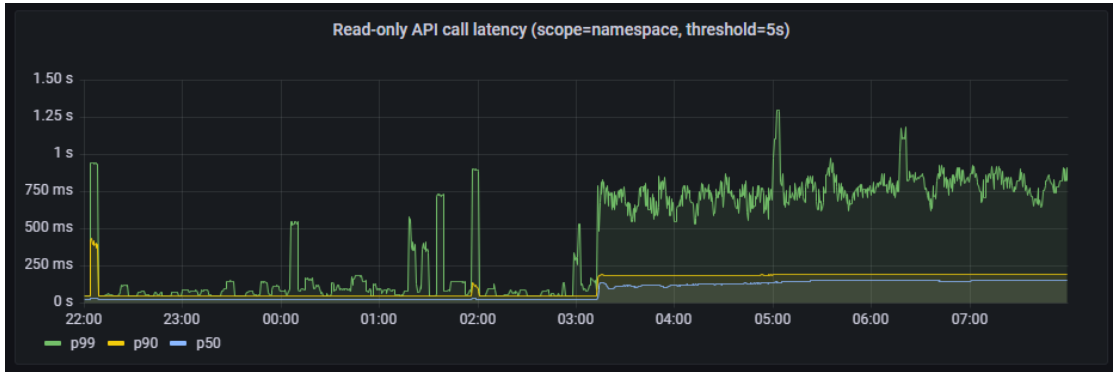
- mutating API latency（threshold=1s）：



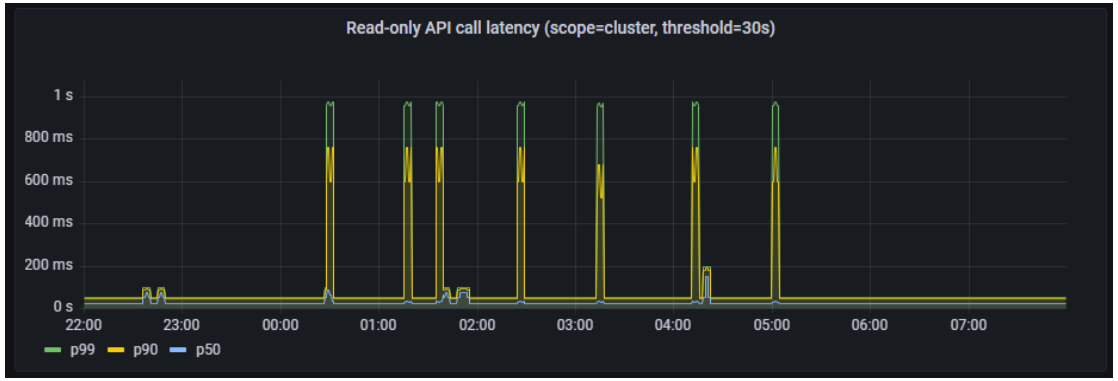
- Read-only API call latency(scope=resource, threshold=1s)



- Read-only API call latency(scope=namespace, threshold=5s)



- Read-only API call latency(scope=cluster, threshold=30s)



KubeEdge Scalability Tests Results

PodStartupLatency

metric	p50(ms)	p90(ms)	p99(ms)	SLO(ms)
pod_startup	1688	2751	4087	5000
create_to_schedule	0*	0*	1000	N/A
schedule_to_run	1000	1000	1000	N/A
run_to_watch	1087	1674	2265	N/A
schedule_to_watch	1657	2724	3070	N/A

* kube-apiserver does not support RFC339NANO, only degree of second. ClusterLoader2 shows 0 for fast responses.

Conclusions

- **KubeEdge supports 100,000 Edge Nodes and manage 1,000,000 pods**

- Full test report was published post KubeCon EU 2022

Future Roadmap

Technical

- Cross subnet communication support on the edge.
- Storage: edge cloud collaboration
- Strong security edge protection.
- Decentralized Security for applications on the edge.
- Edge device management extensibility, Device Mapper SDK.
- Managing Clusters at edge from cloud (aka. EdgeSite).

Community

- Better Contributor Experience
- More contributor events
- More cross community collaboration
  - EdgeX Foundry
  - Akri
  - Eclipse
  - WasmEdge

Join us!

- **Website**: https://kubeedge.io
- **Github: https://github.com/kubeedge/**
- **Slack channel: https://kubeedge.slack.com** | sign up here
- **Weekly community meeting: https://zoom.us/j/4167237304** | Subscribe Meeting Calendar
- **Documentation**: https://docs.kubeedge.io/en/latest/
- Mailing List: https://groups.google.com/forum/#!forum/kubeedge
- Twitter: https://twitter.com/KubeEdge

Thank you!