



Dr. Kyoungho An
Research Engineer
kyoungho@rti.com



Dr. Protima Banerjee
Research Engineer
protima@rti.com

Bringing Real-Time Performance to the Edge Cloud

Data Distribution Service (DDS) & Real-Time Publish Subscribe Open Standards

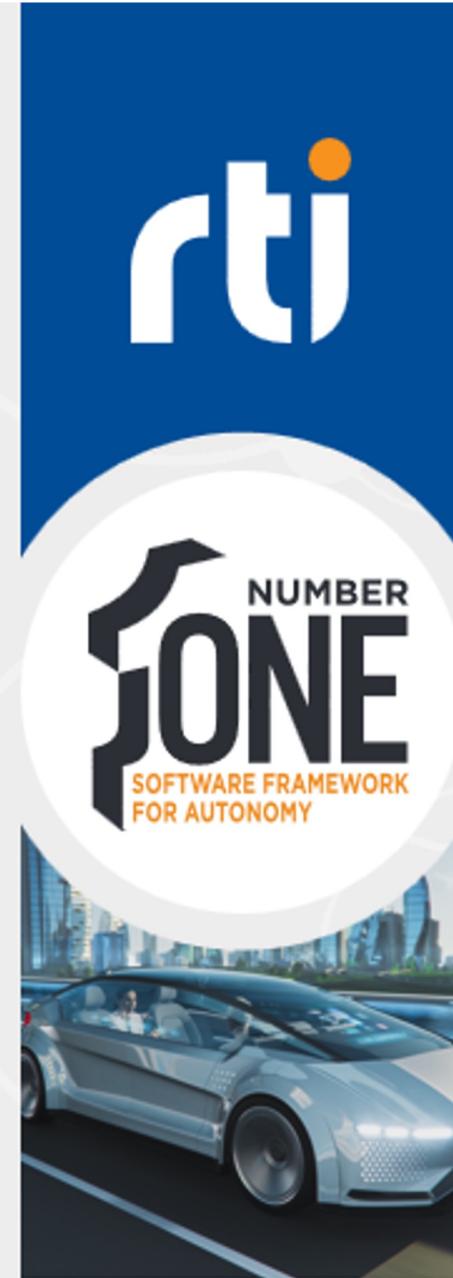
KubeCon North America
November 2023



2000+
DESIGNS



LEADER IN
20+
industry standards



NUMBER
ONE
SOFTWARE FRAMEWORK
FOR AUTONOMY



750+
RESEARCH
PROGRAMS



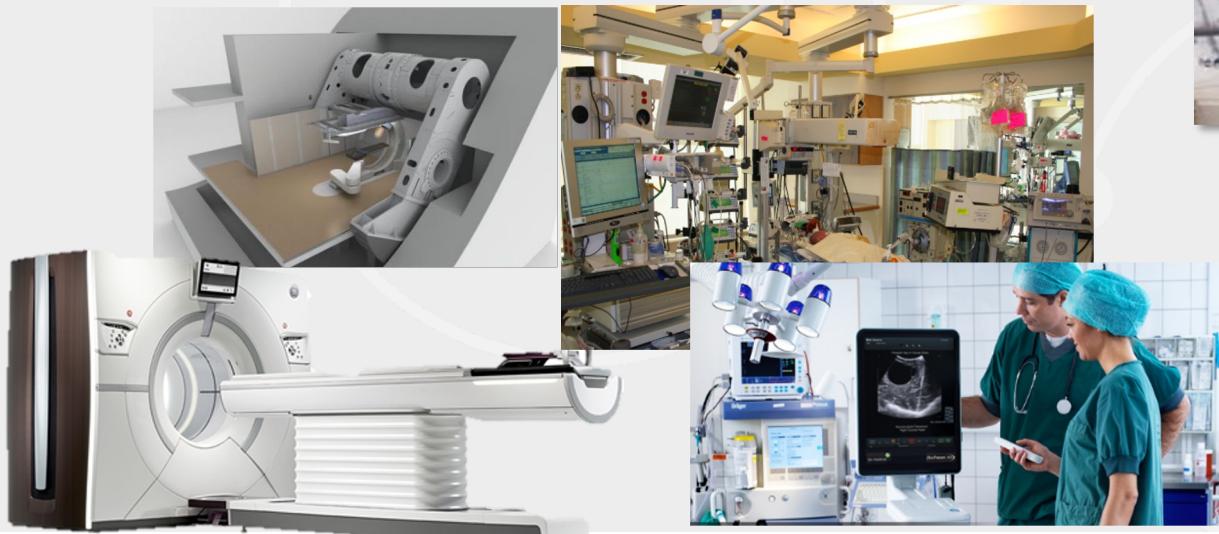
250+ EMPLOYEES
Silicon Valley • Denver
Spain • Singapore

Problem Spaces We are Interested In

Government & Defense



Medical and Healthcare



Commercial Automotive



The Challenge

A single messaging infrastructure to support:

- Edge Systems (strict timing requirements)
- Edge Cloud (less strict timing requirements)
- Extension to Cloud environments (more latency tolerant)

Technology and Approach

Data Distribution Service (DDSTM) and Real-Time Publish Subscribe (RTPS) :

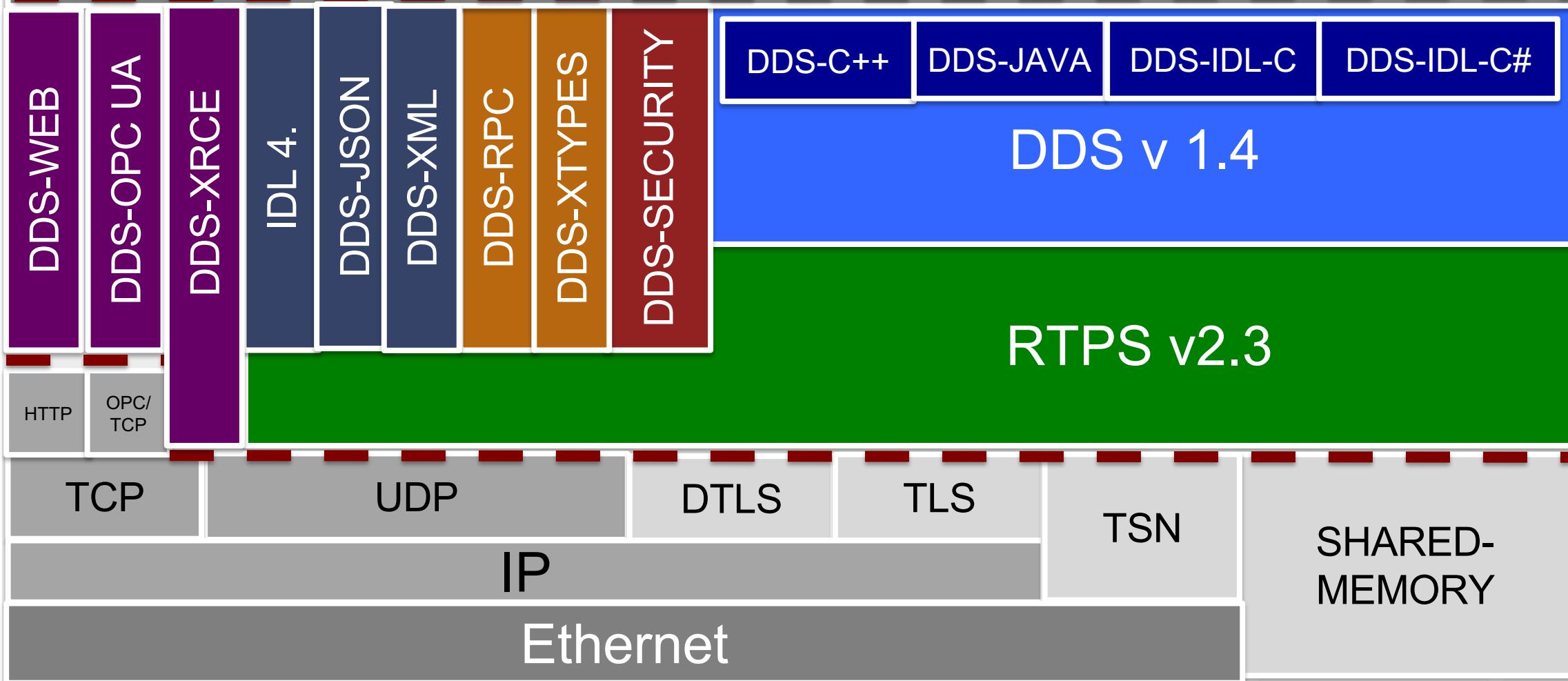
- Open standards for secure, interoperable **real-time data-centric** communications
- Enables platform independent, transport agnostic and **loosely coupled peer to peer** interactions
- Provides controls and patterns via QoS (e.g. ordering, durability, coherence) to achieve **ultra low latency at the Edge and Edge Cloud**

DDS Specification Family

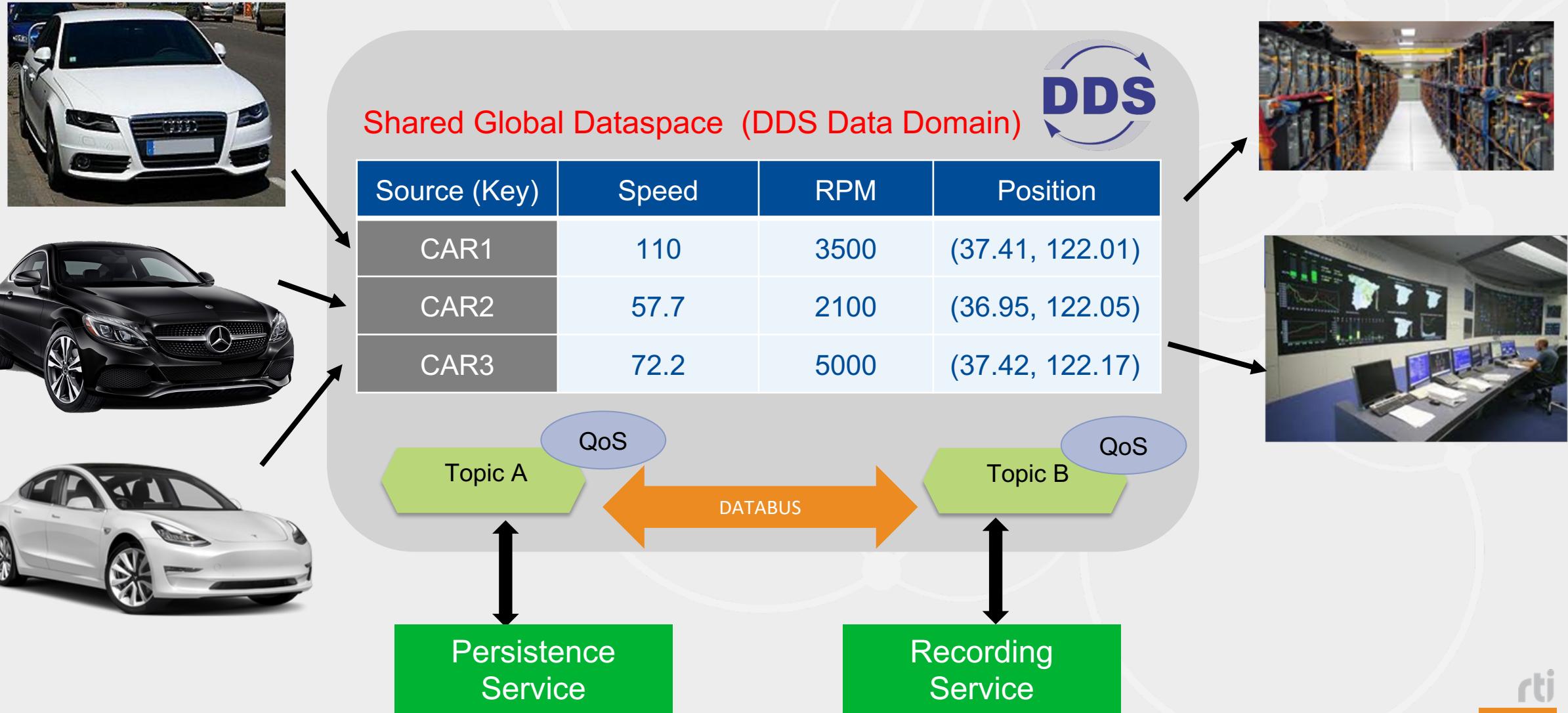


OMGTM
Standards
Development
Organization[®]

Application

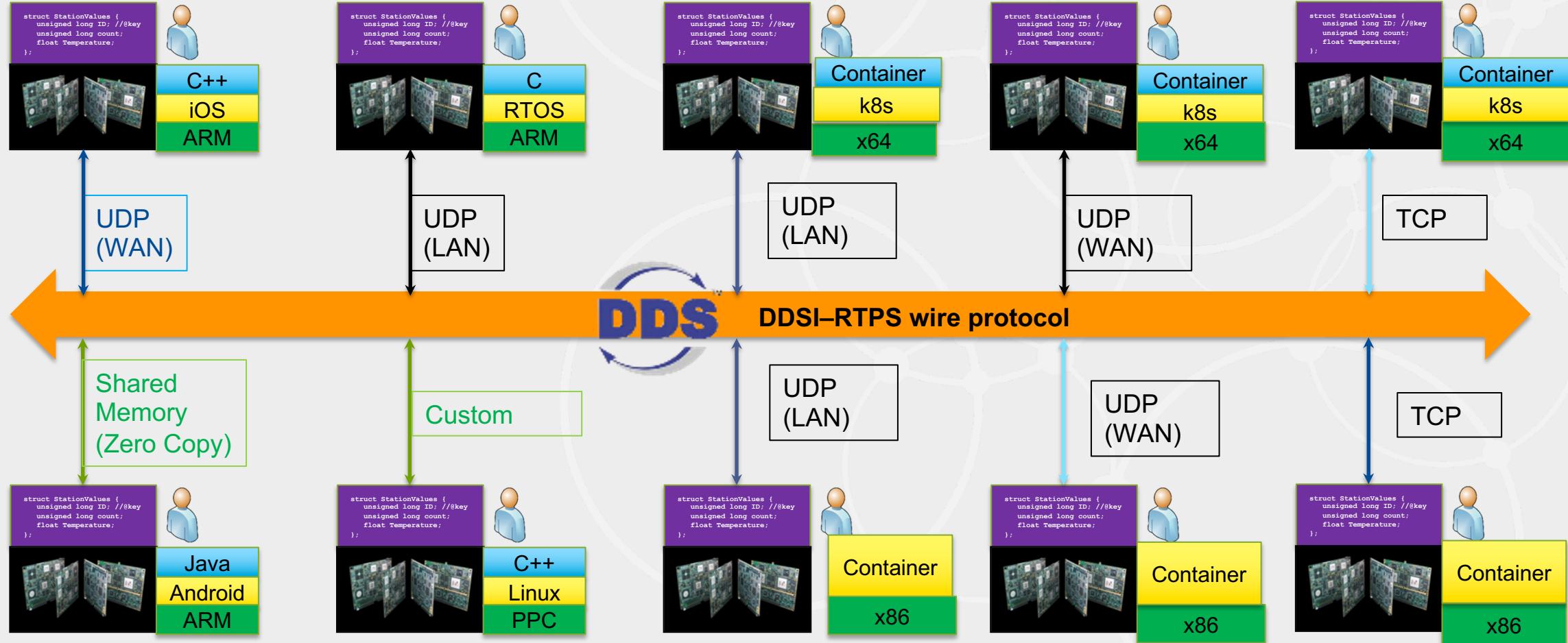


DDS Data-Centric Publish-Subscribe

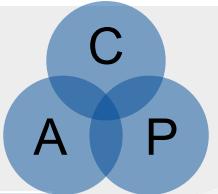


Peer to Peer Interactions (No Brokers)

Platform independent, transport agnostic and loosely coupled



QoS Configurability (per data flow)



| Guarantees | QoS Policies | Behaviors |
|------------------------|---|--|
| Delivery | RELIABILITY TIME BASED FILTER DEADLINE CONTENT FILTERS DURABILITY | Controls reliable data exchange and the ability to tune the strictness of reliability guarantees . Includes settings such as "best-effort", "strict reliable," and "latest value reliable", also notifies of missed delivery deadlines |
| Consistency & Ordering | DURABILITY HISTORY READER DATA LIFECYCLE WRITER DATA LIFECYCLE LIFESPAN PARTITION PRESENTATION DESTINATION ORDER | Controls how long data remains relevant and accessible within the DDS middleware so that all consumers see a consistent system state . Presentation QoS ensures that data is received in order within a single topic and across topics. |
| Availability | OWNERSHIP OWNERSHIP STRENGTH LIVELINESS | Data flows can be tailored to meet the fault-tolerance requirements of distributed, real-time applications, ensuring continuity of critical data flows, even in adverse conditions . |

Benefits of DDS Data Centric Pub/Sub for Edge Cloud

- Can accommodate situation-specific **tradeoffs between reliability, resource utilization and determinism**
- Provides **sender-side filtering** to limit the amount of data “put on the wire”
 - Filtering can be content-based and/or time-based
 - Deterministic performance with limited bandwidth or CPU
- **Eventual consistency with real-time performance**
- Data models can be defined and **evolved** over time while maintaining interoperability

Comparison Exemplar

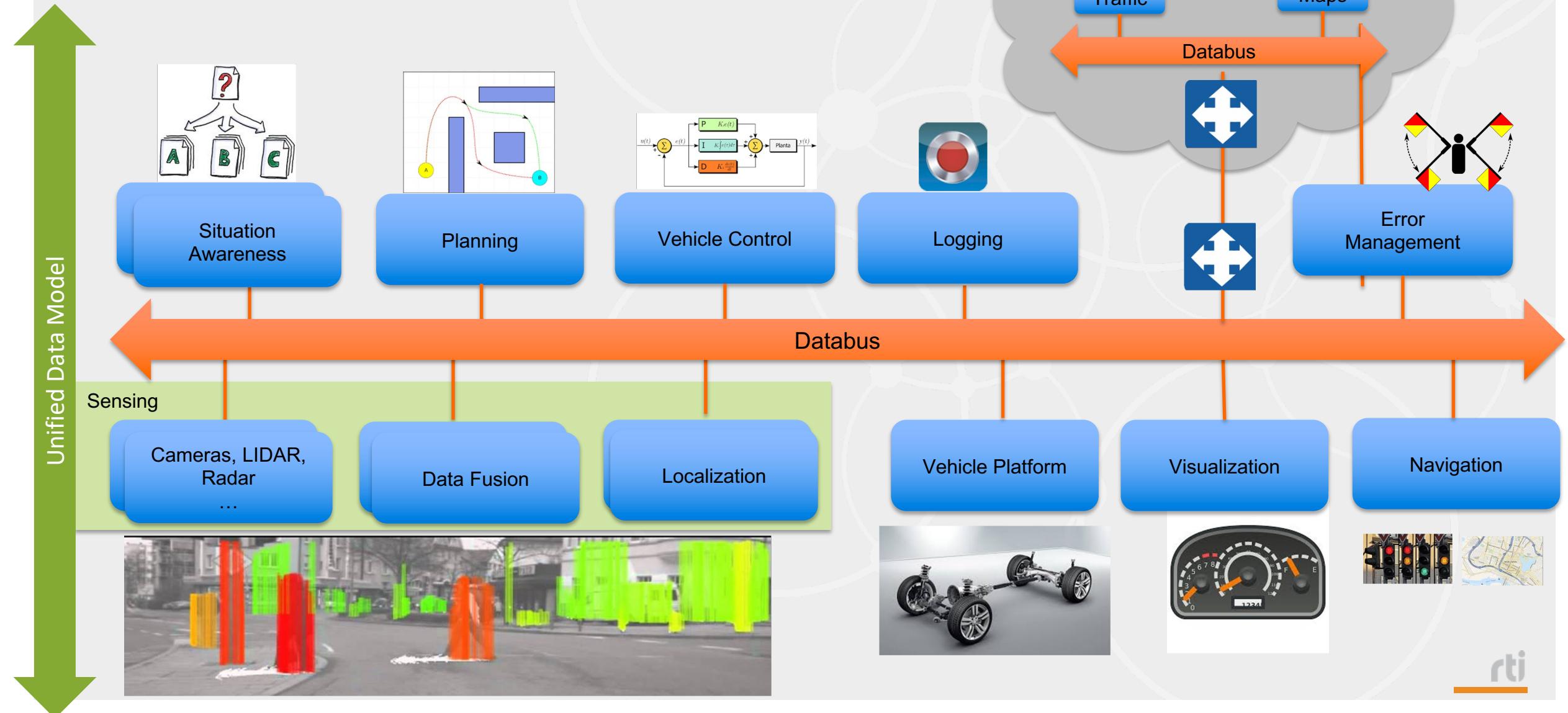
(OMG) DDS

- Real-time, data-centric framework for distributed applications
- No server or broker, Peer to Peer
- Publish-Subscribe, Request/Reply
- Transport independent: Runs over UDP, TCP, shared memory, TSN
- Transport independent security
- Includes type system
- Created for:
 - Distribution of real-time event and periodic data at the edge, with state synchronization

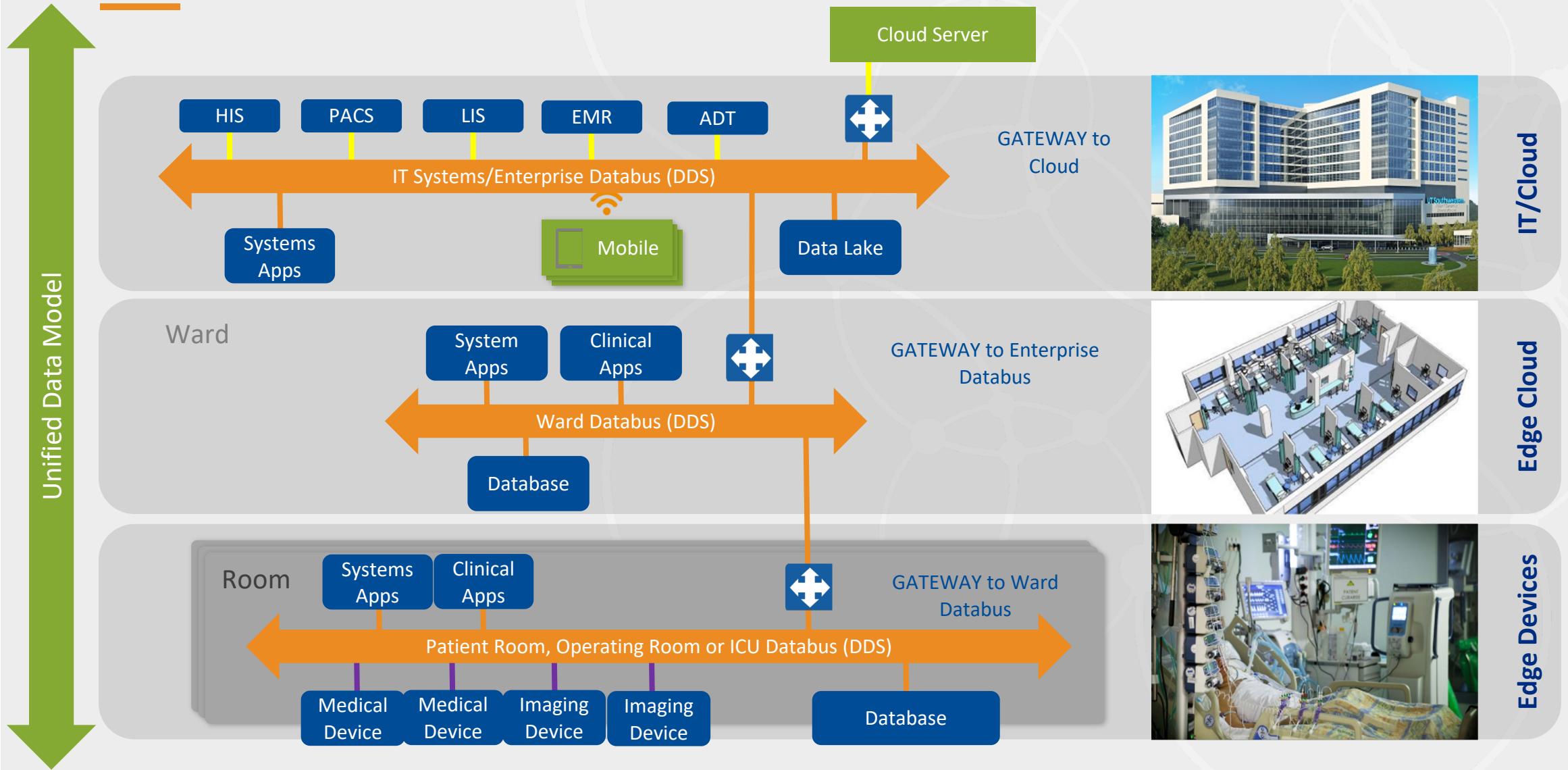
(Apache) Kafka

- A distributed log and streaming protocol for high-performance data pipelines
- Cluster based
- Publish-Subscribe
- Runs over TCP
- TLS for security
- Agnostic to type system
- Created for:
 - Large scale streaming event distribution

Use Case 1: Vehicle Layered Databus



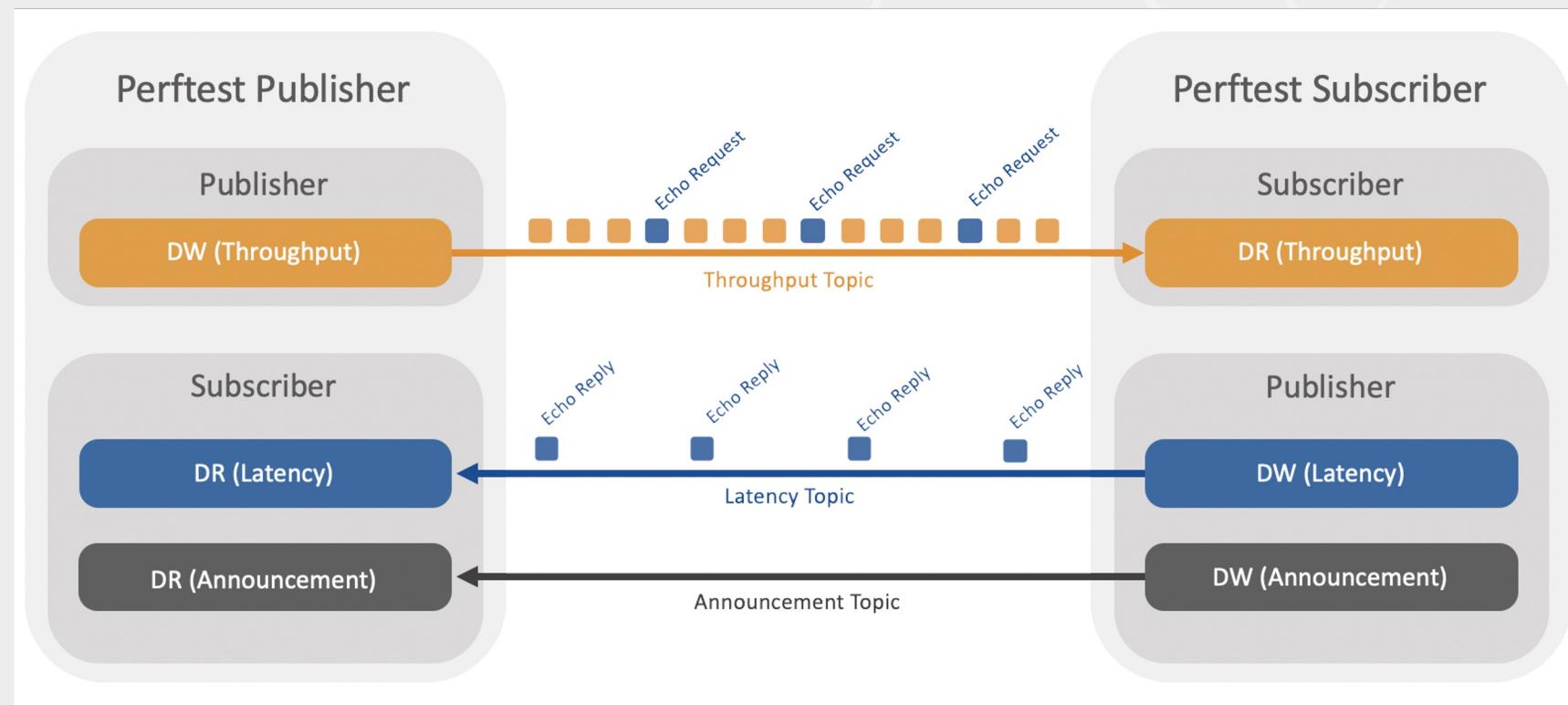
Use Case 2: Medical IIoT



Perftest Benchmark

The Perftest benchmark provides a repeatable way to evaluate the DDS performance

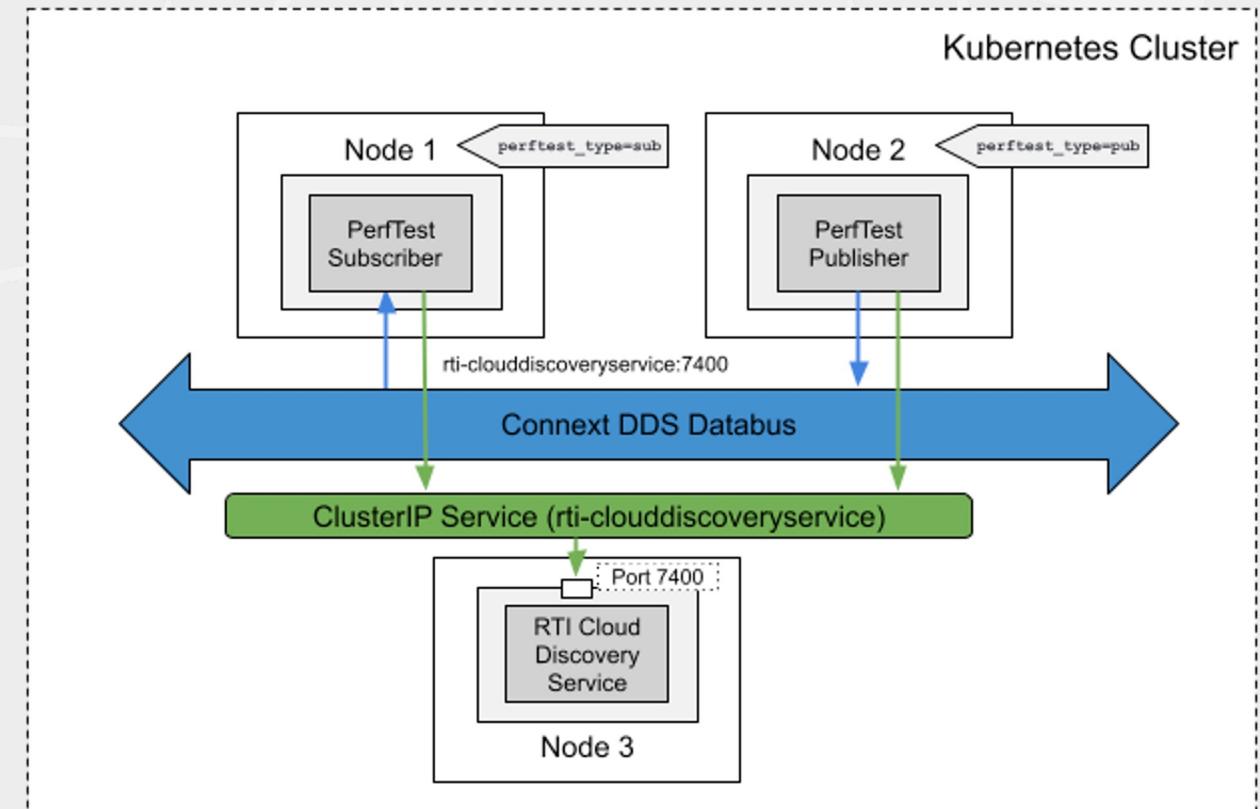
- **Measures the Round-Trip Time (RTT) and then the one-way latency.**
- **Since all timestamps are recorded on a single compute node, there is no need to account for potential clock skew between publisher and subscriber.**



<https://github.com/rticommunity/rtpfertest>

Performance Benchmarking with k8s

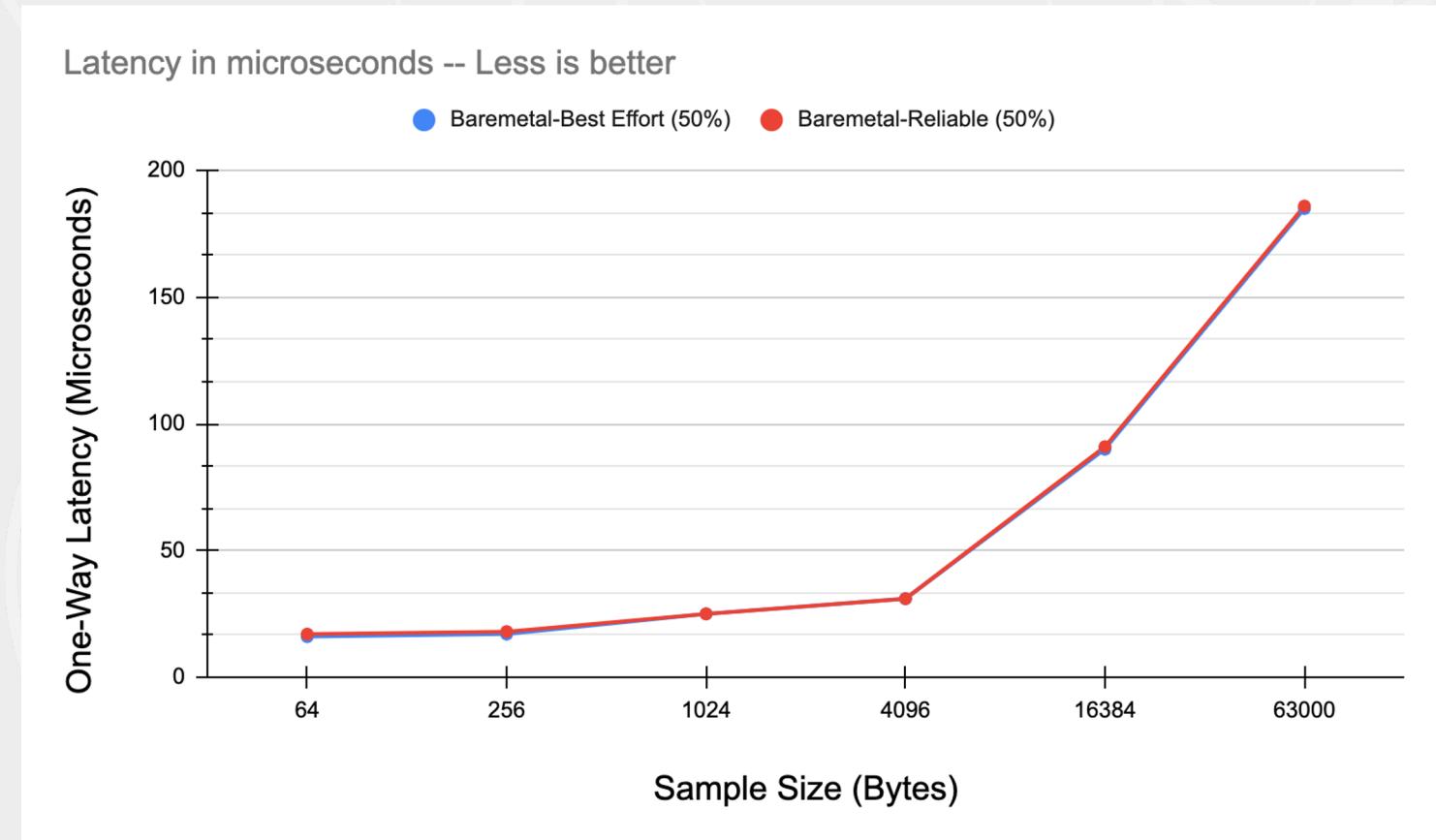
- Test Software
 - RTI PerfTest4.1
 - RTI Connext® 7.1 – Reference DDS Implementation
- Kubernetes Configurations
 - **ClusterIP Service** for RTI Cloud Discovery Service
 - **nodeSelector** to select specific nodes for publisher/subscriber



https://github.com/rticommunity/kubernetes-examples/tree/master/perftest_cds

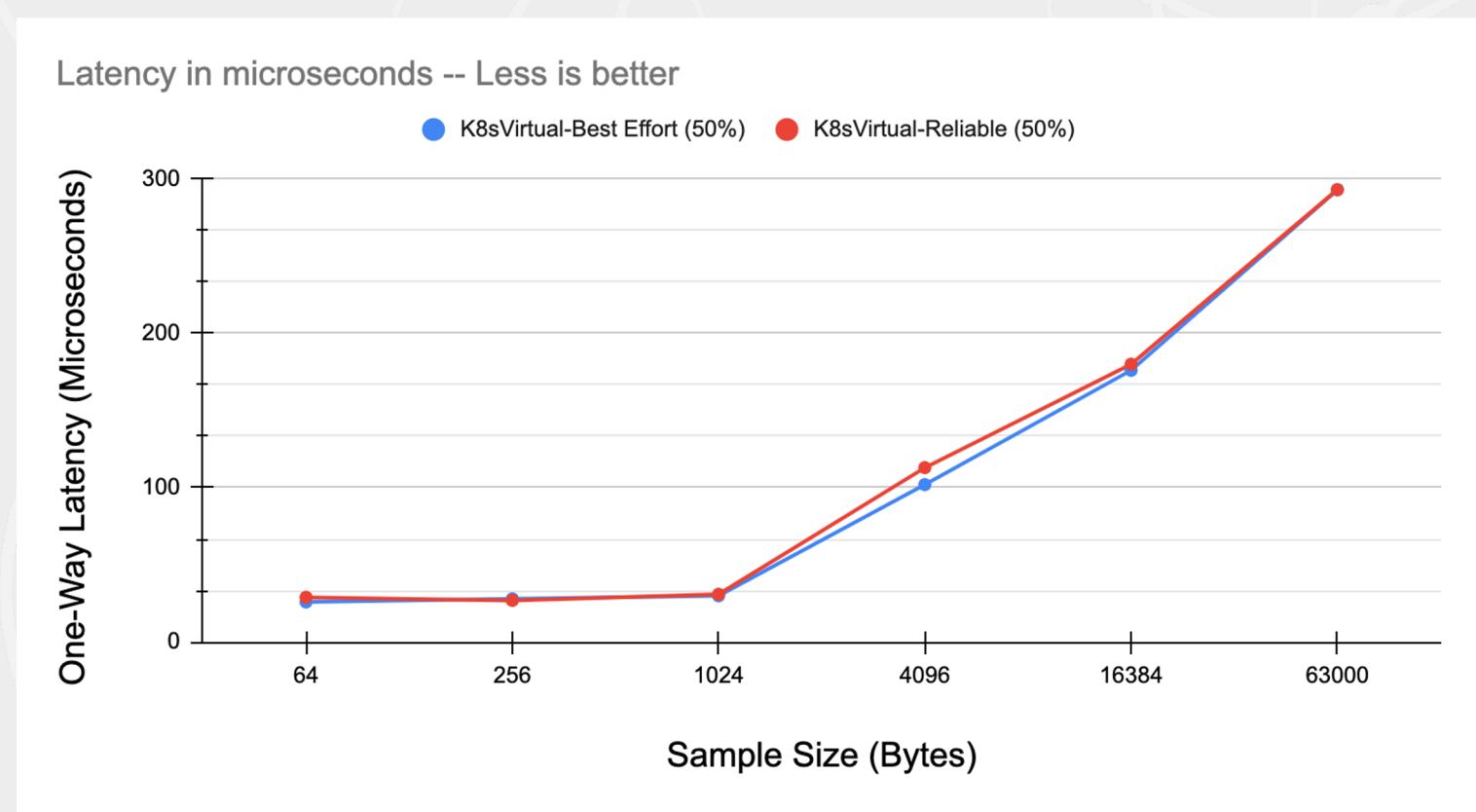
Latency at the Edge (Bare Metal)

- Edge Platform
 - Dell R340 Servers
 - Processor: Intel Xeon E-2278G
 - RAM: 4x 16GB 2666MHz DIMM (64GB RAM)
 - HD: 480GB SATA SSD
 - NIC: Intel 710 dual port 10Gbps SFP
 - Switch: Dell 2048 -- 10Gbps
- Test Software
 - OS: Ubuntu 20.04 -- gcc 9.3.0



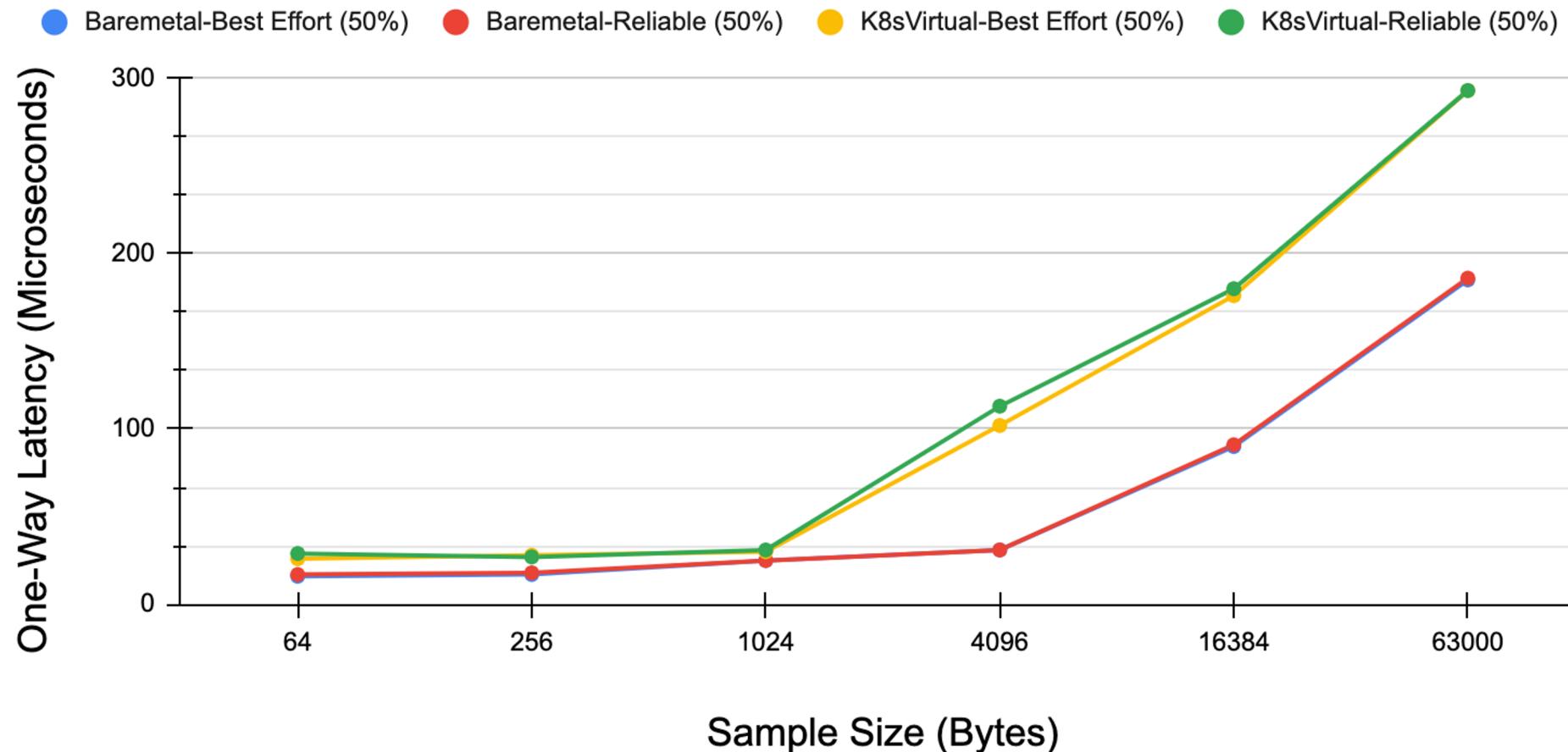
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- Test Software
 - OS: Ubuntu 20.04 -- gcc 9.3.0
 - K8S v1.28.2 (installed w/ kubeadm)
 - CNI: Calico v3.26.1



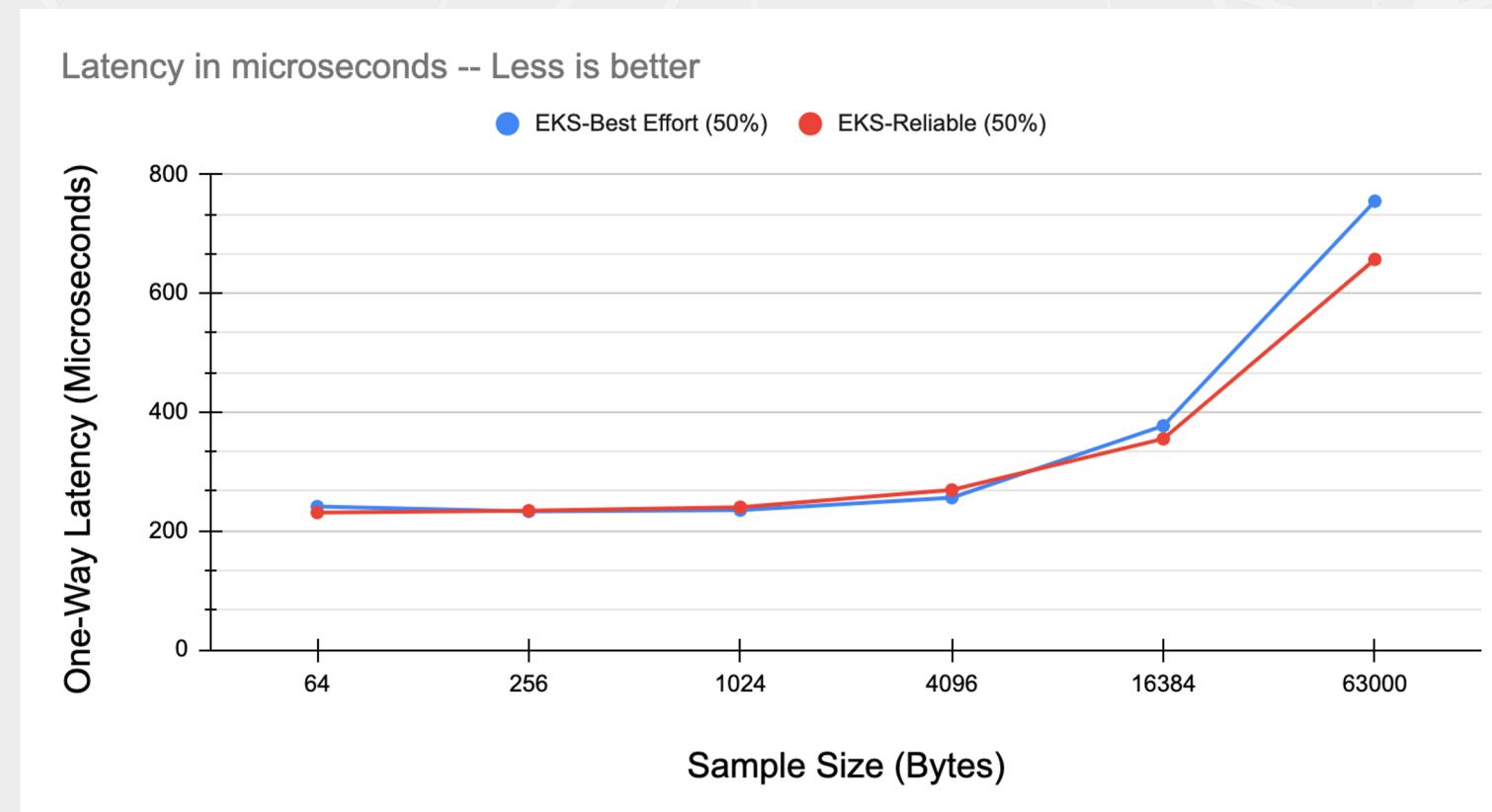
Latency - Bare Metal vs. K8s

Latency in microseconds -- Less is better

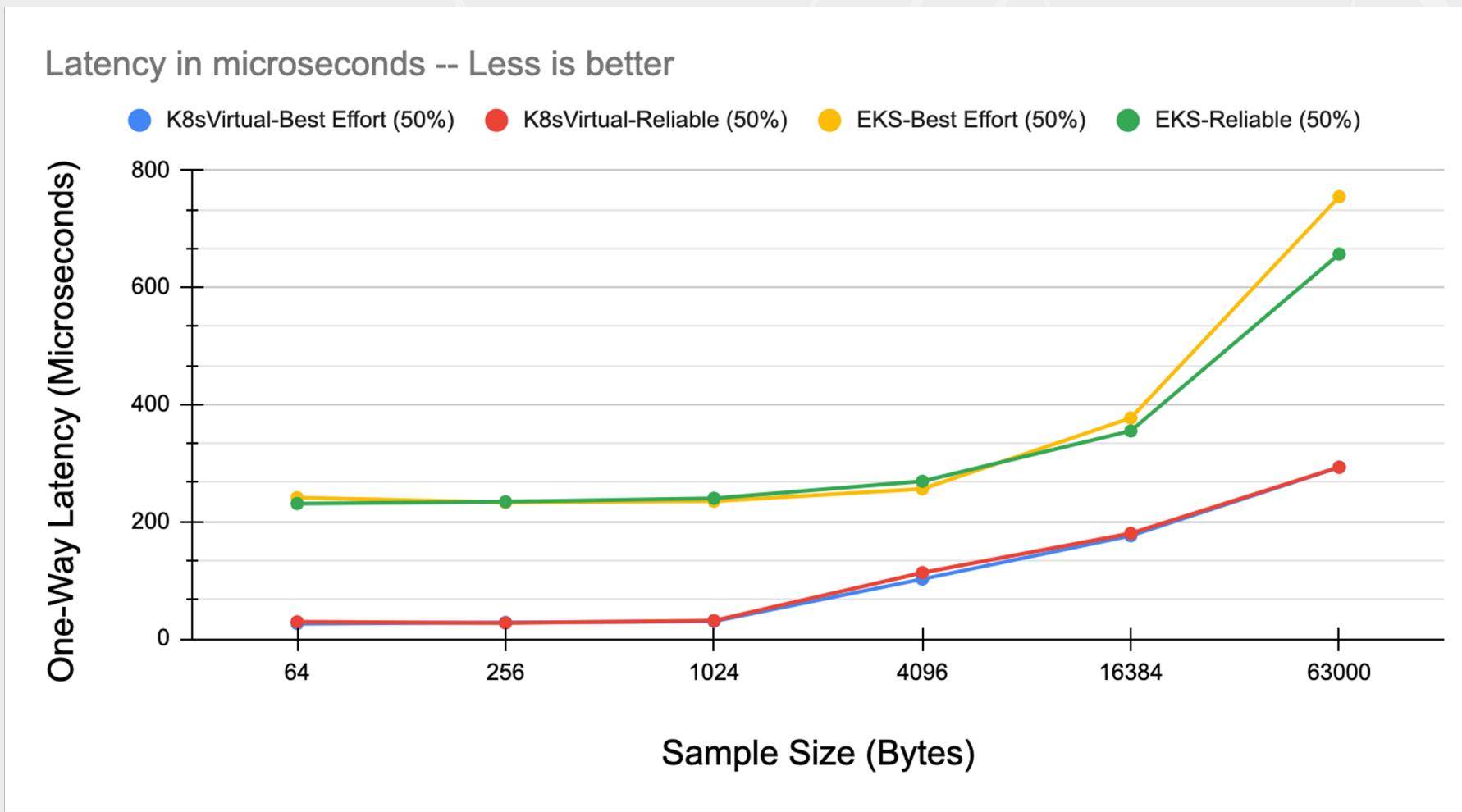


Latency in the Cloud (EKS)

- Cloud Platform
 - AWS EKS v 1.25
 - us-east-2-c
 - t2.small instances
 - 1 vcpu
 - 2 GB RAM
- Test Software
 - OS: Amazon Linux 2 (5.10.176-157.645.amzn2.x86_64)
 - K8s version: 1.25
 - CNI: Amazon VPC CNI



Latency – Edge k8s vs. EKS



Next Steps...

- What types of Cloud-native applications could benefit from DDS data-centric, peer to peer capabilities and performance?
- Should we consider development of Cloud-native extensions to DDS?

Thank you!



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