Data-Distribution Service (DDS) – the IIoT Connectivity Standard

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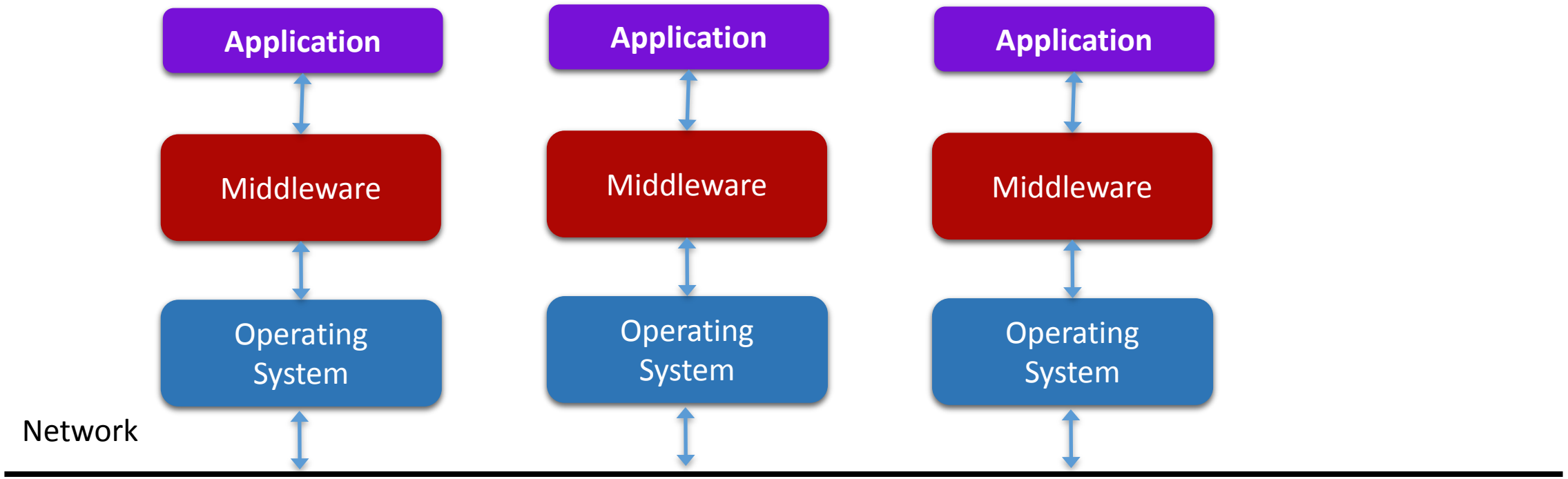
Co-Chair DDS SIG
December 2017

OBJECT MANAGEMENT GROUP®

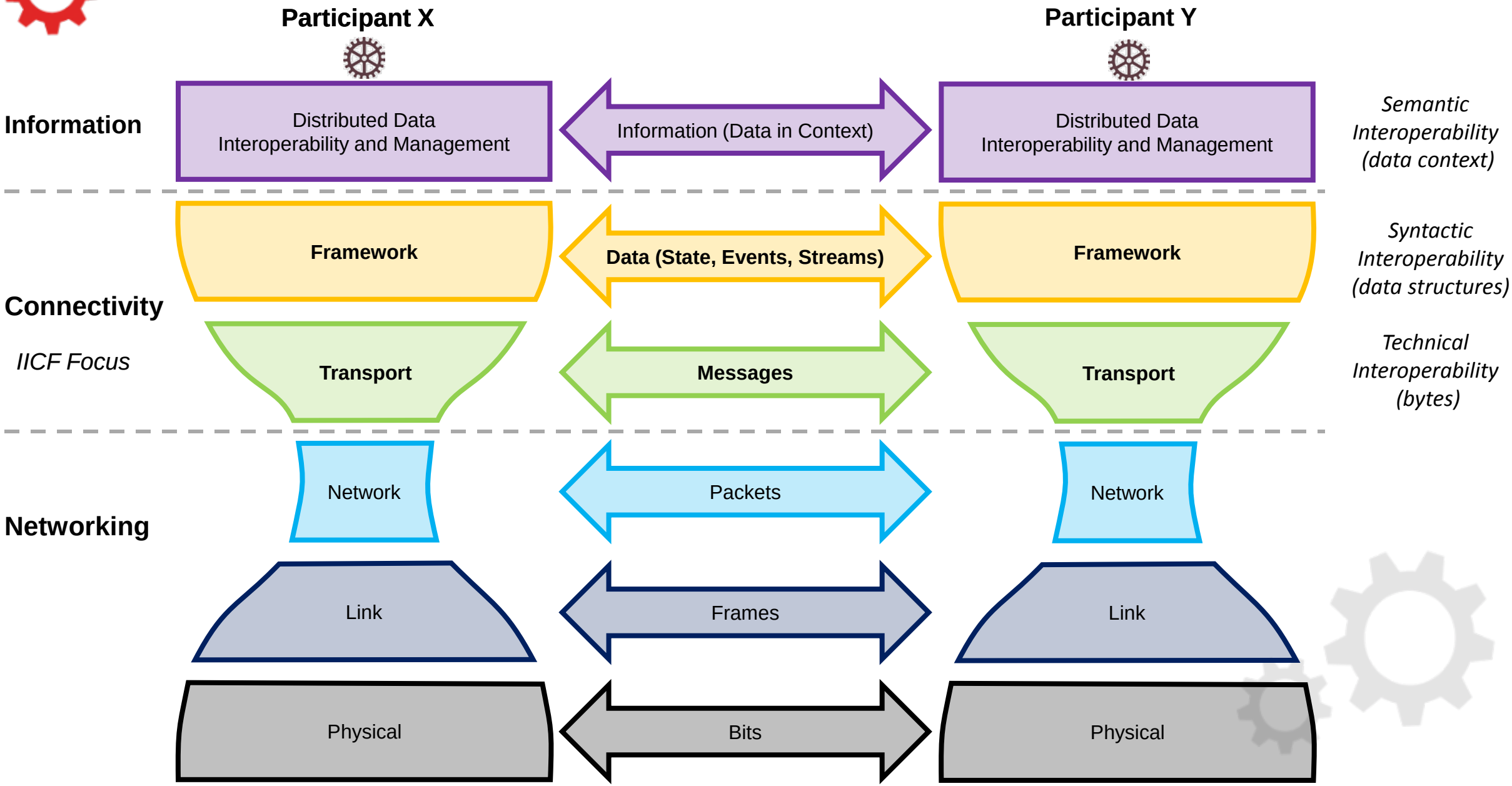
Outline

- Understanding Connectivity
- Understanding DDS
- Solving IIOT Problems with DDS

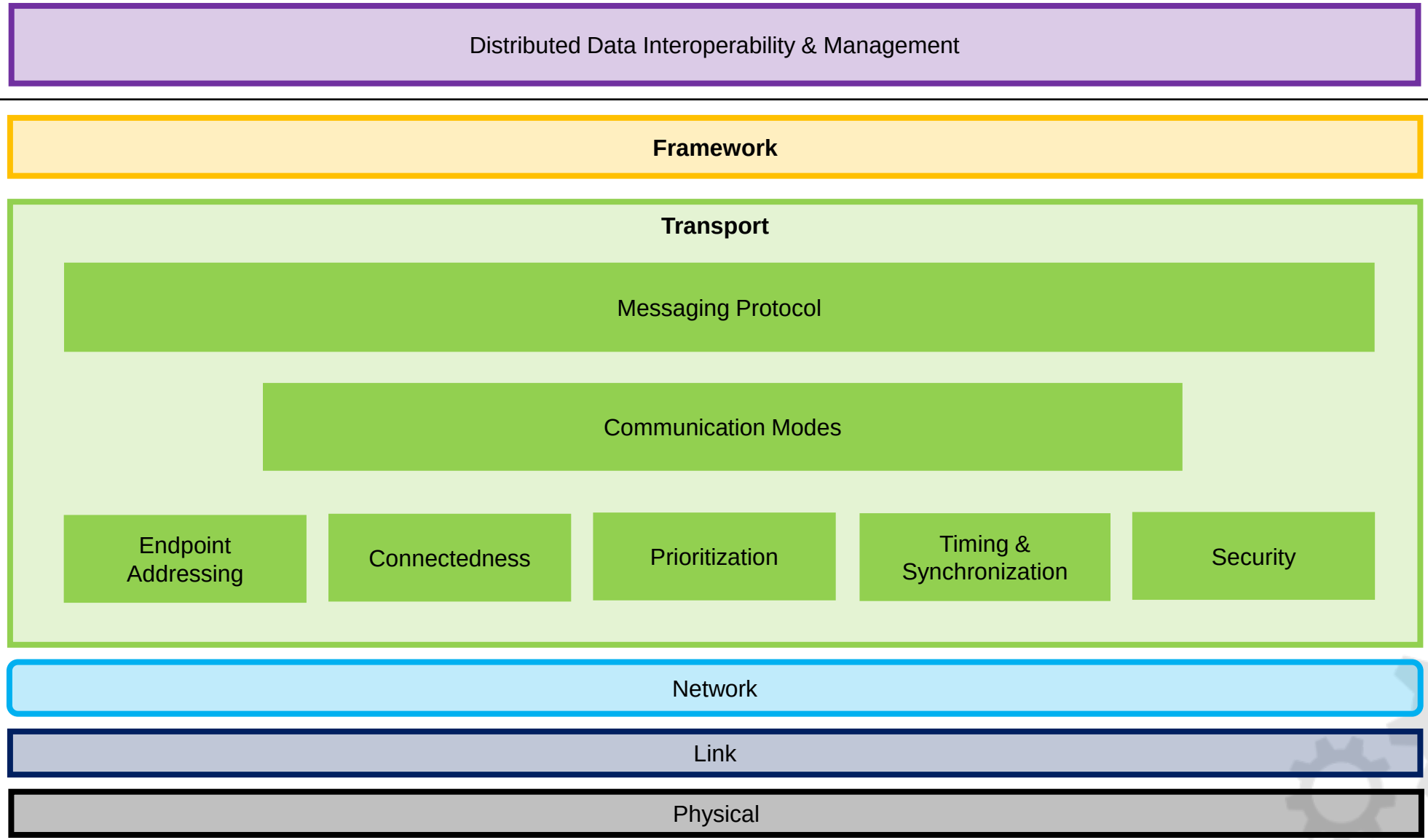
Using Connectivity Middleware for Application Development



IIoT Connectivity Stack Model



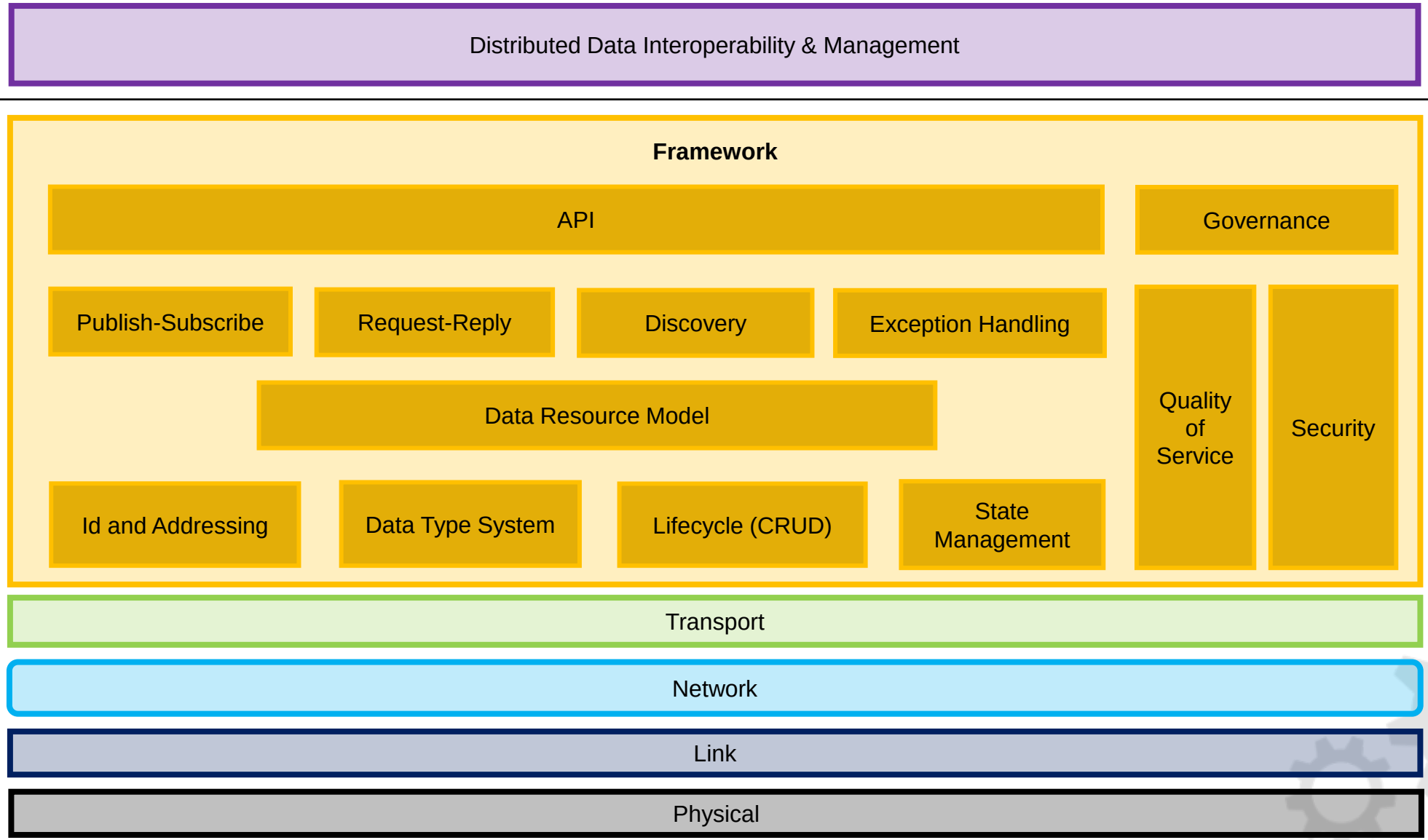
Connectivity Transport Layer



Connectivity Transport Functions

Technical Interoperability

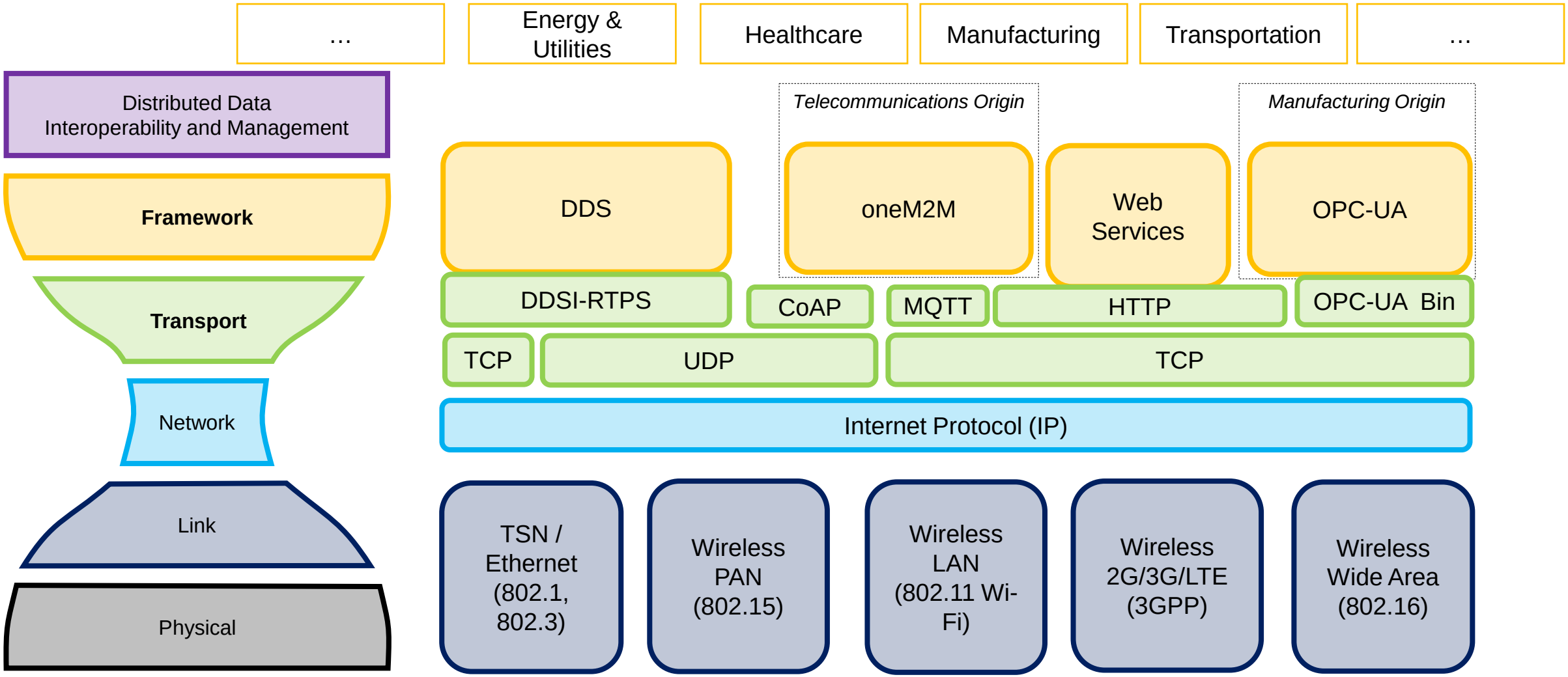
Connectivity Framework Layer



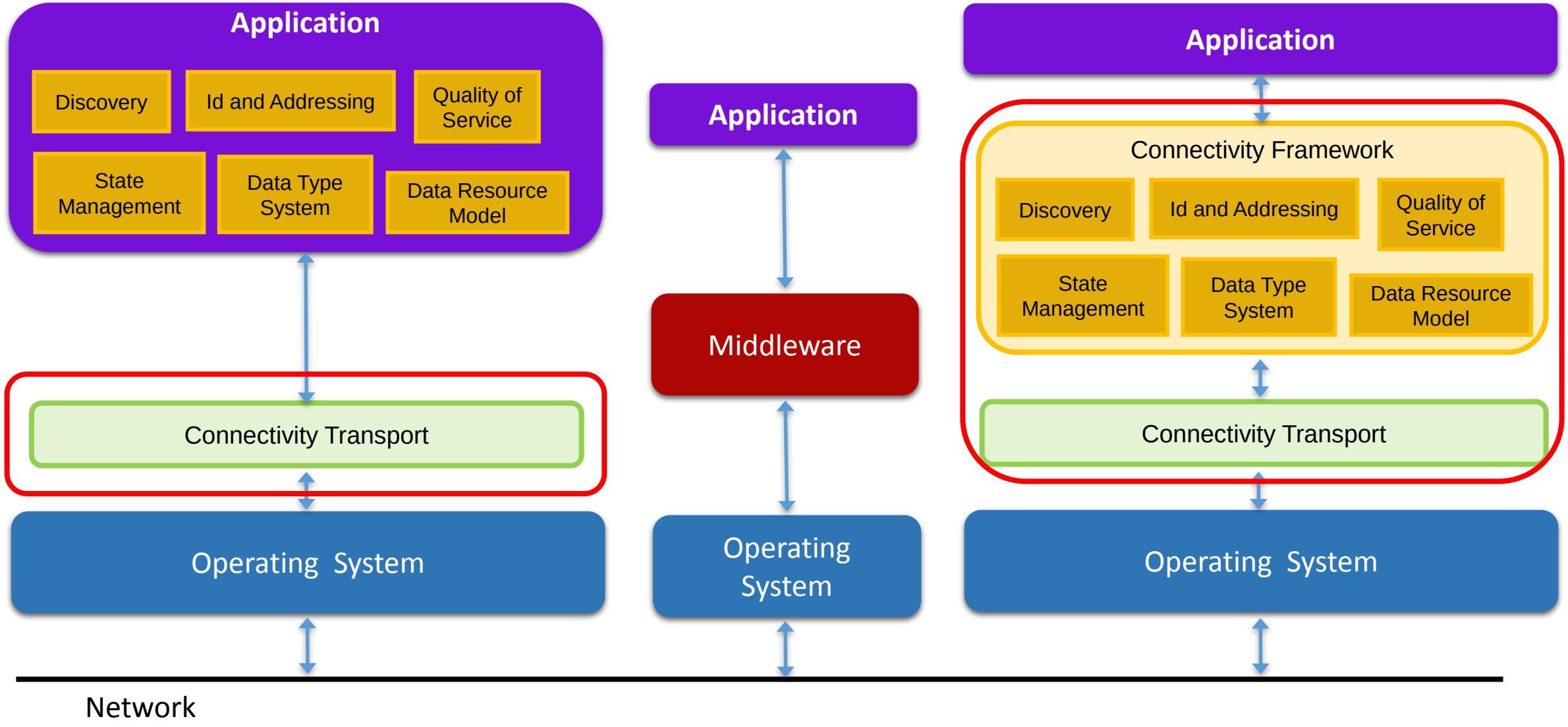
Connectivity Framework Functions

Syntactic Interoperability

Connectivity Standards



Complexity of the Application Code

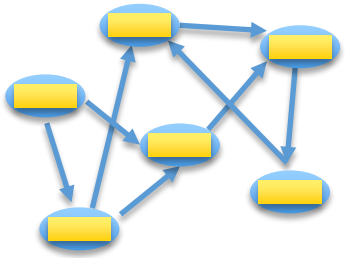
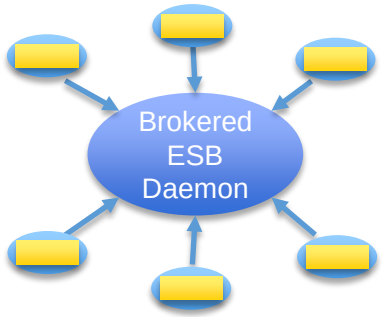
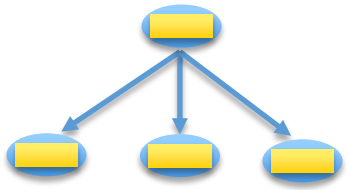
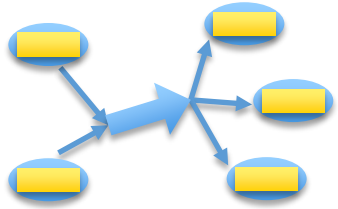
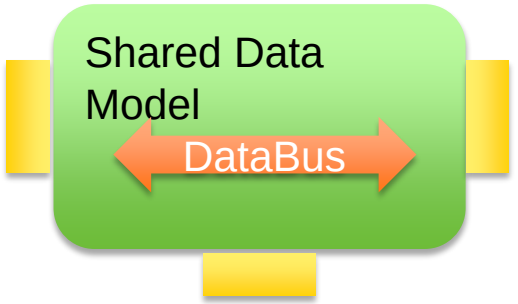


Understanding the DDS Connectivity Framework

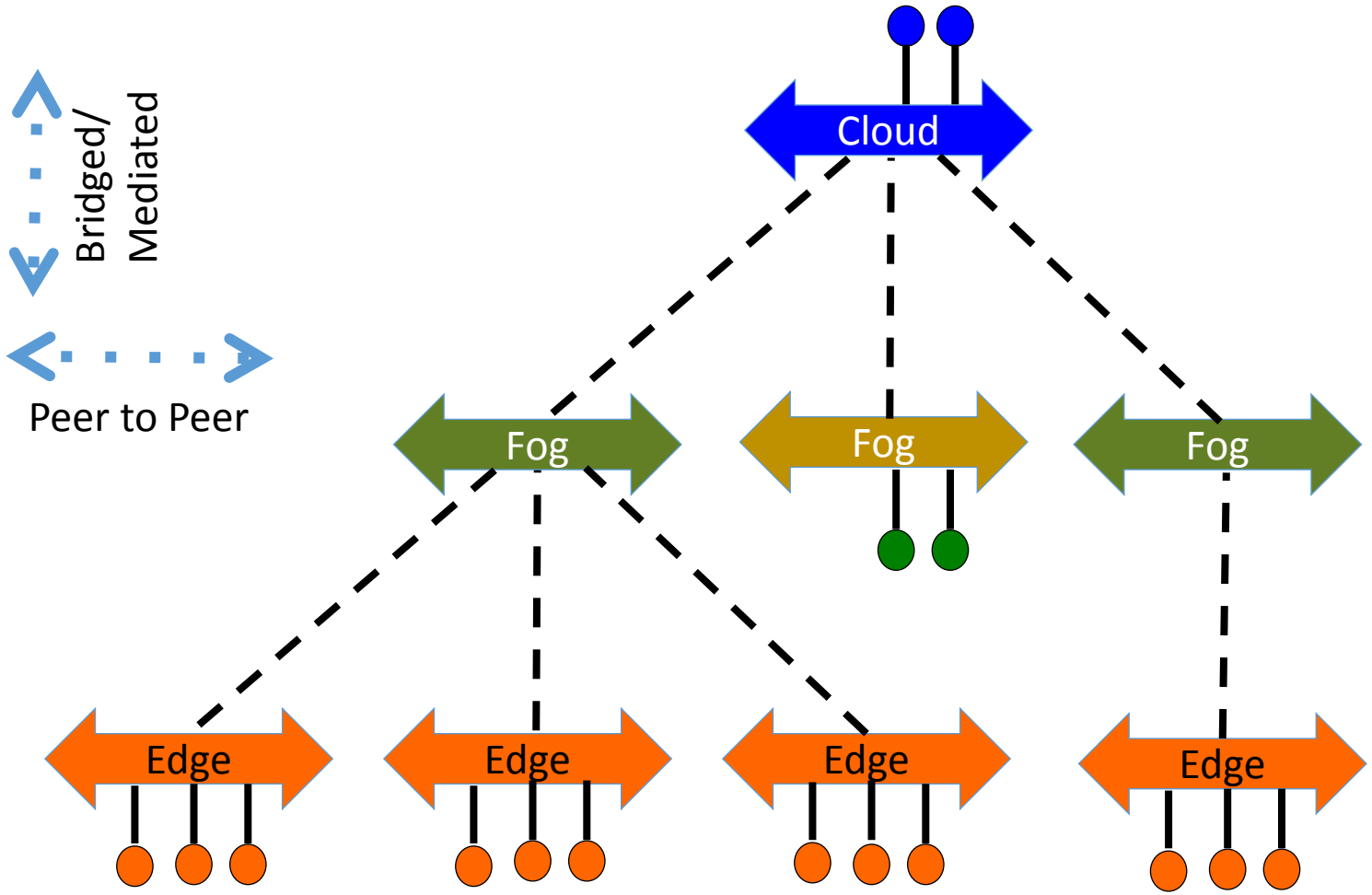
Powerful abstractions to build highly modular, robust, and secure real-world systems

December 7, 2017

DDS is Different!

Point-to-Point	Client/Server	Publish/Subscribe	Queuing	Data-Centric
				
				
TCP Sockets	MQTT XMPP OPC CORBA	Fieldbus CANbus ZeroMQ JMS	AMQP Active MQ	DDS

Layered Databus Architecture



- Cloud:
  - Datacenter
  - Elasticity, Provisioning, Management, Analytics
- Fog:
  - Distributed computing
  - Processing “close to the edge”
  - Latency, Robustness, availability
- Edge:
  - Locality
  - Information Scoping

DDS Model: Virtual Global Data Space

CRUD operations

DDS DOMAIN

Topic A

QoS

Topic B : "Turbine State"

QoS

Source (Key)	Speed	Power	Phase
WPT1	37.4	122.0	-12.20
WPT2	10.7	74.0	-12.23
WPTN	50.2	150.07	-11.98

Topic C

QoS

Topic D

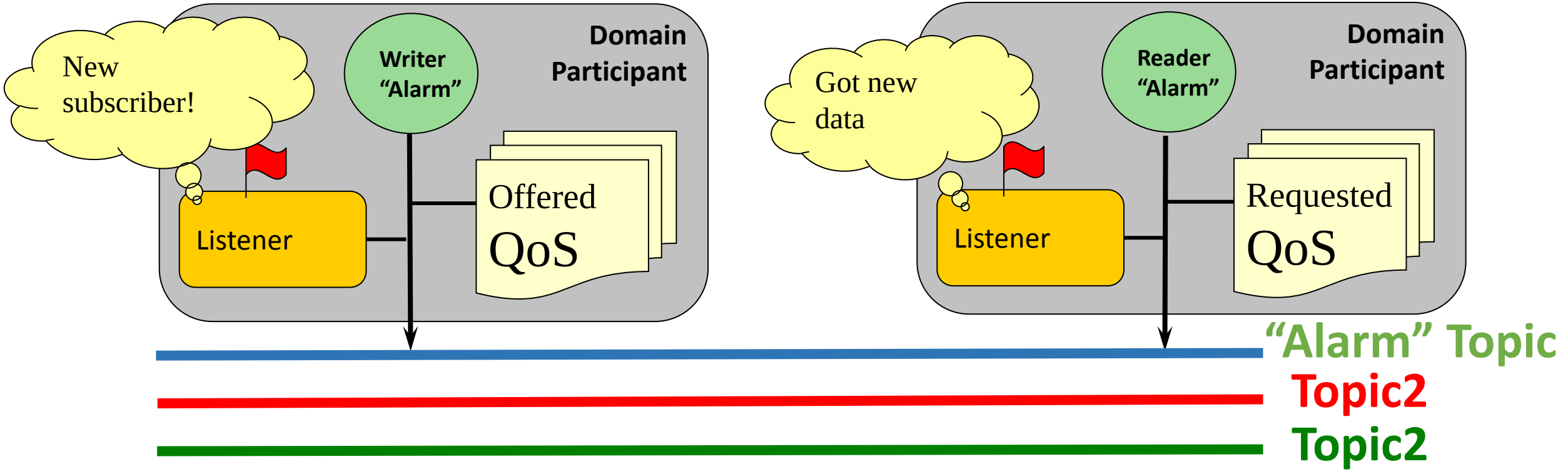
QoS

DDS

Persistence Service

Recording Service

Data-Centric Communications Model



- **Participants** scope the global data space (domain)
- **Topics** define the data-objects (collections of subjects)
- **DataWriters** publish data on Topics
- **DataReaders** subscribe to data on Topics
- **QoS Policies** are used configure the system
- **Listeners** are used to notify the application of events

Request <= Offered QoS compatibility checking and run-time monitoring

Request vs Offered Examples

Result

- DW offers DEADLINE of 10ms
- DR requests DEADLINE of 20ms

Compatible:
20 ms "less" 10 ms

- DW offers RELIABILITY kind RELIABLE
- DR requests RELIABILITY BEST_EFFORT

Compatible:
BEST_EFFORT "less" RELIABLE

- DW offers LIVELINESS kind AUTOMATIC
- DR requests LIVELINESS kind MANUAL

Not Compatible:
MANUAL "more" AUTOMATIC

QoS Policy
DURABILITY
HISTORY
LIFESPAN
WRITER DATA LIFECYCLE
READER DATA LIFECYCLE
ENTITY FACTORY
RESOURCE LIMITS
RELIABILITY
TIME BASED FILTER
DEADLINE
CONTENT FILTERS

Cache

Resources

Delivery

QoS Policy
USER DATA
TOPIC DATA
GROUP DATA
PARTITION
PRESENTATION
DESTINATION ORDER
OWNERSHIP
OWNERSHIP STRENGTH
LIVELINESS
LATENCY BUDGET
TRANSPORT PRIORITY

User QoS

Presentation

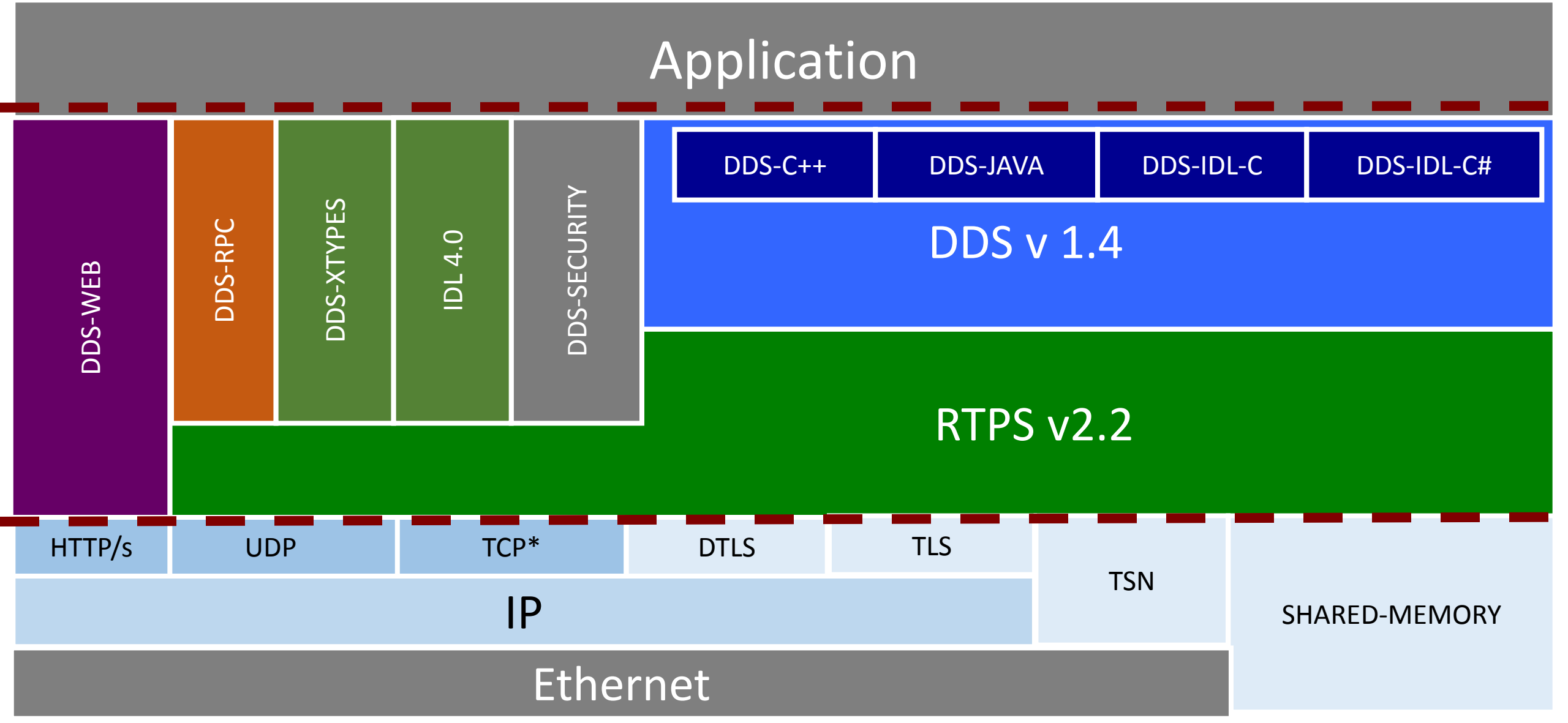
Availability

Transport

Handling Highly Heterogeneous systems

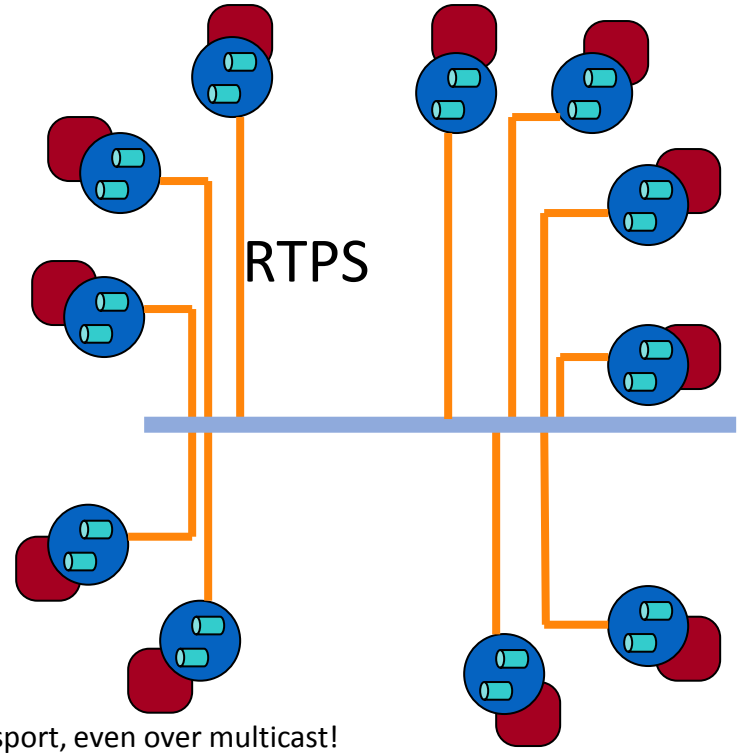
- How to handle vast differences in speed? ✔
  - Use Time-Based Filters
  - Leverage Data Cache in Reader and Writer
- How manage big differences on data needs and volumes ✔
  - Select only needed Topics
  - Use Partitions
  - Use Content Filtered Topics
- How to handle various network transports? ✔
  - DDS mechanisms are independent of the network transport

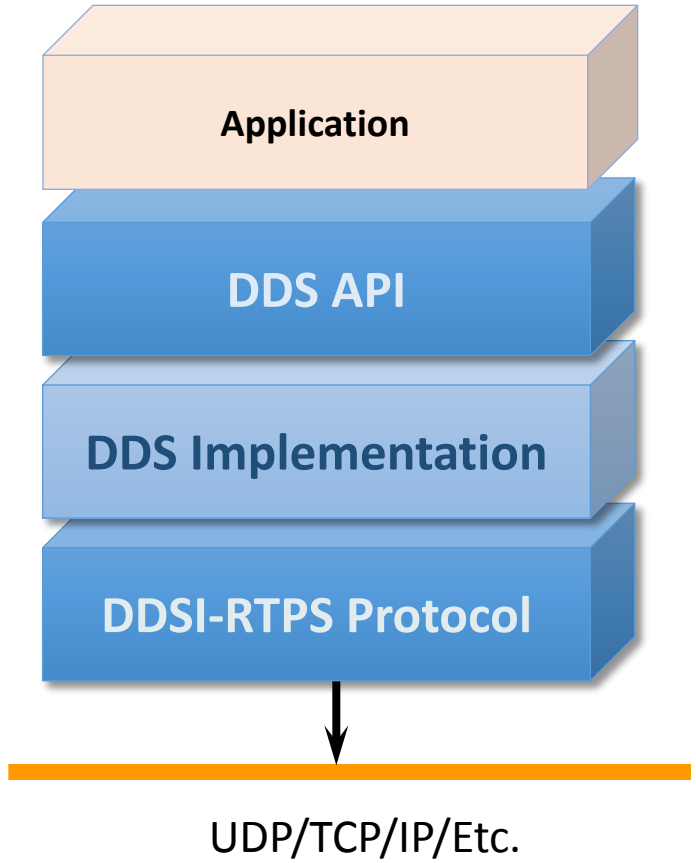
DDS Standard family



RTPS Wire Protocol

Highly Scalable
Brokerless
Transport-Independent

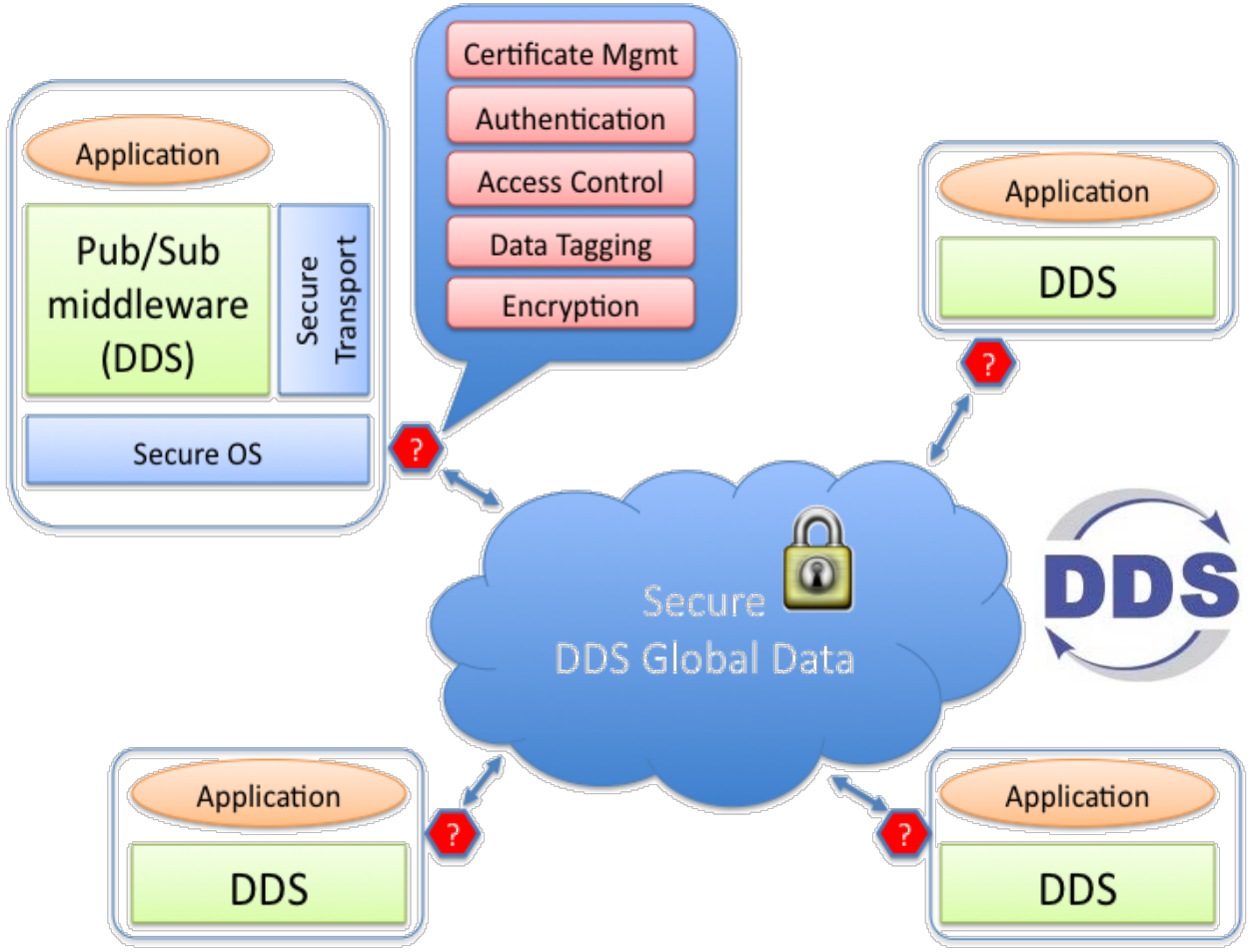




- **Peer to peer** no brokers or servers
- **Qos Aware & Reliable** best efforts top reliable independent of transport, even over multicast!
- **Any size data** automatic fragmentation & reassembly. Smart (fragment) repairs
- **Automatic Discovery and Presence** plug & play. No need to configure discovery services
- **Decoupled** start applications in any order allow readers without writers and vice-versa
- **Redundant** supports multi path and multiple networks. Automatically discards duplicates
- **High performance** native “wire” speeds
- **Scalable** no need to maintain N^2 network connections

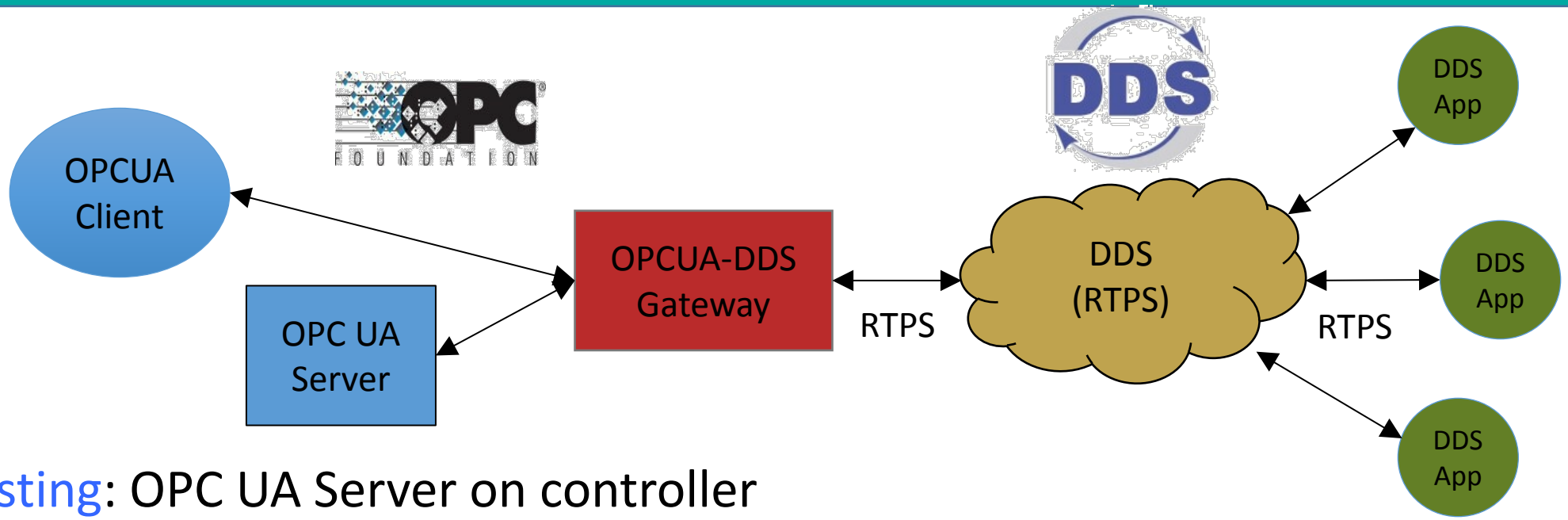
DDS Security Standard

- DDS entities are authenticated
- DDS enforces access control for domains/Topics/…
- DDS maintains data integrity and confidentiality
- DDS enforces non-repudiation
- DDS provides availability through reliable access to data



…while maintaining DDS interoperability & high performance

DDS to OPCUA Bridge



- Existing: OPC UA Server on controller
- Existing: OPC UA Client applications
- Existing: DDS App
- New: OPCUA-DDS Gateway– Maps “operations” on OPCUA to DDS

NOTE: OPC foundation also working on a “Pub-Sub” mechanism for OPCUA.
Plan is to make “DDS” one of the 3 supported “communication” models for pub-sub.

DDS-WEB Standard

Operational Data

DDS/ RTPS

Connectivity Core Standards

DDS-WEB Service

GUARD

HTTP/ HTTPS

Solving IIOT problems with DDS

DDS is broadly used across the IIoT

Real World Systems in:

- Healthcare
- Transportation
- Communications
- Energy
- Industrial
- Defense







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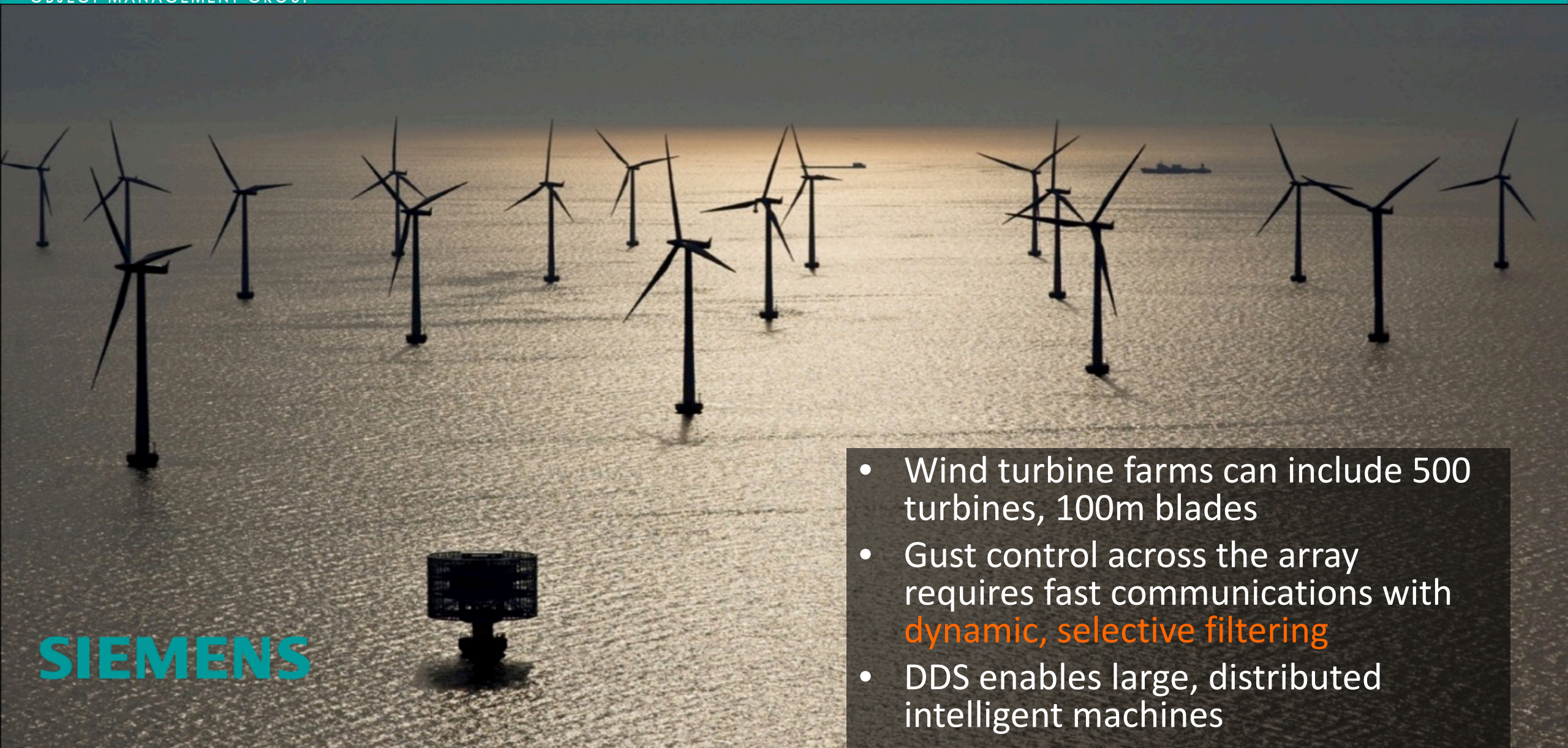
North America Largest Power Generator

- DDS controls the 6.8 GW GC Dam
  - Largest power plant in North America
  - Fastest-responding major power source on the Western Grid
  - Requires 24x7 operation
- DDS met the challenges
  - Extreme availability
  - Wide area communications
  - Multi-level routing
  - High security
  - 300k data values
- **Live since Jan 2014**

U.S. Army Corps of Engineers®

Siemens Wind Power Distributed Control



- Wind turbine farms can include 500 turbines, 100m blades
- Gust control across the array requires fast communications with dynamic, selective filtering
- DDS enables large, distributed intelligent machines

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Largest Single-System SCADA

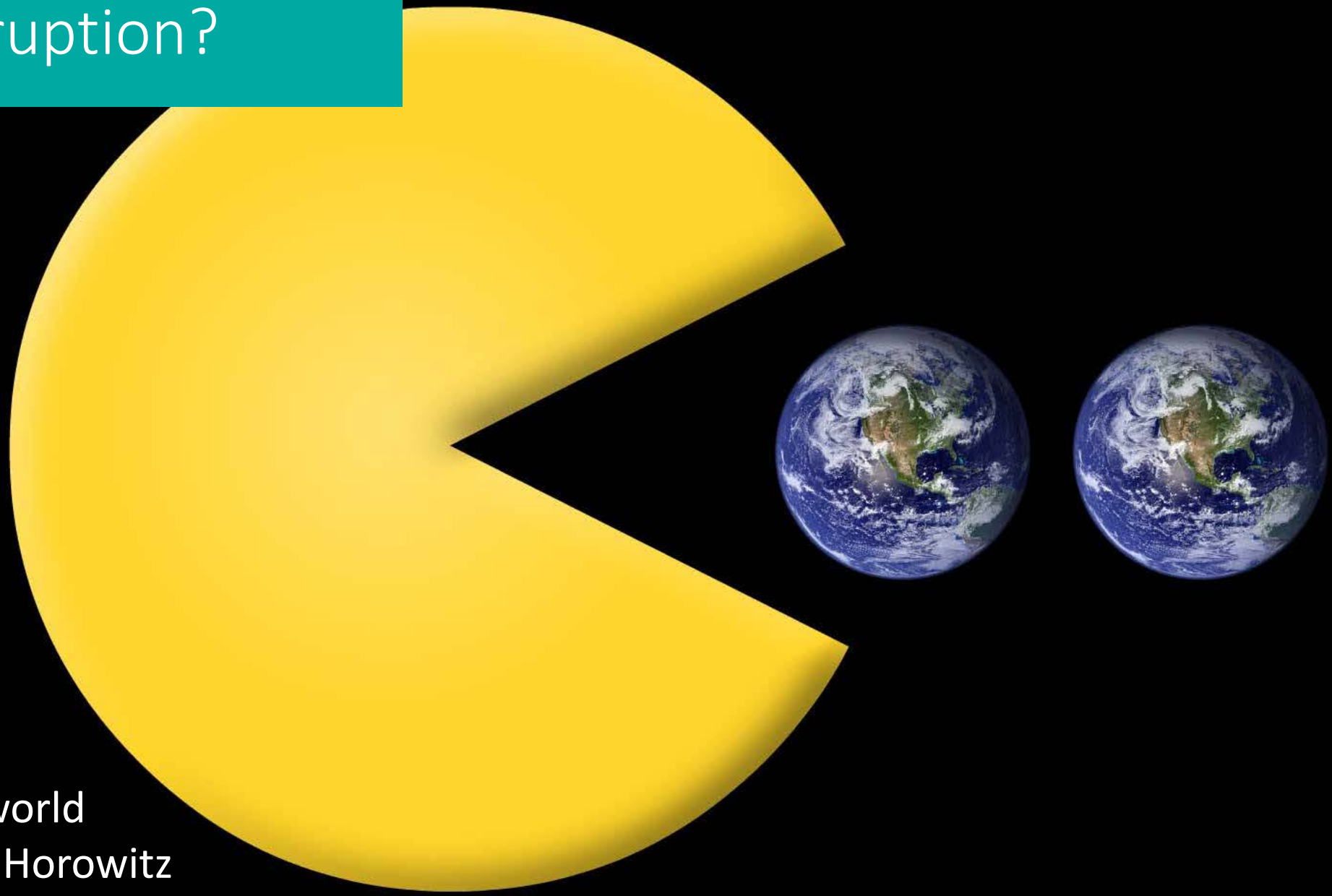
- The NASA KSC launch control claims to be the world's largest single-system SCADA
- It combines 300k points, at 400k msgs/sec
- RTI Connext DDS powers launch control, in-flight monitoring, UAV reentry-tracking ground station, and the recovery ship

The *Industrial* IoT Disruption

You don't compete against competitors.
You compete against market transitions.
– John Chambers

The real value is a common architecture that connects sensor to cloud, interoperates between vendors, and spans industries

What's the Disruption?



Software is eating the world

-- Andreessen Horowitz

Silicon Valley VC

Thank You!

http://www.omg.org/dds/