Building The Internet of Things with DDS

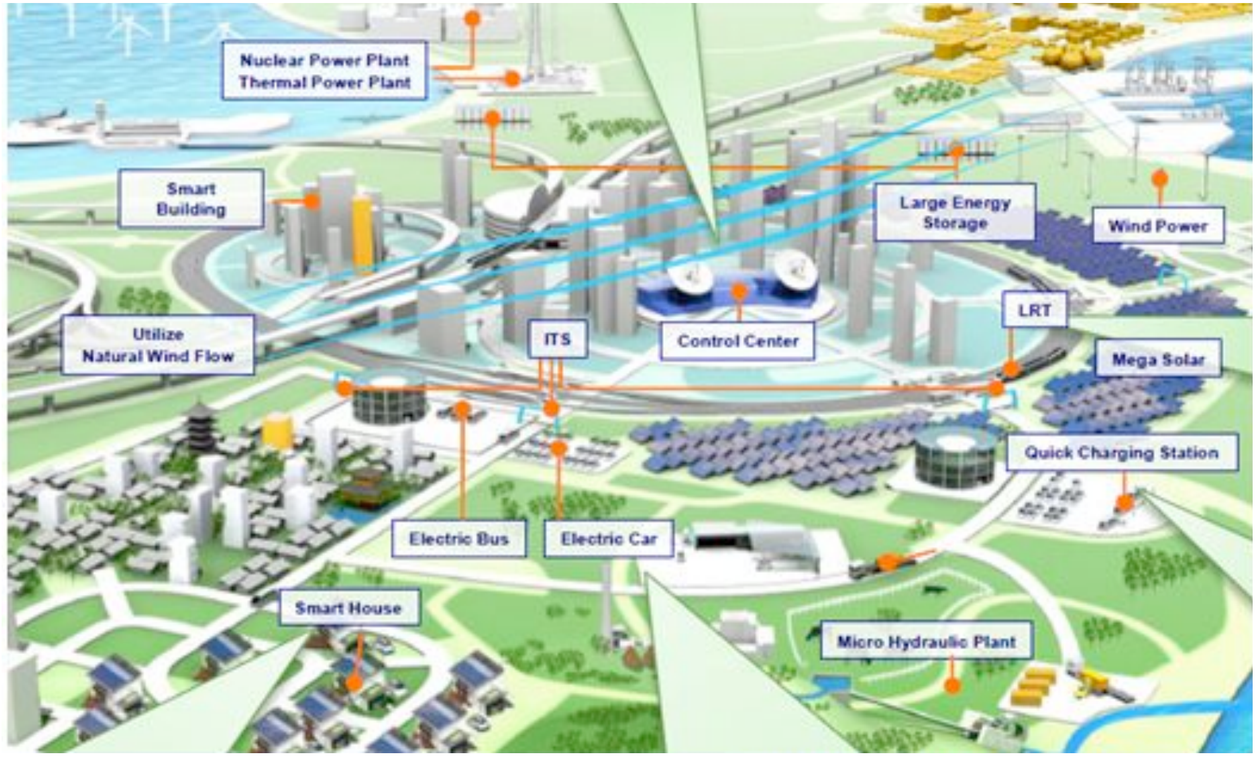
OpenSplice | DDS

Angelo CORSARO, Ph.D.
Chief Technology Officer
OMG DDS Sig Co-Chair
PrismTech
angelo.corsaro@prismtech.com

Coincidences?

The Internet of Things (IoT)

"*The Internet of Things* ***allows people and things to share information Anytime***, ***Anyplace***, *with* ***Anything*** *and* ***Anyone***"

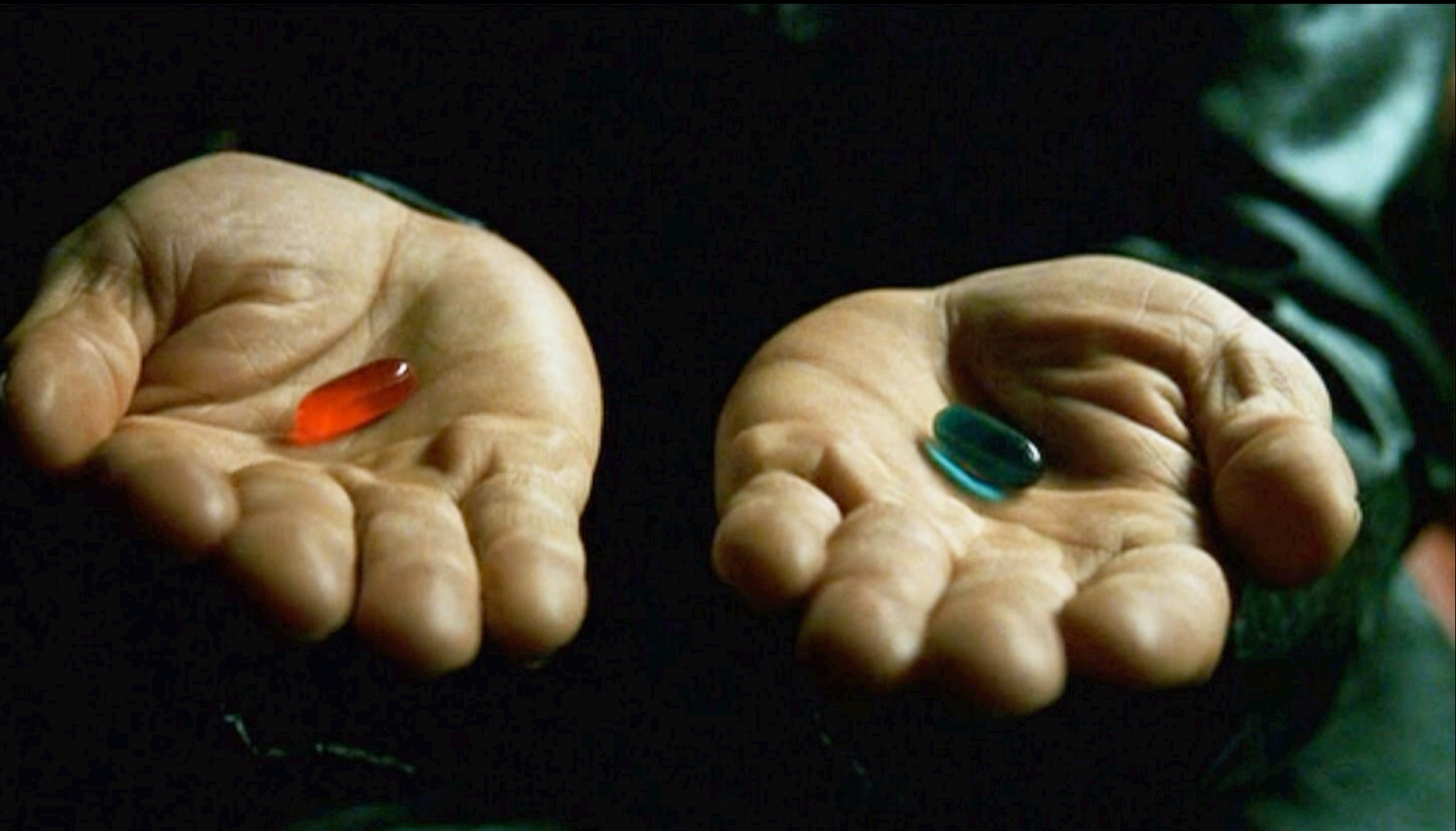


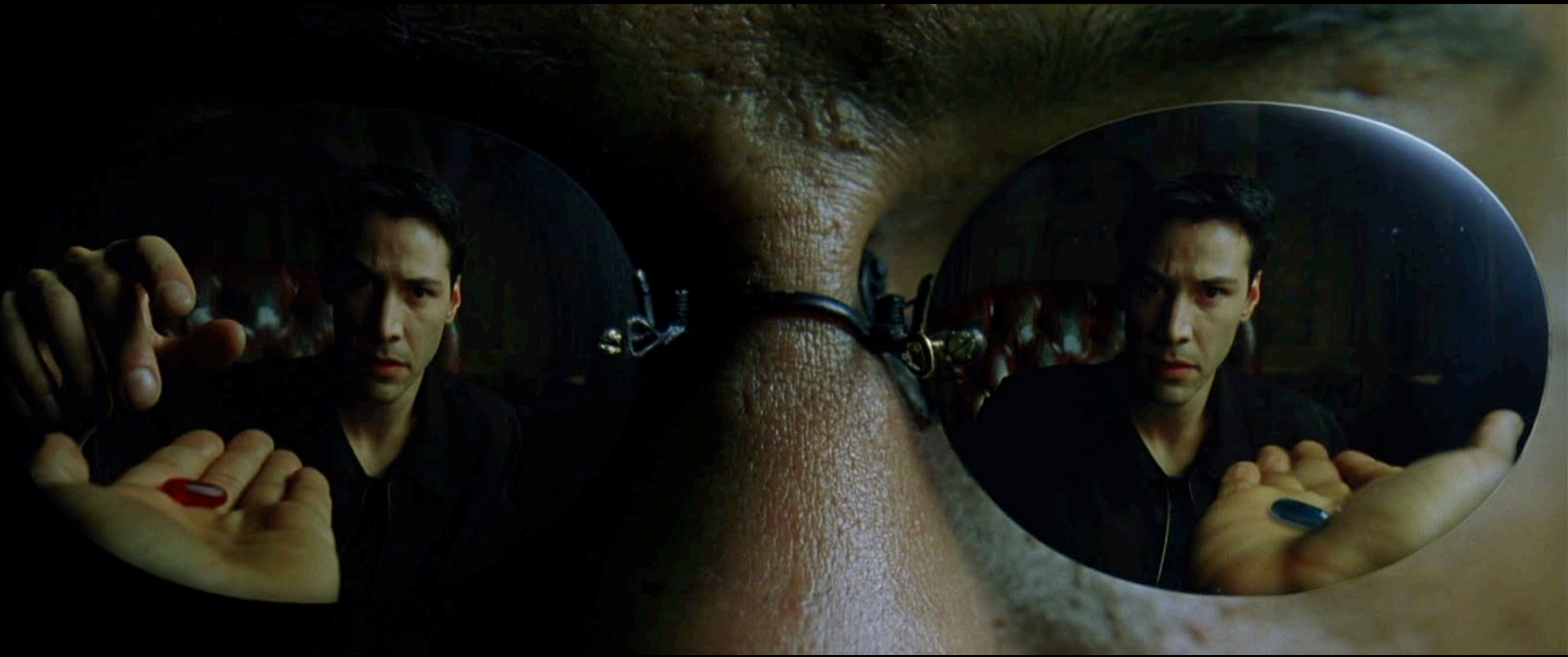
OpenSplice | DDS

The Data Distribution Service (DDS)

DDS *is a standard technology for* ***ubiquitous, interoperable, secure, platform independent, time and space efficient*** ***data sharing*** *across network connected devices*

Is this a Coincidence?





Fasten Your Seatbelt

We are about to take off...

Welcome to Nice, France.
The smartest city on the planet!

Nice Use Case Video

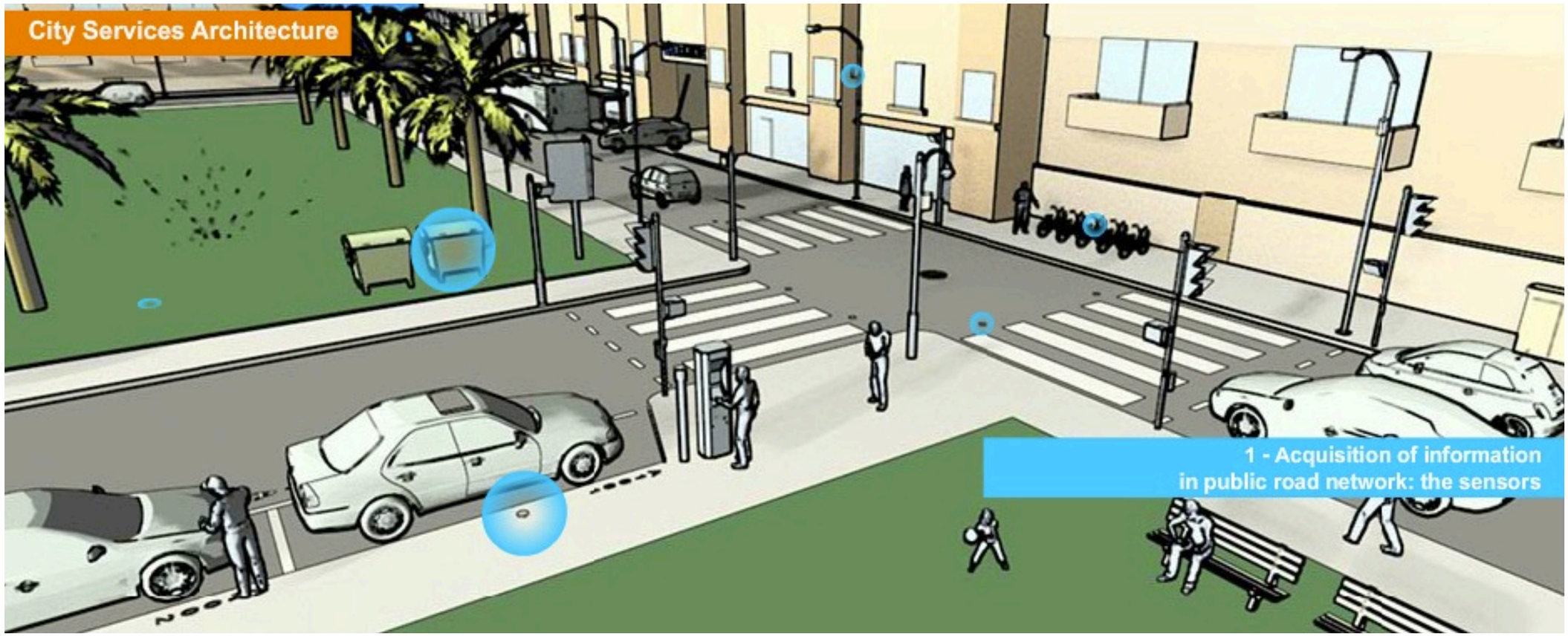
- http://www.youtube.com/watch?v=neVyOTXB4eI

OpenSplice | DDS

Architecture of Nice's Think Global

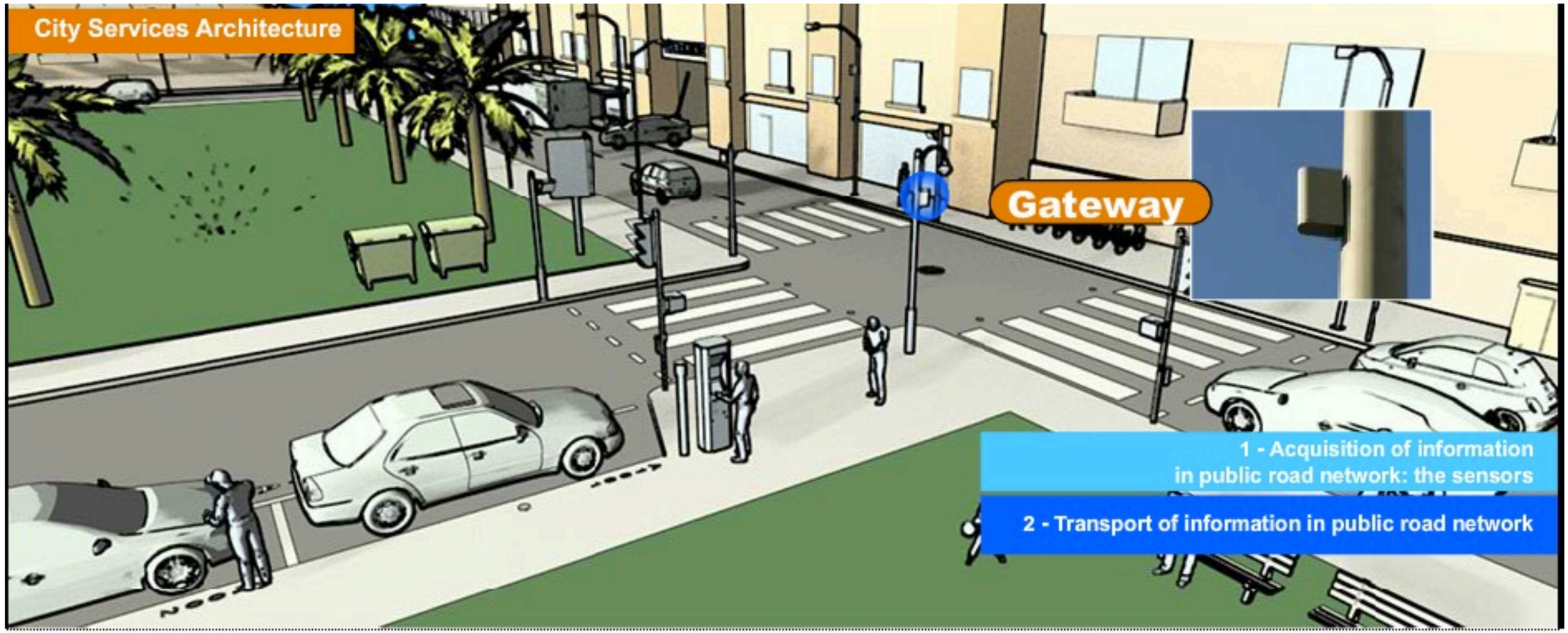
The City Operating System

Collect | Store | Analyze | Share



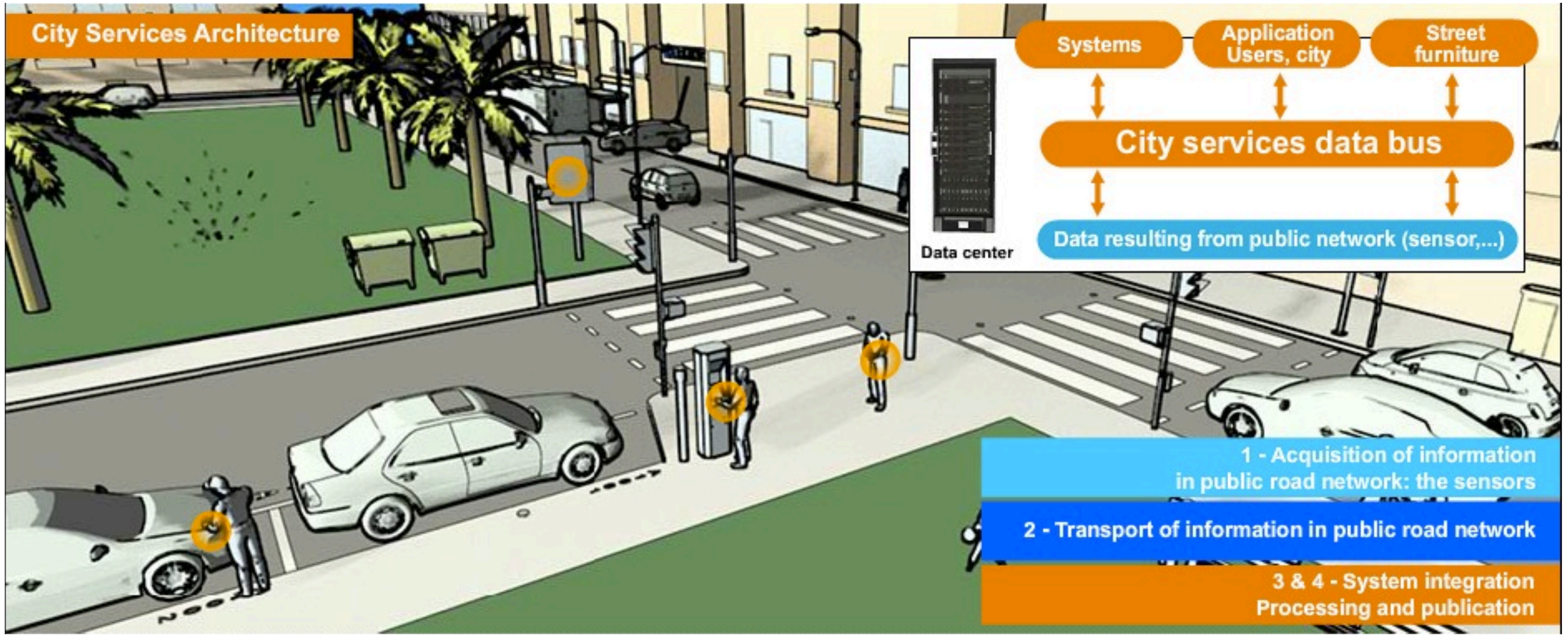
OpenSplice | DDS

Collect | Store | Analyze | Share



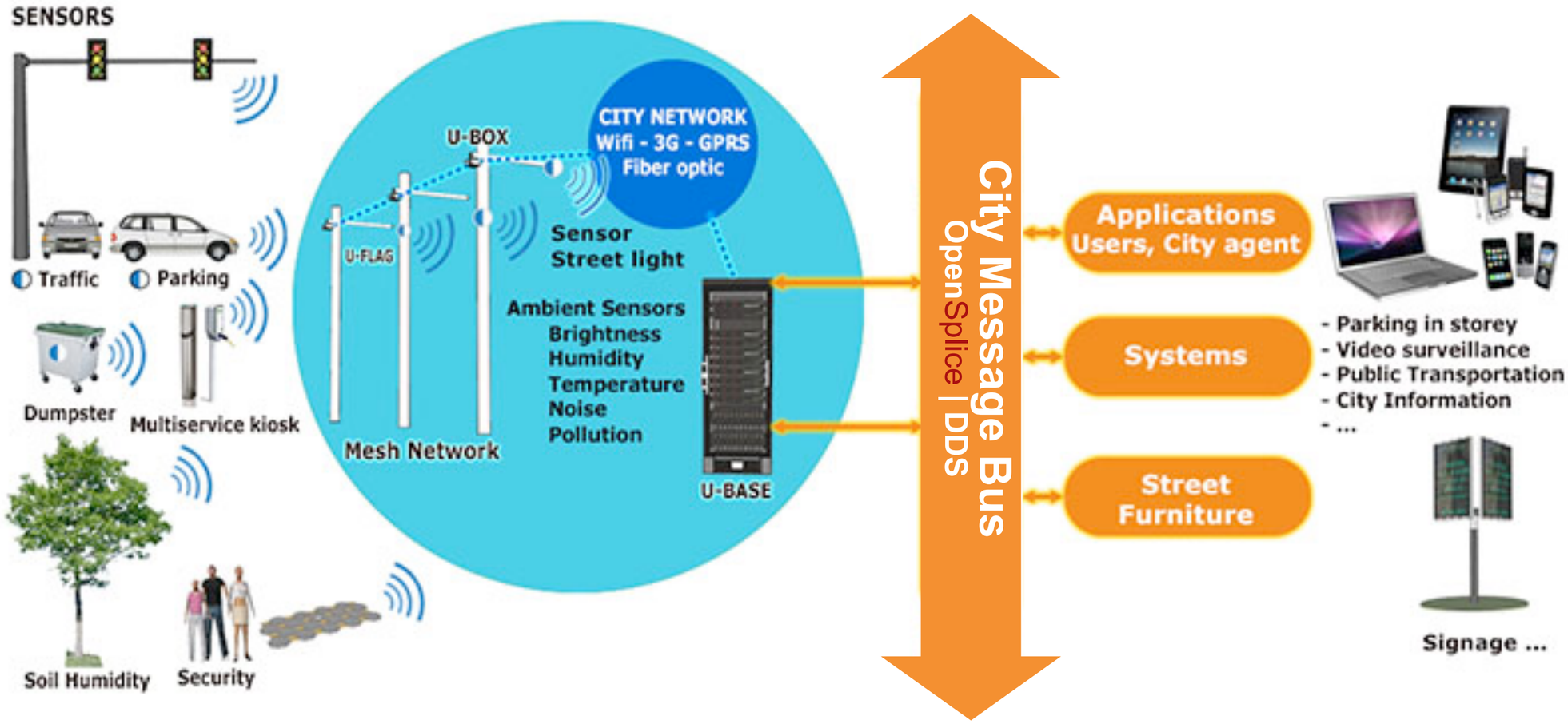
OpenSplice | DDS

Collect | Store | Analyze | Share



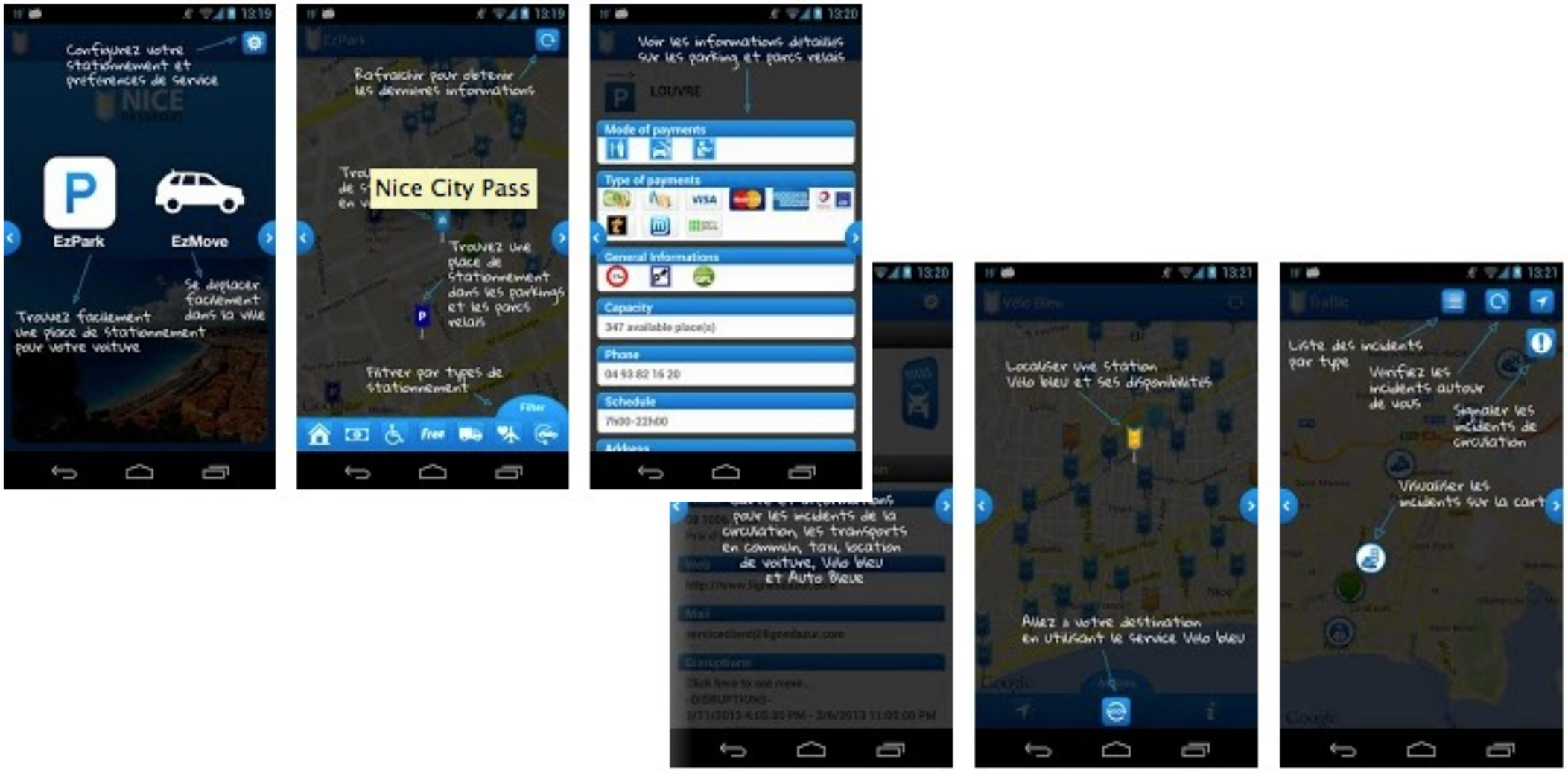
OpenSplice | DDS

City OS Architecture



OpenSplice | DDS

EzPark App



About Opensplice DDS

- Publication Service
  - Filtering and reading a ContentFilteredTopic an hundred time is faster than requesting once on DB

- Started with OpenSplice DDS for sensor data, now using OpenSplice everywhere, even as cloud messaging on Amazon Cloud!

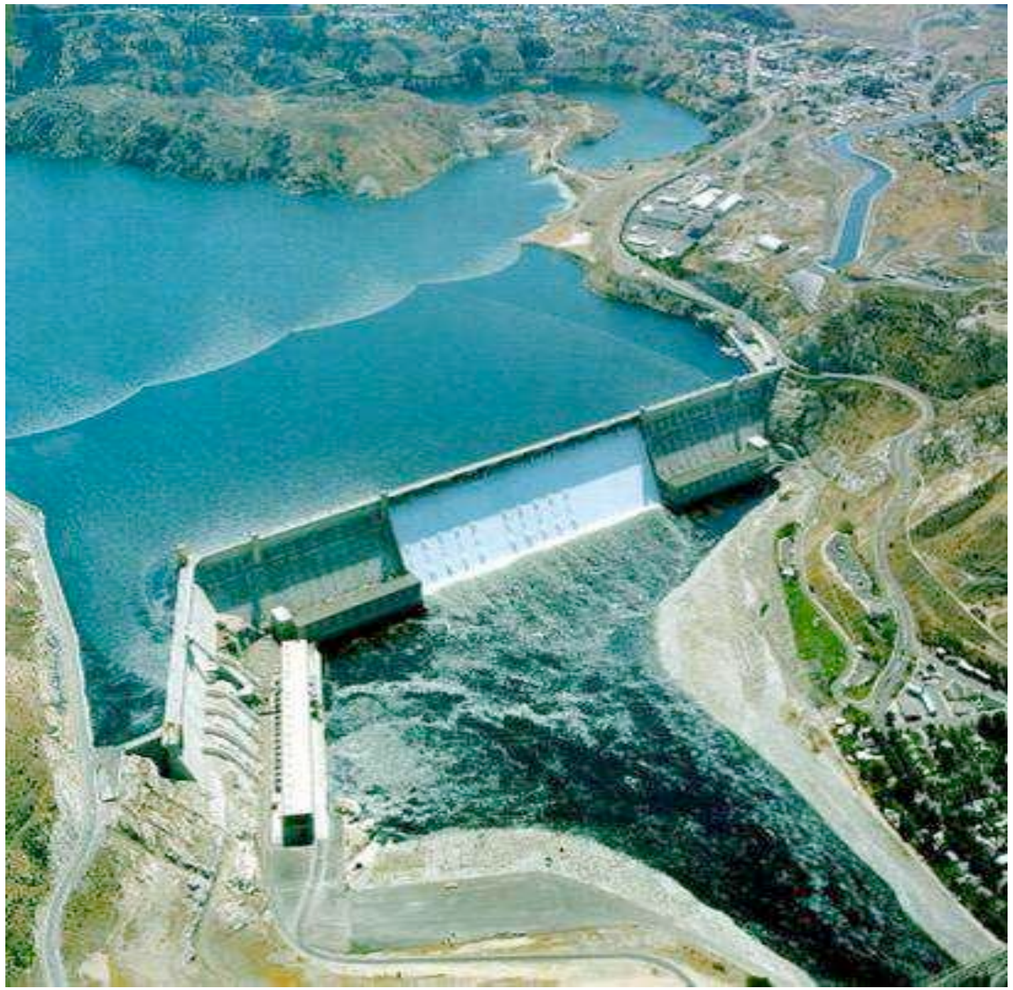
Smart-Grids

OpenSplice | DDS

U.S. Army Corps of Engineers

Grand Coulee Dam

- The Grand Coulee Dam is the largest hydro-electric power plant in the United States
- The dam network connects a 40,000-point SCADA system controlling 30 generators and the transmission switchyard
- PrismTech actively participated in the application development of the GDACS system which will be deployed at the Grand Coulee dam.
- OpenSplice DDS is part of a two vendor development implementation maintained at the Hydroelectric Design Center in Portland, OR.
- OpenSplice DDS is a candidate technology viable for deployment of the GDACS (Generic Data Acquisition and Controls System) program in dams nationwide.



OpenSplice | DDS

Smart-Farming

OpenSplice | DDS

Agricultural Vehicle Systems

- GPS data correction to improve accuracy enabling automated steering, precision ploughing, seeding, fertilizing and spraying
- Tethered control between combine harvester and grain cart enabling unloading on-the-go
- OpenSplice DDS is used to distribute data between the components inside the Combine system
- OpenSplice DDS handles communication between the Combine and the Grain Carts using regular an ad-hoc wireless networks

OpenSplice | DDS

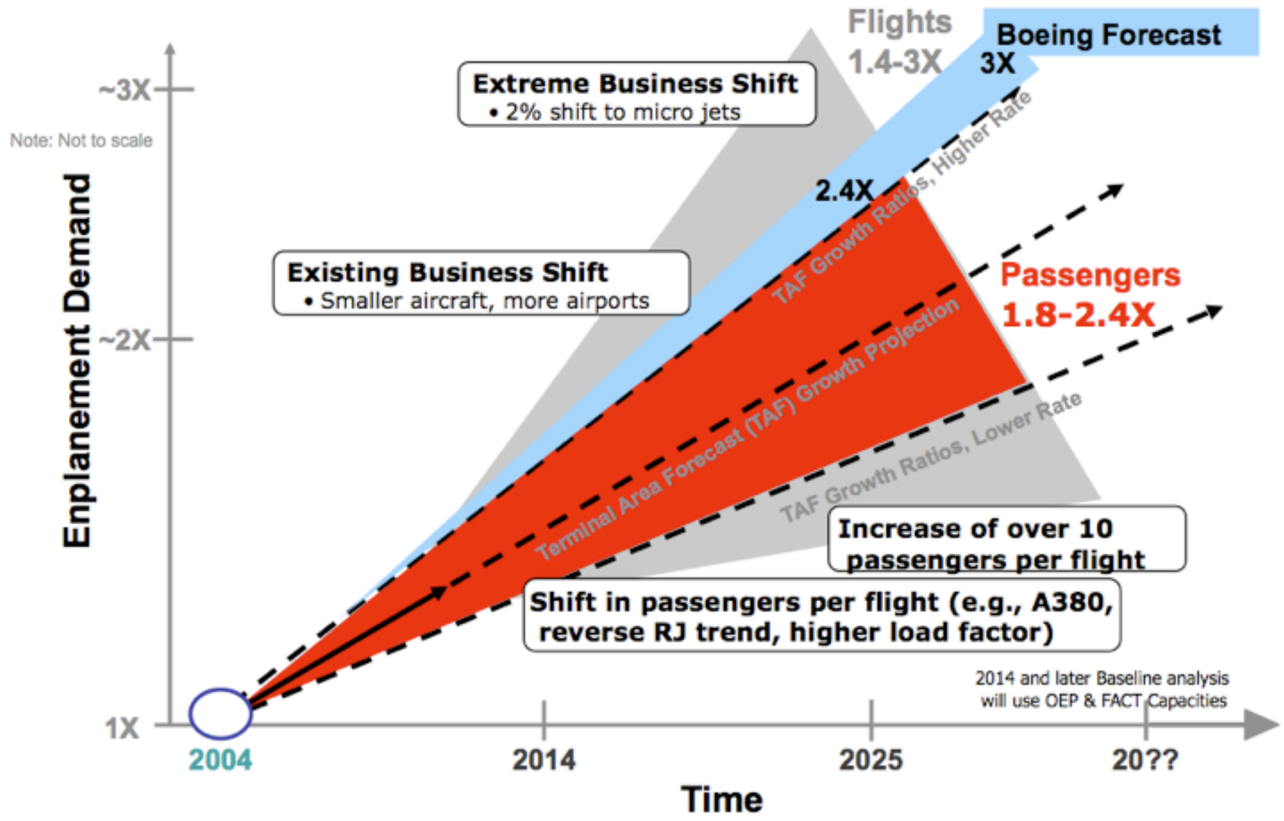
OpenSplice | DDS

SESAR: Single European Sky

Traffic Growth Projections

- The estimated traffic growth projections are forcing a more efficient and integrated approach Air Traffic Control and Management

- On ground systems, most of the inefficiencies derive from stove-piped systems which are unable to effectively exchange relevant informations



European Flight Data Processor

Large program to replace existing Flight Data Processors (FDPs)

- 5 Centers in France
- 4 Centers in Italy
- 2 Centers in Switzerland

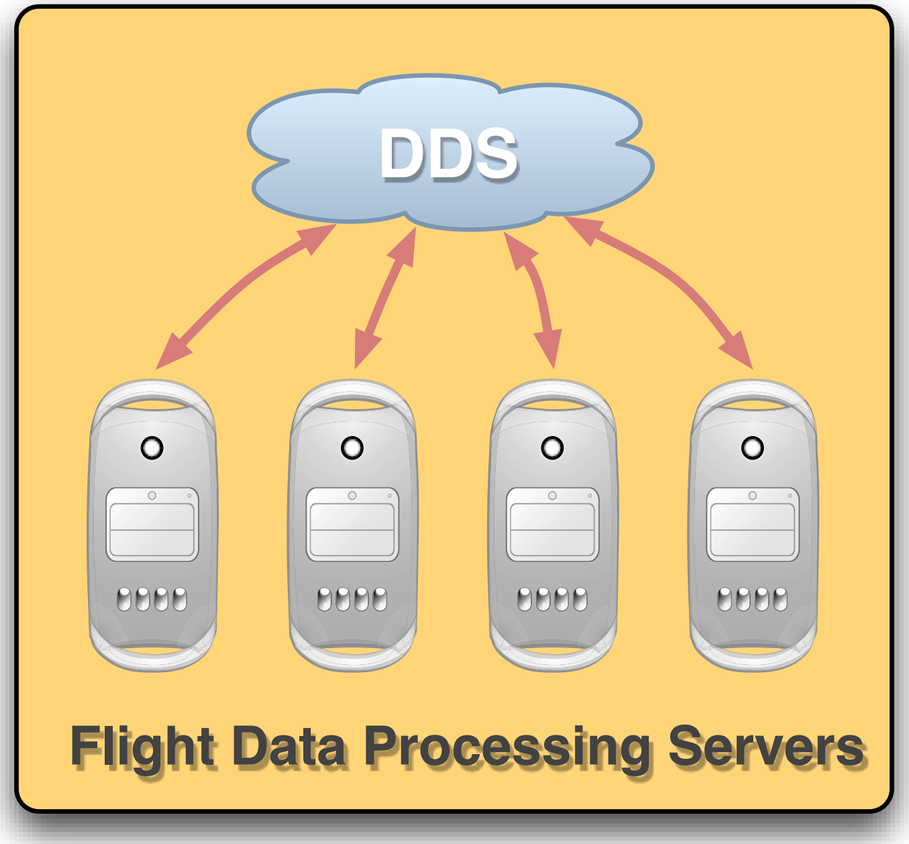
Coflight eFDP

OpenSplice | DDS

FDP Core

- OpenSplice DDS glues together the most critical components of the CoFlight FDP running at a SWAL-2 (similar to DO-178B Level B) assurance level

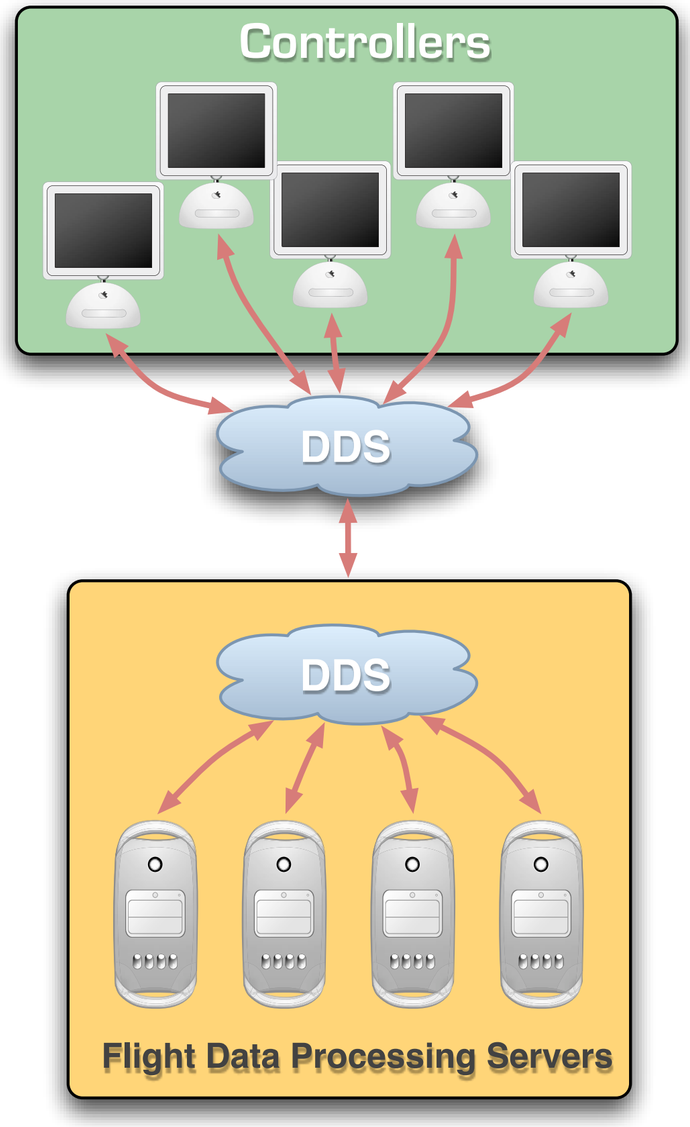
- In this context OpenSplice DDS distributes flights data plans of redundant LANs



Controller Working Positions and Tower

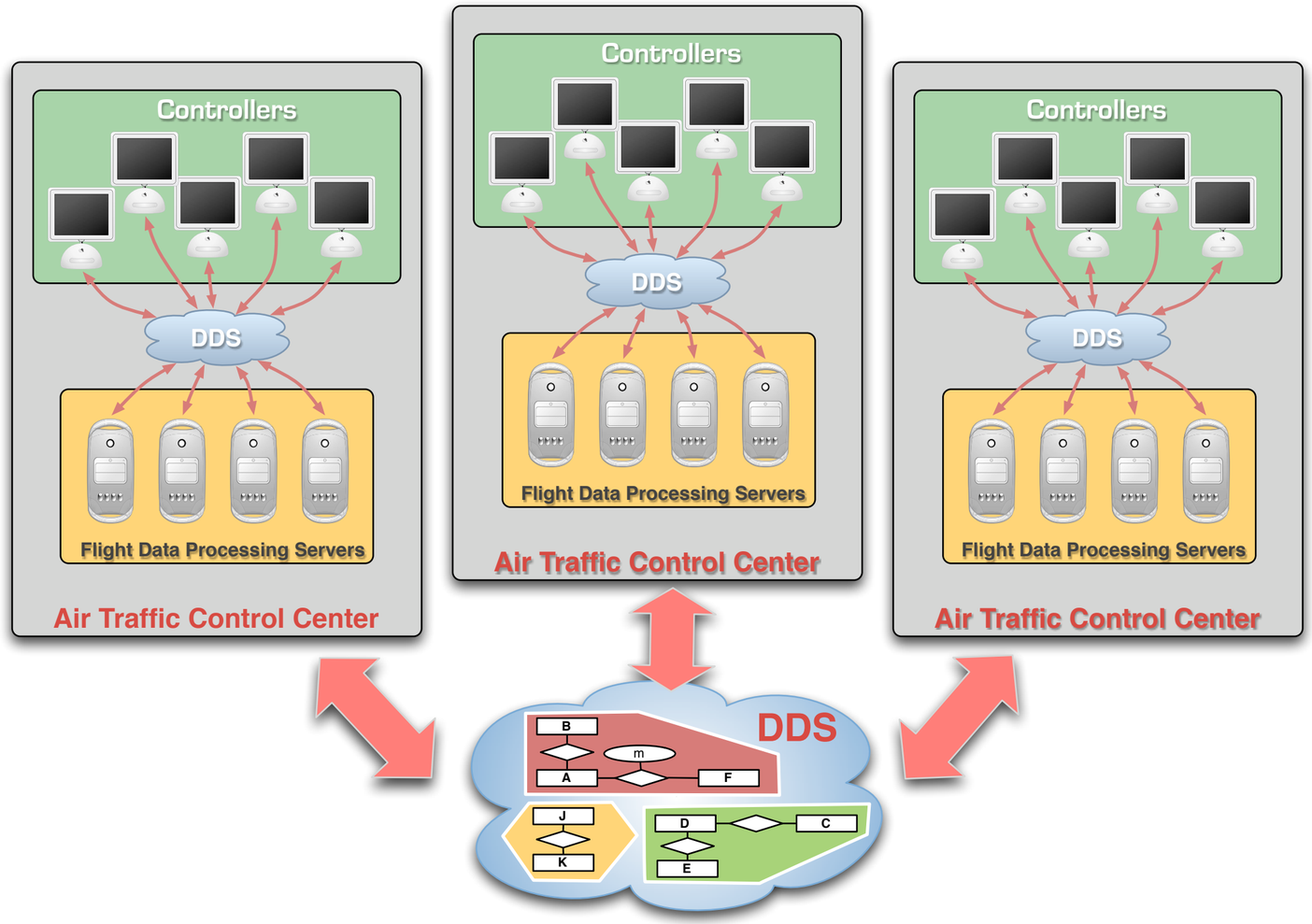
- OpenSplice DDS is used within CoFlight to distribute the "external" Flight Data Plan to Controller Working Positions

- OpenSplice DDS is also used to send FDP data to Towers over narrow band links



Inter-Center Connectivity

- OpenSplice DDS is used to integrate CoFlight-based Centers
- OpenSplice DDS is used to provide interoperability with other Interoperable Centers (as per EUROCAE ICOG-2)



Defense and Aerospace

Integrated Modular Vetronics

Training & Simulation Systems

Naval Combat Systems

Air Traffic Control & Management

Unmanned Air Vehicles

Aerospace Applications

OpenSplice | DDS

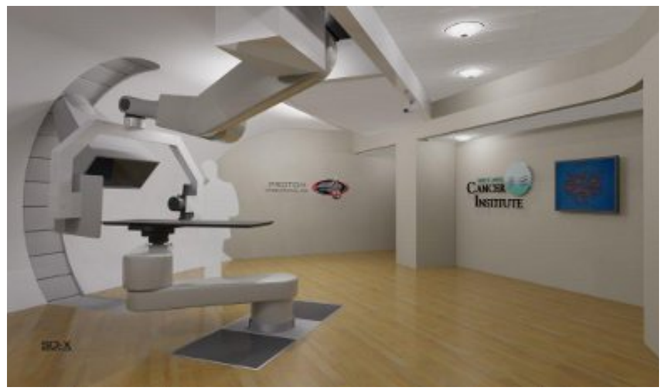
Commercial Applications

Agricultural Vehicle Systems

Large Scale SCADA Systems

Smart Cities

Train Control Systems



Complex Medical Devices

High Frequency Auto-Trading

OpenSplice | DDS

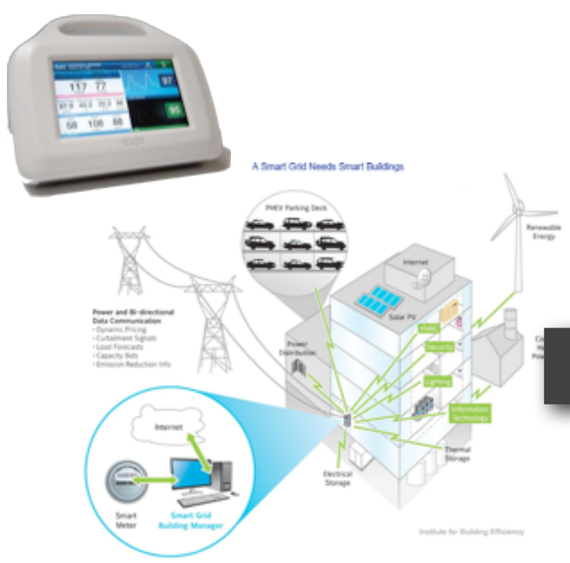
Why IoT Applications Choose DDS?

OpenSplice | DDS

Data-Centricity

IoT Applications are Data Centric

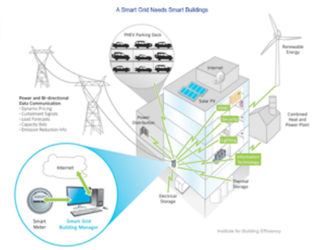
Collect | **Store** | **Analyze** | **Share**



Data

Public/Private Cloud

Data



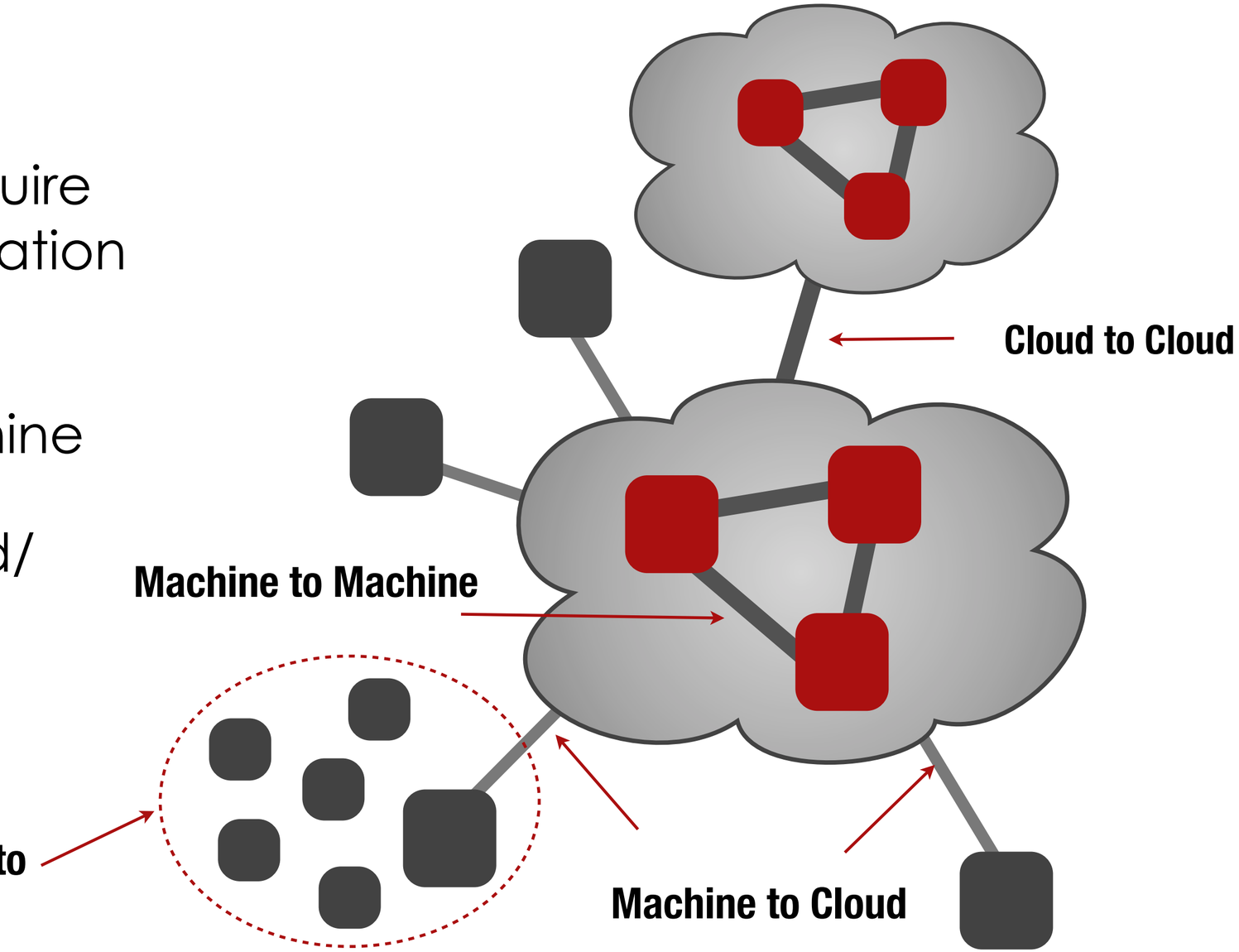
Devices | **Data Center** | **Devices / IT Infrastructure**

OpenSplice | DDS

Communication Patterns

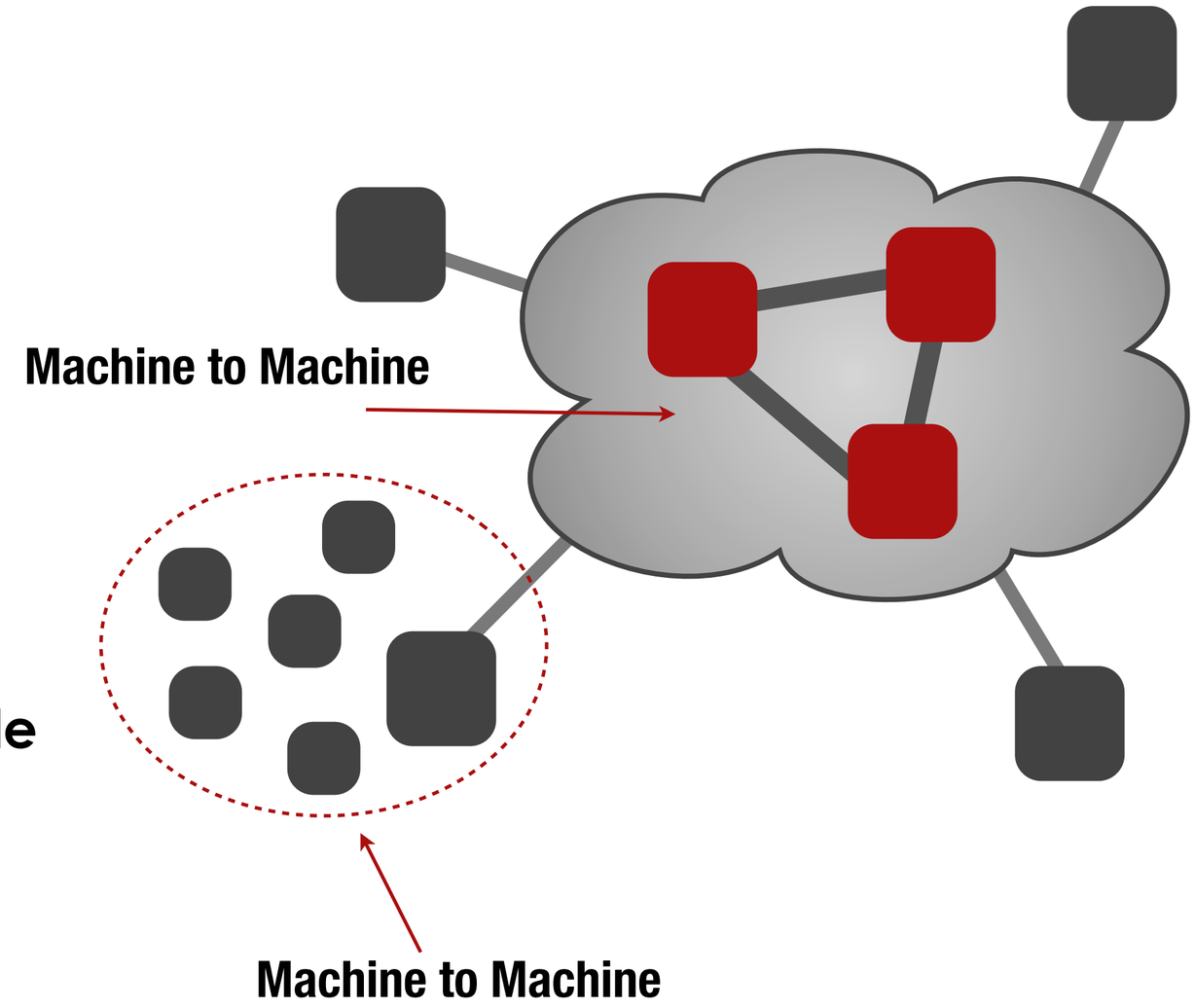
IoT Applications Require different Communication Patterns

- Machine to Machine
- Machine to Cloud/ Data-Centre
- Inter Data-Centre



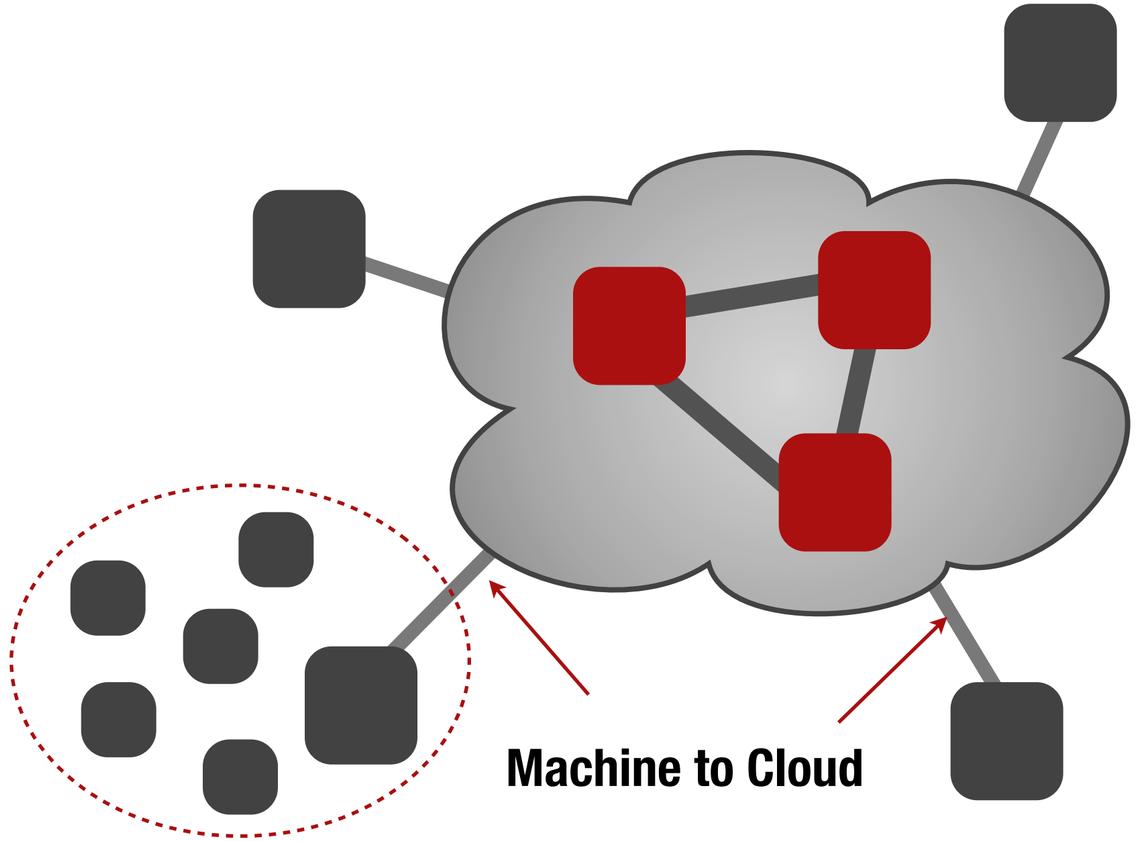
Machine to Machine

- **Peer-to-Peer Communication** between devices with potentially **very different hardware and networking capabilities**
- In some use cases, e.g. inside the data center, low latency / high throughput are relevant
- To enable **Open and Interoperable IoT**, **Machine- Machine** communication has to rely on **standard protocols**



Machine to Cloud/Data-Centre

- Characteristic of the communication depends on the kind of application
  - Sporadic data updates vs. Real-Time data updates
  - Potentially Constrained Bandwidth
  - Intermittent Connectivity
  - Variable Latency Links
  - NAT, Firewalls
  - Security
- To enable **Open and Interoperable IoT**, **Machine- to-Cloud/Data-Centre** communication has to rely on **standard protocols**



A Short DDS Intro

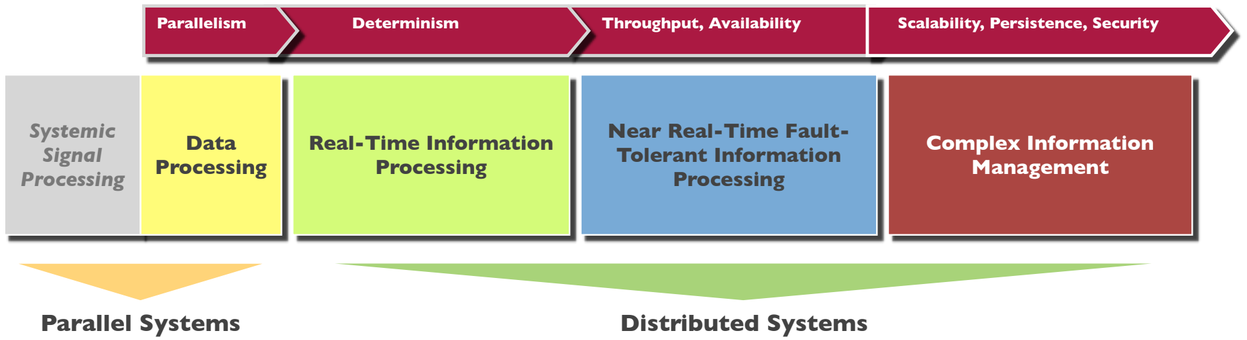
OpenSplice | DDS

Data Distribution Service

For Real-Time Systems

- Introduced in 2004 to address the **Data Distribution challenges** faced by a wide class of **Defense and Aerospace Applications**

- Key requirement for the standard were to deliver very **high and predictable performance** while scaling from embedded to ultra-large-scale deployments



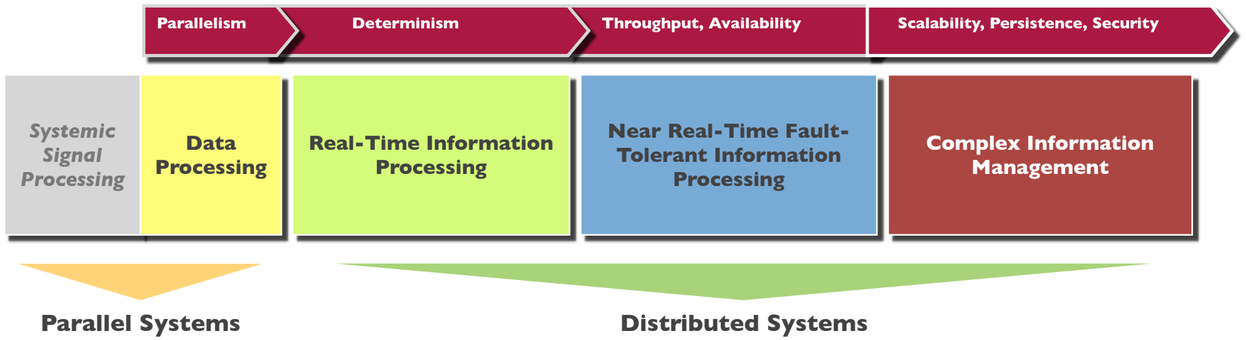
OpenSplice | DDS

Data Distribution Service

For Real-Time Systems

- **Recommended** by key administration **worldwide**, e.g. DoD, MoD, EUROCAE, etc.

- **Widely adopted** across several different domains, e.g., Smart Cities, Smart Grids, Automated Trading, Simulations, SCADA, Telemetry, etc.

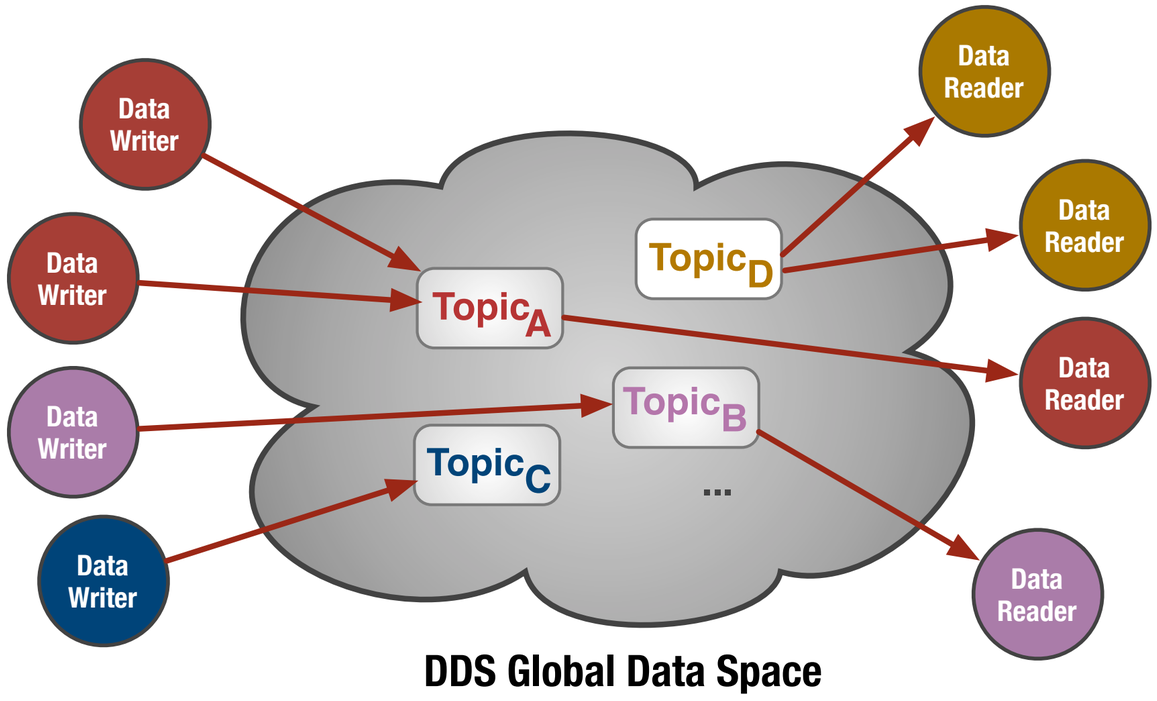


OpenSplice | DDS

Data Distribution Service (DDS)

- *DDS provides a **Global Data Space** abstraction that allow applications to **autonomously**, **anonymously securely** and **efficiently share data**.*

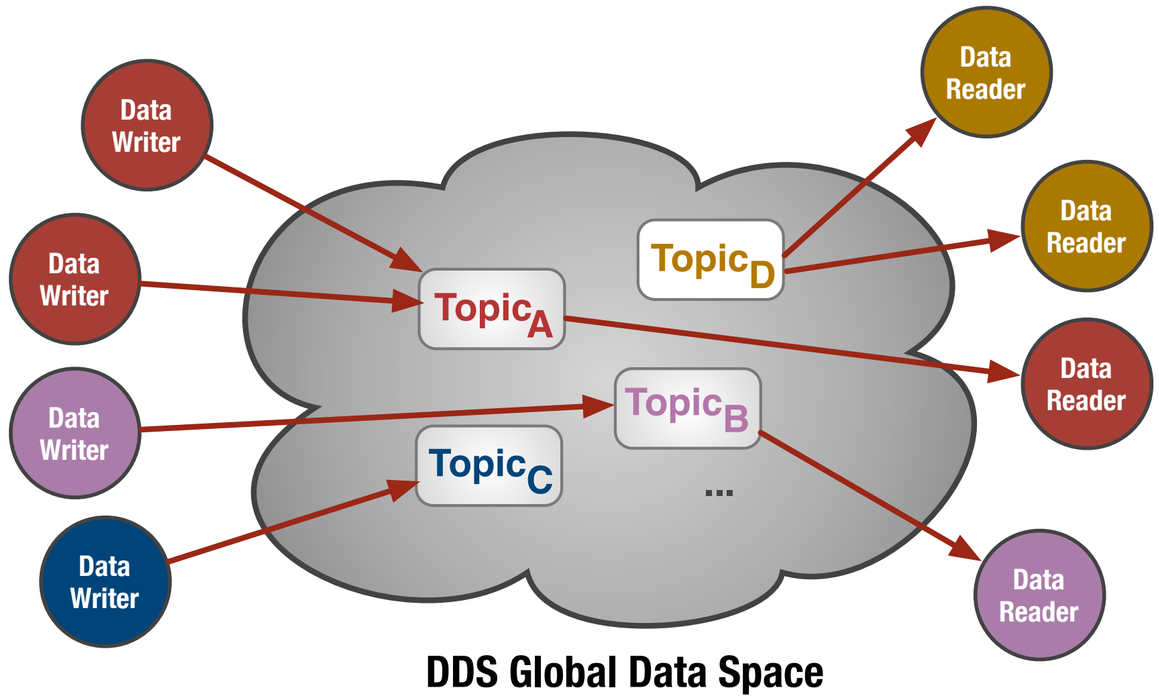
- *DDS' Global Data Space is **fully distributed**, **highly efficient** and **scalable***



DDS Global Data Space

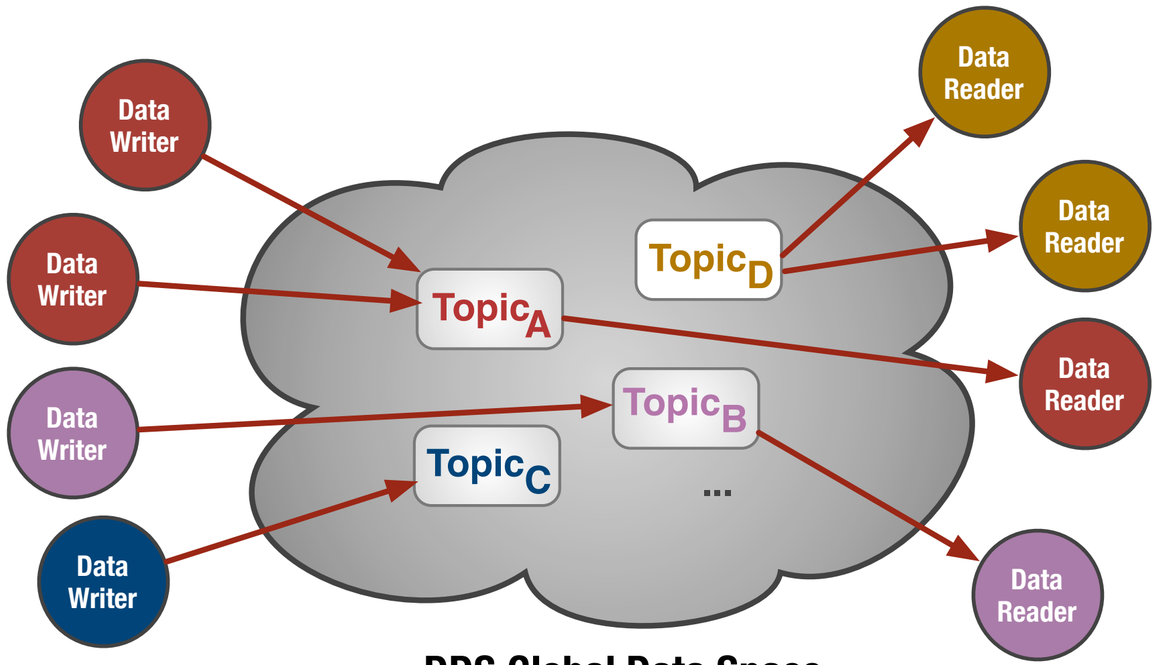
Data Distribution Service (DDS)

- DataWriters and DataReaders are automatically and dynamically matched by the DDS **Discovery**
- A rich set of **QoS** allows to **control existential, temporal, and spatial properties of data**



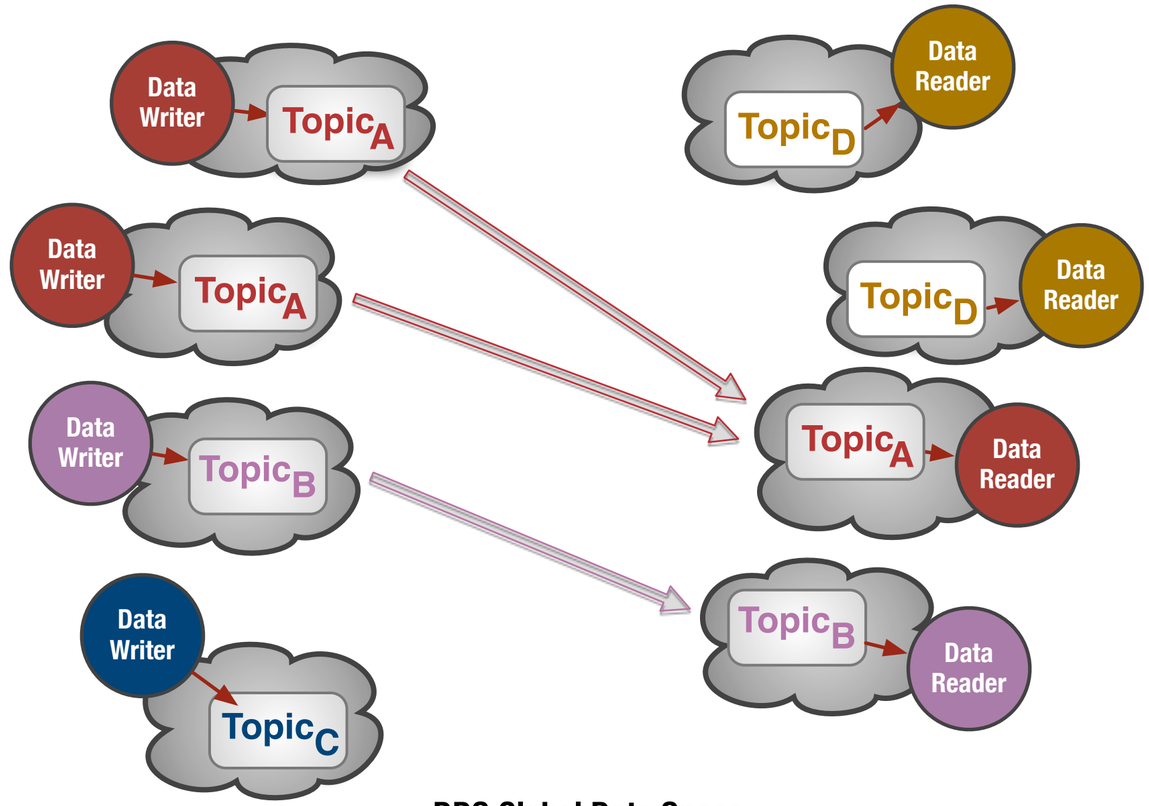
Fully Distributed Data Space

Conceptual Model



DDS Global Data Space

Actual Implementation



DDS Global Data Space

OpenSplice | DDS

Key DDS Highlights [1/2]

- **Elegant** and **High Level Data Sharing Abstraction**
- **Polyglot** and platform independent
  - Java, Scala, C, C++, C#, JavaScript, CoffeeScript etc.
  - Android, Windows, Linux, VxWorks, etc.
- **Peer-to-Peer** by nature, **Brokered** when useful
- **Time and Space Efficient.** Run efficiently over small bandwidth links and is provides minimal latency

Key DDS Highlights [2/2]

- **Content** and **Temporal Filtering** (both sender and receiver filtering supported)
- **Queries**
- **20+ QoS** to control control existential, temporal, and spatial properties of data
- **High Performance and Scalable**
  - ~50 usec latency
  - 7M msgs/sec node-to-node throughput

Your First DDS App

OpenSplice | DDS

C++ Example

Writing Data

```
auto dp = DomainParticipant(domainId);
// Create a Publisher
auto pub = Publisher(dp);
// Create a Topic
auto tts = Topic<TempSensor>(dp, “TTempSensor”);
// Create a DataWriter
auto dw = DataWriter<TempSensor>(pub, tts);
// Write Data
dw.write(TempSensor(101, 23.5F, 0.55F));
// But you can also write like this...
dw << TempSensor(102, 24.5F, 0.65F);
```

Reading Data

```
auto dp = DomainParticipant(domainId);
// Create a Subscriber
auto sub = Subscriber(dp);
// Create a Topic
auto tts = Topic<TempSensor>(dp, “TTemSensor”);
auto dr = DataReader<TempSensor>(sub, tts);
auto data = reader.read();
```

OpenSplice | DDS

Scala Example

Writing Data

```
val tts = Topic[TempSensor]("TTempSensor")
val dw = DataWriter(ts)
w.write(val TempSensor())
```

Reading Data

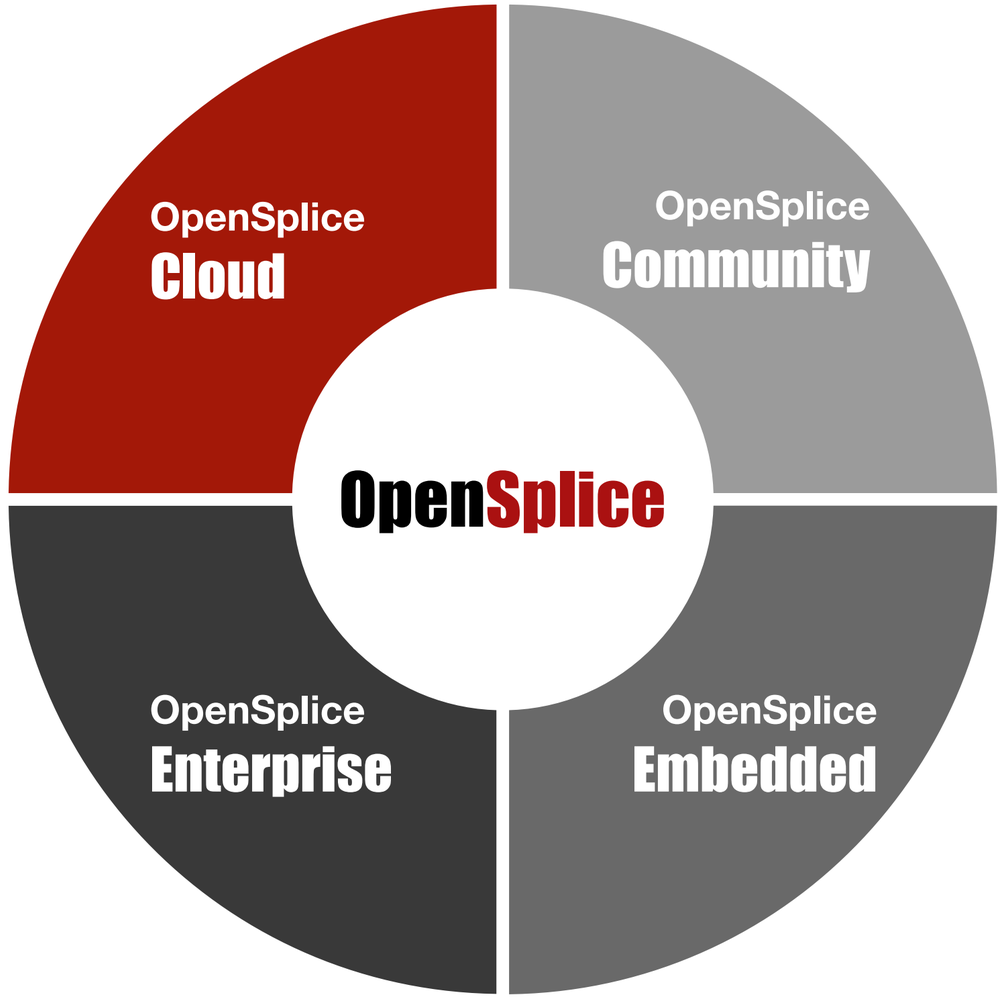
```
val tts = Topic[TempSensor]("TTempSensor")
val dr = DataReader(ts)
dr read() foreach(println(_))
```

DDS Everywhere

OpenSplice | DDS

DDS Everywhere Platform

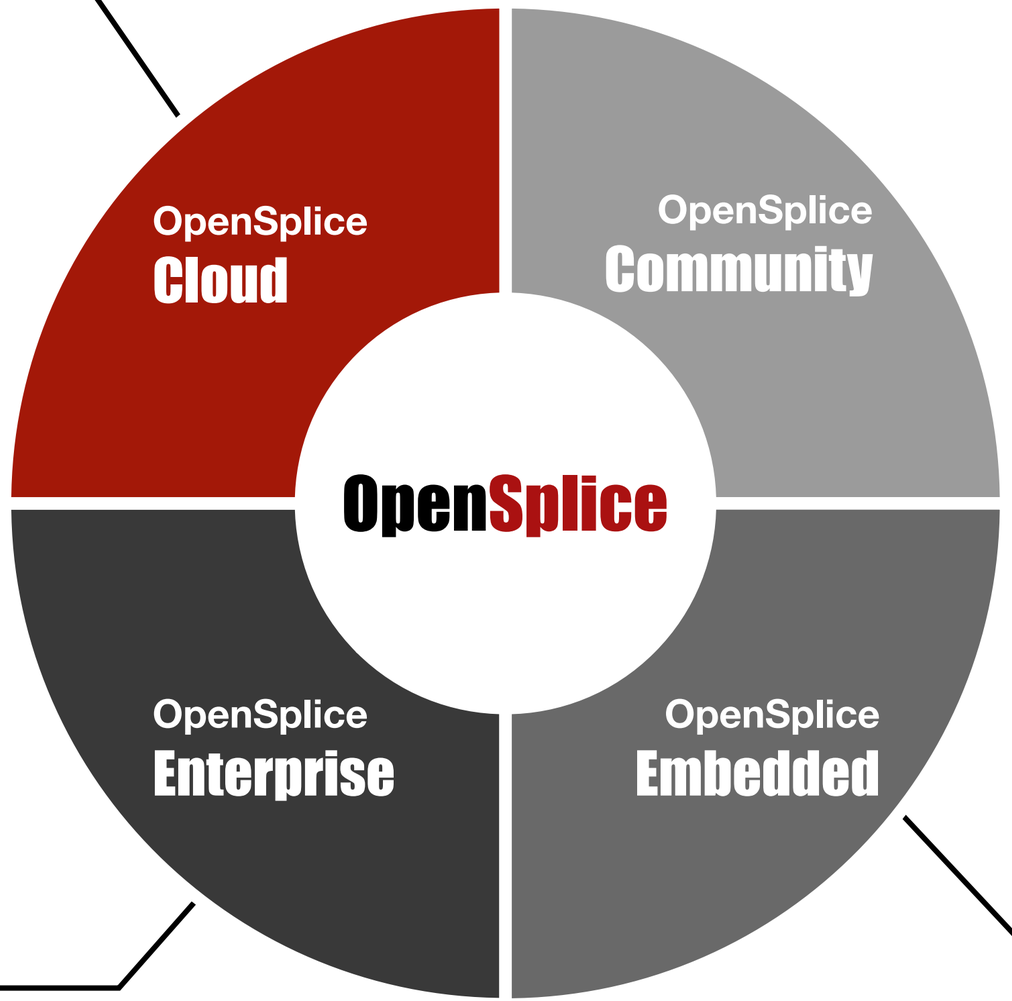
- A DDS-based, interoperable product family addressing systems needs from **Embedded** and **Mobile** to **Enterprise** and **Cloud**
- An **Open Source** core providing **free access** to the OpenSplice Ecosystem, **security of supply** and a **vibrant**, **innovative community**



DDS Everywhere Platform

Consumer Platforms

- Browser / HTML5
- iOS
- Android
- Cloud
- No-SQL
- Mobile/WiFi IP Transp.



IT Platforms

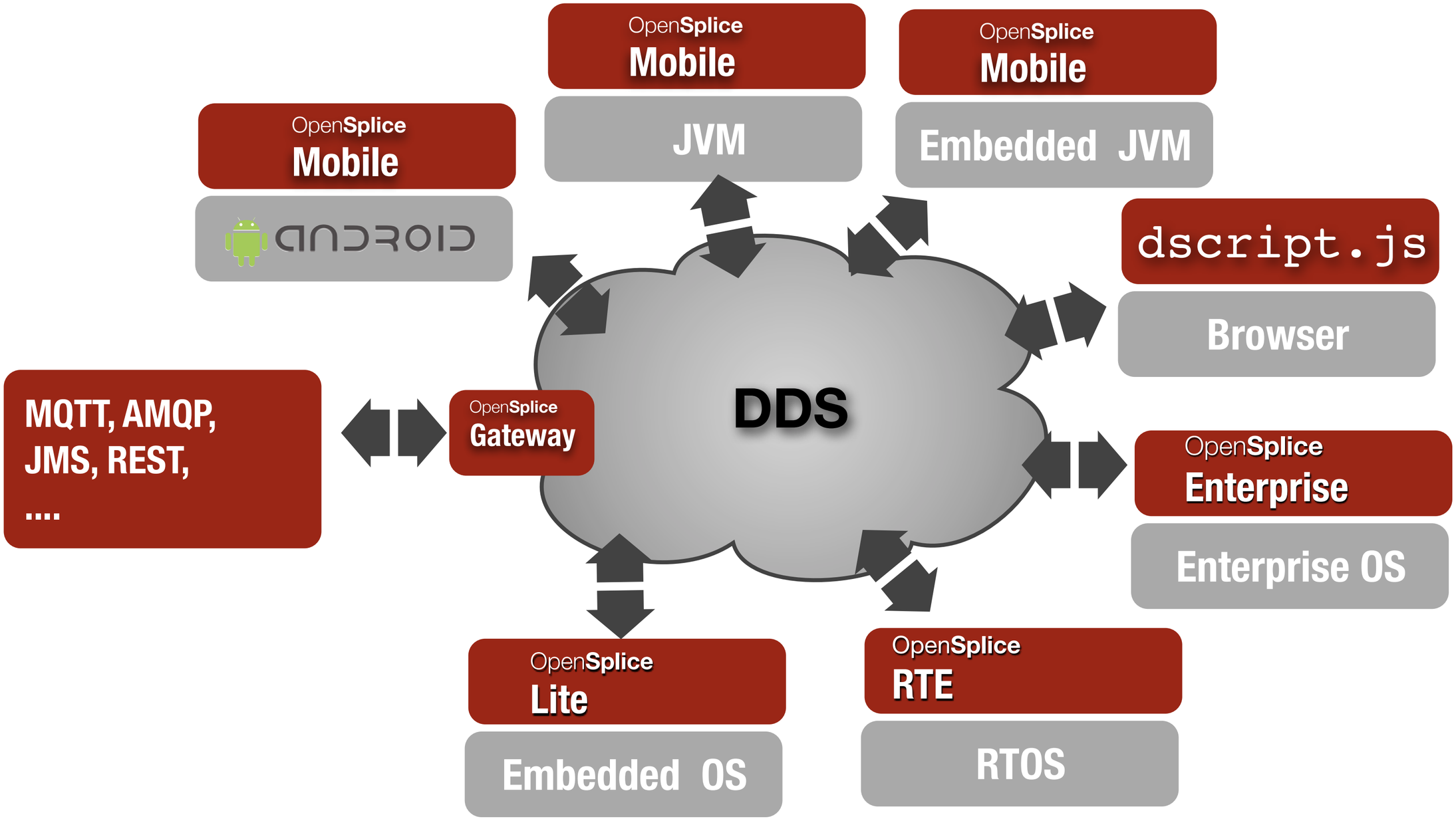
- OS (Linux, Windows, etc)
- Cloud
- DBMS
- No-SQL
- InfiniBand + IP Transports

Industrial Platforms

- RTOS (VxWorks, QNX, etc.)
- FPGA
- BSP / No-OS
- IP + Exotic Transports

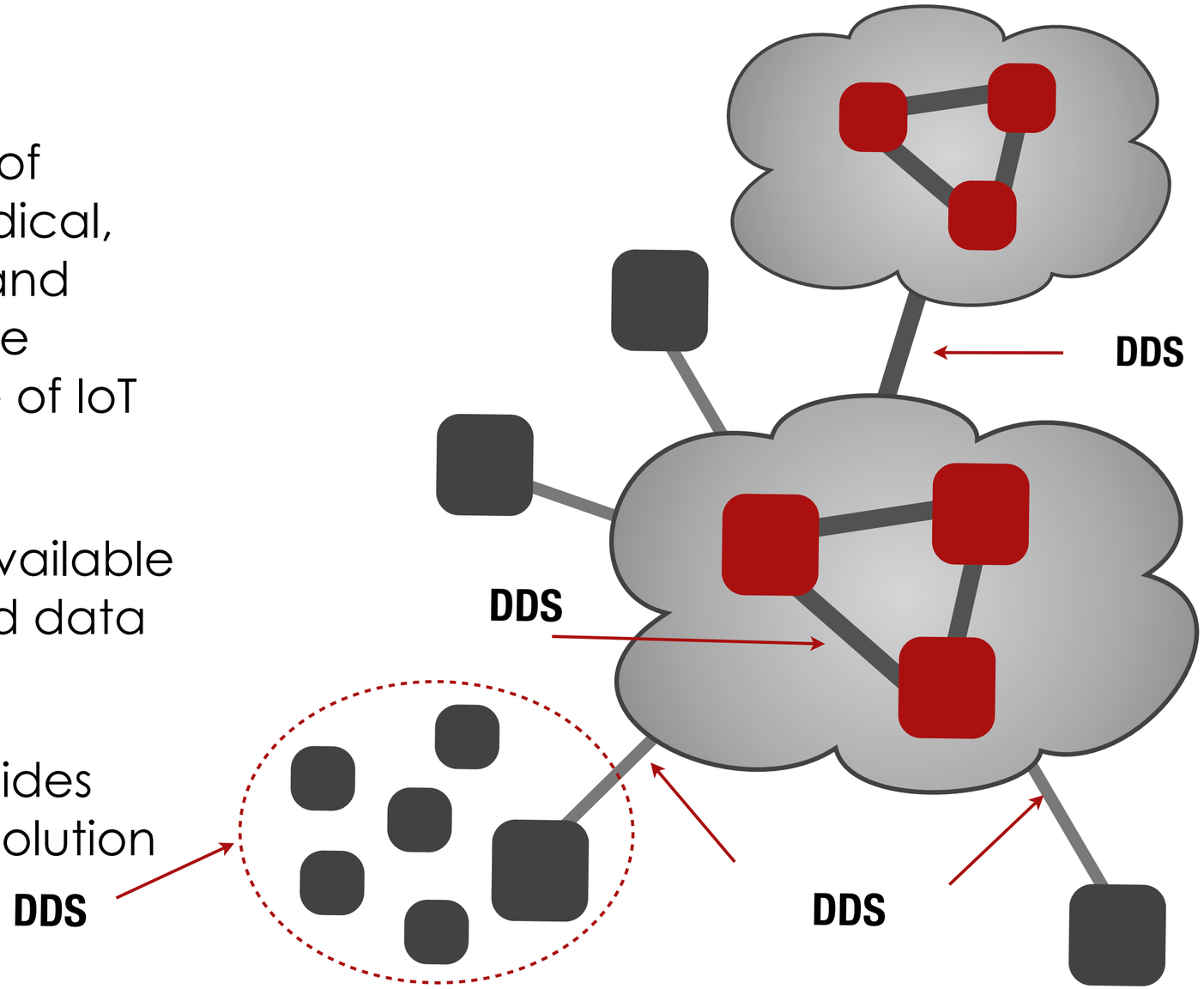
OpenSplice | DDS

DDS Everywhere!



Concluding Remarks

- An increasing number of domains, such as medical, energy, infrastructure and fleet management, are seeing the emergence of IoT requirements
- For IoT is key to have available open and standardized data sharing protocols
- The DDS standard provides the ideal end-to-end solution for the IoT




THANK
YOU
GRACIAS
ARIGATO
SHUKURIA
DANKSCHEEN
JUSPAXAR
KOMAPSUMNIDA
GRAZIE
MEHRBANI
BOLZÏN
MERCI
TASHAKKUR ATU
YAQHANYELAY
SUKSAMA
EKHMET
GOZAIMASHITA
EFCHARISTO
TINGKI
SHUKRIA
MAAKE
PALDIES
SPASIBO
SNACHALHUYA
NUHUN
CHALTU
WABEEJA
MAITEKA
DHANYABAAD
ATTO
ANIHA
SANCO
MERASTAWHY
GAEJTHO
LAH
TAVTAPUCH
MEDAWAGSE
AGUYJE
FAKAAUE
BAIKA
YUSPAGARÄTAM
HUI
GUI
HÄTUR
UNALCHÉESH
MERSI
SPASIBO
DENKAUJA
NENACHALHYA
EKOJU
SIKOMO
MAKETAI
MINMONCHAR

:: Connect with Us ::

OpenSplice | DDS

opensplice.com

forums.opensplice.org

opensplice.org

opensplicedds@prismtech.com

@acorsaro

@prismtech

youtube.com/opensplicetube

slideshare.net/angelo.corsaro

PRISMTECH

crc@prismtech.com

sales@prismtech.com