OMG DDS and its Relation to Unmanned Vehicle Interoperability

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The Global Leader in DDS

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Chief Technology Officer, Real-Time Innovations, Inc.

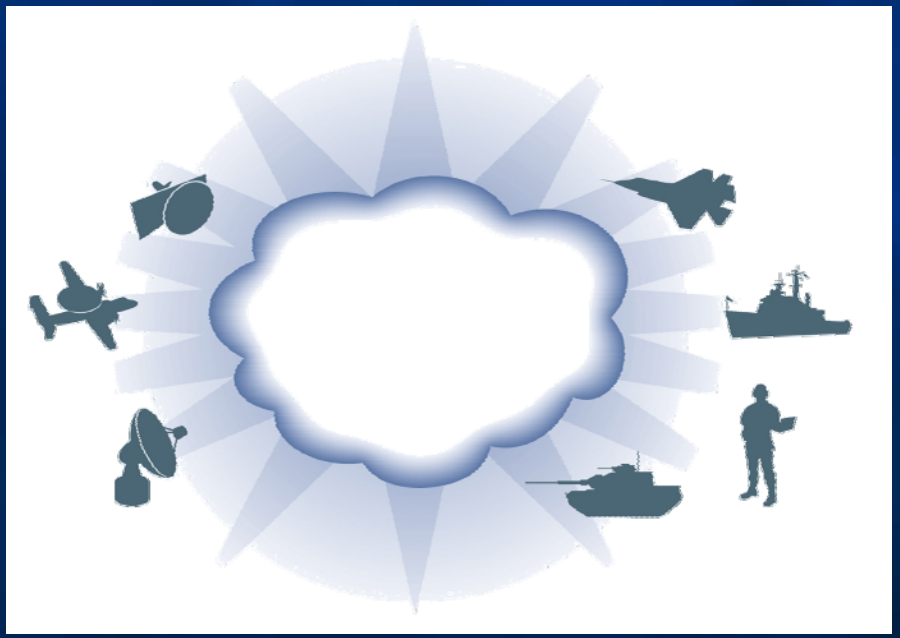
Integration Challenge:
More Providers, More Data, Faster Evolution

TRENDS:

- Increased Mix of Components from different providers
- Accelerating technology insertion and deployment
- Field deployment over disadvantaged links
- Growing Information Volume

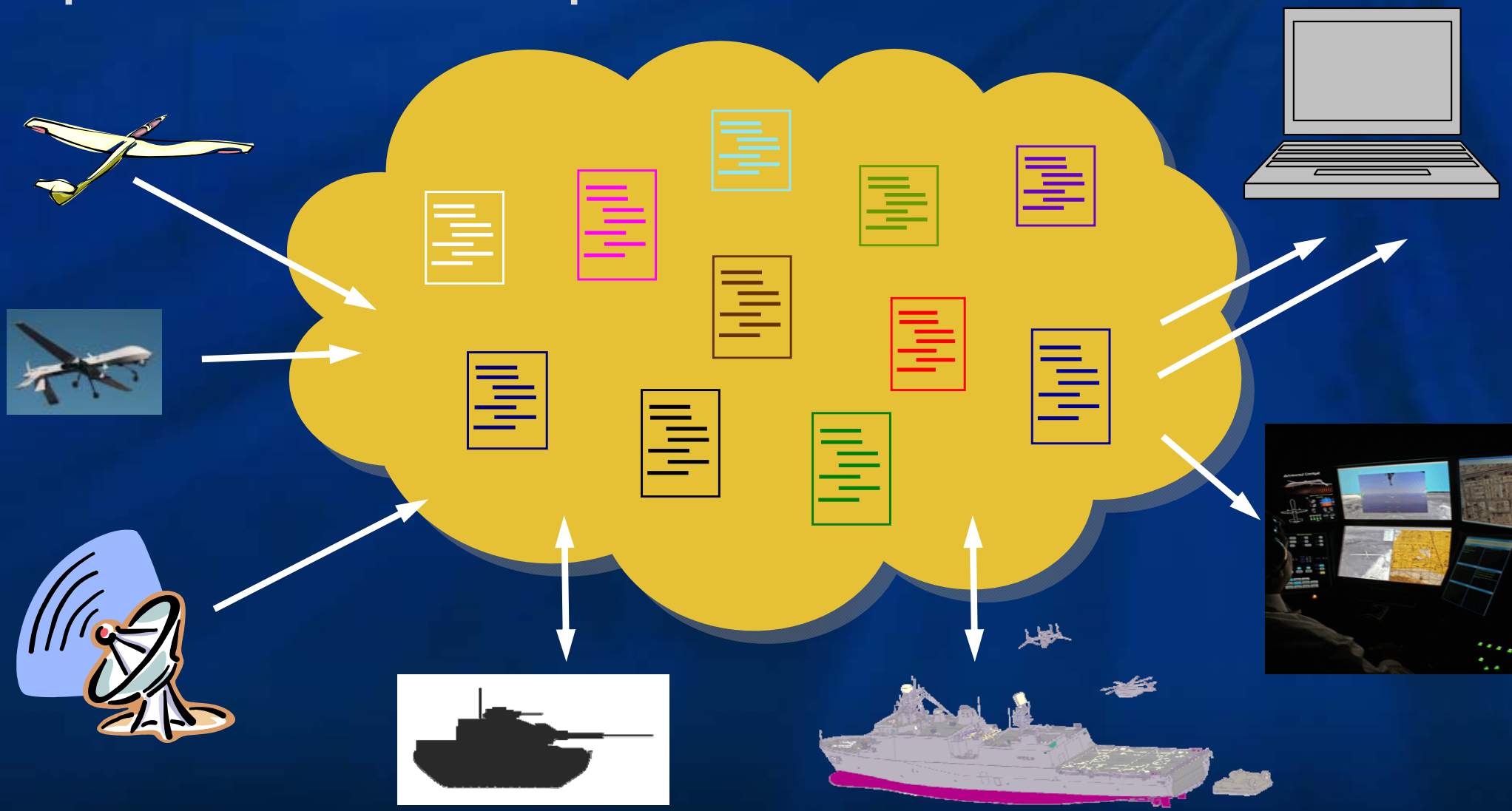
Next-generation systems needs:

- Common Operational Picture
- Interoperability between suppliers
- Rapid Evolution
- Performance & Scalability
- Robustness & Availability
- Safety-Critical Certification
- Security



Solution: Open Architecture & Standards for…
Common Operational Picture Data Model, Protocols, APIs

Open Common Operational Picture

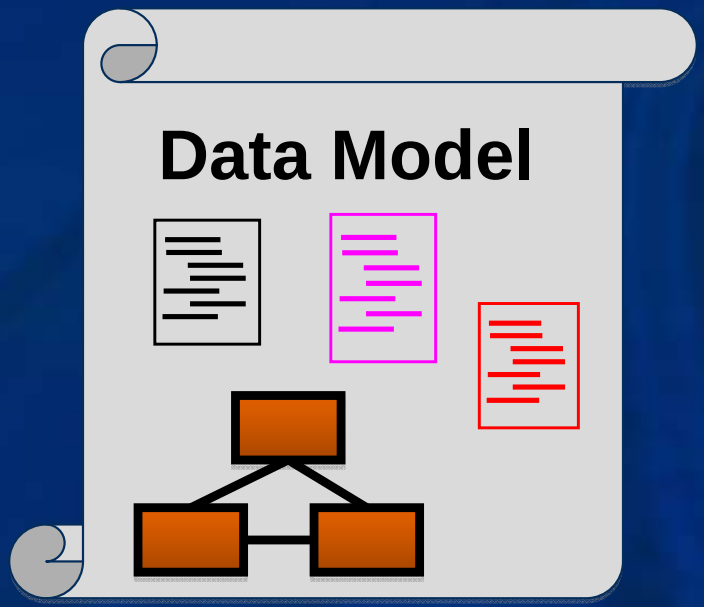


Common Data Model + Interoperable Protocols

Natural Separation into:

- Data Model as Platform Independent Model (PIM)
- Platform Specific Mapping (PSM) to standards-based Middleware

Leverage Existing IT middleware standards



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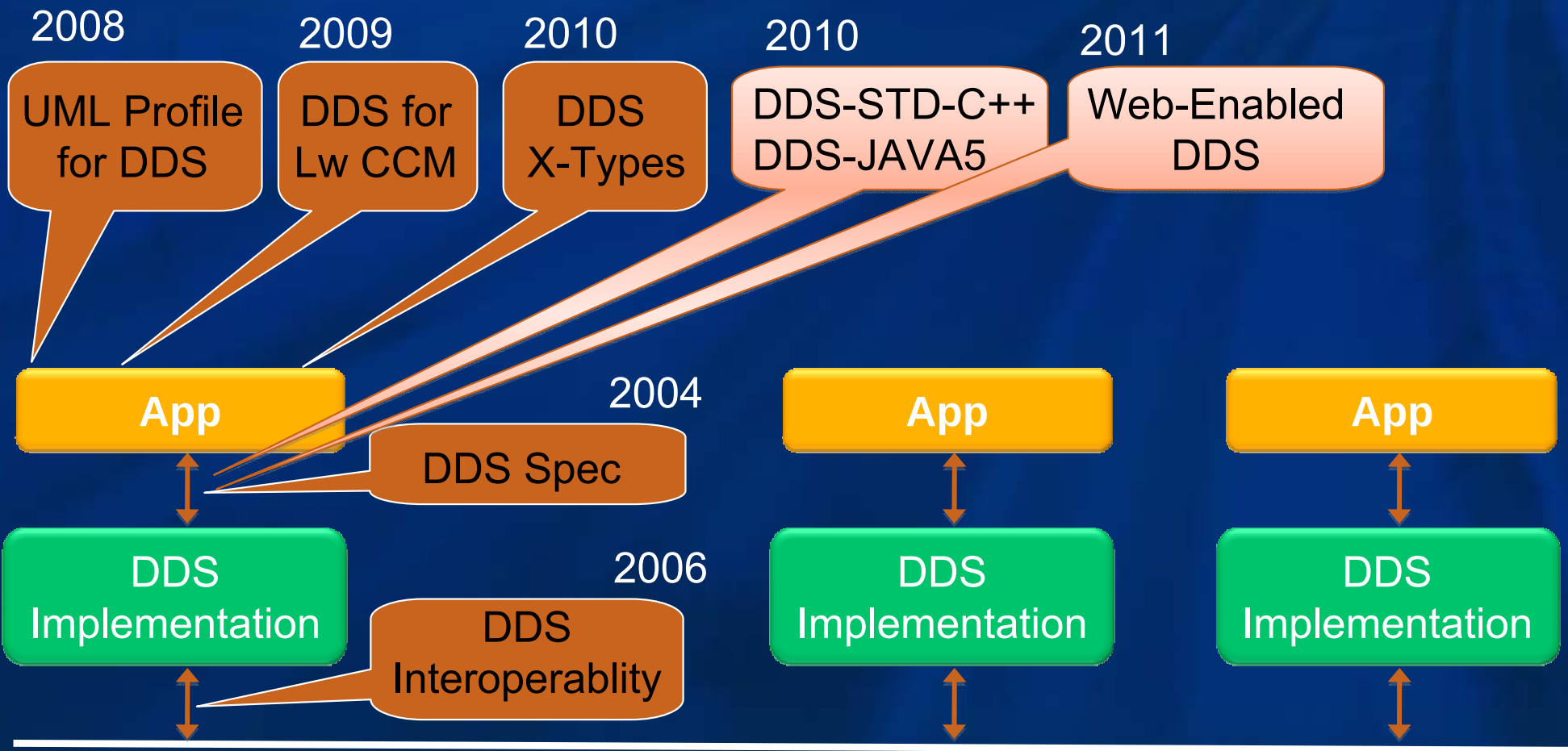
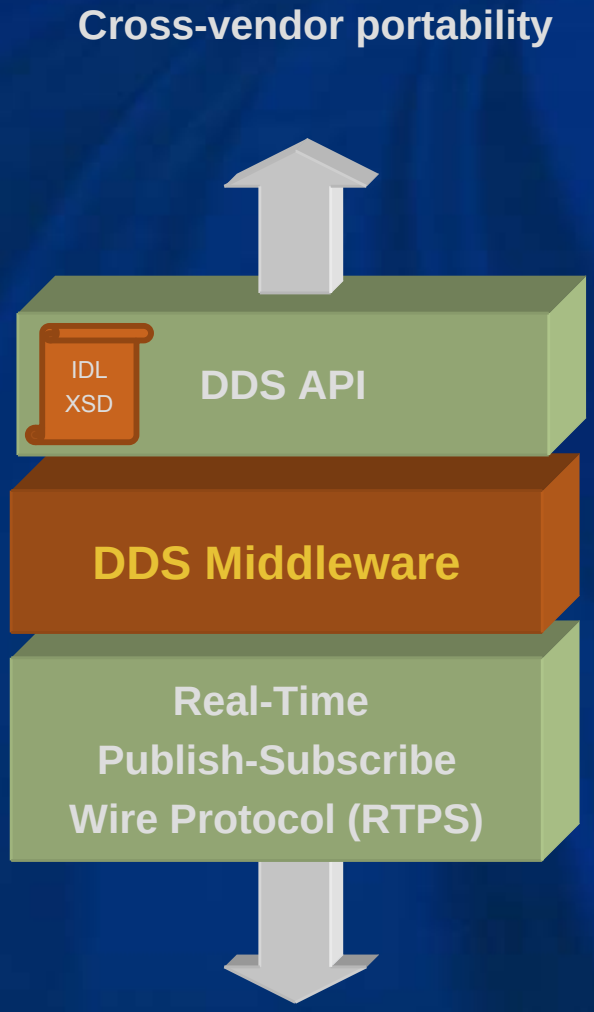
DDS Family of Specifications



The DDS Standard: Open Architecture Interoperability & Portability

- Components
  - Wire protocol for interoperability (RTPS)
  - API for portability (C, C++, Java*)
  - Integration interface (IDL, XML, WSDL)
- Open
  - Object Management Group (OMG)
  - Publicly available (http://dds.omg.org)
  - At least 10 implementations
- Mature
  - Used in 500+ unique systems
  - 300,000+ licensed copies
  - Implementations are TRL 9



**RTI also supports C# (.NET) and Ada*

DDS adopted by key programs

- DISR
  - Mandates DDS for Pub-Sub API
  - Mandates DDS-RTPS for Pub-Sub Interoperability
- US Navy Open Architecture
  - Mandates DDS for Pub-Sub
- *SPAWAR NESI*
  - *Mandates DDS for Pub-Sub SOA*
- *European Air Traffic Control*
  - *DDS used to interoperate ATC centers*
- *UK Generic Vehicle Architecture*
  - *Mandates DDS for vehicle comm.*
  - *Mandates DDS-RTPS for interoperability*

Key A&D Programs Adopt DDS for Interoperability

Aegis Weapon System

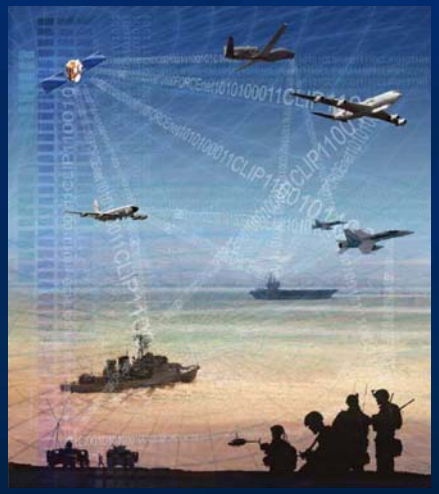
Lockheed Martin

Radar, weapons, displays, C2

B-1B Bomber

Boeing

C2, communications, weapons



Common Link Integration Processing (CLIP)

Northrop Grumman

Standards-compliant interface to legacy and new tactical data links

Air Force, Navy, B-1B and B-52

ScanEagle UAV

Boeing

Sensors, ground station

Advanced Cockpit Ground Control Station

Predator and SkyWarrior UAS

General Atomics

Telemetry data, multiple workstations

RoboScout

Base10

Internal data bus and link to communications center

Key A&D Programs Adopt DDS for Interoperability

Air-Traffic Management

Eurocontrol

UK, Germany, Spain, France, Italy, Switzerland

Ship Self Defense System

Reagan Class Aircraft Carrier

Combat Management System

Advanced Cockpit Ground Control Station

Predator and SkyWarrior UAS

General Atomics

Driver safety Volkswagen

vision systems, analysis, driver information systems

Korea FFX Frigate

Samsung-Thales

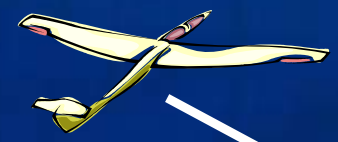
Combat Management system

AWACS

Radar System

Data-Centric Qos-Aware Pub-Sub Model

Virtual, decentralized global data space



Source (Key)	Latitude	Longitude	Altitude
UAV1	37.4	-122.0	500.0
UAV2	40.7	-74.0	250.0
UAV3	50.2	-0.7	2000.0

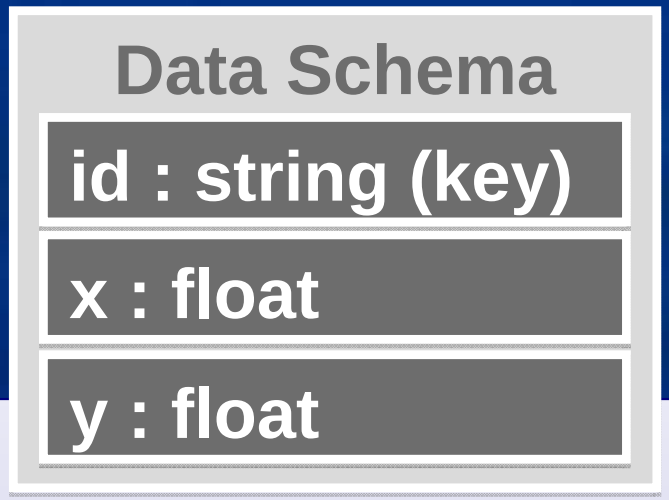
DDS

Persistence Service

Recording Service

CRUD operations

Example: Modern Data-Centric Design
Start with Data Model / Schemas / Meaning



Map this into XML; rows + cols

Express content-based filters

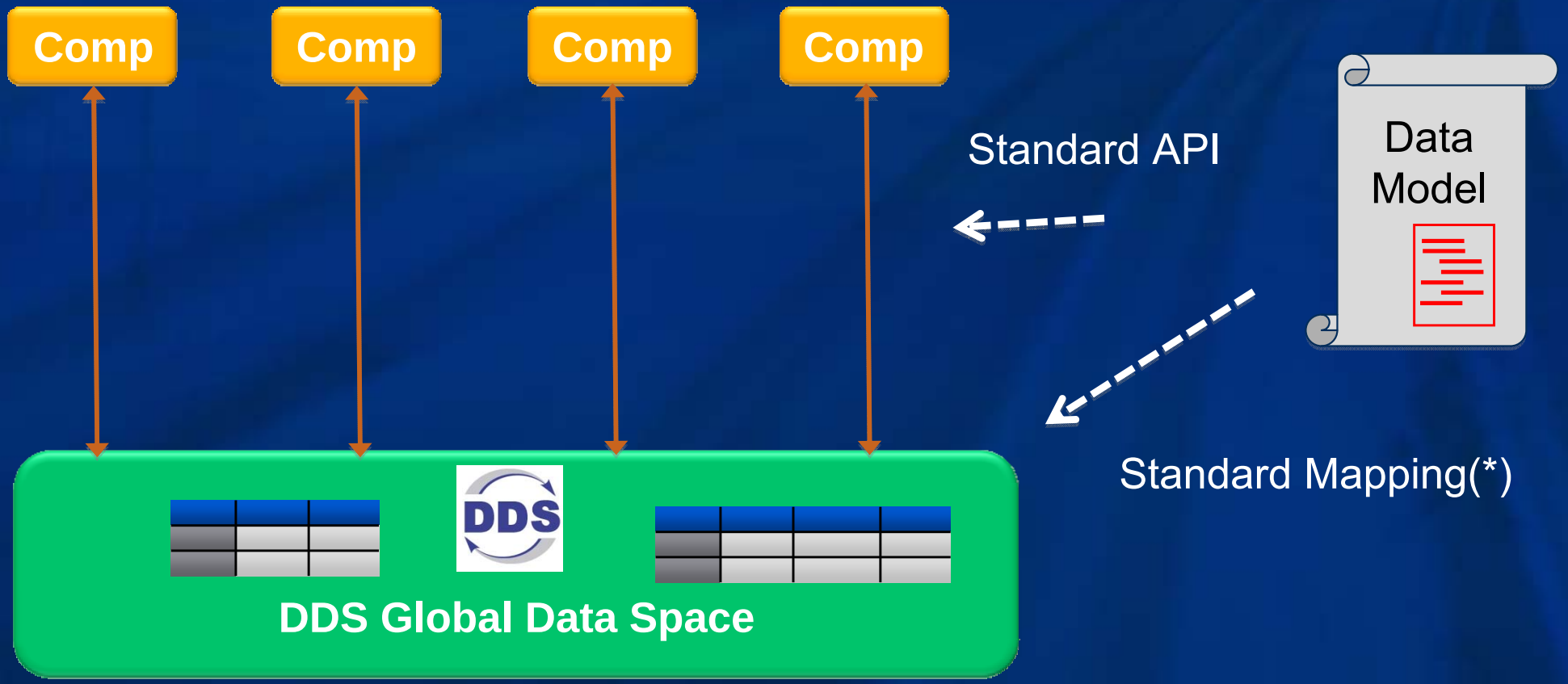
Propagate data efficiently

Publish

Dispose	New	Update	New
"AA123"	"DL987"	"AA123"	"AA123"
X	65.4	56.7	45.6
	32.1	89.0	78.9

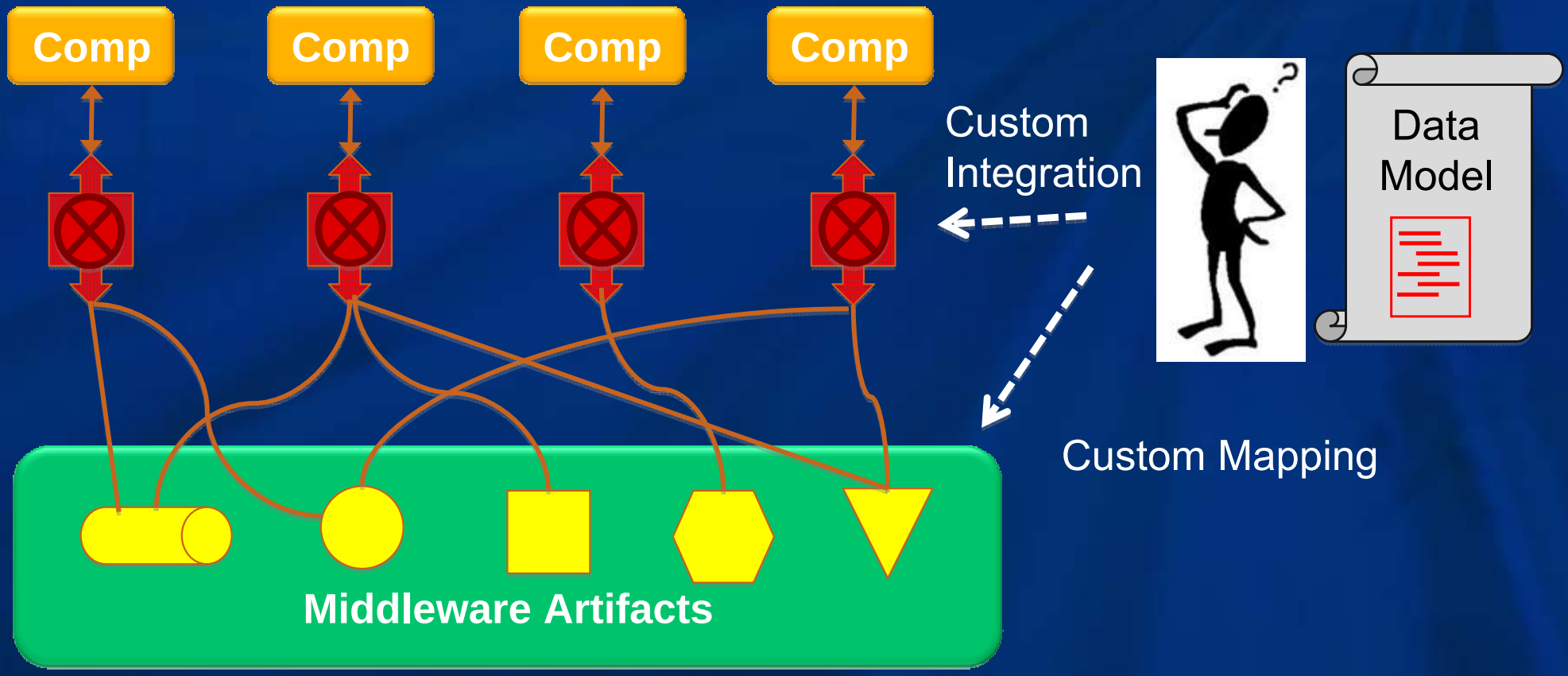
Subscribe

Realizing a Data Model using data-centric middleware technology



No custom mappings / code necessary
Direct support for data-centric actions: create, dispose, read/take

Realizing a Data Model using generic middleware technology

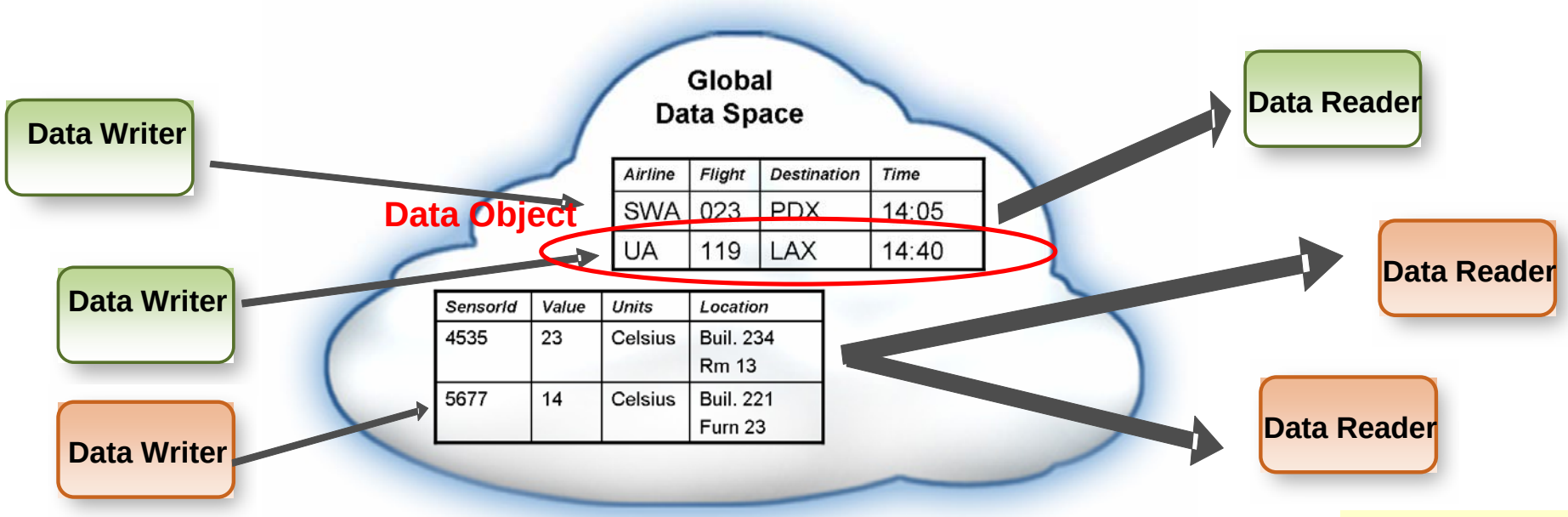


Akin to implementing an OO design on a Procedural Language: Requires mapping inheritance, encapsulation, exceptions, …

Data-Centric Model for Interoperability

"**Global Data Space**" generalizes Subject-Based Addressing

- Data objects addressed by **DomainId, Topic** and **Key**
- **Domains** provide a level of isolation
- **Topic** groups homogeneous subjects (same data-type & meaning)
- **Key** is a generalization of **subject**
  - **Key** can be any set of fields, not limited to a "x.y.z …" formatted string



example

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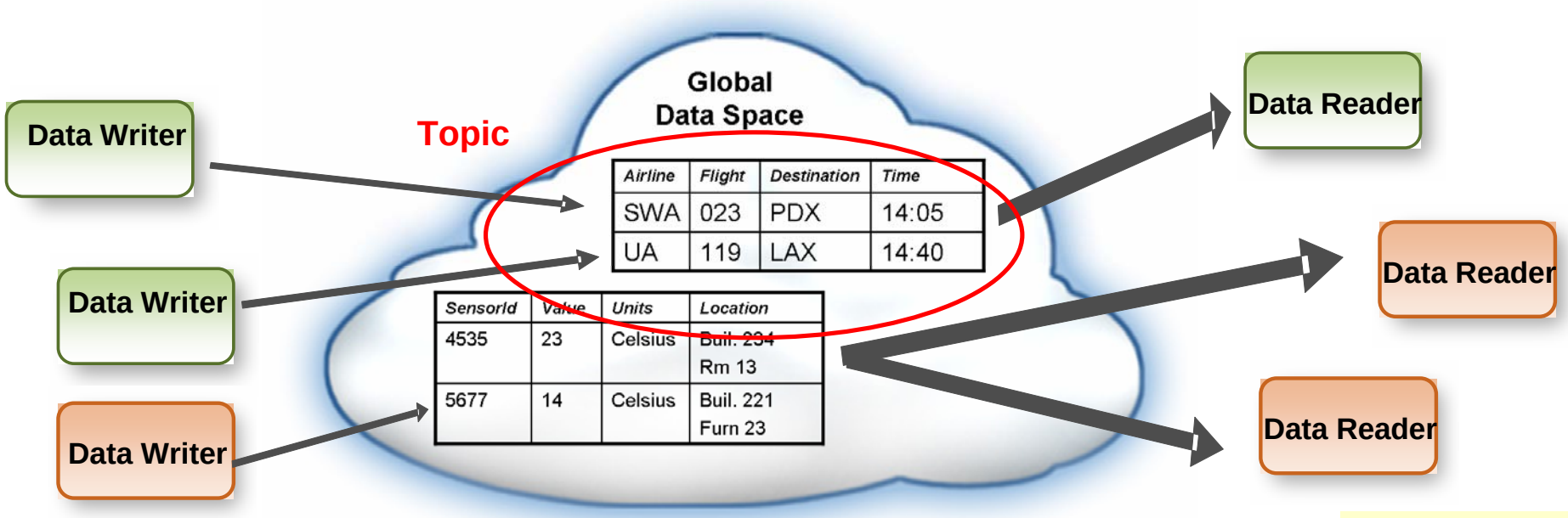

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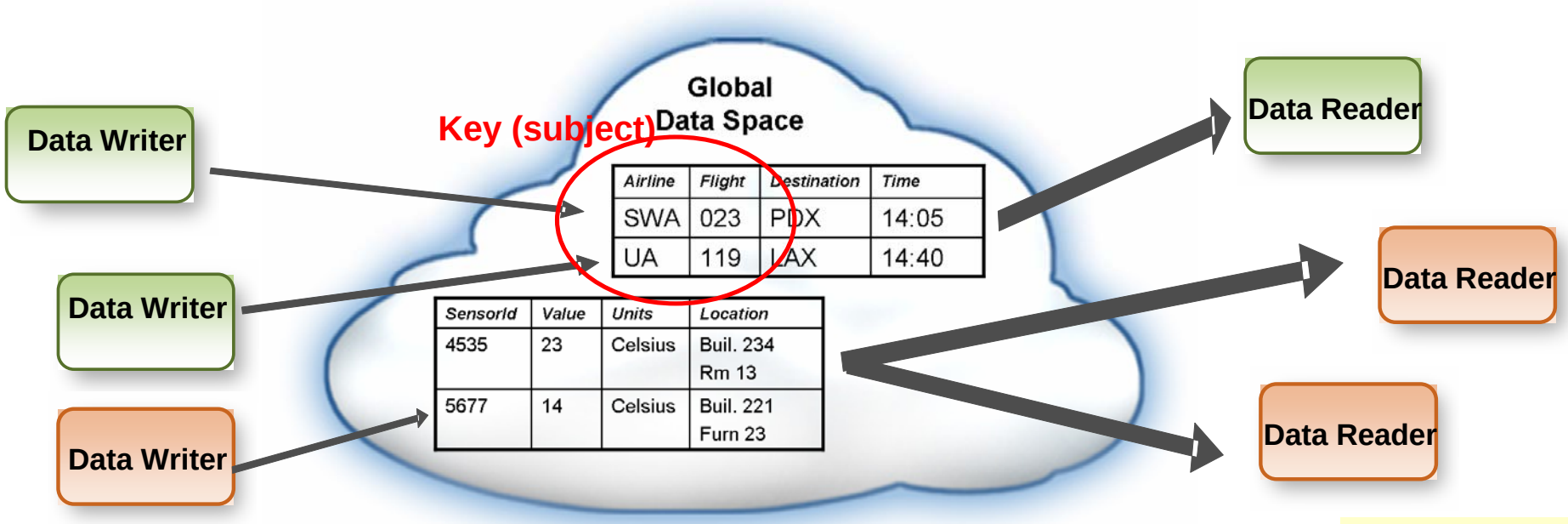


example

DDS Used for Integration of TDLs into a Common Data Space

Tactical Data Links

LINK16

LINK22

LINK11

Displays & other systems

TCP/UDP/IP

DDS

Global Data Space

"Working with RTI has been both effective and productive."

– Jim Miller, CLIP Program Manager

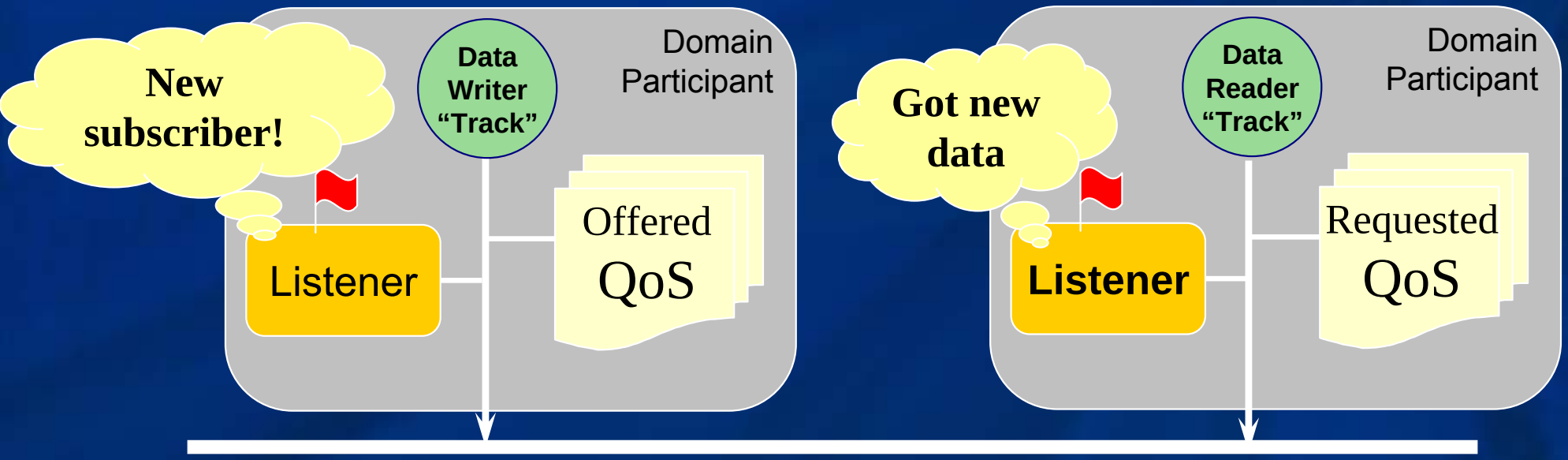
- Common Link Integration Processing (CLIP): a key U.S. Air Force and Navy joint project to build Tactical Data Link (TDL) aggregator
- RTI Services helped architect, design, develop, and test software that 'mediated' between platform systems and CLIP

DDS used for Integration of Multiple CAN busses into a Common Data Space

- The VW Driver Assistance & Integrated Safety system
  - Provides steering assistance when swerving to avoid obstacles
  - Detects when the lane narrows or passing wide loads
  - Helps drivers to safely negotiate bends

DDS middleware integrates multiple CAN bus

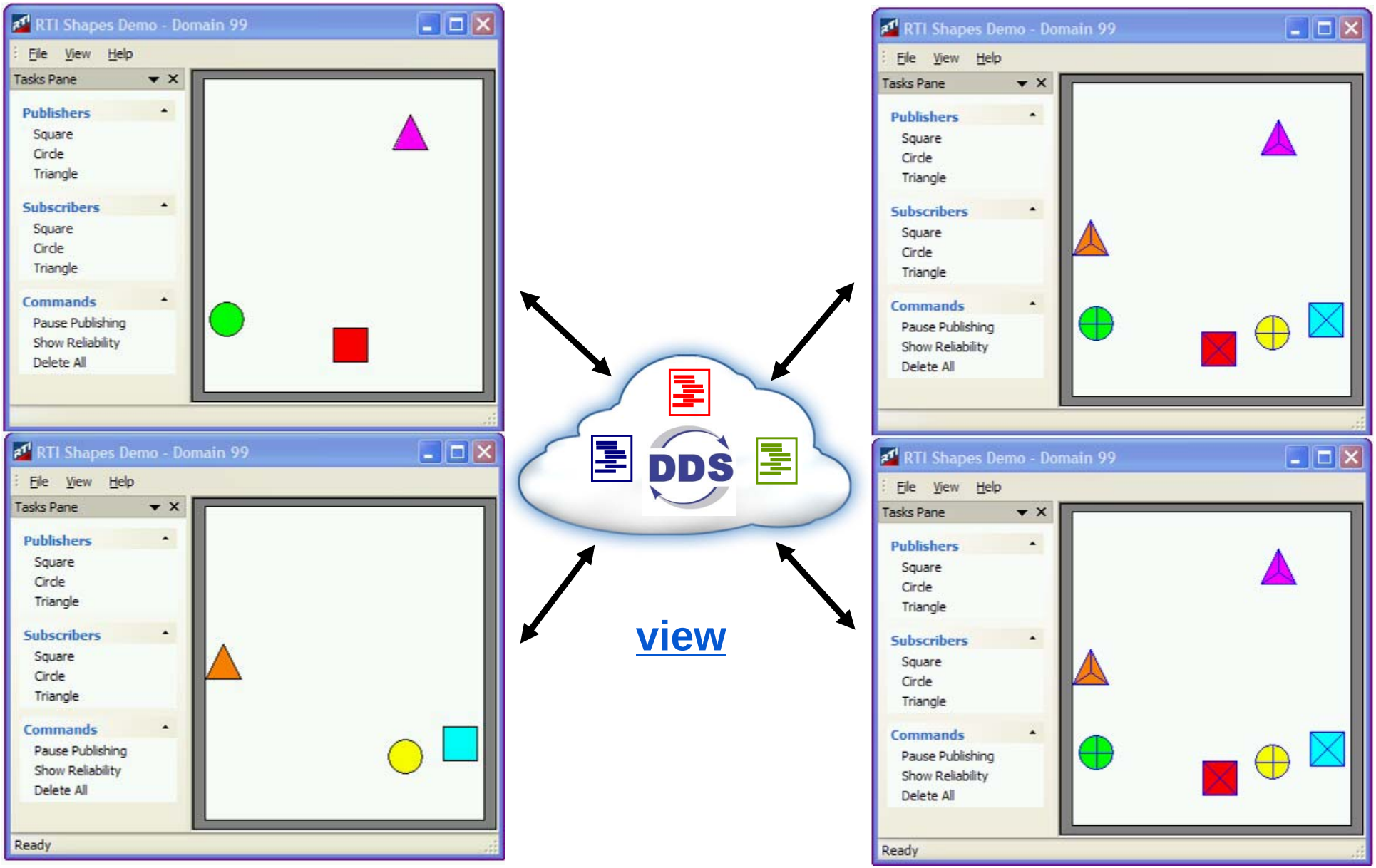
DDS QoS Aware communications model



- Typed, topic-based subscriptions ensure correct, easy communications
- QoS Contracts control information flow
  - Reliability, filtering, liveliness, resources
- Real-time notification provides deterministic behavior

Demo: Publish-Subscribe

ShapesDemo



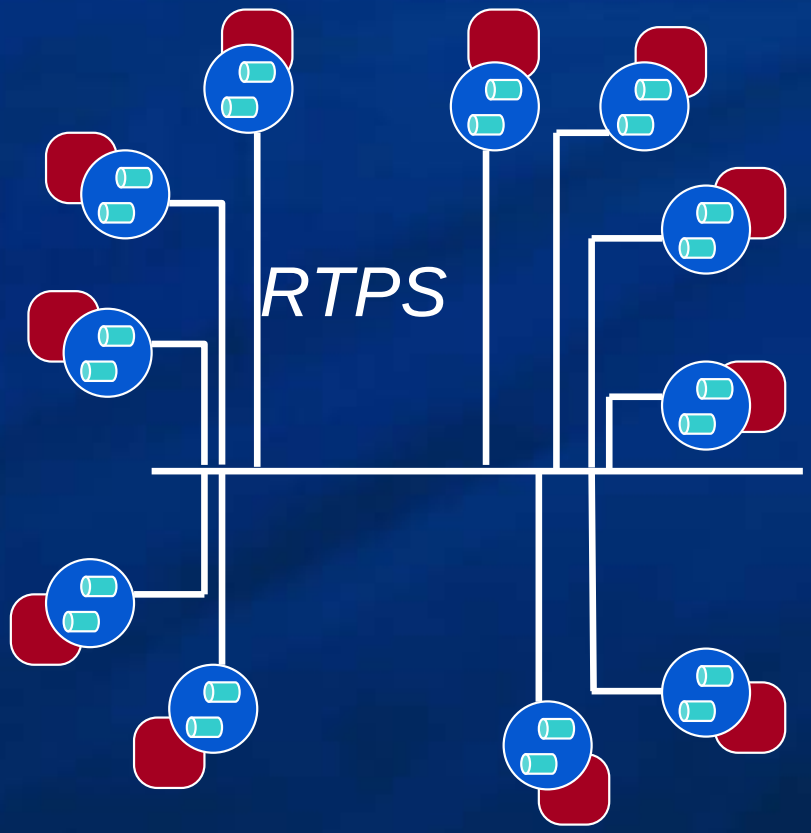
Real-Time Quality of Service (QoS)

Volatility	Infrastructure	Delivery
DURABILITY	ENTITY FACTORY	TIME BASED FILTER
HISTORY	RESOURCE LIMITS	DEADLINE
READER DATA LIFECYCLE	RELIABILITY	CONTENT FILTERS
WRITER DATA LIFECYCLE		
LIFESPAN		

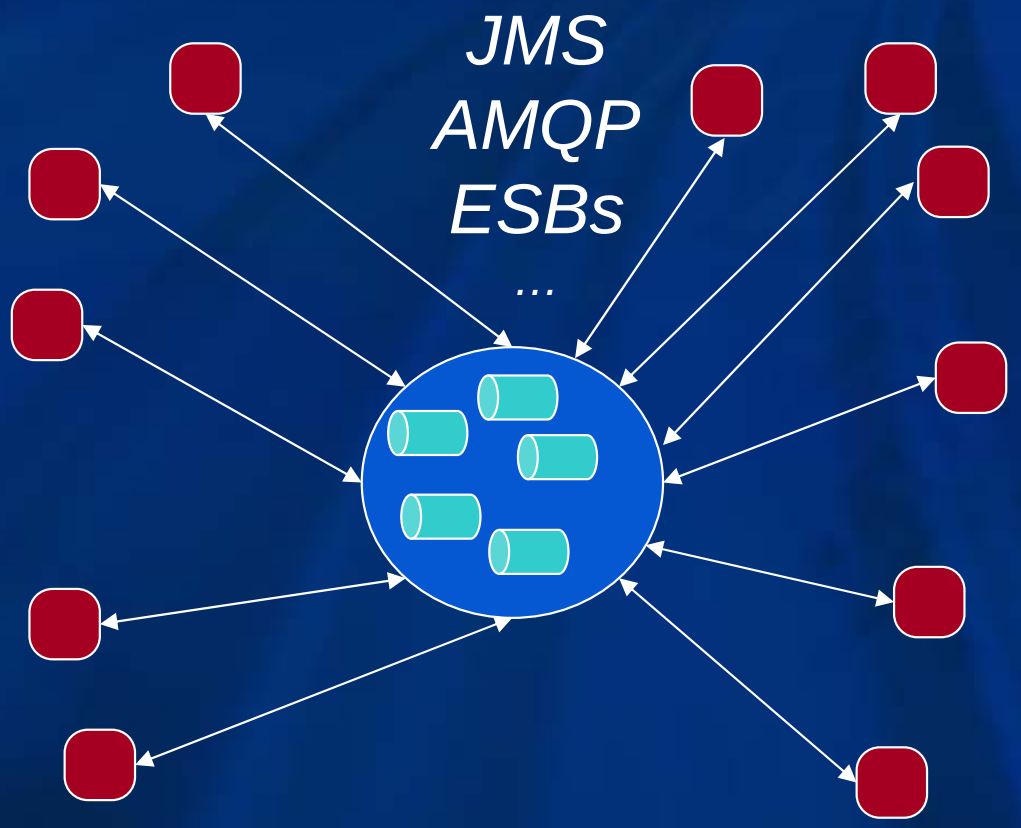
User QoS	Presentation	Redundancy	Transport
USER DATA	PARTITION	OWNERSHIP	LATENCY BUDGET
TOPIC DATA	PRESENTATION	OWNERSHIP STRENGTH	TRANSPORT PRIORITY
GROUP DATA	DESTINATION ORDER	LIVELINESS	

Realizing Performance & Scalability

DDS Approach



Others: Broker-based middleware

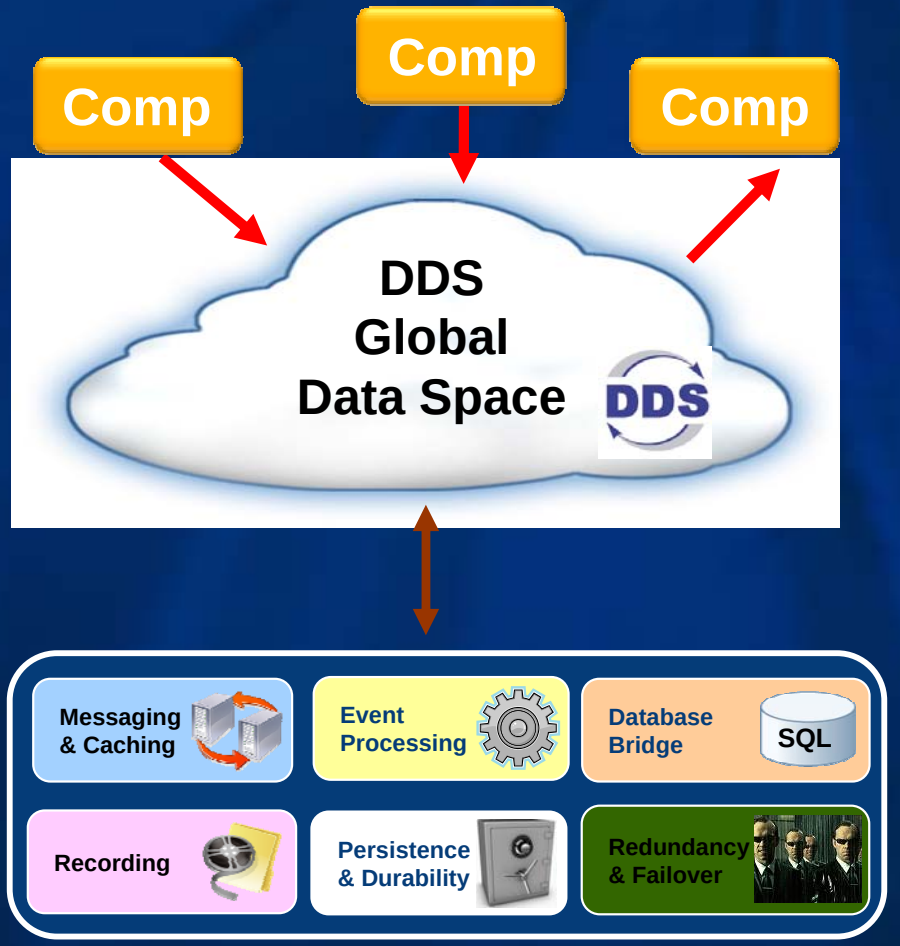


- *DDS operates peer-to-peer, without brokers*
- *DDS uses RTPS, an Advanced Multi-Session protocol supporting Reliable Multicast*

DDS builds Higher quality, Lower TCO Systems

Pre-built components address many challenging use-cases

- Presence
- Discovery
- Content-Based Delivery
- Scalable pub-sub (Rel. multicast)
- Large Data (Frag & Reassembly)
- Real-Time QoS
- Qos Monitoring
- Historical Cache
- Durable Data
- Availability
- Redundancy & Failover
- Security Guard Hooks



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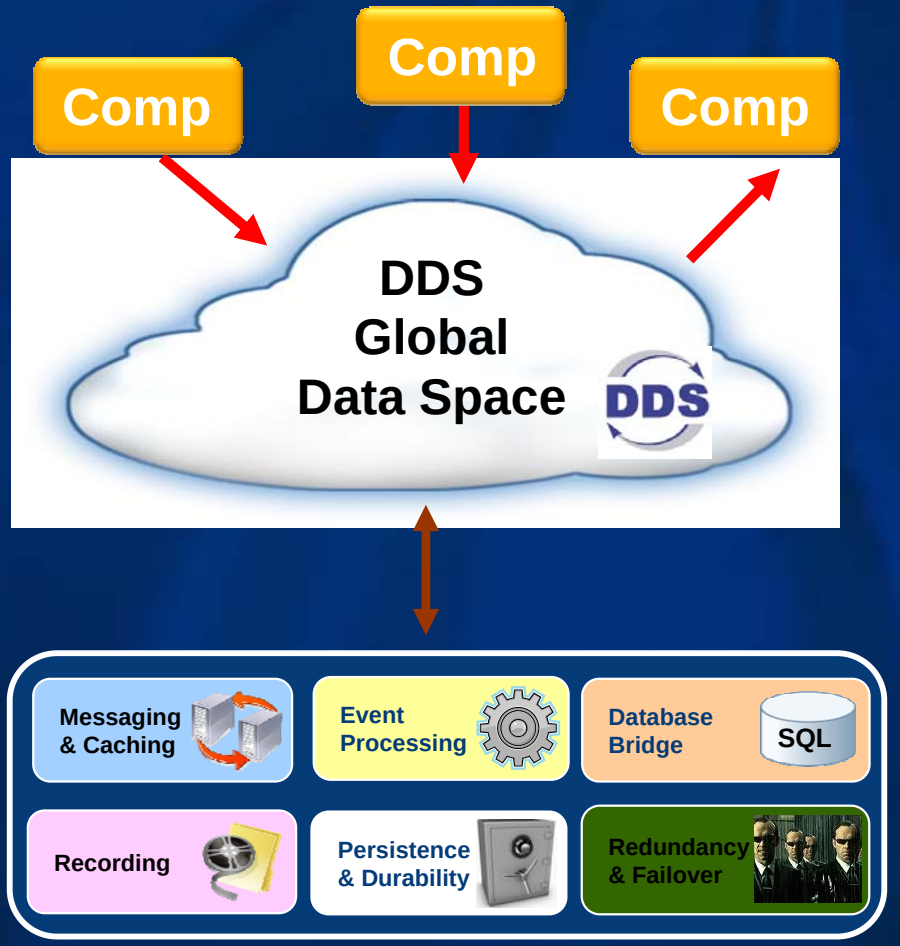

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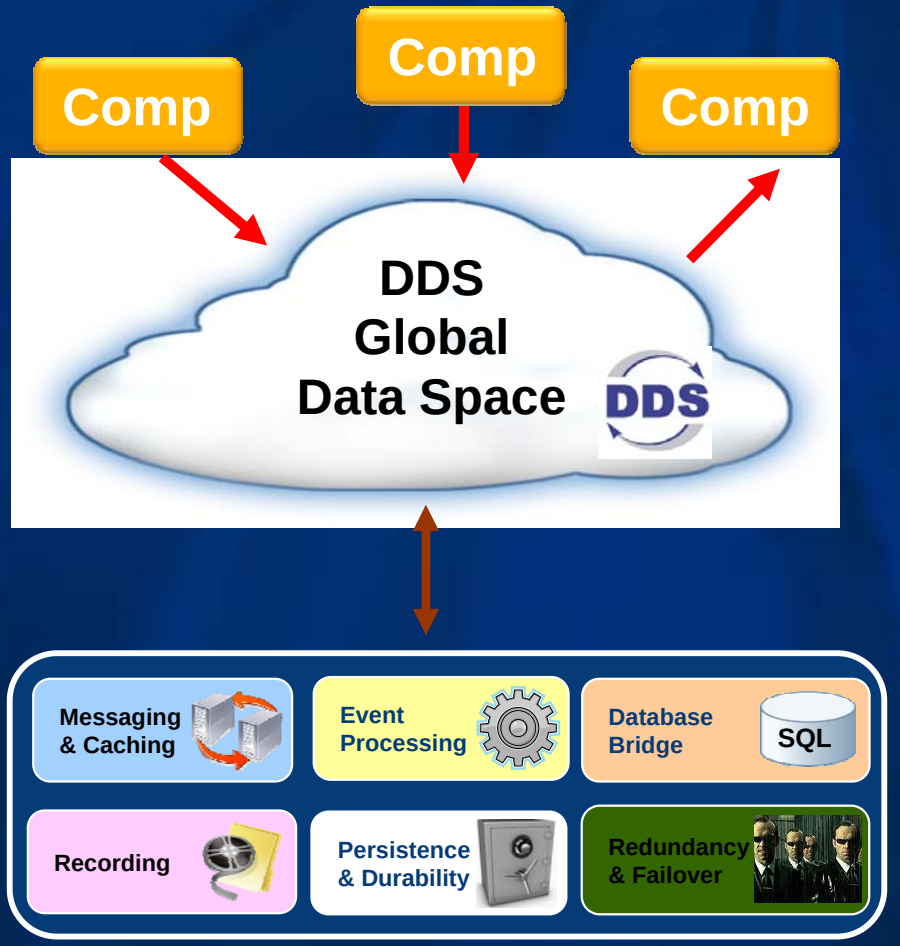

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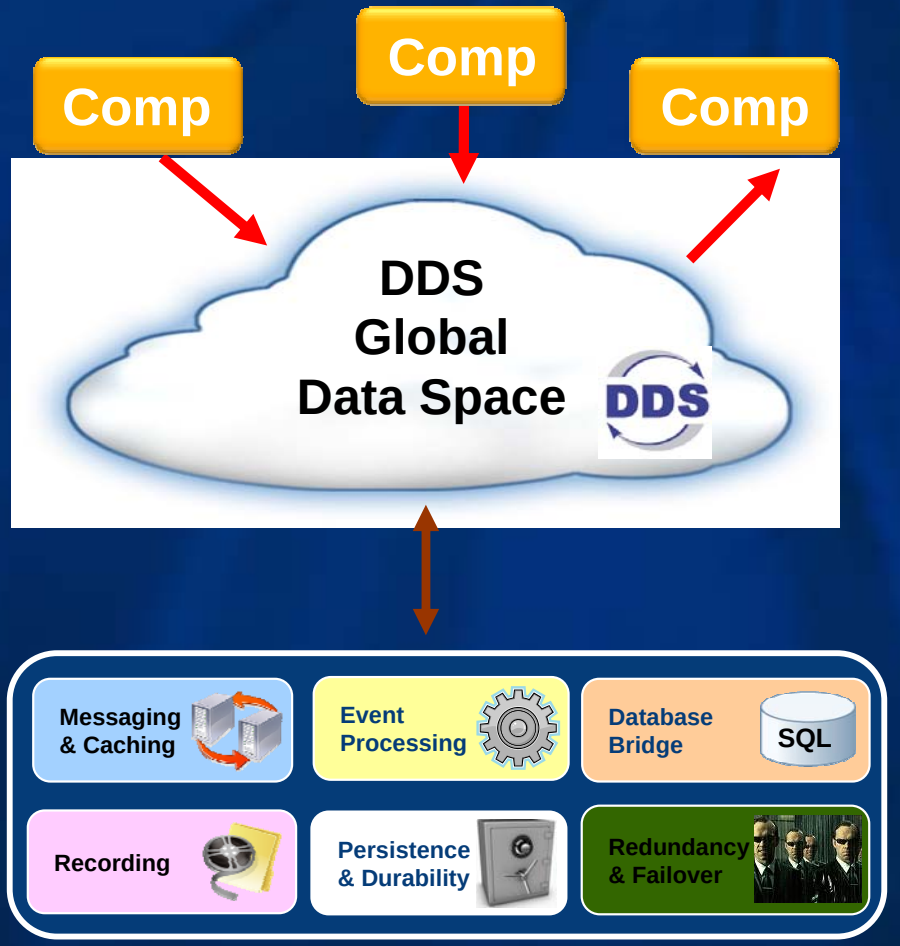
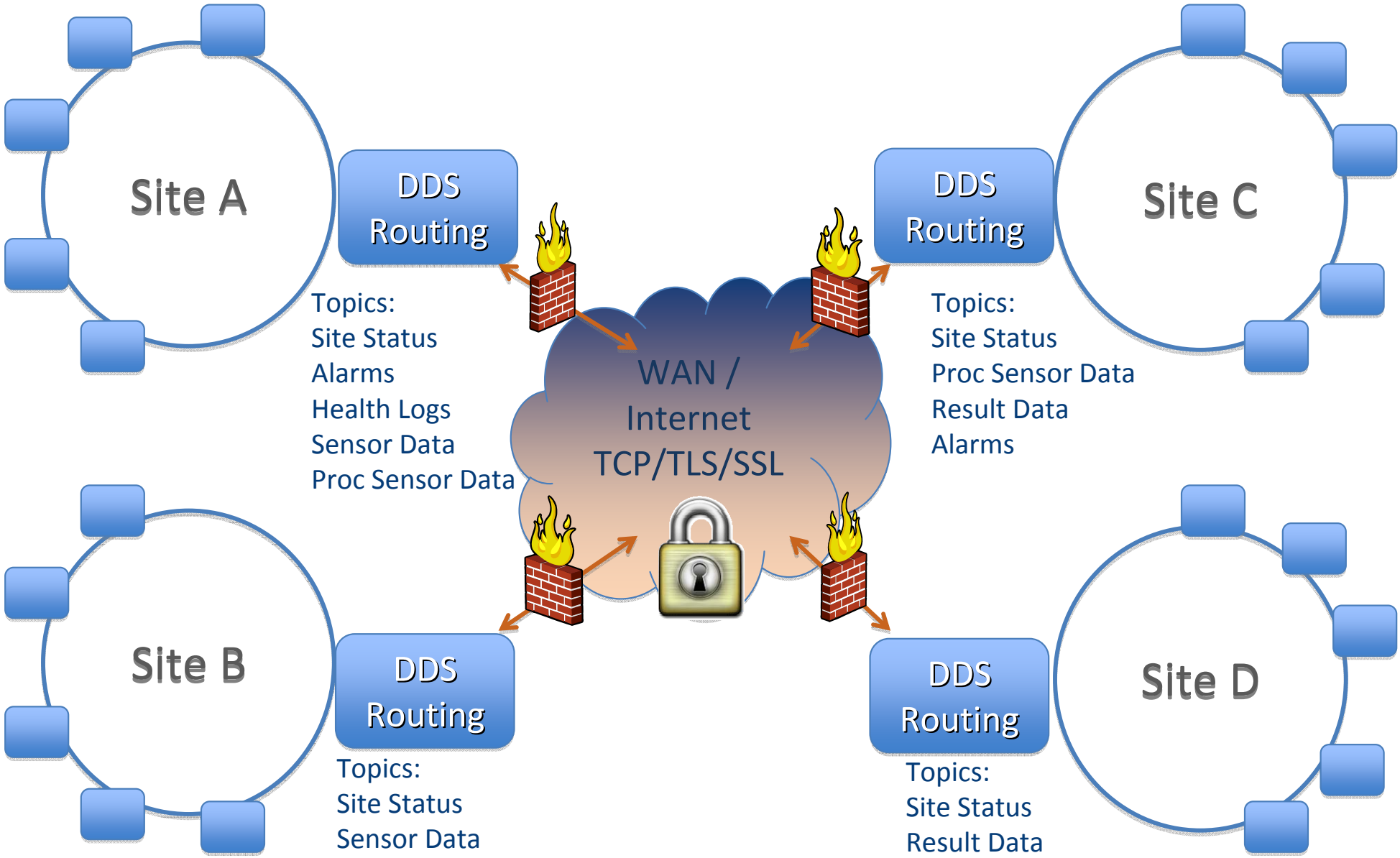


Global Scalability: LAN to WAN…
…without sacrificing Performance and Security



DDS-RTPS Protocol optimized for disadvantaged networks

- Full peer-to-peer protocol
  - No required brokers or servers
- Adaptable via Qos
  - Reliability, timeouts, message priority
- *Native multicast support*
  - *Fully uses transport multicast, if available*
  - *Handles reliability, avoids duplicates*
- *Tunable Reliability*
  - *Best Efforts, ACK Based, NACK Based*
- *Supports disconnected media*
  - *Based on UDP robust to disconnects*
- *Efficient data encapsulation*
  - *Binary CDR is 20 X better than XML/SOAP*
- *Built-in availability and durability*
  - *Historical cache, Durable & Persistent data*
  - *Failover support*

OMG WE SET THE STANDARD™

DDS Interoperability Wire Protocol adopted in 2007

DDS

Summary

- Integration of Unmanned and Manned Systems need interoperability
- Problem can be decomposed into Data-Model PIM and Platform-Specific Middleware PSM
- DDS is a family of OMG specifications that directly supports data-centric publish-subscribe communications
- DDS includes APIs and an Interoperable Wire Protocol that can handle the real-time and DIL environment
- Use of DDS results in open, interoperable systems with reduced programming, cost, and risk
- DDS can provide the right transport for the JAUS and STANAG 4586 Message Sets

Interoperability and Cost are key drivers

About RTI – Global Leader in DDS

- Market Leader
  - Over 70% DDS market share[1]
  - Largest embedded middleware vendor of all types[1]
  - 25% growth in 2010, 2009
- Standards Leader
  - Authors of DDS Standard
  - OMG Board of Directors
  - Chair DDS committee
- Real-Time Pedigree
  - Founded by Stanford researchers
  - Robotic control and real-time tools history
- Maturity
  - 12+ years of commercial availability
  - Diverse industries: defense, finance, medical, industrial, power generation, communications
  - 400+ commercial customers, 100+ research projects
  - 300,000+ licensed copies
  - U.S. DoD Technology Readiness Level (TRL) 9

[1]Embedded Market Forecasters (EMF) and Venture Development Corporation (VDC)

Thank You