UCS UAS Control Segment

The Data Distribution Service

Reducing Cost through Agile Integration

EXECUTIVE SUMMARY 2011

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Executive Summary

This briefing provides an overview of the Data Distribution Service (DDS), an important networking middleware standard. This package will describe DDS in largely non-technical terms by illustrating its use and benefits across many types of programs of interest to the US Department of Defense (DoD).

DDS is widely deployed in some of the nation's most mission-critical systems. DDS is the backbone of the Navy's Open Architecture initiative, integrating shipboard subsystems and weapons on most all new ships (LPD, LCS, DDG, SSDS on CVG).[1] It powers major Army programs under development like JBC-P (Blue Force Tracker/FBCB2 upgrade). It also forms the advanced architectures for many new air systems, manned and unmanned. All major US prime system integrators and most US defense research laboratories are users. It also has growing footprint in commercial telecommunications, train, automotive, medical, science and financial applications. There are over 300,000 commercial licenses running on or designed into well over $500 billion worth of equipment.

These hundreds of commercial and government programs adopted DDS for the same purpose: to open their architectural designs, thus lowering system integration and deployment costs. DDS uniquely enables building large real-time systems from simpler, reusable, interchangeable subsystems. It changes the business model from single-vendor "stovepipes" to a much more competitive network-centric architecture consisting of plug-in modules. By exposing subsystem-level interfaces and eliminating supplier lock-in, DDS reduces costs across the full life cycle, including systems integration, maintenance and upgrades.

[1] Please see pages 14-15 for details.

DDS is an open standard managed by one of the world's largest and most successful standards bodies, the Object Management Group (OMG). There are now 10 implementations of the DDS standard; six vendors offer commercial versions in a robust and competitive market.

DDS fundamentally makes development more agile. It lets system integrators deliver vital technology to the front lines faster and more reliably. It is proven to improve on-time and on-cost delivery. DDS is an established, pervasive and valuable standard that will serve commercial and DoD applications for years to come.

DDS cost control benefits

- Exposed interface design process eliminates proprietary lock-in
- Plug-and-play architecture enables multi-source procurements and multi-site development
- Automatic discovery of new applications simplifies administration and maintenance
- Standard Application Programming Interface (API) prevents middleware vendor lock-in
- Standard network wire protocol ensures interoperability

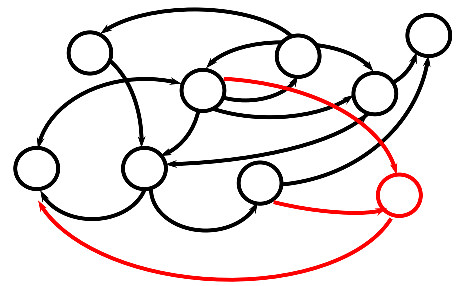
DDS technical benefits

- Real-time design delivers unprecedented performance
- Scalable, flexible architecture integrates the tactical edge to enterprise SOA
- Full redundancy supports non-stop reliability
- Quality of Service contracts enable open, modular integration
- Tools streamline test and evaluation

1. DDS Agile Integration Reduces Cost

Traditional Point-to-Point Integration Is Unaffordable

Network-centric "Systems of Systems" (SoS) provide a fundamentally better defense capability by improving speed of command and situational awareness. However, SoS also drive growth in complexity. If interactions between components are not somehow controlled, complexity grows exponentially.

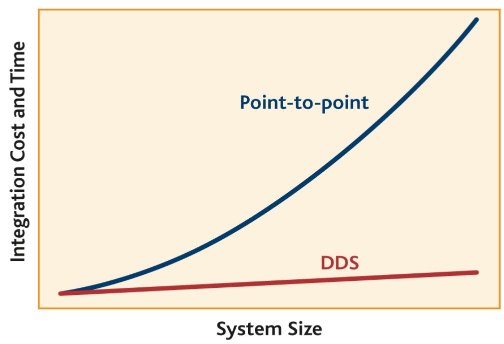


Traditional point-to-point integration causes exponential growth in complexity over time. Adding or changing one component has a cascading effect on the rest of the overall program.

Traditional Program and Technical Management uses "point to point" integration; each interaction is considered separately. For a small system, this is manageable. However, as systems grow, each new component may have many interactions. The total number of interactions is hard to control. Understanding all those interactions is difficult, especially across various suppliers.

Integration complexity also drives risk. Each individual element interaction introduces a dependency. Point-to-point integration offers no explicit way to understand these dependencies. Unforeseen behaviors and schedule slips result. While all issues appear to be "unique" problems, they are actually caused by hidden dependencies.

The traditional way to address these issues is to buy everything from one supplier, leading to a "stovepipe" architecture. A single supplier can better understand all the dependencies and interactions. Of course, vendor lock-in results in uncontrolled costs and suboptimal component choice.



Systems integration cost increases exponentially with traditional point-to-point integration. With DDS, cost scales linearly.

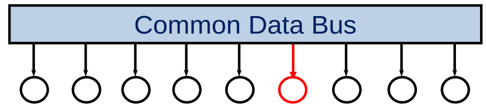
DDS Enables Modular Data-Bus Integration

Rather than using point-to-point techniques, DDS employs a *data-centric* integration model to decouple applications. Applications communicate by publishing the data they produce and subscribing to the type of data they consume. They require no knowledge of each other, only of the data they exchange.

Importantly, DDS goes beyond simple publish-subscribe. DDS middleware enables a “plug in” open architecture approach to integration. The key technology is the ability to capture all the timing, reliability, and other important interface constraints. These are called “Quality of Service” (QoS) properties.

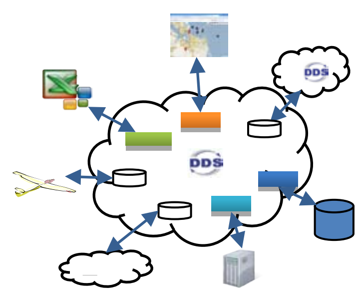
Other types of middleware support QoS. DDS is unique; its data-centric approach captures reliability, timing and system health. It also automatically discovers matching publishers and subscribers and then enforces the QoS contracts between them.

With this unique facility, DDS systems can add, modify, restart or update new modules without redesigning other interfaces. System integration is done one component at a time without impacting other components—a much simpler task. Importantly, it also enables programs to evolve and mature without constant rework. Automatic discovery eliminates most configuration control issues and supports networks that change at runtime. Even live systems can be dynamically updated. This is a qualitative and quantitative improvement over the difficult, static integration employed today.



With DDS, components can be added, upgraded, or replaced as a routine part of a program’s evolution and maturation. Integration is much simpler.

DDS *brings the agile integration benefits of a Service Oriented Architecture (SOA)* to real-time systems. DDS integrators can build large systems from subsystems supplied by multiple sources. DDS enables interoperability, extensibility, and component reuse. Expensive stovepipe vendor lock-in is replaced by a competitive open-architecture business model providing desired Enterprise Web Services and Enterprise Service Bus Technologies to end users.



DDS offers broad interoperability. It connects with enterprise technologies like Web Services, with other protocols, and between vendors of DDS. It fosters net-centricity and eliminates the need for custom bridging and integration solutions.

Relation to Acquisition Guidance

On September 14, 2010, Dr. Ashton Carter issued a guidance memorandum on *Better Buying Power: Guidance for Obtaining Greater Efficiency and Productivity in Defense Spending.* Using DDS directly addresses several points in this guidance. Most importantly, it drives an open architecture, thus enabling real competition between component subsystem suppliers. And, by crisply defining modular interfaces, it enables the reuse that realizes the value of acquired technical data rights. Of course, DDS also allows faster integration, and thus shorter timelines.

2. DDS Standard is Widely Adopted

The Object Management Group (OMG), one of the world's largest systems software standards organizations, adopted DDS in 2003 and finalized it in 2005. OMG manages dozens of standards. It has a long history of success, including the widely-used UML modeling language and middleware such as CORBA.

Many vendors now offer implementations of the OMG DDS specification. These implementations are available on a wide variety of computer hardware and operating systems – from large enterprise class server clusters, to ruggedized military and industrial computers, to tiny embedded and handheld devices.

In addition, several DDS vendors publically host interoperability demonstrations showing DDS communications across multiple vendors' applications on a variety of computer hardware.

Thirty-six companies voted to adopt the original specification, including BEA, Borland, Compuware, Ericsson, Fujitsu, IBM, Lockheed Martin, MITRE, Mercury Computer Systems, Objective Interface Systems, Oracle, Rockwell Collins, Real-Time Innovations (RTI), THALES, PrismTech, and Nokia.

There are 10 implementations of DDS; 6 are shipping commercial or supported open source products. Some of the companies currently offering DDS implementations include:

- RTI (comprehensive product, tools, services)
- PrismTech (open source and commercial products)
- Twin Oaks Computing (small footprint DDS)
- Object Computing Incorporated (open source based on ACE/TAO)
- Boeing SOSCOE (DDS derivative)
- Gallium Visual Systems
- IBM (JMS API with DDS interoperable wire protocol)
- MilSOFT
- OCERA ORTE (DDS interoperable wire protocol)

The DDS specification fulfills an obvious need for an open integration standard that meets the technical requirements of real-time and highly reactive systems. DDS has already had a huge impact in military and financial systems, and based on my more than 20 years in the standards community and as Chairman and CEO of the Object Management Group (OMG), it is clear that DDS has the key ingredients necessary for long-term success. There already is a vibrant commercial marketplace including a highly competitive industry; there is also an active community of government, industry and academic participants using the OMG to clarify, improve and update the DDS standard, ensuring its viability for years to come. There also is an expanding base of DDS customers for whom DDS solves both the technical network interoperability and programmatic software reuse problems in a cost-effective manner.

Dr. Richard Mark Soley
Chairman and Chief Executive Officer
Object Management Group (OMG)

DDS Mandates and Guidance

Representative guidance

DDS has been mandated for use across US DoD since 2005. The US Navy was an early advocate and adopter of DDS through its Open Architecture initiatives. Since that time, DDS has been included in the technical architecture and acquisition guidance documentation of other joint and service programs. These include:

- The DoD Information Technology Standards Registry (DISR) / Defense Information Systems Agency's (DISA) central repository of current IT standards mandated for use across DoD.
- DISA / USAF / SPAWAR PEO C4I Net-Centric Enterprise Solutions for Interoperability (NESI)
- OSD / PM UAS UCSWG Core Architecture Profile API Standards (CAPIS)
- Navy (PEO IWS) Open Architecture Computing Environment (OACE)
- Navy (PEO IWS) Objective Architecture ADD
- Surface Navy Combat Systems Software Product Line Architecture Description Document (ADD) v1.0 31 July 2009
- Defense Acquisition Guide (DAG) https://dag.dau.mil
- DAU Open Architecture https://acc.dau.mil/oa
- UK MOD Generic Vehicle Architecture (GVA)
- EUROCONTROL ED-133 Flight Object Interoperability
- ATLANTIDA Consortium (34 organizations designing air traffic management for Europe)

Evolving standard architectures

Many other groups are in the process of developing DDS-related guidance. These efforts include:

- UCS (UAS Control Segment): Unmanned vehicles
- FACE: Future Airborne Capabilities Environment
- FAA: US Air traffic control*
- RJSPO: Robotic Systems Joint Program Office*
- NASPI: North American Synchrophasor Initiative*
- JAUS: Robotics control*
- NATO Research and Technology Organisation (RTO) IST-090
- Internal platform projects at Boeing and Northrop Grumman

*These efforts are in early stages.

Web resources for more information

The official DDS web portal is at:
http://www.omg.org/dds/

The DDS Standard is at:
http://www.omg.org/spec/DDS/1.2/

The DDS wire protocol specification is at:
http://www.omg.org/spec/DDS-RTPS/2.1/

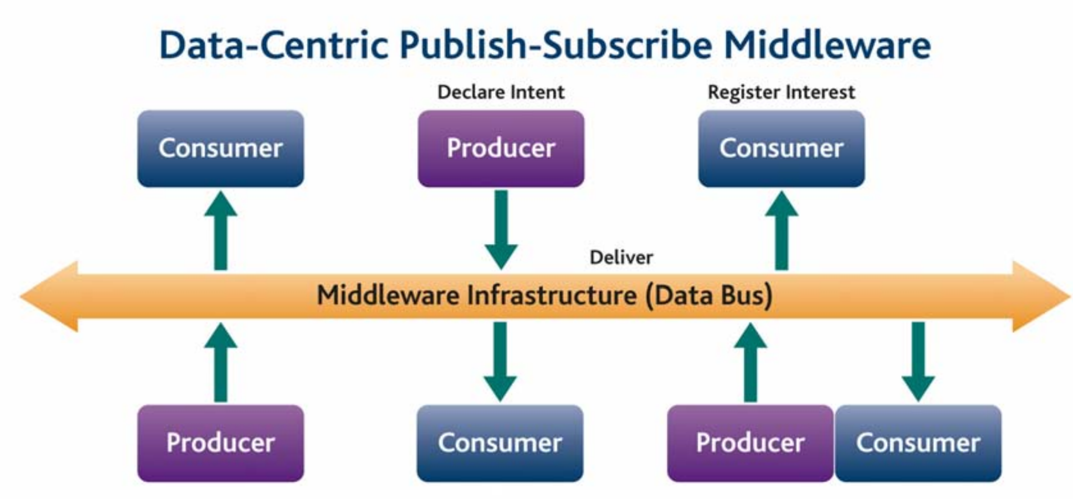
3. DDS Open Standard Drives Competition

DDS defines a data-centric publish-subscribe architecture for connecting information providers with information consumers. DDS standardizes two major interfaces: the Application Programming Interface (API) and the interoperable wire-protocol.

The API standard ensures that code written for one middleware vendor's product can be easily ported to other products. It thus prevents middleware vendor lock in. This ensures a competitive market for the middleware itself.

The standard wire specification ensures that subsystem components that use one vendor's middleware will be able to work with other systems running different middleware. This allows large systems to be assembled freely from any components, from any suppliers, that use DDS. This enables a competitive market for subsystem components.

Thus, the DDS standard is truly open. It enforces openness on both middleware vendors and systems integrators. Vendors cannot hold suppliers (or the government) hostage to unreasonable license fees or policies; users can switch to a different middleware vendor. *Along with its integration power, this openness enables competitive "best of breed" subsystem competition. Government organizations that adopt DDS can drive a new acquisition business model allowing competitive selection of components from multiple sources.*



A DDS application is composed of data providers and consumers, each potentially on different computers. A data provider publishes "topics;" consumers subscribe. An application may both publish and subscribe. A typical DDS application architecture can be represented as a software "data-bus."

DDS creates a global shared data-space that greatly simplifies integration. It transmits data directly from a publisher to all its subscribers with no intermediate servers. Publishers and subscribers can join or leave easily, be anywhere, publish at any time, and subscribe to any data (with permission). Timing and flow are precisely controlled. Computer platform and language differences are automatically translated.

This design allows DDS to connect systems from "best of breed" components, driving competition.

DDS Delivers Unique Real-Time Performance

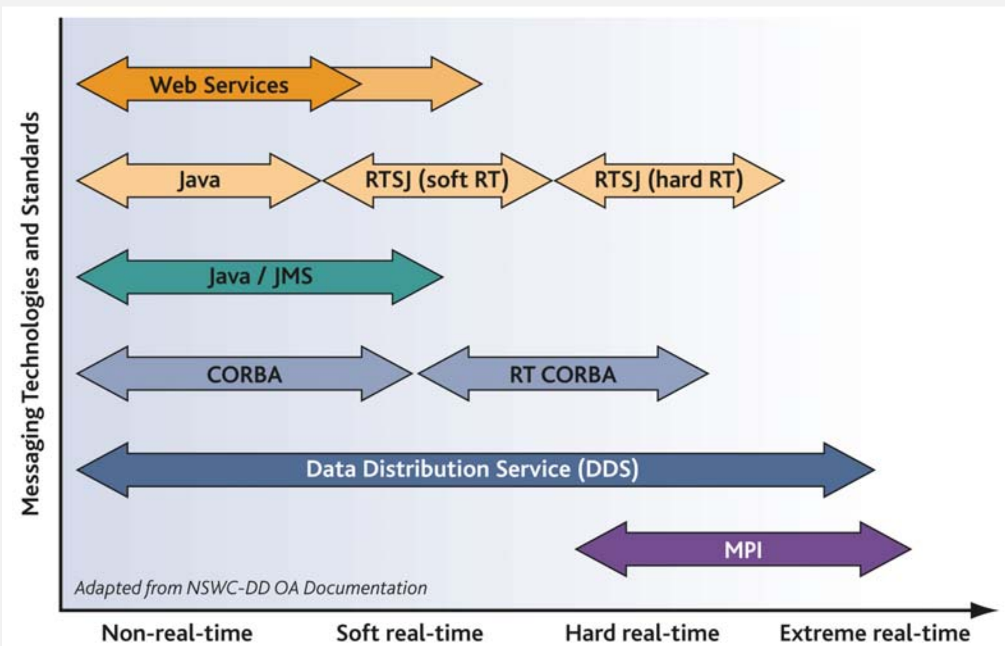
DDS is the first general-purpose middleware standard that addresses challenging real-time requirements. It handles a wide range of data flows, from extremely high performance combat management or flight control to slower command sequences.

Implementations also address other challenges of real-world environments. DDS works on many operating systems and over many transports, including lossy or unreliable links. Versions support constrained environments and strict certification, such as security (Common Criteria) and safety (RTCA/DO-178B).

Thus, the DDS standard addresses both large-scale systems integration and challenging tactical military systems. It truly connects the "edge" to the "enterprise."

DDS combines:

- Performance
- Real-time Quality of Service (QoS)
- DIL transports
- Embedded / SWaP sensitive environments
- Security- and safety-critical applications
- Highly dynamic and ad hoc systems (no servers or system administration)
- High availability (no single point of failure)

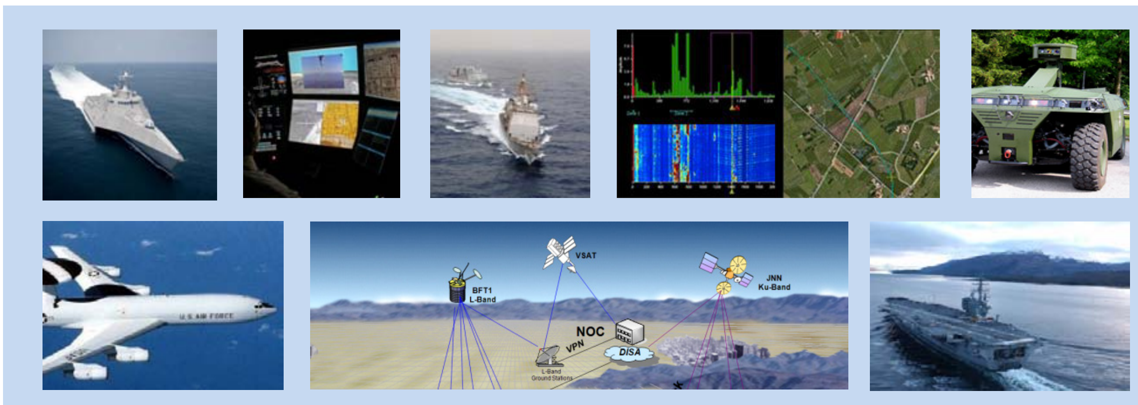


The use of QoS makes DDS especially appealing as an integration middleware in heterogeneous systems… QoS combined with the inherent real-time nature of the DDS allows DDS solutions to span the complete spectrum from Enterprise (non-real-time) to hard real-time applications.

Net-Centric Enterprise Solutions for Interoperability (NESI), a collaborative activity of the USN PEO for C4I and Space, the USAF Electronic Systems Center, and the Defense Information Systems Agency. [***http://nesipublic.spawar.navy.mil/***](http://nesipublic.spawar.navy.mil/)

Appendix A: Military DDS Use Examples

Hundreds of military systems use DDS as their key integration and communications backbone. Applications include most Navy surface programs, unmanned vehicles, ground stations, sensor systems and intelligence.



Military Applications

1. Army JBC-P (Blue Force Tracker)
2. Aegis Open Architecture
3. Ship Self Defense System (SSDS)
4. Littoral Combat Ship (LCS)
5. DDG 1000 Destroyer
6. Landing Platform Dock (LPD)
7. General Atomics Ground Control Station
8. AWACS
9. B-1B
10. Common Link Integration Processing (CLIP)
11. BASE TEN RoboScout
12. Plath Communications Intelligence
13. UK MoD Generic Vehicle Architecture
14. Wind River

1. Army JBC-P (Blue Force Tracker)

The JBC-P system illustrates the dramatic cost savings and efficiency provided by DDS. Compared to the legacy middleware used in each Network Operations Center (NOC), DDS reduced development time from eight years to one year, provides at least 25x higher performance, and requires less than one-fifth the hardware.

These savings are multiplied across five NOCs: three for production and two additional for development, training and backup.

Legacy Design	DDS System
Custom, proprietary implementation for the Army	Standards based, COTS and open architecture
Centralized, monolithic and tightly coupled architecture	Modular, decoupled and distributed implementation
Under development for eight years	Proof of concept implemented in under a week; full redesign on schedule for completion in 12 months
500,000 lines of source code	50,000 lines of source code, one-tenth that of the legacy system
Failed to meet design goal of 100,000 tracks: peak load is 20,000 tracks and sustainable load is about half that	Exceeds design goal: demonstrated support for 250,000 tracks, the maximum supported by the testing framework; expect more than 500,000 tracks are sustainable
Requires up to 21 servers per NOC; each server has two quad core processors, for a total of up to 168 cores per NOC	Only 80% of a single core is required for 250,000 tracks; expect 500,000 tracks can be supported on a single laptop
Suffers reliability and uptime challenges	Supports full redundancy

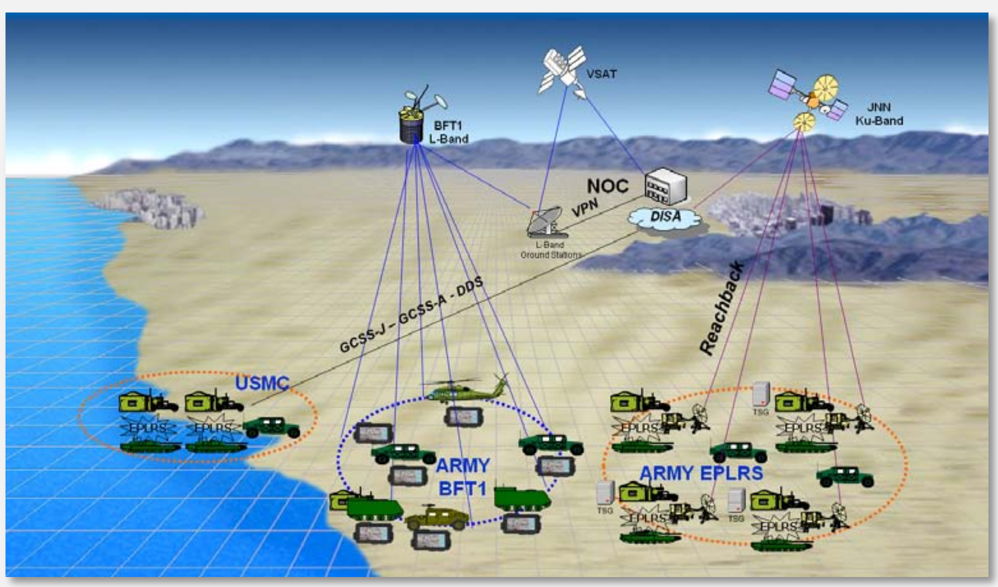
Army JBC-P (Blue Force Tracker)

The US Army Software Engineering Directorate (SED) has chosen DDS to be the communications architecture backbone for its Network Operation Center (NOC). There were numerous reasons why we chose DDS. Here are just a few:

1. *Provides a true broker-less solution - No single point of failure.*
2. *DDS provides true Auto-Discovery of publishers and subscribers. No need to statically set IP addresses of nodes within the NOC for the purpose of message routing. Functional applications can be placed where compute resources are underutilized.*
3. *DDS provides several mechanisms for "filtering" data on sending and receiving. Subscribers determine what messages they want to receive based upon the filter they define. Publishers transmit messages based upon Subscriber side filters.*
4. *Provides intra-node communications through shared memory. Very fast and efficient use of memory resources.*
5. *Provides inter-node communication through multicast and unicast. Developers can choose to use multicast or unicast based upon the publisher and subscriber relationships.*
6. *Extensive set of well prepared documentation.*
7. *Works "right out of the box" and works as documented.*
8. *Excellent support.*

This would not have been possible with any other known technology.

Harold D. Pirtle
NOC Technical Lead
US Army SED/BTI



2. DDS for U.S. Navy Aegis Open Architecture (AOA)

Challenge: to share time-critical and mission-critical data across a highly distributed system while maximizing future scalability and flexibility

Aegis Open Architecture (AOA) is the foundation for the modernization of the Navy's Aegis-equipped cruisers and destroyers. The open architecture approach will allow the Navy to readily incorporate software and hardware updates into its Aegis systems. This allows those systems to be maintained at the highest level of capability while employing low cost, off-the-shelf solutions.

The Aegis Weapon System, developed by Lockheed Martin, is the world's premier naval surface defense system and is the foundation for Aegis Ballistic Missile Defense, the primary component of the sea-based element of the U.S. Ballistic Missile Defense System.

The Aegis Weapon System includes the SPY-1 radar, the U.S. Navy's most advanced computer-controlled radar system. When paired with Lockheed Martin's MK-41 Vertical Launching System, it is capable of delivering missiles for every mission and threat environment in naval warfare. The Aegis Weapon System is currently deployed on 78 ships around the globe, with more than 25 additional ships planned. In addition to the U.S. Navy, Aegis is the maritime weapon system of choice for Australia, Japan, South Korea, Norway and Spain.

Lockheed Martin was seeking a solution that incorporated standards in a comprehensive data distribution framework. Real-time performance with a guaranteed response time was required.

The Navy wanted to do away with decades of old proprietary combat-system software and replace it with modern open architecture solutions. This transition could be costly, but in the long run could save billions of dollars.

The ideal solution was to have an open standards-based messaging middleware solution with the ability to insulate each subsystem from changes in adjacent subsystems.

Lockheed Martin opted to use a commercial implementation of DDS, a COTS solution that optimized development time and provided a better life cycle alternative than a custom solution.

DDS provides the communication infrastructure to coordinate Aegis subsystems, including radar, weapons, displays, and command and control. DDS provides a key advantage for Aegis; it is standards-based and extensible. This enables rapid insertion of future technology upgrades.

3. Ship Self Defense System

The Ship Self Defense System is the "last line of defense" combat management system for CVN, LHA, LPD and LSD class ships.

SSDS coordinates high-speed radars, targets defensive missiles, and directs 1000+ rounds/sec at incoming cruise missiles

SSDS is at sea now with DDS reliably delivering messages in real time.

4. Littoral Combat Ship (LCS)

DDS provides the communications and integration platform for the Littoral Combat Ship (LCS).

It 'plugs' disparate systems together, and handles legacy interfaces (UDP, RS232, TCP, etc.) in multiple languages on multiple operating systems, real-time and non-real-time data flow.

LCS uses DDS middleware for easy, large-scale integration.

5. DDG 1000 Destroyer

The Raytheon Total Shipboard Computing Environment Infrastructure (TSCEI) uses DDS for the US Navy Zumwalt DDG 1000 destroyer.

TSCEI coordinates and manages complex, diverse onboard hardware and software systems.

DDS middleware extends scalability in real time.

6. Landing Platform Dock (LPD)

The LPD-17 Ship-Wide Area Network (SWAN) connects all ship systems: machinery, damage control, steering, magnetic signature, mission control, navigation, communication.

It connects 200+ nodes. All nodes, networks, data, sensors are fully redundant.

DDS middleware provides non-stop reliability.

7. General Atomics Ground Control Station

General Atomics Aeronautical Systems (GA-ASI) will develop a next-generation, open-architecture ground control system (GCS) for its Predator and Reaper unmanned aircraft under a U.S. Air Force contract. The Block 50 Advanced Cockpit will address issues with human factors and proprietary interfaces in the existing GCS and provide for future flexibility and growth, including multi-aircraft control.

8. AWACS

AWACS is an airborne system for surveillance, command and control and battle management.

The USAF is upgrading the radar system to be open, supportable, less expensive to maintain and extend.

Open and extensible middleware reduces integration risk.

9. B-1B Tactial Upgrade

B-1B added new command, control and communications capabilities that needed to work with a legacy flight-certified control system.

B-1B needed and architecture that is open & modular for future extensions and upgrades.

DDS, since it's open and scalable, reduced integration risk. Using standards-based middleware ensured long-term supportability.

10. Air Force Common Link Integration Processing (CLIP)

The Air Force Common Link Integration Processing (CLIP) software provides a common Tactical Data Link (TDL) across multiple platforms, including the B-1B and B-52.

CLIP improves tactical communications while reducing integration and life-cycle maintenance costs. It enables the exchange of information between platforms that natively support incompatible TDLs. CLIP also provides TDL processing for platforms that do not currently have a data link.

DDS provides a network-centric interface to CLIP, easing integration of new and legacy TDLs. The interface also complies with Net-Centric Enterprise Solutions for Interoperability (NESI) guidelines, ensuring best practices for DDS use in open-architecture environments.

11. BASE TEN RoboScout

BASE TEN RoboScout is a satellite-based remote-control UGV. The ground station and vehicle integrate steering, braking, acceleration, dashboard, mapping and up to twelve video feeds.

Data Distribution Service is at the core of our capability to rapidly develop a modular and highly scalable real-time application environment.

Josef Schröttle
Head of Design & Development
BASE TEN SYSTEMS Electronics GmbH

12. Plath Communications Intelligence

PLATH Gmbh is a worldwide leader in communications intelligence.

For its next-generation Intelligence Control and Analysis System (ICAS), PLATH needed system of systems integration with a Service Oriented Architecture

DDS middleware implemented a modern SOA framework

13. UK MoD Generic Vehicle Architecture

Since 1997 the UK MOD have employed QinetiQ to lead the VSI Group, a consortium of UK based defence contractors, towards the introduction of open standards based electronic architectures for land based platforms. Through the VSI Groups activities, UK MOD aim to benefit by reducing the time, cost & associated risk through the introduction of open architecture based electronic systems.

A recent activity for this group has been to address the interface between application software and the architecture, for which we surveyed suitable technologies against UK MOD requirements. The OMG DDS family of standards were easily the most appropriate for military land vehicle application due their openness, the OMGs heritage, the commitment by the vendors to address full interoperability, and technical features of DDS. Most important of the technical features considered were the opportunity to simplify application development through adoption of the data centric nature of DDS and the low coupling achieved by using a publish and subscribe communication model.

In order to fully benefit from the use of DDS and to encourage adoption by its contractors, UK MOD has funded the construction of the UK MOD Land Data Model. This data model will encompass data type definitions, quality of service patterns and vehicle type profiles, it will allow the defence community to generate a set of products that interact over DDS based data network in a number of platforms. The Data Model has been endorsed by the VSI Group and a recommendation to the MOD for standardisation through the GVA Office has enabled the data model to undergo its initial deployment in two procurement activities.

By making the model openly available and mandating its use in future programmes UK MOD will benefit by reducing bespoke interfaces and Industry will benefit by increasing the diversity of platforms targeted by their products. Most importantly the armed services will benefit through the increase in frequency of fully integrated vehicle upgrades.

Mike Haines
Project Manager, FPPS Vehicle Technology
QinetiQ

14. Wind River

Wind River is a global leader of embedded software solutions for the aerospace and defense industry, providing mission proven platforms for the most demanding systems that require certified safety, security, reliability, and high performance. Systems developed using Wind River products have been deployed throughout numerous modern US military platforms, including mission computers, flight computers, sensor management systems, aerial refueling equipment, weapons management systems, RADAR, LIDAR, communications data links, UAV ground stations and ISR platforms.

The world's foremost publish-subscribe communications standard, Data Distribution Service (DDS), is supported by our critical communications partners, including Real-Time Innovations (RTI) and PrismTech. DDS enables system scalability that can support a spectrum of communication requirements, from singular soldier-to-soldier as well as machine-to-machine (M2M) controls to vast swarms of fixed and mobile devices that have intermittent and highly variable communications profiles.

The DDS communications standard is supported across our entire product portfolio, including VxWorks 5, VxWorks 6, VxWorks 653, VxWorks MILS, Wind River Linux, and Wind River Hypervisor platforms from multiple partners. We are seeing many new A&D designs demand this capability, especially in deployments where secure and reliable communications are critical, and scalability across a wide range of battlefield devices and systems is imperative. DDS will certainly be as pervasive as TCP/IP in future critical military systems.

Chip Downing
Wind River
A wholly owned subsidiary of Intel Corporation

Appendix B: Commercial DDS Use Examples

The DDS standard’s broad range of commercial applications includes smart vehicle control, high-speed stock trading, telecommunications, manufacturing, power generation, medical devices, mobile asset tracking, air traffic management and simulation.

Commercial Applications

1. Volkswagen Driver Assistance
2. NASA Robotics
3. CAE Flight Simulator
4. Air Traffic Control
5. Harmonic Digital On-Demand TV
6. Schneider Factory Automation
7. Grand Coulee Dam
8. Financial High-Speed Trading
9. Advanced Telescopes
10. Medical Imaging
11. Cancer Treatment

1. Volkswagen Driver Assistance

The VW Driver Assistance & Integrated Safety system provides steering assistance when swerving to avoid obstacles, detects when the lane narrows or passing wide loads, and helps drivers to safely negotiate bends.

The system includes radars, video cameras, and other sensors, tied to a strategic computer that makes decisions in real time. These high-performance nodes are connected over a high-speed Ethernet. A simple hardware device translates DDS into CAN messages, allowing the system to access---and control---all the car's systems.

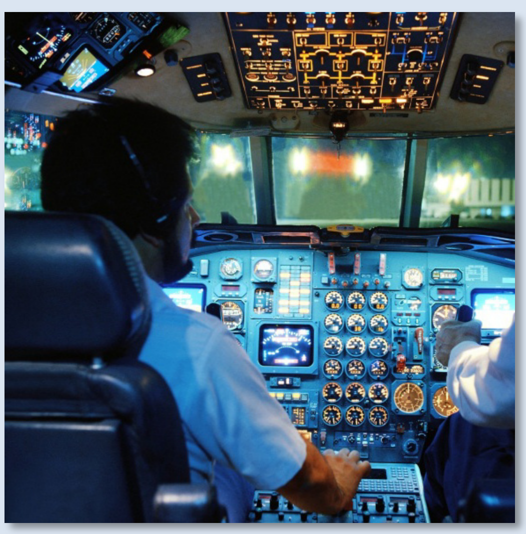
DDS middleware *bridges high speed networking to the CAN bus* to deliver a high-performance soon-to-be-production environment.

2. NASA Robotics

Getting four complex robots with very different designs to use a common data system was challenging. The Data Distribution Service for Real-Time Systems (DDS) standard supports very flexible service parameters. We found that we could adapt the middleware to the unique needs of each robotic system.

Terry Fong
Director, Intelligent Robotics Group
NASA Ames Research Center

3. CAE Flight Simulator



CAE, one of the world's leading providers of simulation and training, uses DDS over high-bandwidth IEEE-1394 on its Sim XXI product line.

Middleware provides transport portability and architecture interoperability

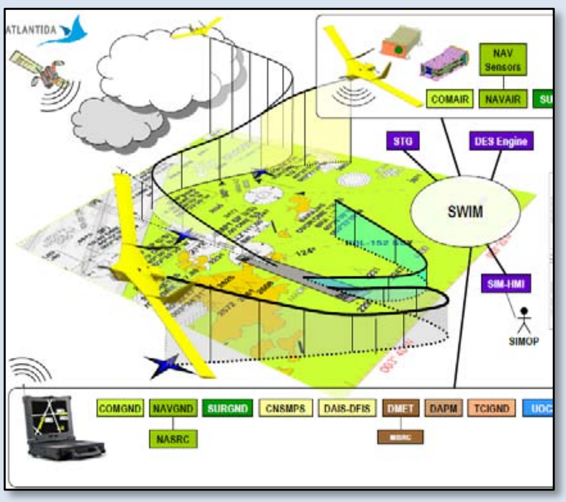
In the past we probably would have developed an expensive, proprietary system for data communications.
By using DDS, we were able to deliver a proven, reliable and cost effective solution to our customers.

Peter Jarvis
Chief Designer

4. Air Traffic Control

Reliability is critical for air traffic control – hardware or software failures mean flight delays and substantial costs.

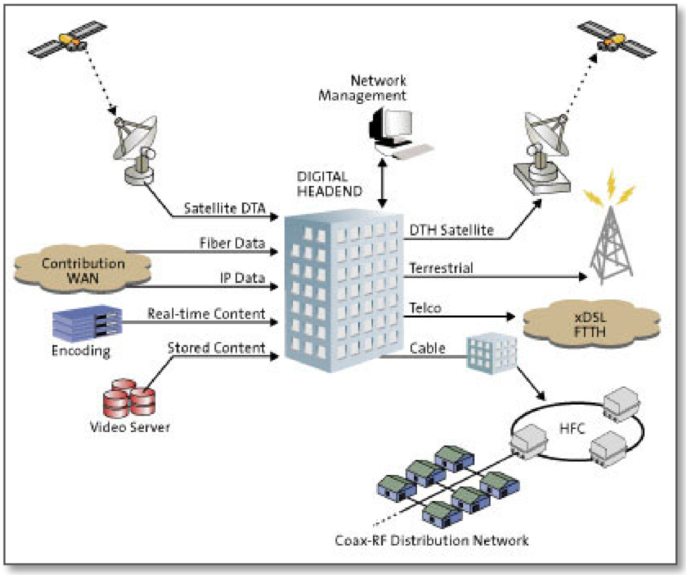
Without disrupting the data flow, DDS permits fast addition, updating and removal of system nodes.



The ATLANTIDA consortium is a group of 34 organizations designing air traffic management for Europe. They use DDS middleware to integrate civilian, military, and unmanned aircraft into a coordinated airspace.

DDS will be used in both ground stations and unmanned vehicles. DDS middleware cleanly specifies interfaces between modules. It defines the dataflow that coordinates the large, distributed team.

5. Harmonic Digital On-Demand TV



DIRECTV SATELLITE TELEVISION

COX COMMUNICATIONS

TIME WARNER CABLE

Alcatel·Lucent

comcast

Harmonic provides equipment to cable and satellite TV companies to manage, monitor and distribute video content (e.g. video on demand).

Harmonic's challenge: Data comes from many disparate sources. The content is managed centrally and distributed to a network of set-top boxes.

DDS offered a richer feature set than other solutions. It also enables scalability and future extensibility of the system.

Standard commercial off-the-shelf middleware was key to meeting tight schedule, lowering costs

Harmonic customers include the biggest names in consumer television.

6. Factory Automation

Schneider Automation is a large global discrete manufacturer of factory automation equipment.

Modern factories require up-to-the-minute data, even with limited memory and processing power. Schneider is a large-volume customer; the DDS protocol drives their PLC (Programmable Logic Controller) product line.

Schneider uses DDS middleware to control large SCADA systems.

7. Grand Coulee Dam

The Grand Coulee Dam, on the Columbia River, WA, is the largest single electricity producer in the US:

- 6.8 Giga Watts output
- 3.5x more than Hoover Dam

The Army Corps of Engineers chose DDS middleware to implement an extremely available system. DDS has no single points of failure. It supports N-way redundant software.

Data centric architecture also allows easy bring up/ bring down of boards and components. It allows the system to be maintained and react to change.

This project is a pilot program for 12 other US hydro retrofits.

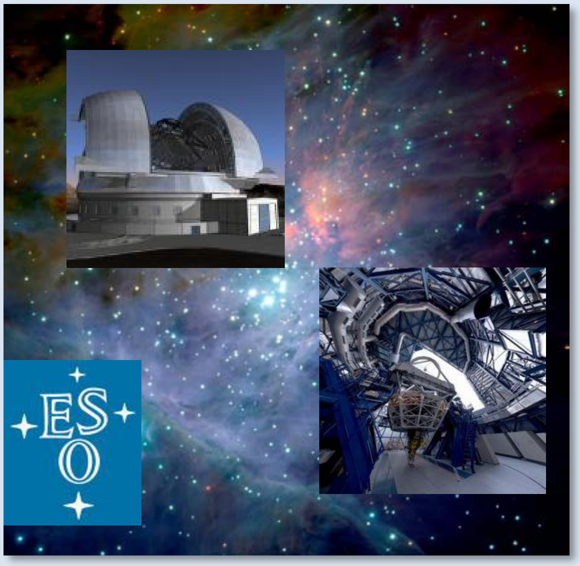
8. Financial High-Speed Trading

Some of the world's largest trading companies, including Citigroup and PIMCO, use DDS for market-data distribution and to ensure compliance with regulatory and client-specified trading rules.

DDS gathers pricing information from various exchanges, and feeds it to price-prediction engines and automated trading applications. The end-to-end latency is critical to success. Trading floors may require thousands of computers.

DDS middleware provides competitive advantage because it delivers low latency under load. DDS also eliminates intermediate servers, saving power and space in the data center.

9. Advanced Telescopes



ESO's Very Large Telescope array has four 8.2m diameter telescopes. Each can see objects four billion times fainter than can be seen with the unaided eye. ESO's objective is to gather light from a planet orbiting a distant star.

DDS coordinates hundreds of servo mirrors and scientific instruments.

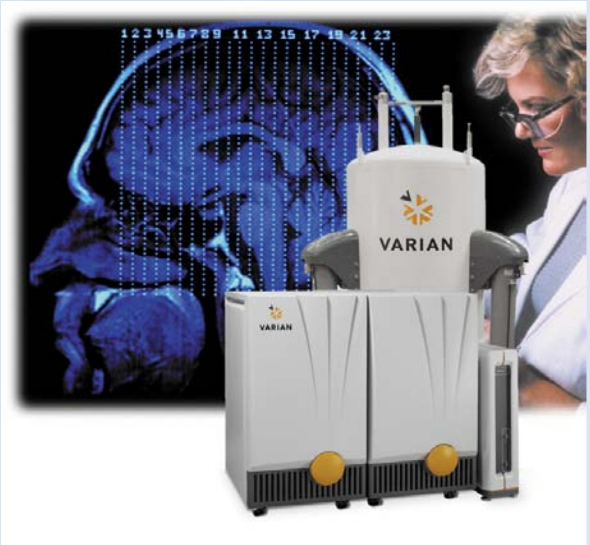
10. Medical Imaging

DDS powers Varian's entire NMR and MRI product lines.

A single MRI receiver can saturate a 1Gbit network. An instrument may have up to 16 subsystems.

DDS's flexible and powerful QoS optimizes network use.

DDS middleware handles megabytes of data.



11. Cancer Treatment

Still River's PBRT (Proton Beam Radiation Therapy) system zaps tumors with accelerated protons.

The treatment must be continuous for 30-40 days; downtime endangers treatment success.

Still River built the world's smallest, reliable, autonomous, turn-key, therapist-operated PBRT system in record time.

DDS was critical for high-performance system integration.

Appendix C: Vendors

DDS is a vibrant, competitive market. Six companies ship commercial products compliant with the DDS standard. Some of the companies currently offering DDS implementations include:

- RTI (comprehensive product, tools, services)
- PrismTech (open source and commercial products)
- Twin Oaks Computing (small footprint DDS)
- Object Computing Incorporated (open source based on ACE/TAO)
- Gallium Visual Systems
- MilSOFT
- IBM (JMS API with DDS interoperable wire protocol). Announced; not yet shipping commercially.
- Boeing SOSCOE (derivative of DDS standard)
- OCERA ORTE (DDS interoperable wire protocol)

The OMG also has a standard for a UML profile for DDS. Three UML tool vendors offer DDS profile integrations.

- Sparx Systems Enterprise Architect
- IBM Rational Rhapsody v 7.5.2
- Atego Artisan UML

This appendix contains representative literature from these companies.

RTI Data Distribution Service Platform

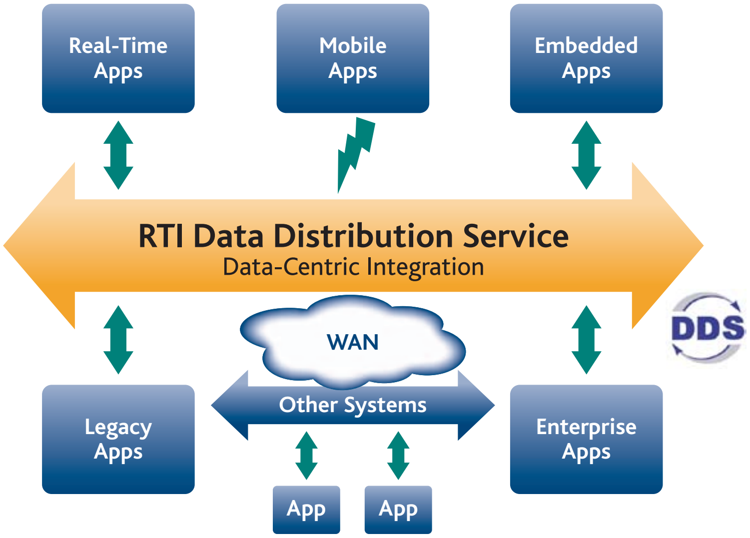
Fast and Flexible Real-Time Application Integration





RTI Data Distribution Service is an integration platform for real-time systems. Based on a serverless software bus, it allows real-time applications to communicate with each other and with enterprise and legacy applications.

RTI Data Distribution Service features a unique combination of high performance and broad standards support. It gives integrators of demanding applications an alternative to custom integration that is off-the-shelf and supports an open architecture.



BENEFITS

- Accelerates integration and technology insertion
- Increases reuse
- Reduces software lifecycle costs
- Enhances situational awareness
- Eliminates vendor dependence
- Avoids obsolescence

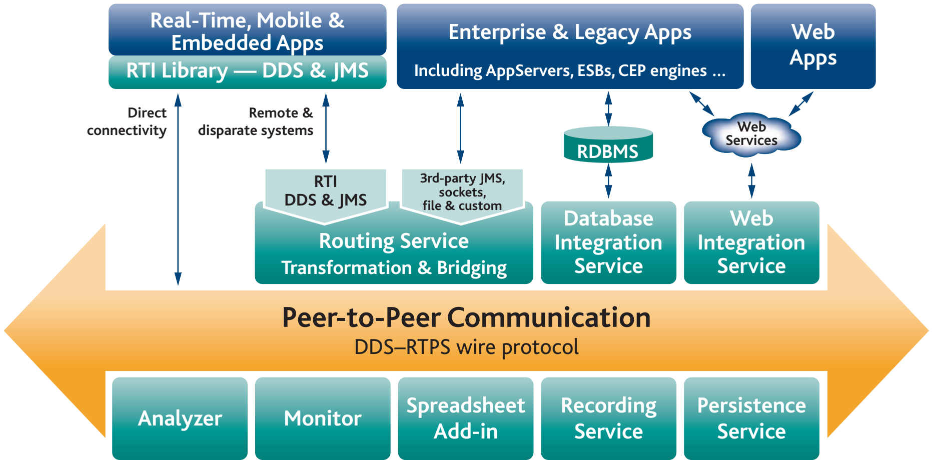
CAPABILITIES

- Delivers throughput up to millions of messages per second
- Provides consistent microsecond-order low latency
- Supports ad hoc systems without administration or servers
- Communicates reliably over unreliable and non-TCP links
- Supports security and safety standards
- Connects diverse enterprise, mobile and embedded platforms

Highlights

- Replaces complex, stovepipe and brittle point-to-point integration with loosely coupled and net-centric publish/subscribe communication
- Satisfies demanding real-time and mission-critical requirements that are well beyond the reach of traditional enterprise messaging and service bus (ESB) implementations
- Provides a peer-to-peer foundation for a Real-Time Service Oriented Architecture (RT-SOA) that is high performance, embedded and completely decentralized
- Complies with DDS and other popular standards including JMS and Web Services

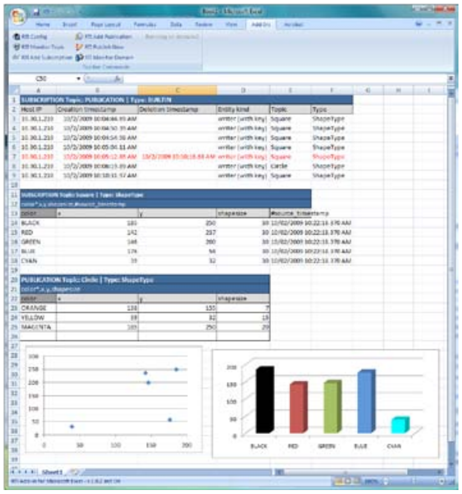
Comprehensive Integration Platform



Why DDS?

DDS is the only general-purpose messaging and integration standard designed to satisfy the Quality of Service (QoS) requirements of demanding real-time systems. It can deliver in excess of 50x the performance of non-real-time standards such as JMS, AMQP and Web services.

RTI Web Integration Service enables easy integration of real-time data into Web applications such as Google Maps.



Spreadsheets can subscribe to and publish real-time data with RTI Spreadsheet Add-in for Microsoft Excel

RTI Data Distribution Service builds on RTI's leading implementation of the Object Management Group (OMG) Data Distribution Service for Real-Time Systems (DDS) standard. It extends DDS with support for other integration standards, advanced transformation and routing capabilities, and a comprehensive set of tools and run-time services. This accelerates the integration of DDS applications with non-DDS applications and into Systems of Systems.

Broad Interface Support

Support for a wide range of standard interfaces and protocols accelerates the integration of both new and legacy applications.

Embedded DDS and JMS
Included libraries comply with the DDS and Java Message Service (JMS) standards. Applications that use RTI's libraries can communicate peer-to-peer for the highest possible performance.

RTPS interoperability
Native support for the DDS Real-Time Publish-Subscribe (RTPS) wire protocol provides direct interoperability with applications that use other RTPS compliant middleware. No bridge is required.

Web and Database integration
Web and enterprise applications can interface to real-time applications through a database or using Web services interfaces, including WSDL/SOAP and REST.

Systems of Systems Integration
RTI Routing Service provides on-the-fly data transformation and cross-network routing to support the integration of disparate and geographically dispersed systems. It can interface to multiple protocols using off-the-shelf or custom developed adapters, including to third-party JMS implementations and legacy data links.

Rich Run-Time Tools and Services

RTI's tools accelerate debugging and testing while easing management of deployed systems.

Analyzer
Accelerates integration and debugging by providing visibility into a running system including applications, QoS and interface definitions.

Monitor
Accelerates testing and optimization while easing management of deployed systems. Provides comprehensive insight into real-time performance and system health.

Spreadsheet Add-in
Allows use of Microsoft Excel for real-time data visualization, analysis and injection.

Recording Service
Logs high-speed real-time data for future analysis. Replays recorded data for testing and simulation.

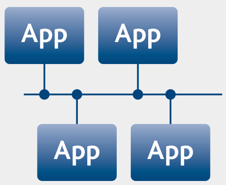
Persistence Service
Persists real-time data in-memory or to disk, making it available to late-joining subscribers even if the original publisher is no longer accessible.

Optimized for Real-Time and Embedded Systems

Peer-to-Peer Communication
An innovative, completely decentralized architecture delivers ultra low latency, high throughput and virtually unlimited scalability. Applications directly exchange data in a true peer-to-peer manner. There are no servers, message brokers or daemon processes acting as bottlenecks or single points of failure.

Architecture Comparison

RTI: Peer-to-Peer



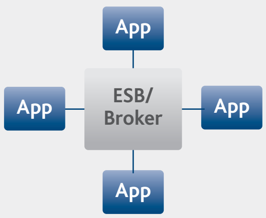
BENEFITS of RTI's decentralized architecture:

- Ultra low latency and jitter
- High throughput and capacity with virtually unlimited scalability—the network switch is the only point through which all messages pass
- Fault tolerance—no single point of failure
- Easily embedded—applications do not depend on any external software

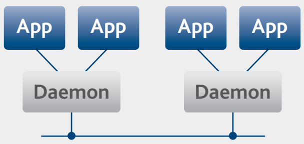
Non-RTI architectures

Other integration technologies rely on intermediate brokers, servers or daemon processes to route messages.

Server-Based



Daemon-Based and Federated



DISADVANTAGES of other architectures:

- Much higher latency and jitter—with at least one or two intermediate processes and additional message hops
- Constrained throughput—limited to the capacity of the server or daemon
- Single point of failure—either per-system or per-node

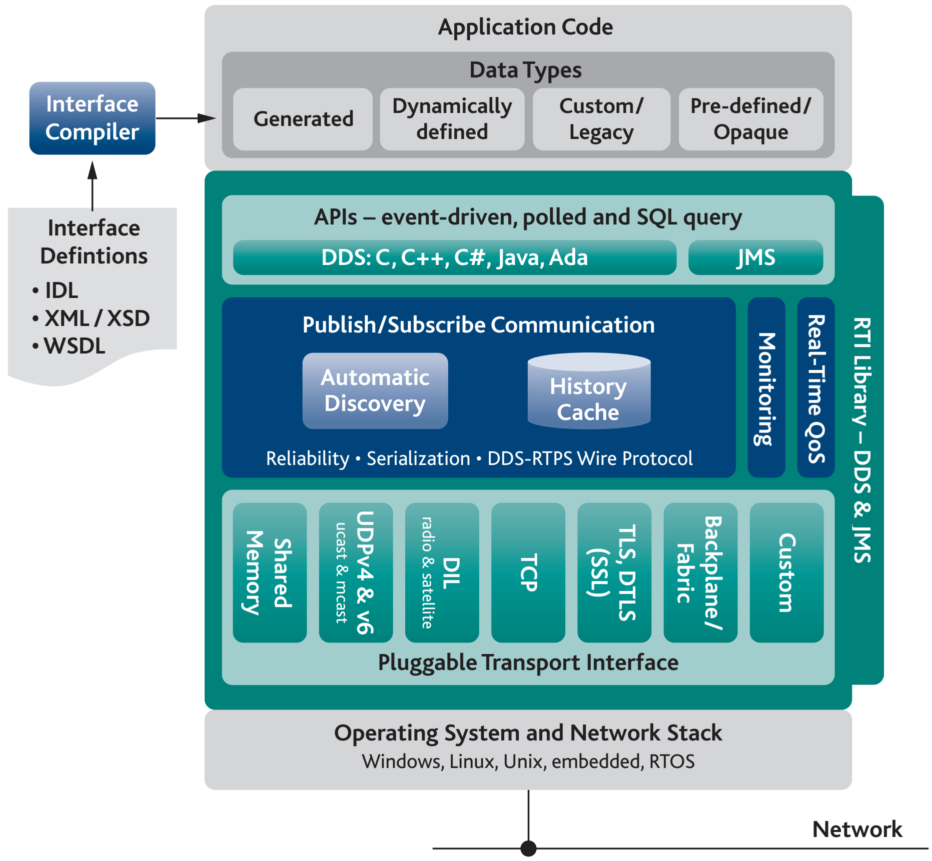
Daemon processes also complicate configuration and can preclude live updates since the configuration of all daemons must be consistent.

Plug-and-play integration
Applications are automatically discovered and connected at run-time. No system administration or directory service is required, allowing use in autonomous, dynamic and ad hoc systems.

Real-time Quality of Service (QoS)
Applications have comprehensive control over and visibility into real-time behavior, including timing, deadlines, resource utilization and system state. QoS can be specified per-topic and per-subscriber.

Integrated data cache
A built-in data cache frees developers from having to write complex data structures and search algorithms. SQL like queries provide fast and flexible data access.

Transport flexibility
Applications are independent of the underlying transport and protocol. TCP and IP are not required. RTI's reliability protocol supports Disconnected, Intermittent and Low-bandwidth (DIL) networks such as radio and satellite.



Optimized publish/subscribe
Data can be reliably multicast to multiple subscribers for extremely efficient streaming data distribution. Messages are routed and filtered by the switch, not by software.

Flexible interface specification
Integration interfaces can be specified programmatically, using a variety of standard description languages, or generated by all leading UML tools. A Compatibility Kit allows use of types generated by a CORBA IDL compiler for easy CORBA and DDS cohabitation.

Wire efficiency
The DDS-RTPS wire protocol is extremely wire efficient. Data is sent in a compact binary representation. Most metadata is only exchanged once, at discovery time.

High-performance architecture
Zero-copy interfaces and shared memory communication support High Performance Computing (HPC). Core libraries are written in C for maximum performance and efficiency. Non-Java applications do not require a Java Virtual Machine (JVM) or Application Server.

Well Suited for Mission-Critical Systems

High availability
RTI's serverless architecture has no single point of failure. Systems are self-healing when applications disconnect and reconnect. Automatic failover provides continuous availability when an application is no longer accessible.

Inherently secure architecture
Because applications directly communicate, security policies can be enforced by the operating system (OS)—such as a Mandatory Access Control (MAC) or partitioned OS. Secure transports are also supported for authentication and encryption.

High assurance
A small-footprint edition facilitates safety and security certification, including to DO-178B Level A and Common Criteria.

Proven technology
More than 300,000 copies of RTI Data Distribution have been licensed for use in over 400 unique designs. Proven in successful U.S. Department of Defense missions, it qualifies for the highest Technology Readiness Level, TRL 9.

Representative Customers

Defense
Boeing
EADS
General Dynamics
Lockheed Martin

Aegis Weapon System
Northrop Grumman
PLATH
QinetiQ
Raytheon
Saab
Samsung Thales
Ultra Electronics
U.S. Air Force
U.S. Army
U.S. Navy
U.S. Special Operations Command

Embedded and Control Systems
European Southern Observatory
Harmonic
IPC Information Systems
Nikon
Schneider Electric
Still River Systems
U.S. Army Corp of Engineers

Grand Coulee Dam SCADA System
Still River Systems
Varian

Simulation
CAE
Force Technology
U.S. Army & University of Iowa

Unmanned Systems and Robotics
Base Ten Systems
CASSIDIAN (EADS)
General Atomics

Advanced Cockpit Ground Control Station for the Predator and Reaper
Insitu
NASA

Human-Robotic Systems
Schilling Robotics

Transportation
ATLANTIDA
City of Tokyo

Highway Traffic Monitoring
Volkswagen
Wi-Tronix

Finance and Enterprise
Automated Trading Desk

Market Data Distribution
Citigroup
Paremus
PIMCO
Xuenn

STANDARD INTERFACES
- DDS – ANSI C, C++, C# (.NET), Java, Ada
- RTPS wire protocol
- JMS
- WSDL/SOAP
- REST
- SQL
- Lightweight CORBA Component Model (CCM)
- Sockets
- File
- Custom via adapter interface

OMG DDS COMPLIANCE
- DDS API 1.2
  – Minimum profile
  – Persistence profile
  – Ownership profile
  – ContentFilteredTopic & QueryCondition
- DDS Interoperability Wire Protocol (RTPS) 2.1
- Web-enabled DDS (draft)
- Extensible and Dynamic Topic Types (draft)

ADAPTERS
- Relational databases
- Microsoft Excel
- Complex Event Processing (CEP) engines
- Visualization platforms
- Application Servers and ESBs

PLATFORMS
- INTEGRITY
- Linux, SELinux and Embedded Linux
- LynxOS and LynxOS-SE
- Mac OS X
- QNX
- Unix – AIX and Solaris
- VxWorks , VxWorks 653 and VxWorks MILS
- Windows and Windows CE/Mobile

PROCESSOR FAMILIES
- x86
- ARM
- PowerPC / Cell
- SPARC

Try RTI Data Distribution Service Now!

RTI middleware is free-of-charge for evaluation and qualifying IR&D, research and University projects. Download it at: **www.rti.com/downloads**.

ABOUT RTI RTI provides high-performance integration middleware for real-time systems. RTI is the leader in the rapidly growing market for DDS compliant middleware with more than 70% market share and 10x more designs than any other supplier. A broad range of industries leverage the company's software and integration expertise, including aerospace, defense, finance, industrial control, intelligence, medical, power generation and transportation.

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TWIN OAKS COMPUTING, INC.
Practical Middleware Expertise

World Leader in Small-Footprint DDS Applications

CoreDX DDS—Small Footprint Publish Subscribe

CoreDX DDS™ is an Open-Standard High Performance Publish Subscribe Middleware Component

CoreDX DDS™ is the leading small footprint implementation of the Data Distribution Standard (DDS) that is sponsored by the Object Management Group (OMG). DDS was designed specifically to meet the performance and Quality of Service requirements of real-time, embedded, time-critical, and mission-critical applications.

CoreDX DDS™ offers a compliant implementation of the DDS Standard in a Small-Footprint product (measured in Kilobytes, not Megabytes) that is fully capable of exploiting multicore processing hardware.

The OMG DDS Open Standard specifies a Data-Centric Publish-Subscribe infrastructure and a wire protocol for Interoperability. The standards include a robust set of configurable Quality of Service policies for precise control over data communications.

CoreDX DDS™ supports BEST_EFFORT and RELIABLE communications, so it can easily be employed in wireless and other unreliable network environments. The small-footprint of CoreDX DDS™ makes it the best choice for Size Weight, and Power (SWaP) constrained applications. The multicore architecture of CoreDX DDS™ lets you exploit the processing and power benefits of modern CPU cores.

CoreDX DDS Supports Open Architecture

Integrate the CoreDX DDS™ infrastructure into your system and realize the benefits of Open Architecture: modularity, extensibility, interoperability, and scalability.

- Publishers are loosely coupled to Subscribers
- Publishers and Subscribers can be added to and removed from the system dynamically with automatic discovery
- Data Types can be pre-defined or created and discovered dynamically at run-time.
- Data is independent of the middleware implementation
- Applications are insulated from the details of the communication medium
- Developers are relieved of the burden of developing and maintaining complex communications software

Twin Oaks offers Free CoreDX DDS™ IR&D Licenses to qualified research projects and institutions.

Ordering Instructions

Get started by visiting our website and downloading the 30-day Full Featured CoreDX DDS™ Evaluation software. During the download process, you can indicate that you are interested in the University or IR&D License Program.

Start here: Download 30-Day evaluation

Twin Oaks Computing, Inc | 720-733-7906 | www.twinoakscomputing.com

CoreDX DDS Features

Interoperable Transport:
- Proven multi-vendor interoperability with the Real Time Publish Subscribe (RTPS) wire protocol

Small Footprint:
- Complete C library < 500KB

No Operating System Services Required:
- CoreDX does not install any operating system services or daemons
- Eases installation, deployment and maintenance
- Eliminates a single-point-of-failure concern

Dynamic Discovery:
- Dynamic discovery of local and remote Topics, Readers and Writers
- Multi-Vendor Interoperable
- Peer-to-Peer or centralized

Powerful Data Tools
- Filtering—content based and time based
- User Defined data types (including keys)
- Robust DDS IDL compiler for basic and constructed IDL types
- Supports Dynamic Data Types

Event Notification:
- Symmetric notification via Conditions / WaitSets
- Asymmetric notification via Listeners (callbacks)

Product Support:
- Phone / web / in-person
- Training and Professional Services available
- Flexible Licensing

Compliant with DDS v1.2 and RTPS v2.1.
Made in the U.S.A

CoreDX DDS Quality of Service Support

USER_DATA, GROUP_DATA, TOPIC_DATA	Supports user defined QoS data
DURABILITY: VOLITILE, TRANSIENT_LOCAL	Supports late-joining Readers
DEADLINE	Specifies a required data update interval
DESTINATION_ORDER	Controls ordering of data presented to Reader
ENTITY_FACTORY	Controls the ‘auto-enable’ function for created Entities
HISTORY	Configures amount of data preserved in infrastructure
LATENCY_BUDGET	Performance tuning parameter
LIVELINESS	Controls mechanism used to determine Entity liveliness
OWNERSHIP	Shared and exclusive data instance ownership
PARTITION	Establishes data partitions to segregate entities and data
READER/WRITER_DATA_LIFECYCLE	Disposition of data instances
RELIABILITY: RELIABLE, BEST_EFFORT	Tailors reliability of the data transport
RESOURCE_LIMITS	Configures limits for data resources in infrastructure
TIME_BASED_FILTER	Specifies maximum desired data update frequency
Content Filtered Topics	Tens of thousands of filter instances / second

CoreDX Specifications

Operating Systems:
- Linux 2.6
- LynxOS
- Windows
- Solaris 10
- QNX
- VxWorks

Hardware Platforms:
- X86, 32bit, 64bit
- UltraSPARC
- ARM7, ARM9
- MIPS
- PowerPC

Development Languages:
- C
- C++
- C# *
- Java

* planned

Transports:
- RTPS
- Multicast / Unicast
- Serial

Customizations for additional platforms and transports are possible, contact us for information.

About Twin Oaks Computing

Twin Oaks Computing, Inc. provides state-of-the-art engineering in support of high-performance communications, including device drivers, communication protocols, inter-process communications, network services, and secure environments. Our unique company culture allows us to be agile and provide superior responsiveness to our customers, and our extensive domain experience is essential to our customers’ ability to perform their missions. We are committed to being a premier source of quality high-performance communications technologies for use in DoD and commercial applications.

Twin Oaks Computing, Inc

755 Maleta Ln Ste 203
Castle Rock, CO 80108
Phone: 720-733-7906

www.twinoakscomputing.com
contact@twinoakscomputing.com

The Right Data at the Right Time at the Right Place - All the Time.

OpenSplice DDS is an Open Source extreme-performance, real-time, and highly scalable data-centric publish/subscribe middleware that provides next generation mission- and safety-critical applications with the ideal platform for addressing complex real-time information distribution and management challenges.

Real-time information distribution and management has historically supported high performance data processing systems, such as radar processors, flight data processors, combat management systems, and flight control.

The need for real-time information distribution and management is rapidly expanding as systems increasingly run in net-centric environments characterized by thousands of platforms, sensors, decision nodes, and computers connected together to exchange information, support sense-making, enable collaborative decision making, and effect changes in the physical environment. OpenSplice DDS has been designed to optimally address the real-time information distribution and management challenges posed by traditional high performance real-time data-processing systems, as well as next generation netcentric systems. It has a proven success record of scaling from systems ranging from multi-processor single-board computer, to large scale net-centric system of systems.

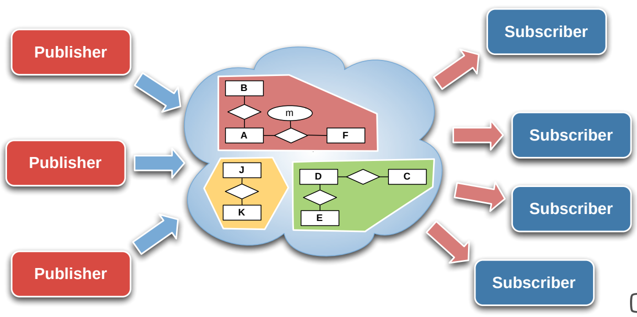
A Field-Proven Solution

OpenSplice DDS has many proven production deployments that demonstrate its exceptional strengths in supporting complex mission-critical systems in a range of application domains, such as defense, aerospace, transportation, telecommunication, and financial services. For example, the TACTICOS combat management system developed by THALES Naval Netherlands uses OpenSplice DDS to achieve (1) exceptional scalability, from small ships to aircraft carriers, and (2) high applications performance, availability, and determinism even under temporary overload conditions. TACTICOS is currently in use in over 15 Navies worldwide serving more than 26 ships-classes ranging from small patrol boats up to large frigates and aircraft carriers.

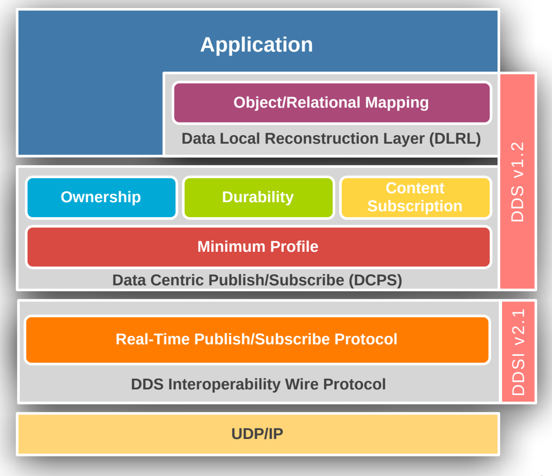
Setting Higher Standards for Publish/ Subscribe Technologies

With its extraordinary support for complex QoS and data-centricity, OpenSplice DDS provides the future Publish/Subscribe technologies today.

Real-Time Data-Centric Publish/Subscribe



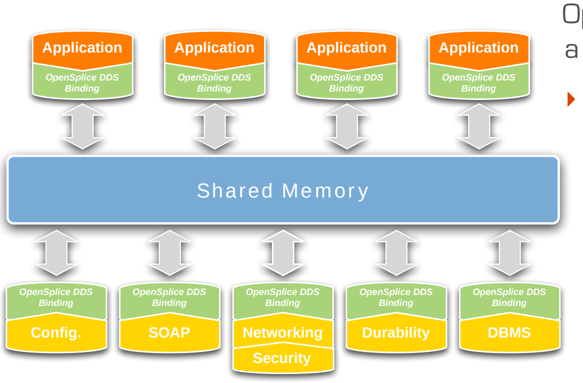
OpenSplice DDS perfectly blends and extends the most useful features found in real-time messaging middleware and relational data-bases. From real-time messaging middleware, OpenSplice DDS inherits the efficiency in distributing data, the predictability, and the throughput. From relational data-bases, it inherits the ability to define relational data models and operate on them via SQL92 expressions to specify content-based subscriptions, join, projection, filters, and queries. These capabilities are provided via a fully distributed architecture that ensures performance, predictability and scalability, and are enhanced with a rich set of QoS properties that allow traffic prioritization, traffic shaping, hardware and software filtering, and persistence.



Standards Based

OpenSplice DDS is fully compliant with the Object Management Group (OMG) "Data Distribution Service for Real-Time Systems v1.2" (DDS) Specification and DDSI v2.1 interoperability wire protocol, supporting the Data Centric Publish/Subscribe (DCPS) layer, and the Data Local Reconstruction Layer (DLRL). The DCPS layer enables publish/subscribe over a distributed relational data model. The DLRL provides an Object/Relational Mapping to bridges the impedance mismatch between relational and Object Oriented representation of data. When using the DLRL layer, familiar Object Oriented constructs, such as inheritance and relationships, can be used to model the information to be shared and distributed within the system, thus further improving expressiveness, productivity, and reusability.

Architectural Highlights



OpenSplice DDS achieves efficiency, scalability, and determinism via a shared-memory architecture that

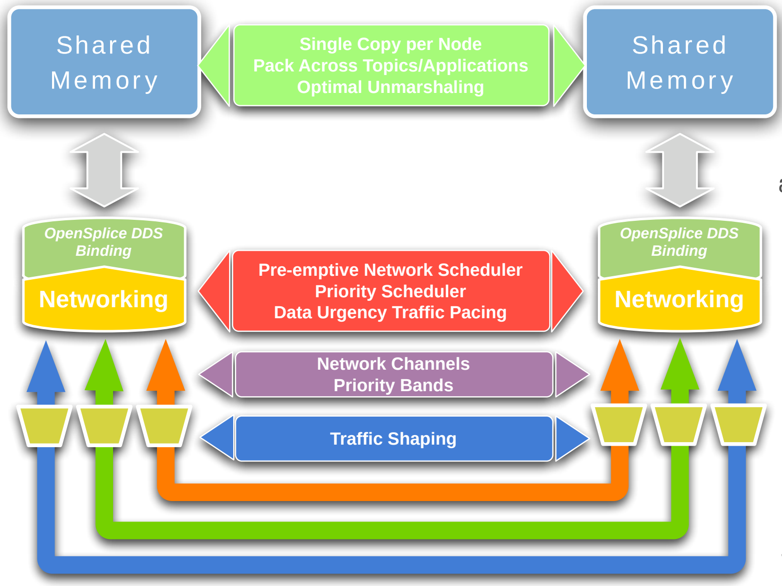
- Fosters efficient information sharing and communication between applications running on the same host, and
- Enables node-to-node, as opposed to application-to-application, communication and discovery, thereby achieving fine-grained control over networking resources, scalability and discovery, and communication performance.

OpenSplice DDS is built as a highly modular collection of pluggable services that provide a rich set of features, such as advanced networking, security, database integration with any ODBC 3.0-compliant DBMS, and web services integration.

Designed for Performance, Predictability and Scalability

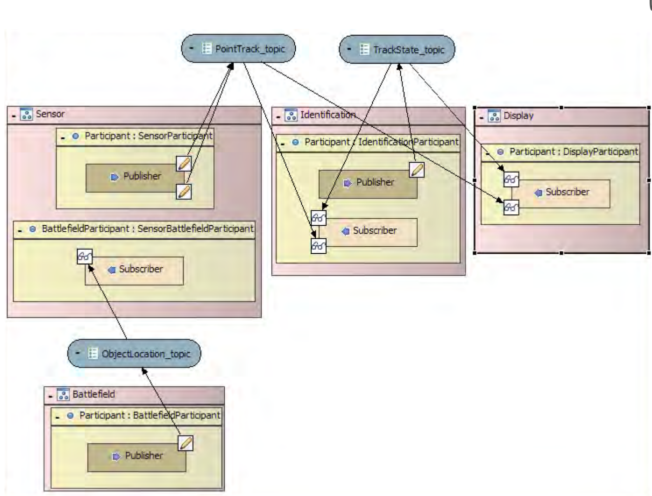
OpenSplice DDS handles millions of messages per second, ensuring high determinism and ultra low latencies. Its advanced support for network traffic engineering ensures that the system remains stable and predictable even under the most extreme overload conditions.

Advanced Networking Technology



The OpenSplice DDS networking service is one of its most distinguishing features. The networking service fetches the data from the shared memory segment and ships it to interested parties, thereby making optimal use of resources whilst enforcing the required QoS levels. By employing a shared memory architecture, the networking service can optimize network utilization by bundling information across topics and applications. The networking service also supports any user-defined number of partitions and of network channels. Partitions are mapped to IP multicast addresses to segregate different traffic flows, while network channels are dedicated to handle traffic for specified priority range's. Network channels help enforce messages priority even on non-priority-preserving transports, such as the TCP/IP or UDP/IP. Another important feature provided by the OpenSplice DDS's networking service is traffic shaping. For every channel it is possible to define the traffic profile, and ensure that the network utilization never exceeds a user-specified value. In summary, the OpenSplice DDS's networking service allows users to (1) fine-tune the use of network resources by means of partitions and channels, (2) prioritize data for every single node to ensure that the more important data always preempts less important data, and (3) bundle data across topics and applications to ensure optimal throughput and reduce CPU utilization.

Unparalleled Productivity



OpenSplice DDS is available on all major operating systems (OS) including AIX, Linux, Solaris, Windows, Integrity and VxWorks. Language bindings are available for C/C++, C#, Java and XML. Its rich support for platforms and language bindings enables software developers to select the most appropriate development language and target OS for use in various parts of their systems. The OpenSplice DDS Power Tools further enhance productivity by a factor of 10x, via an Eclipse-based information, application, and deployment, model-driven engineering tools, as well as tools for runtime monitoring and system tuning.

Who is using OpenSplice DDS?

Financial Services

OpenSplice DDS is the technology of choice for next generation Financial Applications. It currently powers some of the most innovative Automated Trading Systems, providing capabilities well beyond those of traditional ultra-low-latency technologies.

Defense & Aerospace

Some of the most advanced, next-generation, defense and aerospace systems are currently powered by OpenSplice DDS. For instance, the TACTICOS Combat Management System (CMS), one of the most successful CMS available on the market, uses OpenSplice DDS to achieve its renowned performance, scalability and availability.

SCADA

OpenSplice DDS has been applied with great success to wide variety of SCADA and Utility applications ranging from industrial control to telemetry.

Transportation

OpenSplice DDS powers some of the most challenging transportation programs, such as next generation European Air Traffic Control System, and several Metro Systems throughout Europe.

Technical Specification

Licensing

- LGPL/Commercial

Operating Systems

- AIX
- Linux
- Solaris
- Windows 2000, XP
- INTEGRITY
- VxWorks

Language Support

- C/C++
- C#
- Java
- Real-Time Specification for Java

OMG DDS Compliance

OpenSplice DDS is compliant with the full OMG DDS v1.2 specification, including the Data Centric Publish/Subscribe(DCPD) and the Data Local Reconstruction Layer (DLRL) profiles.

About PrismTech

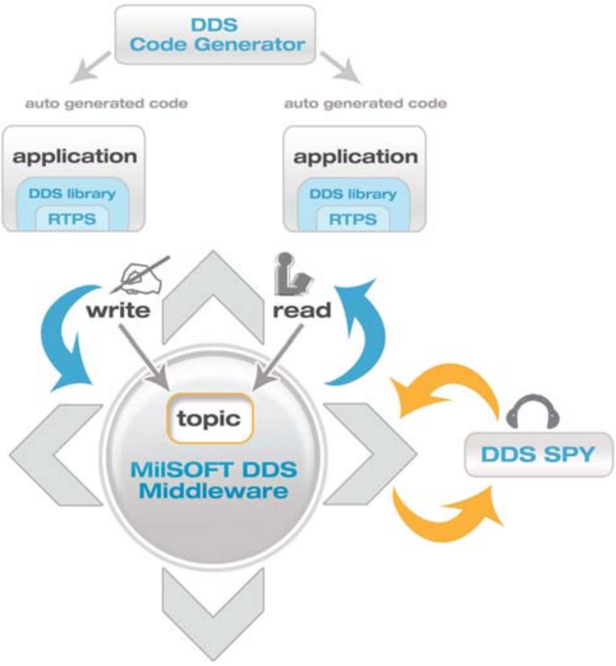
Founded in 1992 with offices in the USA and Europe, PrismTech is a privately held software products company. PrismTech serves international Fortune 500 customers in the telecommunications, data communications, defense and aerospace, transportation and financial sectors.

PrismTech is an acknowledged leader in middleware and software productivity tools, with solutions ranging from embedded real-time systems to wide-scale integration, supporting applications from operations support systems through to software-defined radio.

European Headquarters: +44 191-4979900 | **USA Headquarters:** +1 781 569 5819

Technical: crc@prismtech.com | **Sales:** sales@prismtech.com

MilSOFT DDS MIDDLEWARE



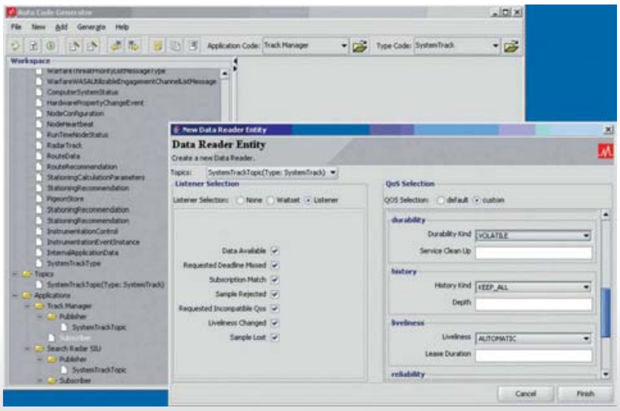
MilSOFT DDS MIDDLEWARE

- Implementation of middleware standard by Object Management Group
- Data Centric Publish-subscribe mechanism for distributed applications.
- C++ API
- No shared memory or DDS service per node
- Implemented features
  - DDS Minimum profile
  - Durability Profile
  - Content Subscription Profile
- Real-time Publish-Subscribe (RTPS) protocol interoperability protocol for communication
- High performance and reliability

MilSOFT DDS TOOLS

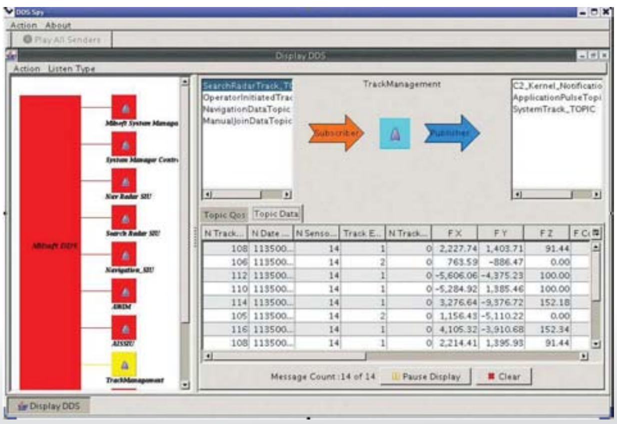
www.milsoft.com.tr

DDS CODE GENERATOR



- Helps application developers to generate DDS interface related code
- Isolates application programmers from details of DDS API thus
  - Enables faster code development
  - Avoids programming errors using DDS API
- Manages topics (system interfaces) from single source

DDS SPY



- Listens network and displays DDS related information
  - Participating applications
  - Topics each application publishes or subscribes
  - Data
- Injects data into DDS domain using copy paste
- Great tool for system integration and testing

Gallium

InterCOM DDS™

High Performance Real-Time Middleware

To reduce the effort needed to integrate distributed real-time systems, InterCOM DDS provides an open-standard middleware for high performance data distribution.

Data Distribution Service

This easy-to-use software allows developers to quickly define and share real-time data across systems, networks, platforms and processors. The API is available in multiple languages and platforms and includes the following capabilities:

- High-reliability publish/subscribe API
- Detailed quality of service controls
- Easy-to-use debug tools
- Complete reference solutions
- Intuitive training tutorials
- Complete documentation

Fifteen years of research and development have been used to create the high- reliability publish and subscribe back-bone that has been deployed in operational systems around the world.

This optimized backbone with detailed quality of service controls allows developers to maximize the available network resources and easily integrate complex distributed systems.

Publish and Subscribe

As opposed to traditional client and server models, the publish and subscribe model facilitates better data distribution from sensors to many subscribers.

Quality of Service

Quality of Service (QoS) policies are used to control data flows and manage system performance. You can use policies to prioritize data delivery and error handling to optimize system resource usage.

Policies can be divided into custom categories for refined control.

The categories can include:

- Volatility
- Transport timeliness
- Transport integrity
- Entity configuration
- Entity metadata

View Tool

The view tool allows developers and integrators to view the network traffic and inject test messages.

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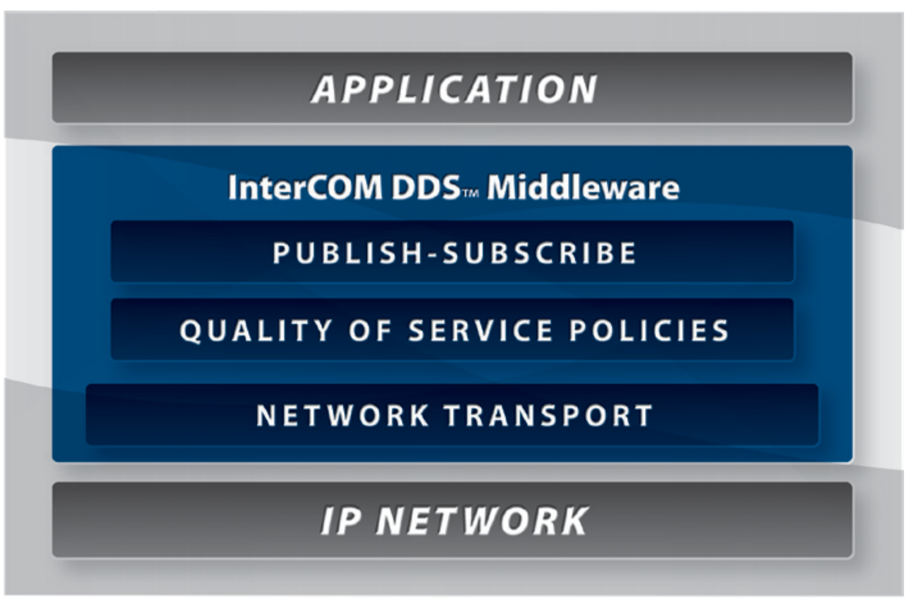
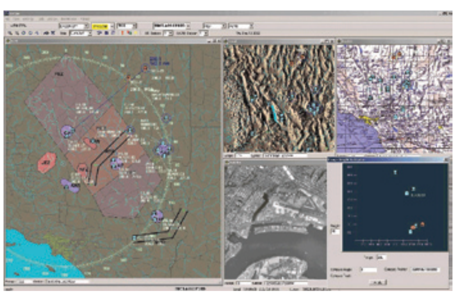


Features

Multi Platform Support	Obtain an SDK for any of the following platforms: Windows, Linux & Solaris.
Multi Language Support	Obtain an API for both C++ and Java.
High Performance Engine	Ensure reliable, high performance data delivery
Open-Standard Interface	Open-standard Data Distribution Service API managed by OMG can reduce development cost
Communication Middleware	Easily define, send, marshal and de marshal data across different platforms and languages.
Publish and Subscribe	Anonymous publish and subscribe communication model makes system integration easier
Quality of Service	Maximize network resources and behavior by customizing QOS policies to your needs.
Object Oriented API	Easily integrate the API into your software architecture.
Training	Custom five-day training course that focuses on your key implementation issues.
Support	Direct access to engineering team for problem resolution and questions.

InterCOM DDS is part of the **InterWORX** suite of high-performance development tools for mission-critical systems, which also includes **InterMAPhics**.



InterMAPhics is our purpose built, high performance geospatial SDK for mission critical systems.

Company Facts

Gallium, a wholly owned subsidiary of Kongsberg Defense & Aerospace, is the international leader in the development of COTS software components and tools for mission critical systems. Gallium's software is used by military and civilian agencies worldwide to provide Command and Control, situational awareness, missile defense, air traffic control and other high performance display applications.

Gallium also provides the **I-SIM** Air Traffic Control simulator. **I-SIM** is a comprehensive, integrated software suite that meets all the high-fidelity simulation requirements for ATC training, testing and research.

Gallium has more than two decades of software-engineering experience and is ISO 9001-certified

InterWORX™ PRODUCT SUITE

Find out more – Contact Gallium today

info@gallium.com
www.gallium.com
1 800 267-2626

Gallium

OpenDDS

About OpenDDS

OpenDDS

OpenDDS is an open-source C++ implementation of the Object Management Group's specification "Data Distribution Service for Real-time Systems". Although OpenDDS is itself developed in C++, Java and JMS bindings are provided so that Java applications can use OpenDDS.

OpenDDS is built on the ACE abstraction layer to provide platform portability. OpenDDS also leverages capabilities of TAO, such as its IDL compiler and as the basis of the OpenDDS DCPS Information Repository (DCPSInfoRepo).

The primary development of OpenDDS was done by the ACE/TAO development team at Object Computing, Incorporated in St. Louis and Phoenix. It is released under the same generous license terms as ACE, TAO and MPC. See the LICENSE file for details.

Features

OpenDDS was originally on the 1.0 DDS Specification (formal/04-12-02), but more recent developments are based on the 1.2 DDS Specification (formal/07-01-01).

It offers the following default transport protocols (IPv4 and IPv6):

- TCP/IP
- UDP/IP
- IP multicast

The pluggable transport framework allows anyone to create a transport to fit custom requirements.

OpenDDS has been found to perform better than other TAO services (notification and real-time event channel) by a factor of two or three. The features offered by the Real-Time Event Channel and Notification Service are similar to DDS, but not identical, so carefully examine your use-cases before choosing one service over another. Speed is not the only criterion.

Compliance with the DDS Specification

OpenDDS supports the following capabilities defined in the DDS 1.2 Specification:

All profiles (including optional profiles) of the DCPS layer are implemented.

The Built-In Topic functionality is available and enabled by default. To disable Built-in Topic support pass "-NOBITS" option to DCPSInfoRepo and "-DcpsBit 0" to all clients.

Developers can define a structure in IDL that will be used as a DDS data type. The structure may include basic scalar types, strings, sequences, arrays, enumeration and unions. It may not contain interfaces or value types. Zero or more keys can be specified for a data type.

OpenDDS provides a pluggable transport framework that makes it easy to add a new transport.
The following transports are provided in OpenDDS:

- SimpleTCP
  A TCP/IP based transport.
- udp
  A UDP/IP based transport.
- multicast
  An IP multicast transport.

Peformance Testing

Performance testing of OpenDDS can be performed using the **OpenDDS-Bench** performance testing framework. This framework is currently located at:

```
$DDS_ROOT/performance-tests/Bench
```

in the OpenDDS source code distribution. Detailed information about the OpenDDS-Bench framework is located at:

```
$DDS_ROOT/performance-tests/Bench/doc/userguide.html
```

Tests are configured using files. The configuration files for some tests are included in the OpenDDS distribution and can be used to repeat the testing reported here in a user's environment. This way, users can compare existing or other candidate data transport mechanisms in their specific target environment to these results. The test environments include both OCI and customer test labs.

Some testing was performed in the OCI training laboratory. These tests are representative of performance in a busy, user-driven environment of many desktop hosts with other tasks sharing the processing and network resources along with the test execution. Testing in this environment leads to noisy results, but demonstrates the performance of OpenDDS under actual, adverse, conditions.

Additional testing was performed on a single, multi-core box. While this configuration is unlikely to be commonly deployed, its purpose is to establish the baseline behavior of OpenDDS in a non-networked environment. Therefore, the latency numbers are those that directly result from the running of the publisher and subscriber, in different threads, on the same box, in loopback mode so as to ensure that the entire transport stack is exercised.

This baseline behavior on a single host can, of course, be improved by employing shared memory transport and other techniques. Therefore, the performance characteristics reported in the single-host case do not represent the lowest possible latency for OpenDDS. They are intended to provide a reference measurement. For instance, testing with various processor speeds shows that OpenDDS improves in almost a directly proportional manner. Further testing will be performed on boxes with faster processor speeds as they become available to reaffirm this conclusion.

When OpenDDS is introduced into a more typical network setting, additional latency will accrue, of course, depending on the network protocol, topology, distance and network hardware, etc. In general, when measuring the latency in networked settings, these other factors may well swamp the baseline results seen here. The testing in the OCI training lab shows that latency might be two to three times greater on a general purpose LAN. (See the actual results of tests performed at "OCI Lab".)

Further performance testing will be performed on racked systems using the standard protocols supported such as TCP/IP. This configuration is increasingly commonly deployed for certain types of easily distributed tasks that require close cooperation. The advertised latency between boxes on Infinband, for example, is a few hundred nanoseconds. (Other rack fabrics offer similar numbers.) Therefore this should not cause much noticeable additional latency. Testing will confirm this.

Comparison of the latency of OpenDDS with that of proprietary offerings indicates OpenDDS performs about the same as the fastest of its competitors. There is no advantage to be gained by purchasing a proprietary implementation. The bottom line appears to be that when using the open source DDS product, the savings from license fees can be applied to network hardware, racks for co-located systems, etc. All these investments will yield a commensurate return.

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DDS™

Design real-time data distribution services for OpenSplice and RTI DDS using UML today!

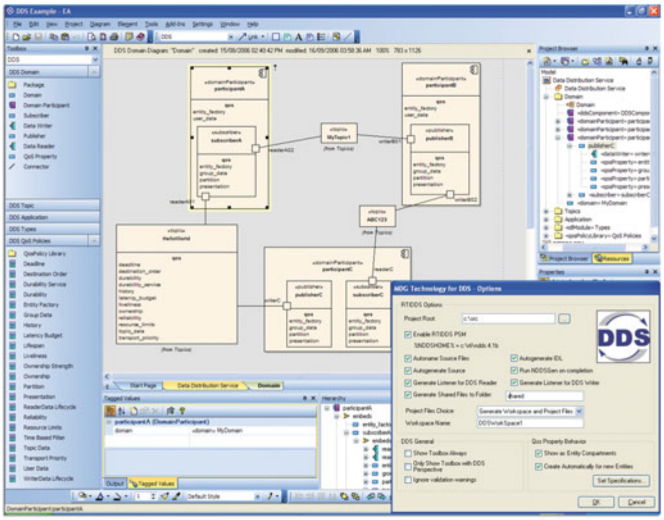
Create, Edit and Integrate Data-Centric Publish-Subscribe Services using UML 2.1 and the UML Profile for DDS. Specify Quality of Service policies to govern reliability and resource limits.

Link Topic Data to Reconstruction Classes for optimum data access. Use Data Local Reconstruction to unify DDS data from multiple topics to create integration-ready APIs for user applications.

Generate Integration-Ready, Executable Source Code for heterogeneous DDS applications. Use Model Driven Architecture to produce C, C++, C# or Java source code for both the OpenSplice and RTI DDS platforms using MDA Transformation.

Extensible UML 2.1 Modeling
Use UML 2.1's extensibility to capture and share DDS designs with other UML software designs, BPMN business processes and SysML system models.

Create rigorous, valid DDS designs
Take advantage of support for model validation to ensure the correctness of DDS design models.



Features:

- Specify **Data-Centric** Publishers, Subscribers, Topics and **QoS Policies**
- Define **Data Local Reconstruction** mappings for effective DDS data access
- Create **heterogeneous DDS applications** across different host environments
- **Generate executable source code** in C, C++, C# and Java using MDA (Model Driven Architecture)
- Target DDS implementations for the **RTI and OpenSplice** platforms

OpenSplice DDS
Sparx Systems: DDS Solution Provider and Technical Partner with PrismTech

RTI
Sparx Systems: DDS Solution Provider and Technical Partner with RTI

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