The Real-Time Middleware Company℠

The Data-Centric Future
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“The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it.”

-- Mark Weiser, 1991 Scientific American article on Pervasive Computing

“The shift today is from thinking about servers and objects and code to thinking only about information flow. The network can bring everything you need to know, now.”

-- RTI 2006, The Real-Time Middleware Company
Today’s newly-connected distributed systems are just the beginning

Pervasive data will drive the vast distributed applications of the future
What is DDS?

- **DDS = Data-Distribution Service for Real-Time Systems**
- Data-centric publish-subscribe communications
  - Just declare your intent to publish or receive data
  - No or minimal configuration
- Real-time performance
  - No need to specially request every piece of data
  - Direct peer-to-peer transport (no servers!)
  - Event-driven transfer
- Flexible & powerful QoS control

Applications just send or receive data with a standard API.
Messaging Technologies

- Web Services
- Java
- Java/JMS
- CORBA
- RTSJ (soft RT)
- RTSJ (hard RT)
- RT CORBA
- Data Distribution Service / DDS
- MPI

Adapted from NSWC-DD OA Documentation
Data-Centric Programming

- **Data-Centric Perspective**
  - Focus on how the data is moving and transforming in your system
  - Sources and sinks
  - Static vs dynamic
  - Filtering: who needs what data when?
  - Storage and retrieval
  - Size and complexity
  - Physical system and transport limitations

- **Tenets of Data-Centric Programming**
  - Expose the data
  - Hide the code
  - Separate data and code
    - Data-handling and data-processing
  - Code generated from Interfaces
  - Loosely coupled
# Object Oriented vs. Data Centric

<table>
<thead>
<tr>
<th>Object Oriented</th>
<th>Data Centric</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hide the data (encapsulation)</td>
<td>Expose the data</td>
</tr>
<tr>
<td>Expose methods – code</td>
<td>Hide the code</td>
</tr>
<tr>
<td>Intermix data &amp; code</td>
<td>Separate data &amp; code</td>
</tr>
<tr>
<td>Mobile code</td>
<td>Must agree on data mapping, mapping system</td>
</tr>
<tr>
<td>API / object model</td>
<td>Messages are primary</td>
</tr>
<tr>
<td>Combined processing, no restrictions</td>
<td>Data model or schema</td>
</tr>
<tr>
<td>Changes:</td>
<td>Strict separation of parser, validator, transformer, and logic</td>
</tr>
<tr>
<td>Read &amp; change code</td>
<td>Changes:</td>
</tr>
<tr>
<td></td>
<td>Change declarative data file</td>
</tr>
<tr>
<td>Tightly coupled</td>
<td>Loosely Coupled</td>
</tr>
</tbody>
</table>
A Great Time for DDS!

- The infrastructure evolution cycle is churning…
  - New -> Emerging -> Standard -> Commodity
  - Middleware is emerging as OS declines
- …DDS is maturing…
  - OMG focus
  - Wire spec
  - Tools
  - Enterprise integration
  - Multiple products fielded
  - Deployed applications!
- …and adoption is on the rise
  - Navy
  - DISR
  - FCS/SoSCOE
  - Many significant applications
Who is RTI?

- DDS market leaders
- Experts in real-time distributed information management
- Founded out of the Stanford Aerospace Robotics Lab
- Active in standards, including OMG, NCOIC, Eclipse, Open Group
- Sustained growth, strong financials
- Committed to customer success: 98% customer satisfaction
Mission

To be the Recognized Leader of Software and Solutions for Real-Time Communications Middleware
RTI Experience & Maturity

- ~400 different publish-subscribe applications
  - 75 DDS API applications
    - 20+ major Navy programs
    - Thousands of deployments
- 350+ graduates of RTI’s DDS QuickStart
- 65 OS+CPU+Compiler combinations supported as standard product
- Nightly automated build & performance measurement, stress testing
A Tour of Some RTI Applications…

- **Aerospace and Defense**
- **Robotics and Automation**
- **Transportation**
- **Telecom/Datacomm**
- Ship-Wide Area Network (SWAN)
  - Shipboard control
  - Machinery control
  - Damage control
  - Integrated condition assessment
  - Steering control
  - Advanced Degaussing (Magnetic signature)
  - Mission control systems
  - Navigation systems
  - Communication systems
  - Support systems for “visitors”
Navy Open Architecture Ship Self Defense System (SSDS)

- Project to employ standards throughout ship systems (frameworks, OS, etc.)
- Goal: Reduce total cost of ownership, ease system upgrades, reduce interoperability issues
- RTI Services provided advanced integration, support & consulting
- First deployment at sea now
Littoral Combat System (LCS)

- Distributed combat and control system for U.S. Navy ship

- Concerned with extensibility of system, compatibility between vendors, easy upgrades

- OMG DDS is the specified standards-based middleware in US Navy Open Architecture

- RTI Data Distribution Service selected on performance, extensions and advanced services
Lockheed Martin US Navy Aegis Open Architecture Weapon System

- Next-generation of the U.S. Navy Aegis Weapon System
- Challenge to share time-critical data across highly distributed system including radar, weapons, displays and controls
- Need to maximize future scalability and flexibility
- RTI provides real-time communication infrastructure. Standards-based & extensible for future system enhancements
Zumwalt is the lead ship in a class of next-generation, multi-mission surface combatants.

RTI powers the Total Ship Computing Environment Infrastructure (TSCEI), the backbone of the network computing system and basis for all DDG 1000 application software programs.

"The selection of RTI came through a process which uses formal evaluation criteria and a source selection board to ensure that the Navy gets the best value. This is an emerging product market and it was determined that the offering from RTI, a small privately held company, provides the best value to the Navy."

-- Raytheon DDG 1000 System Software Development Director Bob Martin
Highway Traffic Monitoring in Tokyo

- The City of Tokyo provides real-time information to commuters and officials about traffic problems.
- Hundreds of traffic monitors and information kiosks along the highway.
- Challenge to deliver information to variety of server & client platforms, via links varying in bandwidth & location.
- RTI enables reliable delivery of information over heterogeneous systems and with minimal bandwidth.
Train Communications

- US railways embarked on an effort to standardize communications – 10,000 trains, 100,000 communications stations
- Required combined wireless, wired, real-time and enterprise elements
- RTI Data Distribution Service chosen because of its high performance and scalability
- RTI Services helped develop proposal, educated on the DDS standard and created performance tests
The US Army built a “smart” robotic crane to automate manpower-intensive munitions transfer process.

Challenge to coordinate multifaceted system requiring high level of precision.

RTI offered the performance and reliability required for complex system.

RTI Services integrated hardware and software systems from many vendors.
DARPA Flying Fox Autonomous Vehicle Systems

- Autonomous vehicle in the 2005 DARPA Grand Challenge race
- Unique characteristic of FireFox: adaptive vision system – vehicle “learns” through example
- Complex network of control and vision systems, sensors, processors, operating systems
- RTI integrates all kinds of data sources, shares data with minimal latency
Ship-to-Ship Cargo Transfer

- ONR asked RTI to develop the software for a ship-to-ship cargo transfer system for rough sea conditions.
- RTI Consulting Services developed turn-key control software for the robotic crane, and successfully demonstrated it at sea.
The National Advanced Driving Simulator provides state-of-the-art real-time driving simulation.

High number of systems – visual, motion, controls, etc. – exchanging and processing data in real-time.

Real-time performance was critical: other middleware such as CORBA and DCOM were simply not fast enough.
Flight Simulator Takes Off with RTI

For communications between full flight simulator subsystems, CAE, one of the world's leading providers of simulation and training, used RTI over high-bandwidth IEEE-1394 on its Sim XXI product line.

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

--Peter Jarvis, Chief Designer, CAE Civil Simulation & Training Division
FORCE trains ship captains by using accurate simulations of actual locales worldwide.

- Performance - many components need to come together and share data in real-time.
- Scalability - Want to integrate systems more rapidly.
- RTI delivered on the performance and scalability requirements. RTI Services also helped design the application.
Modern factories require the exchange of up-to-the-minute data on manufacturing processes, even with resource-constrained devices.

RTI met the challenge to incorporate devices with limited memory or processing power.

RTI Engineering Services with Schneider created a compact real-time publish-subscribe service – it resides & executes in under 100 kb!
Harmonic builds transmission equipment to enable video-on-demand worldwide.

Challenge delivering data over WAN to and from disparate hardware.

RTI offers richer feature set than other solutions. Also enables scalability and future extensibility of the system.

Standard commercial off-the-shelf solution key to meeting tight schedule, lowering costs – chose RTI as leader of COTS publish–subscribe solutions.
AWACS Radar System Upgrade

- Airborne control system for surveillance, command & control and battle management
- Upgrading system to be open, supportable, less expensive to maintain and extend
- RTI is standards-based, open and extensible, reducing integration risk
- RTI is a proven COTS solution, reducing total cost of ownership over in-house development
DDS B-1B Tactical Systems Upgrade

- Adding new command & control and communications capabilities that need to work with legacy control system
- B1B needs an architecture that is open & modular for future extensions and upgrades
- RTI is open and scalable, reducing integration risk, standards-based ensuring supportability
So, Why DDS?

• Why do all these customers buy publish-subscribe middleware?
  
  – System Integration
  – Flexibility
  – Performance
  – Standards compliance
Why Distribution Middleware?

- Hawkeye has functionally oriented software modules
- Each module talks to many other modules
- Adding new functionality cascades integration re-work across many other modules
- Grouping the modules into functional clusters does nothing to change that reality and ease software integration
- Changing the communication between the modules can ease integration, when the new ‘Publish Subscribe’ approach is used – each module publishes its output w/o regard to who is receiving it, in contrast to the point-to-point approach of traditional inter-process communication

**It's about an architecture that can assimilate evolving functionality, rather than remaining set in time**
**Flexibility**

- *Per-data-stream* Quality of Service
  - 22 QoS parameters
  - Determinism vs. reliability, bandwidth, filters, deadlines, ordering, etc.
  - Handles a huge range of demanding delivery requirements
  - Integrates systems with very different needs
- Fault tolerant (esp. over unreliable media)
  - Natural fail-over to alternate publishers
  - Notification on QoS contract violation
Industry-Leading Performance

Benchmark performed over Gigabit Ethernet between 2.0 GHz Opteron PCs running Linux. RTI can saturate the network with packet sizes greater than 2,048 bytes.
Standards

- Standards invite competition
- Competition builds excellence
- Excellence creates markets & pushes technology into new markets

- We welcome competition!
  - Together we will realize DDS’s potential
 DDS Is Building an Ecosystem

- Life needs an ecosystem to thrive
- Technology needs an ecosystem to thrive
- What’s in an ecosystem?
  - Many products
  - Services and support
  - Tool chains
  - Platform support
  - Integration with enterprise technologies
  - Best-of-class 3rd party technologies
RTI’s Ecosystem

- Best-of-class technologies
  - *Object Computing Inc. (OCI): ACE-TAO CORBA
  - *Oracle: In memory and enterprise databases
  - *Sherrill Lubinski (SL): Dashboard and GUI building
  - SparxSystems: UML and MDA tools
  - Themis: Application Management Tools
  - Dot21: Track Analysis and Visualization Tools
  - Motorola: Hardware integration
  - Arrow: Enclosures, packaged product
  - Wind River, LynuxWorks, Green Hills: RTOS

- The ecosystem can deliver whatever you may need

*RTI resells these technologies
RTI Data Distribution Service 4.1

- Fourth-generation maturity
  - Based on experience with ~400 different designs since 1996
  - Proven in real-world, mission- and life-critical applications

- Market-leading adoption
  - #1 in embedded middleware market share* (encompassing all middleware types)
  - >70% worldwide share of DDS market**

- Industry-leading technology
  - Consistently highest-performance middleware
  - Advanced buffering architecture
  - Standards compliant
  - Pluggable transport design
  - Wide and deep platform support (over 60 platforms)
  - Zero-configuration deployment
  - Strict reliability mode
  - Large-data-type support

*Embedded Market Forecasters, June 2006; **VDC Analyst Report, Nov 2006
CORBA Integration and Support

- RTI supports CORBA and DDS applications with a common IDL file and language mapping
- RTI is now distributing and supporting CORBA
  - ACE TAO
  - Partnership with OCI
RTI Real-Time Connect

Database changes

Real-time messages

Embedded application

Embedded application

Embedded application

RTI Real-Time Connect

Enterprise infrastructure

(In-Memory) Database

Table.Tracks

<table>
<thead>
<tr>
<th>Flt</th>
<th>Lat</th>
<th>Long</th>
</tr>
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<tbody>
<tr>
<td>C129</td>
<td>34.5</td>
<td>102.3</td>
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<tr>
<td>C054</td>
<td>27.7</td>
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Table.Passengers

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<thead>
<tr>
<th>Flt</th>
<th>Name</th>
<th>Addr</th>
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<tbody>
<tr>
<td>C129 A. Johnson</td>
<td>...</td>
<td></td>
</tr>
<tr>
<td>C054 J. Smith</td>
<td>...</td>
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</tr>
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</table>
Enterprise Integration

DDDS Application

RTC Database Integration

Relational Database

SQL Application

BPEL Service Orchestration

Web Server

JMS Application

SOA services

WSDL, XML

SOA architecture
Standard APIs
Standard Components
Standard Interfaces

Real-Time

Enterprise

Standard Networks and Transport Interfaces
A first step towards the pervasive data “e2E” vision

- All data is accessible to all applications with standard APIs
- The system can provide any information, past or present, to any location at any time.
- Data models map transparently
- No need for application-level bridging
To Learn More About DDS…

- OMG DDS Portal live!
  - www.omg.org

- RTI Webinars
  - DDS Introduction
  - Data-centric design
  - Enterprise integration

- QuickStart training
  - DDS basics
  - Hands-on RTI product training
  - Tools use
  - Over 350 graduates!
RTI Shapes Demo

- **Goals**
  - Teach DDS concepts in a “fun” way
  - Explain PS concepts, QoS, multiple connections, ease of configuration

- **Download includes**
  - Demo application
  - Guide with background material and illustrative examples

- **Where**
  - www.rti.com
  - Live now!
The Data-Centric Future

- Pervasive data will change the future
- DDS is key to this data-centric future
  - High performance
  - Fine delivery control
  - Enterprise integration
- The real change is a profound thought shift:
  - Code/architecture-centric
    - Where are clients & servers?
    - What objects & methods?
    - How do I access info?
    - How synchronized?
  - Data-centric
    - What information?
    - How fast/reliable/flexible?
    - When is it available?
    - How is it stored?
- We’ve only just begun
  - Huge problems remain: integrating many technologies, scalability, impedance matching, technology adoption
You can be overwhelmed by the challenge or amazed by the opportunity...