Introduction & Overview



Lynne Canavan

VP Marketing, DDS Foundation

March 22, 2023

OMG Standards Development Organization

The DDS Foundation

- Vendor-neutral, collaborative nonprofit formed to grow DDS usage
  - DDS Users, Government Institutions, Researchers, Universities, Vendors
- Promotes the adoption, interoperability and success of DDS family of standards to a wider user community
- Collaborative with the DDS Special Interest Group
- Focus on technology, interoperability, applications, ecosystems, marketing and communications
- Goals:
  - Drive future requirements for the DDS standard
  - Define industry-specific data models and adaptations of DDS
  - Vendor interoperability
  - Industry education and resources

© 2018 Object Management Group

DDS Officers 2022-2023

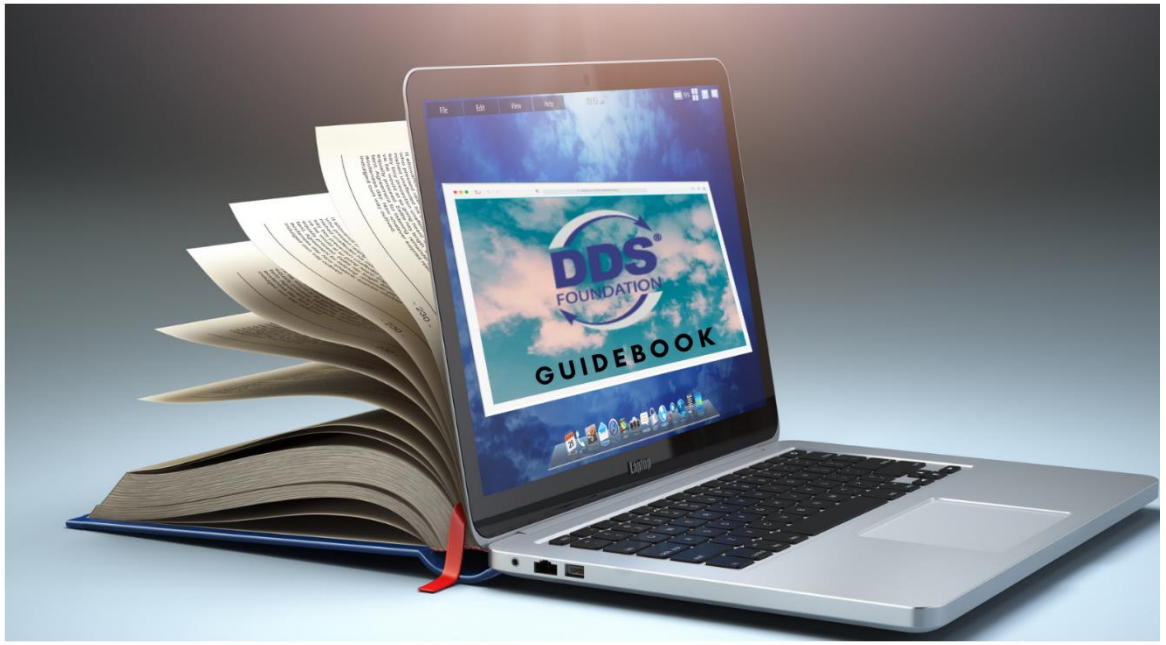
- Director of Interoperability – Adam Mitz (Object Computing, Inc.)
- VP Communications – Laura Clark (Twin Oaks)
- VP Marketing – Lynne Canavan (RTI)
- VP Technology - Nick Stravos (Jackrabbit Consulting)

With support from:

Terrance Milligan, Object Management Group



DDS Guidebook



e. Table of Contents

return to Front Matter

Edit

Front Matter

- a. Cover Page
- b. Summary of Changes
- c. Abstract
- d. Copyright Notice
- e. Table of Contents
- f. Preface
- g. OMG Discussion Paper Disclaimer

User Experiences

- Use Case 1: Connected Healthcare
- Use Case 2: Tactical Microgrid Standard (TMS)
- Use Case 3: Smart Manufacturing
- Use Case 4: Digital Agriculture
- Use Case 5: General Vehicle Architecture (GVA)
- Use Case 6: Kubernetes (K8s)
- User Scenario 1: Energy Sector
- User Scenario 2: Data Acquisition and Instrumentation
- User Scenario 3: Medical Devices

Appendices

- Appendix A: DDS Family of Standards

DDS Foundation Library: Webinars and Use Cases







www.dds-foundation.org → Resources

© 2020 Object Management Group

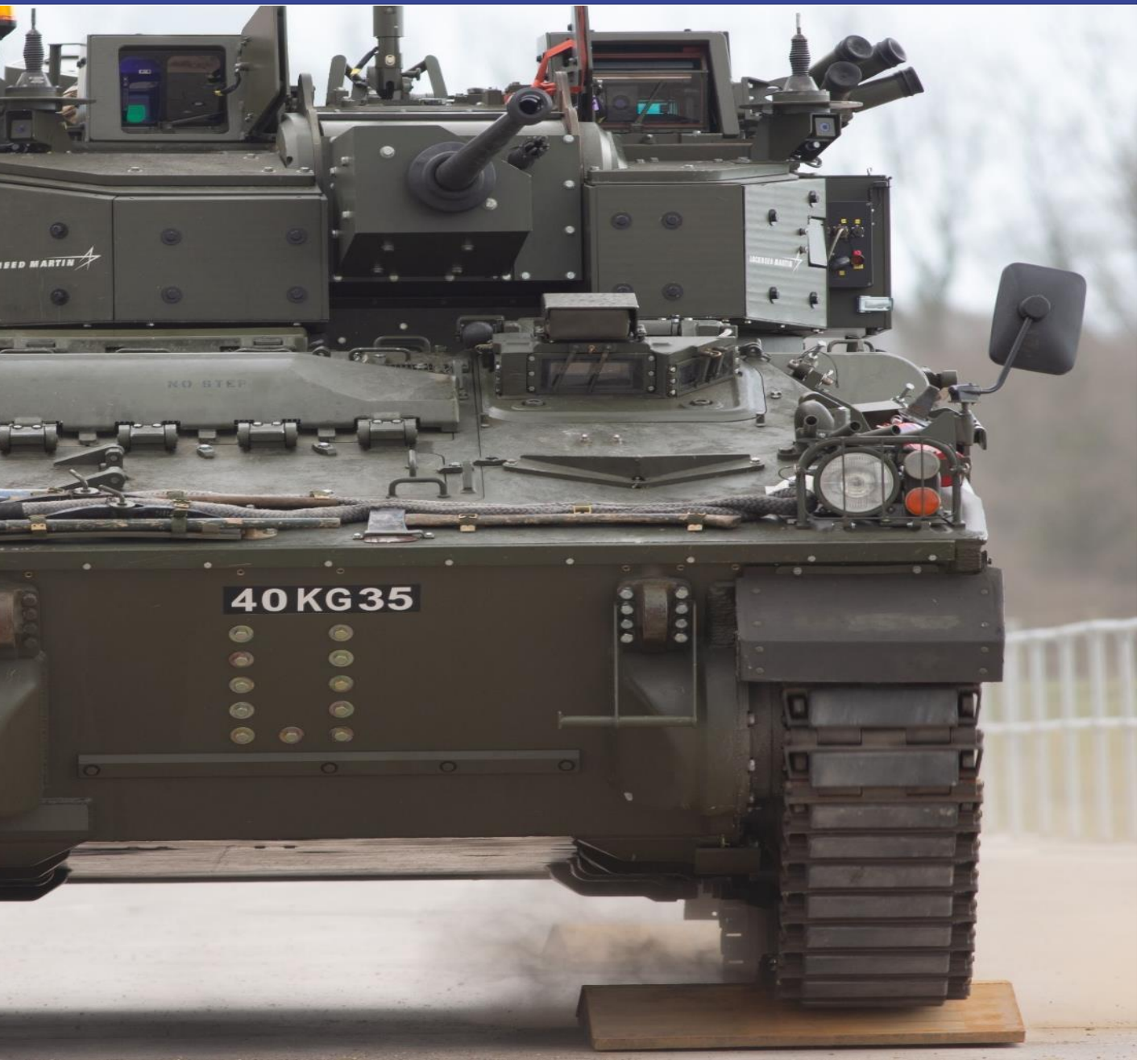
Sample Use Cases
&
Shared Learnings

www.dds-foundation.org



OMG Standards Development Organization

Sample Use Case – Military



CGI

DDS Foundation Use Case Study: Generic Vehicle Architecture

Dr. Richard Saull
Subject Matter Consultant
CGI Secure Platform Systems, UK

(NATO) Generic Vehicle Architecture Components

GVA is the UK/Australian mandated standard for OPEN vehicle architectures.

(NGVA is based on GVA)

It covers:



How to connect equipment: Power/ Ethernet



How to communicate: DDS messaging



How to describe items: Land Data Model (LDM)



System look and feel: (HMI) – Not in NGVA

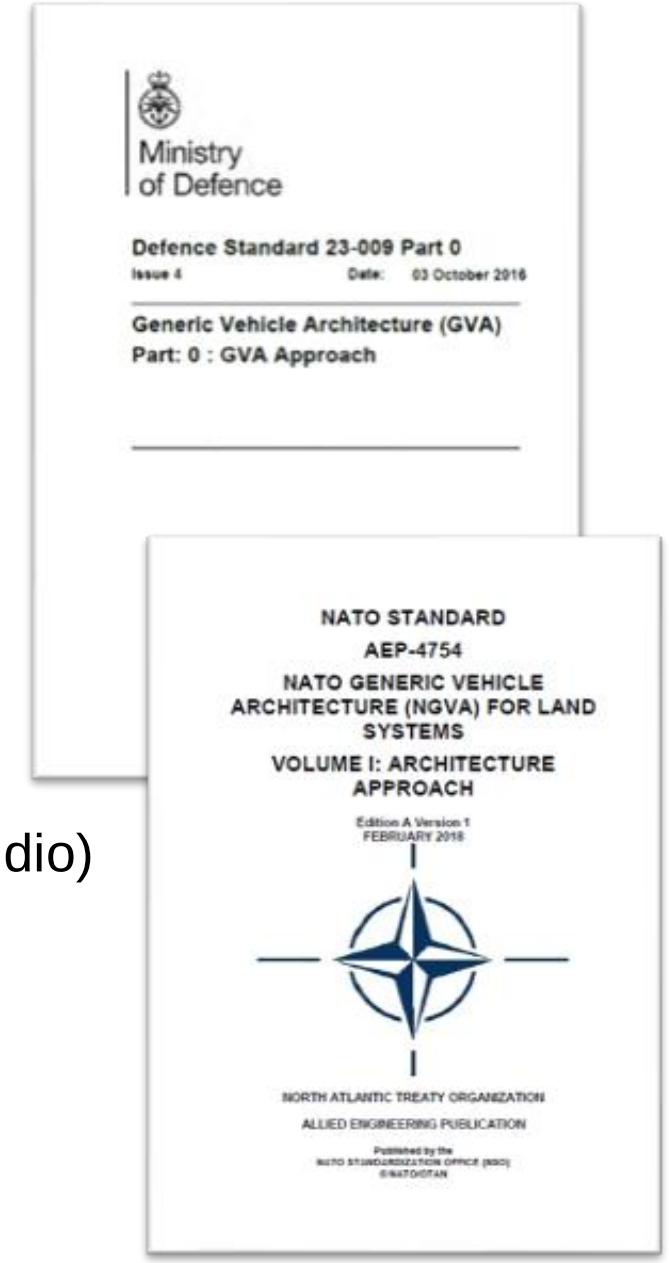


Storage of diagnostic data & Alarms: HUMS

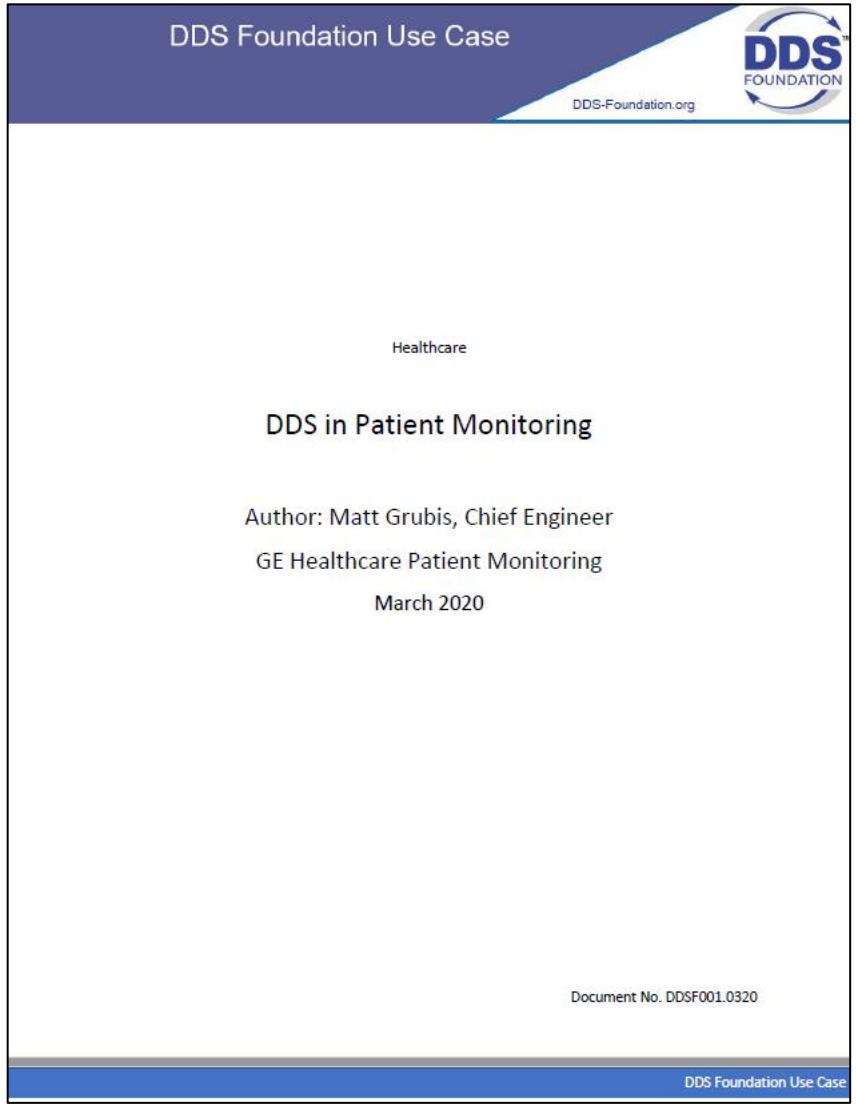
Why (N)GVA uses DDS

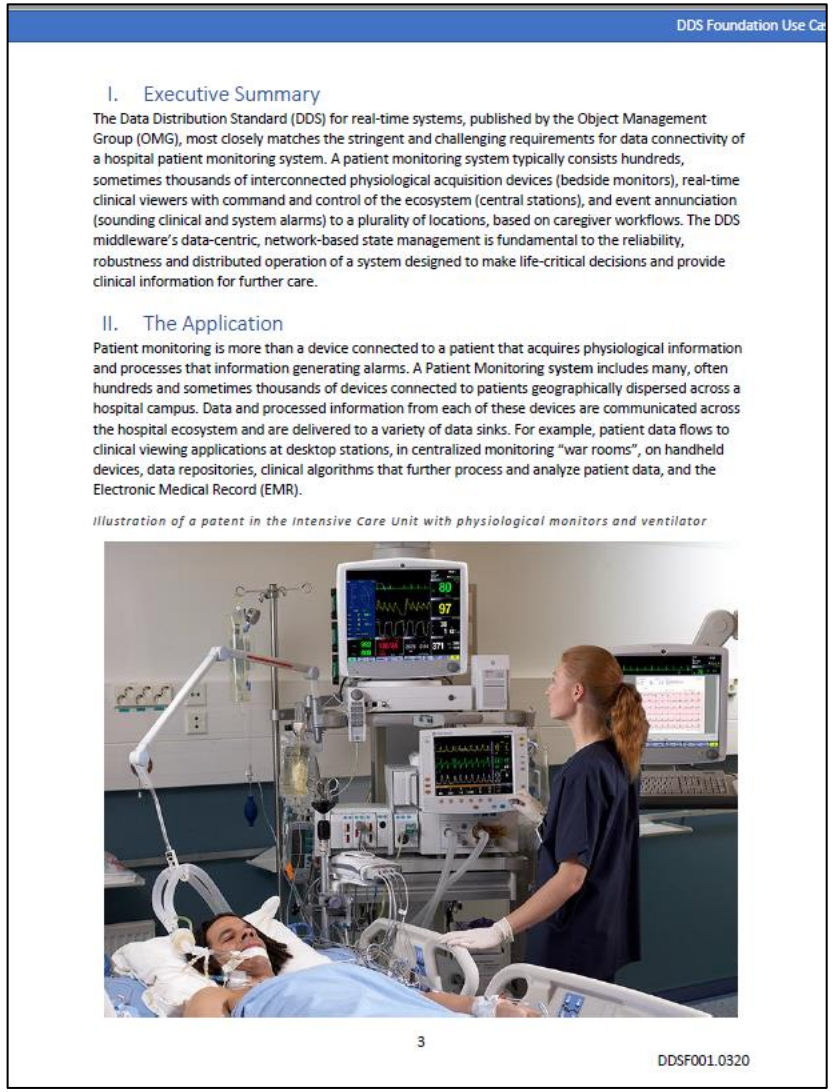
- Enables system of systems approach (modularity and connectivity)
- Platform agnostic
- Mature, multi-vendor standard
- Minimises data on the wire via Quality of Service (QoS)
- Robust – no single point of failure
- Efficient
- Scalable
- Standards defined data model driven code generation
- Distinct middleware layer that could be replaced in the future

- Used for quantitative data rather than streamed data (e.g. video and audio)



Sample Use Case - Healthcare





© 2018 Object Management Group

Sample Use Case – Smart City



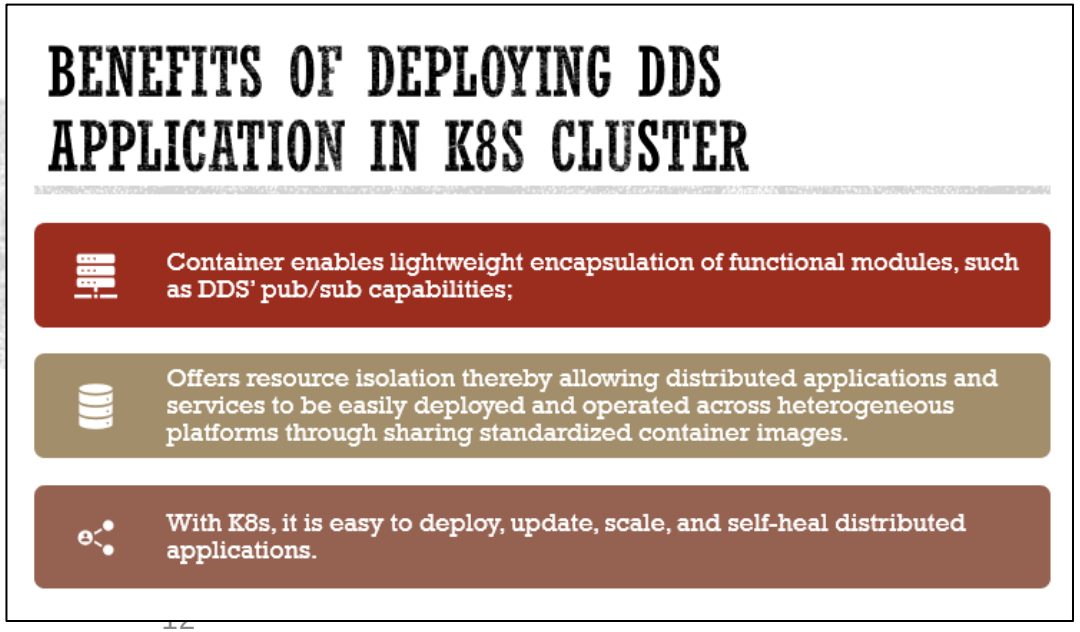
> *"The best way **not** to move forward is to follow **fixed** ideas."*
>
> —Jacques Prévert

© 2018 Object Management Group

Student Poster Session

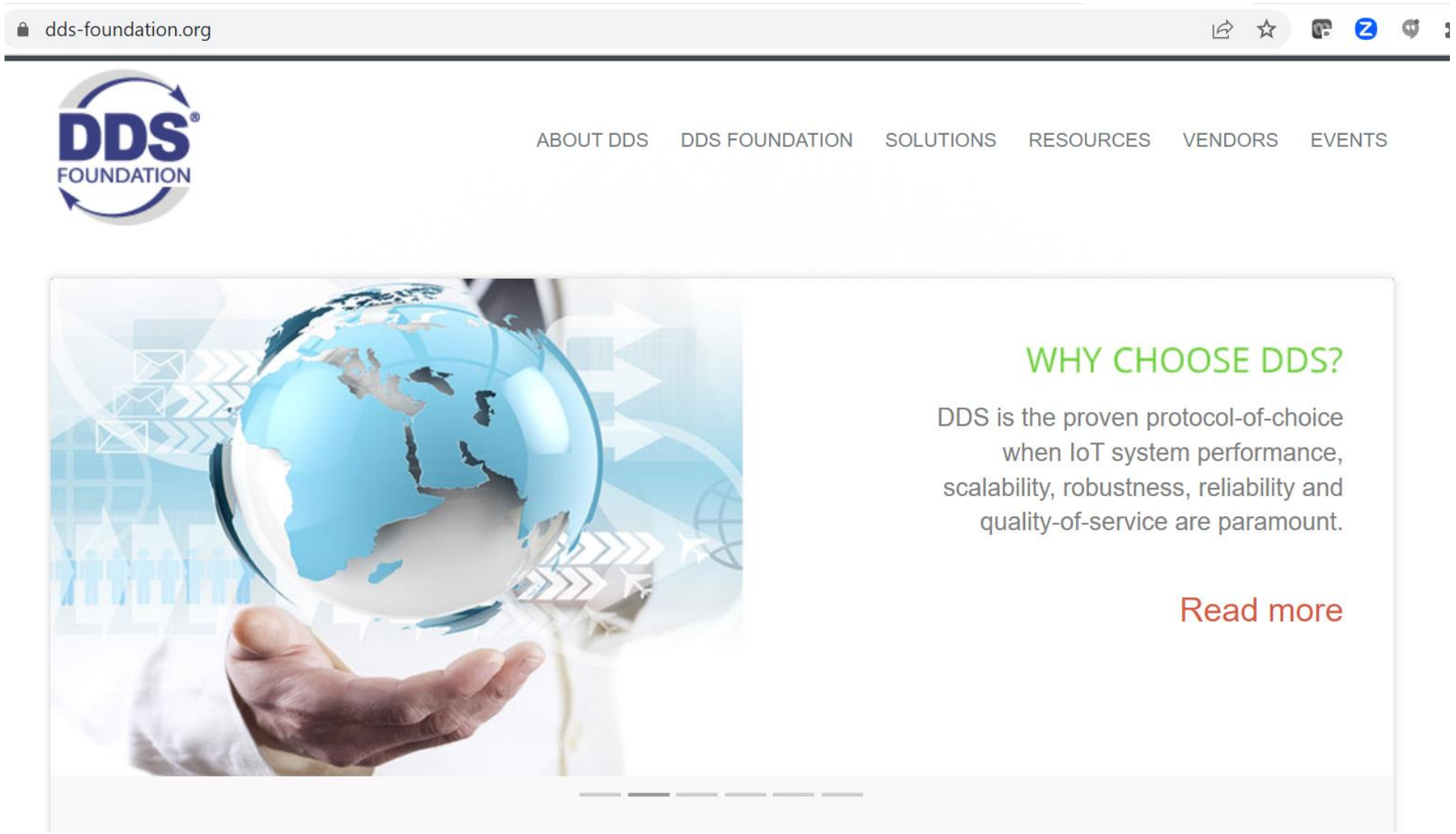
A COMPREHENSIVE PERFORMANCE EVALUATION OF DIFFERENT KUBERNETES CNI PLUGINS FOR EDGE-BASED AND CONTAINERIZED PUBLISH/SUBSCRIBE APPLICATIONS

Zhuangwei Kang
Vanderbilt University

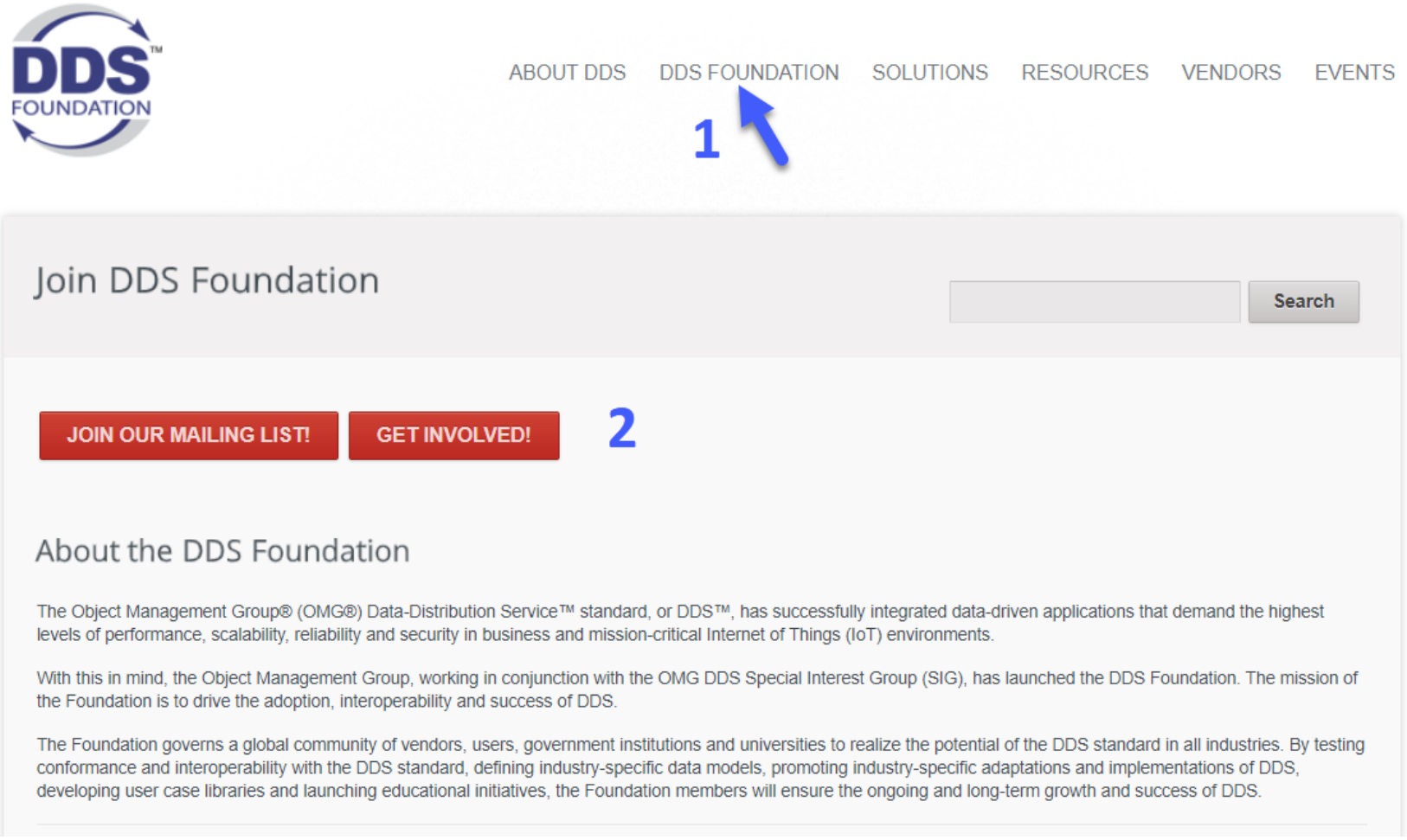


© 2018 Object Management Group

Where to Find Us



Join the DDS Foundation



© 2018 Object Management Group

Thank you!



Email:
ddsfoundation@omg.org

www.dds-foundation.org

OMG Standards Development Organization

DDS Introduction

Nina Tucker

March 22, 2023



OMG Standards Development Organization

Today's Connected Systems

How will we reduce jet engine failure & maintenance costs?



How will we reduce passenger fatalities?





How will we minimize unplanned factory downtime?

How will we save lives through better patient care?



How will we reduce waste of natural resources?



DDS FOUNDATION

Data Distribution Service

- DDS is a Communications Middleware Standard



© 2023 Object Management Group

Data Distribution Service

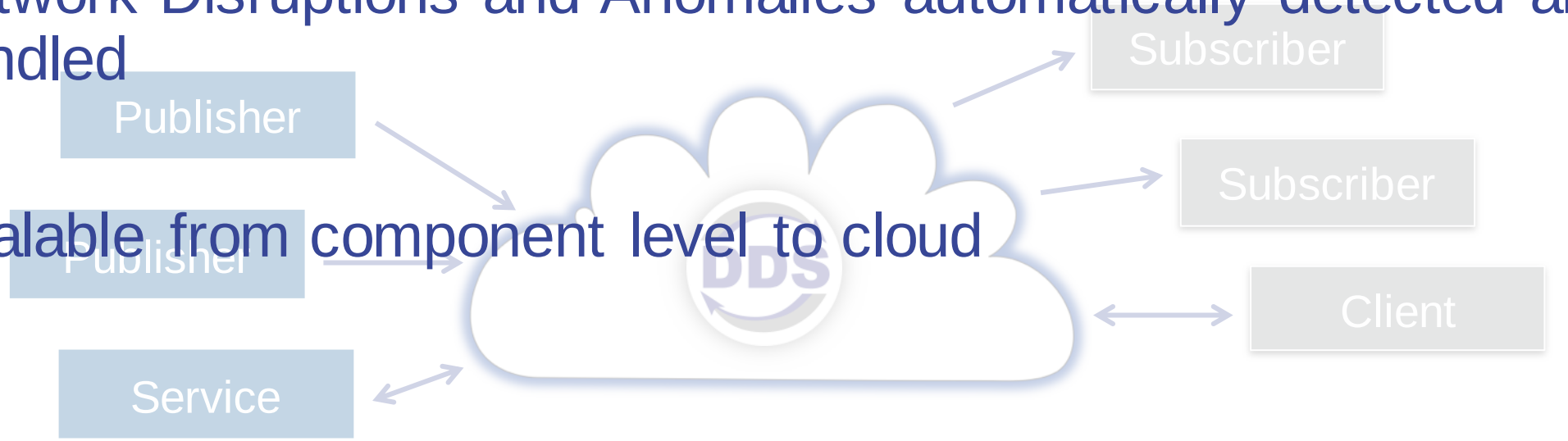
- DDS is a Communications Middleware Standard
- Network Disruptions and Anomalies automatically detected and handled



© 2023 Object Management Group

Data Distribution Service

- DDS is a Communications Middleware Standard
- Network Disruptions and Anomalies automatically detected and handled
- Scalable from component level to cloud



© 2023 Object Management Group

Data Distribution Service

- DDS is a Communications Middleware Standard
- Network Disruptions and Anomalies automatically detected and handled
- Scalable from component level to cloud
- Secure data communications



© 2023 Object Management Group

DDS: Standards Based Communications

- Data Distribution Service from the Object Management Group
  - Fully Standardized
    - Programming API
    - Wire Protocol
    - Quality of Service
    - Type and Data Representation
    - End-to-end Security
  - Vibrant Community
    - Multiple Vendors with Compliant DDS Products
    - User Community across commercial, DoD, and research domains
    - Active standards evolve with current technologies and user requirements

© 2023 Object Management Group

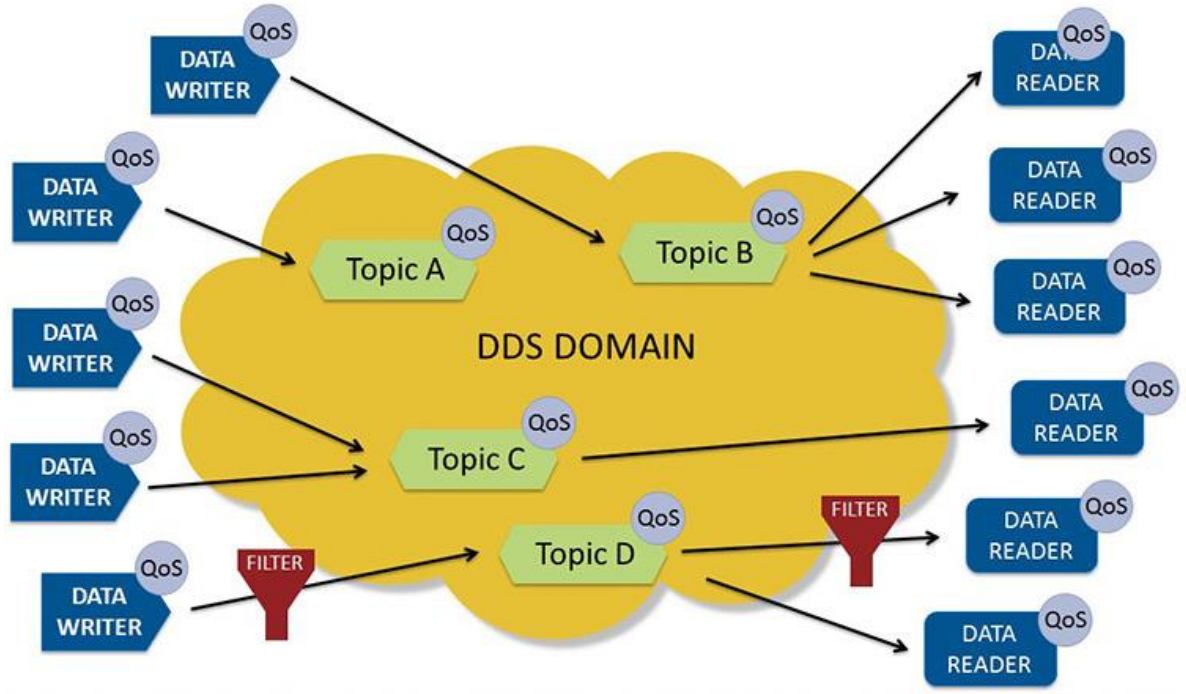
DDS: Robust Infrastructure

- Today's distributed systems operate in **dynamic**, **demanding**, and **unpredictable** environments
- These systems require ability to cope with **errors**, **attacks**, **unexpected events**
  - All connected components, including deeply embedded
- DDS Automatically handles
  - Network disconnects / reconnects
  - Dynamic network topologies
  - Redundant network paths
  - Unreliable physical networks
  - Low-bandwidth networks
  - Disadvantaged CPU's / resource challenged devices

© 2023 Object Management Group

DDS: Extensive Flexibility

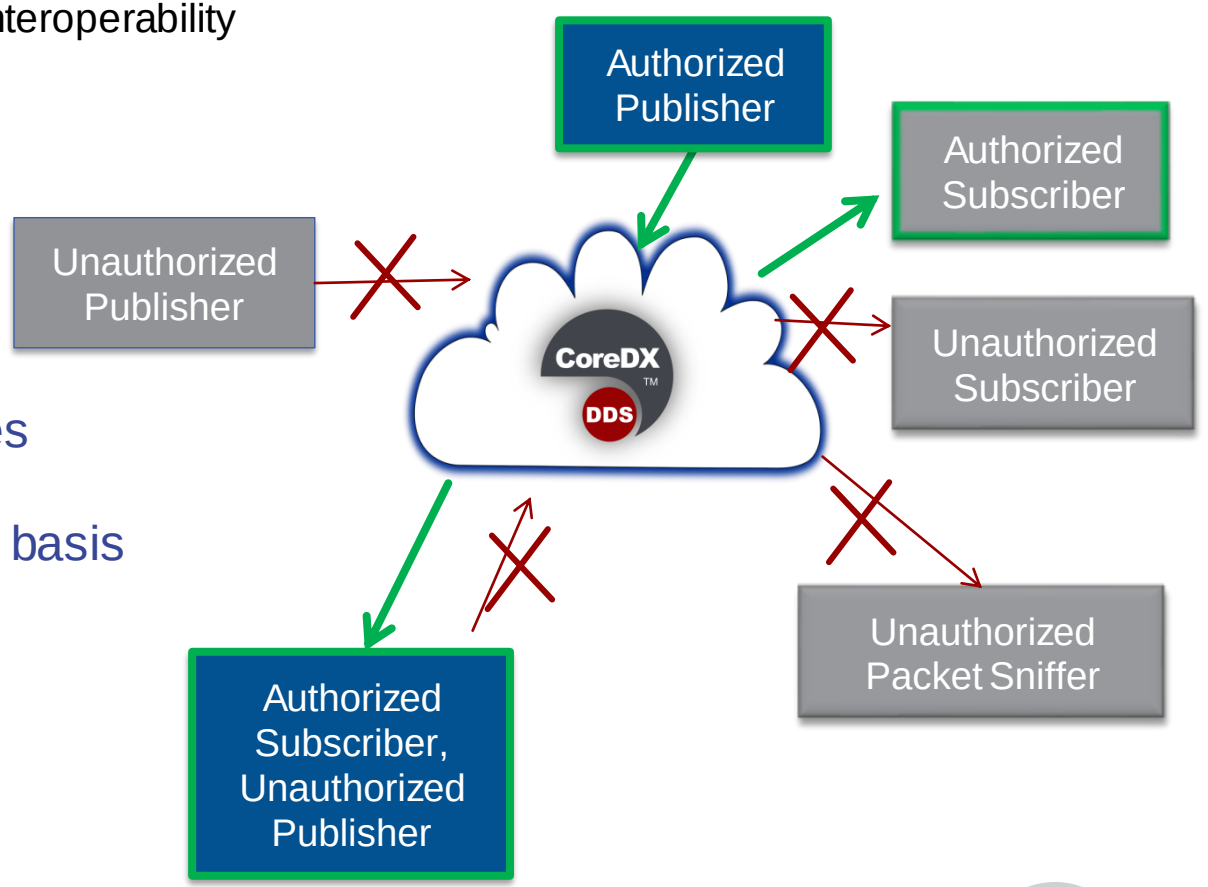
- DDS Quality of Service (QoS)
  - Enables **Configurable Behavior** of Data Communications
  - **Adapt** to meet a variety of IIoT system requirements
  - Enables machines to **React** to environment, events



© 2023 Object Management Group

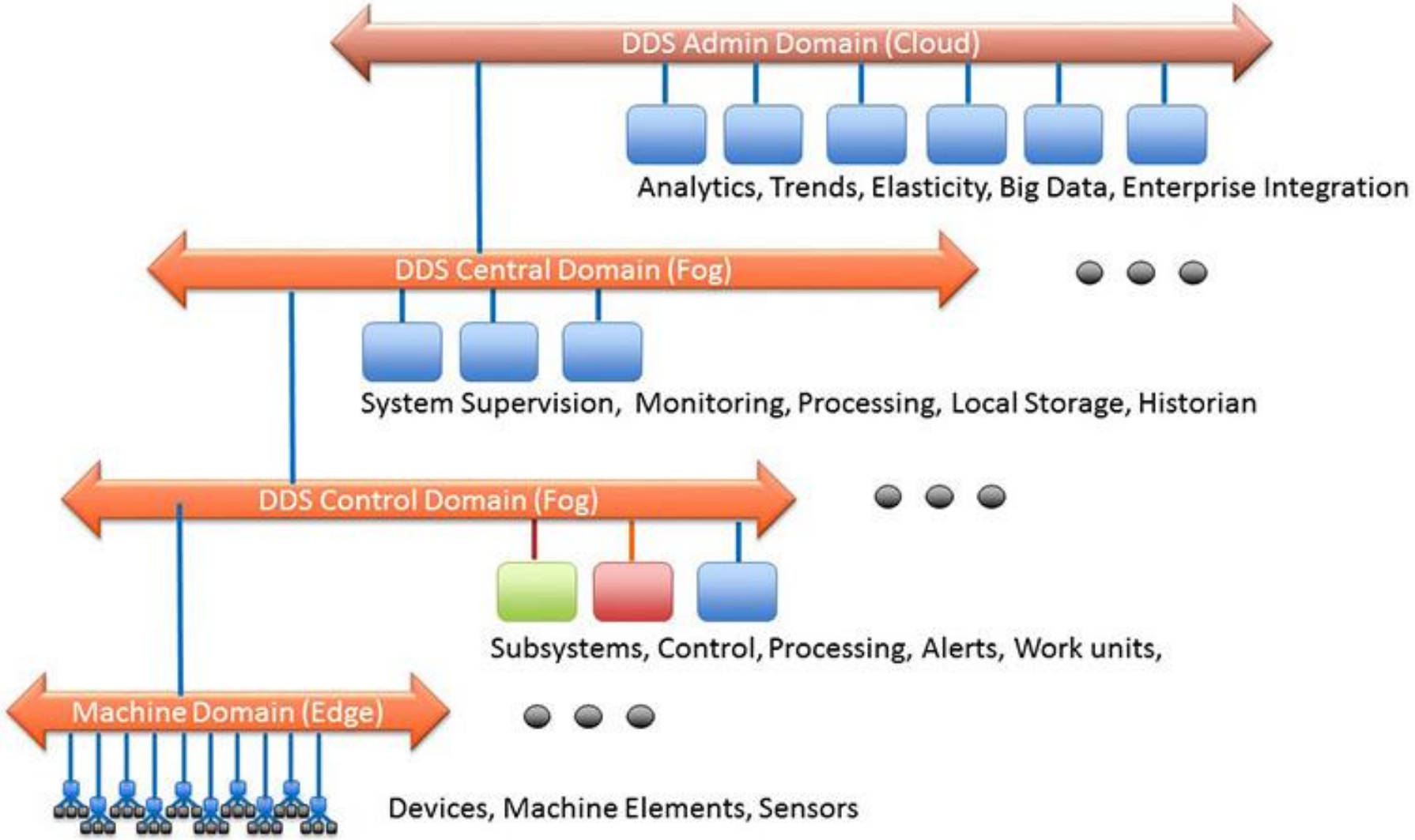
DDS: Secure Data Communications

- **DDS Secure Communications** solution fully integrated into DDS protocols
  - Standardized API and wire protocol for Portability and Interoperability
- **Covers all Aspects** of secure communications
  - Authentication
  - Access Control
  - Integrity
  - Confidentiality
- **Plug-in Model** allows user-defined security features
- **Full Configuration Flexibility** on a Topic-by-Topic basis
- **State-of-the-art** Security Technologies
  - PKI Crypto
  - GCM/GMAC, AES
  - Forward Secrecy



© 2023 Object Management Group

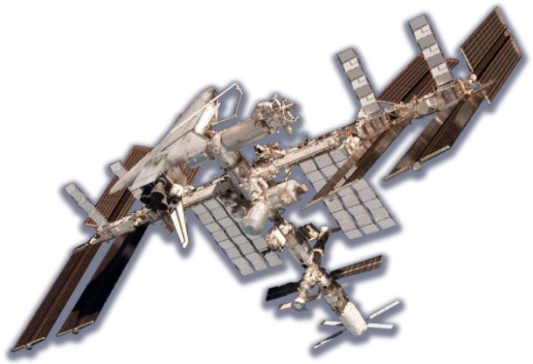
DDS: Scalable Architecture



© 2023 Object Management Group

DDS: Widely Deployed, Proven







- DDS is used in a wide range of Industries:
  - Aerospace & Defense
  - Consumer Electronics
  - Energy Solutions / Smart Grid
  - Financial
  - Healthcare
  - Home Automation / Smart Home
  - Scientific Research
  - Simulation
  - Space Exploration
  - Transportation
  - Unmanned Vehicles











© 2023 Object Management Group

Summary

- Today's connected systems have complex communication requirements
  - How do I secure my data and my communications?
  - Where do I get my data? How often?
  - What happens if you don't send it? Or if I don't receive it?
  - How time sensitive is my data?
  - How much data do I need to store for future use?
  - How do I select (filter) only the data I need to receive?



DDS addresses **complex communication** challenges across **diverse** components in **challenging** environments

© 2023 Object Management Group

DDS Standards Family

Adam Mitz

March 22, 2023



OMG Standards Development Organization

DDS Family of Standards

- Data Distribution Service

  omg.org/spec/DDS

  - Data-Centric Publish-Subscribe
  - API and Semantics – QoS Policies
  - Asynchronous, strongly-typed multi-point cache sync
- DDSI-RTPS

  omg.org/spec/DDSI-RTPS

  - Wire Protocol for UDP/IP, unicast and/or multicast
  - Configurable and QoS-integrated reliability
  - Includes discovery

© 2019 Object Management Group

DDS Family of Standards

- DDS Security omg.org/spec/DDS-SECURITY
  - Authorization, Access Control, Encryption
  - Built-in (interoperable) implementations or use custom
- Extensible … Topic Types ... omg.org/spec/DDS-XTypes
  - Schema definition, semantics, network exchange
  - Programming language mappings (incl. Dynamic)
  - Data encoding system (XCDR)

© 2019 Object Management Group

DDS Family of Standards

- DDS Consolidated [XML|JSON] Syntax
- DDS for Extremely Resource-Constrained Environments
- RPC over DDS
- Web-Enabled DDS
- OPC/UA-DDS Gateway
- Java and C++ PSMs
- DDS for Lightweight CCM

omg.org/spec/category/
omg-data-distribution-service

© 2019 Object Management Group

Some Related OMG Standards

- Platform
  - IDL
  - IDL Language Mappings
  - IEF Reference Architecture
- Domain
  - Alert Management Service
  - Command and Control Interface for Navigation Systems
  - Open Architecture Radar Interface Standard

© 2019 Object Management Group



A Use Case for DDS

Christine Judd and Matt Judd

3/22/2023

Company Overview

Metron is an employee-owned company dedicated to delivering innovative solutions to the toughest problems

Key Metrics

- Founded in 1982
- $75M in annual revenue; $270M in total contract value
- 190 employee-owners with offices in Reston, San Diego, and Portland, OR
- Strong technical staff with extensive experience
  - 62% hold advanced degrees; 31% PhDs
  - 60% with >10 years experience

Core Capabilities

- **Analytics** - tools to process massive amounts of data, helping our clients make sense of their numbers.
- **Autonomy** – Innovative autonomy technologies enabling complex missions in challenging environments.
- **Decision Support** - systems that help operators make the best possible decision even in chaotic situations with ambiguous information.
- **Modeling & Simulation** - mission-level simulation tools that support the Department of Defense and Department of Homeland Security.
- **Sensing Systems** – tailored solutions that transform physical sensor data into useful information.

Unmanned Systems Division - Resilient Mission Autonomy ™

Mission Autonomy: Focused on maximizing mission success through intelligent, mission-driven, adaptive, non-scripted decision making without requiring human operators *in situ*

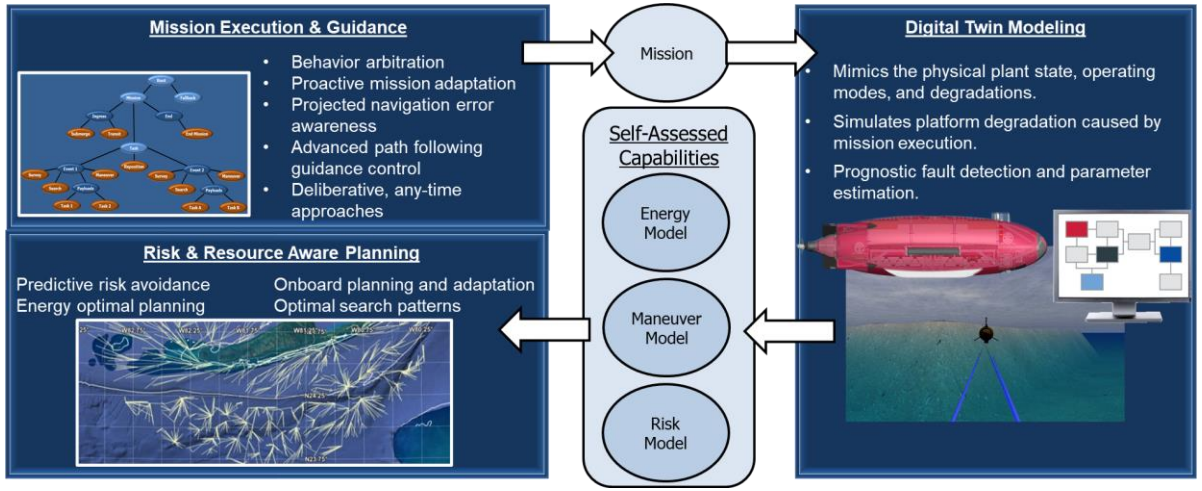
Resilient Autonomy: Autonomy that fuses fault detection, diagnosis and mitigation with mission requirements, priorities, and asset capabilities

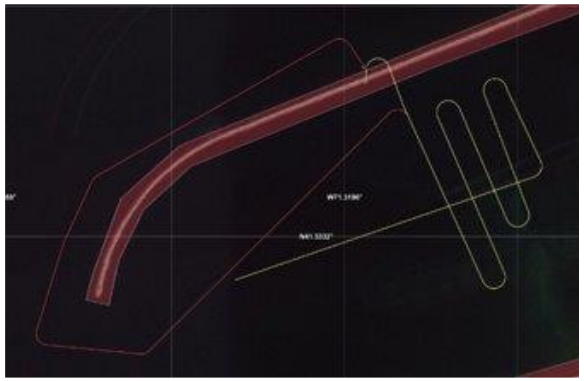
Risk & Resource Aware Sortie Planning

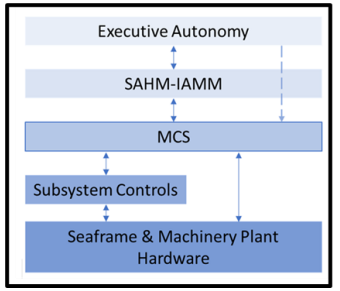
- Predictive risk avoidance
- Energy optimal planning
- Onboard planning and adaptation
- Optimal search patterns

Avoidance Planning

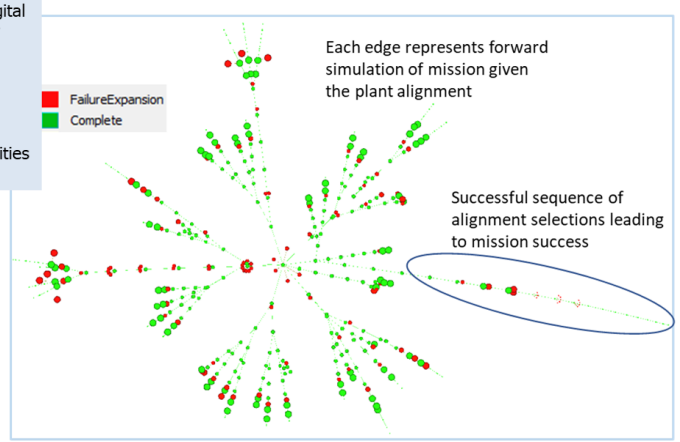
- Surface and subsurface obstacle avoidance behaviors for fixed & moving objects
- Avoidance planning accounting for uncertainty, currents, maneuver capabilities







SAHM-IAMM Digital Chief Engineer
- Digital Twin Modeling
- Ontological Representation: current mission, systems, capabilities & resources



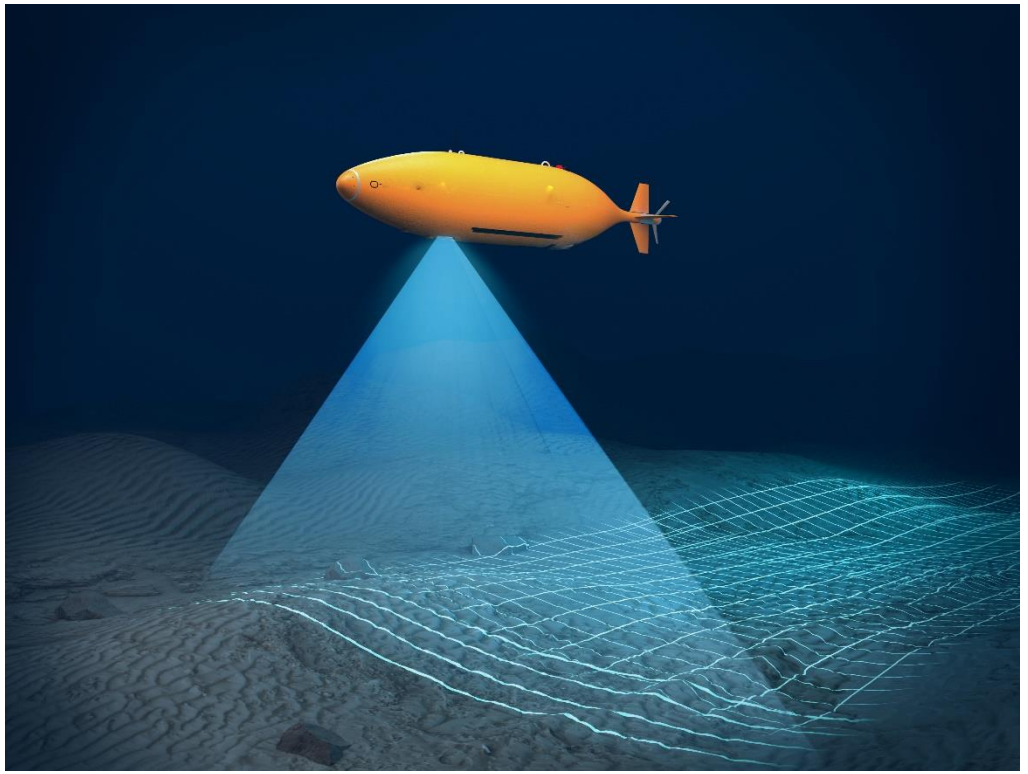
Onboard Self-Assessment Enabled Technologies

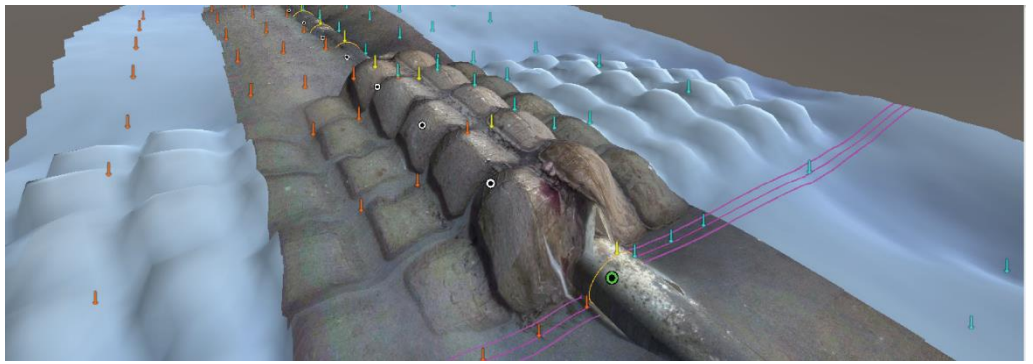
- Health-Aware Adaptive Planning
- Mission-Informed Fault Management
- Holistic Mission Management and Prioritization
- Condition-Based Autonomy

AUV Commercial Applications

Offshore Energy

- Oil and Gas
  - Pipeline Inspections
  - Asset Inspection and Monitoring
- Wind/Renewables
  - Cable and Turbine Inspections
  - Pre-site and Environmental Monitoring
- Goal:
  - Mitigates risks/events/threats
    - weather, erosion, hazards, impacts
  - Delivers 4D data collection
  - Allows for multiple sensor and payload configurations
  - Ensures overall pipeline/cable/asset integrity, monitors environmental conditions, and overall hazards bio/chemical/electrical that would reduce production levels.

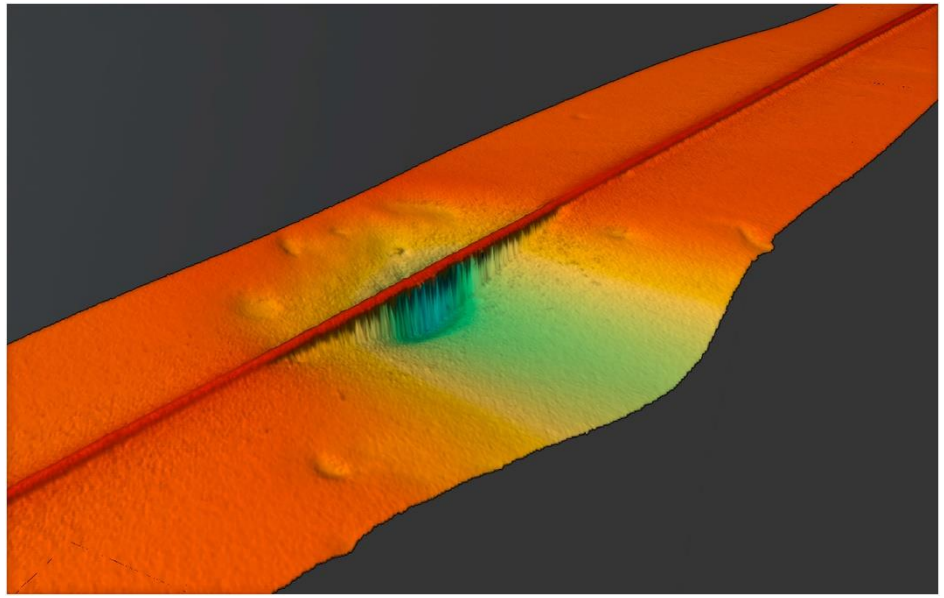




AUV Commercial Applications

General Requirements:

- Visual inspection
- Damages detection
- Debris detection
- Free span detection
- Buckling detection
- Autonomous pipeline tracking
- Geo-referenced data and mosaic for quick report analysis
- Acoustic Tether capability for real time QA / QC
- Video mosaicking
- Compatible with high resolution survey made by HD camera, SSS, SBP, SAS, MBES or laser
- Low magnetic signature for specific integration



Use Case – Development

Autonomy Development

Developing and testing this system involves running target architecture against world simulation to emulate target environment

- Software developed on amd64 Linux
- Deployed on ARM (e.g. rb5) computers
- Simulation runs on desktops with high end graphics engines; gazebo extension
- Optional monitoring GUI is a Java application running on Linux or Windows desktop

DDS Requirements

Architecture

- Amd64 Linux / C++
- ARM Linux / C++
- Windows / Java

Sensor messages

- High frequency small size
- Low frequency large size
- Guaranteed delivery not needed

Command & Control messages

- Intermittent
- Variable size
- Guaranteed delivery required

Monitoring messages

- Status messages for infrequent comms
- Widely varied in size and frequency

Use Case – Deployment

UUV Deployment

Target vehicles tend to be power constrained, containing a small number of low power computers in a closed network

- Vehicle interface at UDP or TCP/IP layer
- Autonomy deployed on ARM (e.g. rb5) computers
- Sensors and payloads provided by teammates communicate via DDS
- DDS Logging service logging all DDS messages for off-vehicle post mission analysis

DDS Requirements

Architecture
- Amd64 Linux / C++

Sensor messages
- High frequency small size
- Low frequency large size
- Guaranteed delivery not needed

Command & Control messages
- Intermittent
- Variable size
- Guaranteed delivery required

Post Mission Analysis messages
- Status messages for infrequent comms
- Widely varied in size and frequency
- Lowest priority compared to messages in the C&C loop

Use Case – Analysis

Post Mission Analysis

DDS Logging on board UUV (using native capability from RTI) preserves all autonomy messages generated during the mission

- DDS logging along with human-readable log files generated by autonomy components extractable as a single large compressed file
- Java GUI used in Post Mission Analysis mode allows for rapid understanding of the results of the mission
- When PMA identifies timestamps of interesting or concerning events, human readable logs can be examined for more detailed understanding

DDS Requirements

Architecture
- Windows / Java

Sensor messages
- Generally representable as simple structured timestamped data
- Potentially more data than comfortably contained in memory
- Sampling when attempting to address full mission, fully retrievable for subsets

Command & Control messages
- Must be fully available for diagnosing system performance
- Sometimes complex data structures requiring custom displays

- Post Mission Analysis messages
  - Required for understanding system performance

Use Case – Example

Resilient Mission Autonomy is a Trademark of Metron



Panel

March 22, 2023



OMG Standards Development Organization

Panel Discussion

Moderator



Char Wales
Co-Chair
OMG MARS Group



Erik Hendriks
Senior Architect
ZettaScale Technology



Andy Krassowski
Senior Field Application Engineer
Real-Time Innovations (RTI)



Adam Mitz
Principal Software Engineer
Object Computing, Inc (OCI)



Nina Tucker
VP of Technology
Twin Oaks Computing

© 2023 Object Management Group