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DDS Security

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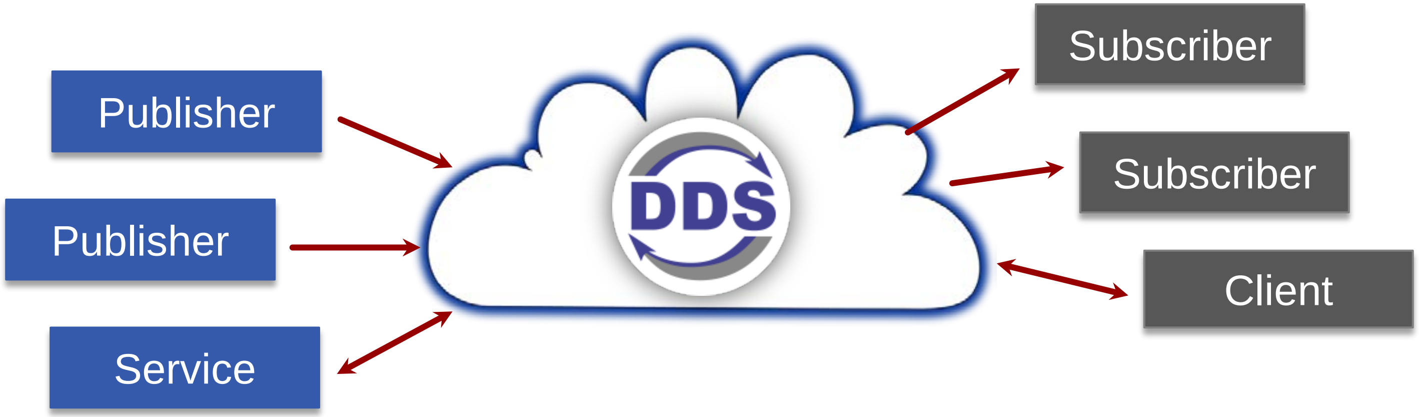
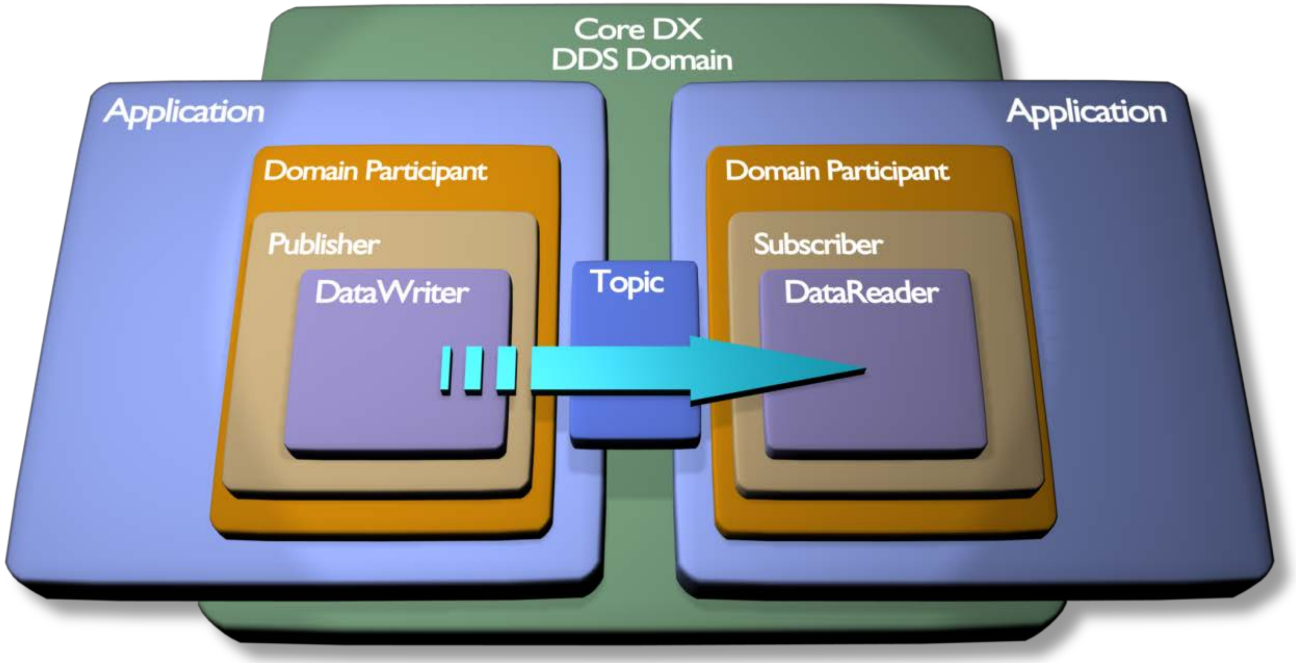
Data Distribution Service

- DDS is a Data-Centric Communications Middleware
  - **Distributed** Data Communications – no brokers required
  - System Components are **Decoupled**
  - **Robust** infrastructure for critical systems
  - **Scalable** from edge to cloud, from bare metal to servers



DDS Architecture and Terminology

- DomainParticipant
  - Associated with a Domain
  - Communicates with other DomainParticipants in the same Domain
  - Contains DataWriters, DataReaders, Topics
- DataWriters and DataReaders are “matched” during Discovery
- DataWriter publishes data on a Topic
- DataReader subscribes to a Topic
- Each Topic has a defined Data Type



DDS Discovery

- Automatic
  - No configuration of IP address, port numbers, servers, or brokers
  - Peers may be on the same machine or across a network
  - Simply indicate your intent to publish or subscribe, and start writing/reading
- Dynamic
  - Peers may come and go, or move at any time
  - Publishers and Subscribers may be created an deleted
  - Networks may be disconnected and reconnected

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DDS Configurability: QoS

	QoS Policy
Cache	**DURABILITY**
	HISTORY
	LIFESPAN
Resources	WRITER DATA LIFECYCLE
	READER DATA LIFECYCLE
	ENTITY FACTORY
	RESOURCE LIMITS
Delivery	**RELIABILITY**
	TIME BASED FILTER
	DEADLINE
	CONTENT FILTERS

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

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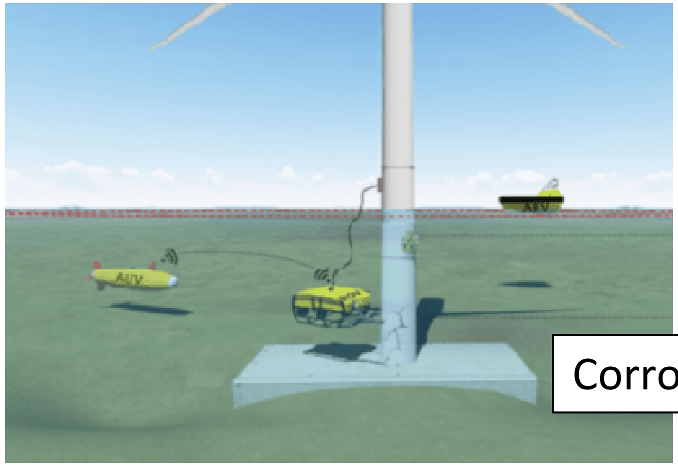
Cyber Threats

Real World Examples

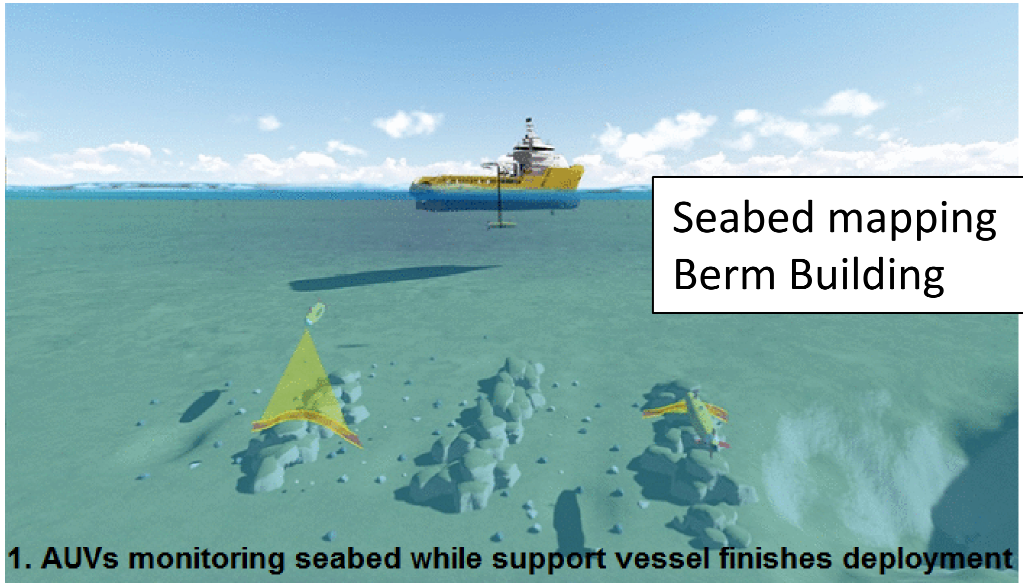
Example Threat Analysis

Smart and Networking Underwater
Robots in Cooperation Meshes

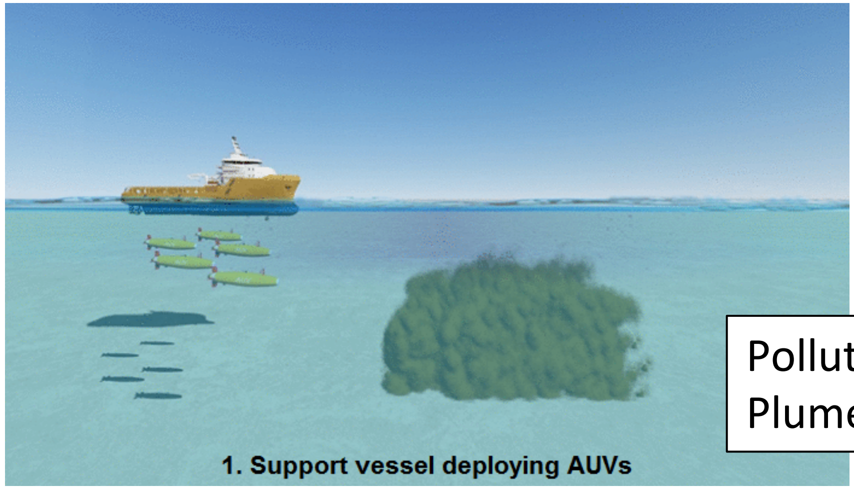
SWARMS Case Study



Corrosion Prevention


1. AUVs monitoring seabed while support vessel finishes deployment

Seabed mapping
Berm Building



Pollution Monitoring
Plume Tracking

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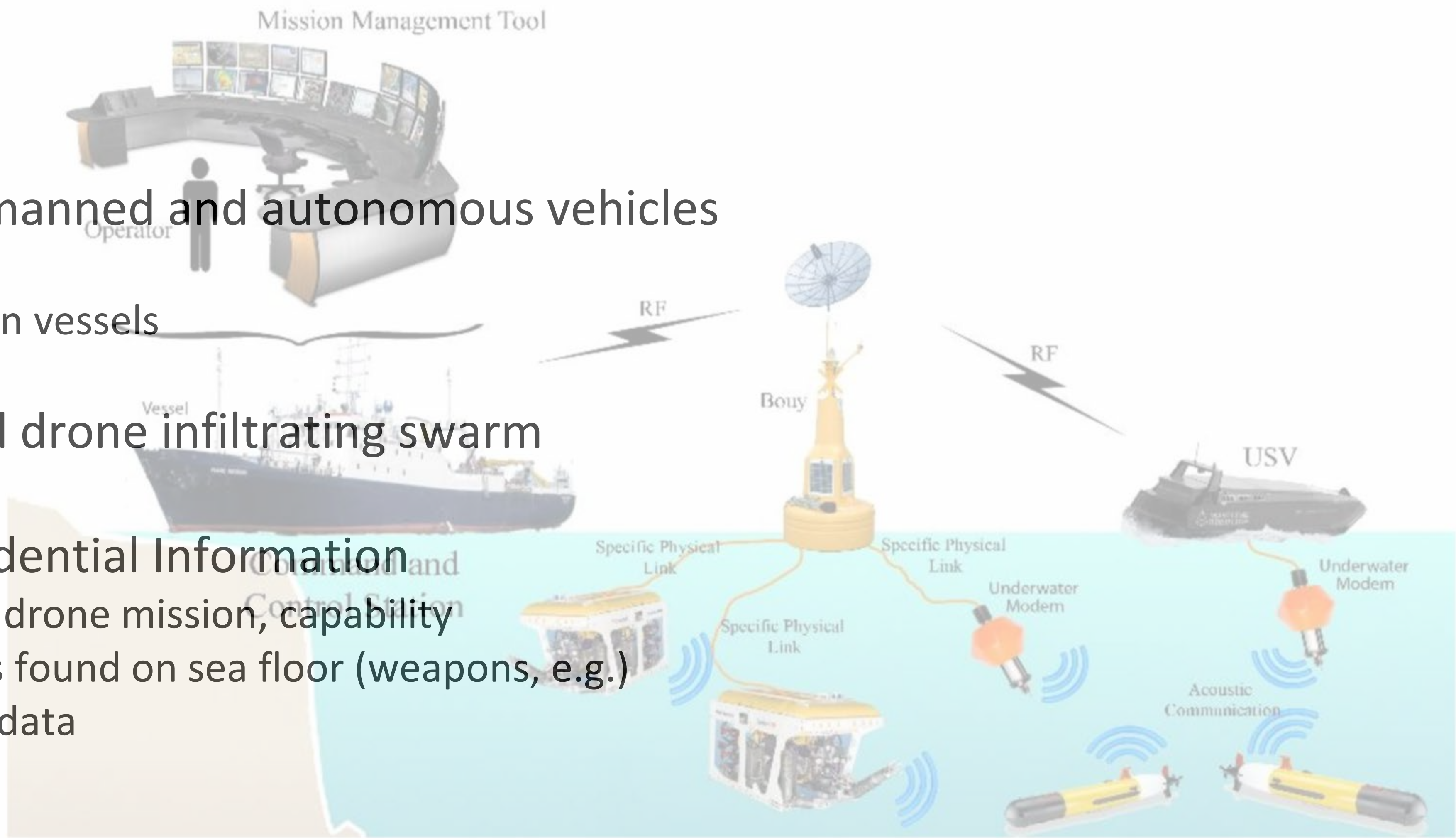
SWARMS Case Study

- Threat Analysis
  - Take over of unmanned and autonomous vehicles
    - Oil / gas lines
    - Military / civilian vessels
  - Unauthenticated drone infiltrating swarm
  - Release of Confidential Information
    - Information on drone mission, capability
    - Nature of items found on sea floor (weapons, e.g.)
    - Environmental data



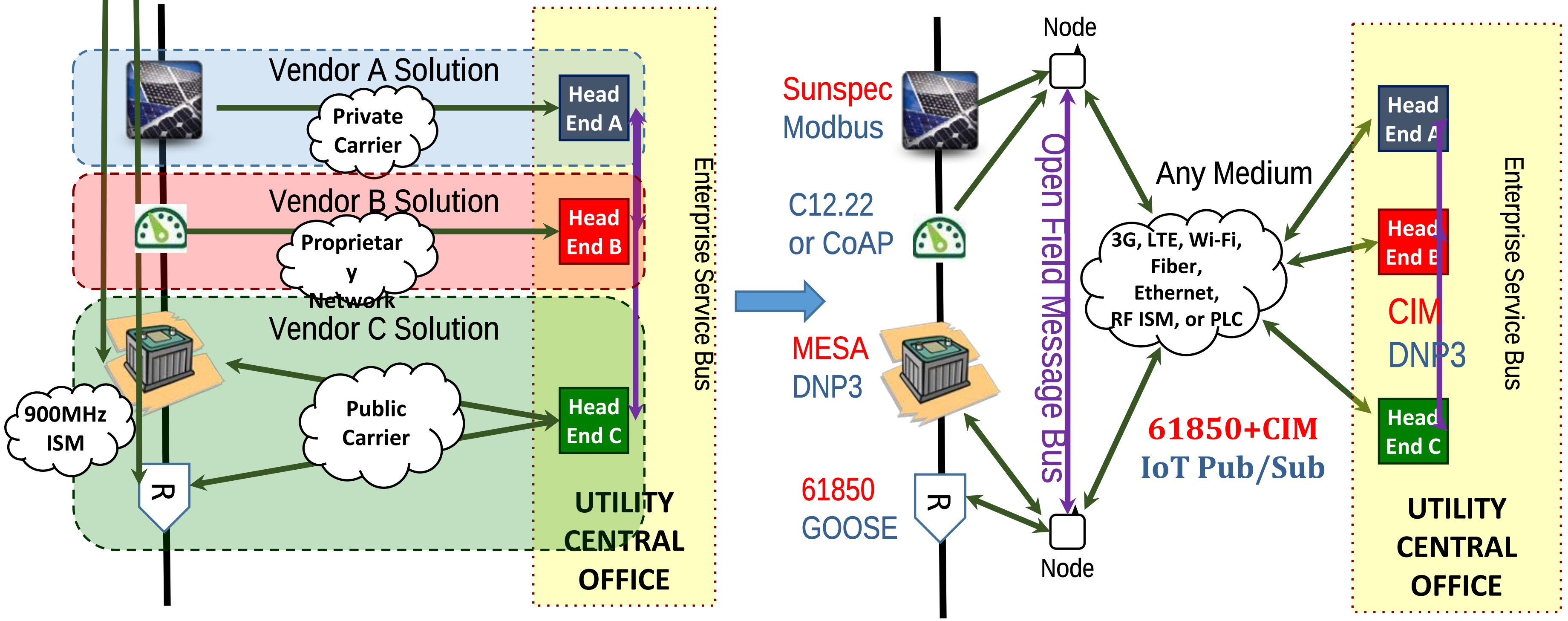
SWARMs

Example Threat Analysis

Duke Energy Emerging Technology Office

OpenFMB Cyber Security Overview

OpenFMB Case Study



Key Observations:

1. Single-Purpose Functions
2. Proprietary & Silo'ed systems
3. Latent , Error-prone Data
4. OT/IT/Telecom Disconnected
5. No Field Interoperability!

Key Observations:

1. Multi-Purpose Functions
2. Modular & Scalable HW&SW
3. End-to-End Situational Awareness
4. OT/IT/Telecom Convergence
5. True Field Interoperability!

OpenFMB Case Study

- Loss of power, small areas to wide scale
  - Loss of life
  - Safety and Security Issues
  - Failure of critical infrastructure operation

- Masquerade / Takeover control applications
  - Control the Switch / Breaker / Recloser / Voltage Regulator / PCC
  - Spoof Status
  - Change Setpoints, Disable Protection
  - Drive Distributed Denial-of-Service attack (DDoS)

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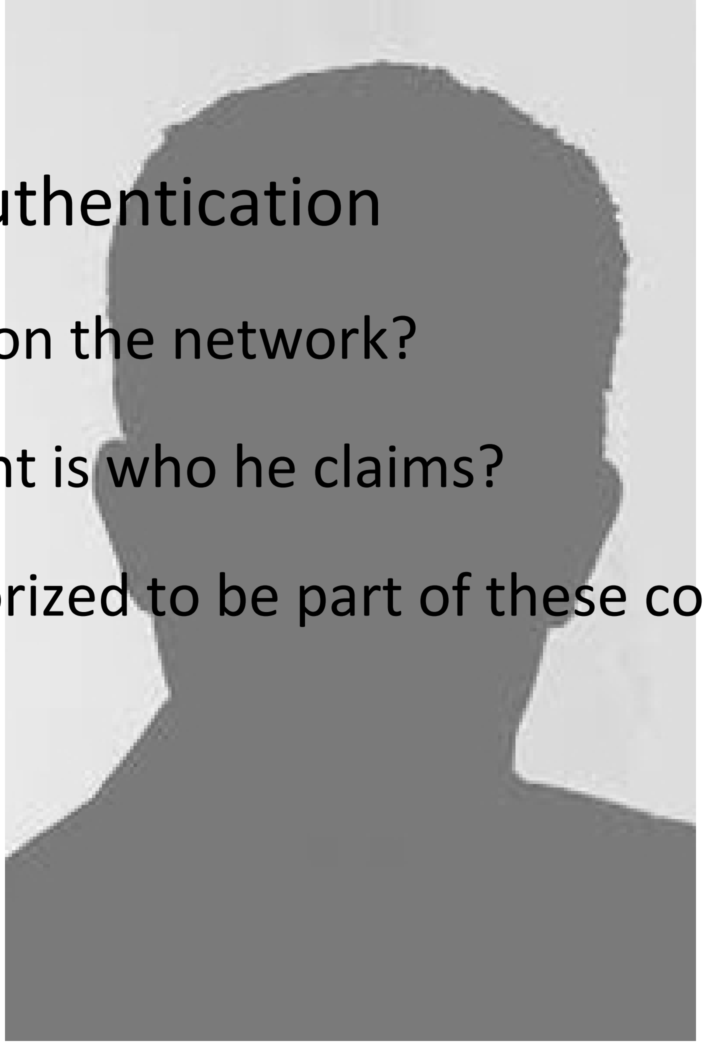
Cyber Security Elements

Identification and Authentication



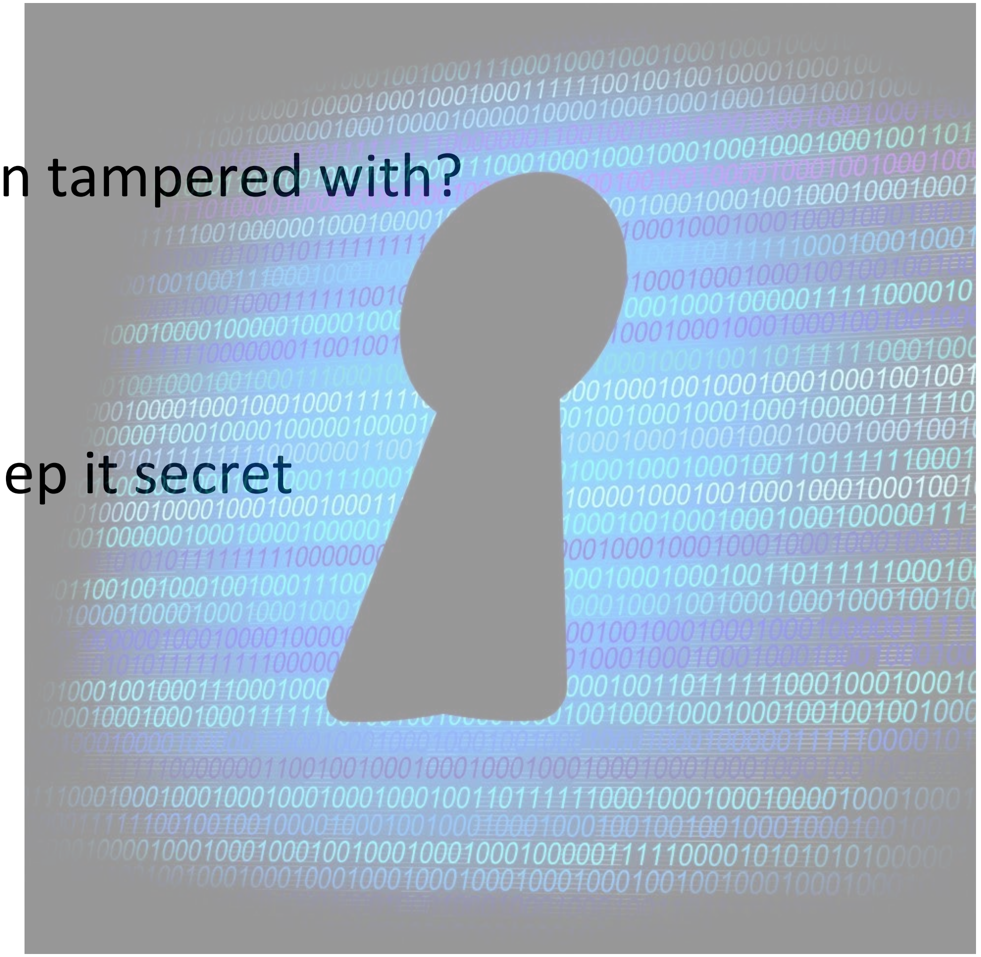
- I&A: Identification & Authentication
  - Who is this participant on the network?
  - Do I trust this participant is who he claims?
  - Is this participant authorized to be part of these communications?

Access Control

- Access Control
  - Is checked after Identification & Authentication
  - Does this participant have permission to join the network?
  - Does this participant have read and/or write access on the network?

Integrity and Confidentiality

- Integrity
  - Has the data been tampered with?
- Confidentiality
  - Hide the data, keep it secret



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DDS Security

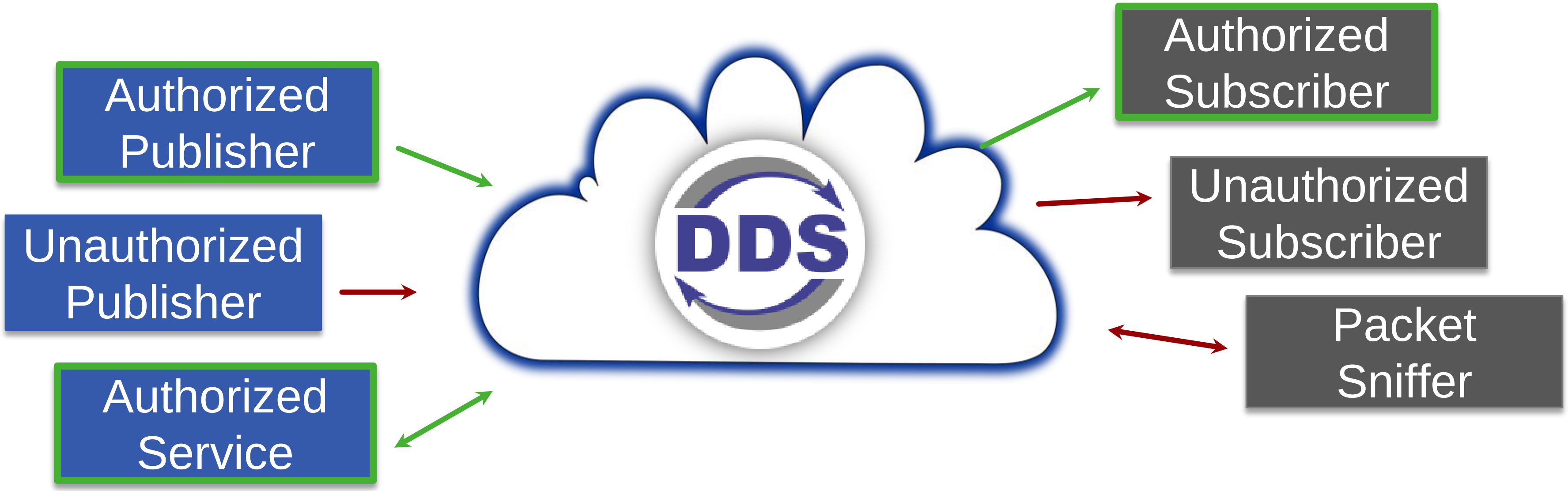
The Basics

DDS Security

- Secure communications solution fully integrated into the DDS architecture
  - Standardized API and wire protocol for Portability and Interoperability

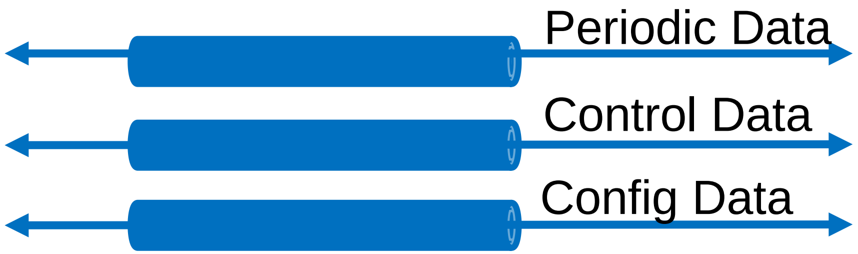
- Covers all aspects of secure communications, including:
  - Authentication
  - Integrity
  - Confidentiality
  - Access Control

- Plug-in model
  - Standardized
  - User defined

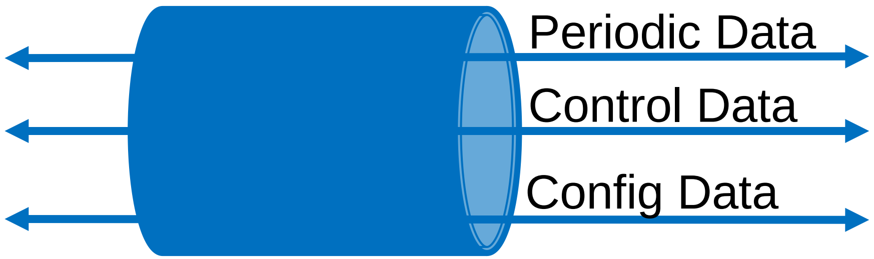


Why DDS Security

- DDS Security is still DDS
  - Decoupled, Flexible, Scalable architecture
  - Eases development of distributed systems across disparate computing platforms
  - Powerful configurability
- Scalable high-performance Security
  - Topic-by-Topic configuration (not transport-level configuration)



Topic Level Configuration



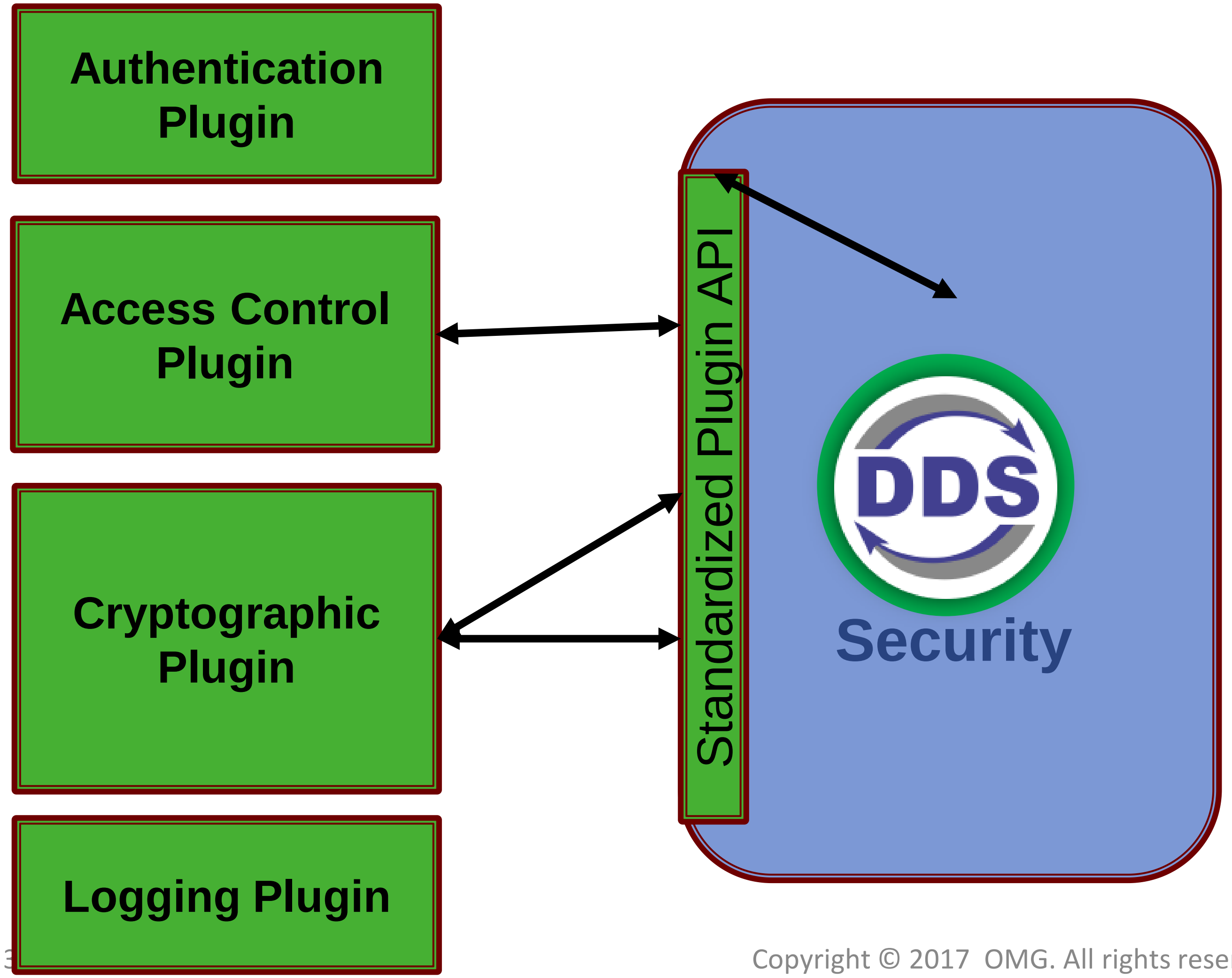
Transport Level Configuration

Who Uses DDS Security

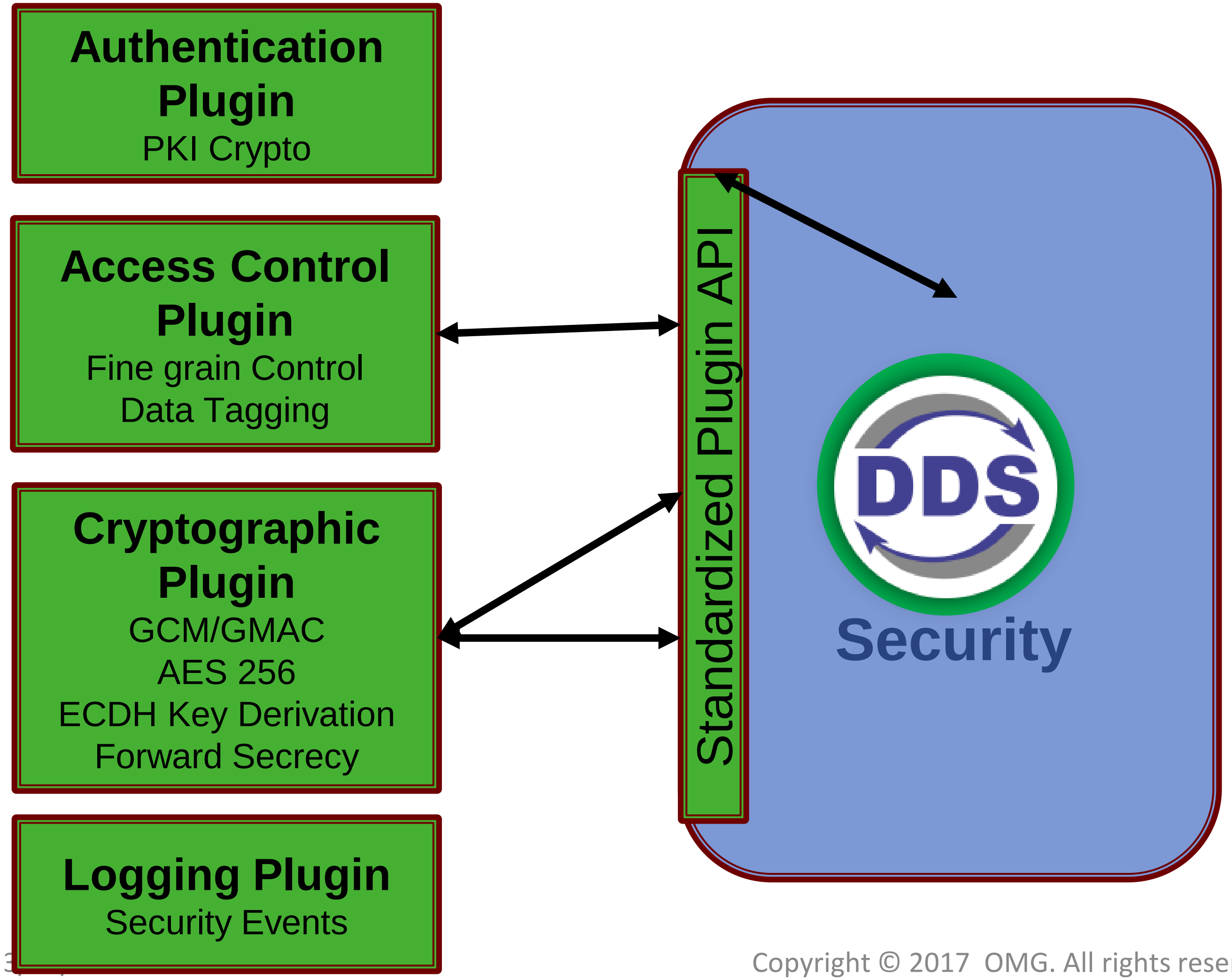
- Military:
  - Avionics
  - Naval
  - Unmanned Vehicles
  - Ground Stations

- Commercial:
  - IIoT Systems
  - Avionics
  - Automotive
  - Consumer Electronics
  - Energy Solutions / Smart Grid
  - Medical Devices

DDS Security: Plug-in Architecture



- Standardized API
  - Interface between modules and DDS Security protocols
  - Modules may be Standard or Custom
  - Includes all aspects of secure communications
- Standardized modules
  - Interoperable
  - Use common crypto algorithms



Authentication Plugin
PKI Crypto

Access Control Plugin
Fine grain Control
Data Tagging

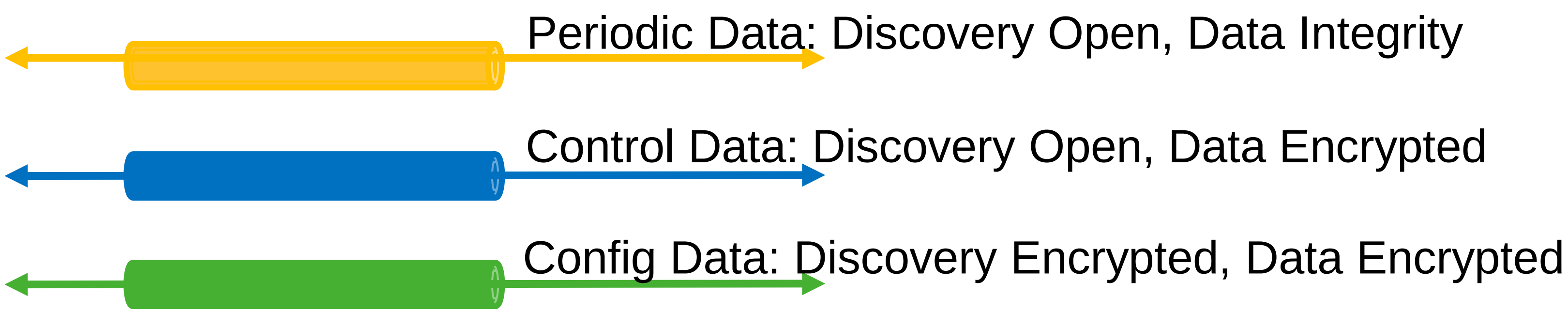
Cryptographic Plugin
GCM/GMAC
AES 256
ECDH Key Derivation
Forward Secrecy

Logging Plugin
Security Events

- Standardized Plugin Modules
  - PKI + GCM + GMAC
  - AES 256
  - ECDH Key Derivation
- Interoperable

DDS Security: Configurability

- Apply security policies
  - Integrity / Encryption / Access Controls
- With fine grained controls
  - Individual Topics
  - Application Data, Discovery Data, Liveliness Data



Periodic Data: Discovery Open, Data Integrity

Control Data: Discovery Open, Data Encrypted

Config Data: Discovery Encrypted, Data Encrypted

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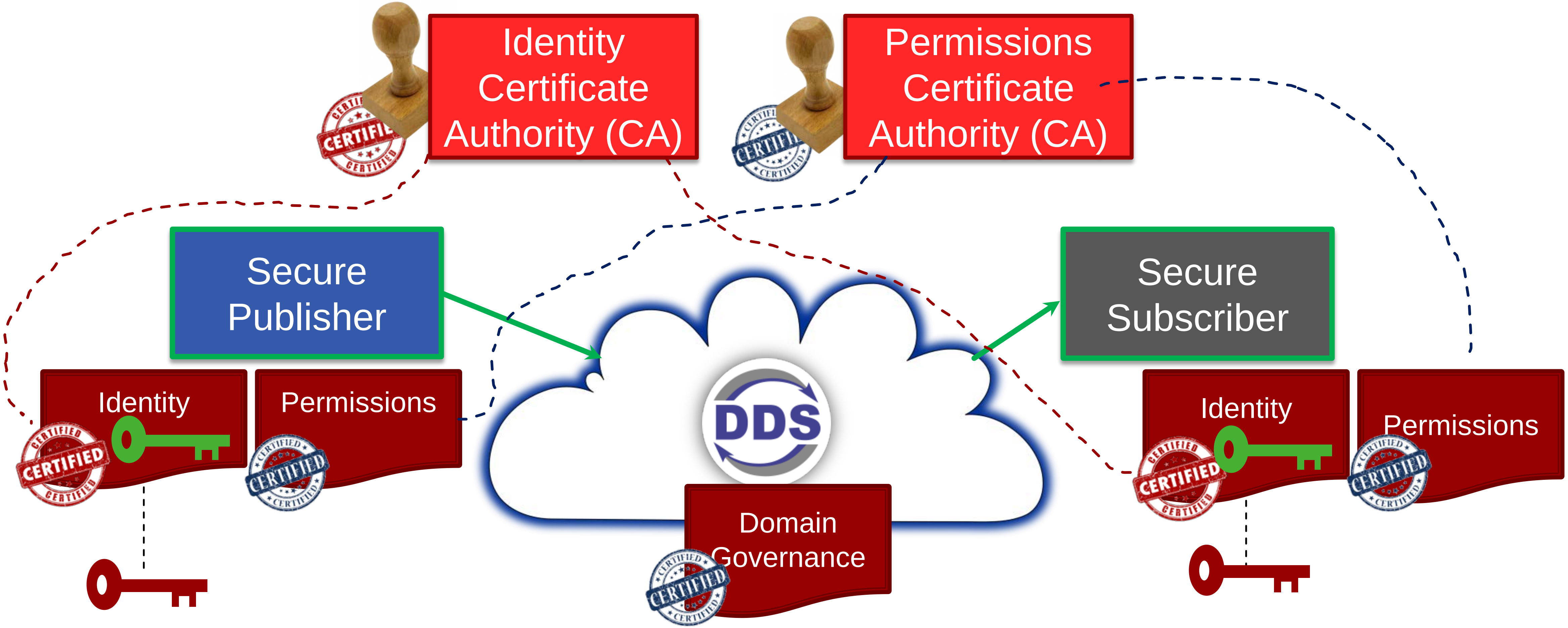
DDS Security Components

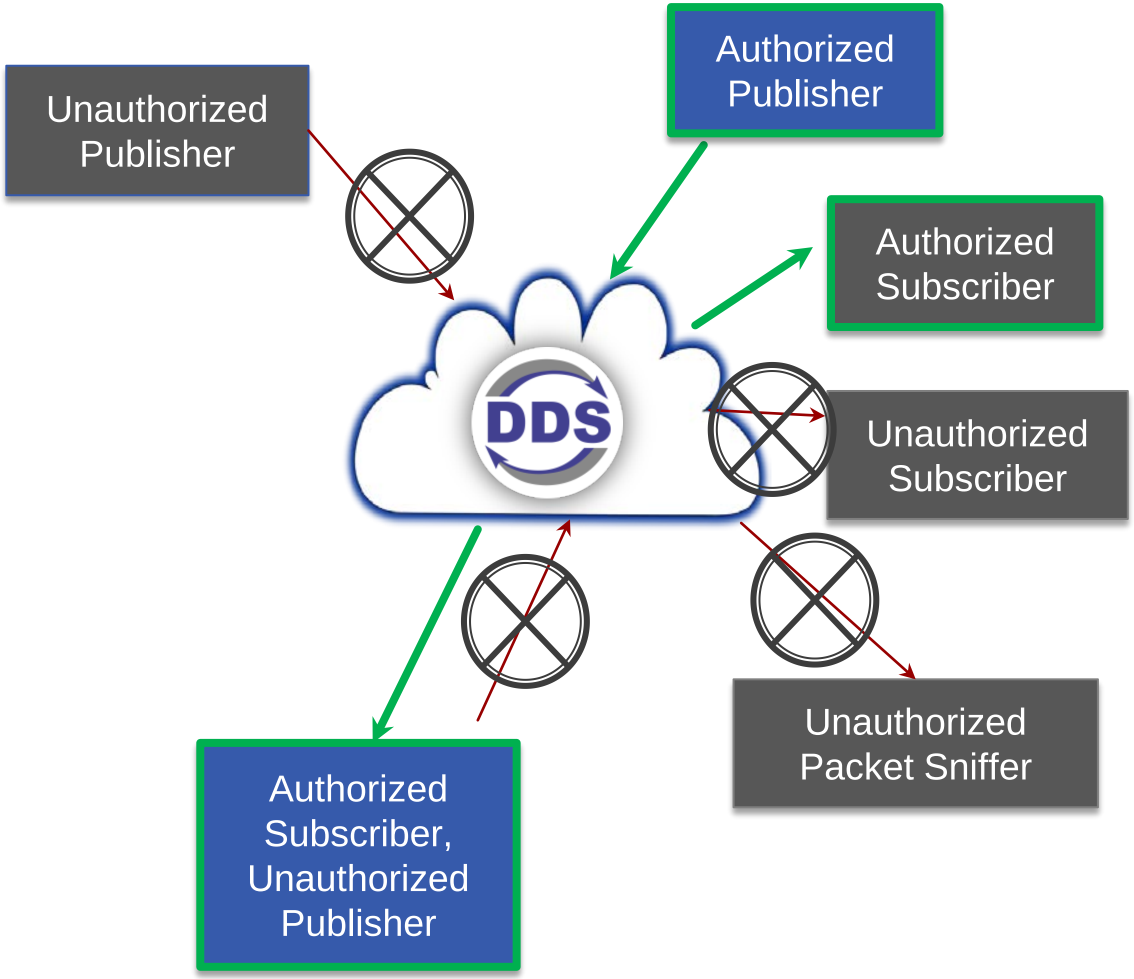


DDS Security

Live Demonstration

DDS Security Overview

- **Covers all Aspects** of secure communications
  - Authentication
  - Access Control
  - Integrity
  - Confidentiality
- **Full Configuration Flexibility** on a Topic-by-Topic basis
- **State-of-the-art** Security Technologies
  - PKI Crypto
  - GCM/GMAC, AES
  - Forward Secrecy
- Maintains key benefits of DDS:
  - **Distributed** Data Communications – no brokers required
  - System Components are **Decoupled**
  - **Robust** infrastructure for critical systems
  - **Scalable** from edge to cloud, from bare metal to servers



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Thank you!

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