NSRP | National Shipbuilding Research Program

(SHIPBOARD OPERATIONS USER EXPERIENCE OF AN AIRCRAFT CARRIER DIGITAL TWIN)

On-Board Ship 3D Environment

Project Overview

Proof-of-Process Technical Evaluation

September 15, 2021

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Carla Coleman; Newport News Shipbuilding

Virtual Model

Closing The Loop…

Validation

Physical Ship

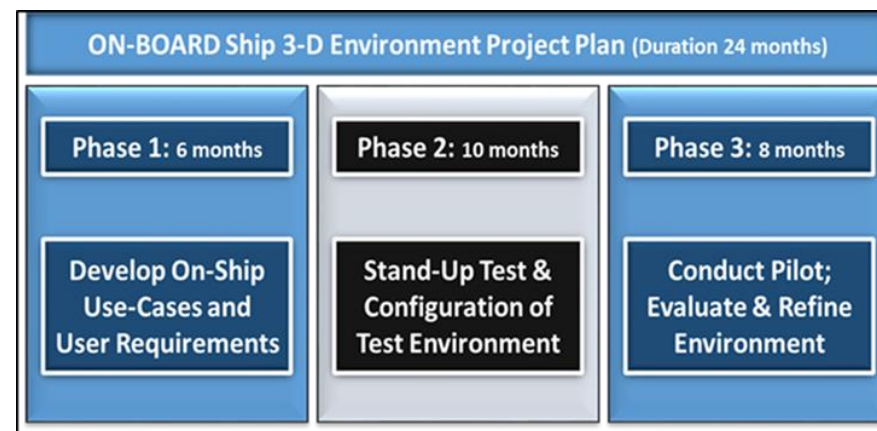The collaboration, technical strength, and depth of our team is making this project successful.

On-Board Ship 3D Environment "Problem & Objective"

PROBLEM TO BE ADDRESSED: Current state of the art; for on-board ship data systems, uses a range of technology from "decades-old" 2D drawings and publication & management systems to manage critical ship information.

These systems lack integration and visualization interfaces with the 3D product models and the ship configuration. These legacy processes & systems create a high lifecycle RISK for accurate 3D product model sustainment.

PROJECT OBJECTIVE: Provide the Navy a viable, and operationally capable Commercial-Off-The-Shelf (COTS) solution for an "On-Board Ship 3-D Environment" based on a direct copy from the Hull Planning Yard (HPY) digital product model. We will provide the Ship's Force access to the most current ship configuration data.

ON-BOARD Ship 3-D Environment Project Plan (Duration 24 months)

Phase 1: 6 months	Phase 2: 10 months	Phase 3: 8 months
Develop On-Ship Use-Cases and User Requirements	Stand-Up Test & Configuration of Test Environment	Conduct Pilot; Evaluate & Refine Environment

Capabilities provided by this project will significantly reduce the Navy's ship lifecycle Total-Ownership-Costs (TOC).

HARD STUFF DONE RIGHT   **A DIVISION OF HUNTINGTON INGALLS INDUSTRIES**

On-Board Ship 3D Environment "Implementation Target CVN78"

The next Generation is here...

CVN 78 Gerald R. Ford & CVN 75 Harry S. Truman

On-Board Ship 3D Environment "Implementation Target CVN78"

Aircraft Carrier "GERALD R. FORD" the Big Picture

An unparalleled level of managed Intellectual Property
"A National Asset"

- 10+ Year Build Cycle
- ~ 55,000,000 Man-Hours of Navy Investment

Design
- ~ 3 Million Piece Parts

Purchasing
- Over 2,000 Suppliers
- Over 70,000 Part Numbers

Manufacturing
- 150,000 Shop Work Packages
- 50,000 Tons of Fabricated Steel Assemblies

Shipboard
- Over 50,000 Ship Work Packages
- 9 Million Feet of Cable
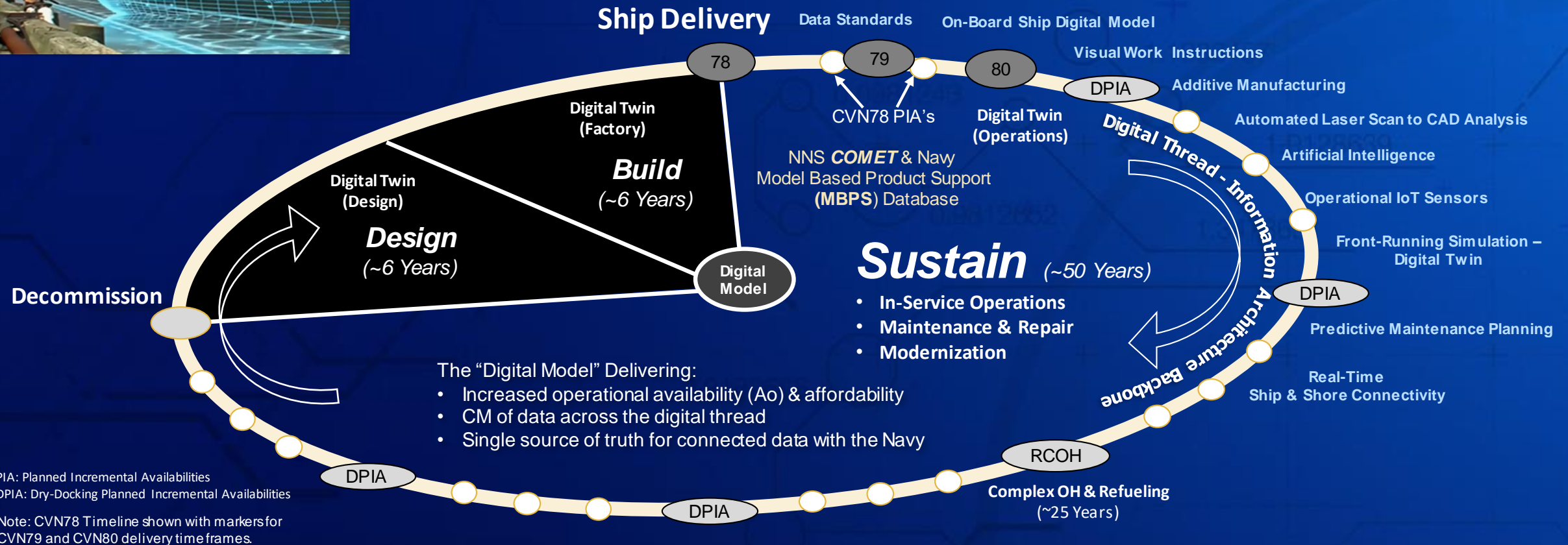- 4 Million Feet of Fiber

Lifecycle
- 50 Year Life
- Obsolescence Management
- Configuration Management Throughout

Our Challenge is Managing Complexity while implementing Disruptive Technologies

Digital Ship Lifecycle – The Digital Thread
Ford Class Ship Sustainment will require New Capabilities

Ship Delivery

Data Standards

On-Board Ship Digital Model

Visual Work Instructions

Additive Manufacturing

Automated Laser Scan to CAD Analysis

Artificial Intelligence

Operational IoT Sensors

Front-Running Simulation – Digital Twin

Predictive Maintenance Planning

Real-Time Ship & Shore Connectivity

Complex OH & Refueling (~25 Years)

Digital Thread - Information Architecture Backbone

Digital Twin (Factory)

Build (~6 Years)

Digital Twin (Design)

Design (~6 Years)

Digital Model

Decommission

CVN78 PIA's

Digital Twin (Operations)

NNS **COMET** & Navy Model Based Product Support **(MBPS)** Database

Sustain *(~50 Years)*

- **In-Service Operations**
- **Maintenance & Repair**
- **Modernization**

The "Digital Model" Delivering:
- Increased operational availability (Ao) & affordability
- CM of data across the digital thread
- Single source of truth for connected data with the Navy

78
79
80
DPIA
DPIA
DPIA
RCOH
DPIA

PIA: Planned Incremental Availabilities
DPIA: Dry-Docking Planned Incremental Availabilities

Note: CVN78 Timeline shown with markers for CVN79 and CVN80 delivery time frames.

Advancing Digital Data Management through the Ship's Lifecycle
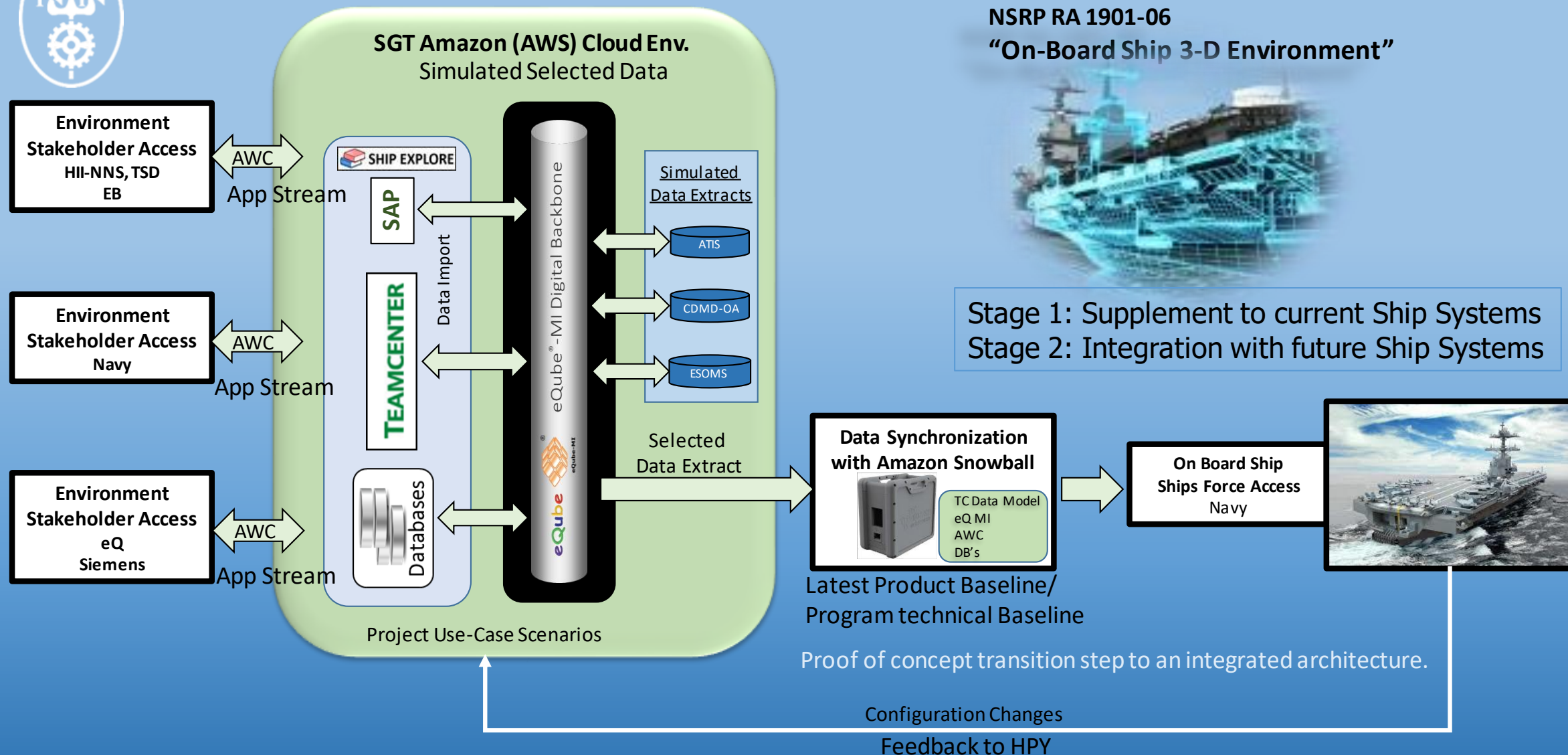
On-Board Ship 3D Environment "Navy Communication Vision"
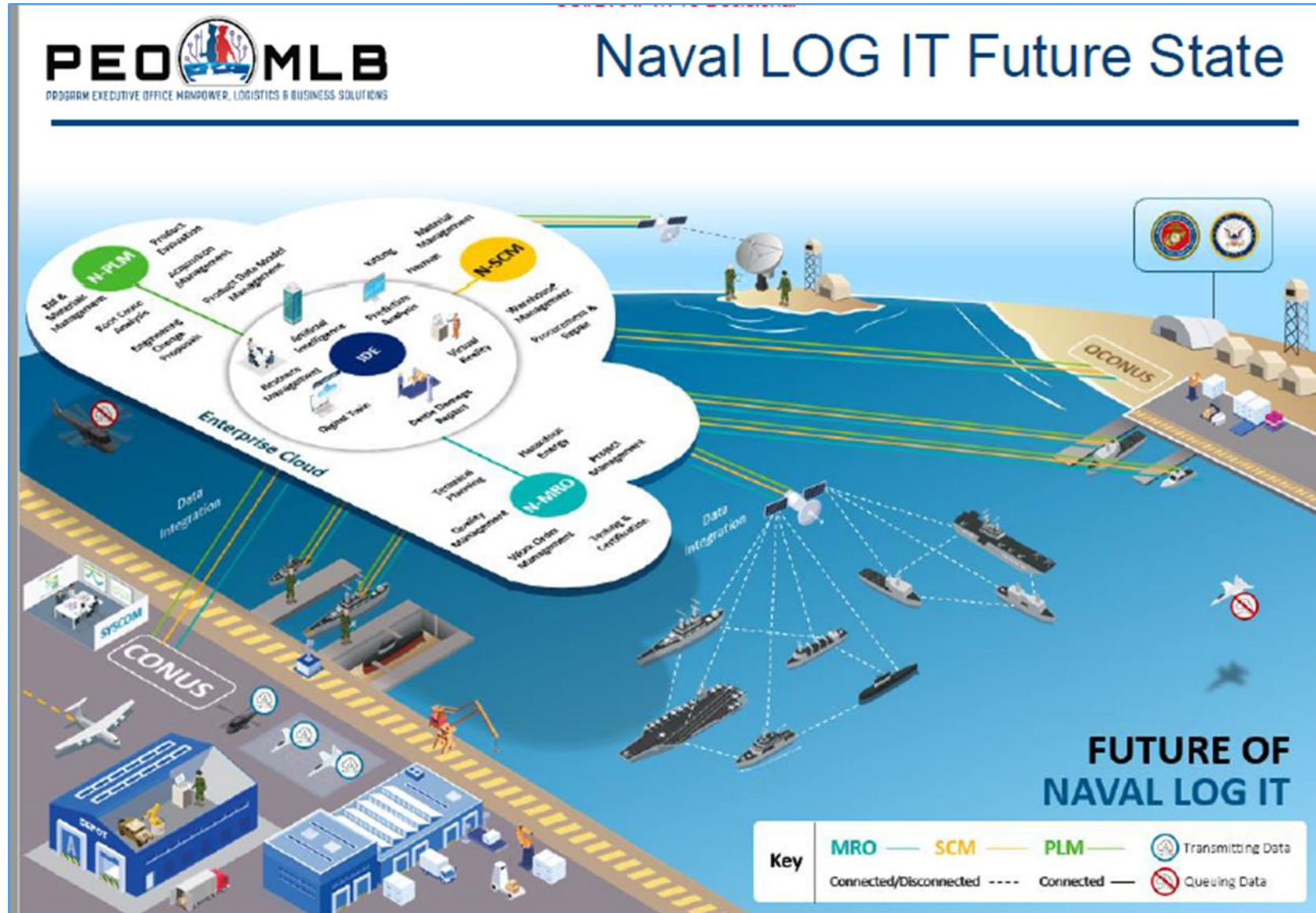
On-Board Ship 3D Environment – Architecture for Data Integration Evaluation

SGT Amazon (AWS) Cloud Env.
Simulated Selected Data

NSRP RA 1901-06
"On-Board Ship 3-D Environment"

Stage 1: Supplement to current Ship Systems
Stage 2: Integration with future Ship Systems

Environment Stakeholder Access
HII-NNS, TSD
EB

AWC
App Stream

Environment Stakeholder Access
Navy

AWC
App Stream

Environment Stakeholder Access
eQ
Siemens

AWC
App Stream

SHIP EXPLORE

SAP

TEAMCENTER

eQube

Databases

Data Import

eQube®-MI Digital Backbone

eQube-MI

Simulated Data Extracts

ATIS

CDMD-OA

ESOMS

Selected Data Extract

Project Use-Case Scenarios

Data Synchronization with Amazon Snowball

TC Data Model
eQ MI
AWC
DB's

Latest Product Baseline/
Program technical Baseline

Proof of concept transition step to an integrated architecture.

On Board Ship
Ships Force Access
Navy

Configuration Changes
Feedback to HPY

On-Board Ship 3D Environment "Project Use Cases"

Use Case	Purpose: represent most common functionality needed for ship sustainment
1. Maintenance Initiate a routine repair.	Purpose is to illustrate a simple to use interface that enables a user to locate a component, validate it's the right component that needs to be repaired, and obtain some ordering information that can be 1) Entered* into a Navy on-board system to initiate an order for replacement, or 2) Entered* into a form to order replacement material, or 3) Entered* into a form to request authorization for repair.
2. Casualty incident Report evaluation assessment of damage	Purpose is to show that by using 1 piece of information about a damaged part, you can quickly learn about the entire space and be able to identify other components in the vicinity also needing repair, so that larger scale replacement work can be initiated.
3. Look-Up Find information related to a component or system	Purpose is to show how to use one piece of information to find out most any other design / build / maintenance information that would not be shown on construction drawings.

* Prototype will demonstrate the ability to view and reuse data efficiently, follow-on projects can orchestrate the automation and population of downstream systems.
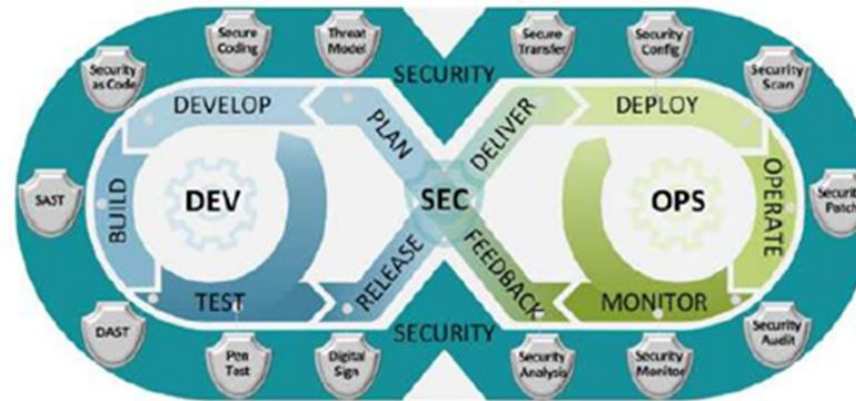
On-Board Ship 3D Environment

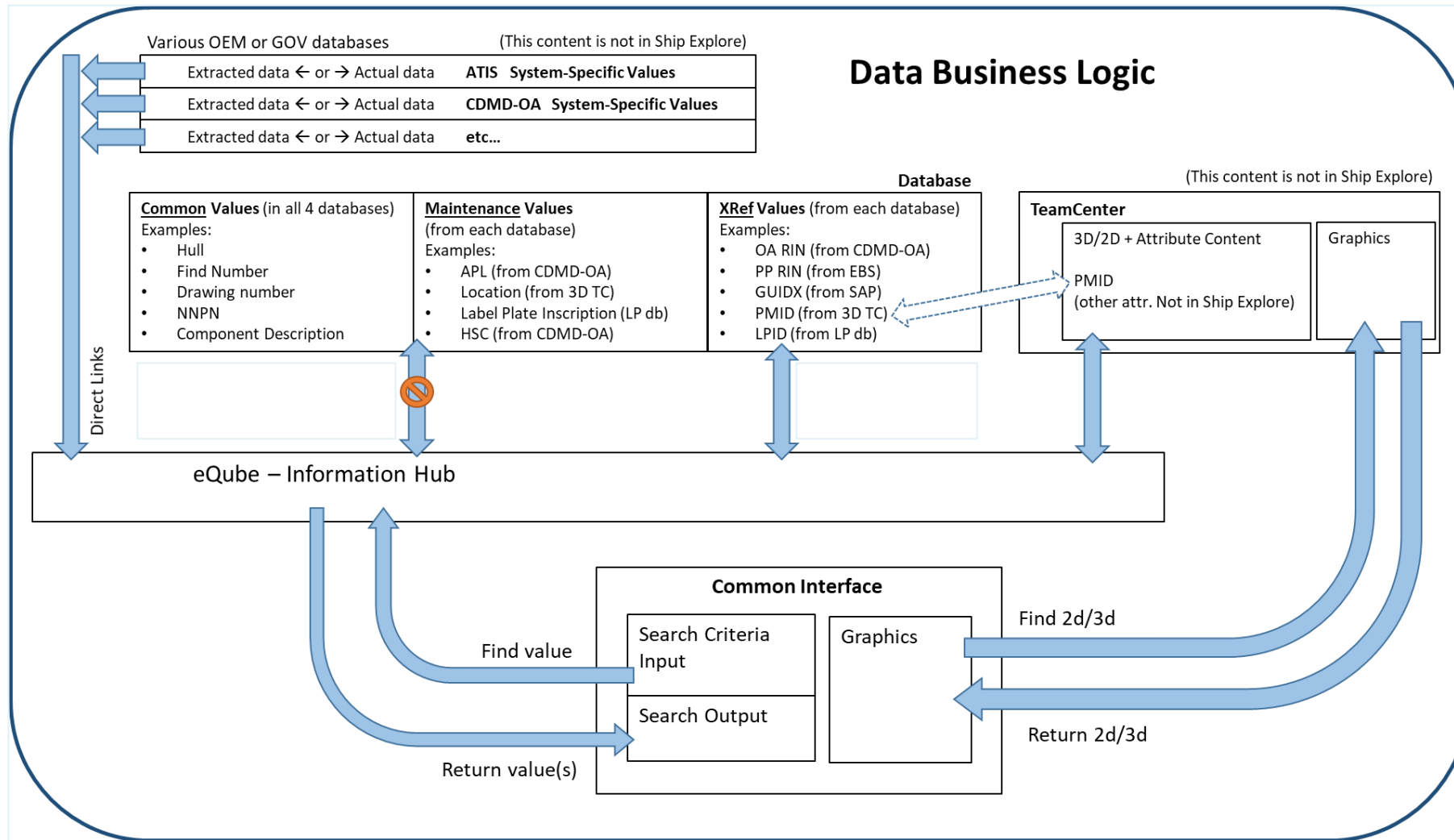# On-Board Ship 3D Environment – eQube
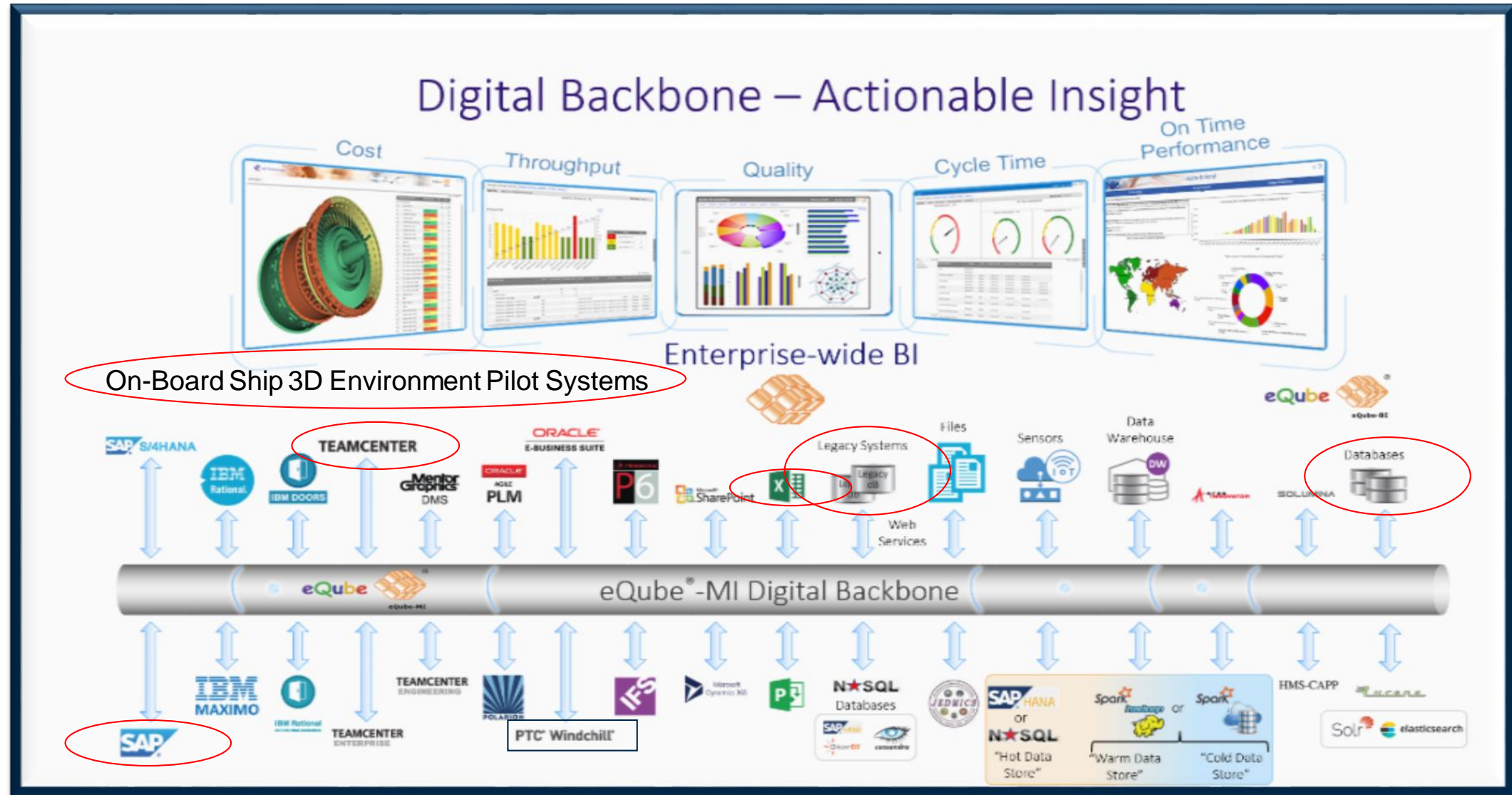
On-Board Ship 3D Environment – Pilot Security Level Maturity

The pilot structure consists of a secure **NIST level IL-4 AWS cloud environment with CUI-Level classification.**
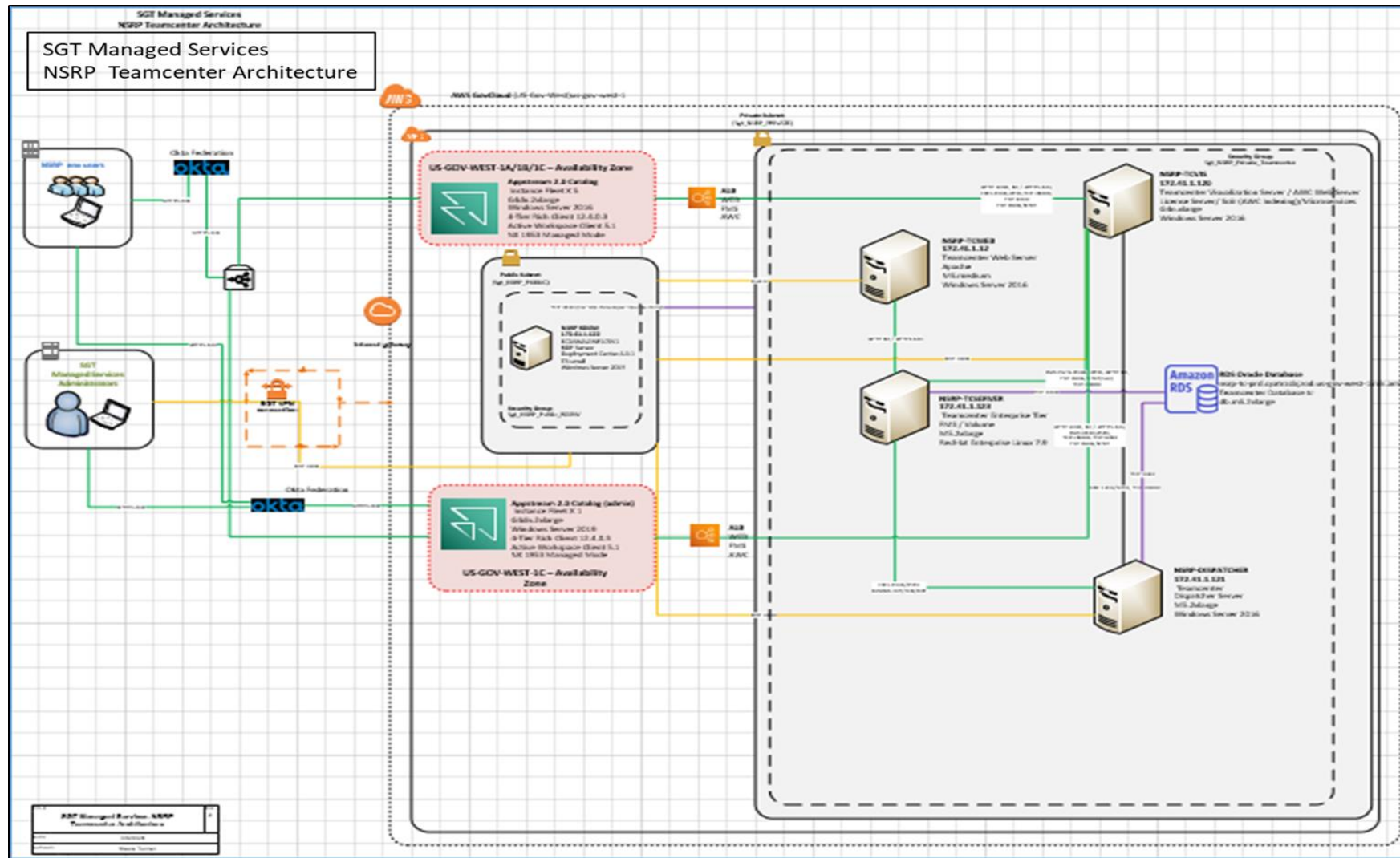

U.S. International Traffic in Arms Regulations (ITAR)

Federal Risk and Authorization Management Program (FedRAMP)

Defense Federal Acquisition Regulation Supplement (DFARS)

- The AWS GovCloud (US-East) and (US-West) Regions are operated by employees who are U.S. citizens on U.S. soil.

- AWS GovCloud (US) is only accessible to U.S. entities and root account holders who pass a screening process.

- Customers must confirm that they will only use a U.S. person to manage and access root account keys to these regions.

- The Govcloud will allow for limited access to sensitive data by individual, time, and location and restrict which API calls users are able to make.

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On-Board Ship 3D Environment "Business Logic Architecture"

Various OEM or GOV databases (This content is not in Ship Explore)

Extracted data ← or → Actual data	**ATIS System-Specific Values**
Extracted data ← or → Actual data	**CDMD-OA System-Specific Values**
Extracted data ← or → Actual data	**etc…**

Data Business Logic

Database

(This content is not in Ship Explore)

Common Values (in all 4 databases)
Examples:
- Hull
- Find Number
- Drawing number
- NNPN
- Component Description

Maintenance Values
(from each database)
Examples:
- APL (from CDMD-OA)
- Location (from 3D TC)
- Label Plate Inscription (LP db)
- HSC (from CDMD-OA)

XRef Values (from each database)
Examples:
- OA RIN (from CDMD-OA)
- PP RIN (from EBS)
- GUIDX (from SAP)
- PMID (from 3D TC)
- LPID (from LP db)

TeamCenter

3D/2D + Attribute Content

PMID
(other attr. Not in Ship Explore)

Graphics

Direct Links

eQube – Information Hub

Common Interface

Search Criteria Input

Search Output

Graphics

Find value

Return value(s)

Find 2d/3d

Return 2d/3d

On-Board Ship 3D Environment "POC - Environment"

Proof of Concept (POC) Environment Data & Systems

The systems and databases necessary to provide authorative source use-case data/information (simulated non-classified) will consider the following:

- Navy Databases attributes; simulated data:
    - CDMD-OA: Configuration Data Manager Database -Open Architecture
    - ESOMS: Electronic Ship Operation Management System
    - ATIS: Advanced Tech Information System (related to TeamCenter)
    - (TBD) AIM: Advanced Industrial Management, Others…
- Teamcenter (Configuration Management, Program Technical Baseline)
- NX, JT (Geometry & Attributes)
- SAP (material & supplier) attributes
- Environment interface via Appstream & Active Workspace screen search
- SIEMENS AWS GovCloud
- eQube Technologic – Information Hub
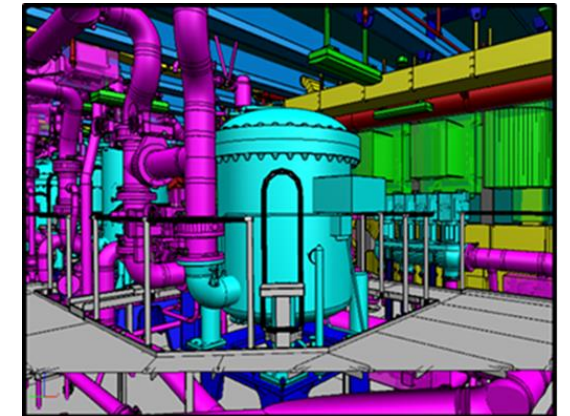
On-Board Ship 3D Environment "Teamcenter Active Workspace"

Log in screen for On-Board Ship's Environment
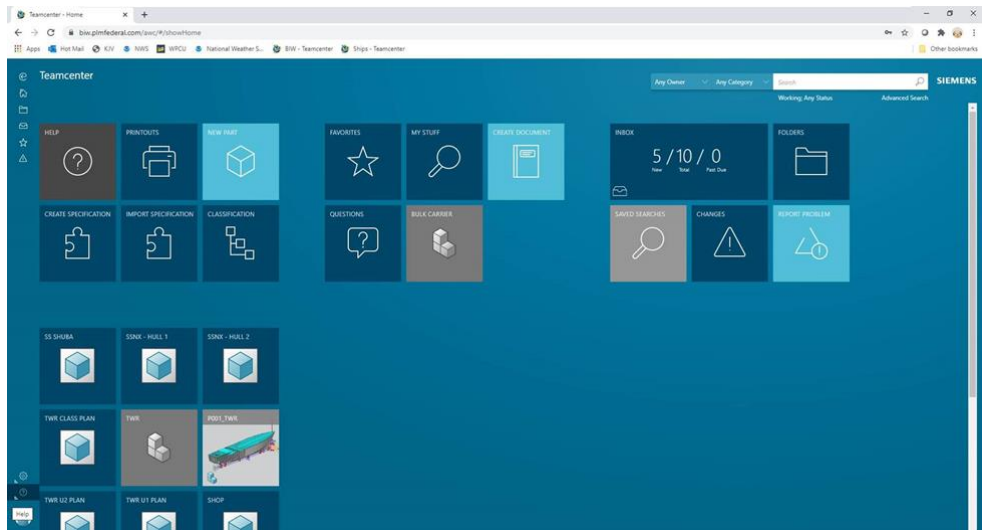
Active Work Space (AWC) Environment

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	
	HULL	NNS_MDL	DESCR	QTY	SPEC	LOCAT ION	COMP	GFE	MC	FIND_NO /PRID	DWG	PP_RIN	PL_RIN	MANUAL	EFD	SI	APL	HSC	ESWBS	NNS NNPN	LABEL PLATE	NNS_PMID
	TWR99 3D, PP, OA	TWR227_0 003_MI_3 001	GENERATOR SET, DIESEL	1	FAIRBANKS MORSE 401-499B	DECK 2, FR 8, ON CL	2-1A-1	GFE	SSS	CAT-340G	ATIS Drawing A Example	B98886	0BAGD	TDMIS Tech Manual B Example	CAT-340G GENERATOR SET	938888 3003	16A888 012X	38882E AAAA	38882 | GENERAT OR SET, DIESEL -	88836444	DIESEL GENERAT OR (PORT)	FND000002DE0 00002
	(TC link)										(Doc Link)	(G1 link)	(G2 link)	(Doc link)								(not shown)

Query results: Attribute fields and Document links

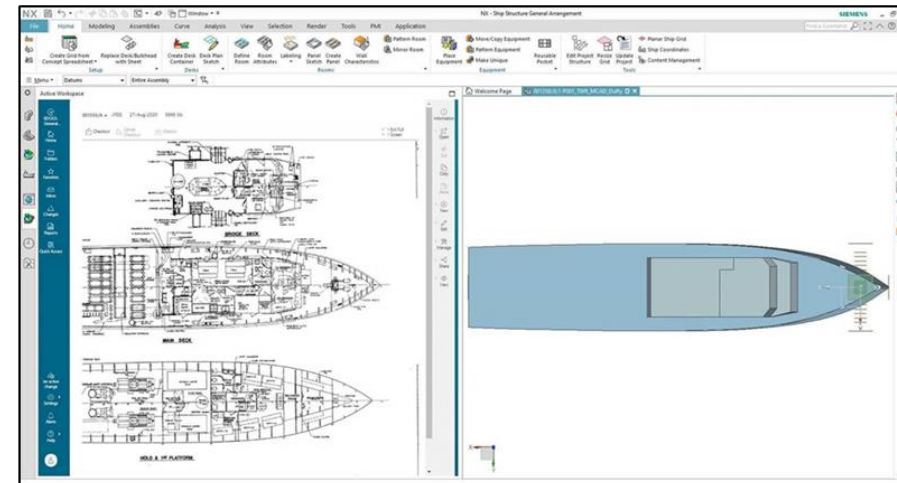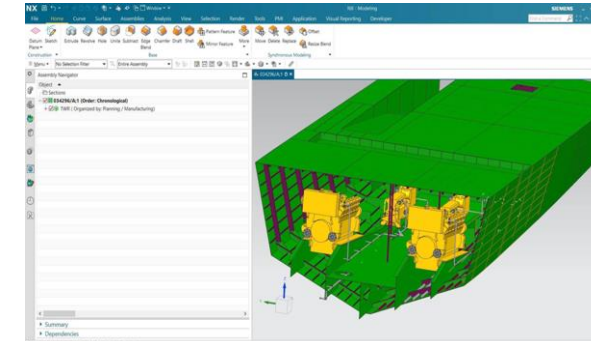# On-Board Ship 3D Environment "Torpedo Weapon Recovery Ship"
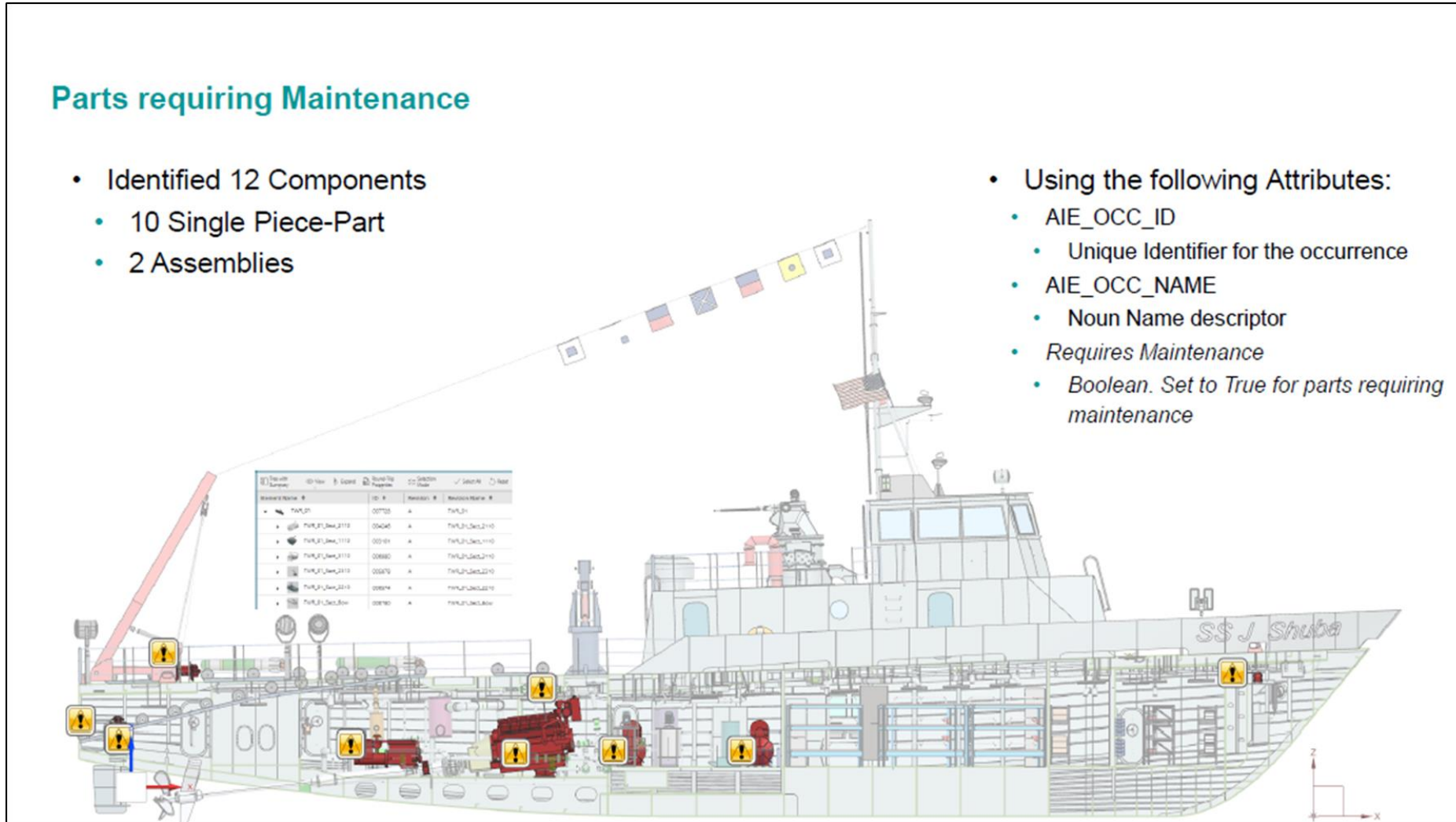
On-Board Ship 3D Environment "3D Models"
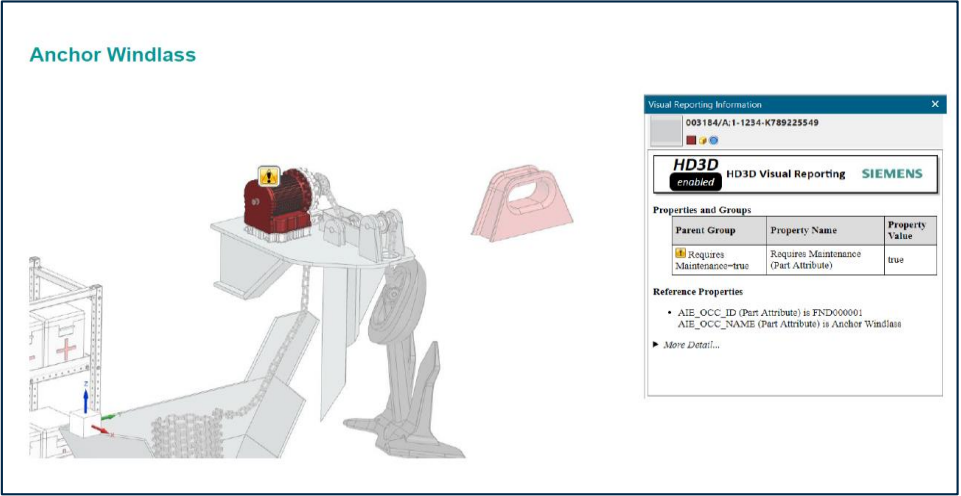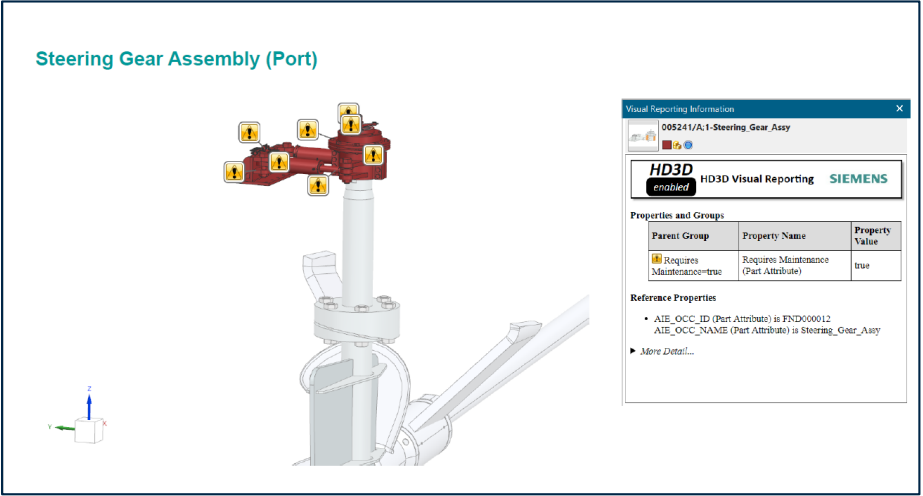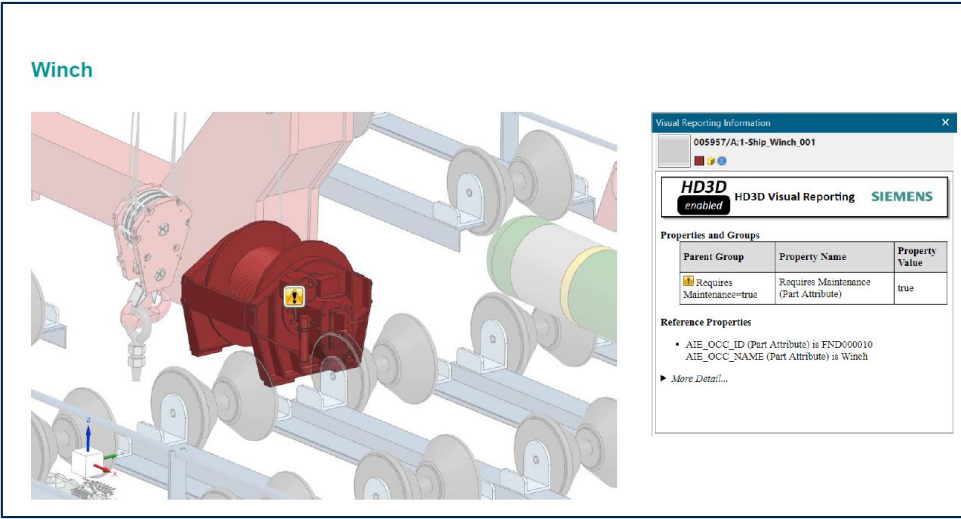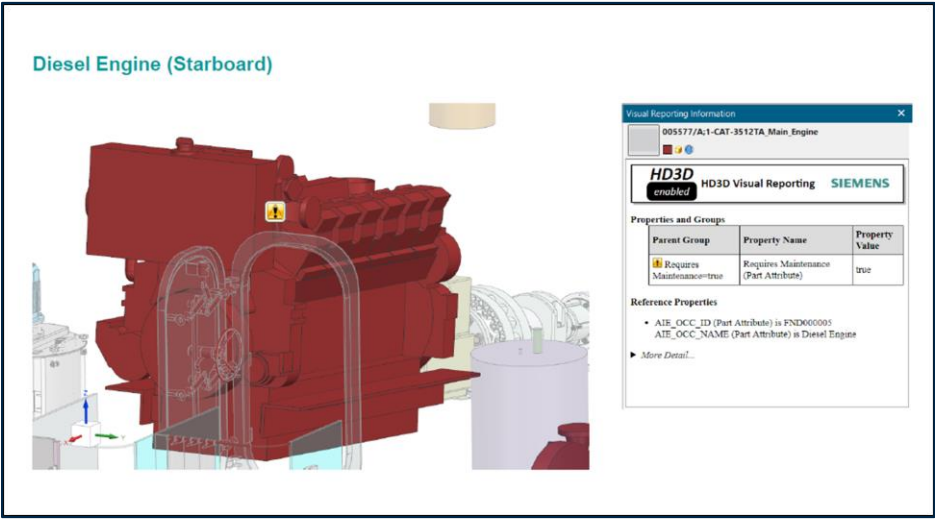
On-Board Ship 3D Environment – 3D Model
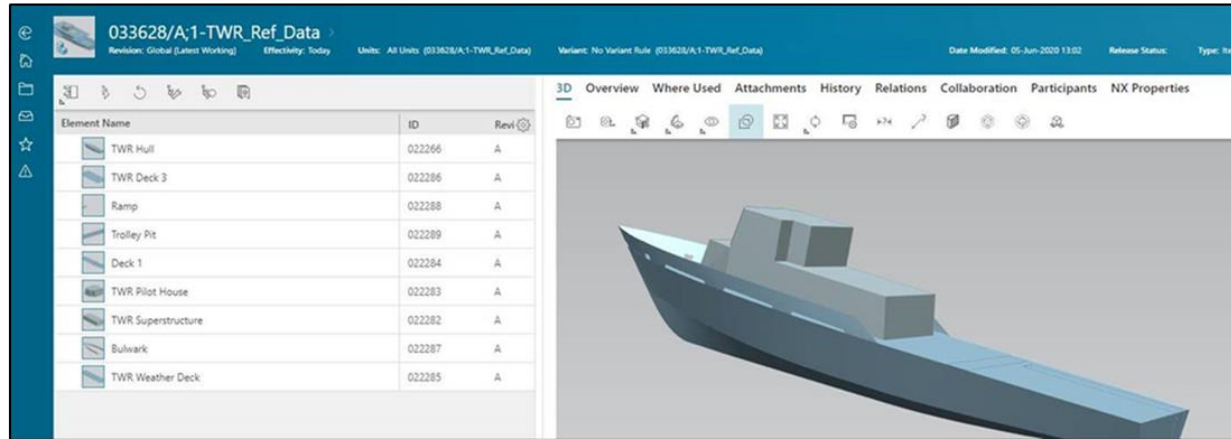
Reference information in AWC solely

NX and AWC Split Screen

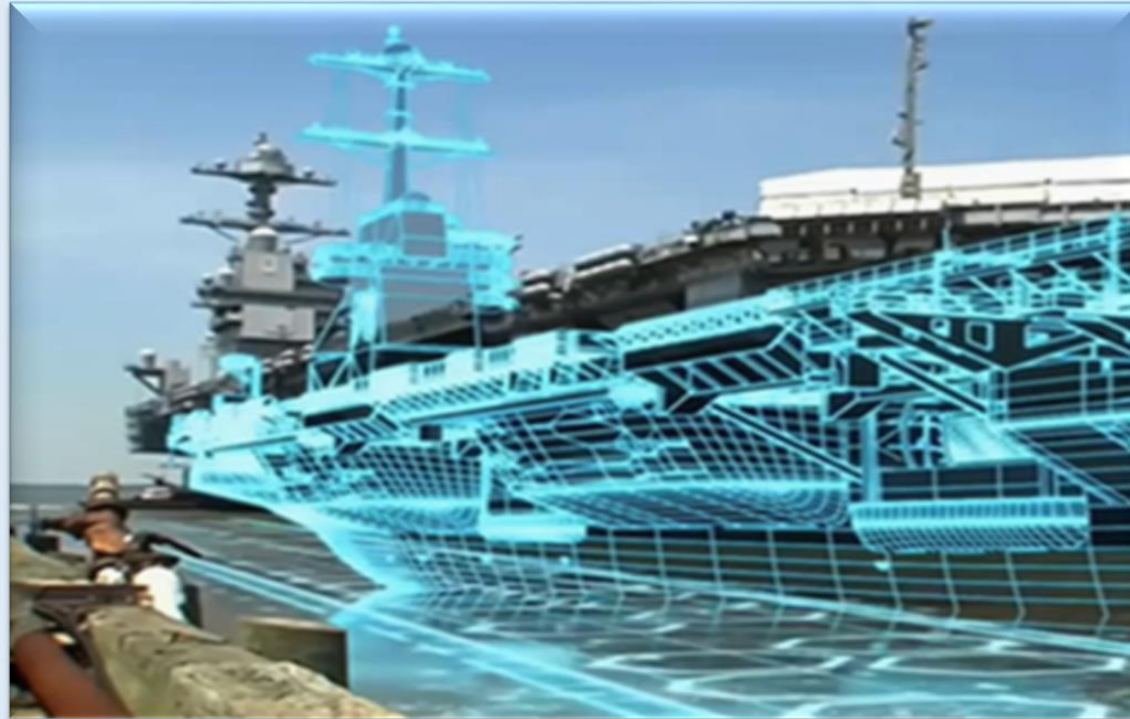# On-Board Ship 3D Environment "Logistics Components"

On-Board Ship 3D Environment "Summary"

- ✓ Successfully developed Siemens Teamcenter/NX data model and loaded TWR ship data

- ✓ Successfully implemented AWS GovCloud (configuration validation complete)

- ✓ Successfully integrated multiple data sources & systems together

- ✓ Successfully configured & implemented Active Workspace (GYI)

- ✓ Successful implemented Siemens APPstream application for cloud information access

- ✓ Successfully implemented eQube Information Hub (Business Logic / mapping)

- ✓ Successfully downloaded Logistics environment to the Snowball database

- ✓ Currently completing Phase 3 User Testing of use cases

- ❑ Overall the project is a huge Success demonstrating capabilities to effectively integrate source data from multiple systems & databases and provide user friendly interface tools

- ❑ Project scheduled to be completed in December, 2021 (with consideration for a follow-on project)

Thank You, Discussion…

On-Board Ship 3D Environment Project