



Enabling Shipbuilding Interoperability (ISE-6 Project)

Presented by :

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GENERAL DYNAMICS
Electric Boat

Date:

December 11, 2007



Agenda



- **Interoperability Problem**
- **Standards Based Solutions (STEP & XML)**
- **ISE Architecture**
- **Previous ISE Projects**
- **Enabling Shipbuilding Interoperability Throughout the Entire Life Cycle (ISE-6)**
- **Summary of ISE Efforts**



Interoperability Problem



- **Communication between diverse computer systems is a big challenge in today's environment:**
 - **As CAD/CAE/CAM systems have expanded in the U.S. shipyards, interoperability among these systems has become a major issue**
 - **Interoperability is an issue within a shipyard as well as between partnering yards and with the Customer**
- **These problems are exacerbated because:**
 - **Most recent and future ship design and build contracts involve multiple shipyards**
 - **Length of time to design and build a ship often exceeds the life span of current computer systems**
 - **Requirements for life cycle support of the ship will far exceed the life span of current computer systems**



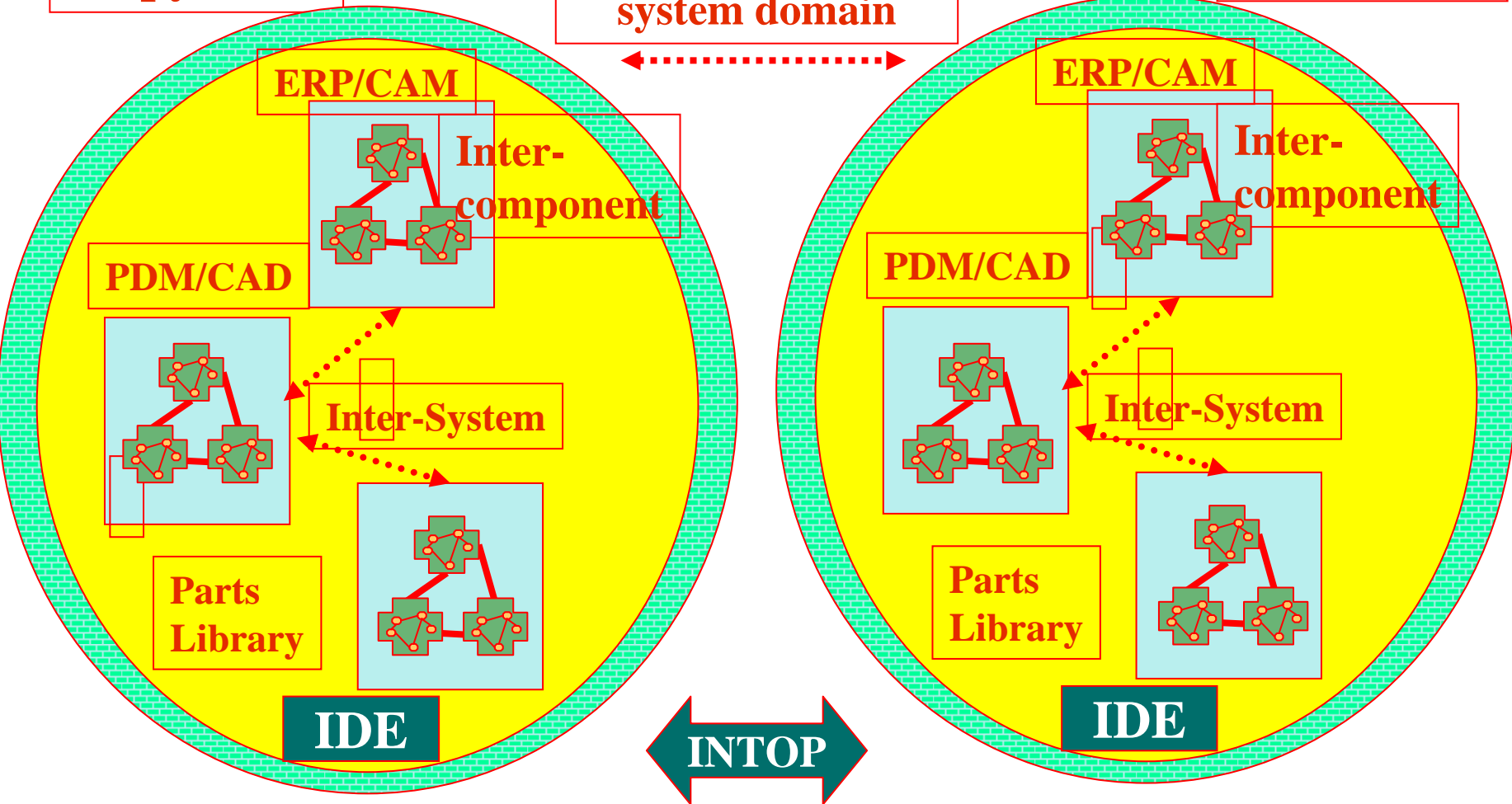
Levels of Interoperability



Shipyard A

Inter-business
system domain

Shipyard B





Collaboration Among Shipyards is Required in Today's Environment



- **Almost every major recent U.S. Navy ship design and/or construction contract has involved collaboration among multiple shipyards**
 - **For example:**
 - CVNX (NGNN & EB)
 - DDG1000 (NGSS - Ingalls & Bath)
 - Initial LPD Award (NGSS - Avondale & Bath)
 - VIRGINIA (EB & NGNN)
- **This trend will continue**
- **Navy views system interoperability as enabling multiple yards to be viewed as “One Shipyard”**



ISE Solution



- **The Integrated Shipbuilding Environment Consortium (ISEC) is attacking the interoperability problem on a broad front involving numerous standards, tools, and organizations, including:**
 - **STEP**
 - **XML**
 - **isetools.org Website**
- **The ISE Projects have helped develop these standards, defined the approach, and implemented the solution**



Goals of Integration



- **Better analysis through simulation**
- **Re-use of data instead of redundant data**
 - **Increased accuracy**
 - **Eliminates unnecessary checking**
 - **Speed of data entry (already entered)**
- **Facilitates partnering with other firms**
- **Reduce overhead costs**



ISE Project Approach



- **Develop and demonstrate tools that are low cost**
 - can be selectively used by shipyards to support interoperability
 - capitalize on XML and related Internet technologies
- **Flexibility is critical**
 - allow shipyards to transform their data to/from common information model
- **Drive development of shipbuilding product data standards (e.g. STEP, PLIB)**
 - Construct a single Shipbuilding Information Model
 - Demonstrate and educate U.S. shipbuilding community



Overview of STEP



STEP (ISO 10303 - Industrial automation systems and integration - Product data representation and exchange)

- **International Standard for the computer-interpretable representation and exchange of product data**
- **The objective is to provide a mechanism that is capable of describing product data throughout the life cycle of a product, independent of any particular system**
- **The nature of this description makes it suitable not only for neutral file exchange, but also as a basis for implementing and sharing product databases and archiving**



XML- Extensible Markup Language



- **Traditional STEP transfers have been via STEP Physical File exchange as defined by Part 21**
- **To take advantage of Web technology, Part 28 has been developed to standardize STEP transfers using XML**
- **ISE Project is implementing its transfers using XML as well as permitting Part 21 file exchanges**



XML

Goal and Mission



- **Goal**
 - **Use XML Schema to represent as much of EXPRESS semantics as possible so that XML Schema can be used to:**
 - Document the information model
 - Provide delegated validation services
 - Support the XML instance formats standardized in Part 28
- **Part 28 Mission**
 - Use XML to publish STEP EXPRESS Schemas
 - Use XML as a STEP implementation method
- **Part 28 (ISO 10303-28 ed. 2) has now been published by ISO as an International Standard**



ISE Architecture



ISE architecture represents an innovative, practical solution to the information interoperability challenge

- **Accessible to large and small shipyards**
 - Only system dependency is Web infrastructure
 - Utilizes open standards
- **Innovative integration of STEP and XML technologies**
 - Supports sharing of geometry & geometric product models
- **Permissive (mediation) architecture**
 - Lets each enterprise choose its own tool set
- **Incorporated into CAD platforms used by U.S. shipbuilders**



ISE Integration Strategy



- **STEP (Standard for Exchange of Product Model Data)**
 - **Approved International Standard providing a good common language for representing product models**
- **XML (Extensible Markup Language)**
 - **Widely accepted, Web-enabled format**
- **Therefore, combine the two, and embed small strings of STEP into XML, based on industry agreements, such as ISE**



XML + STEP = Ideal Combo



Transactions of Data Packaged in Standards



XSLT - map data to another XML schema

XML :

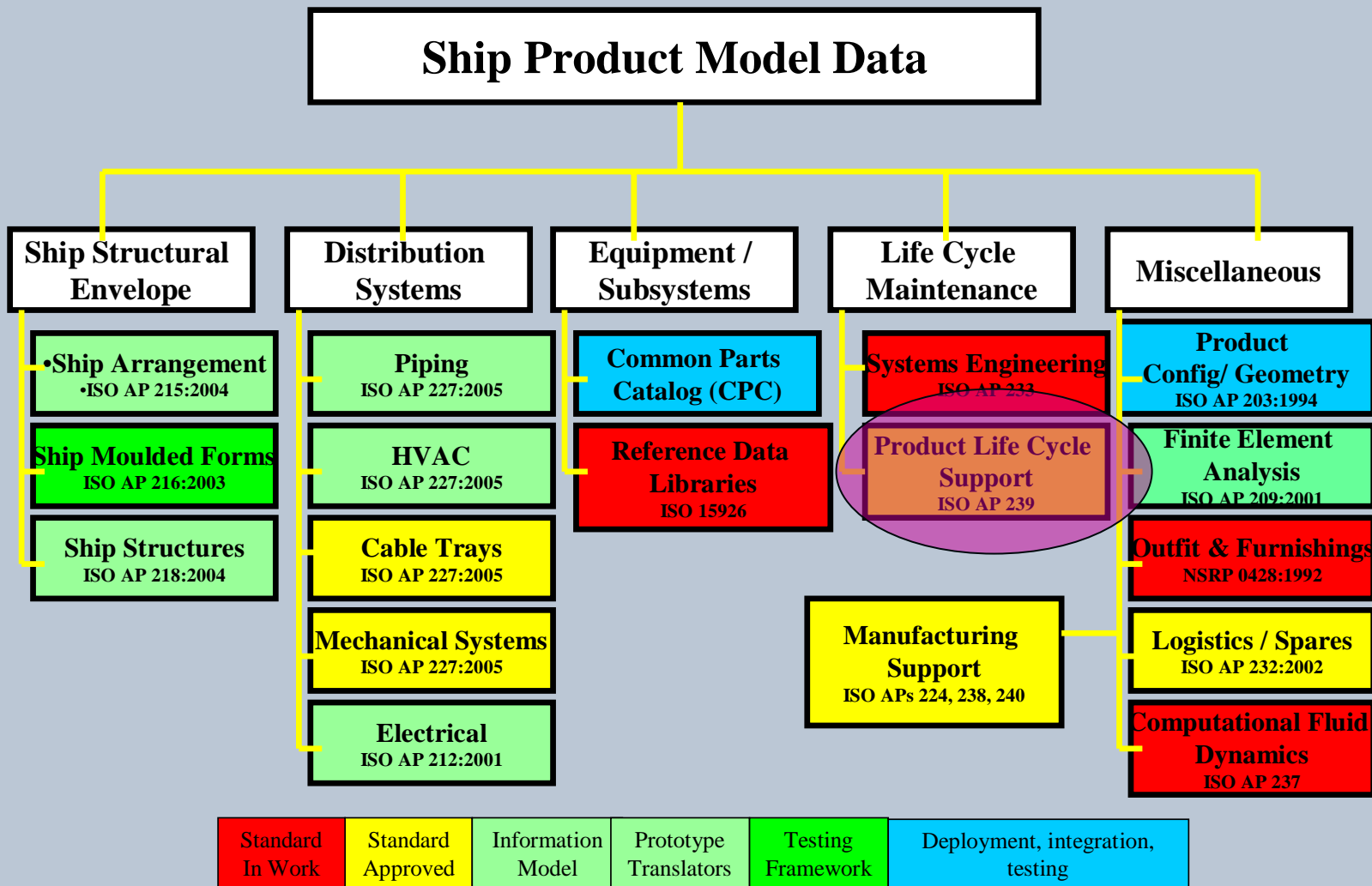
- Accepted format/schema method
- Web-enabling

STEP :

- Standards for data expression
- Standards for geometric exchange

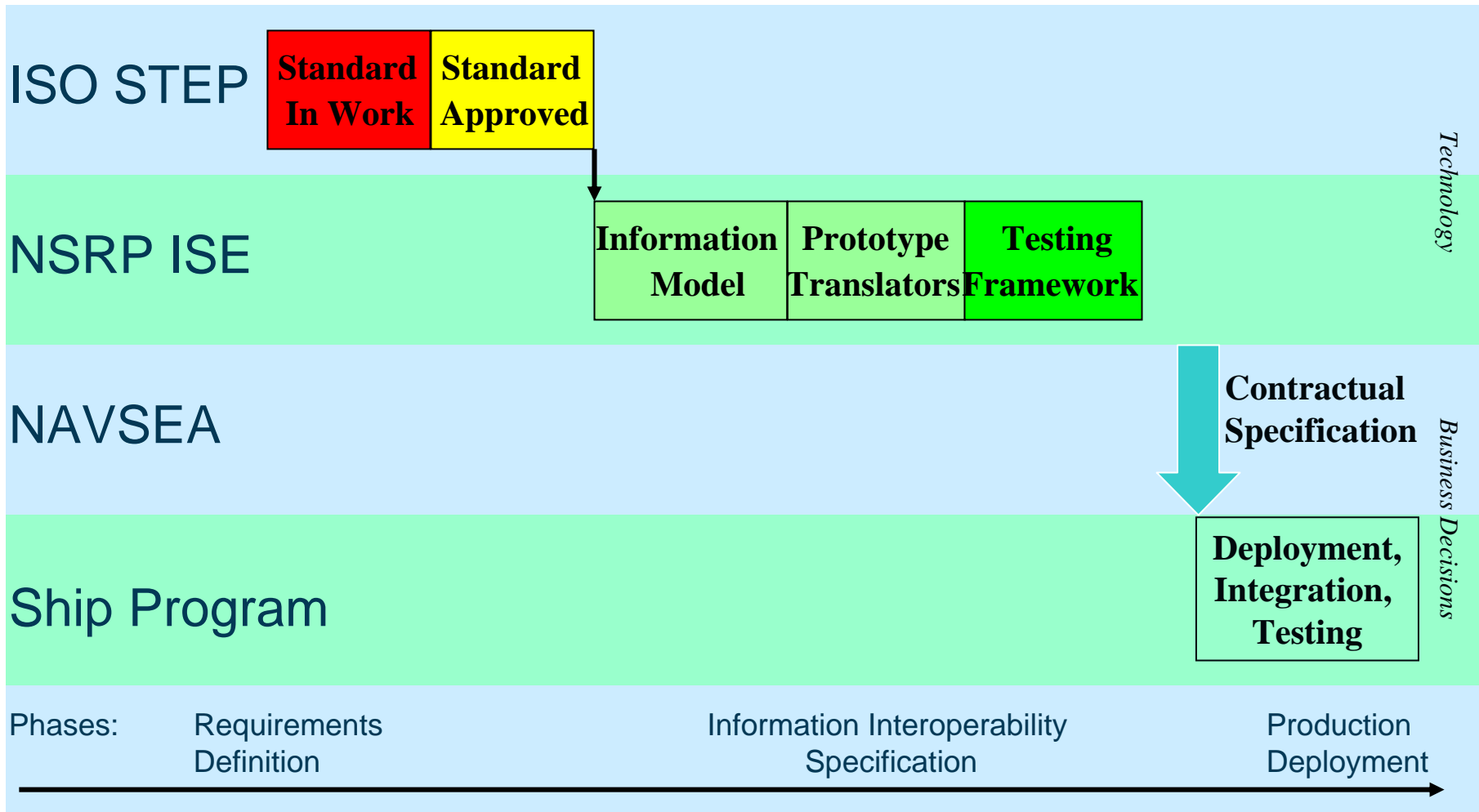


Information Interoperability Roadmap





ISE Information Model Methodology





STEP Application Protocols Needed for Shipbuilding



- **Ship product model data exchange requires use of numerous STEP Application Protocols (APs)**
- **Some implementations are available for the following APs:**
 - **203 Configuration Controlled Design**
 - **209 Engineering Analysis**
 - **212 Electrotechnical Design and Installation**
 - **214 Automotive Mechanical Design**
 - **215 Ship Arrangements**
 - **216 Ship Moulded Forms**
 - **218 Ship Structures**
 - **227 Plant Spatial Configuration**
- **Implementations are being developed in ISE-6:**
 - **239 Product Life Cycle Support**
- **No implementations have yet been developed for APs:**
 - **232 Technical Data Packaging**
 - **233 Systems Engineering Data Representation**



History of ISE Projects



- Performed by Integrated Shipbuilding Environment Consortium (ISEC)
 - Consortium of Shipyards, CAD Vendors, and Universities
- ISE-1 (1999 - 2000)
 - Requirements
- ISE-2 (2000 – 2003)
 - Structures
 - Piping
- ISE-3 (2003 – 2004)
 - HVAC
 - CPC Interfaces
- ISE-4 (2005 – 2006)
 - Ship Arrangements
 - Steel Processing
 - Engineering Analysis
 - Electrical
- ISE-5 (2006 - 2007)
 - Electrotechnical
- ISE-6 (2007 – 2009)
 - Product Life Cycle Support



ISE Team Participants



GENERAL DYNAMICS
Electric Boat



NORTHROP GRUMMAN
Newport News

NORTHROP GRUMMAN
Ship Systems
Ingalls Operations



NORTHROP GRUMMAN
Ship Systems
Avondale Operations

Bath Iron Works
A GENERAL DYNAMICS COMPANY

SENER

INTERGRAPH
GOVERNMENT SOLUTIONS



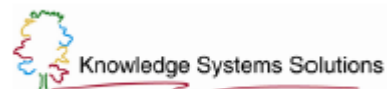
STEP Tools, Inc.
Building STEP Solutions for Interoperability & e-Manufacturing



SIMSMART Inc.

Product
Data
Services
Corporation
marine
machinery
association

NORTHROP GRUMMAN
Information Technology





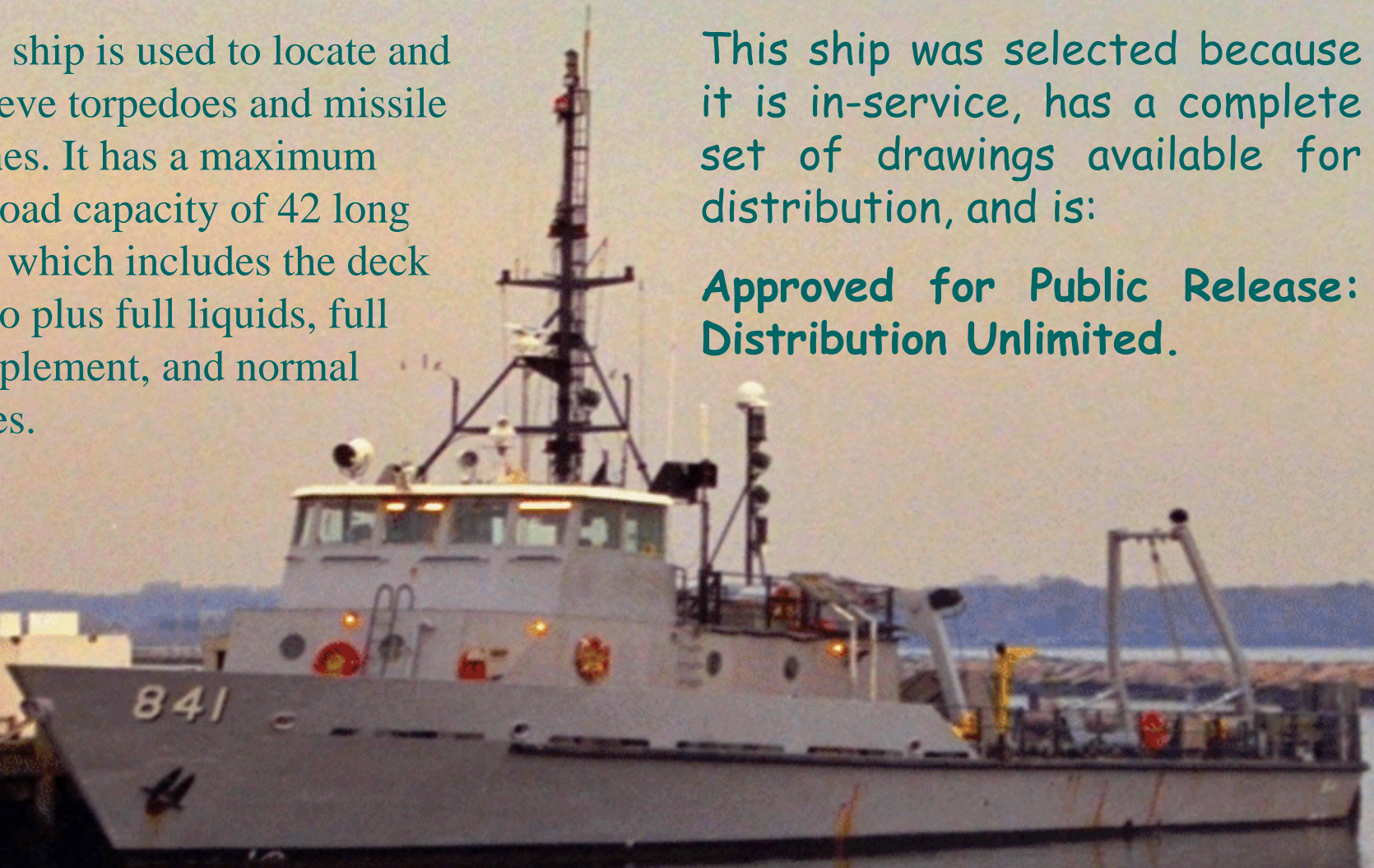
ISE Test Ship – TWR841



This ship is used to locate and retrieve torpedoes and missile drones. It has a maximum payload capacity of 42 long tons which includes the deck cargo plus full liquids, full complement, and normal stores.

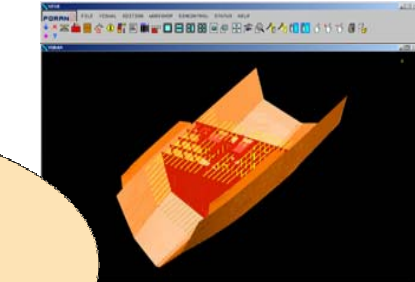
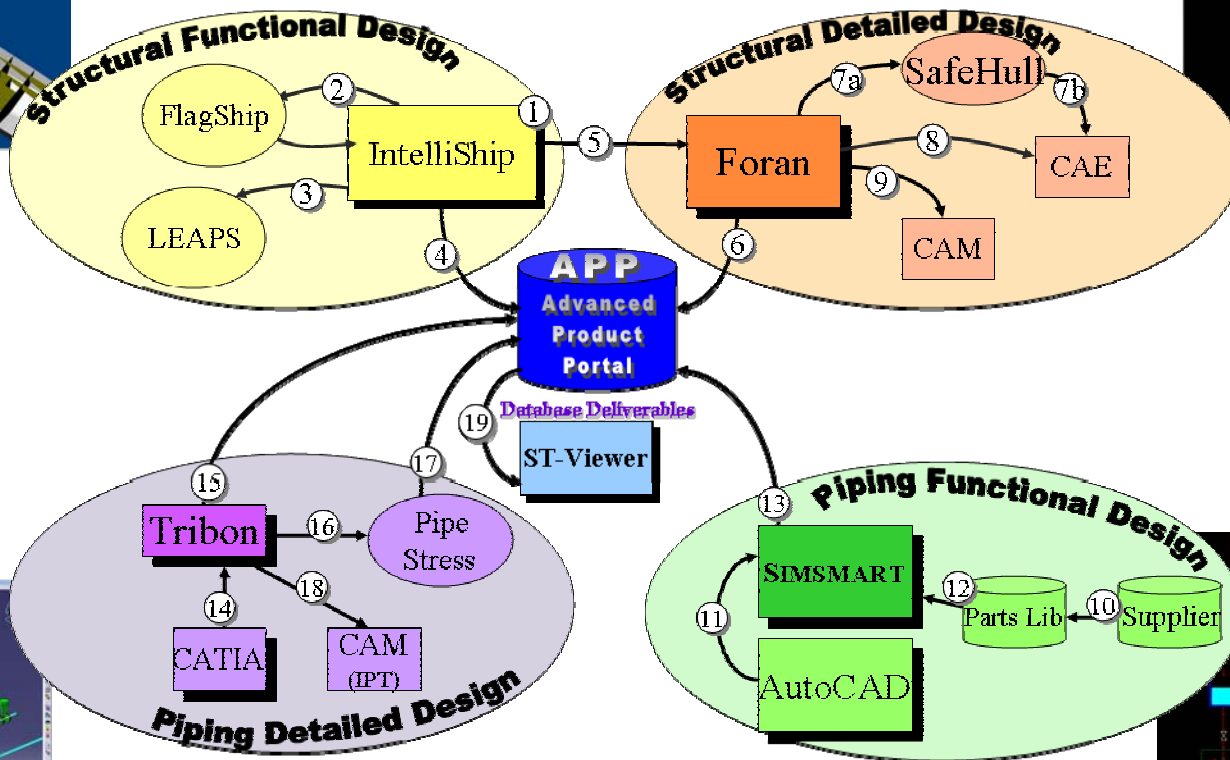
This ship was selected because it is in-service, has a complete set of drawings available for distribution, and is:

**Approved for Public Release:
Distribution Unlimited.**





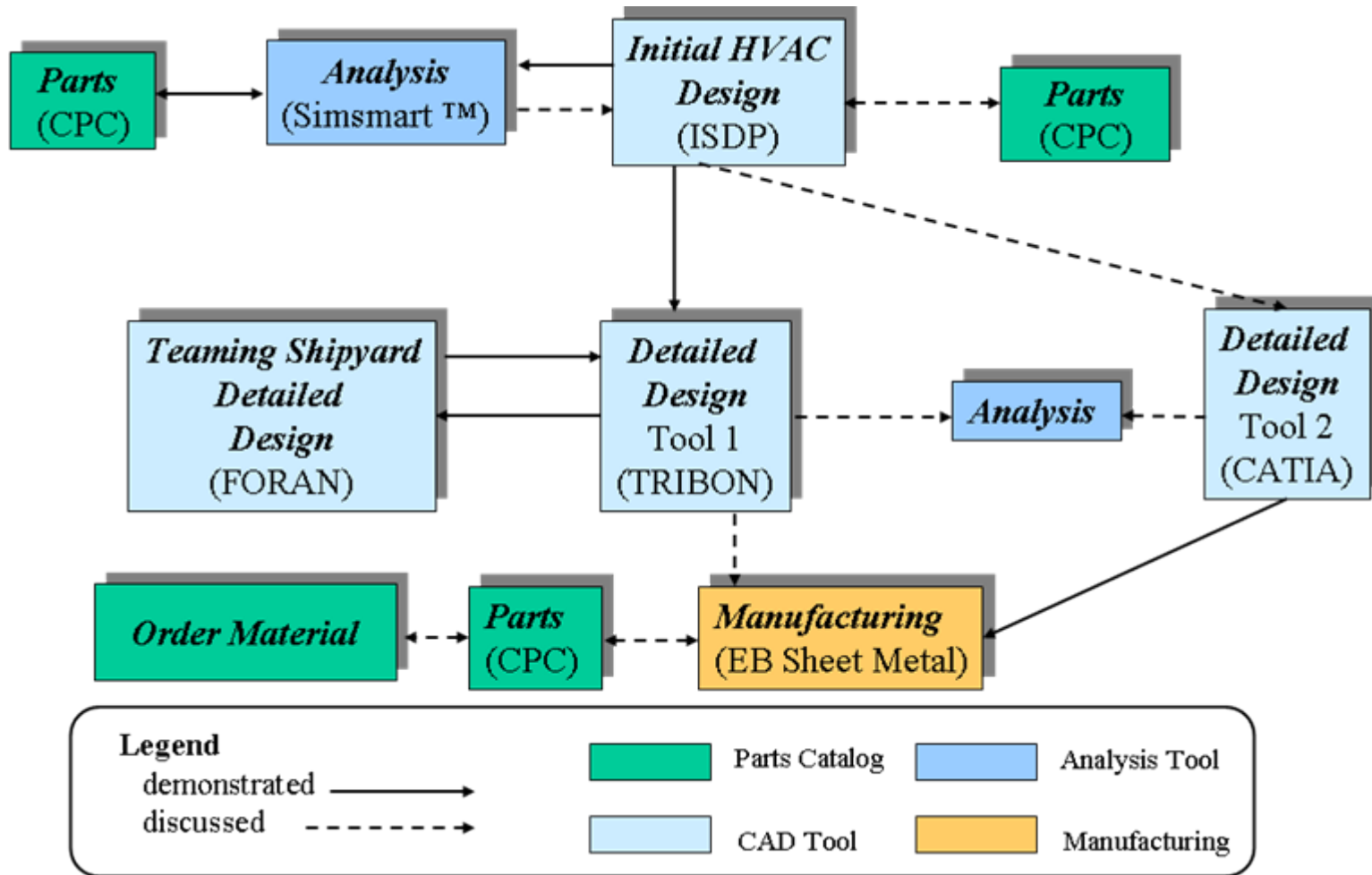
ISE-2 Demonstration (April 2003)



AP216: Ship Moulded Forms
AP218: Ship Structure
AP227: Piping



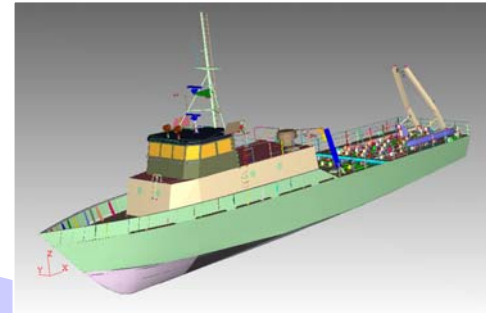
ISE-3 Demonstration (October 2004)



AP227: HVAC

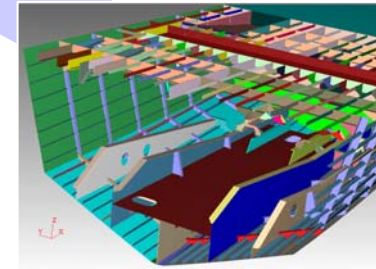
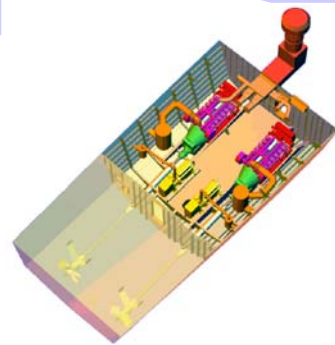


ISE-4 Demonstration (April 2006)



ISE-4:

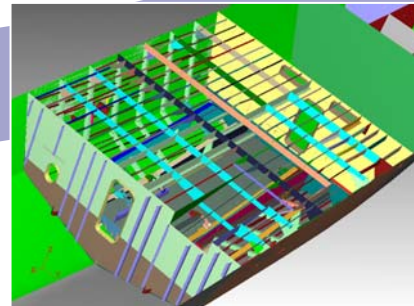
- Ship Arrangements
- Engineering Analysis
- Electrical Design
- Steel Processing



TWR 3D
Product Model
Geometry

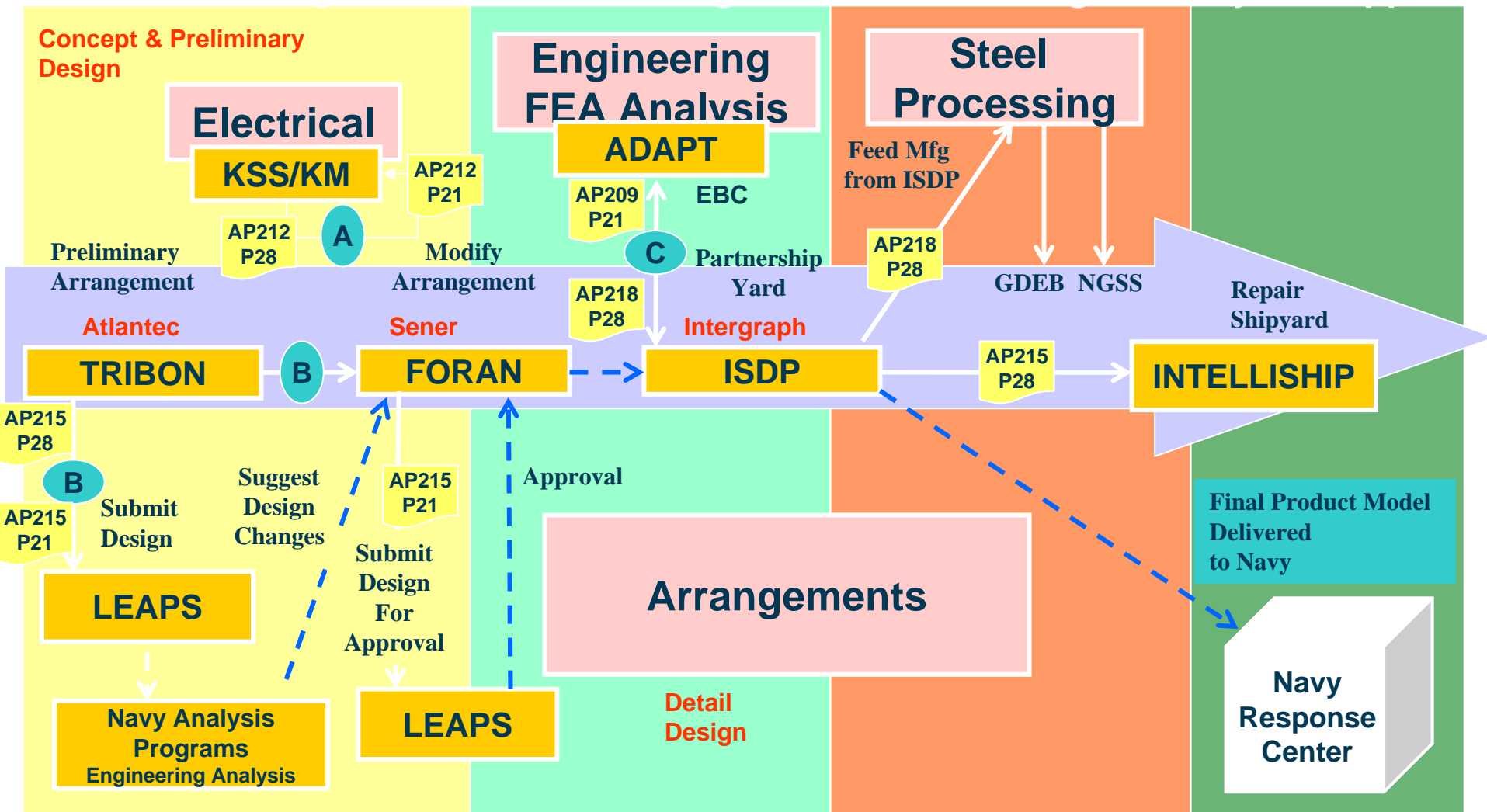


Engine
Room





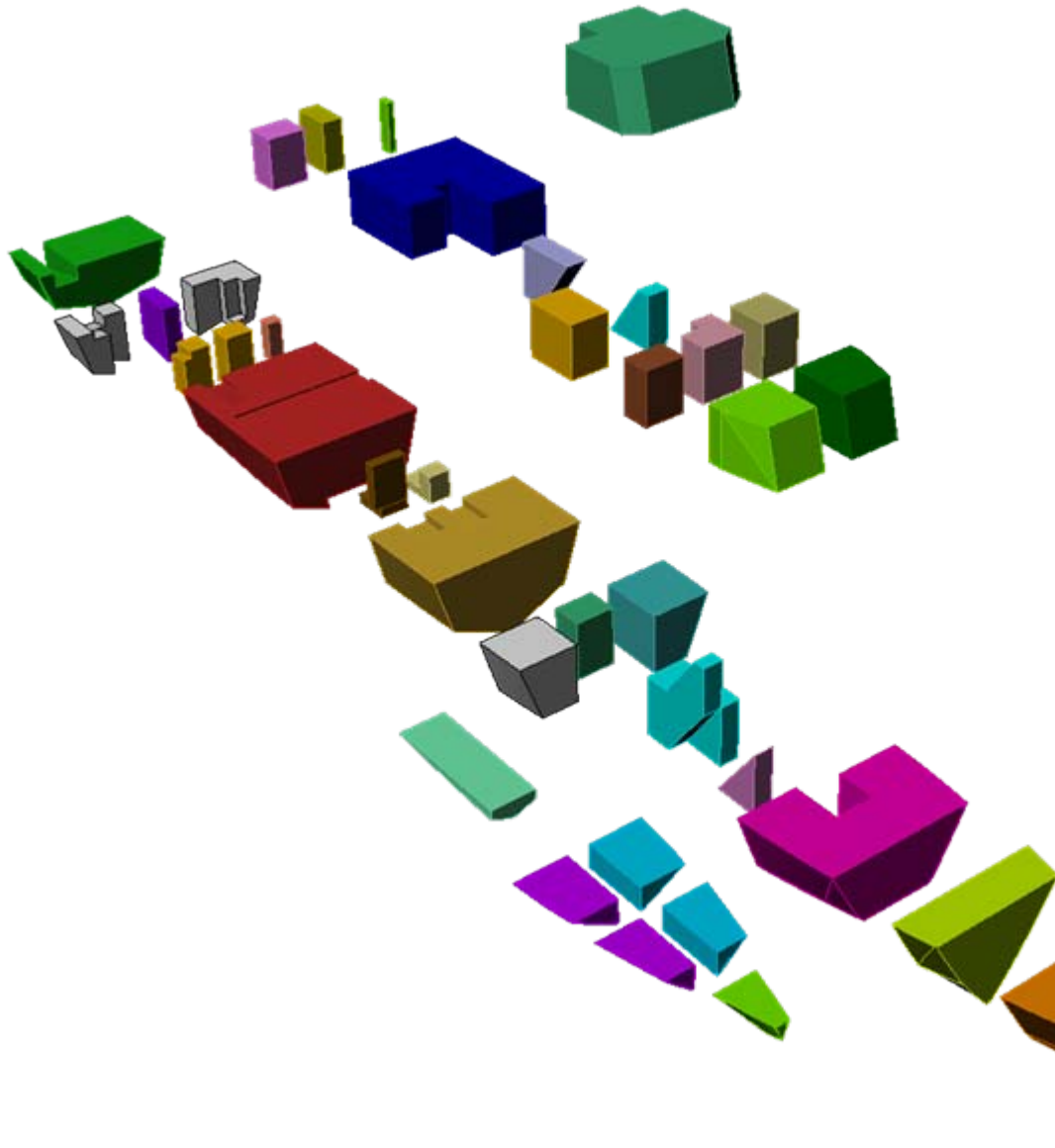
Systems Involved in the ISE-4 Interoperability Demo



Key: = Mediators Required = Demonstrated = Not Demonstrated



TWR Compartment Overview



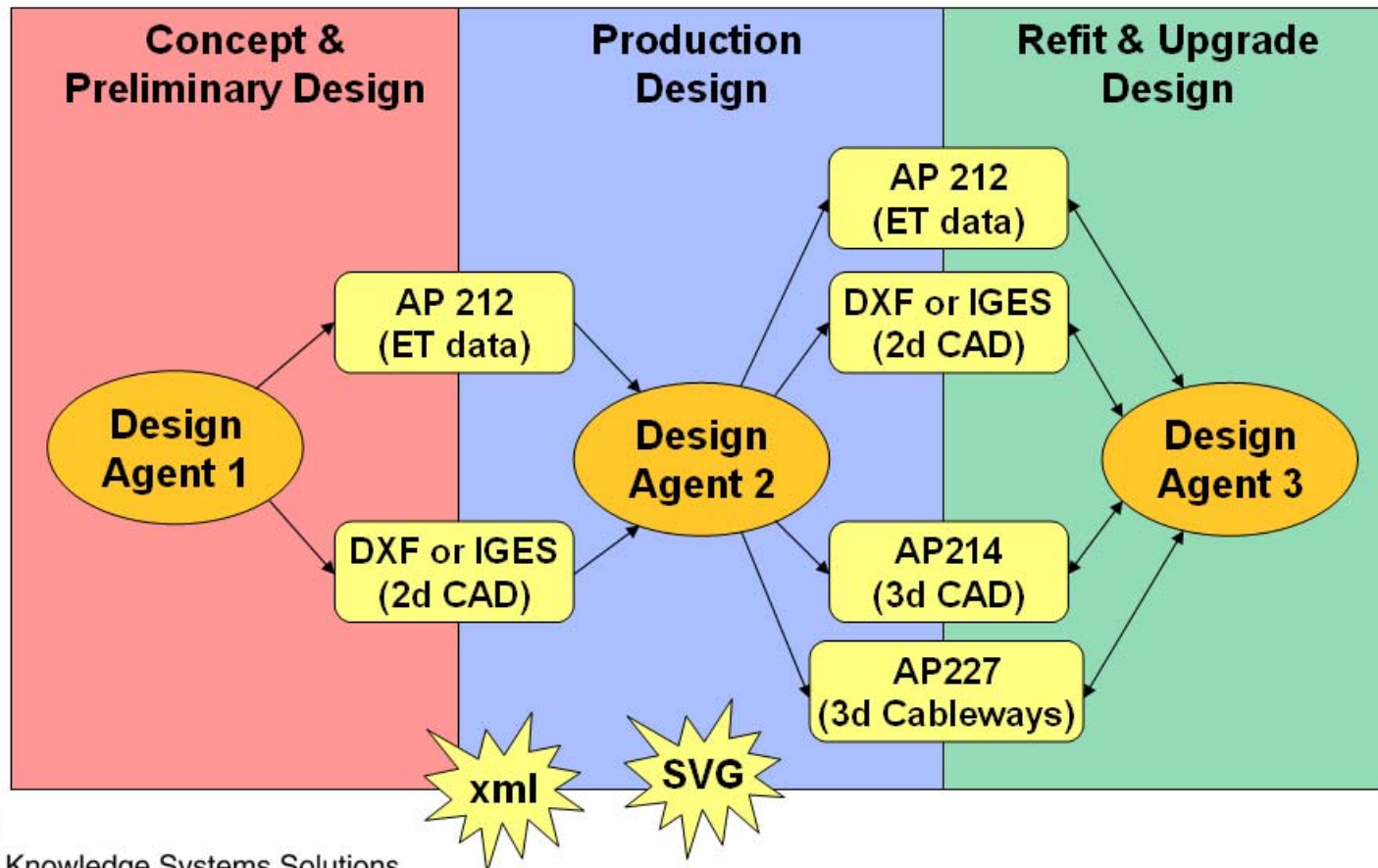
Compartment Name	Compt #	Volume (m ³)	
Air Handling Room	1-8-3-Q	9.344559387	
Ballast Tank #1	2-6-1-V	5.621280313	
Ballast Tank #2	1-6-2-V	5.621280378	
Ballast Tank #3	2-23-6-V	10.94196403	
Ballast Tank #4	1-23-0-F	11.45422363	
Bosuns Stores	2-2-0-A	31.1542512	
Bow Thruster	2-5-0-Q	29.65740748	
Chain Locker	2-2-0-Q	2.128270093	
CO State Room	1-5-2-L	15.19818335	
CPO State Room	1-5-1-L	15.19818517	
Crews Berthing	2-6-0-L	65.55600522	
Deck Gear	1-14-3-A	5.256314651	
Electrical Room	1-7-1-Q	4.672279696	
Engine Room	2-16-0-E	164.4171673	
Engine Room Exhaust Trunk	2-15-1-Q	2.803369266	
Engine Room Supply Trunk	2-15-2-Q	1.897890198	
Forepeak	2-0-0-V	9.703230573	
Fuel Oil Tank #1	2-9-1-F	7.47810508	
Fuel Oil Tank #2	1-9-2-F	7.47810645	
Fuel Oil Tank #3	2-16-0-F	11.87955578	
Fuel Oil Tank #4	2-23-2-F	4.791415503	
Fuel Oil Tank #5	2-9-1-F	4.572601083	
Galley and Mess Area	1-9-0-L	59.46537759	
Hold Head	2-10-2-L	20.57645565	
Hold Passageway	2-8-0-L	18.1679584	
Lazarette	2-25-0-Q	45.19140913	
Lazarette Passageway	2-23-0-Q	6.423977119	
Linen Locker	2-9-1-A	2.786579543	
Lube Oil Tank	2-23-4-F	0.987812699	
Main Deck Head	1-7-2-L	7.00841954	
Main Deck Passageway	1-7-0-L	6.371290497	
Observers Berthing	2-10-1-L	17.82688618	
Pilot House	01-6-0-C	45.87356833	
Pilot House Passageway	1-9-1-L	4.014929551	
Potable Water Tank #1	2-13-1-W	9.928594336	
Potable Water Tank #2	2-13-2-W	9.928594336	
Provisions Storeroom	2-11-0-A	7.495108964	
Pump Room	2-12-0-Q	112.0118041	
Pump Room Passageway	2-14-1-Q	3.82277429	
Pump Room Supply Trunk	1-14-1-Q	0.424752699	
Yard	2-2-0-V	3.395942412	
Waste Oil Tanks	2-15-0-F	0.976931207	



ISE-5 Demonstration (February 2007)



Electrotechnical Data and Document Interoperability





Interoperability Solutions Must Apply to the Entire Life Cycle



- Initial efforts on developing interoperability solutions have centered on Design issues
 - Focus has been on:
 - Transfer between multiple Design agents
 - Exchange between Design and Construction agents
 - Transfer of Product Models from Design agent to Customer
- Increased attention is being given to exchanges for Manufacturing
 - Recent ISE efforts have discussed unique Manufacturing issues involved in transfer of Models for: Steel Processing, HVAC, and Piping
- However, Life Cycle processes (such as Maintenance and Repair) require different information and have other issues



Issues Arising for Transfers Throughout Life Cycle



- **Different information must be exchanged for use in Maintenance and Repair**
 - **As-built conditions of the ship needed**
 - **Changes made during ship's service must be reflected in the product model**
 - **Updates to Catalogs for replacement parts must be available**
- **Ships have long life span (up to 50 years)**
 - **Ship will likely outlive CAD systems used during Design**
 - **Even computer hardware and storage media will not survive for life of ship**
- **Change management is a major cost driver throughout the life of the ship and must be addressed by any interoperability solution**



Enabling Shipbuilding Interoperability (ISE-6)



■ SCOPE

- In the ISE-6 Project for Enabling Shipbuilding Interoperability, the Integrated Shipbuilding Environment Consortium (ISEC) will demonstrate that improved interoperability will achieve cost reductions in Navy and commercial shipbuilding processes across shipyards and across the design/build/support life cycle. This project has the potential to create a fundamental difference in the U.S. shipbuilding industry by enabling the critical business drivers. These ISE interoperability solutions are also required for long-term data archiving and eliminating the problem of legacy CAD data becoming unusable due to upgrades in the computer system.



Enabling Shipbuilding Interoperability (ISE-6)



■ SCOPE cont'd.

- The ISEC is led by U.S. shipbuilders along with commercial software vendors, and information technologists. This team has been together for seven years and has developed much of the infrastructure and architecture necessary for shipbuilding information interoperability. The current effort is leveraging that past work by deploying information technology systems that meet the shipbuilder's interoperability requirements. The environment and infrastructure deployed and demonstrated by this project is also supporting other NSRP initiatives for a better integration among shipbuilding enterprise functions.



Enabling Shipbuilding Interoperability (ISE-6)



■ SCOPE cont'd.

- **The lion's share of the total cost of ownership of a Navy ship accrues after the ship has been delivered. The processes of life cycle support; repair, maintenance and overhaul; ships' operations, testing and training are all information intensive processes. The Navy has steadily moved toward more modern systems and technologies to cope with the burgeoning information needs, but technology has evolved faster than the deployed solutions. As a result there are a number of incompatibilities or opportunities for significant process improvement as a result of systems technologies advances. These opportunities are the reason that ISE-6 is focusing on the area of Product Life Cycle Support data.**



ISE-6 Project Participants



- **Electric Boat**
- **Northrop Grumman Ship Systems**
- **Atlantec-es**
- **Industrial Planning Technology**
- **Intergraph**
- **Knowledge Systems Solutions**
- **NSWC-CD**
- **Northrop Grumman Information Technology**
- **Product Data Services Corporation**
- **ShipConstructor Software USA**

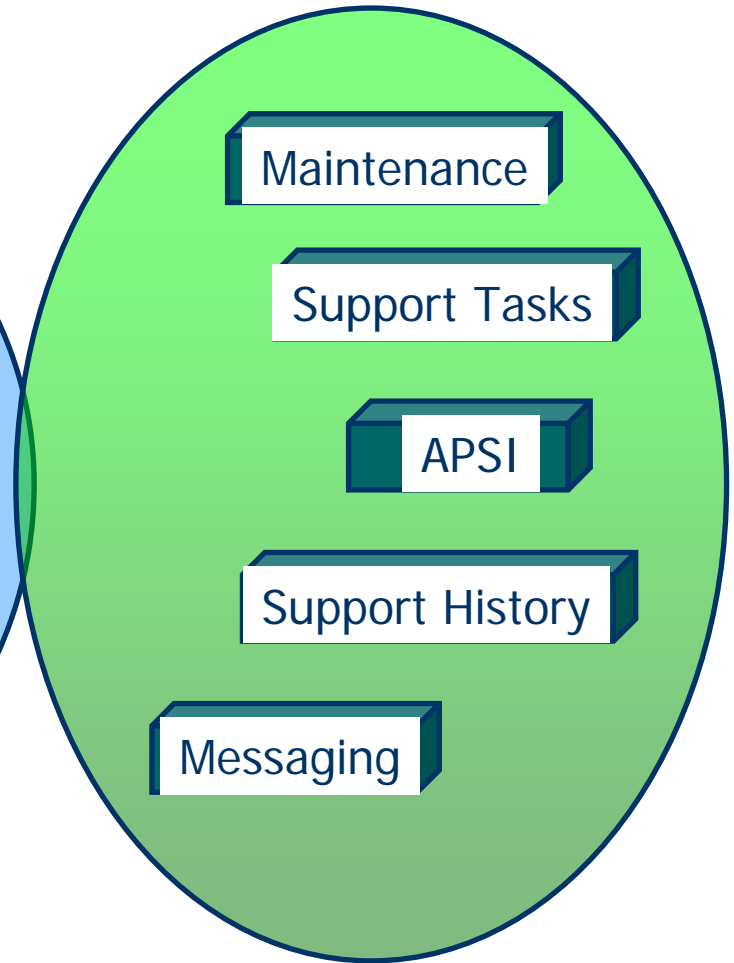


ISO 10303-239

Product Life Cycle Support



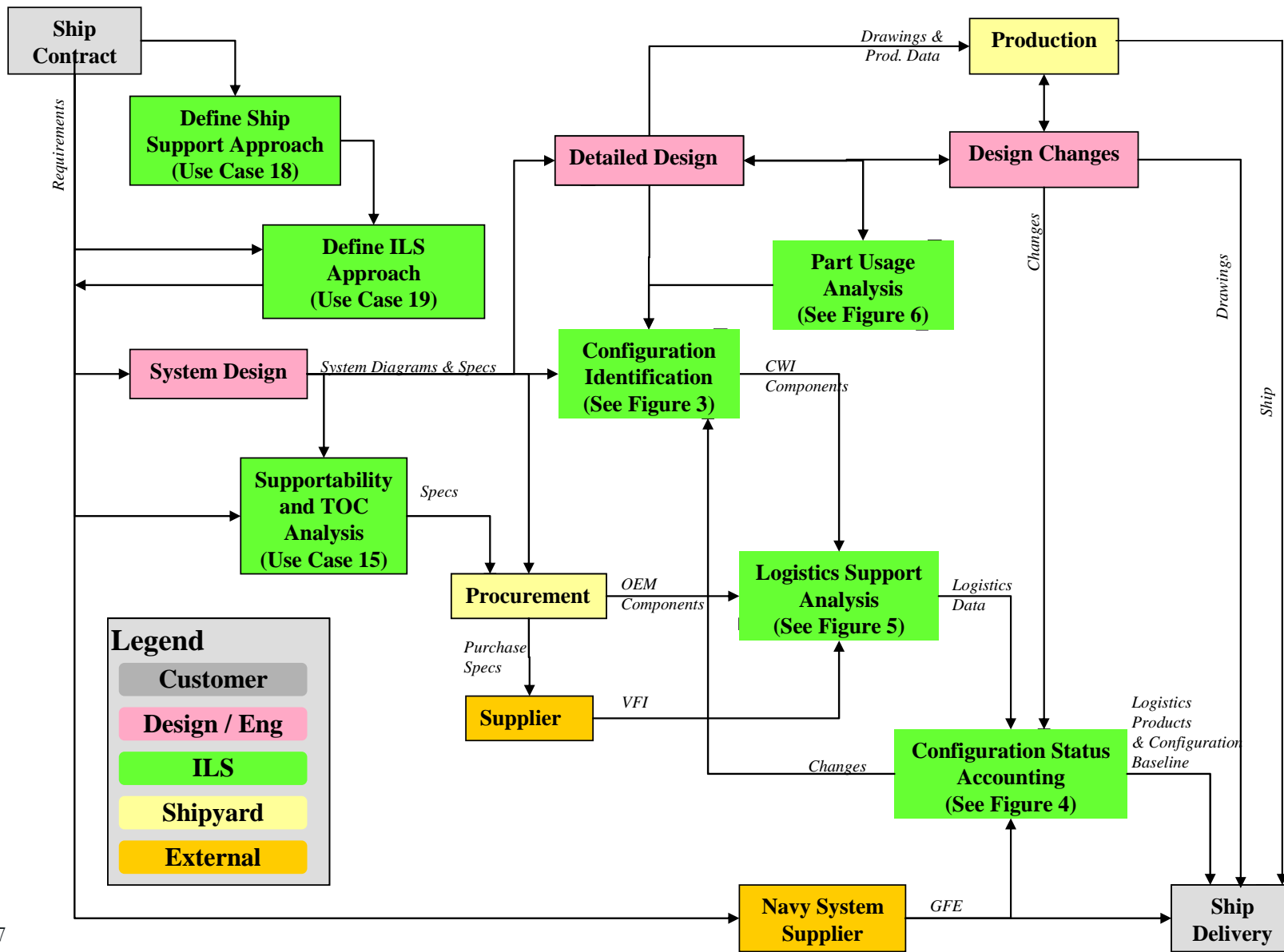
**AP239 Core Modules are shared
with AP233 for Systems Engineering**



**Additional Modules to
support Life Cycle activities**

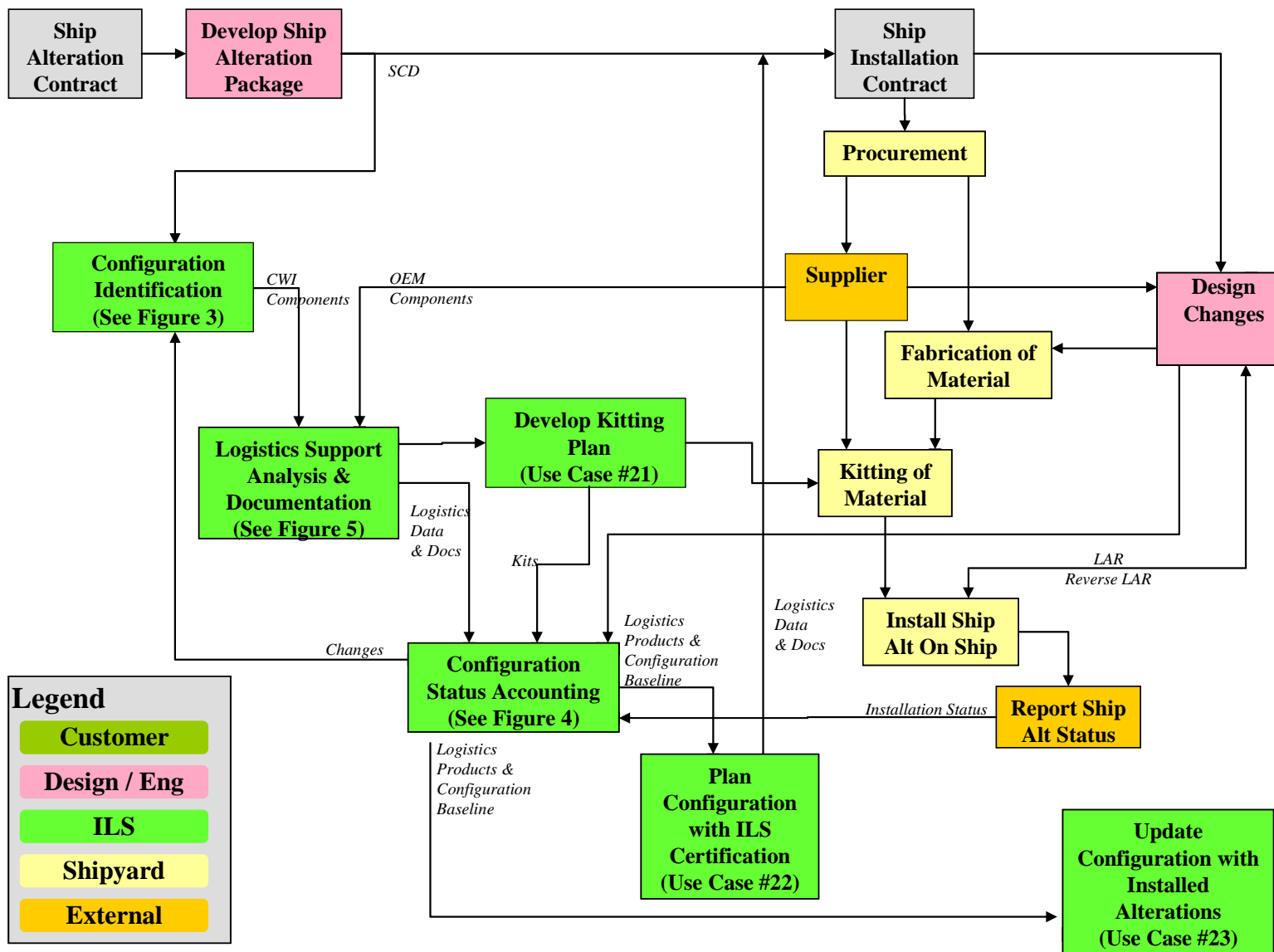


Life Cycle Support Business Process for Ship Acquisition





Life Cycle Support Business Process for Ship Alteration





Life Cycle Support Use Cases

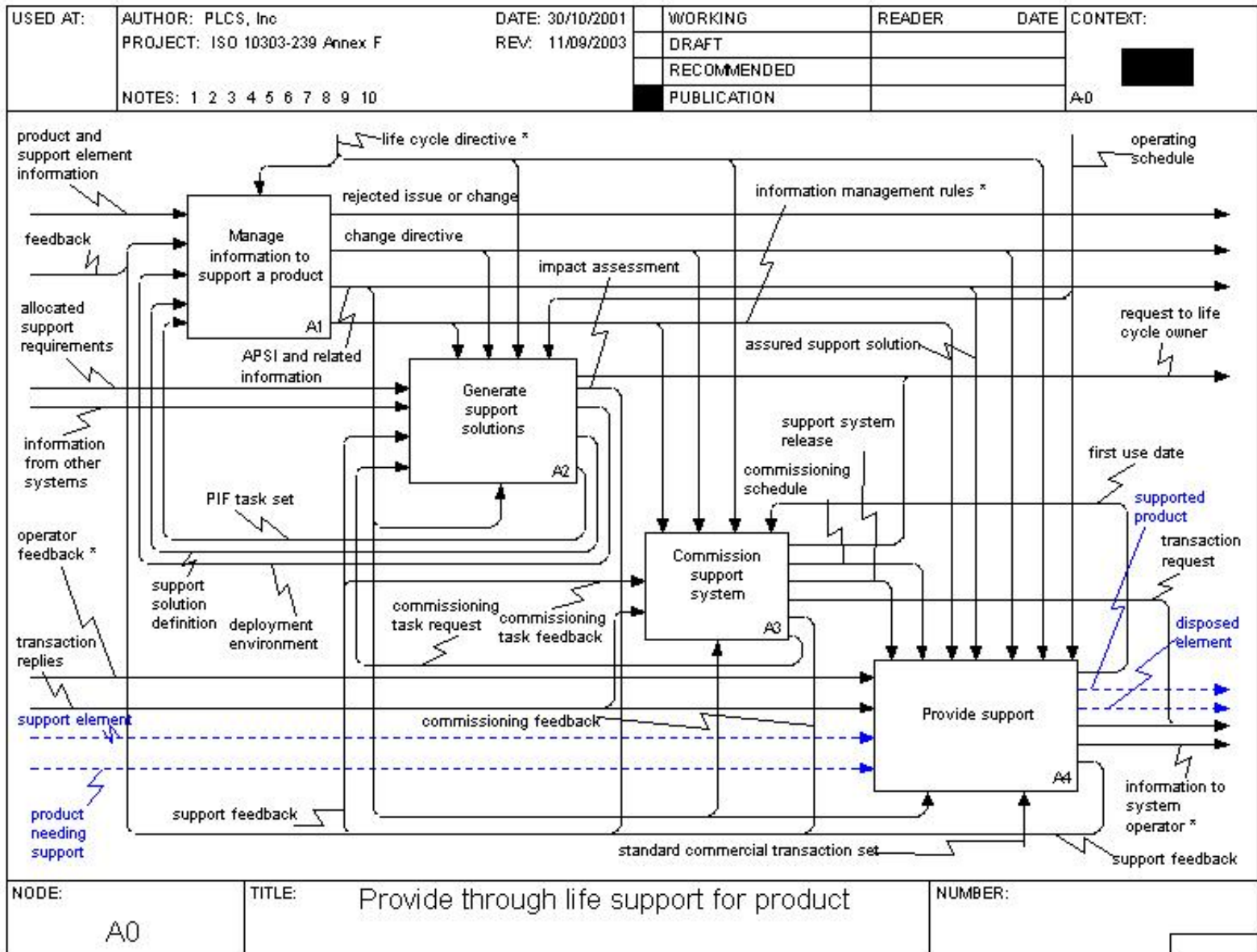


Life Cycle Support Use Cases for Ship Acquisition and/or Ship Alterations:

	<u>Type</u>
1. Identify Hierarchy Classification for Functional and System Designators	Both
2. Identify Configuration Worthy Items	Both
3. Classify Instances Based on Functionality	Both
4. Initial Assessment of Change for Configuration Changes	Both
5. Update Configuration Data & Support Products	Both
6. Develop Logistical Technical Data	Both
7. Develop Provisioning Technical Documentation Packages and Assign Repairable Identification Code	Both
8. Perform Reliability Maintenance Analysis	Acquisition
9. Perform System Safety Review	Acquisition
10. Perform Human Factors Review	Acquisition
11. Perform Maintenance Planning Development	Both
12. Identify Environmental Concerns	Acquisition
13. Establish Stowage Requirements and Identify Locations	Both
14. Develop Training Tools and Documentation	Both
15. Part Usage Requirements	Acquisition
16. Develop Planned Change	Both
17. Release Configuration Data and Support Products	Both
18. Define Ship Support Policy	Acquisition
19. Define ILS Approach	Acquisition
20. Perform Part Supportability and Life Cycle Cost Analysis	Acquisition
21. Develop Kitting Plan	Ship Alt
22. Plan Configuration with ILS Certification	Ship Alt
23. Update Configuration with Installed Alterations	Ship Alt

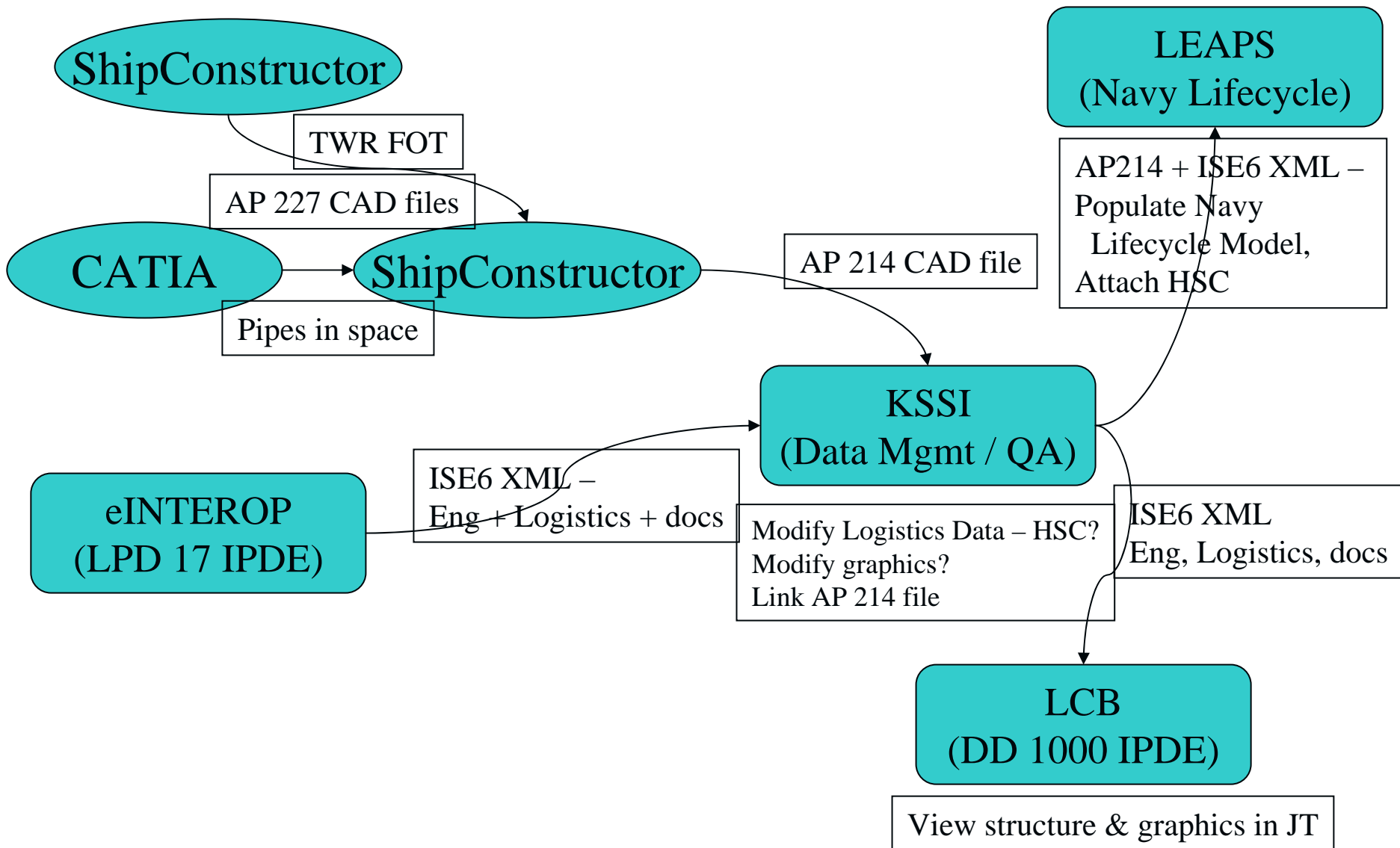


Application Activity Model (AAM) Diagram from AP239





ISE-6 Demo Scenario (Planned for March 2008)





ISE Tools



- **Tools developed by the ISE Project are made available on the Web at: www.isetools.org**
- **These include:**
 - **Formal information requirements published**
 - Ship Piping
 - Ship Structures
 - Ship HVAC
 - CPC Interfaces
 - Electrical
 - **Translator generators for custom representations**
 - **XML schema generators**
 - ISO 10303-28 ed 2
 - **Automated test frameworks for conformance testing**



Threaded Lists on isetools.org Bulletin Board



ISE Forums - Index - Microsoft Internet Explorer

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Back Forward Stop Home Search Favorites Media Print Mail

Links Personal Work Java Google Address http://www.isetools.org/eb-cgi-bin/inet/yabb_ISE/YaBB.pl?board=;action=logout

Integrated Shipbuilding Environment Interoperability Tools

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ISE Forums

News

ISE Tools forum is now operational

Forum name	Topics	Posts	Last post
Ship Arrangement			
Test Cases <i>Moderator: N/A</i>	0	0	N/A by N/A
Schemas <i>Moderator: N/A</i>	0	0	N/A by N/A
Implementation Agreements <i>Moderator: N/A</i>	0	0	N/A by N/A
Deliverable Reports <i>Moderator: N/A</i>	0	0	N/A by N/A
Steel Processing			
Test Cases	0	0	N/A



STEP Shipbuilding Implementation Forum



- **A Testing Forum for the STEP Shipbuilding APs has been established**
- **It is being run under the auspices of the NSRP Systems Technology Panel**
- **It will test and validate implementations of the STEP Shipbuilding APs**
- **Forum began in 2004 with AP216 (Ship Moulded Forms) testing and is currently involved with AP215 (Ship Arrangements) testing**



Goal: Implement in Production



- **The goal of current and future efforts is to make these techniques and tools available in production and to all U.S. shipyards**
 - **STEP Shipbuilding Translators**
 - **XML Tools**
 - **Common Parts Catalog Interfaces**
- **Includes efforts under ISE Project as well as STEP Shipbuilding Implementation Forum**



Interoperability: Continuing Efforts



- **ISE-6 (Enabling Shipbuilding Interoperability)**
 - Deploy information technology systems that meet the shipbuilder's interoperability requirements in the area of life cycle support and post-delivery operations
- **NPDI (Navy Product Data Initiative)**
 - To specify the requirements for and drive the implementation of product data systems based on an open architecture having suitable functionality and enterprise-wide interoperability to support affordable Navy ships design, construction and service life support
- **SCIM (Ship Common Information Model)**
 - SCIM will codify the models developed under the ISE Project under NSRP over the past seven years
 - It will be a separate document from the IPDE Specification to be produced by the NPDI Project, but it will be referenced by that IPDE Specification
 - Initial versions of the two documents will be completed in the same timeframe, but updates and subsequent versions can be issued independently



Summary



- **In order to increase the availability and lower the price of production ready tools:**
 - **The ship owner / operator needs to insist that data be delivered in a system neutral format**
 - **The shipbuilder needs to insist that STEP functionality be an integral part of computer software products**
- **The next challenge is to move this technology into the mainstream and insure that the technology is mature enough to transition into commercial CAD, CAE, CAM, and PDM products**
- **Enabling interoperability throughout the ship's life cycle is a major challenge in achieving the goals of NSRP**