OPEN SYSTEMS ARCHITECTURE (OSA) AND STANDARD INTERFACES AS MISSION CAPABILITY ENABLERS

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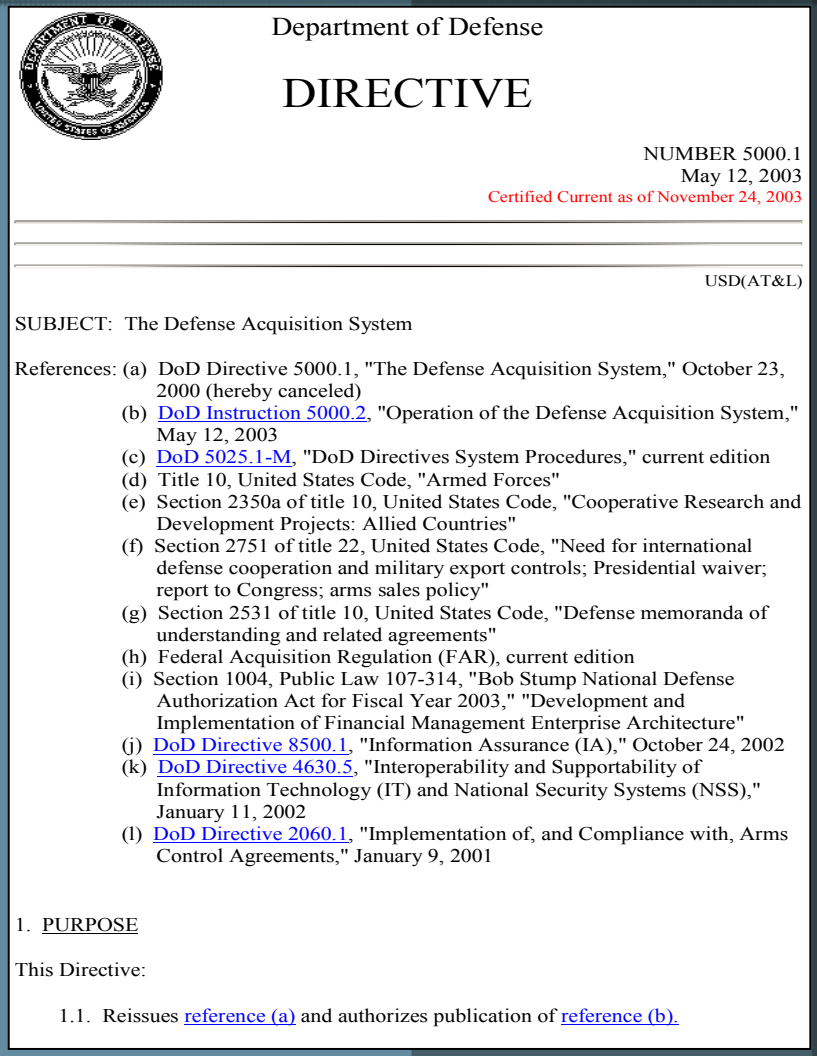
INTRODUCTION

- DoD POLICIES and DIRECTIVES
  - Application of new DoD 5000 series and Joint Integration and Development Systems (JCIDs) to ship acquisition programs through the implementation of the Open Systems Joint Task Force (OSJTF) Modular Open Systems Approach (MOSA)
- CHANGING THREATS
  - New mission capabilities
  - Technology refresh to adapt to changing world climate
  - Requires rapid system and component change-out
- FLEXIBLE FORCE – MODULAR ADAPTABLE FLEET
  - Allows for rapid change of a multi-mission ship
  - Allows a single ship to have multiple capabilities to support and defend against air, surface and submersibles assets
- AFFORDABLE FLEET – FAMILY OF SHIPS
  - Allows for cross-platform component commonality and interchangeability between ships and ship designs

DOD DIRECTIVE 5000.1
THE DEFENSE ACQUISITION SYSTEM

"Acquisition programs shall be managed through the application of a systems engineering approach that optimizes total system performance and minimizes total ownership costs. A modular, open-systems approach shall be employed, where feasible."



Department of Defense

DIRECTIVE

NUMBER 5000.1
May 12, 2003
Certified Current as of November 24, 2003

USD(AT&L)

SUBJECT: The Defense Acquisition System

References: (a) DoD Directive 5000.1, "The Defense Acquisition System," October 23, 2000 (hereby canceled)
(b) DoD Instruction 5000.2, "Operation of the Defense Acquisition System," May 12, 2003
(c) DoD 5025.1-M, "DoD Directives System Procedures," current edition
(d) Title 10, United States Code, "Armed Forces"
(e) Section 2350a of title 10, United States Code, "Cooperative Research and Development Projects: Allied Countries"
(f) Section 2751 of title 22, United States Code, "Need for international defense cooperation and military export controls; Presidential waiver; report to Congress; arms sales policy"
(g) Section 2531 of title 10, United States Code, "Defense memoranda of understanding and related agreements"
(h) Federal Acquisition Regulation (FAR), current edition
(i) Section 1004, Public Law 107-314, "Bob Stump National Defense Authorization Act for Fiscal Year 2003," "Development and Implementation of Financial Management Enterprise Architecture"
(j) DoD Directive 8500.1, "Information Assurance (IA)," October 24, 2002
(k) DoD Directive 4630.5, "Interoperability and Supportability of Information Technology (IT) and National Security Systems (NSS)," January 11, 2002
(l) DoD Directive 2060.1, "Implementation of, and Compliance with, Arms Control Agreements," January 9, 2001

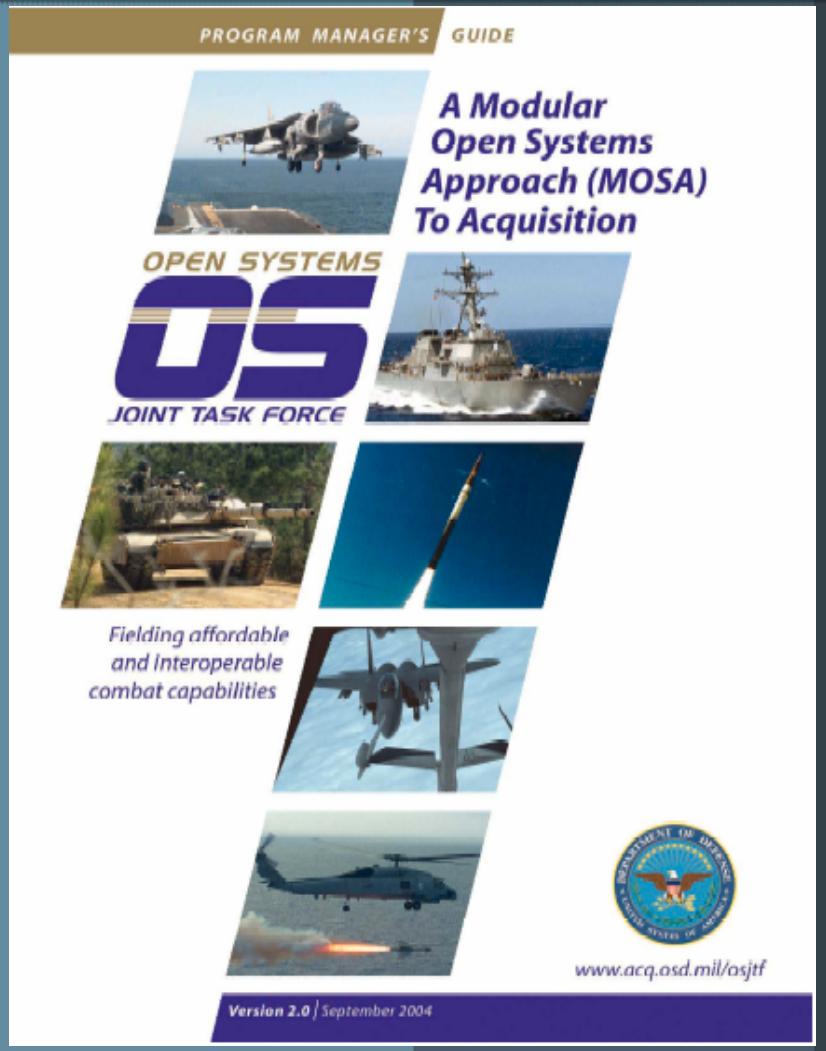
1. PURPOSE

This Directive:

1.1. Reissues reference (a) and authorizes publication of reference (b).

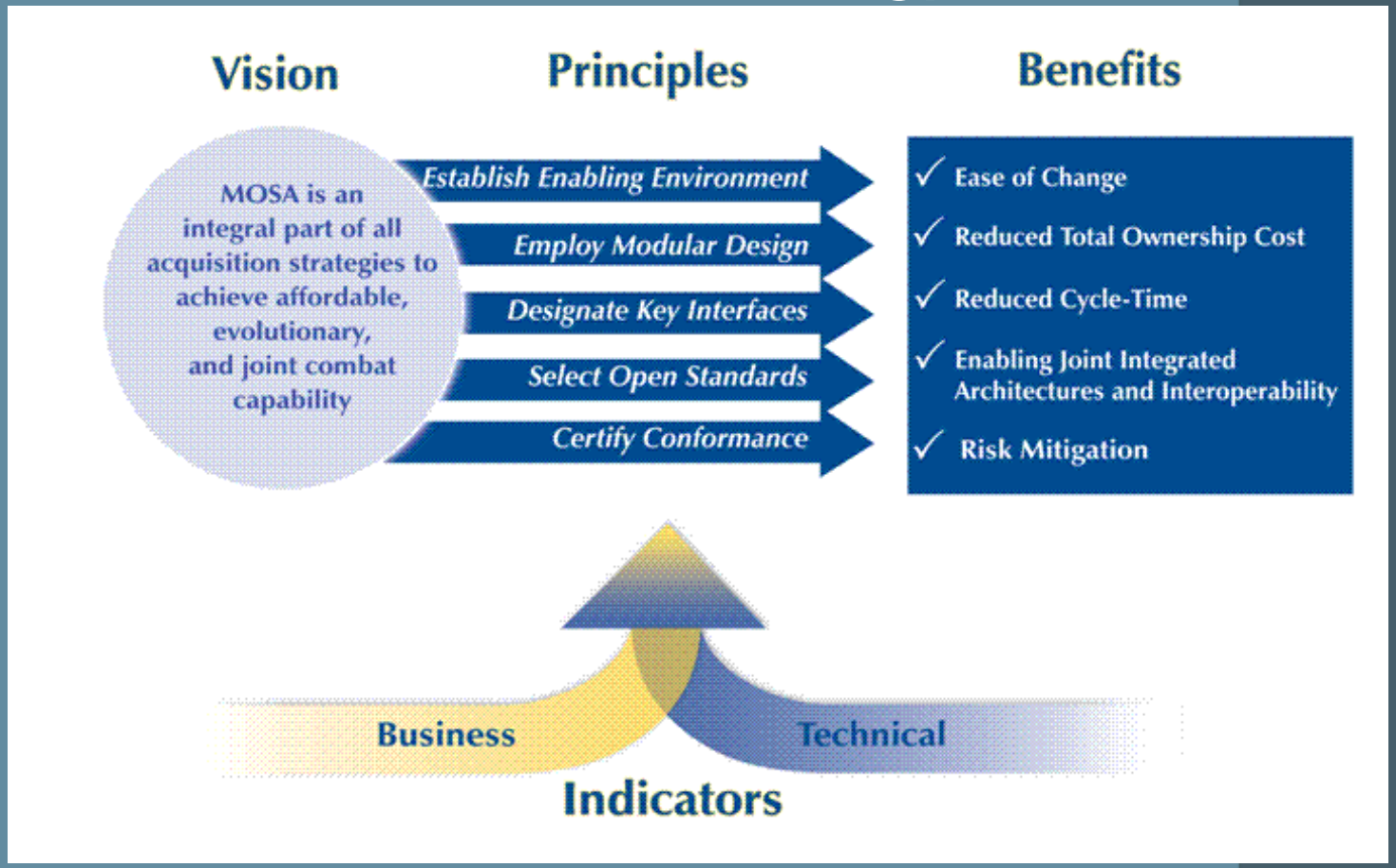
OPEN SYSTEMS JOINT TASK FORCE (OSJTF)

"The OSJTF's modular, open systems approach is a key enabler in the Department's focus on joint architectures and evolutionary approach to weapon systems acquisition. All acquisition programs should employ a modular, open systems approach."



MODULAR OPEN SYSTEMS APPROACH (MOSA)

Integrated Business and Technical Strategy



MOSA AS AN ENABLER

- The MOSA approach is an enabler to achieve the following objectives:
  - Adapt to evolving requirements and threats
  - Promote transition from science and technology into acquisition and deployment
  - Facilitate systems integration
  - Reduce the development cycle time and total life-cycle cost
  - Ensure that the system will be fully interoperable with all the systems which it must interface, without major modification of existing components
  - Leverage commercial investment
  - Enhance access to cutting edge technologies and products from multiple suppliers
  - Enhance commonality and reuse of components among systems
  - Mitigate the risks associated with technology obsolescence
  - Mitigate the risk of a single source of supply over the life of a system
  - Enhance life-cycle supportability
  - Increase competition

THE NAVY'S NEED FOR MODULES AND OPEN SYSTEMS

"Controlling cost while decreasing the cycle time for technology insertion will require the use of open architectures, module interface standards, commercial processors, etc. in conjunction with strict configuration control."

Mr. John J. Young, Jr., Assistant Secretary of the Navy (Research, Development, and Acquisition) before the procurement subcommittee of the house armed services committee United States House of Representatives Fiscal Year 2003 Navy/Marine Corps Shipbuilding programs March 20th 2002.

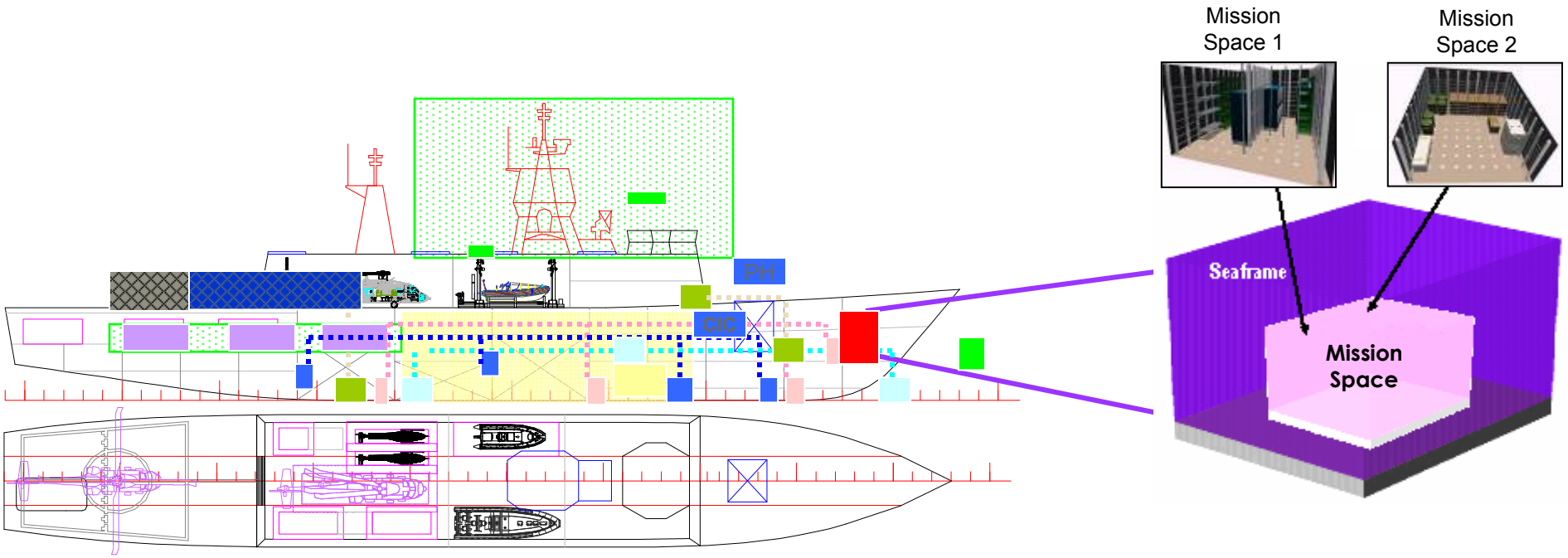
NAVY OPEN SYSTEMS INITIATIVES

- Affordability Through Commonality (ATC) program transitioned to Total Ship Open Systems Architecture (TOSA)
- TOSA IPT formed in 1998
  - Acquisition reform with emphasis on "letting Industry do it"
  - Bring **Open Systems Architectures** (OSA) concepts to ship design
  - Reduce the Total Ownership Cost (TOC) of ships
    - Achieve Fleet-Wide commonality through maximum use of commercial equipment while managing risk
    - Use of non-proprietary OSA and standard interfaces
    - Facilitate improved systems expansions and upgrades in response to changing missions and technology
- Major Products
  - Process to develop **Open System Architectures** for ships
  - Open CIC, HVAC, and Environmental Quality Systems concepts developed
  - Technology Management for DD21 and LCS
- Architectures, Interfaces, and Modular Systems (AIMS) current ongoing initiative evolved from TOSA

ARCHITECTURES, INTERFACES, AND MODULAR SYSTEMS (AIMS) PROGRAM

- Current U.S. Navy RDT&E Program to promote increased Navy use of OSA and modularity
- VISION
  - To create a Modular Adaptable Ship (MAS) through development of open architecture based zones such as C4I, Weapons, and Sensor zones
- GOALS
  - To reduce ship life-cycle costs
  - Enable technology refresh insertion
  - Promote competition
  - Improve mission capability and flexibility
  - To facilitate life-cycle adaptability
- Examine ship designs at the systems, subsystems, and component level to determine what level of modularity makes sense

AIMS VISION – MODULAR ADAPTABLE SHIP



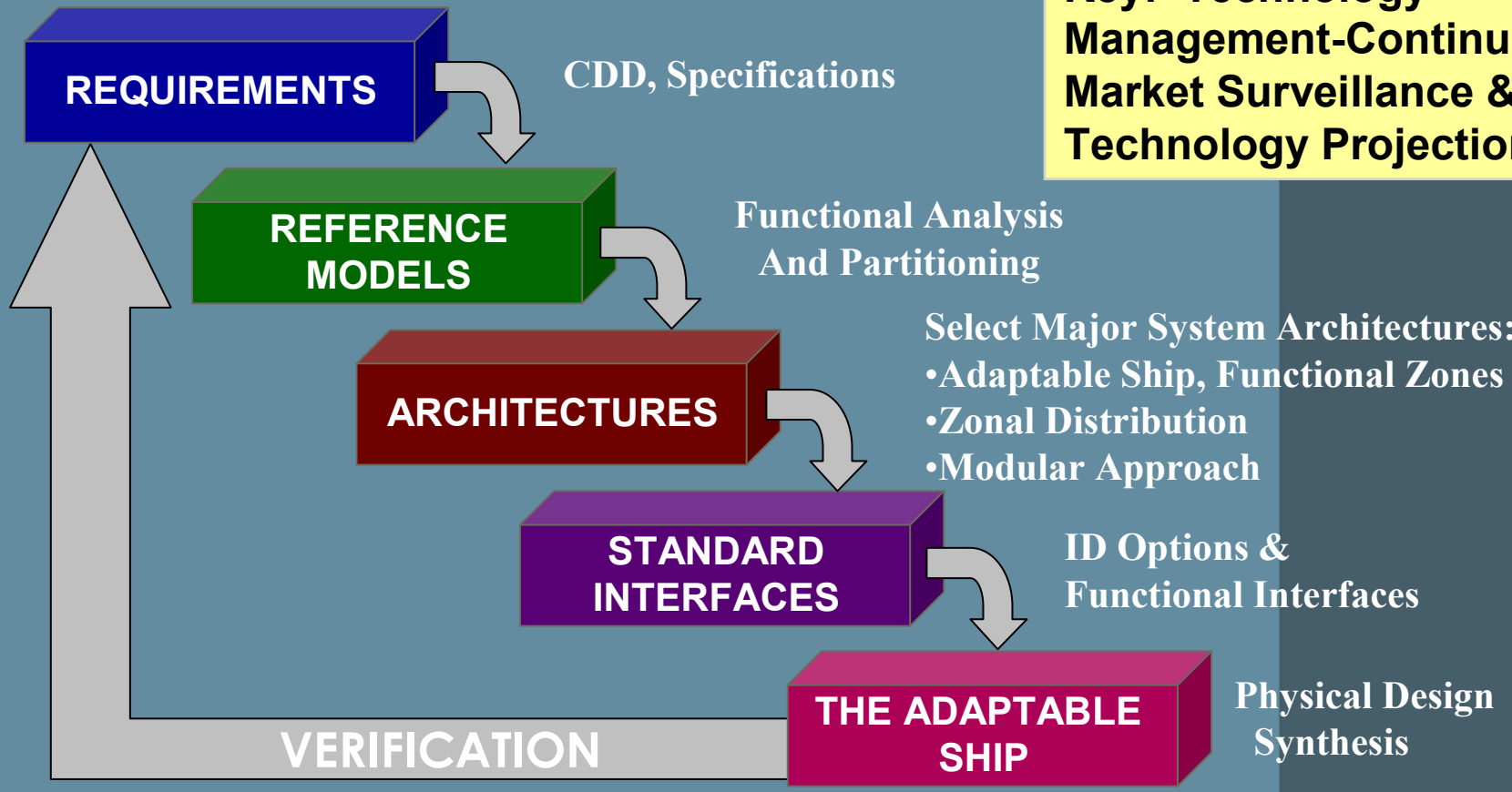
OPEN FUNCTIONAL ZONES

- **Modular C4I Zones**
- **Modular Offboard Vehicle Zones**
- **Modular Weapons Zones**
- **Modular Sensors / Topside Zones**
- **Modular Machinery Zones**
- **Modular Human Support Zones**
- **Other (SOF modules, ISR, modules)**

KEY INTERFACES

- **Data & information (OACE)**
- **Physical (Geometric & Tolerances)**
- **Weight and CG / VCG**
- **Services: Electrical, Air,Cooling**
- **Piping connections**
- **Monitoring & Control Sensors**
- **Human Factors**
- **Survivability/Vulnerability: shock, vibration, EMI, EMC, etc.**

NAVY AIMS PROCESS



Key: Technology Management-Continuous Market Surveillance & Technology Projection

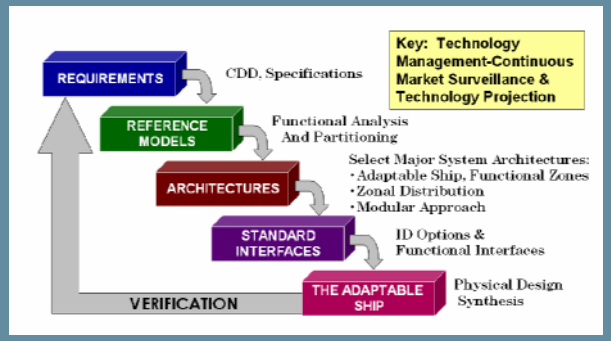
CASE STUDY – OSA AND MODULAR RECONFIGURABLE SPACES

User Needs

- –Multi-Mission Ship on a Single Seaframe
- –Rapid Mission Reconfiguration
- –Increase Availability
- –Rapid Technology Refresh or Insertion
- –Supportability

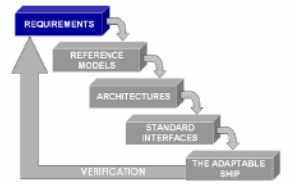
Modular Reconfigurable Spaces

AIMS Process Execution



Mission Capable Ship

REQUIREMENTS ANALYSIS



Constraints
–ABS NVR
–Regulations
–Military Specifications

ICD

CDD

User Needs

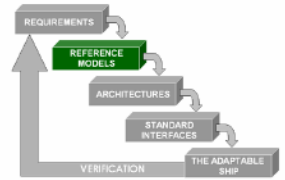
–Multi-Mission Ship
–Rapid Mission Reconfiguration
–Increase Availability
–Rapid Technology Refresh
–Supportability

Requirements Definition

Performance Specifications

Tech Management
-Market Research
-Available Technologies
-COTS Components

FUNCTIONAL ANALYSIS



Human Support Systems

Modular Reconfigurable Spaces

Weapons Systems

HM&E Systems

Propulsion Systems

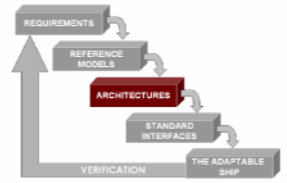
C4I Systems

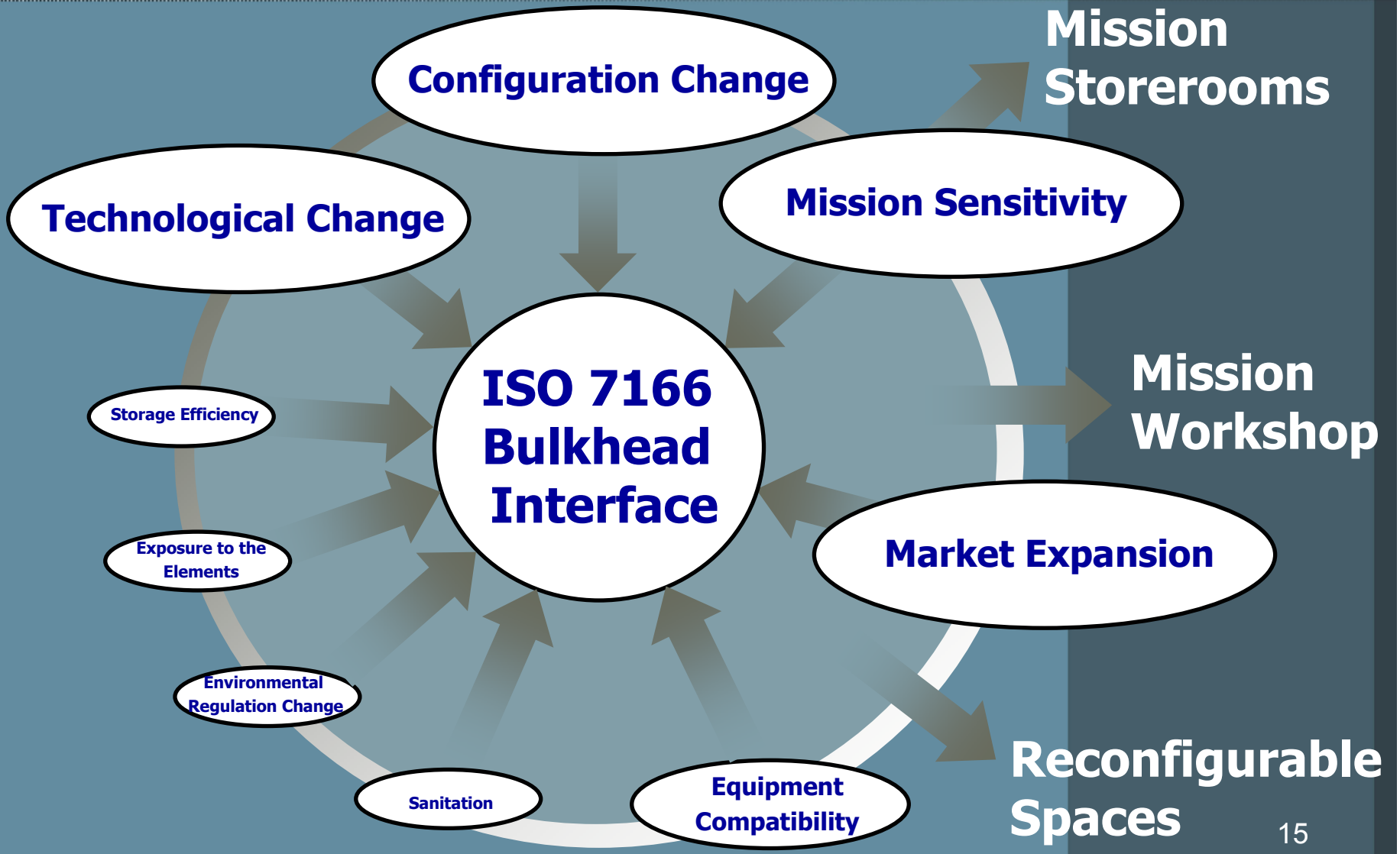
Mission System 1

Mission System 2

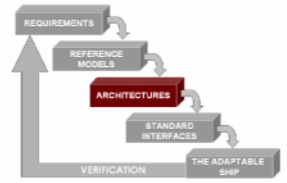
Mission System 3

MODULAR OSA
HUMAN SUPPORT ZONE TRADE STUDY



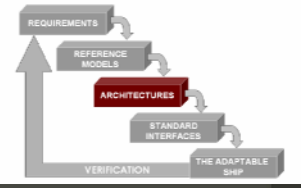


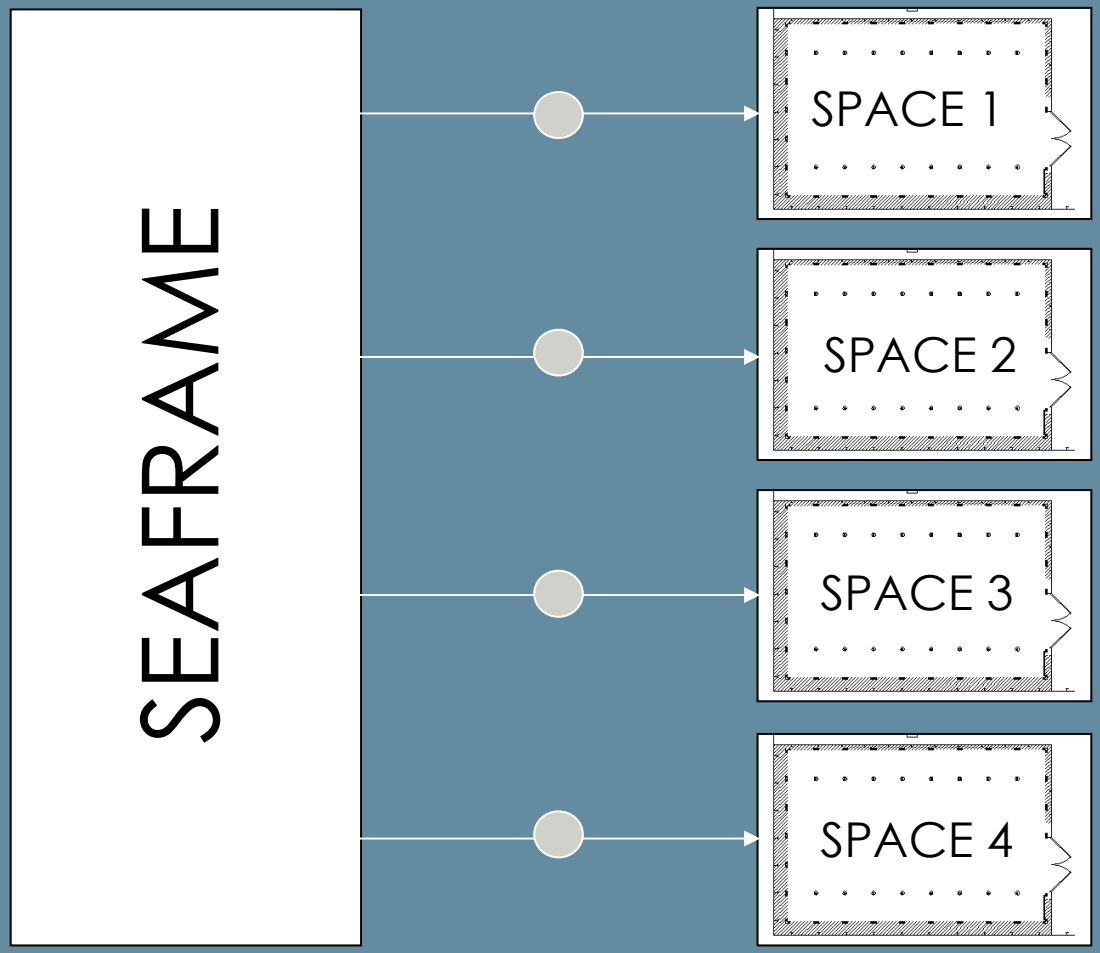
FUNCTIONAL AREA SELECTION EXAMPLE



Estimated Number of Compartments on Ship	Functional Area	Compartment Attributes: Tech. Change	Configuration Change	Mission Sensitivity	Equipment Applicability	Storage Efficiency	Environmental Change	Sanitation	Exposure to Elements	Market Expansion	Ranking
	Attribute Weighting	5	5	5	3	2	2	2	2	5	
3-4 Mission 11 Storerooms	Mission Storeroom: Aviation Storerooms, Hangers, Workshops	1	5	5	5	2	3	3	5	5	121
1	Reconfigurable Space	2	5	5	3	1	1	3	4	5	112
11	Stateroom Crew (4)	1	4	1	4	1	1	4	5	5	89

OPEN SYSTEMS ARCHITECTURE MODULAR RECONFIGURABLE SPACE

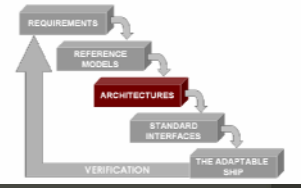




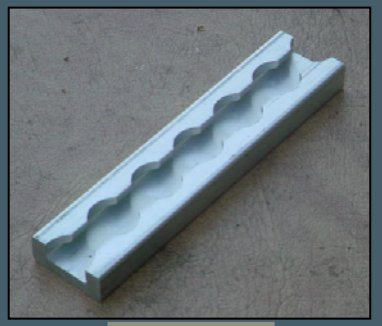
Key Interfaces:

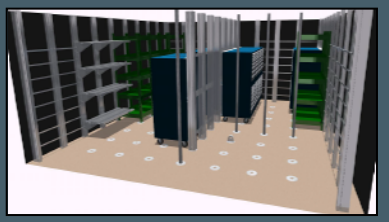
- Data & information (OACE)
- Physical (Geometric & Tolerances)
- Weight and CG / VCG
- Services: Electrical, Air, Cooling
- Piping connections
- Monitoring & Control Sensors
- Human Factors
- Survivability/Vulnerability: shock, vibration, EMI, EMC, etc.

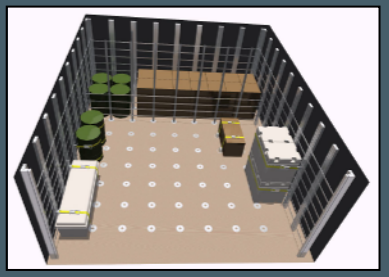
KEY INTERFACES MODULAR RECONFIGURABLE SPACE



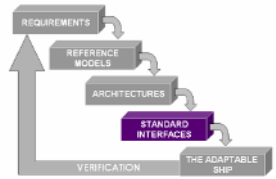
- Data
- Distributed Systems – HVAC, electrical, fluids, etc.
- Structural - foundations
  - International Standards Organization (ISO) 7166
    - Aircraft Rail and Stud Configuration for Passenger Equipment and Cargo Restraint
    - Increase core modularity, mission readiness and contain costs by incorporating ISO 7166 bulkhead interfaces

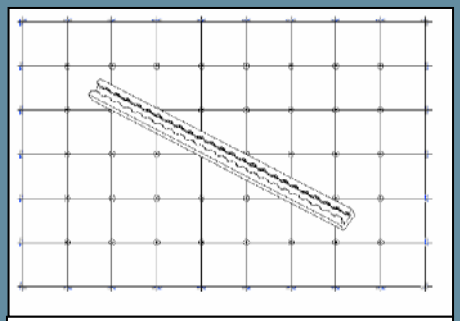




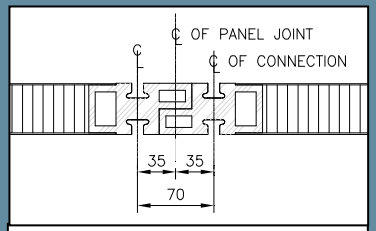


OPEN SYSTEMS ARCHITECTURE AND STANDARD INTERFACE DEFINTIONS

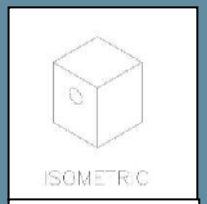




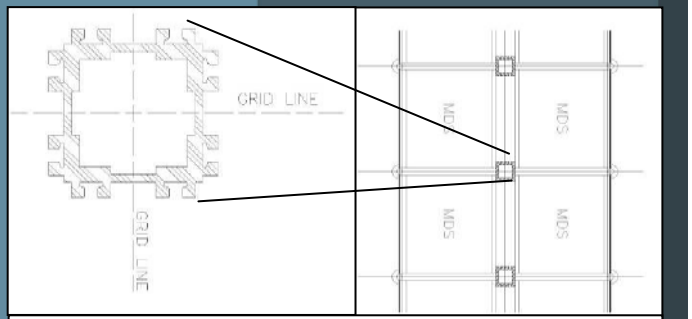
Standardized Dimensional Grid System



Double ISO 7166 Interface

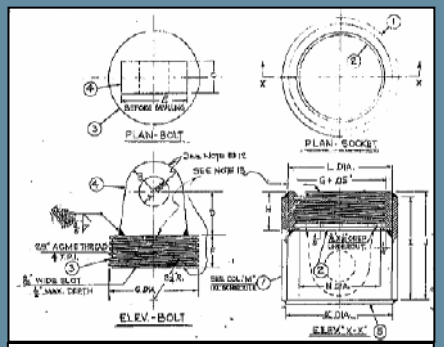


Welded Deck Pins

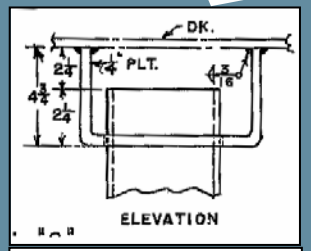


Removable Columns

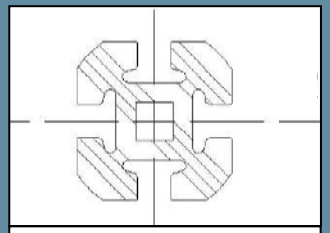
Modular Architecture
Leverages off of Previous Programs
ATC Integrated Joiner Bulkhead Project
TOSA Reconfigurable Stowage
Hull Type Drawings



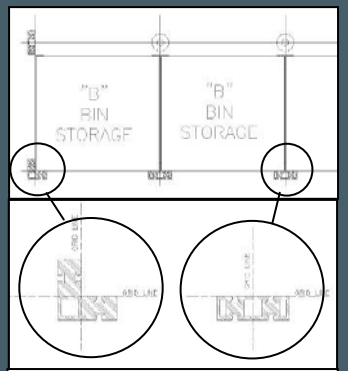
Reversible Deck Sockets



Overhead Column Sockets

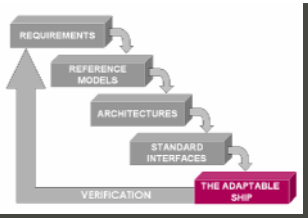


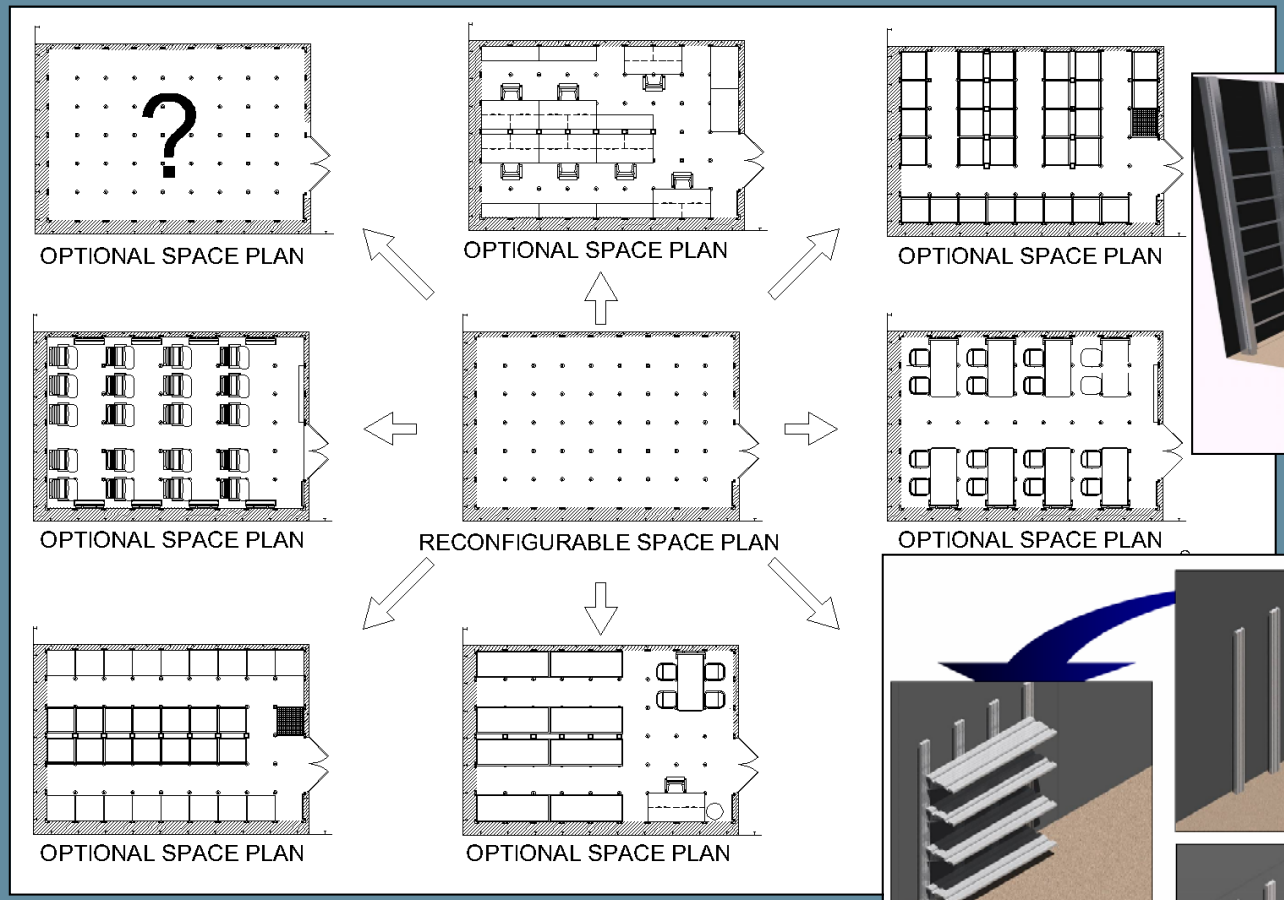
Removable Bulk Storage Telescoping Battens

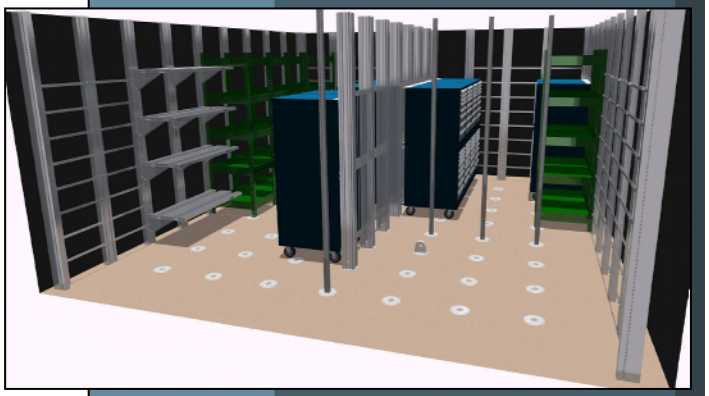


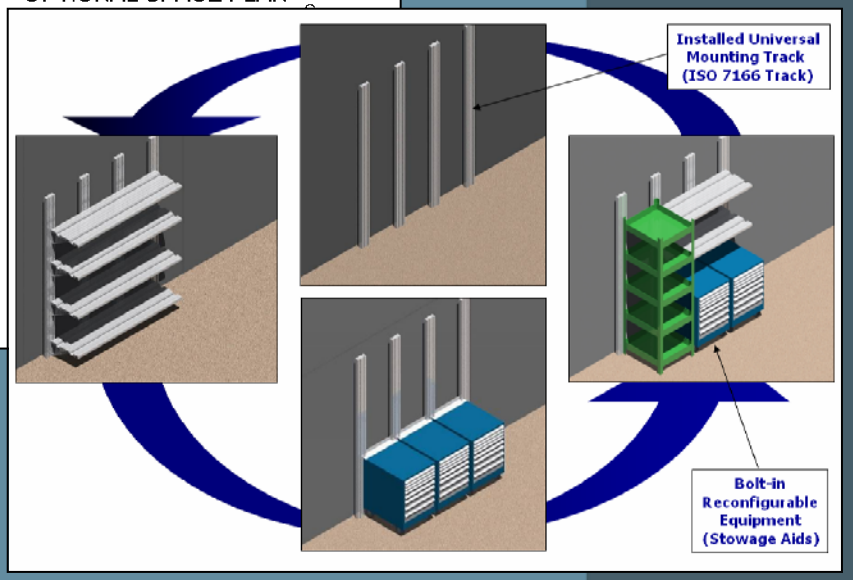
Removable Perimeter Columns

MODULAR OSA SPACES – RECONFIGURATION OPTIONS

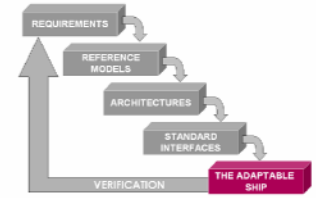








MODULAR OSA KEY: INTERFACE CONTROL



Sea Frame Development

Conceptual Design

High Level Impacts to Seaframe Architecture

Perform Concept Studies to Identify:

- Module Stations including Weapons, Air, Sea, Sensors, and Support
- Gross Mission Characteristics
- Initial Mission Communications

Preliminary Design

Refined Architecture Required for Seaframe Development

Interface Document

- Mission System Physical Requirements
- Notional Mission Packages
- Baseline Tech Architecture for Mission System Interfaces:
  - -Area, Volume, Weights
  - -Number of Module Stations
  - -Clearances
  - -Ship Services: Power, Cooling, Air/Water,Data Link
  - -Launch, Recovery and Handling
  - -Core and Reconfigure Systems
  - -Stand Alone Resource Stations
  - -Ammunition

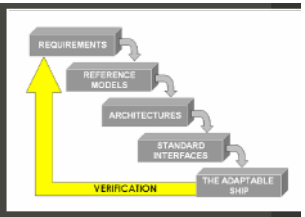
Final Design

Interface Specification for Detailed Design

Interface Control Document (ICD)

- Seaframe definition:
  - Detailed foundation definitions
  - Network
  - Communications
  - Command and Control Software
- Mission reconfiguration definition:
  - Detailed connection definitions
  - Focused Mission Package

RECONFIGURABLE SPACE VERIFICATION: BUSINESS CASE ANALYSIS



Ship Life Cycle Phase		Total Cost	Material Cost	Labor Cost	Cycle Time	Weight	Occurrences During Ship Life	**Life Cycle Cost**	**Life Cycle Availability**
Development	Multi Bulk	N/A	N/A	N/A	N/A	N/A	1	N/A	N/A
Procurement	Multi Bulk	9% 35%	-64% 26%	54% 42%	28 Day 18 Day	-855 kg 465 kg	1	9% 35%	28 Day 18 Day
O&M/ Overhaul	Multi Bulk	90% 70%	N/A	N/A	54 Day 84 Day	N/A	3	90% 70%	162 Day 252 Day
Disposal	Multi Bulk	85% 87%	N/A	N/A	N/A	N/A	1	85% 87%	N/A
Total								**40% 80%**	**190 Day 270 Day**

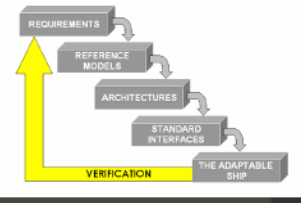
ISO 7166 has Slight Decrease/ Increase over Conventional

ISO 7166 has Decrease/Increase over Conventional

ISO 7166 has Significant Decrease/Increase over Conventional

ISO 7166 is Equal to Conventional

BUSINESS CASE ANALYSIS RESULTS



New Build

Conventional

Layout Compartment (Chalk locations)
- Subbases or Clips (Foundation)
  - Retrieve From Warehouse
  - Scribed for local irregularities, sheer, and camber
  - Cut, Weld and Watertight sealed to the deck
- Welding "Hot Work"
  - Requires Multiple Fire watches
  - Working and Adjacent Compartments must be prepped
    - Removal of paint
    - Removal of insulation
    - Removal of heat affected equipment and items
  - Underlayment & deck covering (where specified) must be installed around foundations
  - Stowage Aid Installation to Foundation
    - All foundations are different
    - Specific stowage aid that mates with foundation must be located and retrieved from warehouse
    - Each Stowage Aid mounts in a different manner requiring multiple tool sets, techniques
- Sway Braces must be installed
  - Custom Manufactured to fit into the mounting location
  - Weld to bulkhead or overhead "Hot Work"
  - Doublers must be installed on Stowage Aid in way of sway brace fasteners
  - Clean and paint, repair insulation

Multipurpose	**64 Days**
Bulk	**52 Days**

ISO 7166

Deck Sockets are built into the deck.
- Layout Perimeter (Chalk Locations) (accuracy very important)
- Deck Clips are welded around the perimeter of the deck on a regular grid spacing.
- Overhead sockets are welded in the overhead on a regular grid spacing interior and perimeter ("Hot Work" Custom Manufacturing and Fitting)
- Underlayment & deck covering installed (Where specified)
- Perimeter columns inserted in overhead socket and slid over deck clips, bolted in place.
- Interior Removable Columns are installed where required
  - Flip deck bolt in deck socket
  - Slide column in overhead socket
  - Pin column through deck socket
- Stowage Aid Installation
  - Retrieve stowage aid from warehouse
  - Bolt stowage aids to ISO track

Multipurpose	**36 Days**
Bulk	**34 Days**

Conventional **ISO 7166**

ISO 7166
Faster and Cheaper

Reconfiguration

Conventional

- Engineering Change Drawings
- Stowage Aid Removal
  - Empty stowage aid
  - Remove deck covering and underlayment
  - Unbolt stowage aid from sway braces, subbase , clips (foundation)
  - Cut sway braces, subbase , clips (foundation) from ship structure ("Hot Work")
  - Grind smooth, paint, repair insulation
- Layout Compartment
- Subbases or Clips (Foundation)
  - Retrieve From Warehouse
  - Scribed for local irregularities, sheer, and camber
  - Cut, Weld and Watertight sealed to the deck
- Welding "Hot Work"
  - Requires Multiple Fire watches
  - Working and Adjacent Compartments must be prepped
    - Removal of paint
    - Removal of insulation
    - Removal of heat affected equipment and items
  - All welded areas must be repainted
  - Underlayment & deck covering (where specified) must be installed around foundations; repair insulation
- Stowage Aid Installation to Foundation
  - All foundations are different
  - Specific Stowage aid that mates with installed foundation must be located and retrieved from warehouse
  - Each Stowage Aid mounts in a different manner
- Sway Braces must be installed
  - Custom Manufactured to fit into the mounting location
  - Weld to bulkhead or overhead, "Hot Work"
  - Doublers must be installed on Stowage Aid in way of the sway brace fasteners
  - Clean and paint, repair insulation

Multipurpose	**59 Days**
Bulk	**81 Days**

ISO 7166

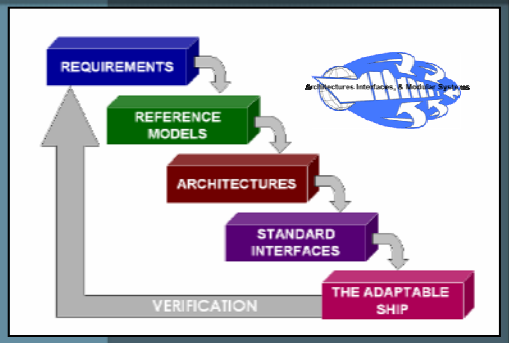
- Interior Removable Columns are installed or removed where required
  - Flip deck bolt in deck socket
  - Slide column in overhead socket
  - Pin column through deck socket
- Stowage Aid Installation
  - Retrieve stowage aid from warehouse
  - Bolt stowage aids to ISO track

Multipurpose	**5 Days**
Bulk	**7 Days**

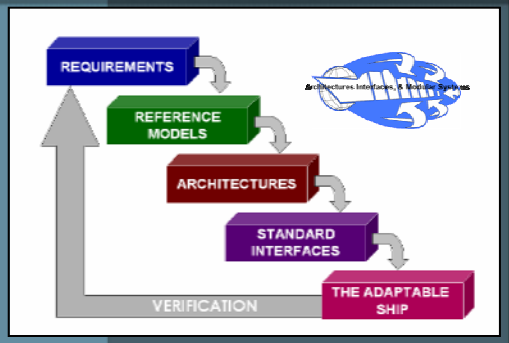
ISO 7166
Faster and Cheaper

SUMMARY AND CONCLUSIONS

- Modular reconfigurable spaces based on OSA and Standard Interfaces:
  - Cost effective solution to meet User Needs.
  - Satisfies Capabilities Requirements and User Needs more efficiently and effectively than conventional system.
  - Enables:
    - Mission flexibility (rapid reconfiguration)
    - Supportability (common components)
    - Technology refresh/insertion



OTHER OSA ACCOMPLISHMENTS – INTERFACE CONTROL DOCUMENT (ICD)



- Former TOSA team members assigned to Mission Systems and Ship Integration Team (MSSIT) for a major ship acquisition program
- Developed J-5 Appendix to RFP and Contract: ICD Requirements
  - Focused initially on HM&E interfaces for preliminary design
  - Progressive definition to include additional interfaces
- Developed J-10 Appendix to RFP and Contract: OSA Open Architecture Requirements