U.S. Navy interest in IEEE P2030.4

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Agenda

- The Fleet Today
- Complexity of Naval Warship Design
- Naval Electrical Power Systems as a Microgrid
- Navy Machinery Control Systems and P2030.4
- Conclusion

Status of the U.S. Navy

- **Navy Personnel**
  - **Active Duty:** 317,587 (52,814 Officers, 260,300 Enlisted)
  - **Midshipmen:** 4,473
  - **Ready Reserve:** 109,038 [As of Oct 2012]
    - **Reserves currently mobilized:** 4,569 [as of 13 Nov 2012]
- **287 Ships and Submarines**
  - **Deployed:** **105 (35% of total)**
  - **Underway for Local Ops / Training:** **20 (6% of total)**
- **3700+ Aircraft**

SOURCE: www.navy.ml on 27 Nov 2012

Battle Force Composition

11 Aircraft Carriers

14 Ballistic Missile Submarines

4 Guided Missile Submarines

54 Attack Submarines

102 Surface Combatants

34 Combat Logistics Ships

29 Amphibious Warfare Ships

32 Support / Mine Warfare Ships

7 Naval Reserve Force, Active (NRFA) Ships

SOURCE: www.nvr.navy.mil on Nov 27, 2012

Maritime Strategy

- **Forward Presence**
- **Deterrence**
- **Sea Control**
- **Power Projection**
- **Maritime Security**
- **Humanitarian Assistance and Disaster Response**

Challenges of Warship Acquisition



Very low quantities, high unit cost, long lives

No prototypes, first ship(s) must be fully operational

Combat / weapons systems developed concurrently

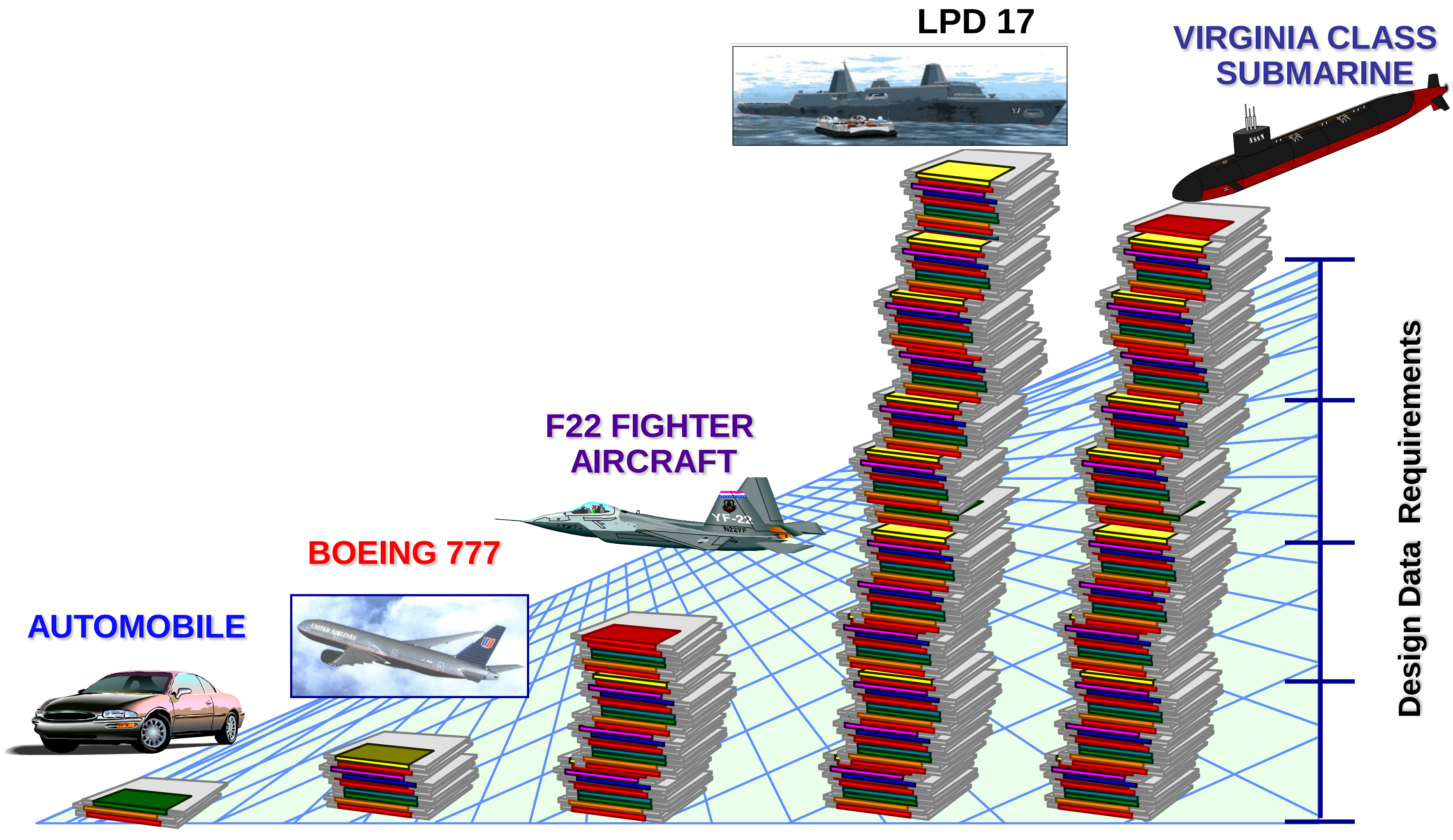
Government assumes responsibility for meeting requirements

Extremely high parts count (in the order of 10 million)

Minimal commercial shipbuilding industrial base

Intense Congressional/OSD oversight

Warship Complexity



Terrestrial vs. Marine Power Systems

Terrestrial Power Systems

- Structure – generally radial
- Large numbers of generators, busses, transmission lines, loads
- Constant frequency – linearized about an operating point
- Load flow analysis
- Market Implications

Marine Power Systems

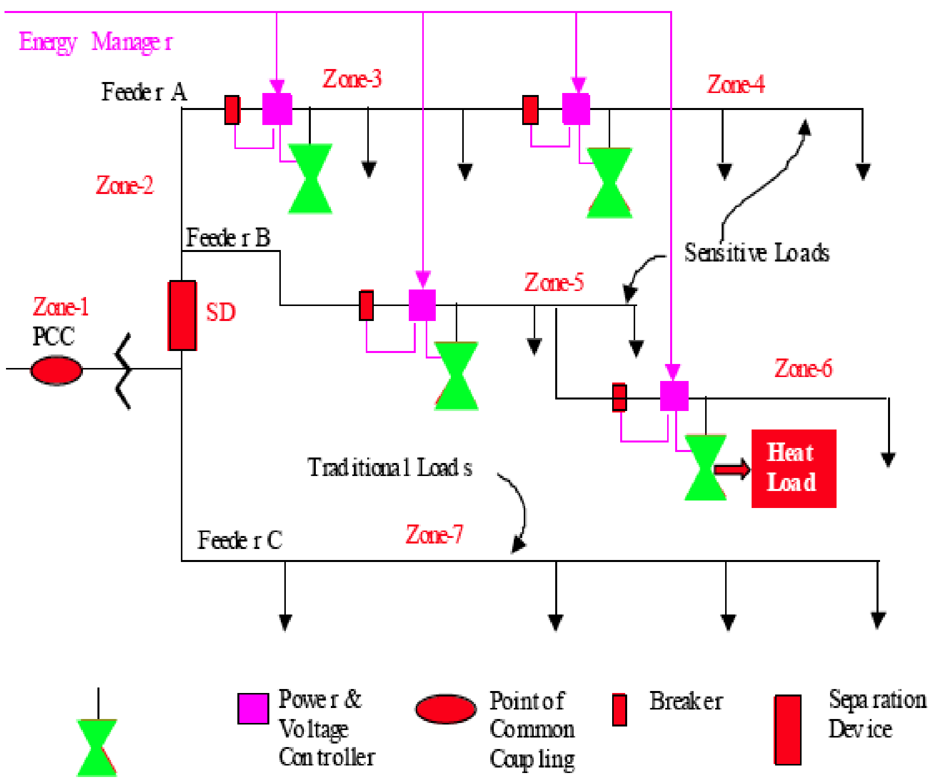
- Structure – zonal / mesh
- Small numbers of generators, busses, transmission lines, loads
- Large transients, often not linearizable
- Frequency domain analysis
- No Market Implications

Traditional Electric Power Systems have distinct differences from Marine Power Systems

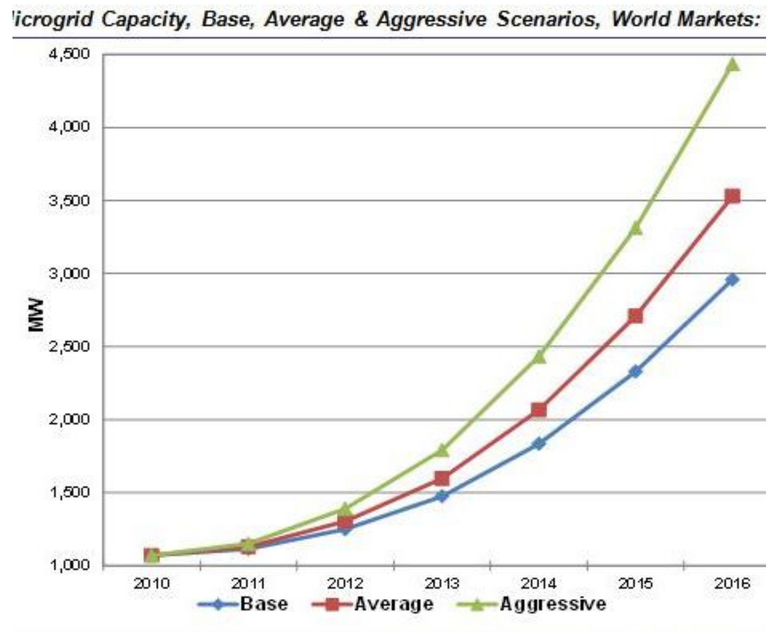
Slide courtesy of Dr. Tim McCoy PMS 320

Microgrids - Overview

Microgrid Architecture[2]



[2] Integration of Distributed Energy Resources, the CERTS Microgrid Concept," Lawrence Berkeley National Lab, 2003



(Source: Pike Research)

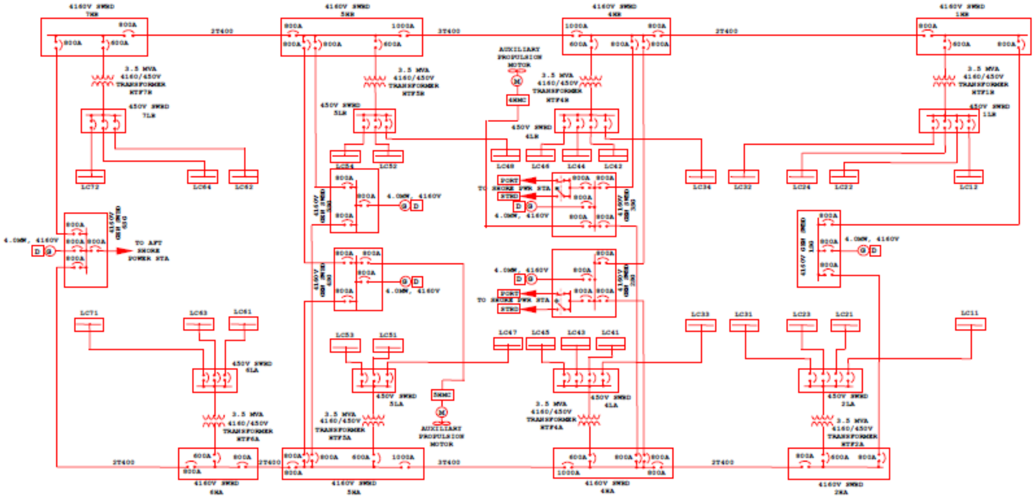
- **Definition of a Microgrid**: An integrated energy system consisting of distributed energy resources and multiple electrical loads operating as a single, autonomous grid either in parallel to or "islanded" from the existing utility power grid.[1]

[1] **" Distributed Energy Systems for Campus, Military, Remote, Community, and Commercial & Industrial Power Applications: Market Analysis and Forecasts," Pike Research, 2012.**

Slide courtesy of Dr. Tim McCoy PMS 320

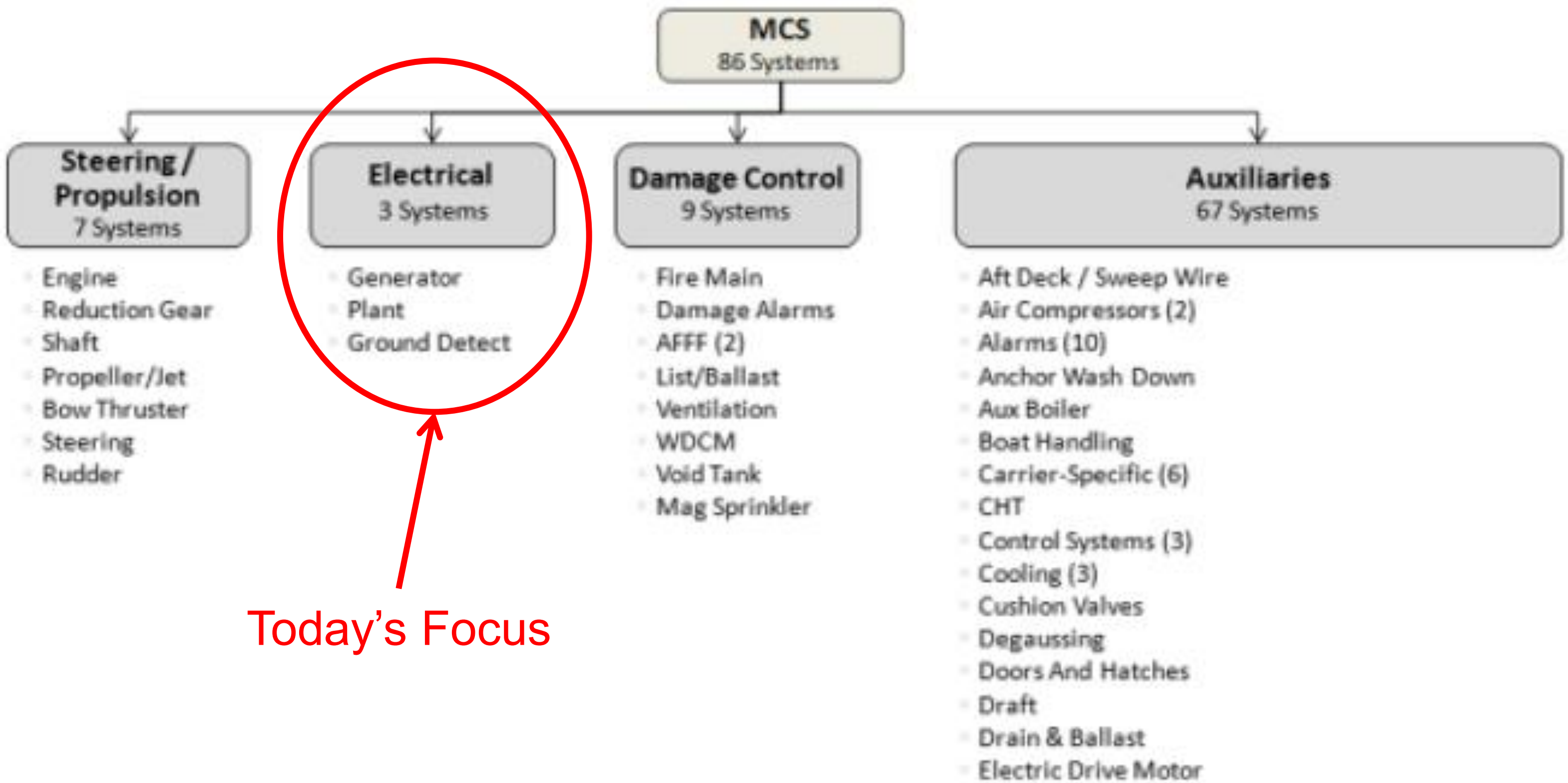
Characteristics of Microgrids

- Distributed
- Autonomous
- Reconfigurable
- Small
- Detachable from Macrogrid



Ships are the original Microgrid

Warship Machinery Control System

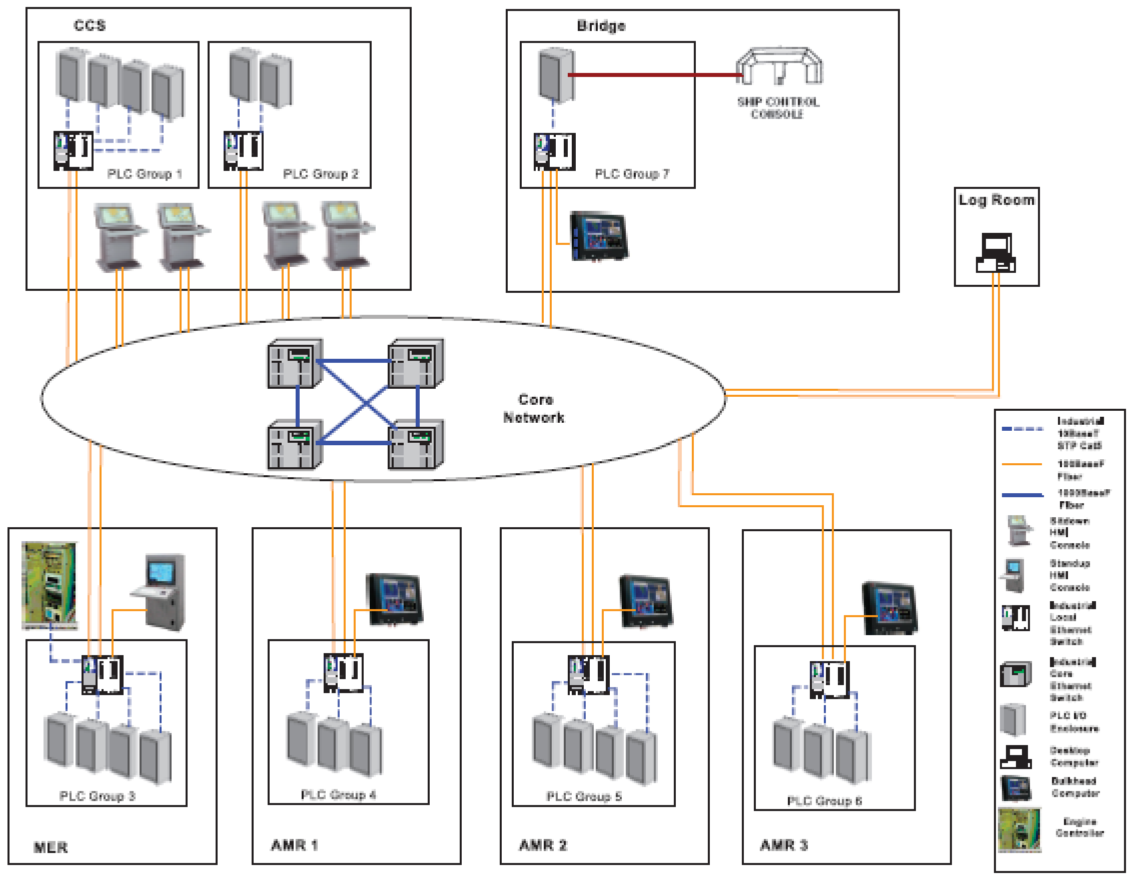


Scherer, Timothy and Jeffrey Cohen, "The Evolution of Machinery Control Systems Support at the Naval Ship Systems Engineering Station," ASNE NEJ 2011 #2, pp. 85-109

Notional Ship Distributed MCS Architecture

Console S/W Applications
- MCS User Interface
- Data/Bell Logging
- DCA Plotting Software
- ICAS
- OBT

PLC S/W Application
- One program per PLC group
- Functions
  - Data Acquisition
  - Signal Conditioning
  - Alarm/Status Logic
  - Machinery Algorithms



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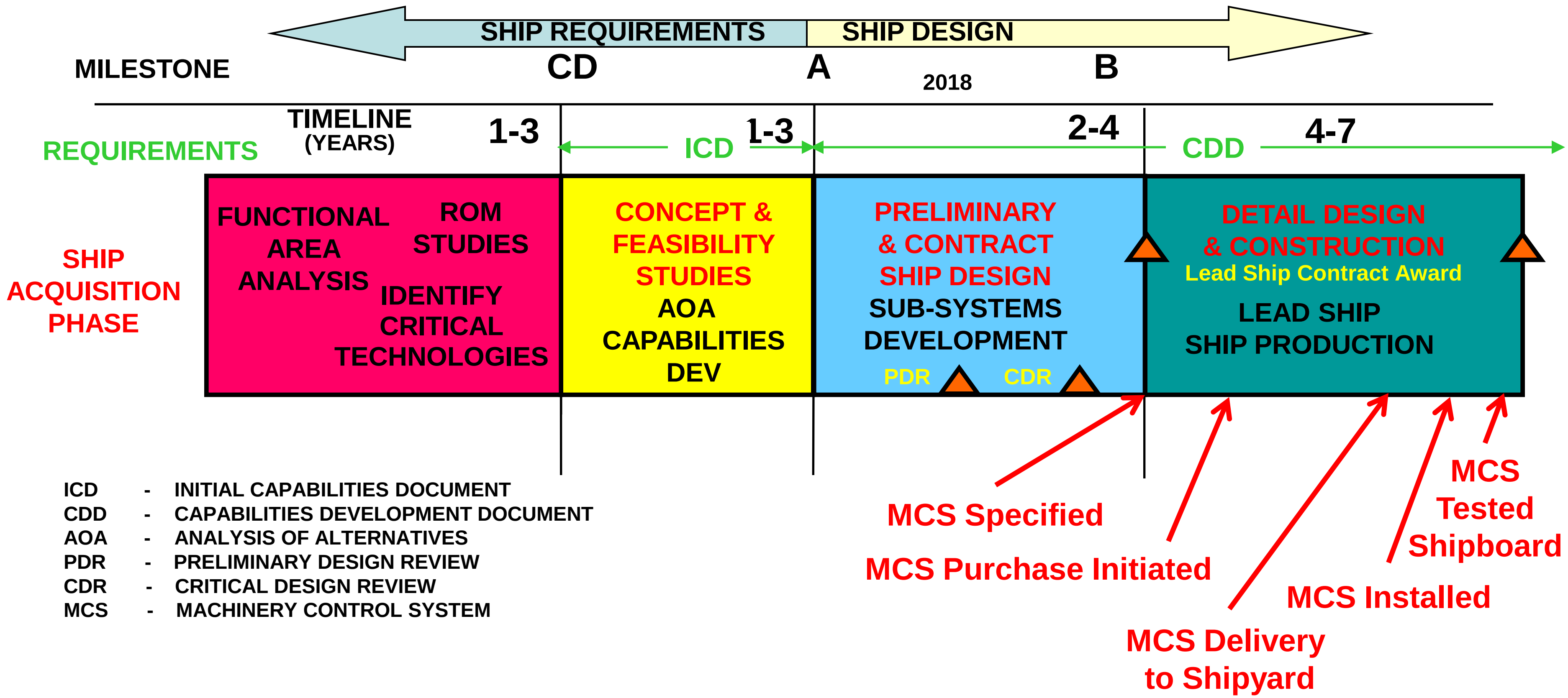
Traditional MCS Development and Ship Acquisition



MCS capability limited by what can be accomplished in allocated time.

Open Architecture (an alternative approach)

Naval Open Architecture:

- Business practices
- Technical practices

Produce Systems:

- Based on open standards
- Published interfaces

OA CORE PRINCIPLES

- Modular, Loose Coupling, High Cohesion
- Design Disclosure and Data Rights
- Enterprise TOC Reduction and Reuse
- Transparency and Peer Reviews
- Competition and collaboration
- ROI and Strategic Investments

Can a qualified third party add, modify, replace, remove, or provide support for a component of a system, based only on openly published and available technical and functional specification of the component of that system

Doerry, Norbert H., Tim Scherer, Jeff Cohen, and Nickolas Guertin, "Open Architecture Machinery Control Systems," presented at ASNE Intelligent Ships Symposium, 25 May 2011

Open Architecture applied to MCS

- Classic approach
  - Independently designed and acquired for each ship class.
  - Furnished by the ship builder
    - Typically subcontracted
  - Functionality limited by the available time.
- Open Architecture approach
  - Create a general MCS functional decomposition
  - Define the MCS Objective Architecture
  - Define supplier market boundaries
  - Apply initially to a specific ship class
  - Evolve the family of systems through Product Lines
  - Establish a framework for incorporating innovation
  - Manage a library of reusable modules for modification and redelivery for following ship classes

Naval Open Architecture:

- ***Business practices***
- ***Technical practices***

Produce Systems:

- ***Based on open standards***
- ***Published interfaces***

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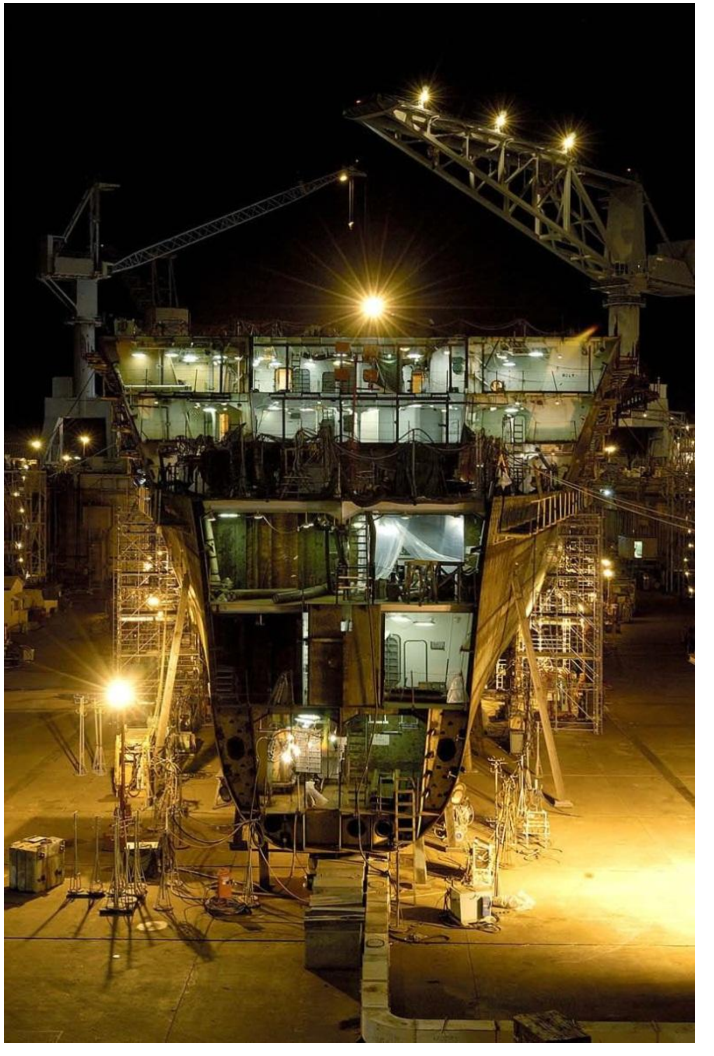
Guide for Control and Automation Installations Applied to the Electric Power Infrastructure

- Because components of Smart Grid will be acquired and developed by **many different parties**, the control and automation systems should be developed according to an **open architecture** that enables the introduction of common functions across multiple systems and platforms in a way that achieves high levels of modularity, extensibility, portability and scalability.
- This guide provides **industry-wide common approaches** to the design, implementation and life cycle management of Smart Grid control and automation systems, in a manner that promotes conformance to the smart grid interoperability reference model (SGIRM), hence reducing the number of infrastructures that might otherwise result from competing architectures.
- Additionally, this recommended practice facilitates the following:
  - **Modular design and design description,**
  - **Reusable application software,**
  - **Interoperable control and automation applications,**
  - **Secure information exchange,**
  - **Life cycle affordability, and**
  - **Competition and collaboration.**
- This guide supports its users by giving them guidance in the selection or development of computational capabilities, information systems, networks, protocols, frameworks, middleware, resource management, software and operating systems, using both established and evolving industry standards. Standard practices will be leveraged to enhance interoperability, operational effectiveness, and the ability to **insert future technologies**.

Navy interest in P2030.4

- Establish an MCS open architecture
  - Initially for electrical power system
  - Eventually adapt to remainder of ship systems
- Expand an industrial base to one that can serve both smart-grid utility applications and naval ships
- Enable the insertion of increased capability over time into shipboard MCS
- Reduce the cost of designing, building, and modernizing shipboard MCS



NAVSEA
NAVAL SEA SYSTEMS COMMAND

Conclusion

- Naval warships are complex engineered products
- Warships are the original micro-grid
- Current MCS development methods are expensive and limit functionality
- An OA approach promises to improve Total Ownership Costs while improving functionality
- P2030.4 is well aligned with the Navy’s goals.