System Fundamentals

Standardizing Warfare System Interfaces to Reduce Integration Costs During Ship Construction, Modernization, and Maintenance

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Study Guidance

Objectives

- **Identify commercial data center development best practices**
- **Evaluate the applicability of commercial data center best practices to Navy shipboard systems**
- **Assess potential to apply commercial practices to reduce cost and schedule to integrate and upgrade warfare systems and other ship systems**

Study Guidance

Objectives

- Identify commercial data center development best practices
- Evaluate the applicability of commercial data center best practices to Navy shipboard systems
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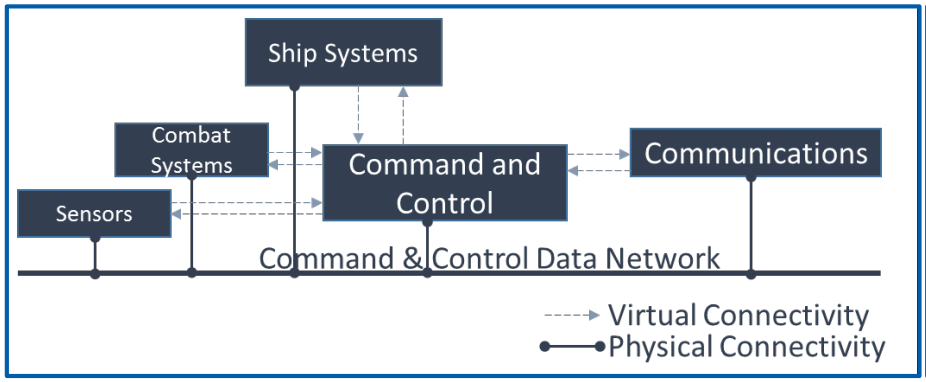
Approach

- **Compare Navy and commercial data center design considerations**
- **Investigate data center industry standards and practices**
  - **Leading data center operators**
  - **Industry periodicals and professional organizations**
- **Assess similarities and differences and their impact on data center installations**

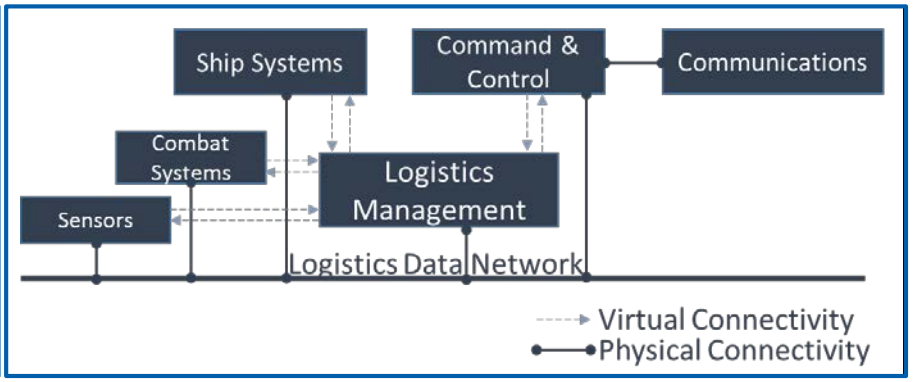
Background

- **Integration of ship / weapon system significant driver of negative cost and schedule performance for new construction & modernization**
  - **Late completion of system design ➔ Rework on ship**
  - **Infrastructure installed after ship construction complete ➔ Additional cost & schedule to install**
  - **Infrastructure installed as part of systems ➔ Unnecessary capacity, conflicts between systems**
- **Technology has largely converged civilian and USN afloat data center design requirements**
  - **USN ship and weapon systems increasingly implemented with COTS equipment**
  - **Civilian data centers increasingly driven to very high reliability and survivability (operate trough and operate after)**
    - **Core Civic functions (police, fire, ambulance, Government operations)**
    - **Critical infrastructure (power, water, phone, hospitals)**
    - **Economic infrastructure (finance, industry, facility controls)**
- **Civilian data center industry has matured rapidly**
  - **$100+ Billion per year industry**
  - **$15-20 Billion per year construction budget**
- **Challenges**
  - **Addressing USN shock and vibration environment**
  - **Accommodating realities of ship / weapon system design process**

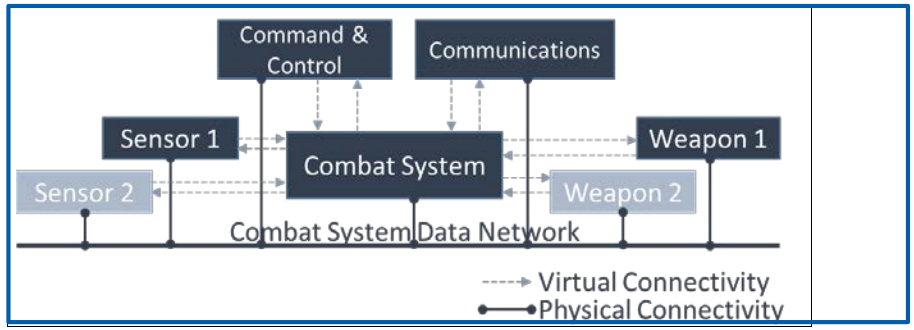
USN Data System Design Patterns



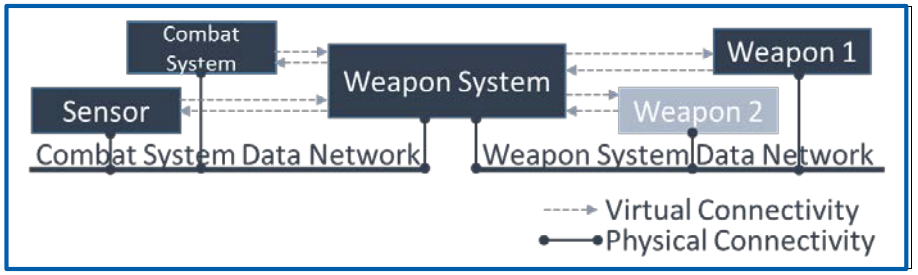
Command & Control Design Pattern



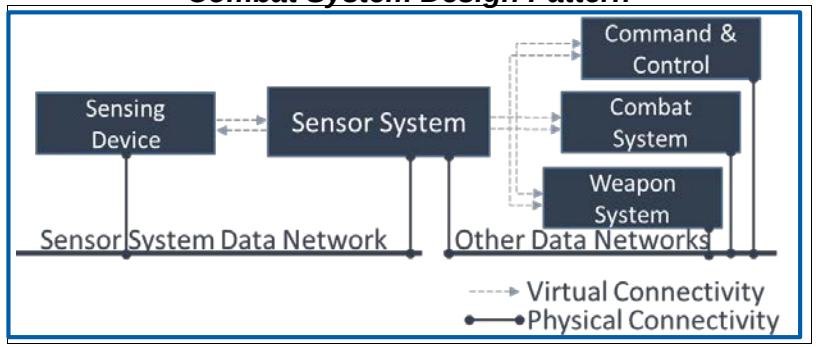
Logistics Management Design Pattern



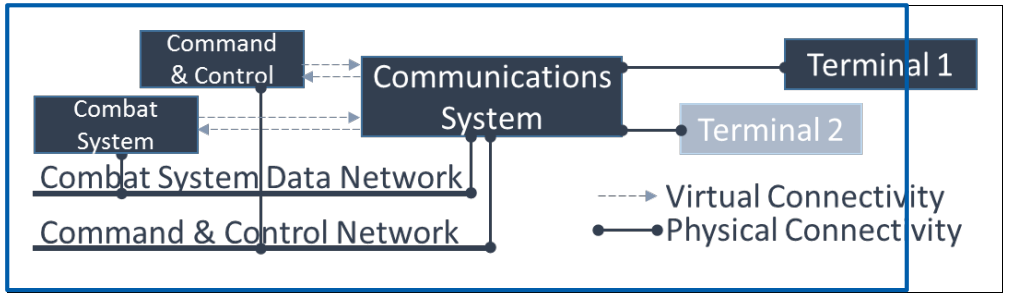
Combat System Design Pattern



Weapon System Design Pattern

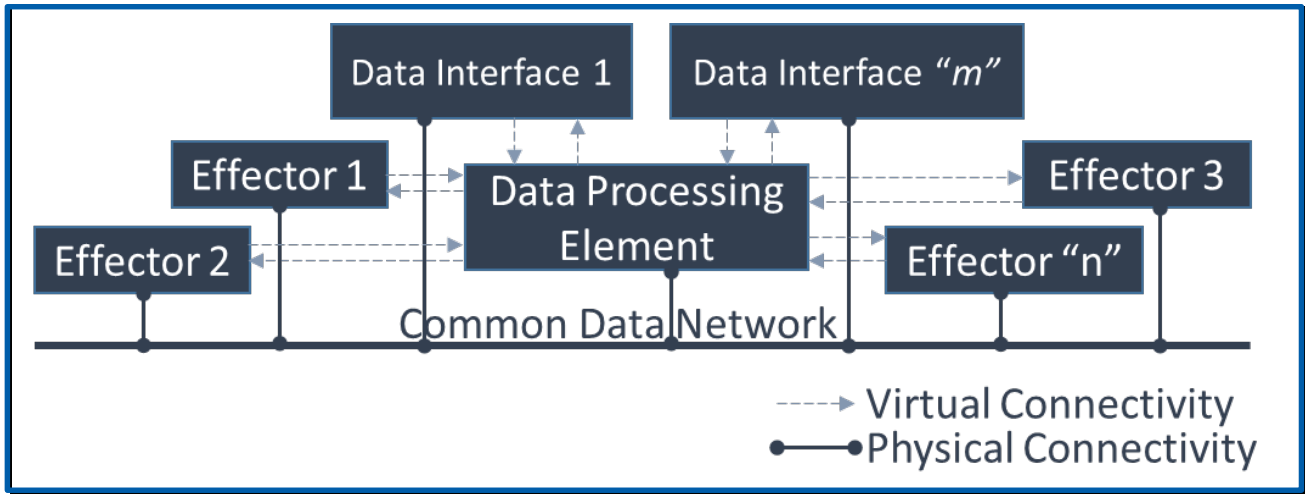


Sensor System Design Pattern

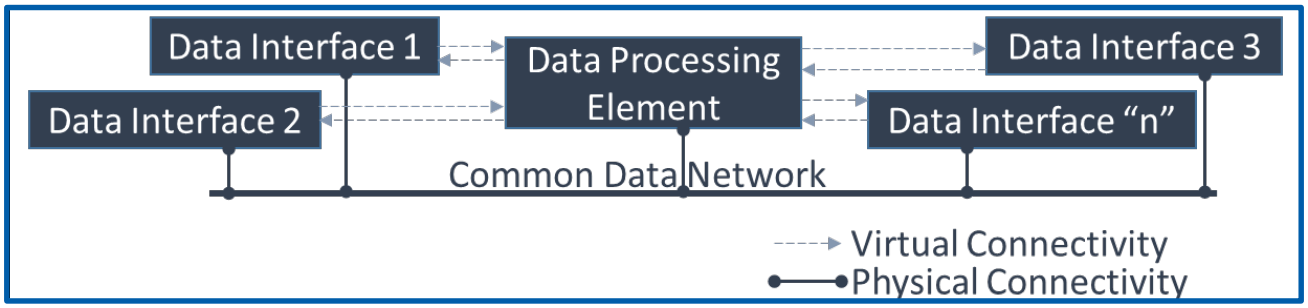


Communication System Design Pattern

Design Pattern Comparisons



Generalized Shipboard Mission System Design Pattern.



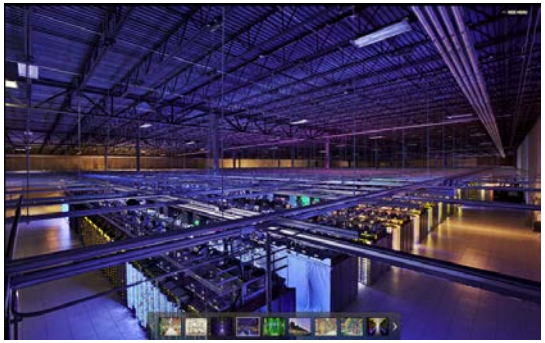
Generalized Commercial Data Center Design Pattern.

Modern Shipboard Systems Are Consistent with Commercial Data Center Architectures

Comparison of Shock & Vibration Approaches

- **US Navy – Governed by**
  - **MIL-STD-167-1A (November 2005) – Design Boxes for Vibration**
  - **MIL-STD-901D (Mach 1989) – Test Boxes for Shock**
  - **NAVSEA 0908-LP-000-3010, Rev. 1 – Design Ship for Shock**
- **Civilian (and military) data centers – Governed by**
  - **International Building Code (IBC) 2012 – Seismic shock design factors**
  - **American Society of Civil Engineers, ASCE-7-10 – Minimum design loads**
  - **Telcordia GR-63-CORE – Rack mounting and fixturing for seismic shock loads**
  - **Telcordia GR-3160-CORE – Data center rack mounting and fixturing**
  - **ASHRAE Datacom Series, Volume 5 – Data center vibration requirements**
- **Vibration standards comparable for COTS computing equipment in a rack**
- **Commercial seismic shock requirements can be very stressing**
  - **Need detailed assessment to verify that MIL-STD levels fully met**

Commercial Best Practices - Design



Reliability through redundancy is cheaper than designing it into the box.

Always use open standards – and don't tailor them.

Always use standard component configurations.

Establish fixed rack SWAP-C allocations.

All shock and vibration loads are mitigated by the facility and rack enclosures.

Commercial Best Practices - Facility

All data, power, and cooling infrastructure belongs to the facility.

Always use open standards – and don't tailor them.

All data, power, & cooling installed and fully configured before data processing components installed.

Color code everything – cables, HVAC, pipes.

Install far more FOC than you think you need.

Applicability of Commercial Best Practices to Shipboard Systems

System Fundamentals

Design

- ✓ Reliability through redundancy is cheaper than designing it into the box.
- ✓ Always use open standards – and don't tailor them.
- ✓ Always use standard component configurations.
- ✓ Establish fixed rack SWAP-C allocations.
- ✓ All shock and vibration loads are mitigated by the facility and rack enclosures.

Facilitization

- ✓ All data, power, and cooling infrastructure belongs to the facility.
- ✓ All data, power, and cooling infrastructure must be installed and fully configured before any data processing components are installed.
- ✓ Install far more FOC than you think you need.
- ✓ Color code everything – power and data cables, facility HVAC and equipment cooling ducts and pipes.

Modern Shipboard Systems Are Consistent with Commercial Data Center Architectures

Challenges of Commercial Best Practices for Shipboard Systems

System Fundamentals

Design

- ✗ Reliability through redundancy is cheaper than designing it into the box. *Paradigm shift for USN*
- ✗ Always use open standards – and don't tailor them. *Historically poor discipline in USN*
- ✗ Always use standard component configurations. *Paradigm shift for USN*
- ✓ Establish fixed rack SWAP-C allocations.
- ✗ All shock and vibration loads are mitigated by the facility and rack enclosures. *Paradigm shift for USN*

Facilitization

- ✗ All data, power, and cooling infrastructure belongs to the facility. *Paradigm shift for USN*
- ✗ All data, power, and cooling infrastructure must be installed and fully configured before any data processing components are installed. *Paradigm shift for USN*
- ✗ Install far more FOC than you think you need. *Cost challenge*
- ✓ Color code everything – power and data cables, facility HVAC and equipment cooling ducts and pipes.

Implementing Commercial Best Practices Will Require USN Commitment

Findings

- **Commercial / civil infrastructure data center operating requirements comparable to or exceed shipboard systems**
- **Commercial data center standards and best practices well defined and applicable to USN shipboard applications**
  - **Requires USN commitment to implement**
- **Adoption of two key practices would significantly reduce new construction effort at no additional cost**
  - **Transferring responsibility for network infrastructure to shipyard**
  - **Establishing standard SWAP-C allocations for equipment racks**
- **Additional effort required to fully reconcile shock and vibration standards**

Recommendations

- **Conduct a formal standards tailoring review of ASHRAE Technical Committee 9.9 Datacom Series for application to maritime systems**

- **Conduct a detailed review of shock and vibration requirements in IBC 2012, ASCE 7-10, ASHRAE Datacom Volume 5, and Telcordia GR-63-CORE to ensure full compliance with MIL-STDs -167-1A and -901D and NAVSEA Report 0908-LP-000-3010.**

- **Define ship system interface with two questions:**
  - ***How many independent networks do we need?***
  - ***How many racks of equipment will we have?***