

# Zonal Ship Design

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NAVAL SEA SYSTEMS COMMAND  
SEA 05DB

**ASNE Reconfiguration and Survivability**

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# Agenda

- Definitions
  - Survivability vs Quality of Service
  - Zonal vs Compartment Survivability
- Zonal Architectures
- Zonal Ship Design

# Definition: Survivability

- Design Threats
- Design Threat Outcomes
  - Performance of the ship following exposure to a Design Threat
- Elements
  - Susceptibility
  - Vulnerability
  - Recoverability
- Zonal Survivability
- Compartment Survivability
  - Provide capability to recover selected undamaged loads in a damaged zone.



# Definition: Quality of Service

- Metric for how reliable a distributed system provides its commodity to the standards required by the user
  - Measured as a MTBF
  - Not all service interruptions are QOS failures
  - Uses Reliability type analysis, but in different ways.
- QOS does not take into account Battle Damage, collisions, fire, flooding, etc.
- QOS ensures the ship can perform its mission under normal conditions (when it is not damaged).

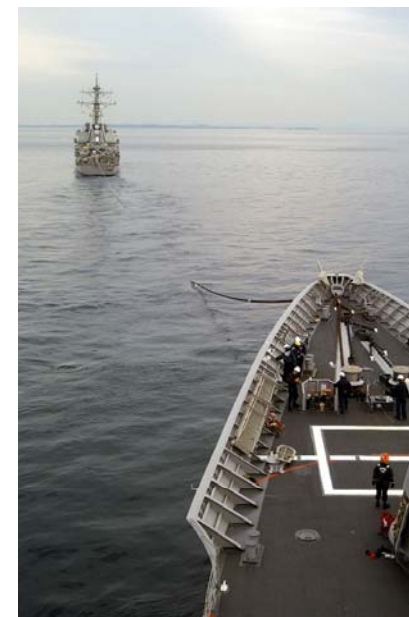
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DSR CTS
*** STOP: 0x00000001 (0x00000000, 0x0000001a, 0x00000000, 0x00000000)
IRQL_NOT_LESS_OR_EQUAL
p4-0300 irq1.1f SYSVER:0xf000030e

Dll Base DateStmp - Name Dll Base DateStmp - Name
80100000 2e534e55 - ntoskrnl.exe 80400000 2e52ebac - hal.dll
80010000 2e41884b - bhaf154r.sys 80013000 2e40c29a - SCSTPORT.SYS
8001b000 2e4e7b6b - Scsdisk.sys 80220000 2e53f238 - Ntfs.sys
fe520000 2e406597 - Elgppp.sys fe410000 2e40651a - Scrtcdtm.SYS
fe440000 2e406559 - Er Rec.SYS fe450000 2e40660f - Null.SYS
fe460000 2e406554 - Bspq.SYS fe470000 2e406534 - Strmouze.SYS
fe480000 2e42a494 - 18042prt.SYS fe490000 2e406604 - NowLass.SYS
fe4a0000 2e40660c - Mdc1ass.SYS fe4c0000 2e4065e2 - VIDEOPRT.SYS
fe4b0000 2e52a494 - ati.sys fe4d0000 2e4065e8 - vga.sys
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fe510000 2e53f222 - NDIS.SYS fe500000 2e40719b - elnkll.sys
fe520000 2e406597 - TDI.SYS fe530000 2e41c740 - nbf.sys
fe560000 2e527949 - nwlakipr.sys fe570000 2e53a89a - nwlakab.sys
fe580000 2e484973 - tcpip.sys fe5a0000 2e928d58 - ardr.sys
fe5b0000 2e527943 - netbt.sys fe5d0000 2e4161e7 - nathlss.sys
fe5e0000 2e4066b3 - mup.sys fe5f0000 2e4f9f51 - rdr.sys
fe630000 2e53f21a - srv.sys fe660000 2ef16062 - nwlakprk.sys

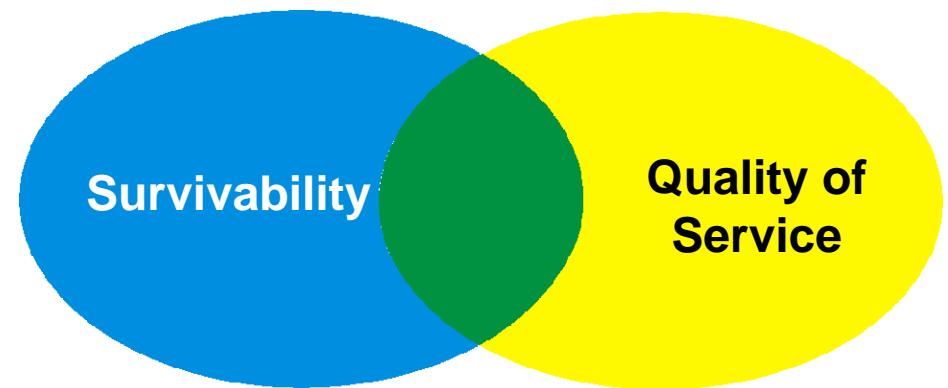
Address dword Dump Build [1057]
ff511e4e fe3106df fe1094f 00000001 ff640128 fe4a8228 000002fe - Name
ff511e60 fe501368 fe501368 0000024c 00004002 00000000 00000000 - NDIS.SYS
ff511e64 fe481509 fe481509 ff6688c8 ff668288 00000000 ff660138 - elnkll.sys
ff511e68 fe481e68 fe481e68 fe482078 00000000 ff511f94 8013c58a - 18042prt.SYS
ff511e6c fe482078 fe482078 00000000 ff511f94 8013c58a ff6688c8 - 18042prt.sys
ff511e70 8013c58a 8013c58a ff6688c9 ff668040 80405900 00000031 - ntlskrnl.exe
ff511e7c 80405900 80405900 00000031 06060606 06060606 06060606 - hal.dll

Restart and set the recovery options in the system control panel
or the /CRASHDEBUG system start option if this message reappears,
contact your system administrator or technical support group.
CRASHDUMP: Initializing miniport drivers
CRASHDUMP: Dumping physical memory to disk: 2000
CRASHDUMP: Physical memory dump complete
    
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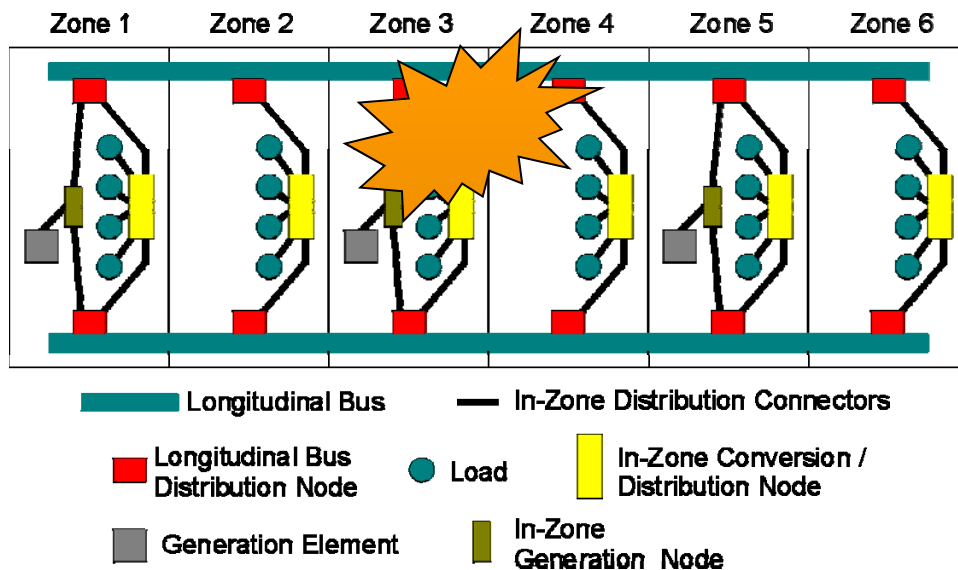


# Interaction of Survivability and QOS

- Many design decisions that impact Survivability will also impact QOS
  - Redundancy
    - May be added for either Survivability (Vital Load) or for QOS
  - Rating of equipment
- Exceptions
  - QOS is not sensitive to equipment location.
  - Survivability is not very sensitive to reliability of equipment.
  - System line-ups can impact one more than the other.
    - Parallel vs. Split Plant

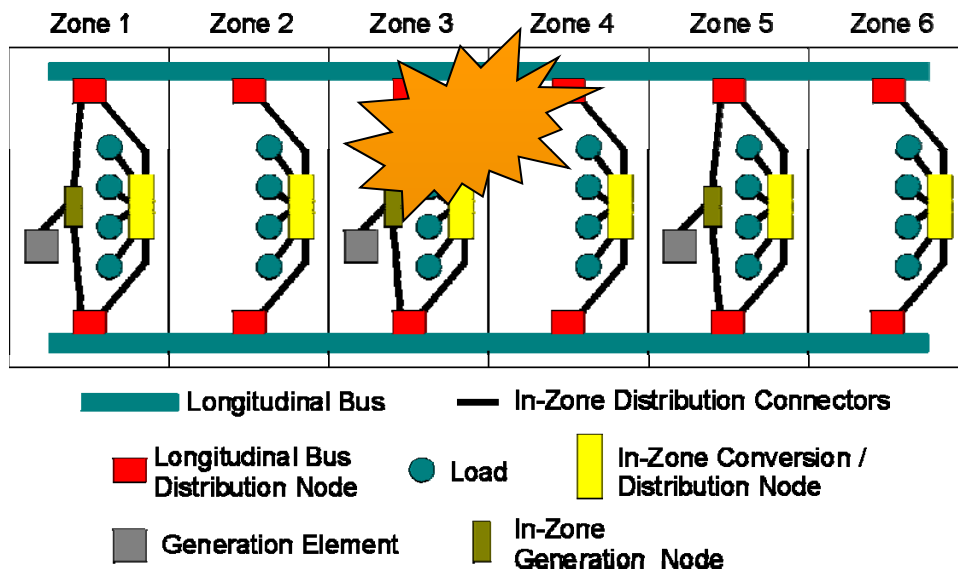


# Definition: Zonal Survivability



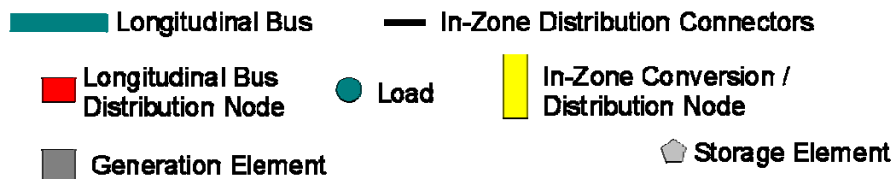
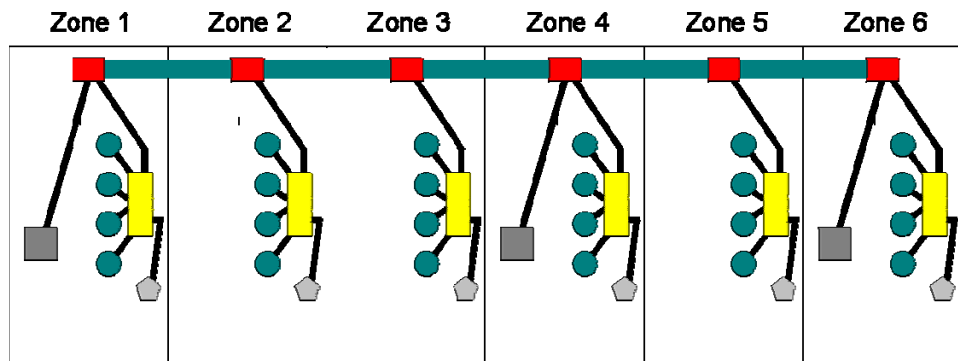
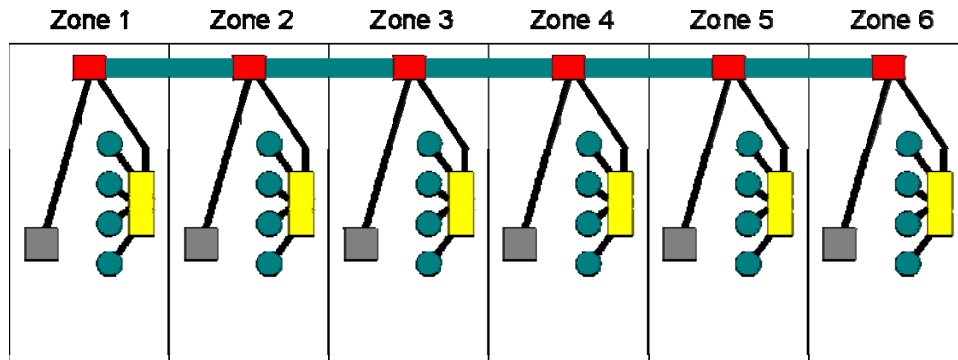
- The ability of a distributed system, when experiencing internal faults, to ensure loads in undamaged zones do not experience a service interruption.
  - Sometimes applied to only Vital Loads.
  - Usually requires one longitudinal bus to survive damage.
- Limits damage propagation to the fewest number of zones.
  - Enables concentration of Damage Control / Recoverability Efforts.

# Definition: Compartment Survivability



- Provide capability to recover selected undamaged loads in a damaged zone.
  - Often requires redundant feeds.
- Which Loads to Select?
  - Non-redundant Mission Systems
  - Loads supporting damage control efforts

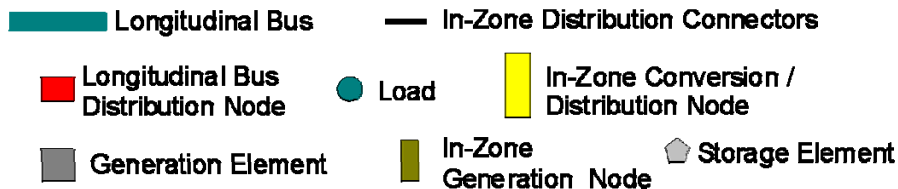
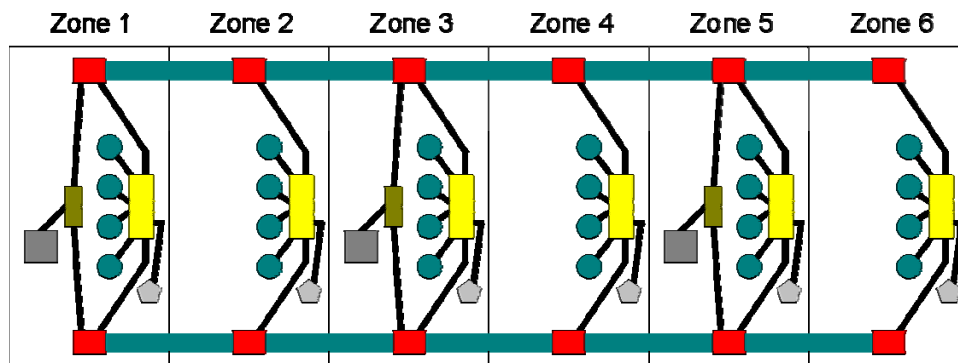
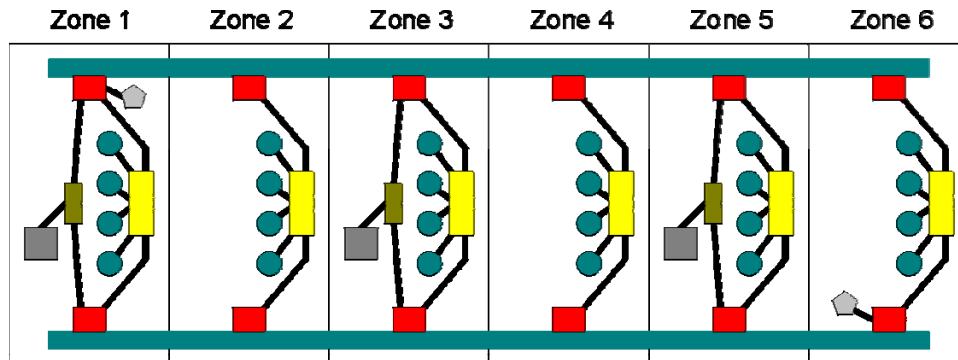
# Single Bus Architectures



- Can achieve Zonal Survivability if Generation or Storage is in every zone.
  - Generation must be in First and Last Zones
  - In-Zone Distribution must be buffered from disturbances on longitudinal bus
- Attractive if Generation / Storage is less expensive than distribution.

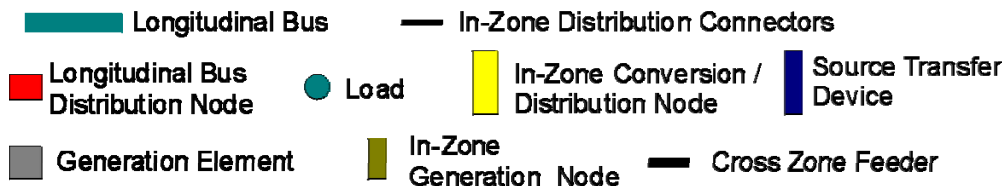
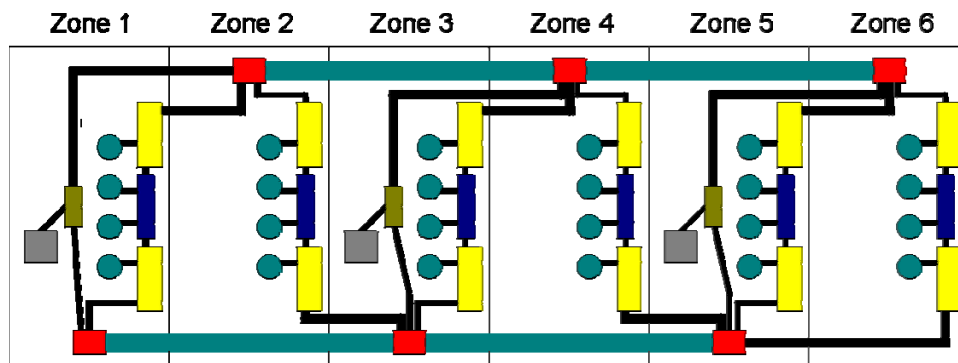
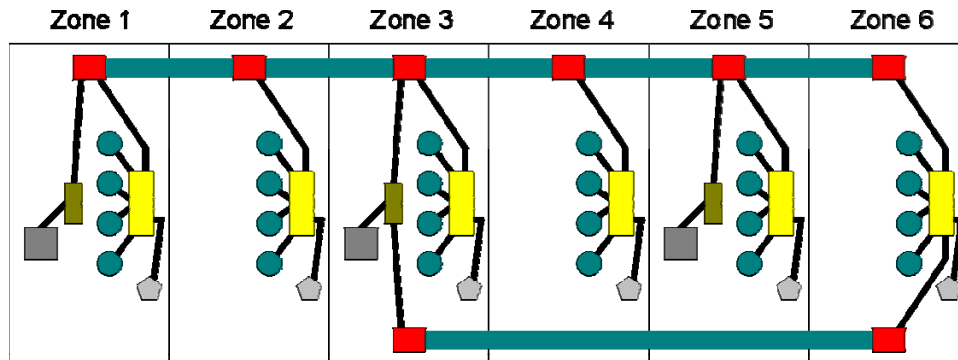


# Dual Bus Architectures



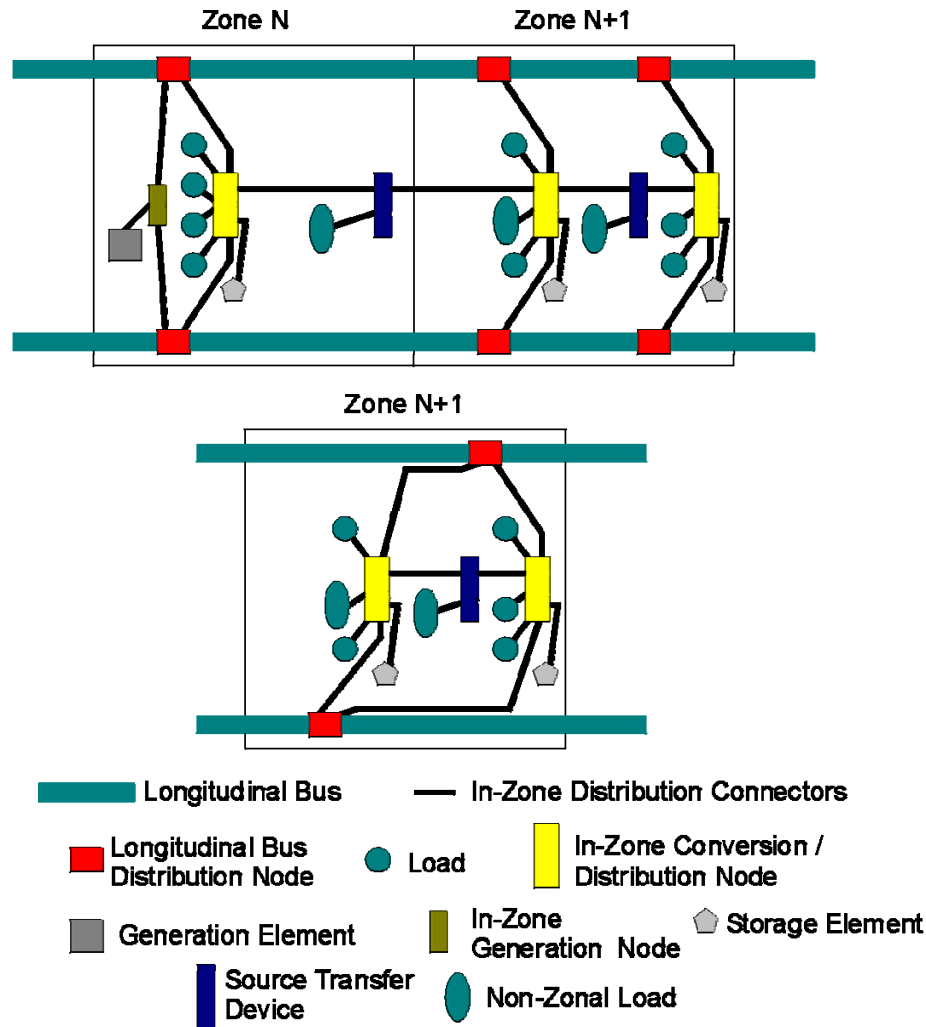
- Generation / Storage is not required in every zone.
- In-Zone Distribution must be buffered from disturbances on longitudinal bus
- Longitudinal buses must be physically protected to prevent loss of both buses from same event
- Without sufficient storage elements, generation and distribution elements must be rated to account for shifting of loads on loss of a longitudinal bus.
- Attractive if Generation / Storage is more expensive than distribution

# Hybrid / Multiple Bus Architectures



- Variations to single and dual bus architectures can optimize cost for specific applications.
  - Inability to locate generation in “end zones” in single bus architecture
  - Minimize cost of longitudinal bus distribution node

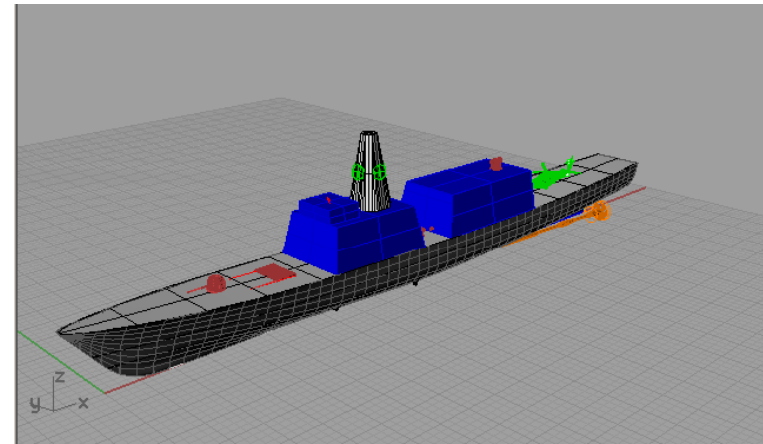
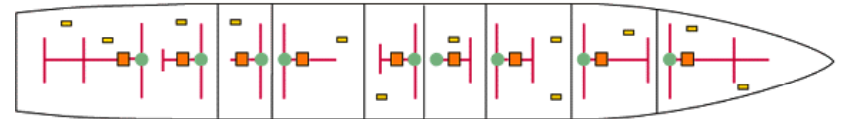
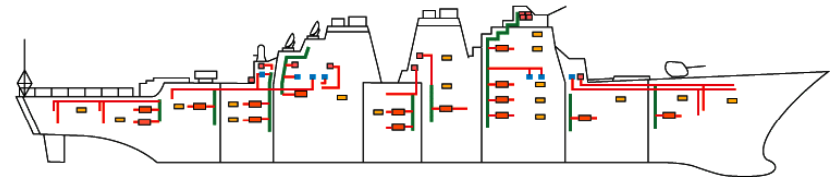
# Non-Zonal Loads



- Loads requiring “Compartment Survivability”
- Requires junction of main and alternate sources to be within damage volume of load.
- Multiple ways of providing “Compartment Survivability”
  - Most require additional equipment beyond that needed for Zonal Survivability.

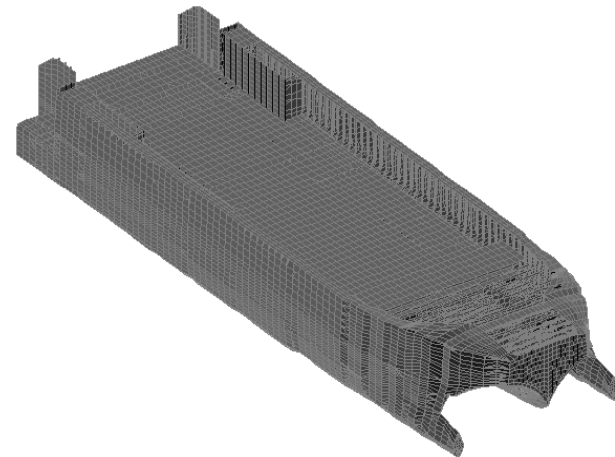
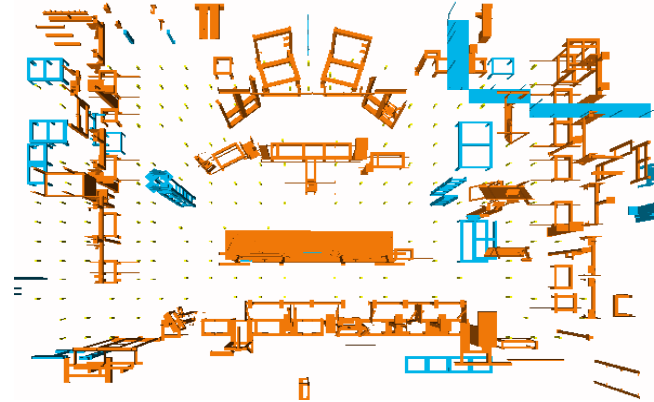
# Zonal Ship Design: Concept Studies

- Identify Zone Boundaries
- Define notional architecture for each distributed system
- Identify and allocate Mission Systems elements to zones
- Create a list of equipment to implement the notional architecture and mission systems
- Incorporate the equipment and architectures into the ship synthesis model.
- Define Ship/Force CONOPS / DRM
  - Define Design Threats
  - Define Design Threat Outcomes



# Zonal Ship Design: Preliminary & Contract Design

- Establish Zone Boundaries and Zonal Architectures
- Develop System CONOPS
- Develop Equipment Lists
- Based on CONOPS / DRM develop ship QOS requirements and allocate QOS requirements to Distributed Systems.
  - Verify QOS by analysis
- Arrangement of major equipment and longitudinal buses
  - Meet Design Threat Outcome requirements
- Total Ship Survivability Analysis
  - Verify Design Threat Outcomes
- Incorporation of Zonal Design requirements into Ship Specification



# Zonal Ship Design: Detail Design and Construction

- Finalize location of equipment and distributed system routing
- Evaluate survivability of longitudinal buses and apply selective protection where needed
- Ensure selected equipment are provided compartment level survivability
- Verify QOS and Survivability requirements are met
- Ensure Procurement Requests for equipment contain the necessary allocated requirements to meet QOS and survivability requirements



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# Summary

- Zonal Ship Design must be done from a Total Ship perspective.
  - Mission Systems and Distributed Systems must be designed synergistically
- Distributed System Design must account for both Survivability and Quality of Service.
- The choice of Distributed System Architecture depends on survivability and QOS requirements and the relative cost of different elements of the distributed system.