

MVDC
Specs and Standards
Design Tools

Advanced Naval Power and Energy Systems
ASNE DAY 2016

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Setting the Scene

“In FY2030, the DON plans to start building an affordable follow-on, multi-mission, mid-sized future surface combatant to replace the Flight IIA DDG 51s that will begin reaching their ESLs [Estimated Service Life] in FY2040.”

Report to Congress on the Annual Long-Range Plan for Construction of Naval Vessels for FY2015

Big differences from DDG 51:

- High-energy weapons and sensors
- Flexibility for affordable capability updates



Photo by CAPT Robert Lang, USN (Ret), from site <http://www.public.navy.mil/surfor/swmag/Pages/2014-SNA-Photo-Contest-Winners.aspx>

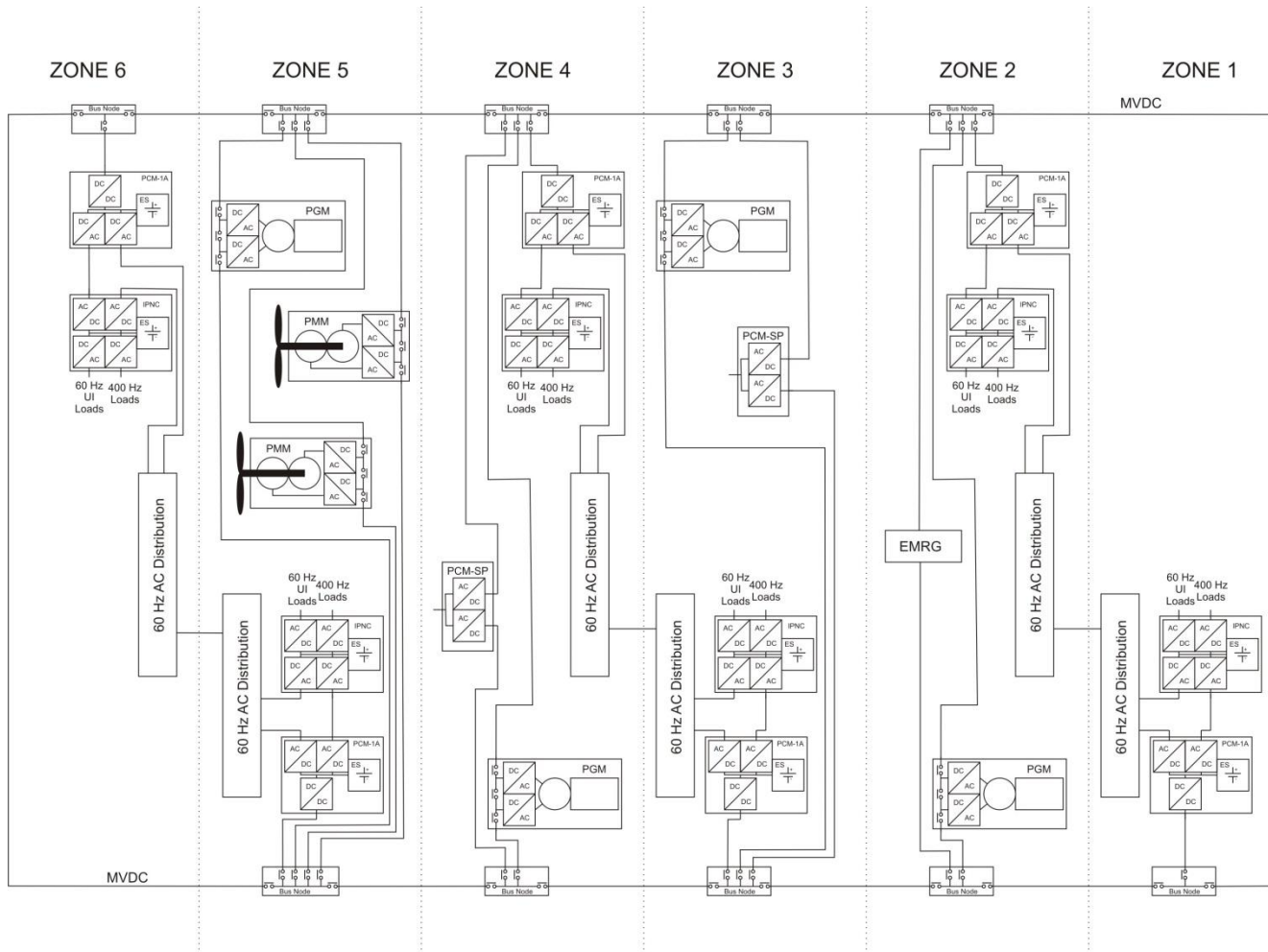
Why Medium Voltage DC?

- Decouple prime mover speed from power quality
 - Minimize energy storage
- Power conversion can operate at high frequency – Improve power density
- Potentially less aggregate power electronics
 - Share rectification stages
- Cable ampacity does not depend on power factor or skin effect
- Power Electronics can control fault currents
 - Use disconnects instead of circuit breakers
- Acoustic Signature improvements
- Easier and faster paralleling of generators
 - May reduce energy storage requirements
- Ability to use high speed power turbines on gas turbines

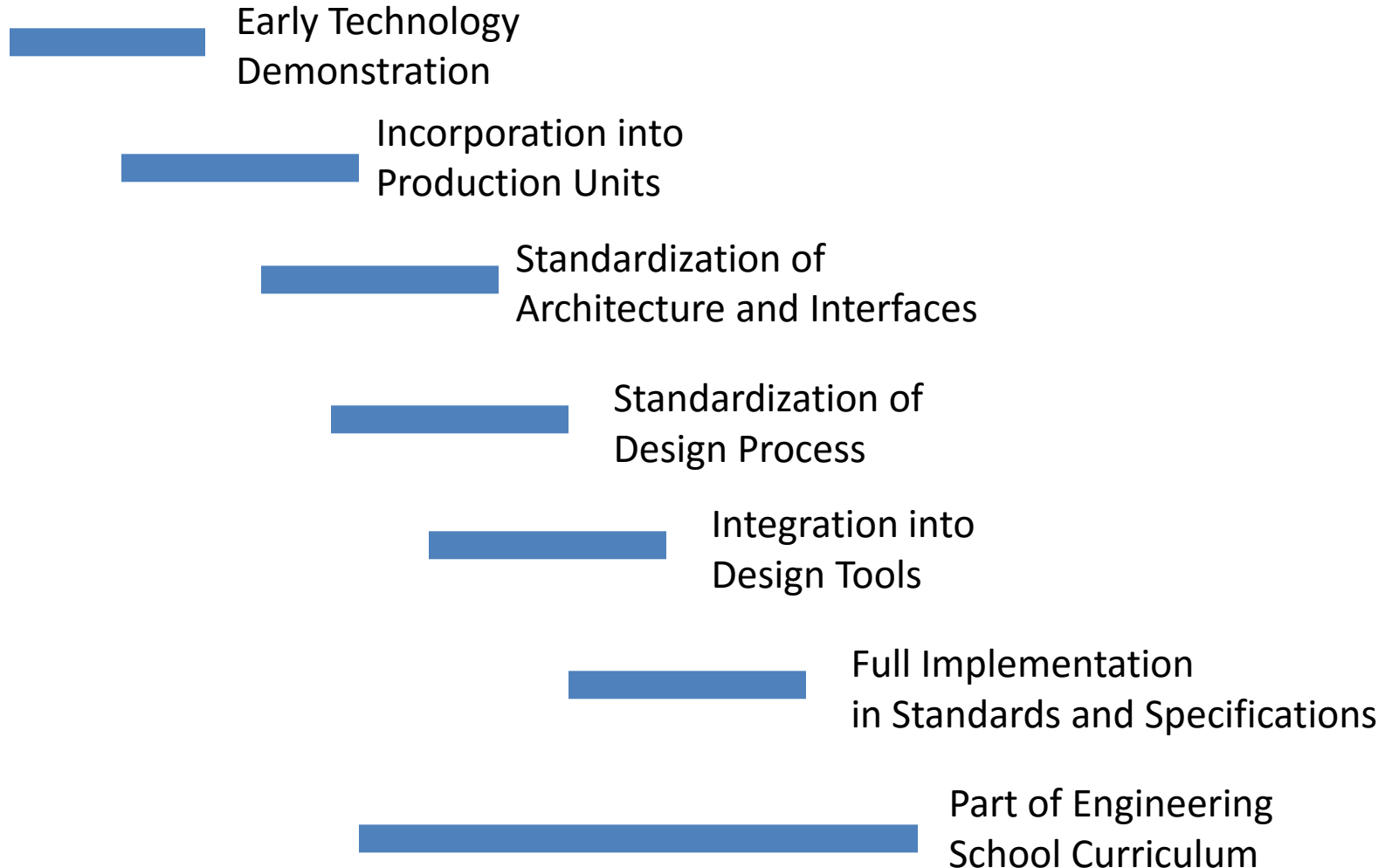
Affordably meet electrical power demands of future destroyer

An AC Integrated Power System would likely require future destroyer to displace greater than 10,000 mt

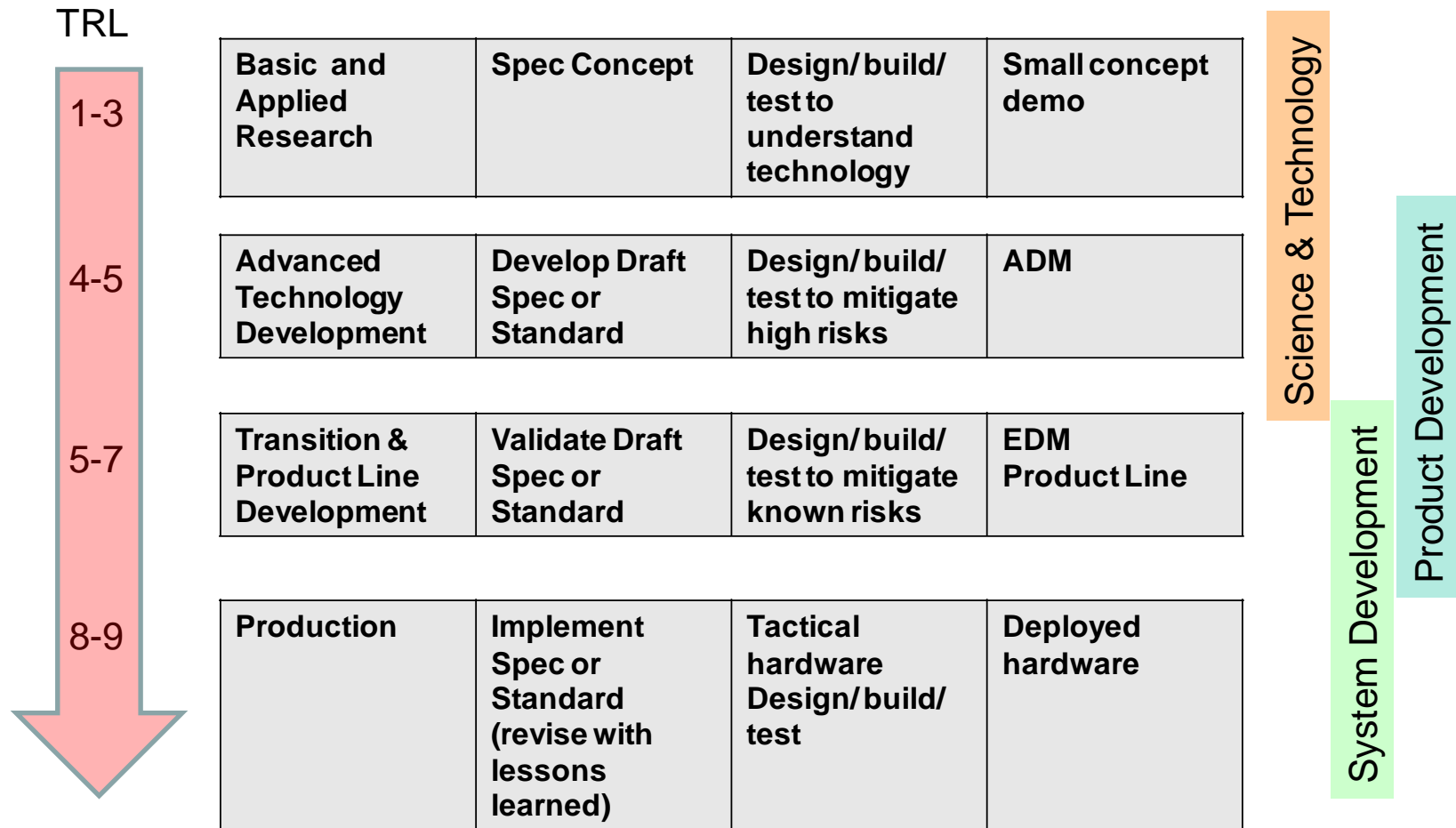
Notional MVDC Architecture



Institutionalizing Technology

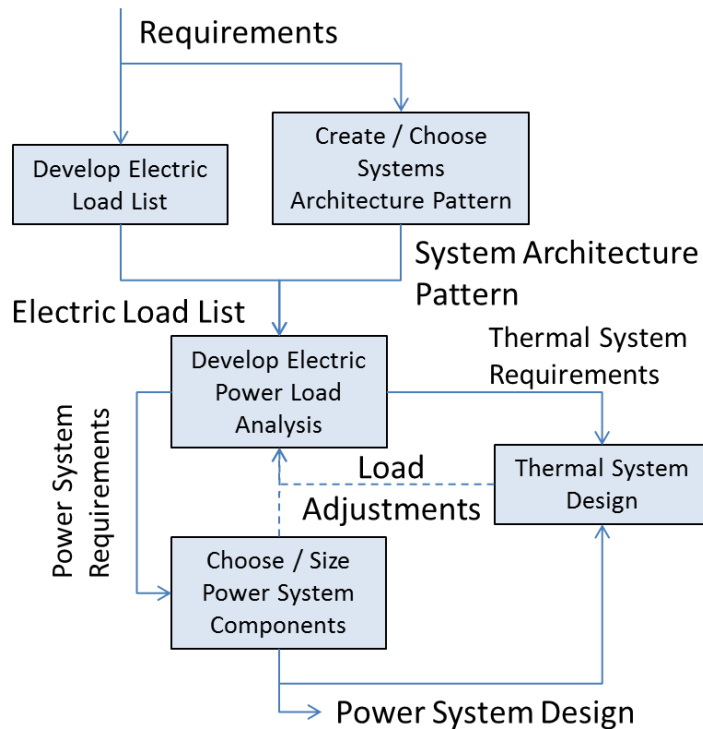


Technology Maturation & Product Development



Electric Plant Analysis: Design Tools

Concept Exploration



Preliminary and Contract Design

- Electric Power Load Analysis
- Load Flow Analysis
- Transient Analysis
- Fault Current Analysis and Protective Device Coordination Study
- Harmonic and Non-Fundamental Frequency Analysis
- Stability Analysis
- Electromagnetic interference (EMI) analysis
- Reliability Analysis
- QOS Analysis
- Vulnerability and Recoverability Analysis
- Arc Flash Analysis

Design Tools Roadmap currently under development

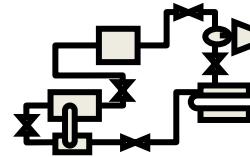
Design Tools: Progressive Definition



Parametric

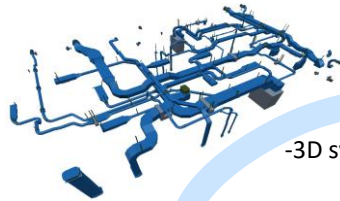
-Gross level definition of system characteristics based on ship size or similar designs.

The amount of data and detail increases as engineers work with smaller areas of the ship.



Schematic

-System network layout and topology

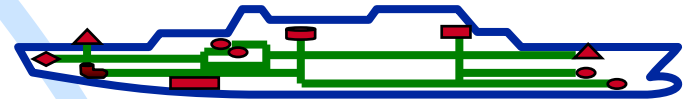


-3D system layout and routing

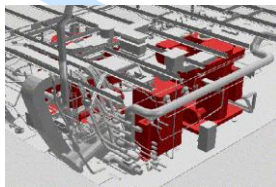
Space Reservation

Diagrammatic

-Schematic level information laid out in 3D ship space

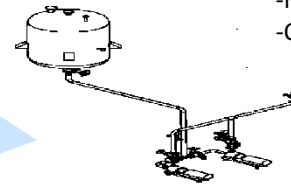


Distributive systems provide the utilities and infrastructure for the individual subsystems and equipment.

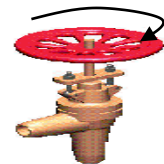


-Assembly drawings
-Work packages

Assembly, Builders Definition, Clearance



-Maintenance Guides
-Operational Manuals



Full Component Breakdown, Maintenance Procedures

Conclusion

- MVDC promises to enable affordable ship designs that can support high power weapons and sensors
- We need to get Institutionalization of MVDC right!
 - Technology Development
 - Specifications, Standards, Design Practices & Criteria
 - Design Tools and Associated Data
 - Trained and educated workforce