MVDC
Specs and Standards
Design Tools

Advanced Naval Power and Energy Systems
ASNE DAY 2016
Dr. Norbert Doerry
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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
Notional MVDC Architecture
Institutionalizing Technology

- Early Technology Demonstration
- Incorporation into Production Units
- Standardization of Architecture and Interfaces
- Standardization of Design Process
- Integration into Design Tools
- Full Implementation in Standards and Specifications
- Part of Engineering School Curriculum
# Technology Maturation & Product Development

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**Science & Technology**

- System Development
- Product Development
Electric Plant Analysis: Design Tools

Concept Exploration

- Electric Load List
- Create / Choose Systems Architecture Pattern
- System Architecture Pattern
- Develop Electric Power Load Analysis
- Thermal System Requirements
- Load Adjustments
- Choose / Size Power System Components
- Power System Design

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

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

- Gross level definition of system characteristics based on ship size or similar designs.
- System network layout and topology
- Schematic level information laid out in 3D ship space
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- 3D system layout and routing
- Assembly drawings
- Work packages
- Maintenance Guides
- Operational Manuals
- Full Component Breakdown, Maintenance Procedures

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

Assembly, Builders
Definition, Clearance

Parametric

Schematic

Diagrammatic

Space Reservation

Approved for Public Release
Distribution is unlimited

2/19/2016
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