MIL-STD-1399 sections for LVDC and MVDC

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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

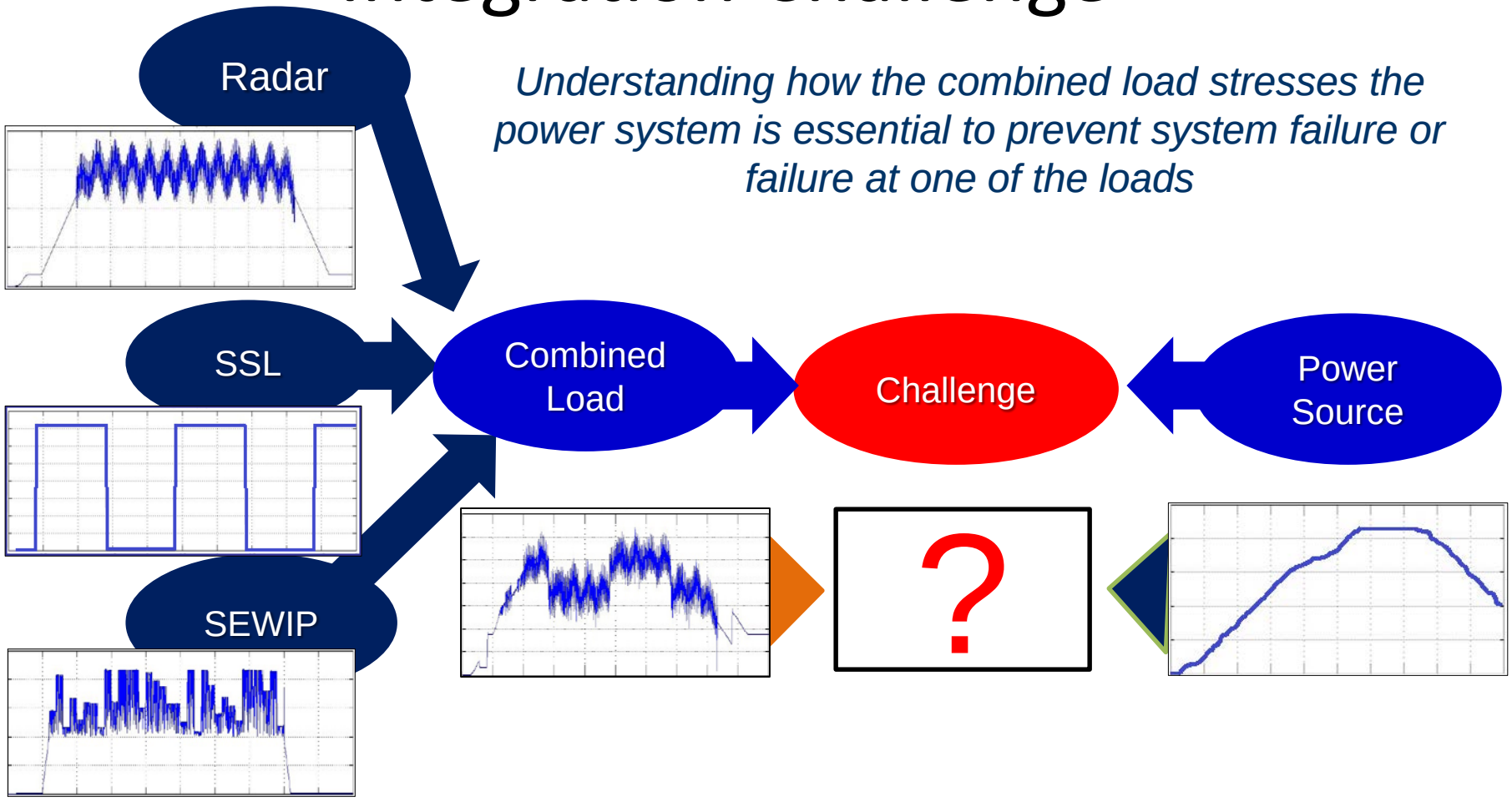
Big differences from DDG 51:

- 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

High Energy Mission Systems Integration Challenge

Understanding how the combined load stresses the power system is essential to prevent system failure or failure at one of the loads



Ships cannot support High Power Systems without modifications to the ship's Electric Power System and other ship systems

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

Interface Standards are Critical

- Low Voltage DC
  - 375
  - 650
  - 1000 (Two Types: Loose and Tight Tolerances)
- High (Medium) Voltage DC
  - 6 kV
  - 12 kV
  - 18 kV

Request for Information

- RFI for Electrical Interface Standards for Naval DC Power Systems. (Solicitation N00024-17-R-4202)
  - Draft MIL-STD-1399 section LVDC
  - Draft MIL-STD-1399 section MVDC
  - Paper on MVDC system to provide context
- https://www.fbo.gov/index?s=opportunity&mode=form&id=daff42b3b70e03b98da84ed498e7e76a&tab=core&_cview=0
- Responses are requested by December 15, 2016.

NEED YOUR INPUT

Format of draft standards

1 Scope
2 Applicable Documents
3 Definitions
4 General Requirements
5 Detailed Requirements
    5.1 Electrical Power System Characteristics
    5.2 Load Requirements
    5.3 Load Verification Methods
    5.4 Source Requirements
    5.5 Source Verification Methods
6 Notes

RFI Questions

1. The two draft standards include a number of "**TBD**"s (To be determined). The values provided alongside the TBD are either a single value or a range of values that the Navy is considering for the particular parameter. Recommendations and rationale for specifying a value for the parameter are desired. (Recommendations need not be limited to the values shown).
2. A number of the parameters and values depend on the eventually chosen **grounding scheme** for each of the interfaces. Recommendations and rationale for the inclusion or deletion of specific parameters, and the associated value, are desired for various possible grounding schemes.
3. A number of the parameters reflect a **balance in increasing cost and complexity of sources vs cost and complexity of loads**. Recommendations and rationale for parameters and parameter values are desired based on this balance of impact on sources and loads.
4. The **voltage spike waveform** requirements are not well understood. Insight into the nature, magnitude, and frequency of spikes on DC distribution systems is sought. Insight on the appropriateness of the proposed requirements is desired. Is the cited pulse waveform appropriate?

RFI Questions (continued)

5. Only a framework for supporting **pulse loads** is provided. Recommendations for how the control negotiations should be performed are desired. Also desire feedback on the choice of the pulse load parameters. (i.e. should pulse limits be described in terms of MW/s or A/ms?)

6. The load voltage **interruption tolerance time** is a balance between the cost and capabilities of fault detection, localization, and isolation within the distribution system, and the holdup time designed into individual loads. Perspective on this trade-off, recommendation for a specific value, and the rationale are desired.

7. An assessment of the practicality, cost, safety, effectiveness, and appropriateness of the different **verification methods** is desired. Can the intent of these verification methods be captured in less costly methods? Would the acquisition of necessary test equipment be an undue burden on industry?

8. **Stability** is not currently addressed. Recommendations for parameters (and values) for the interfaces to ensure small-signal and large-signal stability are desired.

RFI Questions (continued)

9. Recommendations for adding requirements that are **missing** from the standards are desired.

10. Recommendations for **deleting requirements** from the standards are desired.

11. The draft standards include requirements for both sources and loads, primarily because certain equipment may at times behave as sources, and at other times as loads (e.g. energy storage, and regenerative loads). MIL-STD-1399-300 only provides the requirements for loads. What are your thoughts on the need to **include requirements for sources**?

12. Tables 3 and 4 include both "independent" (such as voltage parameters for loads) and "dependent" parameters (such as current parameters for loads). Would you prefer to see these **independent and dependent variables listed in separate tables**?

RFI Questions (continued)

13. The **current ripple frequency limits** as presented are based on MIL-STD-461 CE 101 limits. These limits may prove over-restrictive for pulse load applications. Are frequency limits necessary? If so, should the CE 101 limits be relaxed? How should the ripple frequency limits, if provided, be made consistent with the ability to meet other EMI requirements?

14. Should there be a sentence somewhere **describing what Type 2 is** (i.e. energy storage floating bus) or is it intended that it is understood based on the values in the table.

15. Should there be a requirement for loads to not provide **reverse current** into the DC Bus, particularly during faults?

16. Should **different parameters** from those provided be used? If so, propose the parameter definitions and recommended values for the parameters (i.e. specify line to ground capacitance instead of the current in the capacitor)

Questions?