



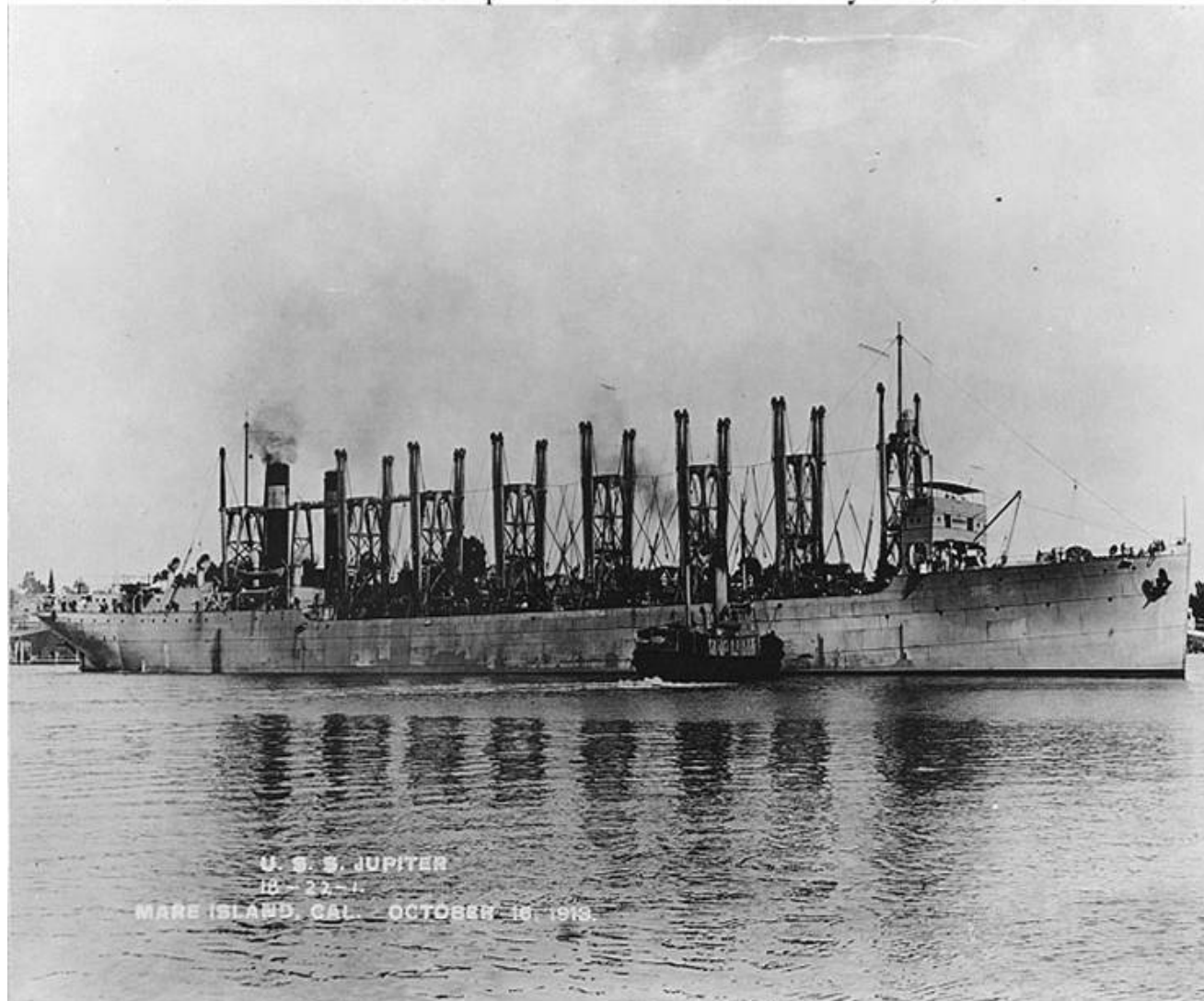
Advanced Capability Electric Systems

NDIA Disruptive Technologies Conference,
September 2006

Scott Littlefield
Office of Naval Research

USS Jupiter- 1913

Early example of Electric Drive



Navy is going electric

- T-AKE (Cargo Ship) – Diesel-electric system, with in-hull electric motors.
 - Enabled improved internal arrangements, with room for more cargo.
- LHD-8 (Amphibious Ship) – Hybrid system, with diesel-electric low speed mode and gas turbine mechanical drive at higher speeds.
 - Enables very efficient low-speed cruise.
- DD(X) Destroyer
 - First attempt at a power-dense, modern, militarized electric drive system.

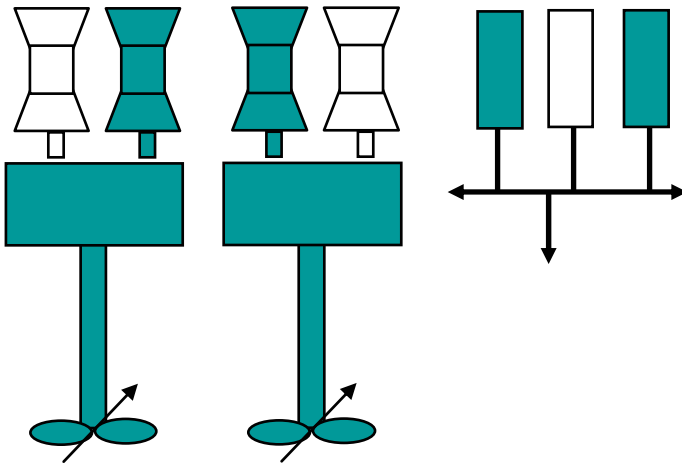
Why is the Navy Going Electric?

- **Enable Transformational Weapons Systems**
 - Electromagnetic Guns
 - Shipboard Laser Systems
 - Advanced Sensors
- **Improve Survivability**
 - Rapid and anticipatory Reconfiguration of Power and systems
- **Reduce Signatures**
 - Eliminates propulsion gear noise
 - Enables lower speed propellers
 - Enables silent watch capabilities
- **Reduce Life Cycle Costs**
 - Reduction in Number of Prime Movers
 - Significantly Greater Fuel Efficiency
 - Eliminate high maintenance hydraulic systems



Integrated Power System leads to Reduced Number of Prime Movers

Mechanical Drive

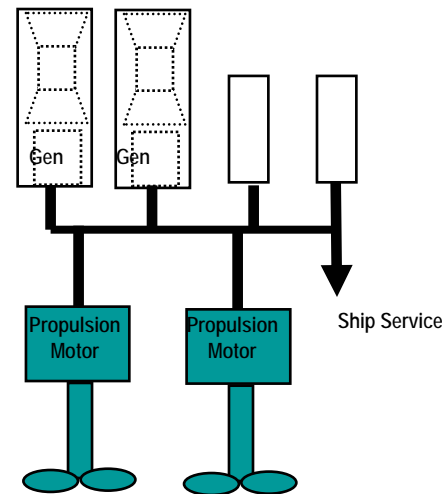


Current DDG-51 class has **seven** gas turbines

Life Cycle Cost Drivers:

- Initial Acquisition Cost
- Manning
- Maintenance
- Fuel Consumption

IPS



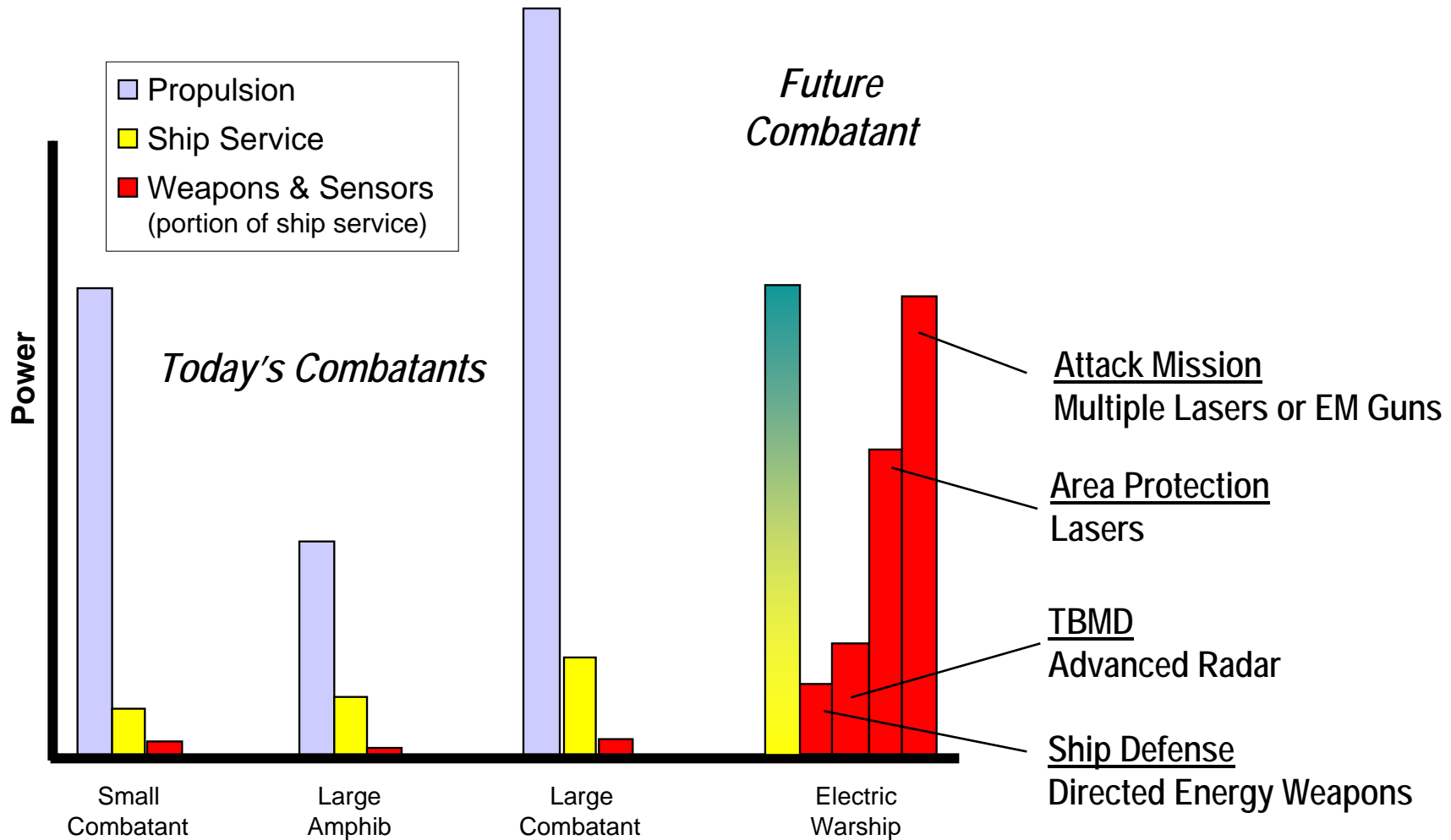
DD(X) will have **four** gas turbines

Thus lower Life Cycle Costs!

Is it Disruptive?

- Potentially - - -
 - Order of Magnitude increase in available power for non-propulsion electrical loads
 - Directed Energy Weapons
 - Electromagnetic Launchers and EM Guns
 - Advanced Sensors
 - Others?

Expected Growth in Power Requirements



Directed Energy



Why is it Important?

- Speed of light delivery for wide range of missions and threats
- Precise aim point and delivery with controlled effects and minimal collateral damage
 - Hard Kill or Soft Kill
- All electric for deep magazine without danger and logistics of conventional ordnance
- Rapid Retargeting

What is it?

Laser Type Tailored to Application

Free Electron Laser Weapon System

- Scalable to high power for ship defense
- Tunable wavelength for maritime environment

Electric Fiber Laser weapon system

- *Light weight Laser system based upon fiber lasers for tactical aircraft*

Who Needs it?

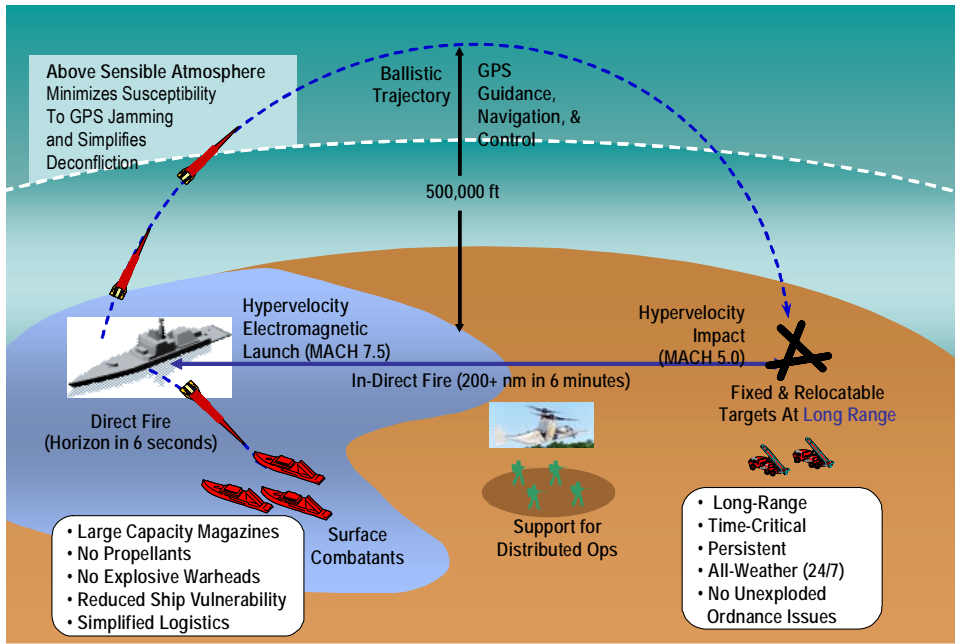
Surface Navy

- Ship self defense against cruise missiles and swarming small targets
- Theater Ballistic Missile Defense

Navy Aviation

- Accurate long range (>20km) land target engagement
- Anti air engagement (offensive & defensive)

Electromagnetic Railgun



Why is it important?

- Volume & Precision Fires
- Time Critical Strike
- All weather availability
- Variety of payload packages
- Deep Magazines
- Non explosive round/No gun propellant
 - Greatly simplified logistics
 - No IM (Insensitive Munitions) Issues
- Scalable effects
- Missile ranges at bullet prices

What is it?

- Gun fired with electricity rather than gunpowder
- > 200 mile range in 6 minutes
- Highly accurate, lethal guided projectile (GPS)
- Minimum collateral damage

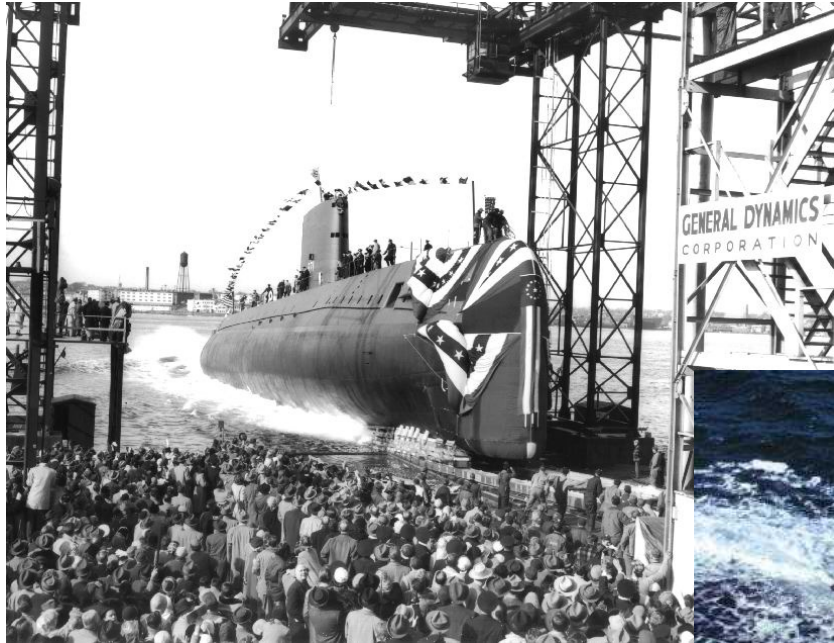
Who needs it?

- Marines and Army troops on ground
- Special forces clandestine ops
- GWOT
- Suppress air defenses

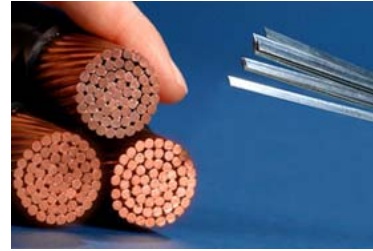
When?

- Feasibility Demo 2011
- System Demo 2015
- IOC 2020-2025

A New Propulsion System can be the Trigger for a Disruptive Capability



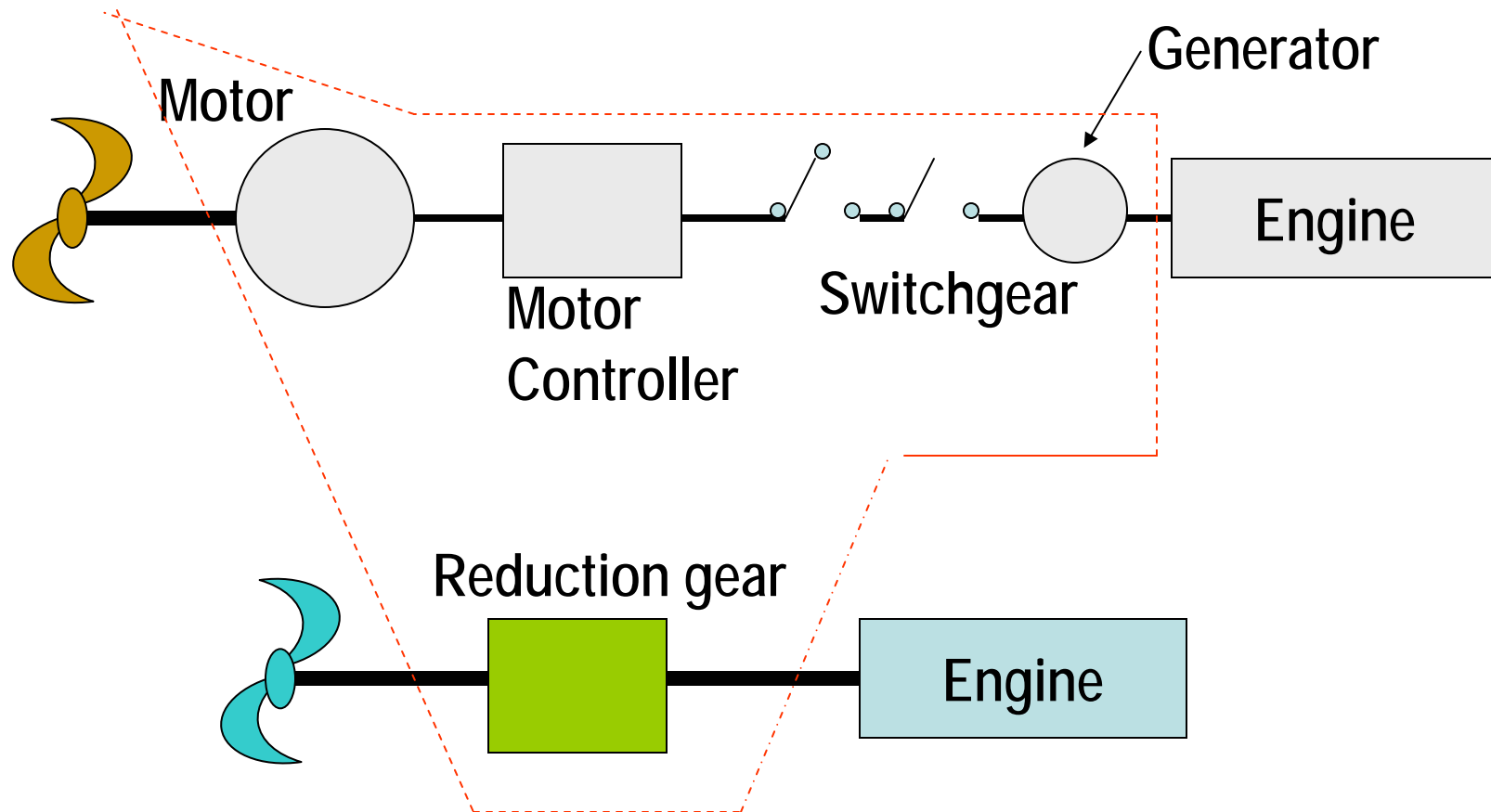
Dual Use Technology?



Key Issues for Navy

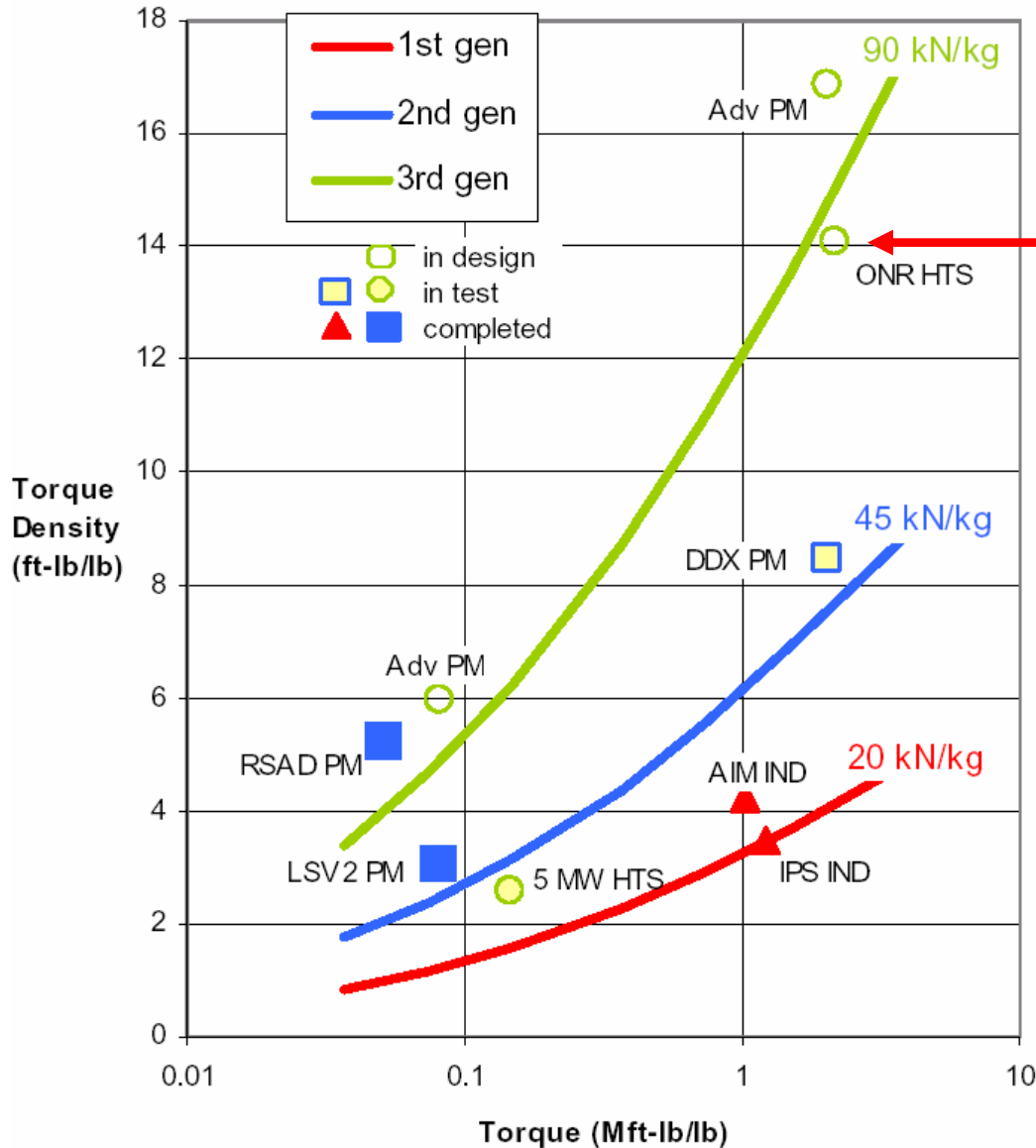
- Power Density
 - Components
 - Distribution Architecture
- Fuel Efficiency
- Pulsed Power
- Signatures

Power Density Issue



Mechanical Drive still beats Electric Drive on Power Density.

Motor Torque Density



To be demonstrated at full scale in 2007.

Figure courtesy of Peter Mongeau,
ASNE Electric Machines
Technology Symposium,
Philadelphia PA, January 2004

NRAC Summer Study – Future Fuels

- National Petroleum Usage – 16M BPD
- DOD Usage – 300K BPD (about 2% of national usage).
- DOD Usage:
 - Aircraft 73%
 - Ground 15%
 - Ships 8%
 - Installations 4%
- Recommendation – DOD catalyze manufactured hydrocarbon liquid fuels infrastructure through long term purchase contracts.

Future S&T Directions:

- High Speed / High Frequency Generators
- Advanced Distribution Architecture
- Innovative Ship Propulsion
- Compact Power Electronics and Energy Storage to Support Pulsed Power Weapons and Sensors.



Questions?