



Defense Research and Engineering in the 21st Century

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Overview



- **Transformation: Capabilities-Based Approach**
- **Quadrennial Defense Review (QDR) Critical Capabilities**
- **National Aerospace Initiative (NAI)**
- **Surveillance and Knowledge Systems (S&KS)**
- **Energy and Power Technologies (E&PT)**
- **Technology Transition/ACTDs**
- **Summary**

Transformation



**“The Evolution and Deployment of Combat Capabilities
That Provide Revolutionary or Asymmetric
Advantages to Our Forces”**

- QDR (Sep 30, 2001)

QDR Critical Capabilities



- **Protect Bases of Operations**
- **Conduct Information Operations**
- **Project and Sustain US Forces**
- **Deny Enemy Sanctuary**
- **Conduct Space Operations**
- **Leverage Information Technologies**

Protecting Bases of Operations



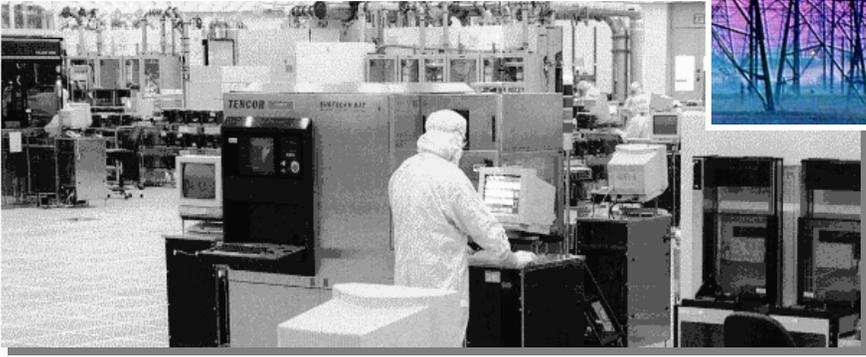
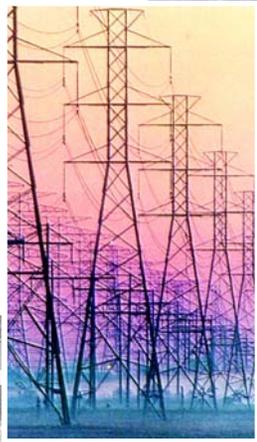
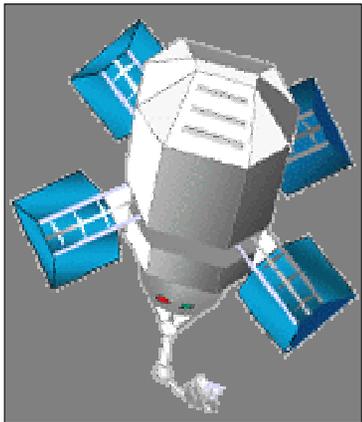
- *Combating Terrorism*
- *Chemical/Biological Defense*
- *Missile Defense*
- *Consequence Management*



Conduct Information Operations



- *Defensive IO and Information Assurance*
- *Offensive IO*



Project and Sustain US Forces



- *Anti-Access Capabilities*

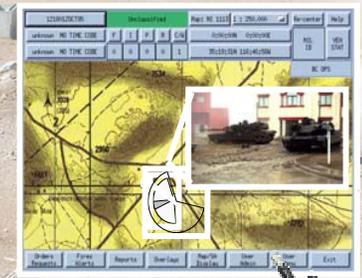
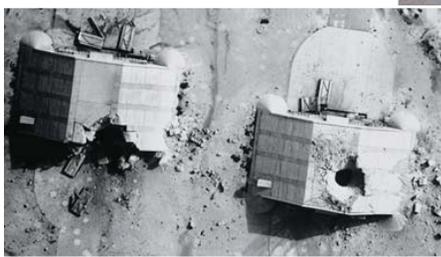
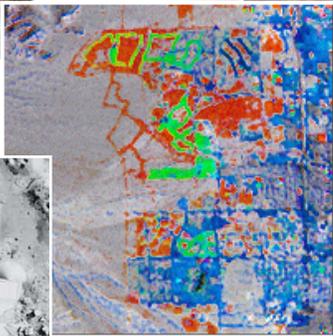
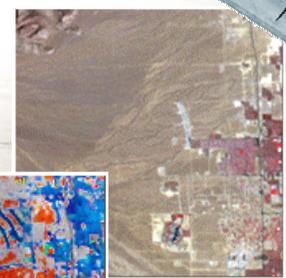
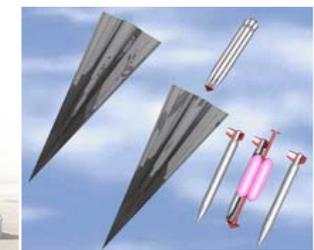


Deny Enemy Sanctuary



Persistent Surveillance, Tracking and Rapid Engagement with Precision Strike

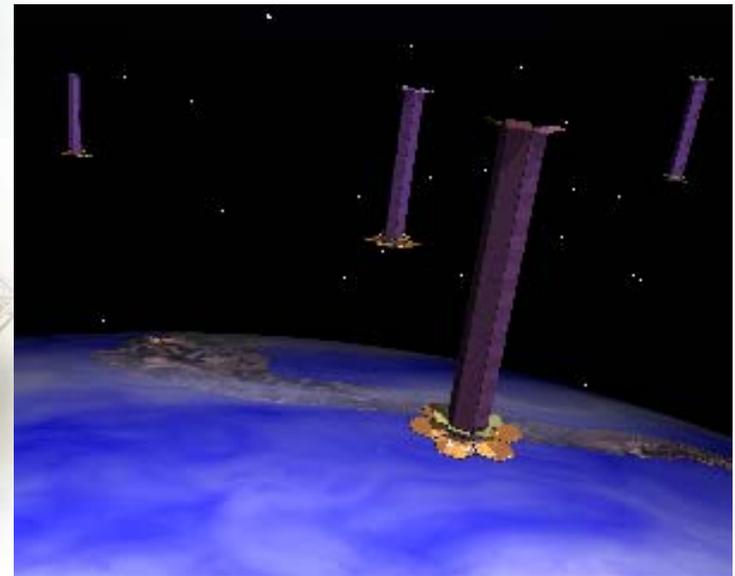
- *Remote Sensing/Enhanced C4ISR*
- *Unmanned Aerial Vehicle*
- *Long-Range Precision Strike*
- *Small-Diameter Munitions*
- *Defeat Hard and Deeply Buried Targets*





Conduct Space Operations

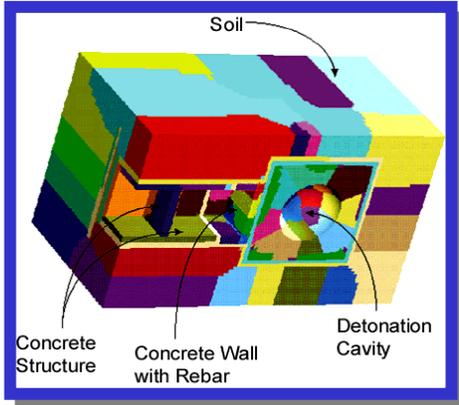
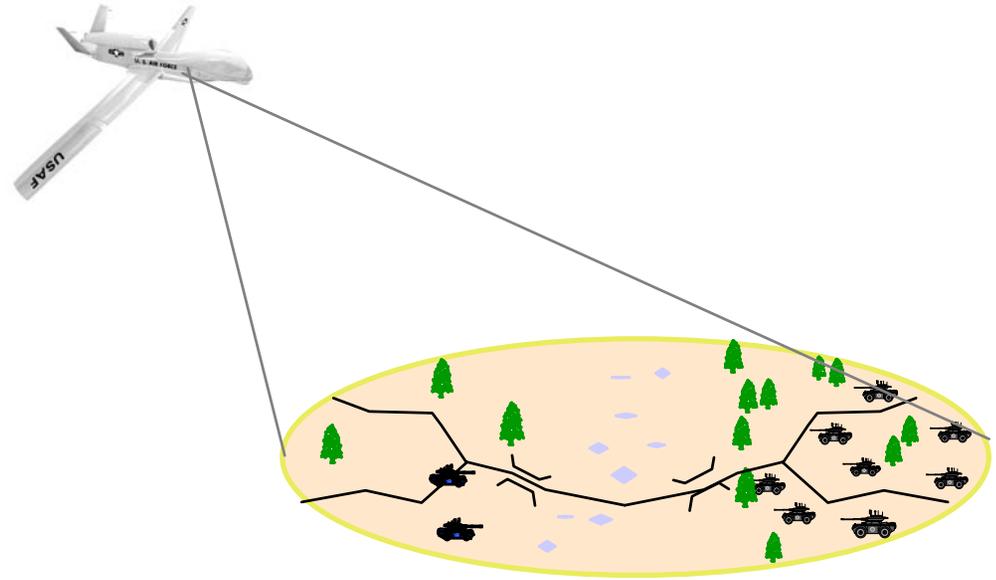
- *Ensure Access to Space*
- *Protect Space Assets*
- *Space Surveillance*
- *Control Space*
- *Sub-Orbital Space Vehicle*





Leverage Information Technologies

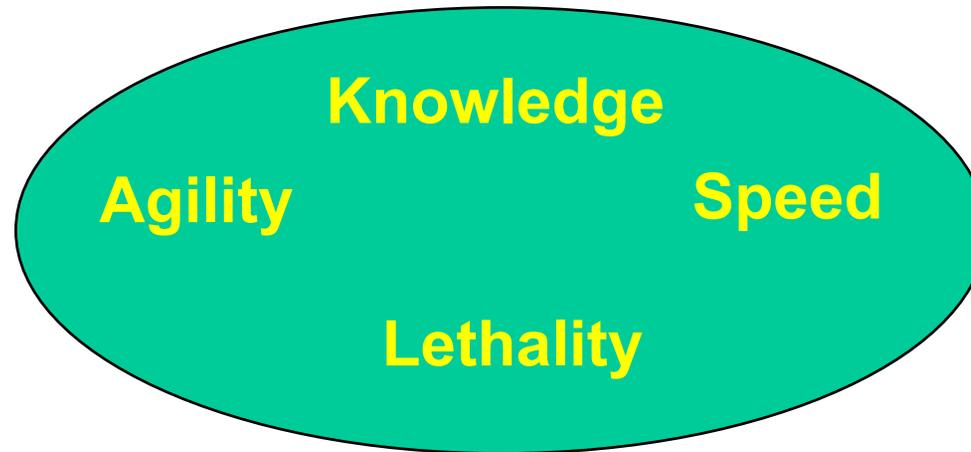
- *High-capacity Interoperable Communications*
- *Survivable, Improved, Tactical and Strategic Communications*
- *End-to-end C4ISR*



Technology and Transformation



- **Transformation Attributes**



- **Transformation Technology Initiatives**
 - National Aerospace Initiative
 - Surveillance and Knowledge Systems
 - Energy and Power Technologies

National Aerospace Initiative

- *Technology Framework*



- **Hypersonics**
 - **Strategic Strike, Time Critical Targets, Suborbital Vehicles, UCAVs, Fast Transportation, etc.**
- **Access to Space**
 - **TSTO: 1st - Air Breathing, 2nd - Rocket; SSTO**
- **Advanced Space Technologies**
 - **Microsats, Multifunction Satellites, etc.**

National Aerospace Initiative

Technology Framework



NAI

- *Strategic Focus*
- *Technical Coordination*
- *Aerospace Workforce*

Hypersonics

TCT/NPR

**Expendable
(Missiles)**

**Reusable
[Mach 0 - 12]**

Mach < 4

4 < Mach < 15

**Long-Range
Strike
[Mach 0-7]**

**Air-Breathing
1st Stage (TSTO)
[Mach 0 - 12]**

Space Access

NASA/DoD

Reusable Launch Vehicle

2nd Stage Rocket Engine

**Space
Maneuvering
Vehicle**

**Space
Technology**

*Space
Commission*

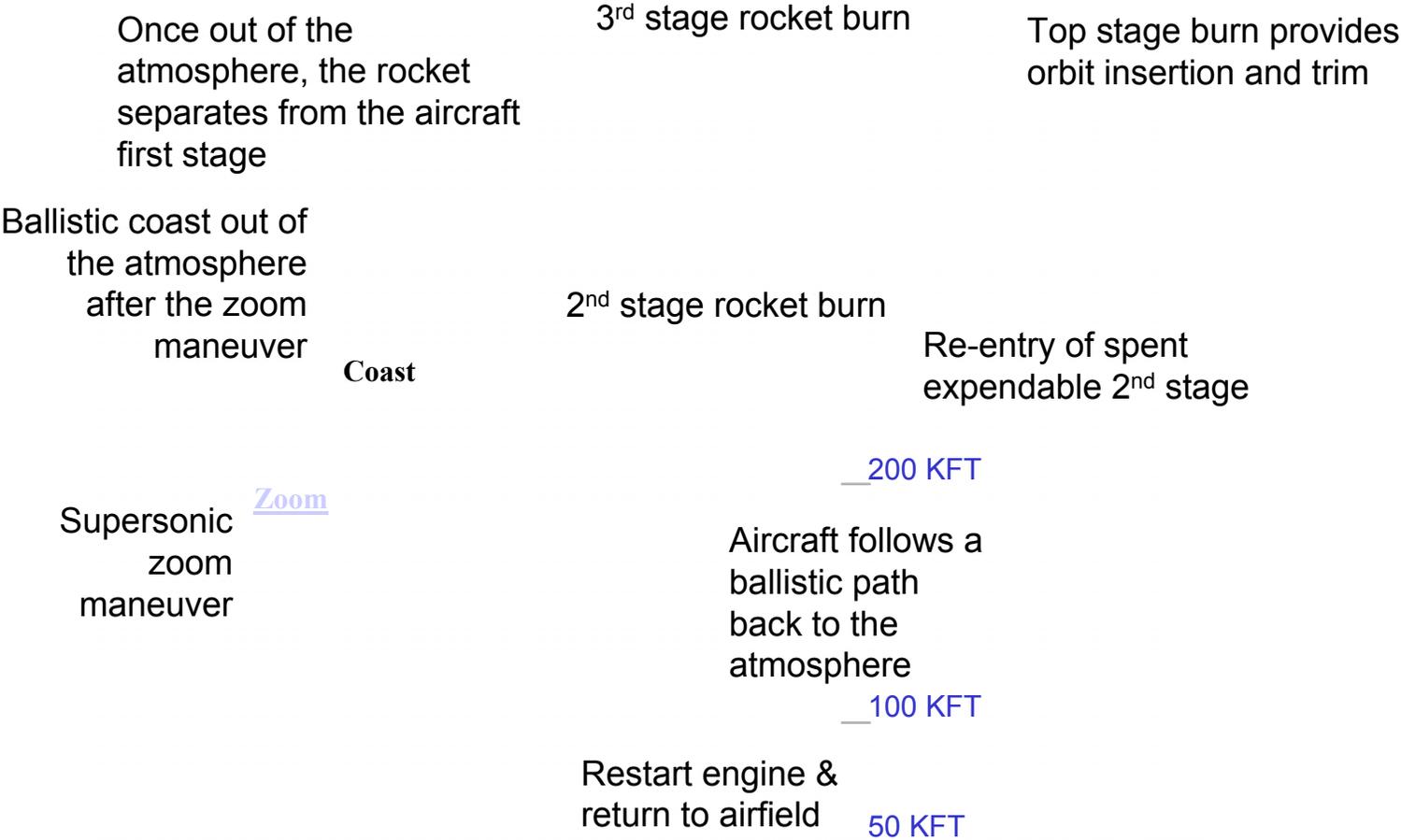
**Responsive
Payloads**

**Flexible
Comm**

ISR

Synergy Goal: 1 + 1 + 1 > 3

DARPA RASCAL PROGRAM



National Aerospace Initiative Approach



Space Access



Weapons



RLV (Affordable, timely access to space)

Hypersonic Cruiser (Global Reach/Attack)

Far-Term

Supersonic/Hypersonic Missiles (Time-critical targets)

Mid-Term

Pursue Stepping-Stone Approach

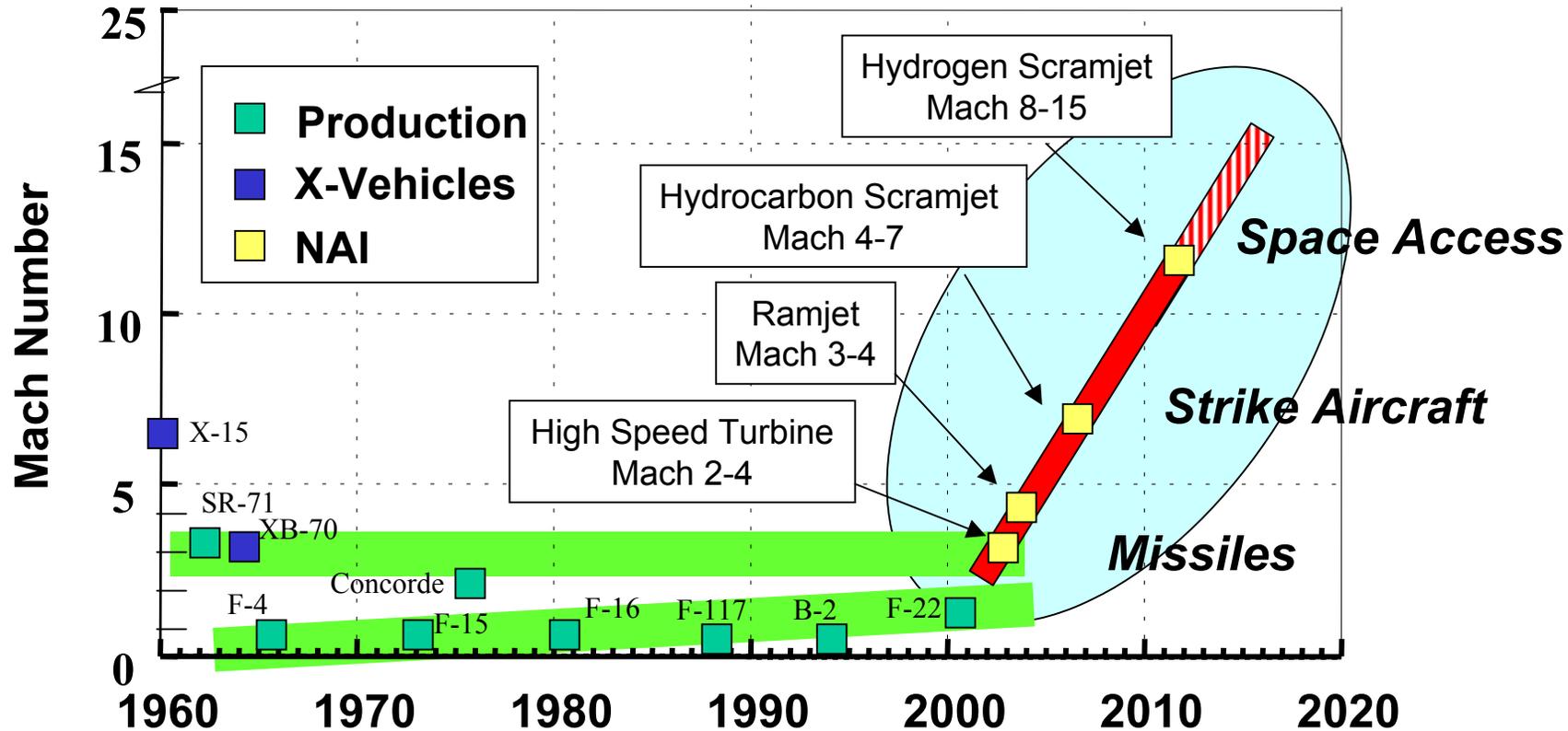
Near-Term

National Aerospace Initiative

Hypersonics



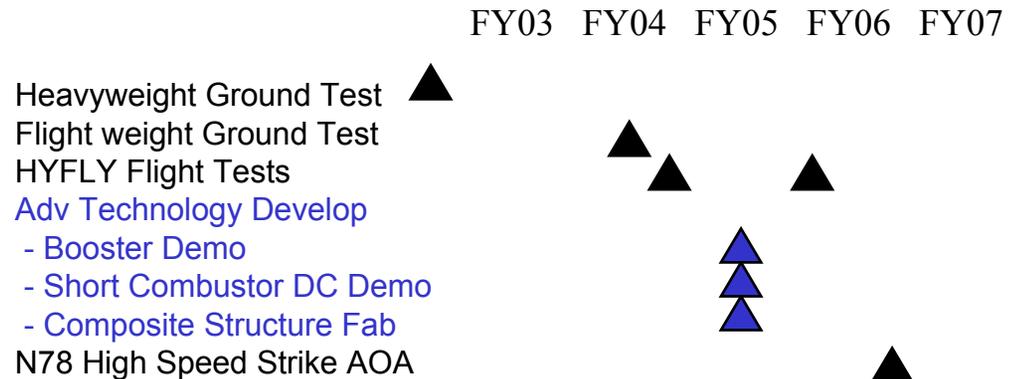
Mach Number per Year to 2012



Navy/DARPA Scramjet R&D



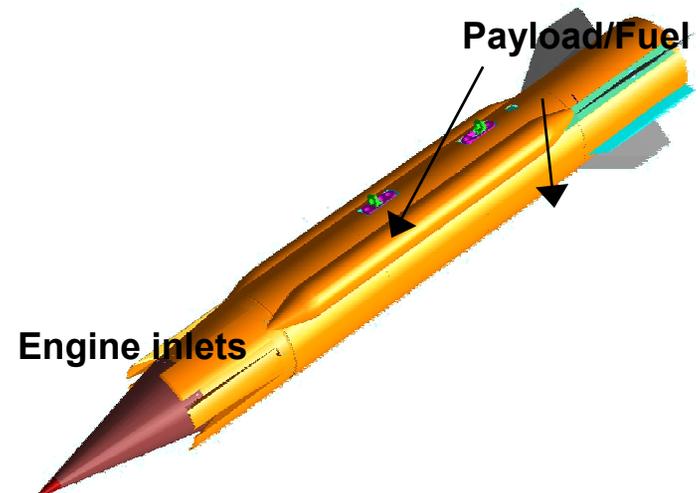
Hypersonic Flight Demonstration Program (HYFLY)



Successful Ground Test - May 30, 2002

HYFLY Weapon Characteristics

- 2150 lb Launch Weight, Length 183”
- 250 lb Penetrator
- F/A 18 E/F Compatible 400 Nmi Flyout
- VLS Compatible - 600 Nmi Flyout

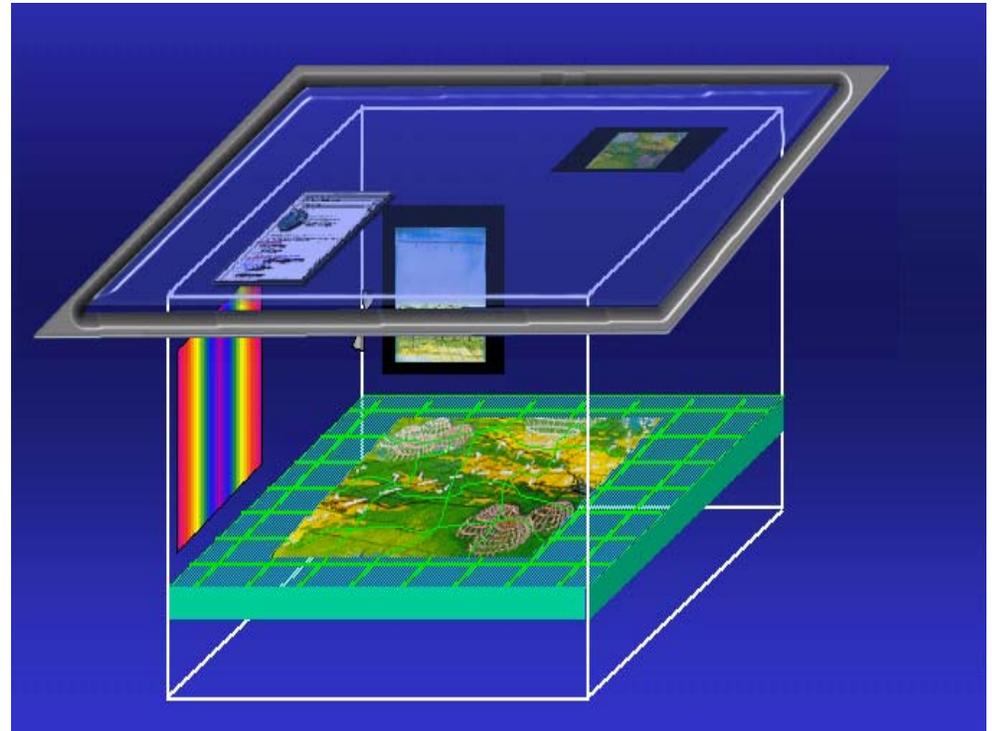
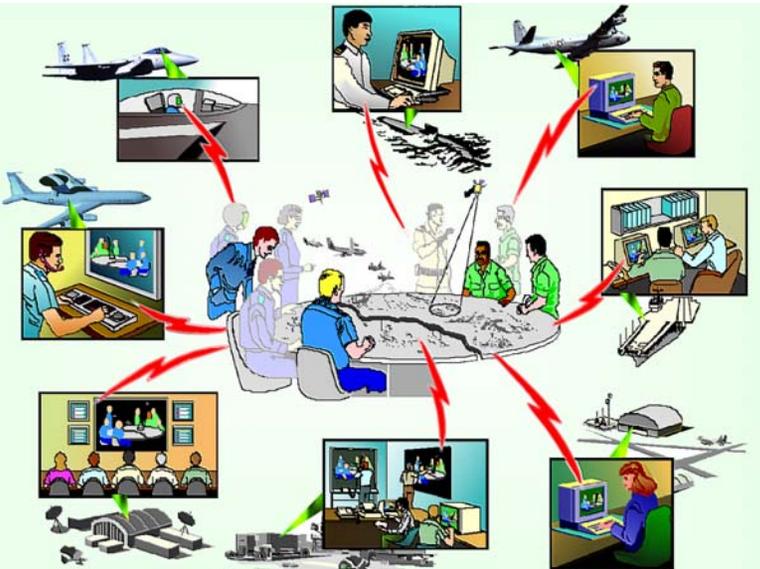
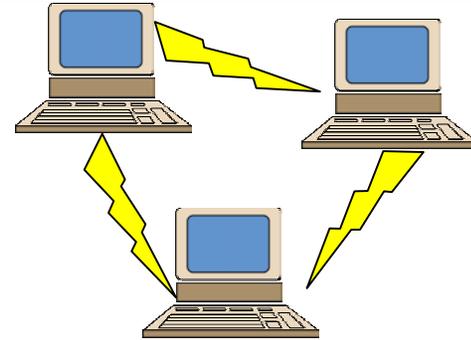
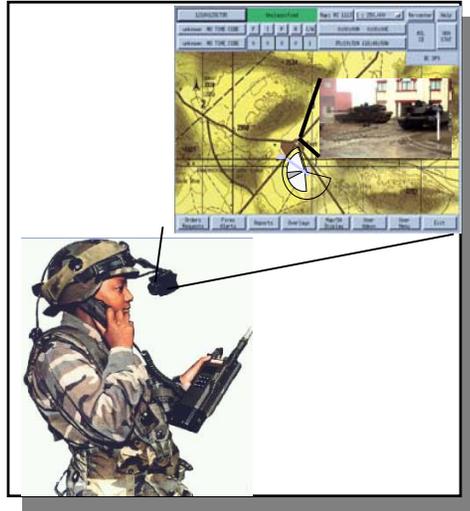


Surveillance & Knowledge Systems (S&KS) - C4ISR



- **Sensors and Unmanned Vehicles**
 - **Bio Sensors, Robotics, UAVs, etc.**
- **High Bandwidth Communications / Information Assurance**
- **Information / Knowledge Management Systems**
- **Cyber Warfare**

Surveillance & Knowledge Systems



Surveillance & Knowledge Systems

Emphasis Areas



Communications, Networking and Information Assurance

- **Transport Networks**
- **Information Management and Distribution**
- **Information Assurance**

Sensing

- **Advanced Sensors**
- **Sensor Network Management**
- **Signal & Information Processing and Fusion**
- **Autonomous Systems**

Knowledge Making

- **Decision-making**
- **Modeling and Simulation**
- **Computing and Software**

Surveillance & Knowledge Systems Technology Areas



- **Adaptive sensor webs**
- **Multi-level fusion involving various protocols**
- **Publish, subscribe, query “information management” techniques**
- **Database manipulation & control**
- **Peer-to-Peer collaboration & information security**
- **Networking**
- **Joint C2 sensemaking – cognitive bridge to understanding and deciding**
- **Modeling and simulation**

Energy and Power Technologies

- Enabling An “Electric” Force



- **Power Generation**
 - Nuclear, Diesel, Jet Engine, Solar Array, Fuel Cells, etc.
- **Energy Storage**
 - Batteries, Fly Wheels, Capacitors, Energetics, etc.
- **Power Management and Control**
 - Energy Conversion, Catapults, etc.
- **Directed Energy Weapons**
 - Lasers, Microwave, etc.



Power Technologies ...Pervasive & Enabling

POWER GENERATION

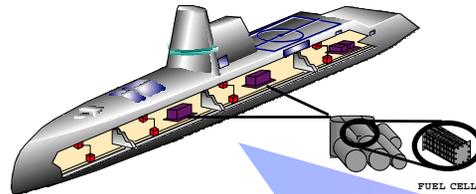
- Fuel Cells & Fuel Reforming
- Novel Power

ENERGY STORAGE

- Batteries
- Capacitors

POWER CONTROL AND DISTRIBUTION

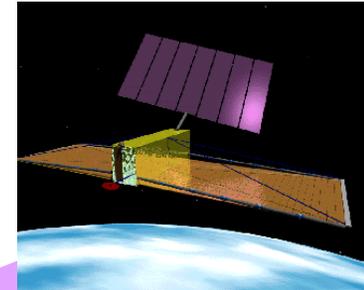
- Switching & Conditioning
- Power Transmission & Distribution
- Thermal Management



Electric Warship



More Electric Aircraft

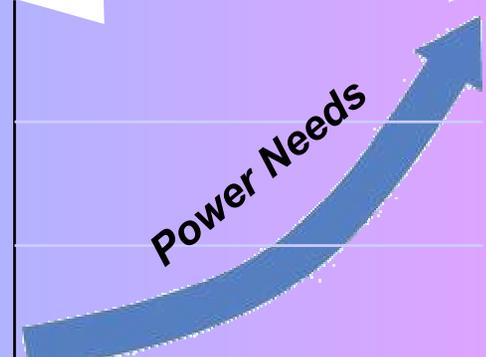
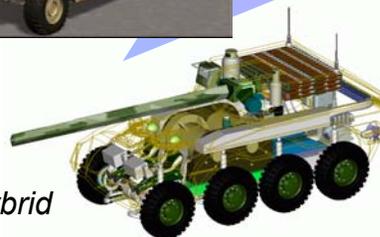


Space Based Radar

High Power Microwave



Electric/Hybrid Weapons



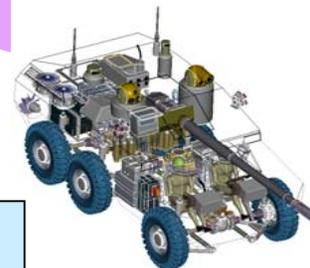
FY02

FY12



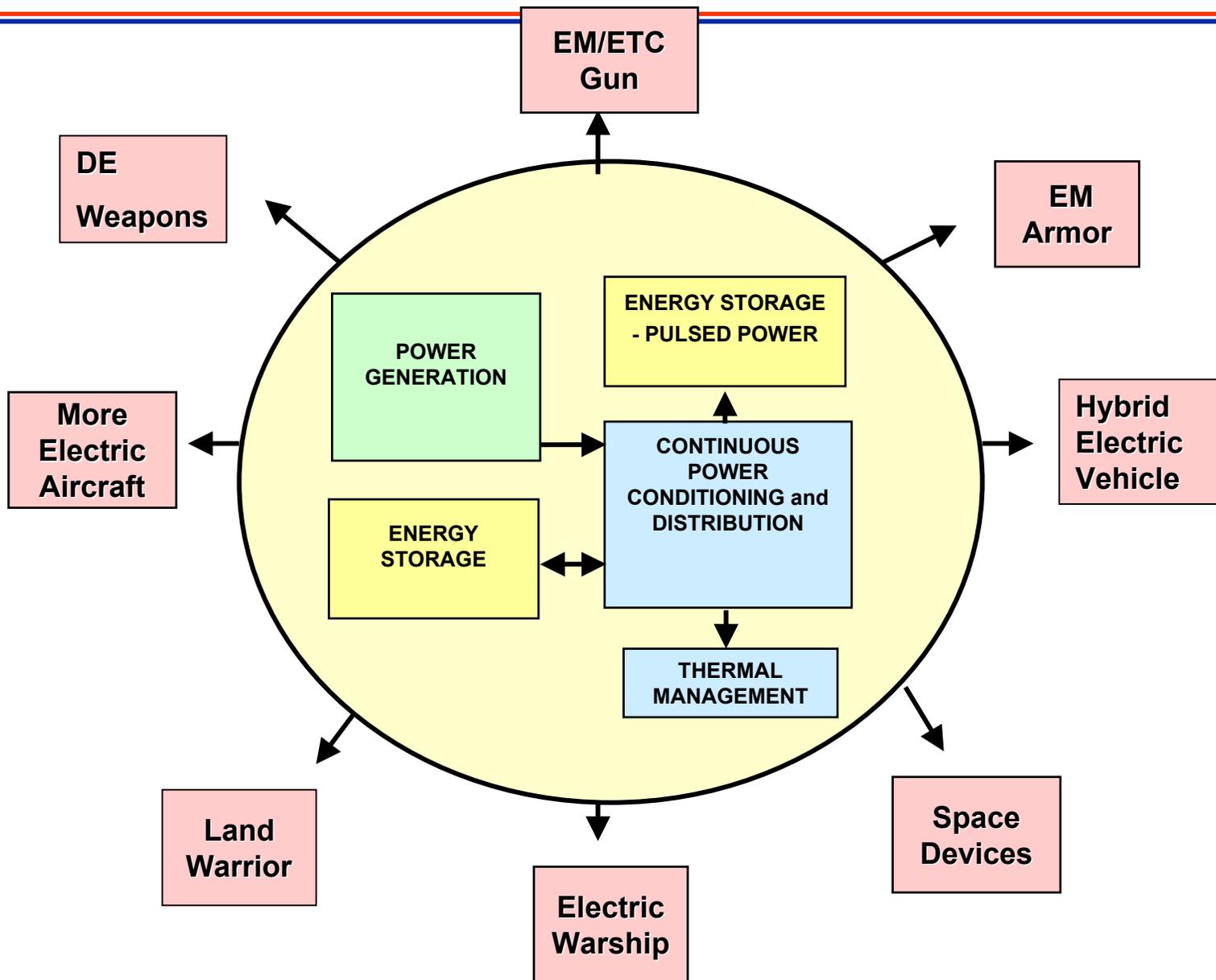
Warrior

Hybrid/Electric Combat Vehicle

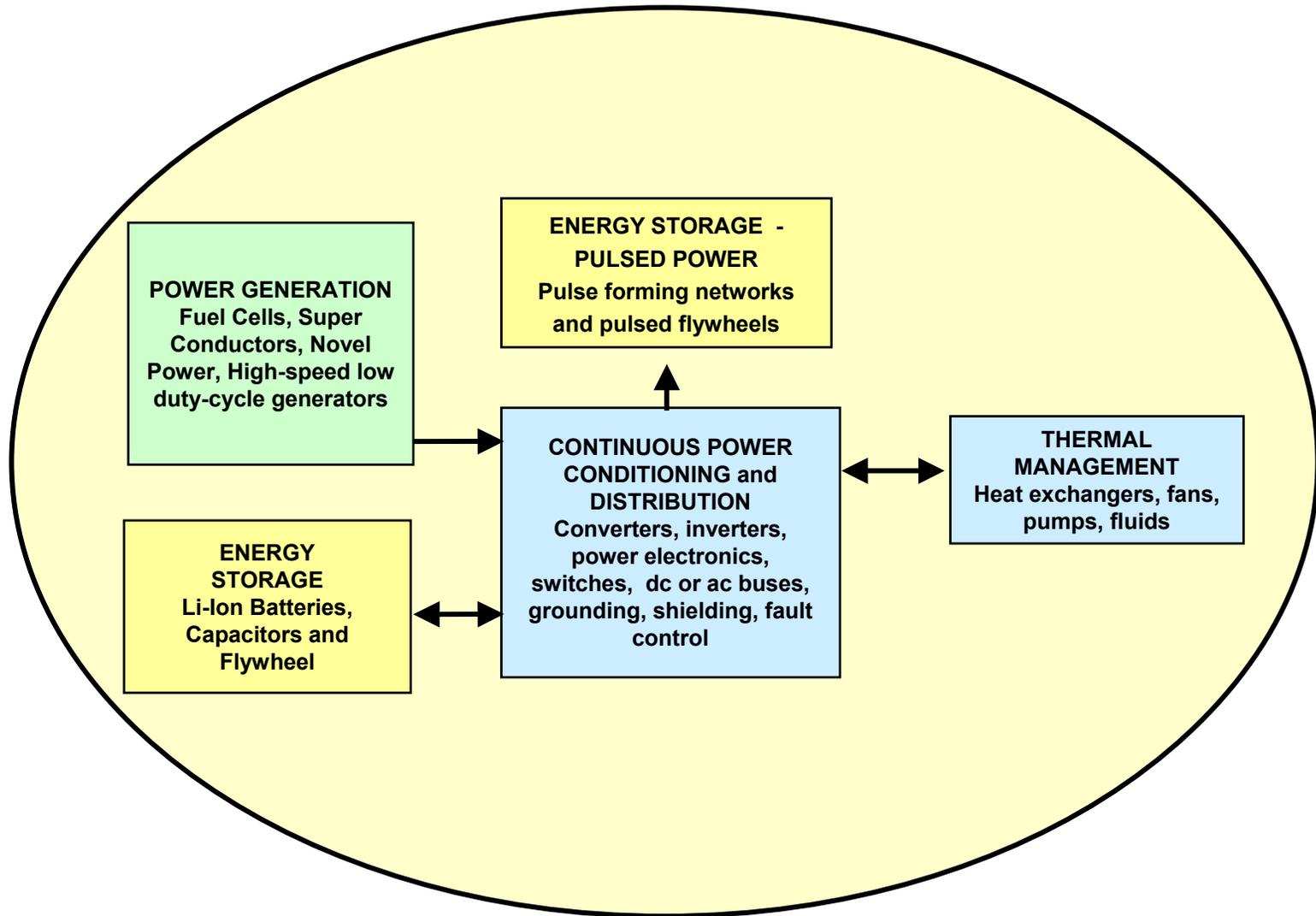


New Operational Capabilities

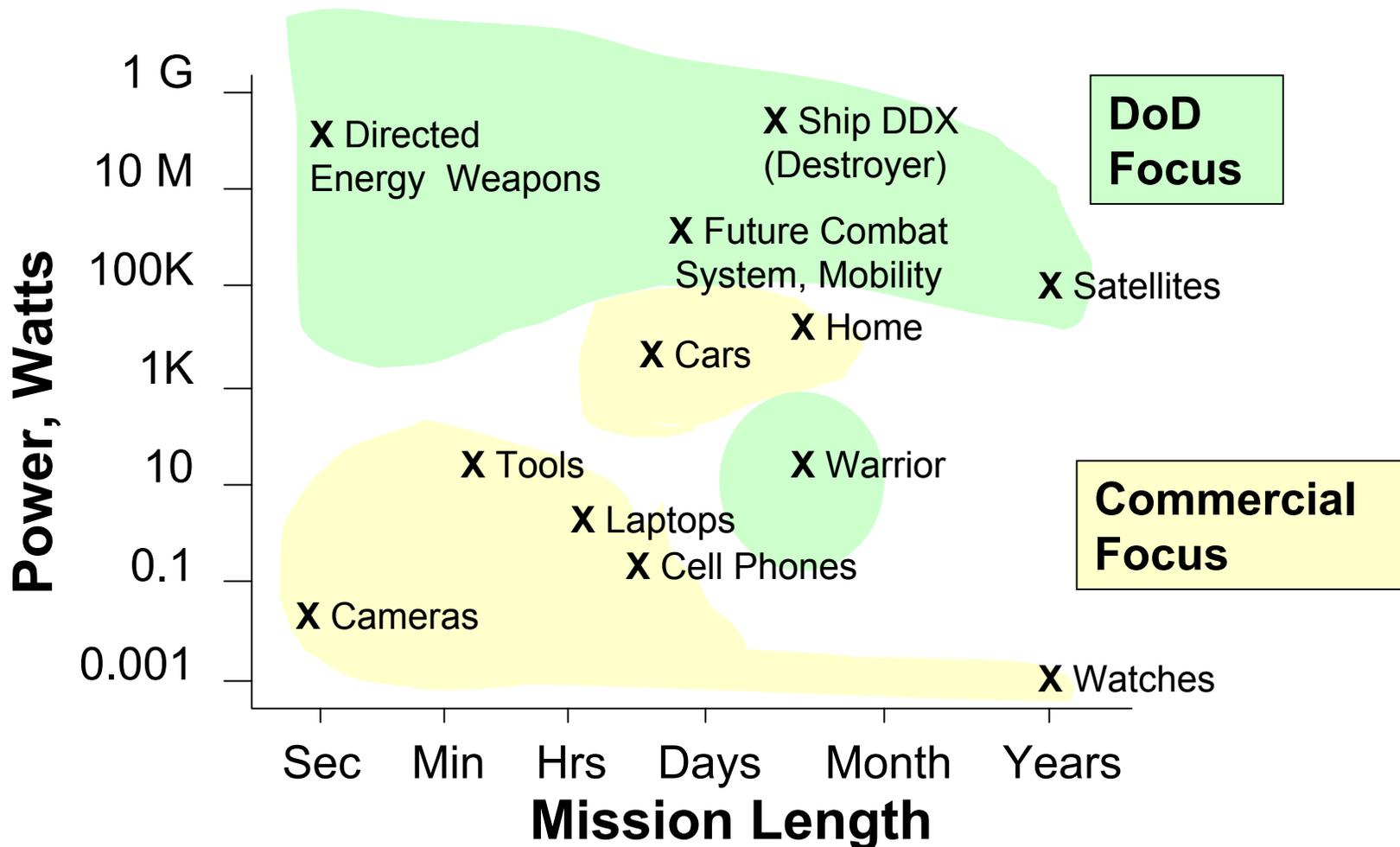
Energy and Power Technologies Enable System Capabilities



Energy and Power Technologies Focus

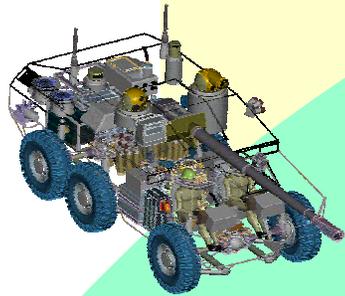


DoD and Commercial Industry Requirements

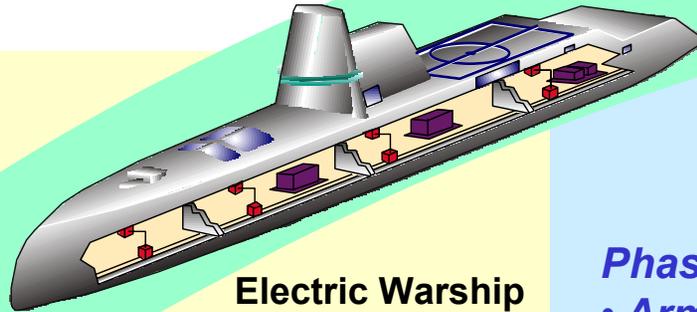




E&PT Accelerates Technology for DoD Systems



Hybrid/Electric Combat Vehicle



Electric Warship



More Electric Aircraft

Phase I – 2008

- Mission times extended up to 6X
- Rechargeable batteries charged 2-3X faster
- Logistic fuels power soldier
- 10X increase in power for non-propulsion uses
- Aircraft, 500 Kilowatt
- Enables dynamic armor

Phase II – 2015

- Armor weight reduced up to 75%
- Ammunition weight reduced by 50%, volume by 67%
- Space payloads increased by 15%
- Fuel savings of 50% per ship
- Warship crew sizes reduced
- Reduced aircraft acquisition and maintenance costs
- Sorties per aircraft wing increased by 15%
- Aircraft, Multi Megawatt



Warrior

2004

Mid Term

2008

Far Term

2015



Technology Transition

- **S&T Investment Aligned With DoD Goals**
 - Transformation, Combating Terrorism, and “Jointness”
 - Strong S&T Base is Critical for Rapid Technology Transition
- **Technology Transition Effort Has Many Facets**
- **Early Emphasis on Systems Engineering Facilitates Technology Transition**

Thermobaric Weapons

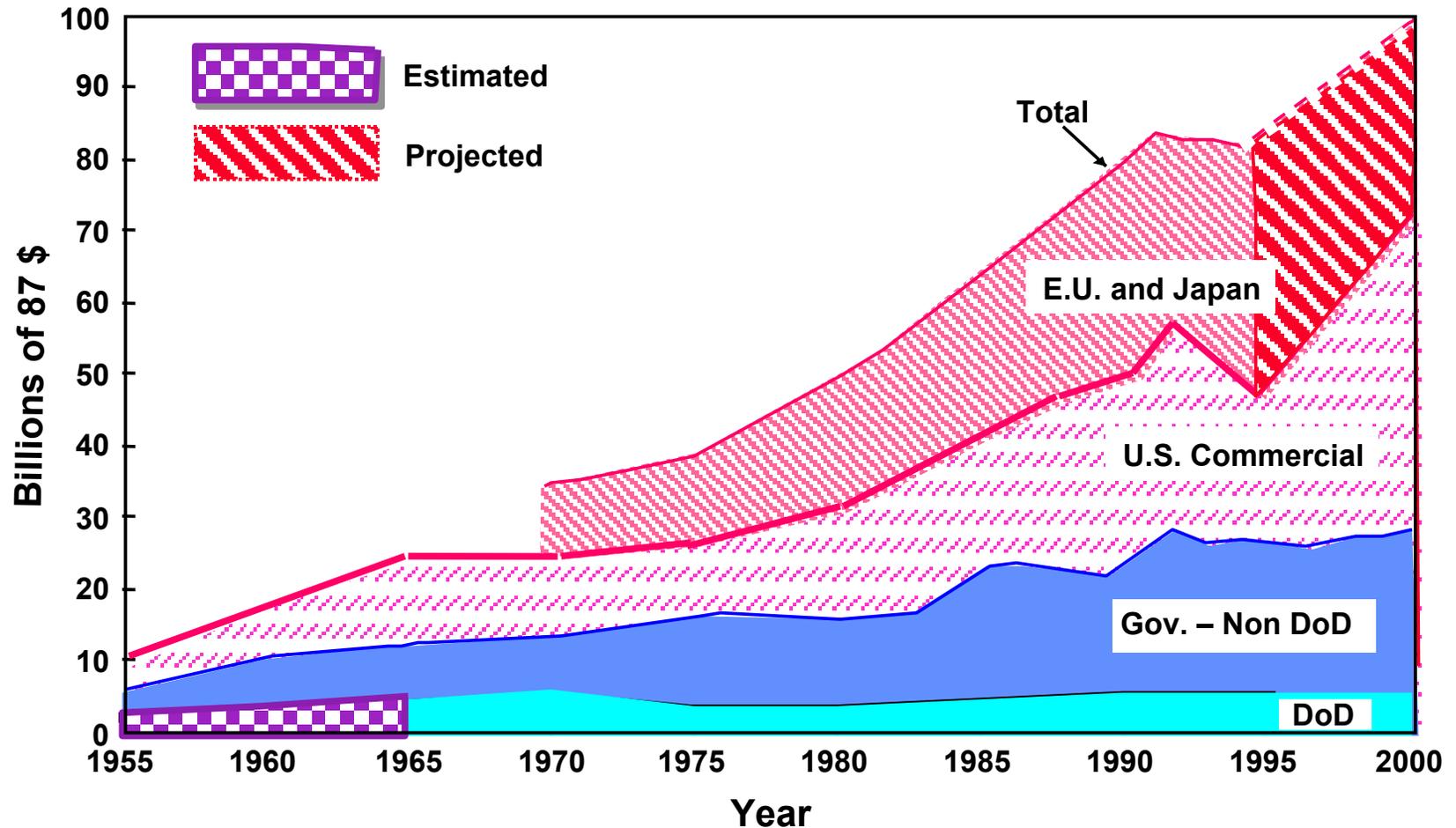
Case Study In Rapid Technology Transition



- A “Quick Reaction” type development, enabled by base S&T program and ACTD Framework
- Chronology: Program Approved Sept 21, 2001
 - Small Quantity Lab Testing – Oct
 - Full Up Static Test – Nov 17
 - Flight Test - Dec 14
- Team: USN, DTRA, USAF, DOE

Chemistry → *Weapon*
3 months

U.S. and Worldwide Research Base Since WWII



Source: Report of the Defense Science Board Task Force on the Technology Capabilities of Non-DoD Providers; June 2000; Data provided by the Organization for Economic Cooperation and Development & National Science Foundation



Summary

- **Technology is a Foundation for Transformation**
- **DoD Research & Engineering Alignment with QDR Operational Capabilities**
- **Integrated Approach for Research & Engineering Across DoD**
- **Increasing Collaboration with Combatant Commands and the Joint Staff**
- **Accelerating Technology Transition is Critical**
- **Future Needs for INNOVATION and WORKFORCE**