Propulsion Technology Partnerships for the New Millennium: *A View From The Pentagon*

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Propulsion Technology Partnerships for the New Millennium: *A View From The Pentagon*

- ***Aerospace Propulsion Technology: Today's Environment***
  - ⇒*Rationale for Investment*
  - ⇒*Current Fiscal Environment for Propulsion S&T Investments*
  - ⇒*Forces Impacting Propulsion S&T Funding Today*

- ***The IHPTET Program: A National Success Story***
  - ⇒ *Recipe for Success*
  - ⇒*Progress Toward the Goals*
  - ⇒*Transition Opportunities and Payoffs*

- ***Propulsion Technology In The Post-IHPTET Era***

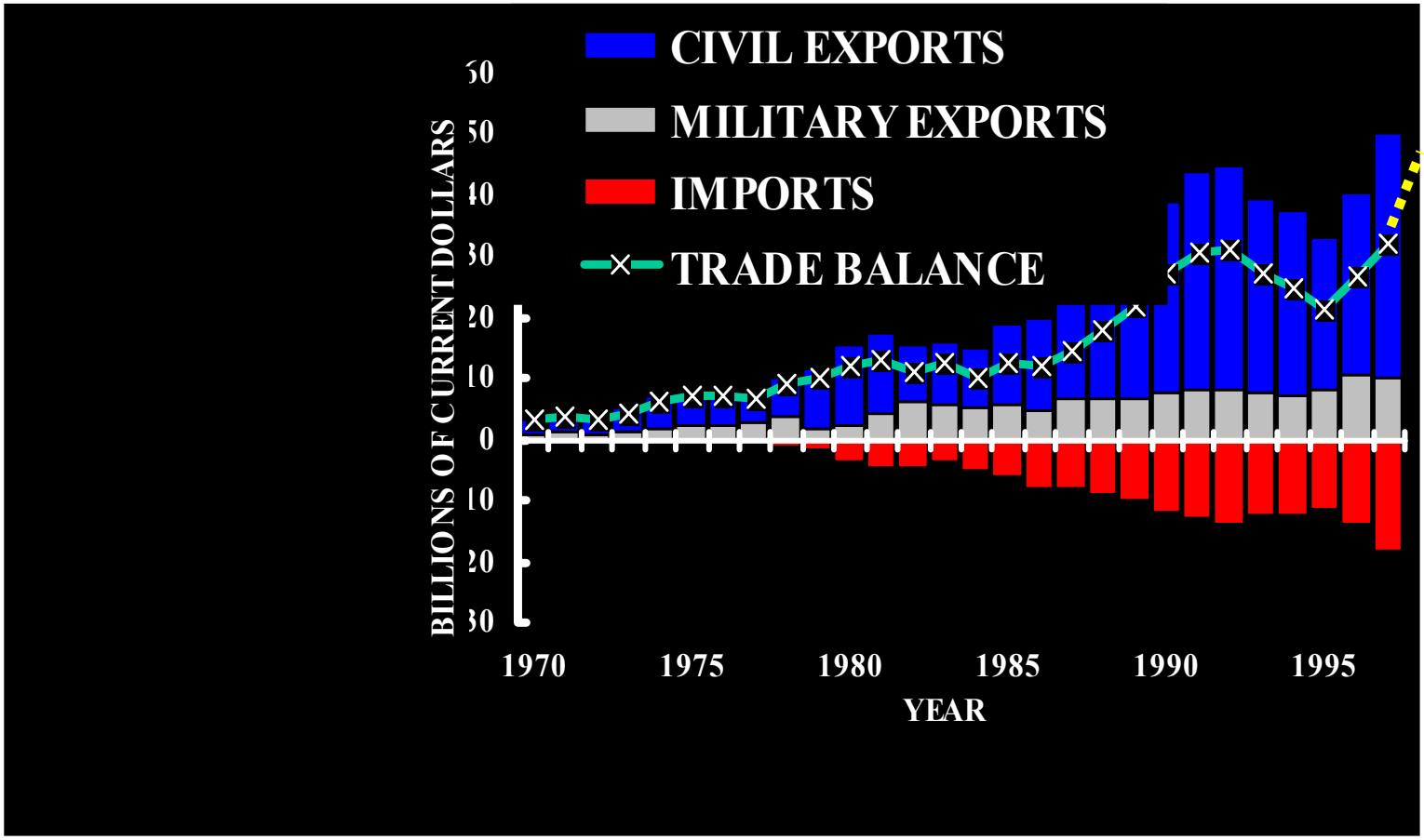
Rationale For Propulsion S&T Investment
The Military Perspective

- **Propulsion technology has strong US military relevance**
  - Aerospace vehicles will continue to play a vital role in joint warfighting capabilities
  - ~40% of DoD budget ($100B/Yr) related to system acquisition, operations, and support
- **Propulsion goals are aggressive and achievable**
  - Increase gas turbine engine performance by 2X/reduce fuel consumption 40% by 2003
  - Increase gas turbine engine affordability by 10X by 2015
  - Increase liquid rocket thrust-to-weight by 2X/reduce stage failure rate by 75% by 2010
  - Demonstrate Mach 8 scramjet capability by 2002
- **Potential weapon systems payoffs are significant**
  - Increased aircraft mission range/payload by 100+%
  - Increased aircraft operational readiness by 10+%
  - Increased aircraft mobility/reduced logistics footprint
  - Reduce space launch costs by 10X
  - Increase on-orbit payload delivered by 30%
  - Reduce missile reaction time by 25+%
  - Reduced aerospace propulsion ownership costs by 35%
- **Numerous windows of opportunity exist for technology transition**
  - Existing fleet: F-14, F-15, F-16, C-5, C-141, B-1, B-2, AMRAAM, Minuteman III
  - F-22, F-18E/F, C-17, RAH-66, AH-64/UH-60, MilSatCom, ATLAS/DELTA/EELV upgrades
  - New system developments: JSF/JTR/UCAV's/AIM 9X/Hypersonic Missile/RLV's
  - New aerospace concepts and capabilities (SOV/SMV)

➢ Aerospace Propulsion Technology Is Vital To U.S. Military Superiority

Rationale For Propulsion S&T Investment

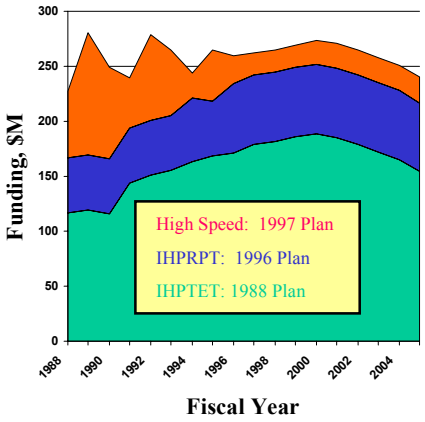
The Economic Perspective



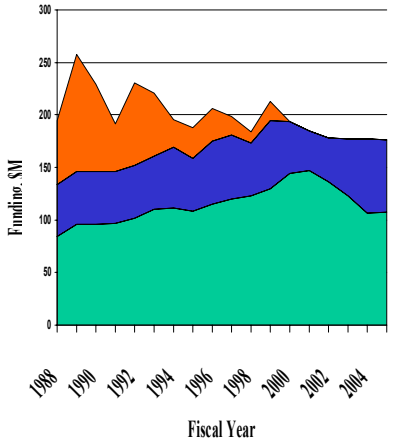
- The Aerospace Sector Ranks #1 In Trade Balance (+$41B in 1998)
- Propulsion Technology Is Vital To U.S. Economic Competitiveness

Service Propulsion S&T Investment Trends *

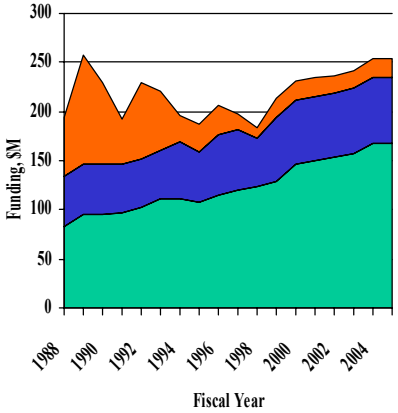
Original Plan ($M)



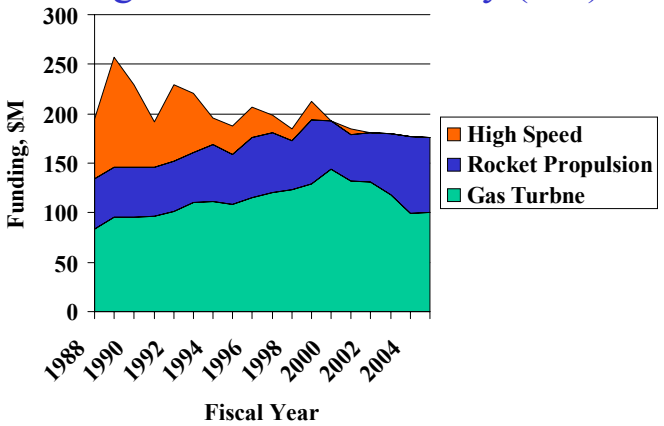
FY00 President Budget Request ($M)



FY99 President Budget Request ($M)



FY01 Budget Estimate Summary ($M)



* FUNDING IN ACTUAL $

➢ Overall Service Propulsion Technology Investments Continue To Decline

Forces Impacting DoD Propulsion-Related S&T Investments

- Service Readiness and Modernization needs driving the budgets (<2% S&T)
- S&T budget of the Air Force -- the primary DoD corporate sponsor for aeronautics-related S&T -- has been continually declining for the past 10 years
- Air Force S&T priorities strongly influenced by "Migration To Space" Initiative
- The role and importance of aircraft in the Joint Warfighting Objectives and Plans are not always recognized or clearly visible (platform vs payload capability issue)
- Perception that there is little system-level capability left to be gained by advancement in aeronautics technologies -- we're operating in the margins

IHPTET: A National Success Story

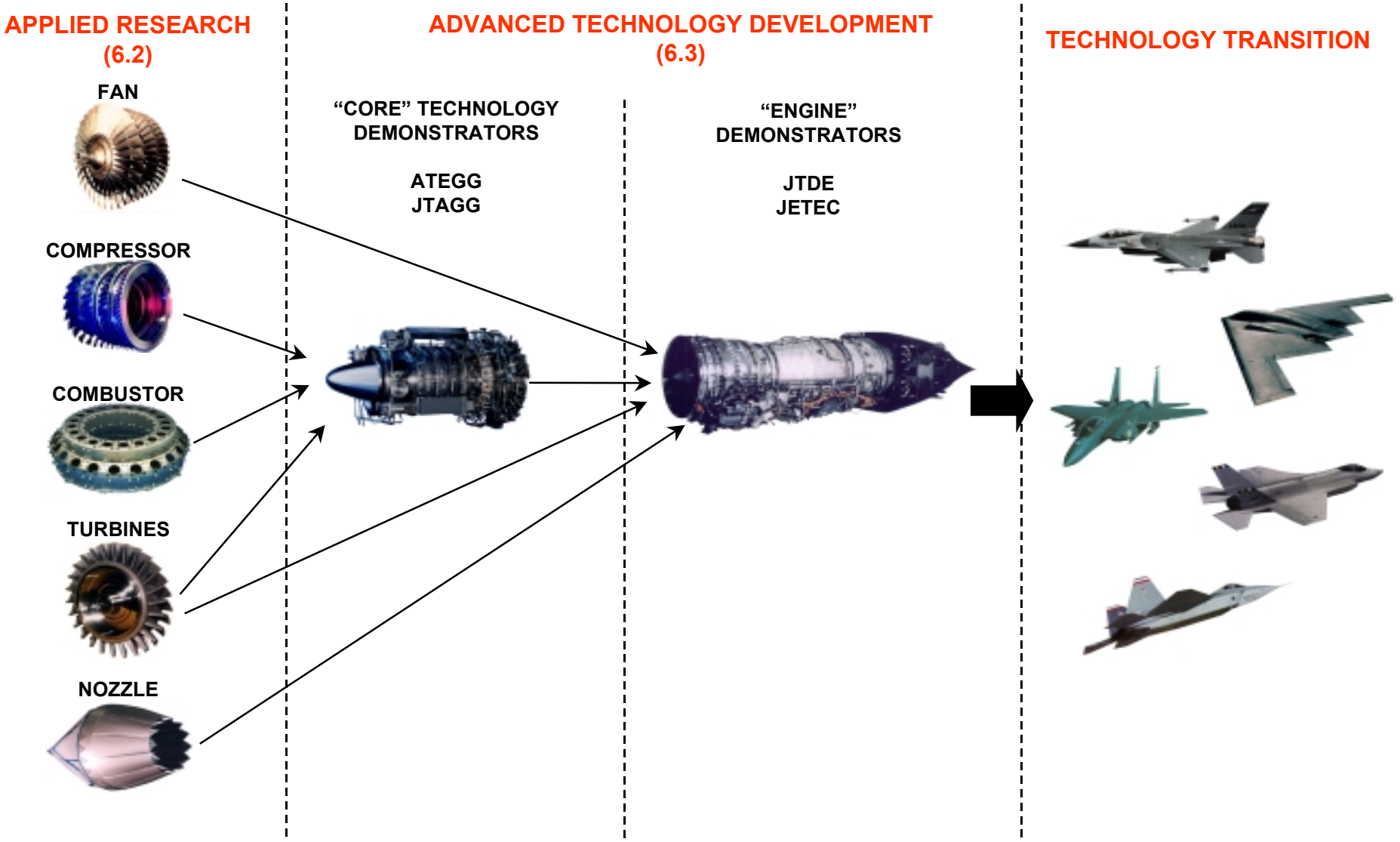
THE IHPTET RECIPE FOR SUCCESS

IHPTET:

- Addresses a critical defense technology
- Has well-defined goals, objectives, and milestones
- Is a dual-use technology
- Integrates a variety of disciplines (e.g., materials, computational fluid dynamics, etc)
- Coordinates government/industry efforts
- Provides nearer-term payoffs to existing systems
- Provides enabling technologies for new systems
- Possesses strong national (DoD and NASA) leadership and oversight

➢ IHPTET is widely viewed as a model S&T program

The IHPTET Process

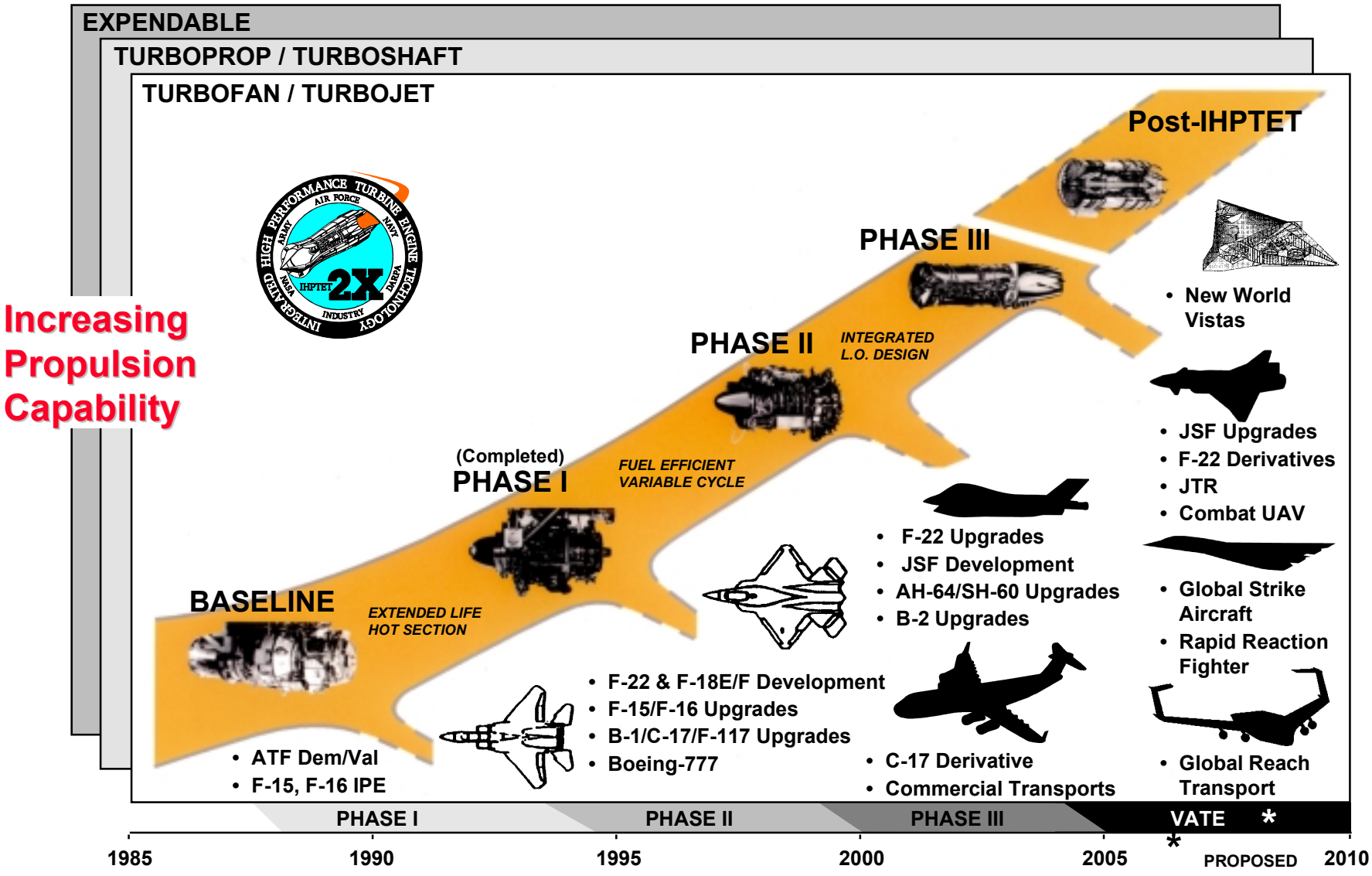


IHPTET Time Phased Goals/Progress *

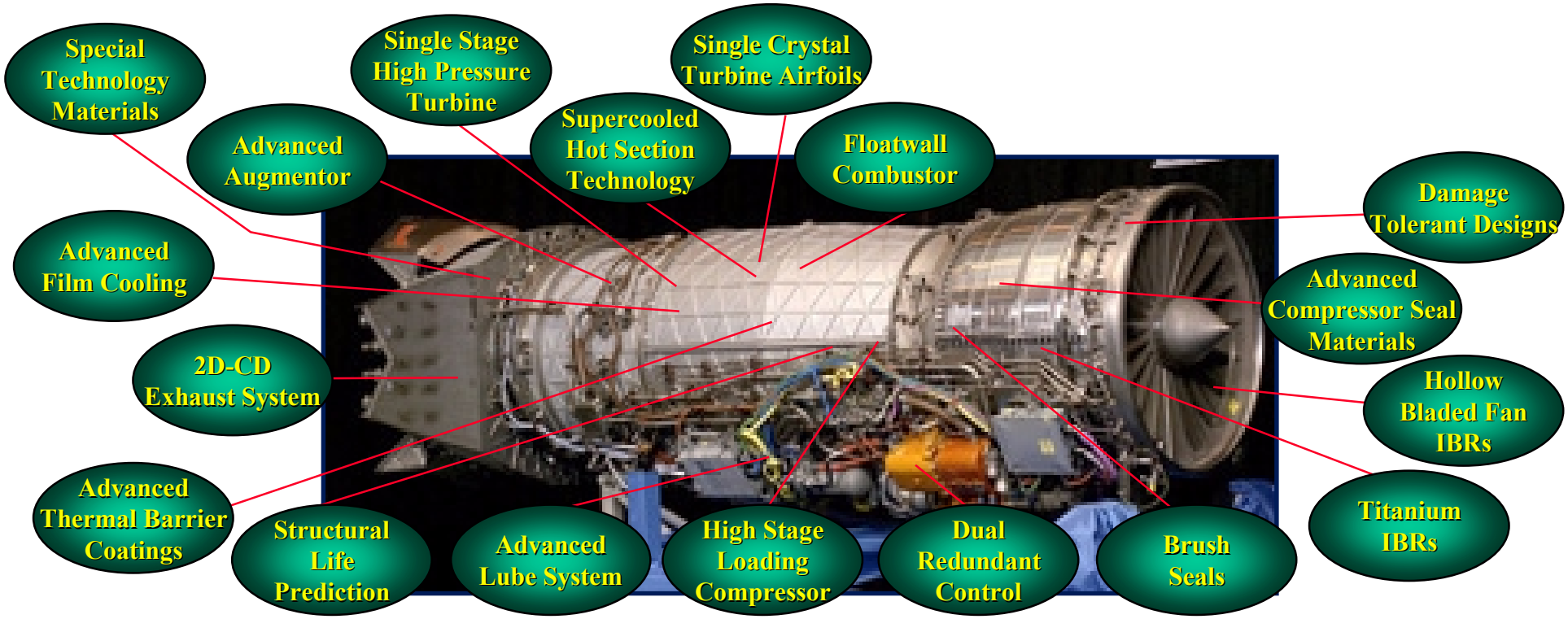
	PHASE I 1991	PHASE II 1997	PHASE III 2003	STATUS
TURBOFAN/TURBOJET				
THRUST / WEIGHT RATIO	+30%	+60%	+100%	+37%
COMBUSTOR INLET TEMP	+100°F	+200°F	+400°F	+60°F
PRODUCTION COST	---	-20%	-35%	-12%
MAINTENANCE COST	---	-20%	-35%	-4%
TURBOPROP/TURBOSHAFT				
SPECIFIC FUEL CONSUMPTION	-20%	-30%	-40%	-22%
POWER / WEIGHT RATIO	+40%	+80%	+120%	+63%
PRODUCTION COST	---	-20%	-35%	-18%
MAINTENANCE COST	---	-20%	-35%	-3%
EXPENDABLES				
SPECIFIC FUEL CONSUMPTION (STRATEGIC)	-20%	-30%	-40%	0%
THRUST / AIRFLOW RATIO (TACTICAL SUPERSONIC)	+35%	+70%	+100%	+39%
PRODUCTION COST	-30%	-45%	-60%	-39%

** REFERENCE 1987 STATE-OF-THE-ART, AT CONSTANT LIFE*

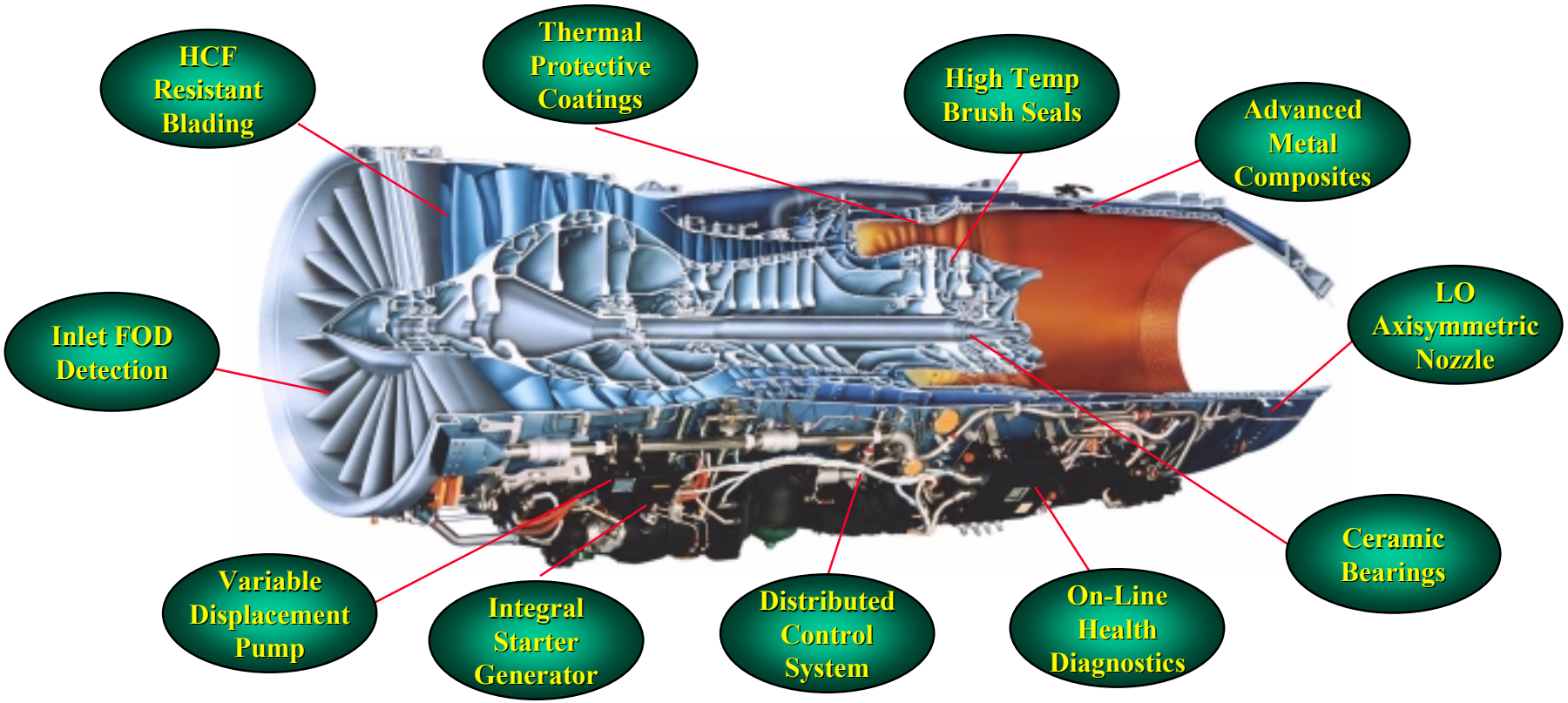
Phased Approach Enhances Transition



IHPTET Has Demonstrated a Wide Variety of Technologies



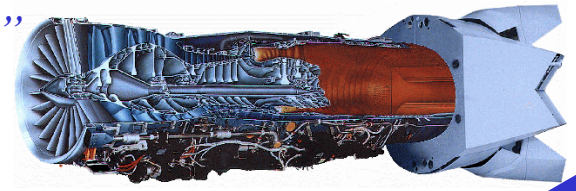
... and Is Continuing to Do So



IHPTET TRANSITION OPPORTUNITIES
The F-22/Joint Strike Fighter Paths

"Our F119 engine derived a substantial number of advanced technologies from the IHPTET program …. There is a tremendous opportunity to incorporate additional emerging IHPTET technologies …."

Michael C. Mushala
Brigadier General, U.S. Air Force
F-22 System Program Director



F119-PW-100

Alternate Engine Program

?

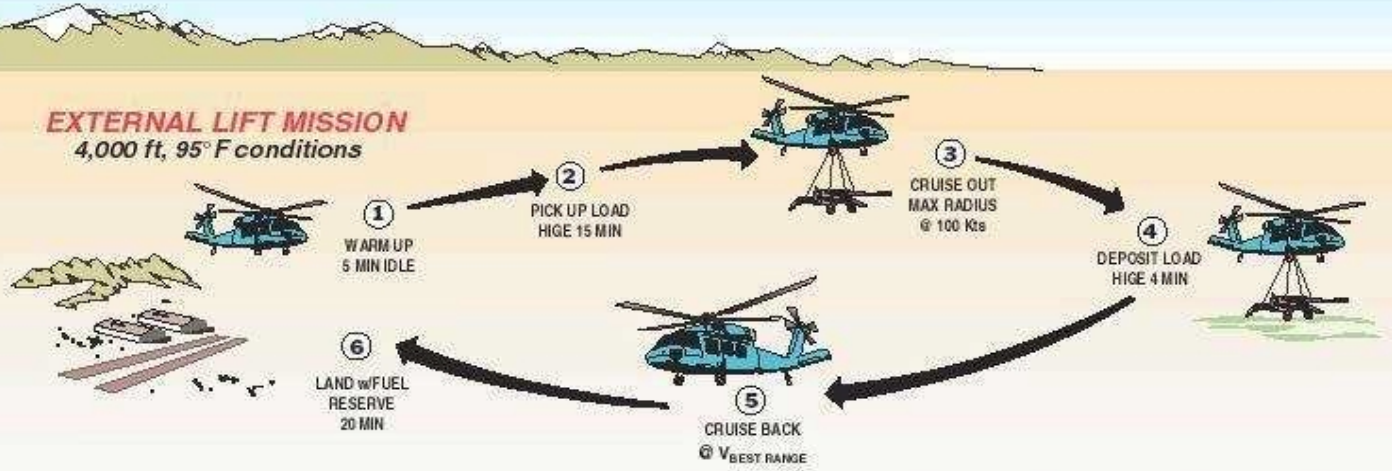
?

"A robust and healthy IHPTET program is vital to the JSF program."

Michael A. Hough
Major General, U.S. Marine Corps
Joint Strike Fighter Program Director

IHPTET Technologies Can Significantly Increase Mission Capability

COMMON ENGINE WILL ENABLE 9,000 LB EXTERNAL LIFT CAPABILITY FOR UH-60(X)



ASSUMPTIONS
- Fuel Load: 305 gal
- Advanced Rotor Blade

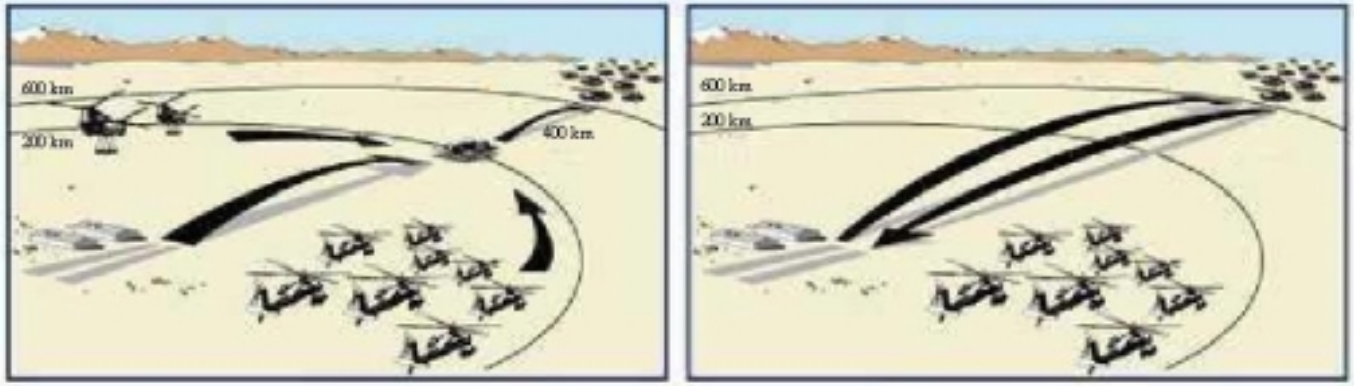
* Engine sized for 26,500 lbs HOGE w/200 fpm ROC at 4k, 95 MRP (~ 2,900 hp SLS)

CURRENT UH-60L 4k, 95 Capability
- 20,050 lbs HOGE @ MRP
- Payload ~ 5,100 lbs external with mission radius of 125 km

ENGINES	Growth HP – 0% SFC + 25% HP/wt	New Core – 20% SFC + 40% HP/wt	New Core – 25% SFC + 60% HP/wt	New Core – 30% SFC + 80% HP/wt
Mission Radius (km)	60	105	135	160
TOGWT (lbs)	26,600	26,600	26,600	26,600
Payload Capability (lbs)	9,000	9,000	9,000	9,000

IHPTET Technologies Can Significantly Reduce Logistics Tail

COMMON ENGINE TECHNOLOGY PROVIDES REDUCED LOGISTICS BURDEN



CURRENT WITH COMMON ENGINE

MISSION: AH-64D Company to Engage Tank Unit at 600 km and Return to Base

	TODAY	WITH COMMON ENGINE
Attack Aircraft		
FARP Support Aircraft		NONE REQUIRED
Mission Fuel	9200 gal	6300 gal
Crew Members	28	16

COMMON ENGINE GOALS

- 25-30% SFC REDUCTION
- 60-80% POWER TO WEIGHT INCREASE
- 20% REDUCTION IN PRODUCTION & MAINTENANCE COST

LOOKING AHEAD: THE POST-IHPTET ERA
-- An Independent Assessment --

- MEMBERSHIP:
  - 10 independent members from government/industry/academia
  - Inputs from 37 sources including program offices, users, NASA, the S&T community, and industry

- TECHNICAL RECOMMENDATIONS:
  - Achieve the IHPTET goals by 2003
  - Create a successor to the IHPTET program
  - Sustain a focused IHPRPT investment on military unique and high leverage technologies
  - Create a DoD Hypersonics Technology Program to establish the foundation for future high-speed military aerospace systems

- This study validated current gas turbine, rocket, and high speed propulsion goals, and recommended a substantial and continuing DoD propulsion technology investment

THE POST-IHPTET ERA:
Significant Messages From Industry

- Weapon System Contractors are stressing affordability in discussions with the engine industry
- Maintain IHPTET TF/TJ, TP/TS, Expendable framework: that's how industry is structured and thinks
- Maintain multiple exit ramps (phases/builds) / enhance product alignment
- Establish an aggressive materials program, particularly early-on in the program
- In the new paradigm: commercial sets configuration & performance / military may have to compromise
- Cost benefits are highly dependent on the level of commonality (COTS - "as is")
- Budget stability is critical to maintain commercial linkage
- Commercial sector does not typically invest in long-term, high risk technology

➢ The worst thing we can do is lose our credibility!

THE POST-IHPTET ERA:
A Potentially New Program Structure/Focus

ENGINE FAMILIES	FOCUS AREAS			GOALS
	VERSATILE CORE	INTELLIGENT ENGINE	DURABILITY/ READINESS	
Turbofan/Turbojet & UAV	◎	◎	◎	➢Thrust/Weight ➢SFC ➢Development Cost ➢Production Cost ➢Maintenance Cost
Turboprop/Turboshaft & UAV		◎	◎	➢Power/Weight ➢SFC ➢Development Cost ➢Production Cost ➢Maintenance Cost
Expendable		◎		➢Thrust/Airflow ➢SFC ➢Development Cost ➢Production Cost
Milestones	➢10X Affordability ➢-50% development time	➢Full L/O @ PH III T/W ➢-50% maintenance time	➢2X life @ PH III T/W	

◎ Demonstrators

Challenges For The New Millennium

- Complete what we set out to accomplish in IHPTET -- **stay focused on the goals**
- Set a new Vision/Goals for the post-IHPTET era -- **with an awareness of our environment**
- Change the misimpression about the benefits of propulsion technology -- **don't assume**
- Be responsive to our customers needs -- **present/listen/discuss/adjust**
- Increase user involvement/participation -- **gain their ownership in the program**
- Maintain DoD investment in propulsion S&T -- **our military/economic future depend on it**
- Continue/enhance government/industry collaboration -- **we gain strength from the alliance**

➢ Keep what's good about IHPTET, and continue to build upon it!