



Propulsion Technologies for Future Air Vehicles

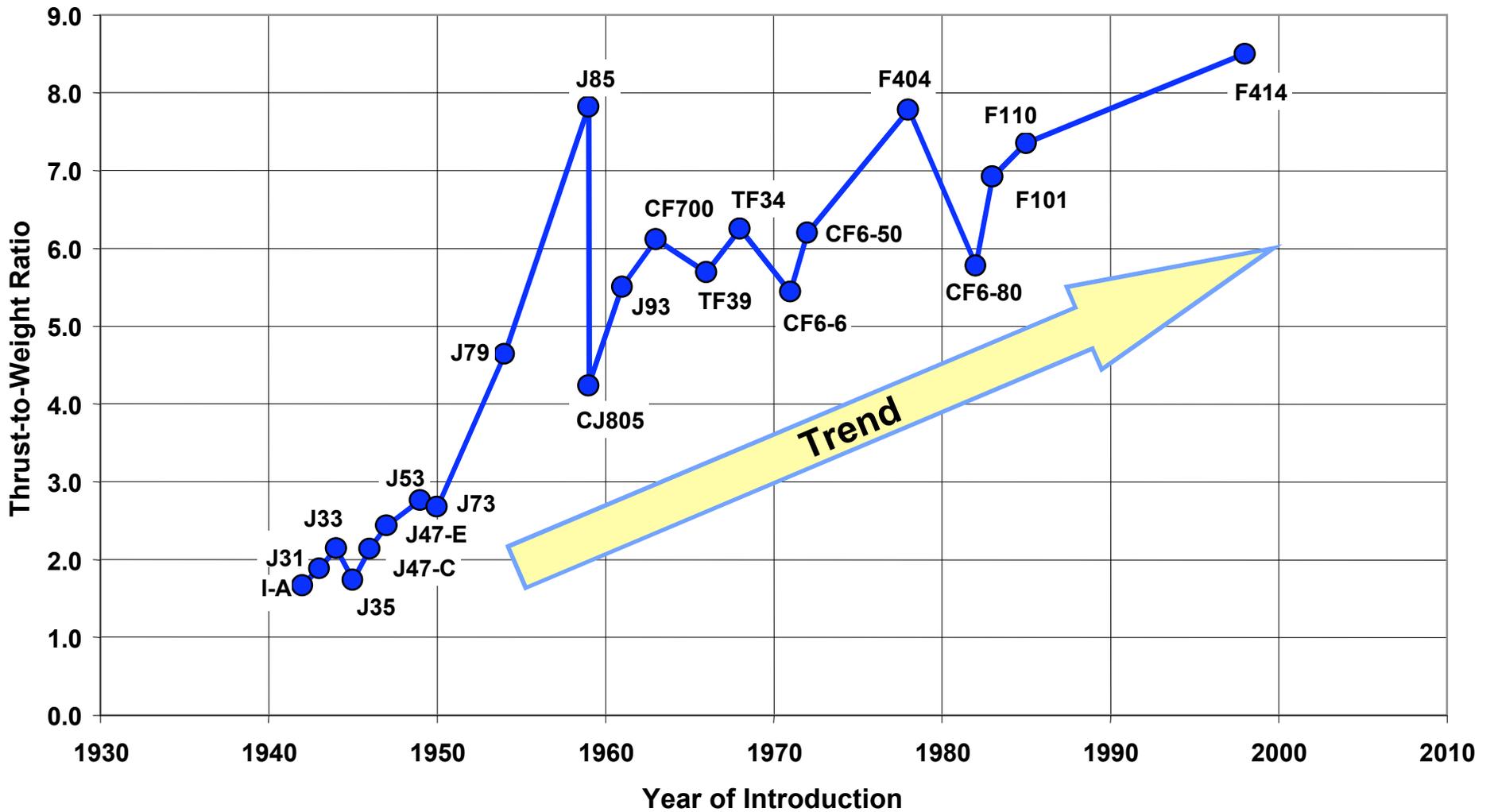
***H.M. Maclin
Advanced Engineering***

June, 2003



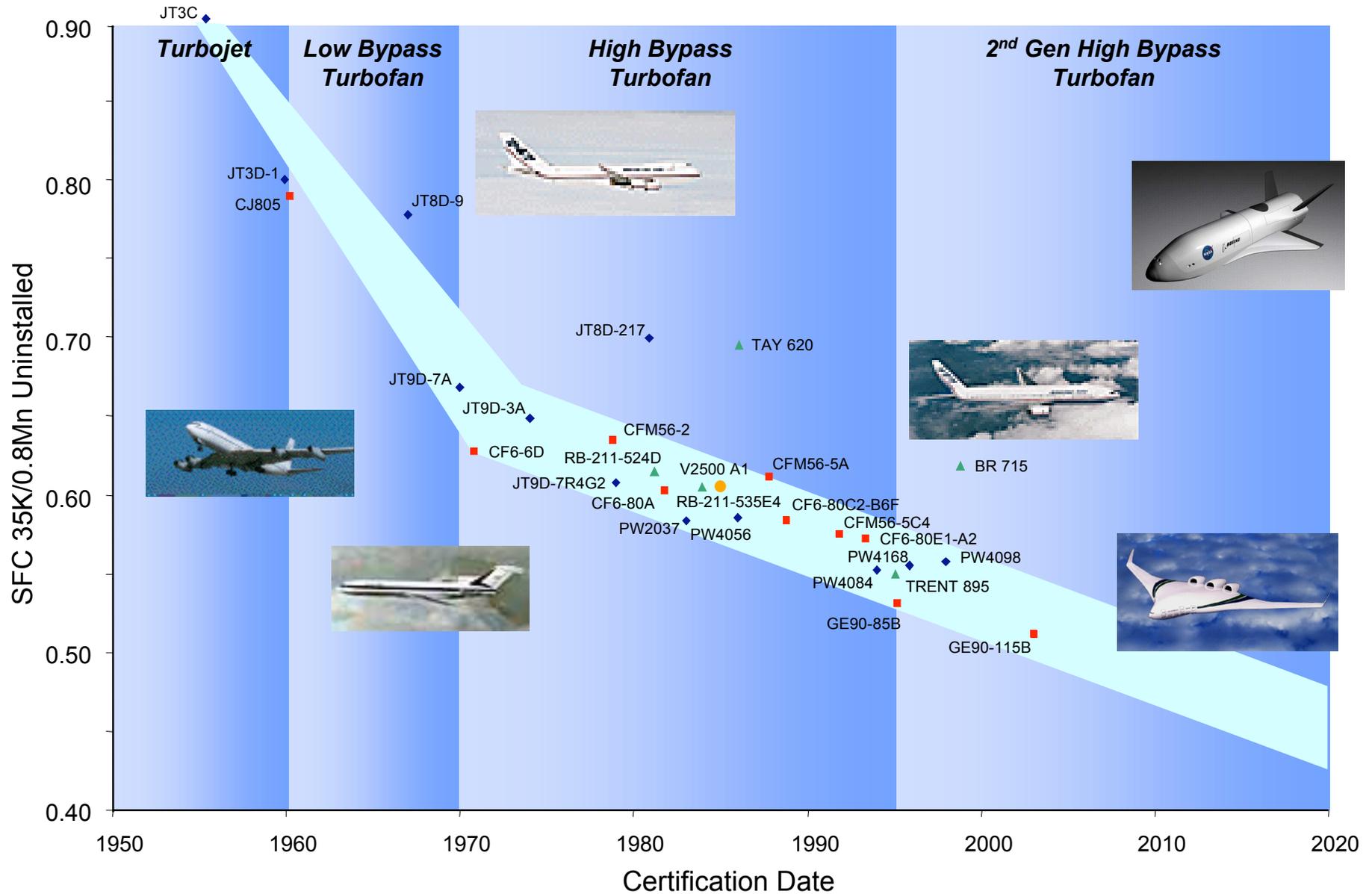
Thrust-to-Weight Trend

GE Engines Fn/Wt



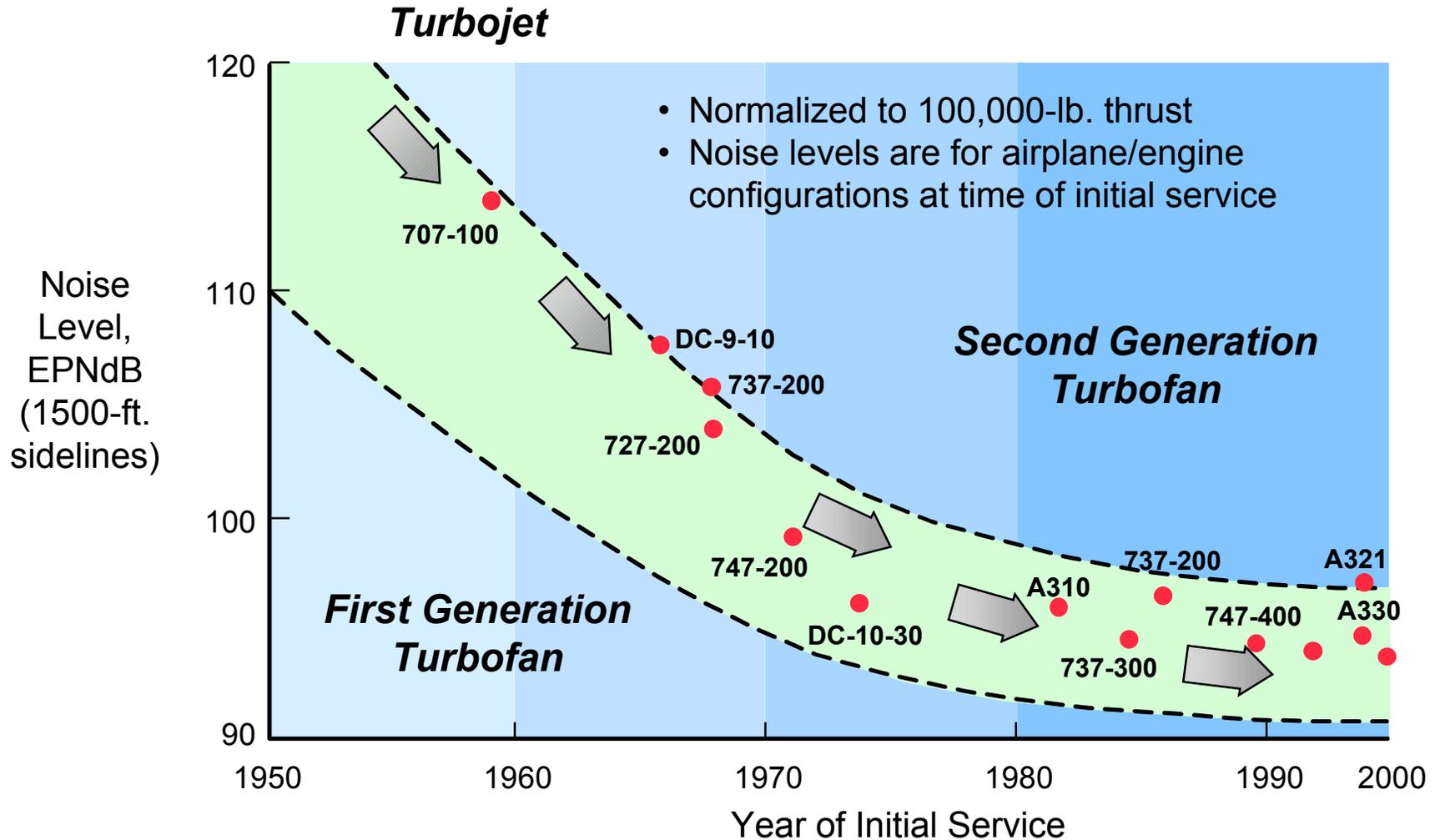


Performance Advancements





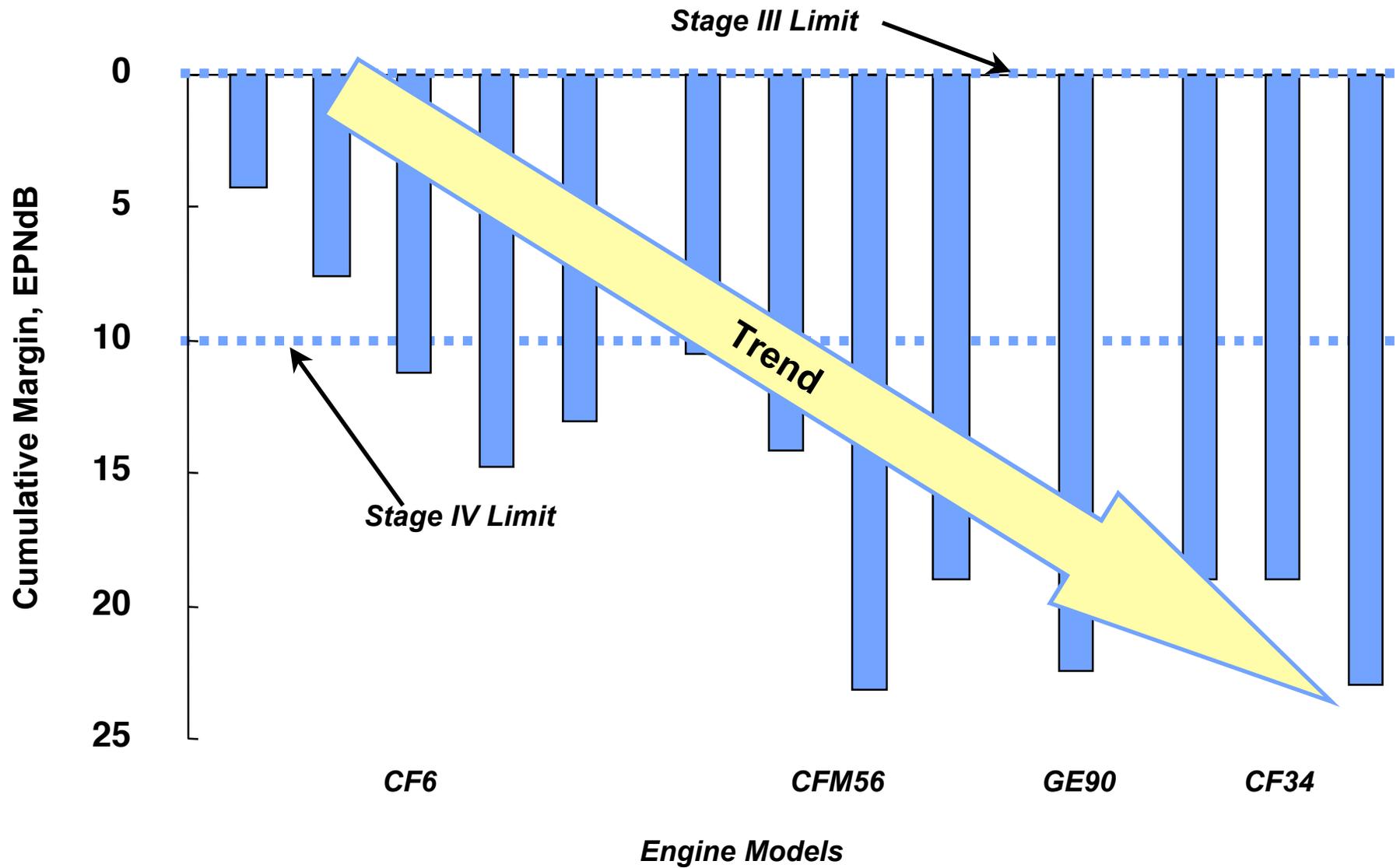
Noise Reduction Advancements



Development of High Bypass Turbofan and Optimization of Rotors/Stators for Acoustics



Emission Reduction Advancement

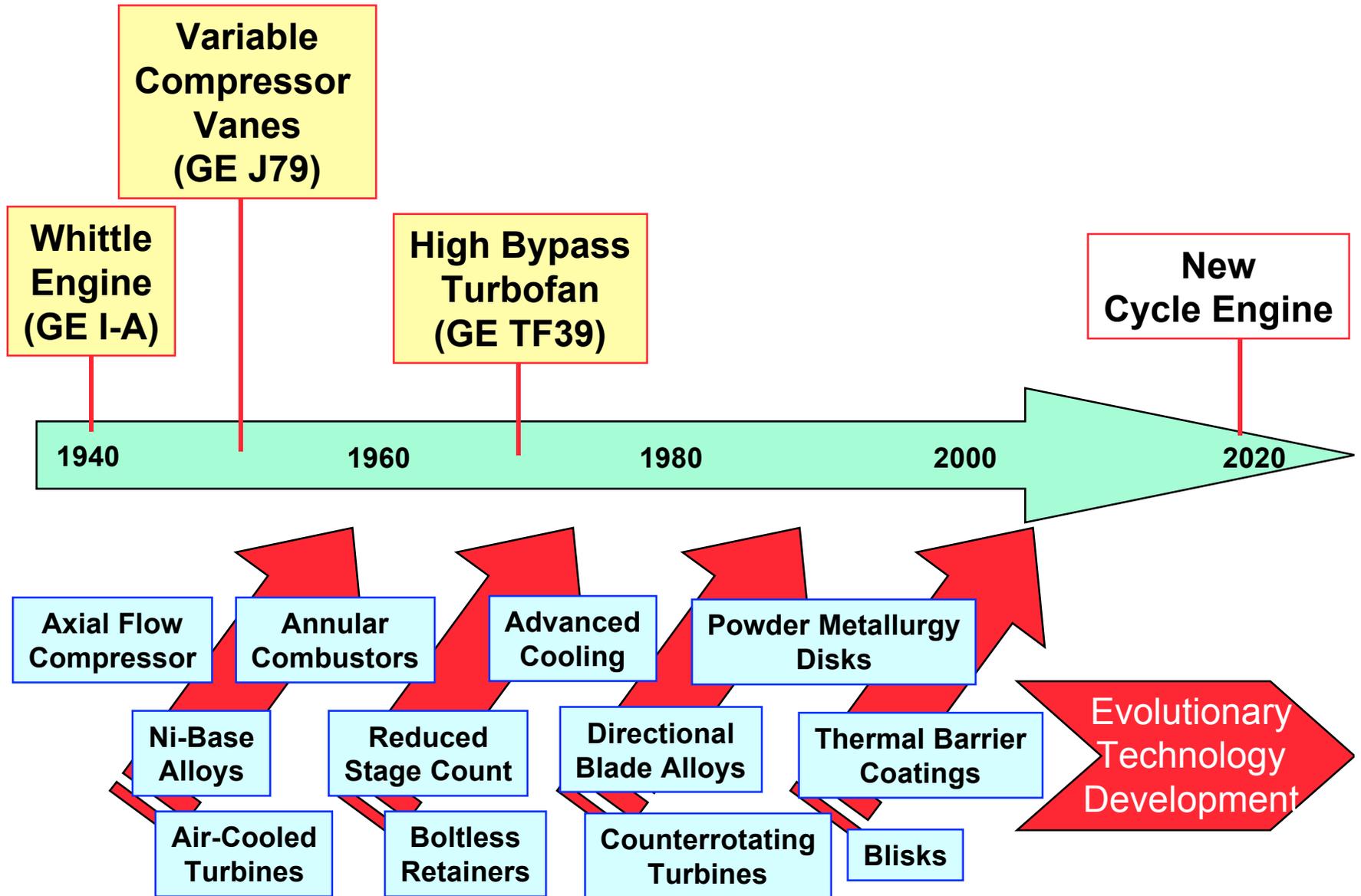




Key Advances in Propulsion

Milestone Technologies

Enabling Technologies





21st Century Vehicle Systems

Safe, Environmentally Friendly, Longer Range Commercial and Military Transportation



Regional



100-150 pax



250+ pax



*Global Reach
Transport*

Overland Capable, Environmentally Friendly, Supersonic Commercial Transport / Military Strike



*Supersonic
BisJet*



*Supersonic
Transport*



*Long Range
Strike Aircraft*



21st Century Vehicle Systems

Heavy-Lift Runway-Independent Aircraft



Apache



V-22 Osprey



High Lift Vehicle

Uninhabited Air Vehicles



Predator



Sensorcraft



21st Century Vehicle Systems

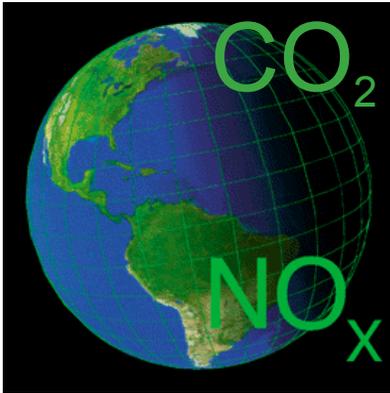
Safe, Low-Cost Access-to-Space Vehicles / Spaceplane





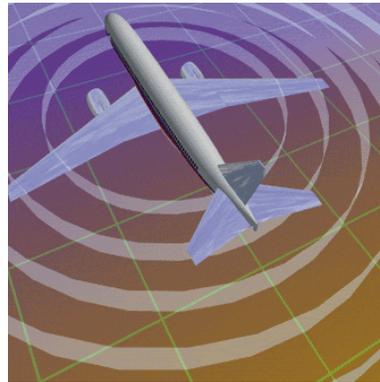
Improved Subsonic Capability

Goals



Performance / Environment

- 20% reduction in fuel burn (CO₂) relative to current technology
- Reliable, durable operation at near stoichiometric turbine inlet temperatures
- 85% reduction in NO_x relative to 1996 ICAO



Noise

- 55% Reduction in noise relative to today's aircraft
- 33 EPNdB below Stage 3



Prognosis/Reliability

- 50% reduction in engine in-flight failures
- 50% reduction in delays and cancellations
- On-condition maintenance

21st Century Aero-propulsion System Preeminence



Supersonic Propulsion Challenges

Commercial

SFC @ M 2.0	1.00
M 2.0 Cruise EI (g NOx/kg fuel)	50%
Cumulative Noise Reduction*	-20dB
Overland Supersonic Capability	

Military

Reduction in Emissions	10%
Safety / Reliability	5X
Affordability Reduction	25%

*Relative to Stage 3 Rules





Access-to-Space Goals

<i>Thrust to Weight</i>	<i>15 to 1</i>
<i>Mission Cost</i>	<i>\$100 per lb. Payload</i>
<i>SFC for Subsonic Return</i>	<i>0.9</i>
<i>Safety flights</i>	<i>1 incident in 10,000</i>





Technology Needs to Achieve Long Range Propulsion Vision

Compression

- High Stage Loading
- Flow Controlled Airfoils
- Core Drive Fans
- Passive & Active Stability
- Composite High Speed Airfoils
- Blisks

Combustion

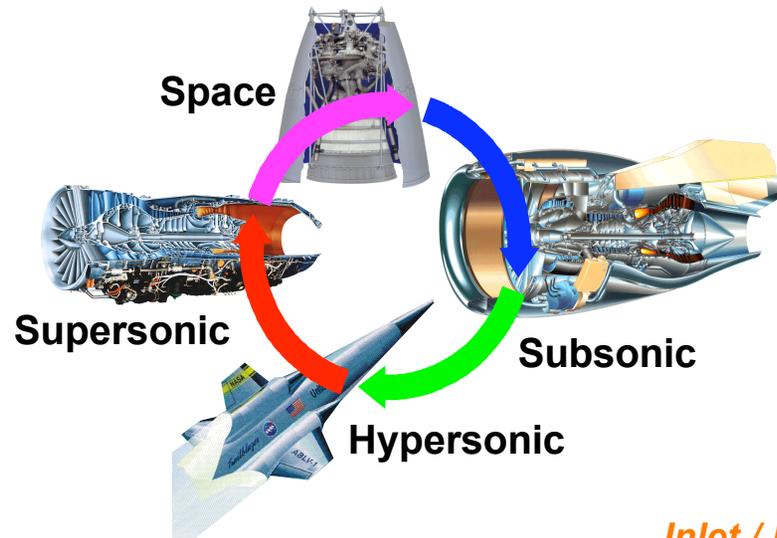
- Low Emission Research
- High Mach Combustion
- High Heat Sink Fuels
- Coke Barrier Coatings
- Active Combustion Control

Controls

- Intelligent Controls
- Distributed Control System
- Prognostic Sensors
- MEMS
- Wireless Communications

Turbines

- Integrated Turbine Blades/Disks
- Advanced Cooling
- Wake/Shock Management
- Clearance Management
- Highly Loaded Aerodynamics



Materials

- High Temp. Ni Alloys
- CMC's
- PMC's
- Nano Structures
- Smart Materials & Structures
- Advanced NDE
- Accelerated Implementation Methods

Modeling

- Physics-based Tools
- Time Unsteady Aero
- Aeromechanics
- CFD Design Tools
- Combustor Codes
- Digital Engine Model
- Noise Prediction Tools
- Manufacturing Modeling

Mechanical Components

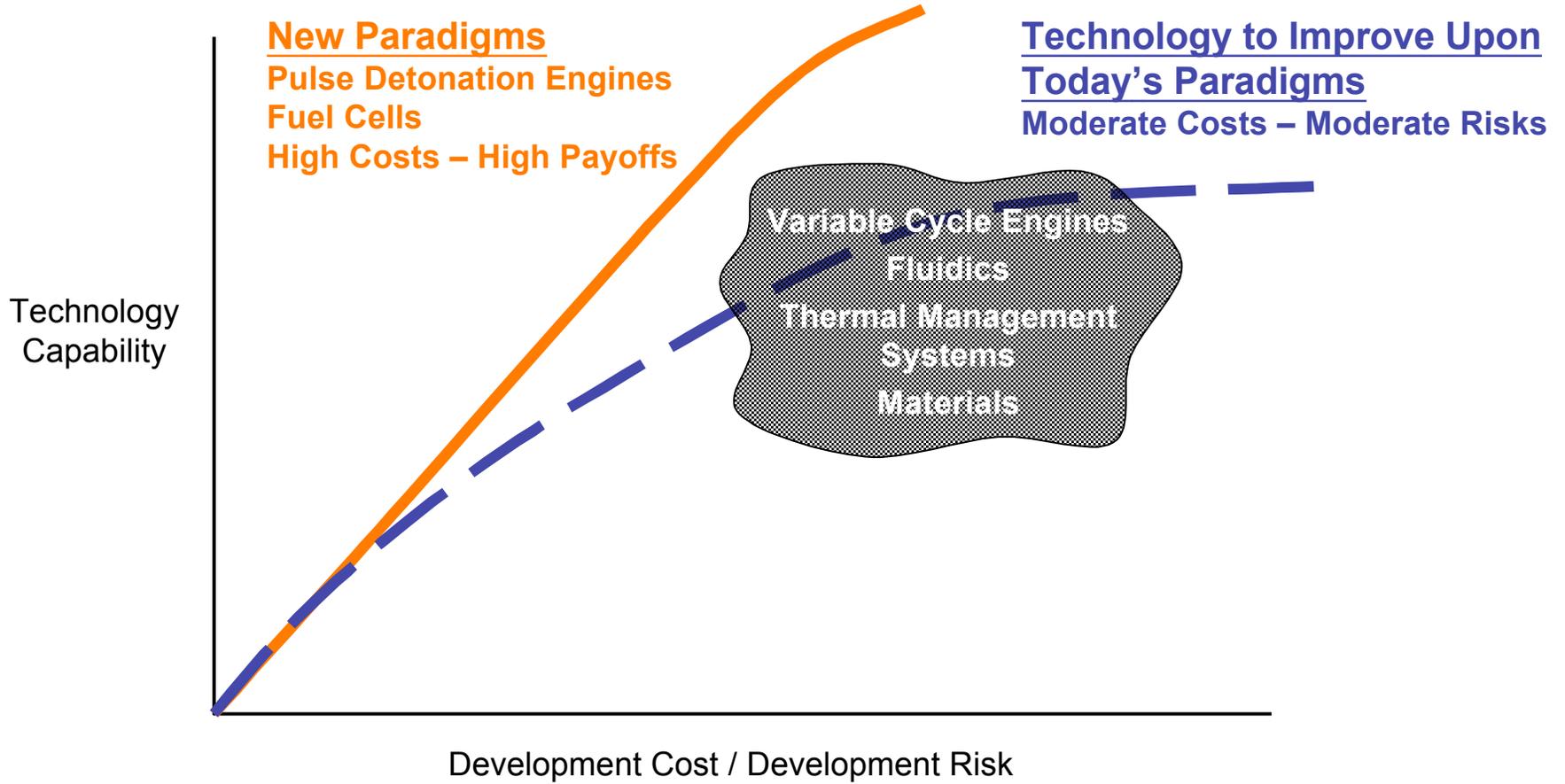
- High DN Bearings
- Magnetic Bearings
- Air-Oil Brush Seals

Inlet / Nacelle/ Nozzle

- Light Weight Structures
- Integrated Airframe/Engine Structures
- TiAl Structures
- Fluidic Mixing
- Fluidic Vectoring

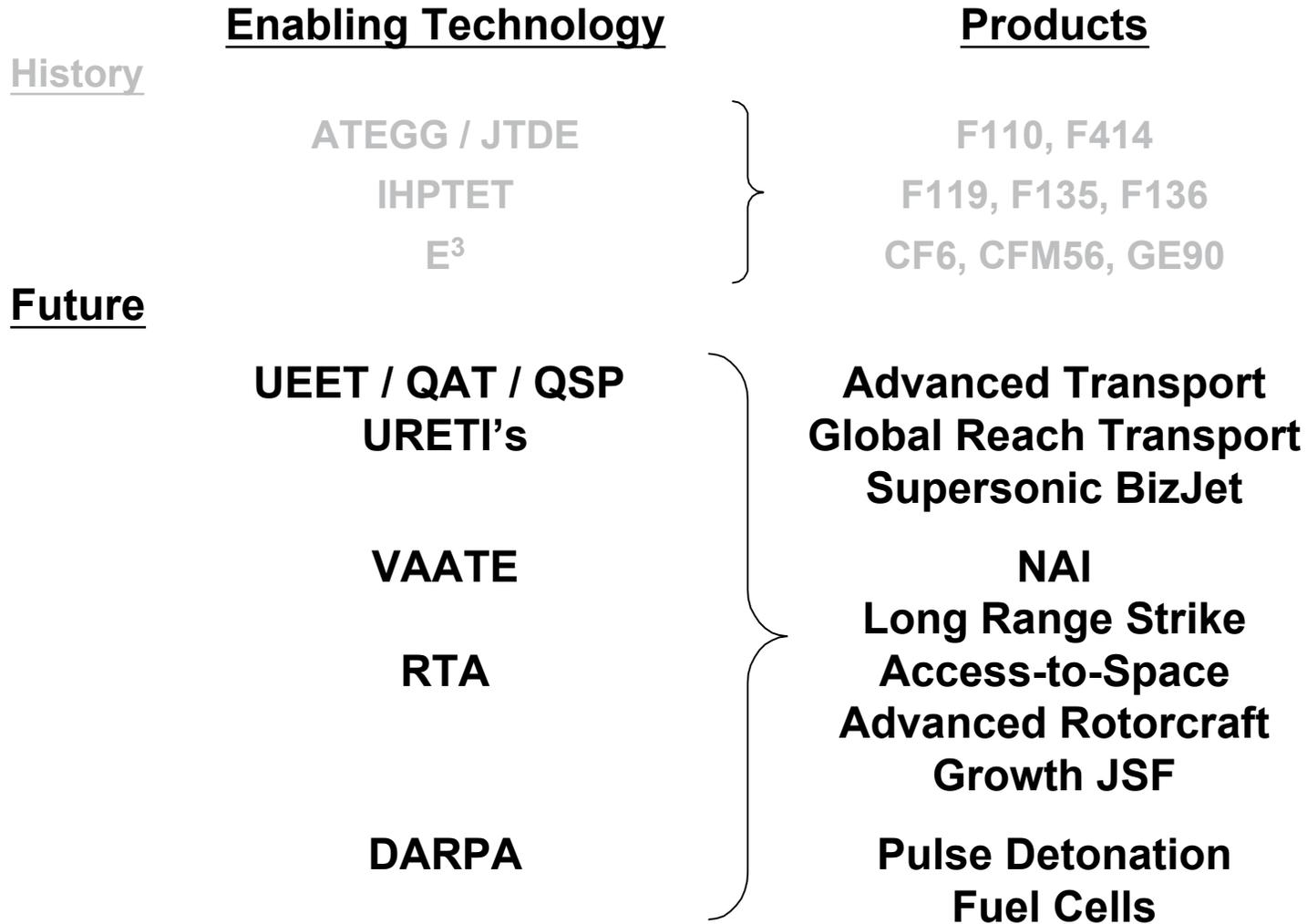


Investing In Technology





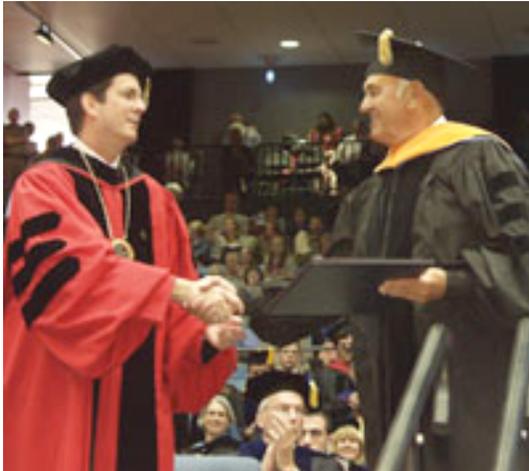
Investment Recommendations



***Adequate Funding in Enabling Technologies
Key to Continued U.S. Aerospace Preeminence***



Propulsion Vision for the 21st Century



Academia



Honeywell



Industry

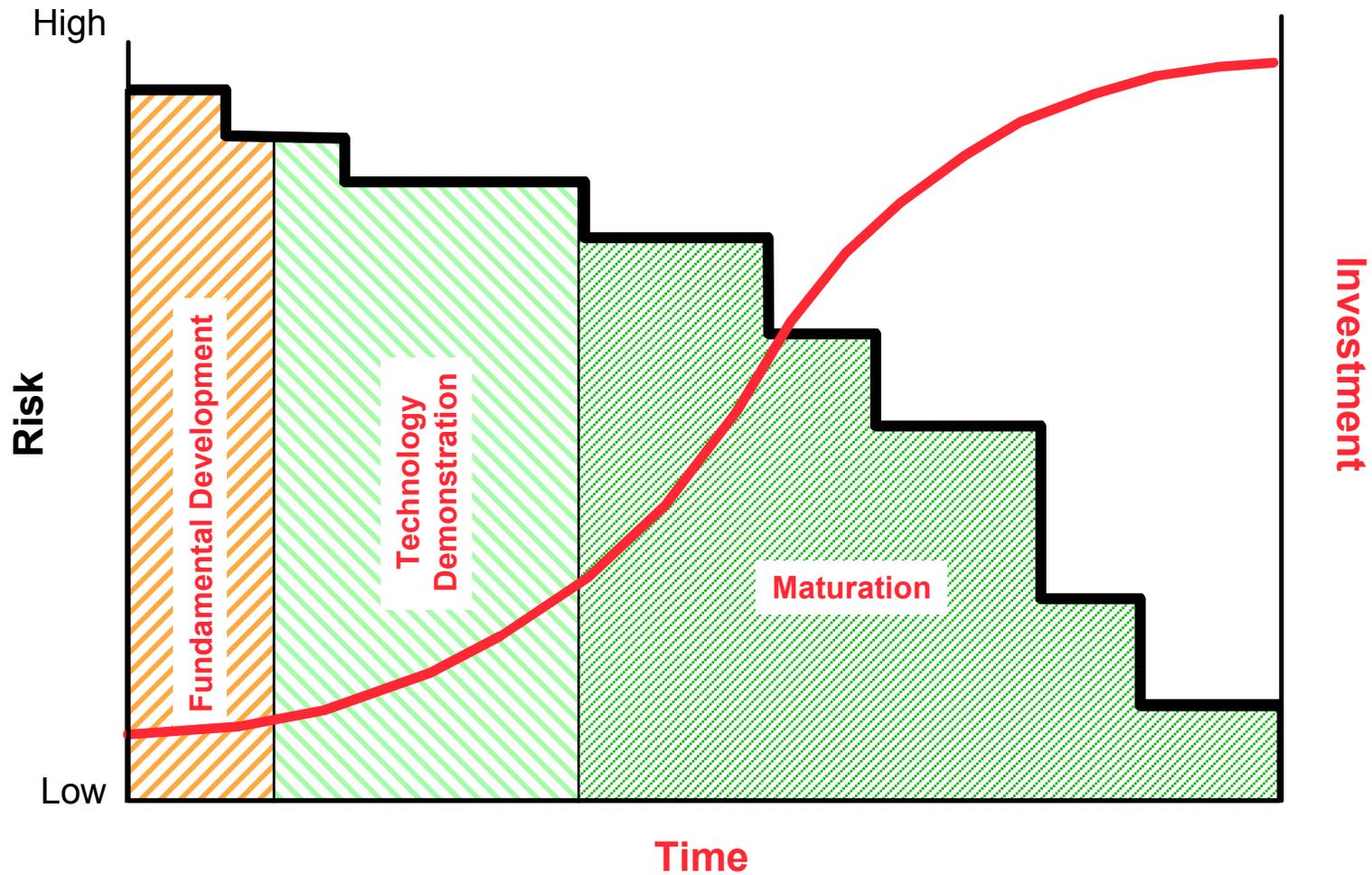


Government

Key to Success is Strong Cooperation Between Academia, Industry, and Government Agencies



Industry / Government S&T Investment ...



... Positioning for the Future



Summary

- **U.S. Aerospace industry provides export leadership, military superiority, and clean, fuel efficient aircraft**
- **Aerospace R&D is the basis for leadership role**
- **Future trends: faster, environmentally friendly, safe aerospace systems**
- **Propulsion key contributor to aerospace superiority**
- **Significant propulsion growth opportunities ahead**
- **Alternate propulsion concepts must be researched**

***Consistent, Steady, S&T Funding Needed
for Research / Maintain Intellectual Capital***