Propulsion Training System

PTS Login

November 16, 2006

Reason: **Jet Engine Symposium 2006**

User ID: **Konstantino Kouris**

Position: **P&W Engineering Manager F100**

Password: **********

Module: **Systems**

Systems Training Modules

Select Module

- ❑ PW1024 Rotor dynamics basic
- ❑ PW1025 Rotor dynamic advanced
- ❑ PW3204 Secondary flow fundamentals
- ■ PW1030 Propulsion integration
- ❑ PW1043 Weapon system integration
- ❑ PW5465 Systems requirements doc.
- ❑ PW3100 Thermal mgmt foundation
- ❑ PW3101 Thermal management design
- ❑ PW3310 Fuel system fundamentals
- ❑ PW3311 Fuel system advanced design
- ❑ PW1010 System design fundamentals
- ❑ PW1020 Performance analysis fundamentals
- ❑ PW1030 System validation 101
- ❑ PW3210 Heat transfer basics
- ❑ PW3211 Heat transfer – HPC
- ❑ PW3212 Heat transfer – HPT
- ❑ PW4100 Control system design
- ❑ PW4103 Control architectures

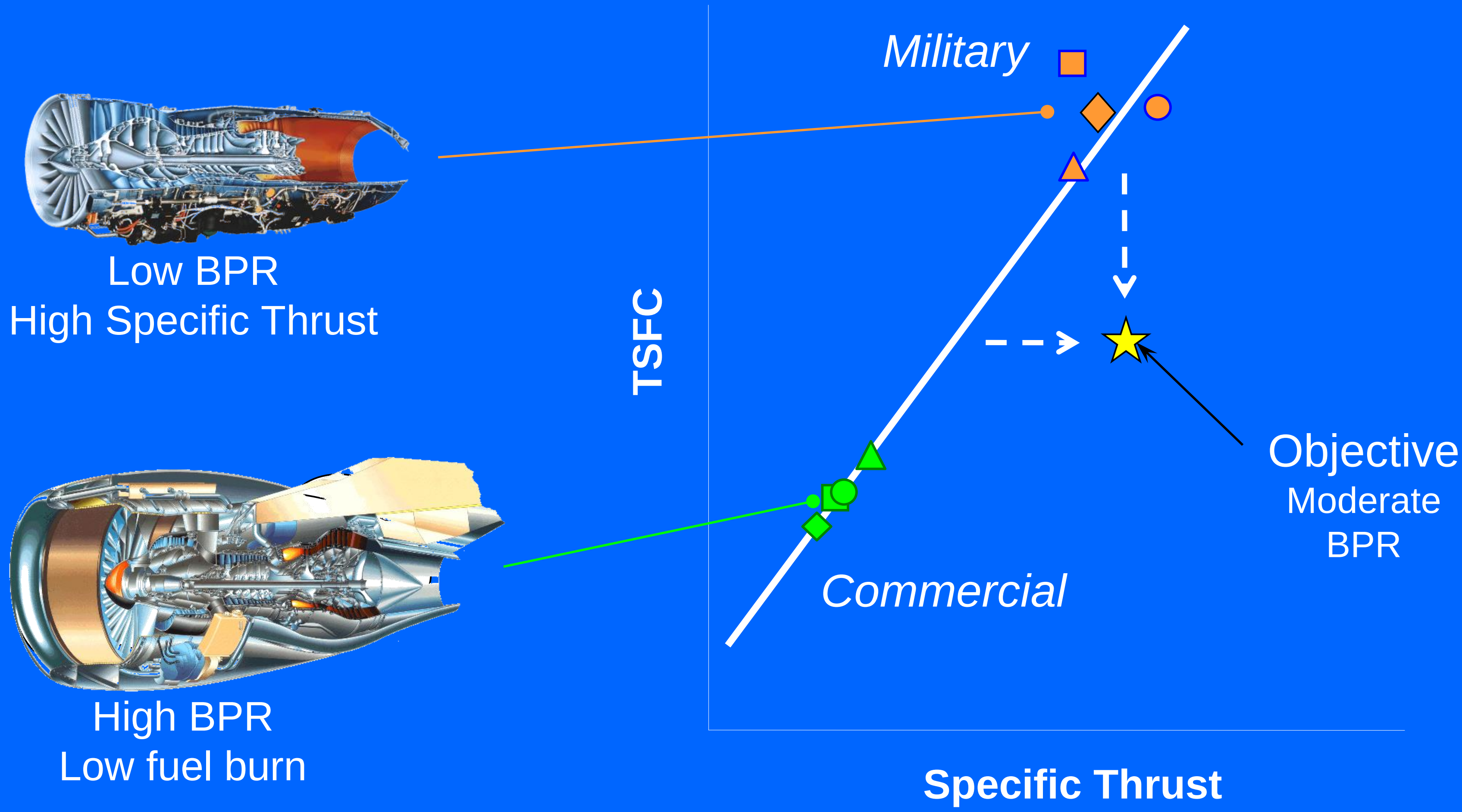
< Previous page / Next page >

PW1030 – UAV Propulsion Integration

Conflicting capabilities desired

- Persistence
- Survivable
- Affordable – size

Propulsion Performance Dilemma



Propulsion Buried Installation Conundrum

Highly Survivable Installation

- Diameter Constraints
- Higher Specific Thrust

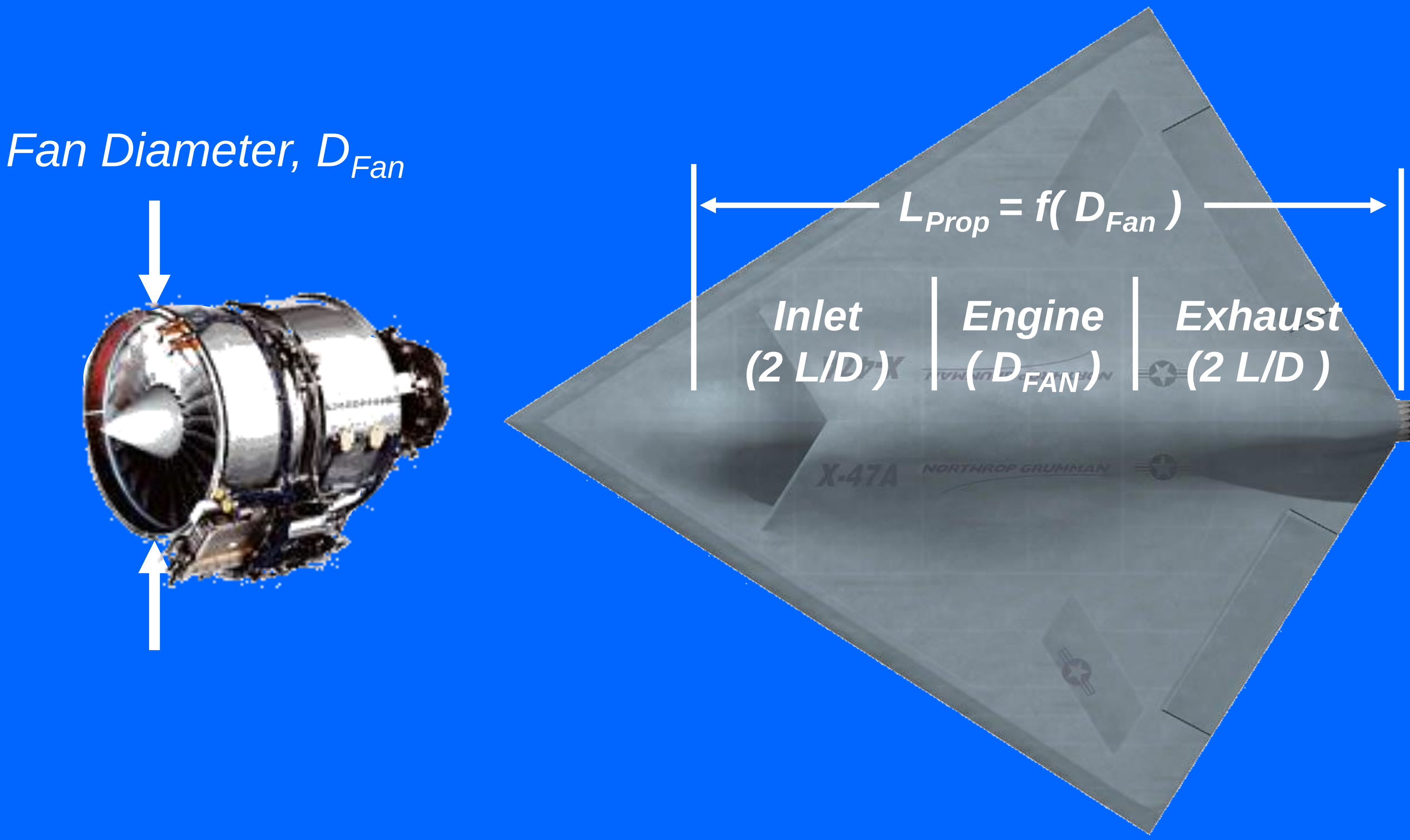
Low Propulsive Efficiency ≠ Low Fuel Burn

High Efficiency Installation

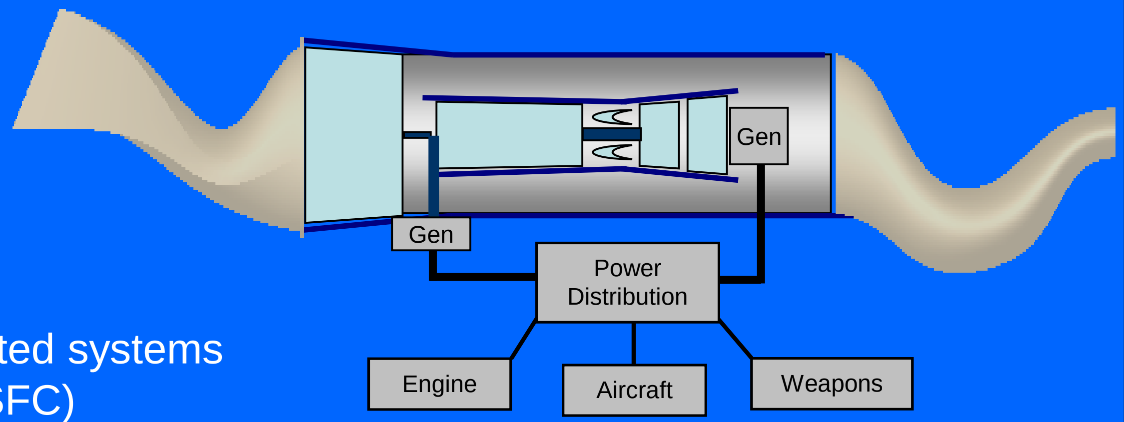
- Low loss inlet & exhaust
- Moderate BPR cycle

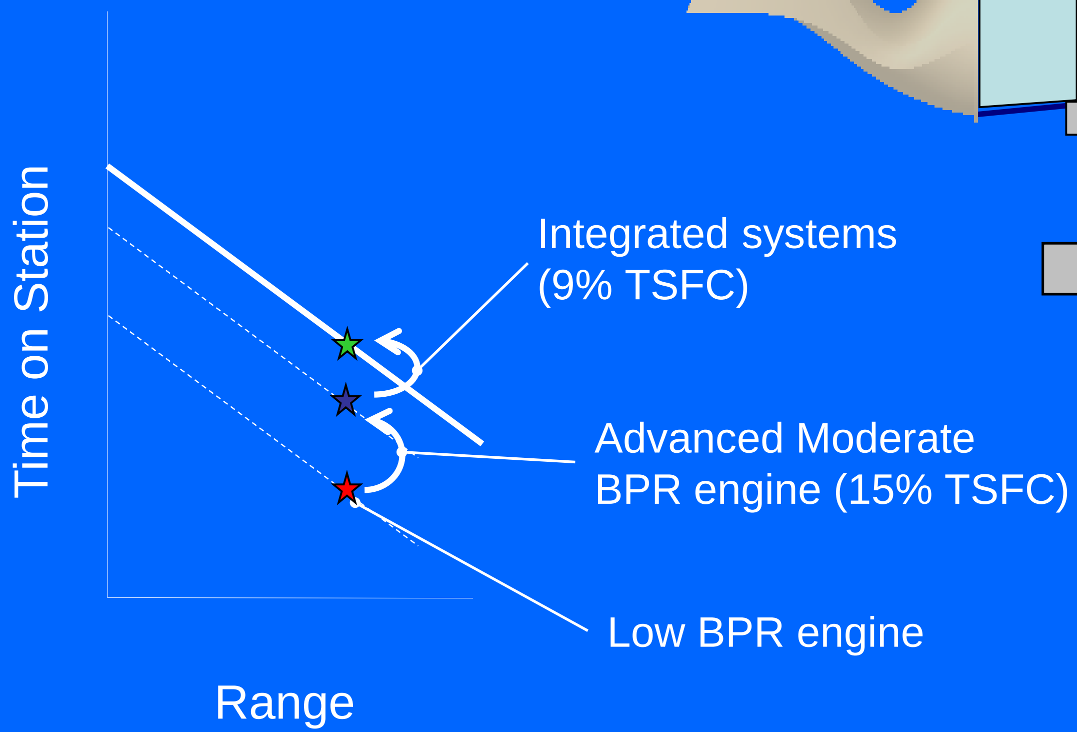
Propulsion Packaging Impact

Vehicle Size Driven by Embedded Engine Diameter

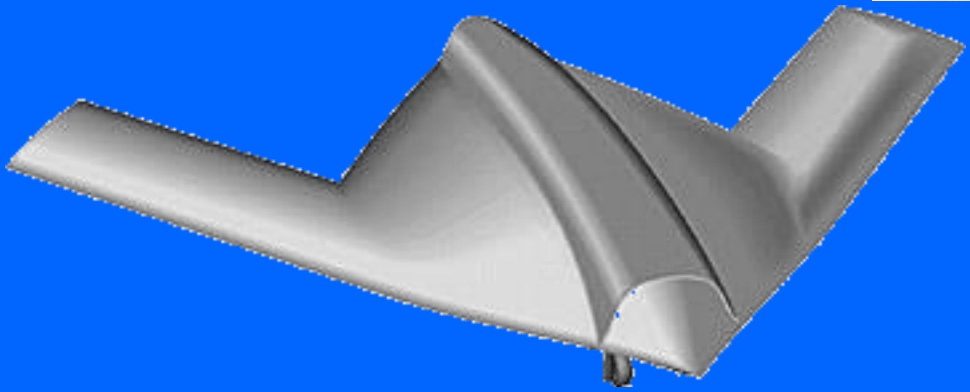


Integrated Subsystems Benefit





PW1030 Course – Assignment

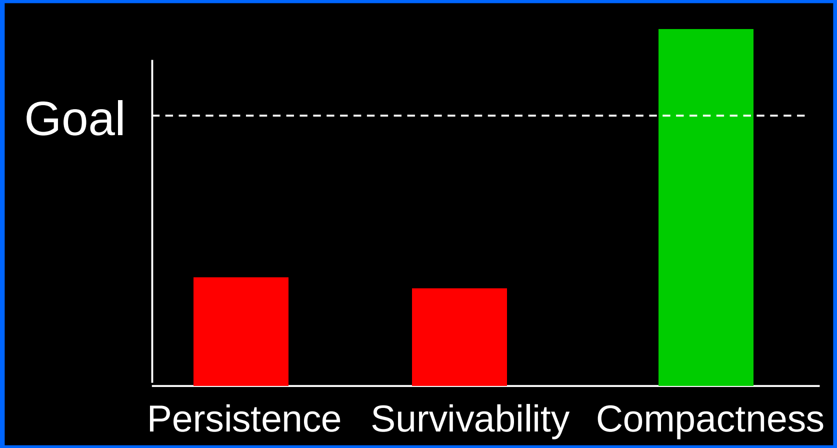


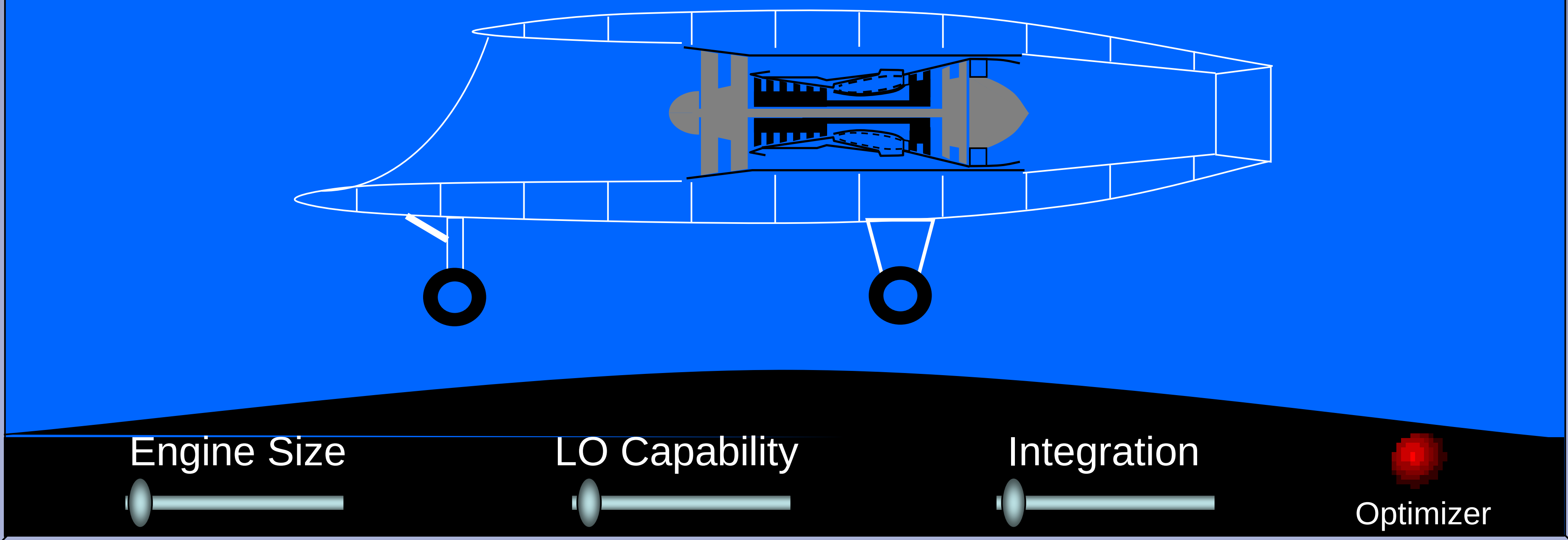
Design a UCAV embedded propulsion system with:

- Maximum persistence
- High Survivability
- Compact Installation (for affordability)

Initial Configuration selected:

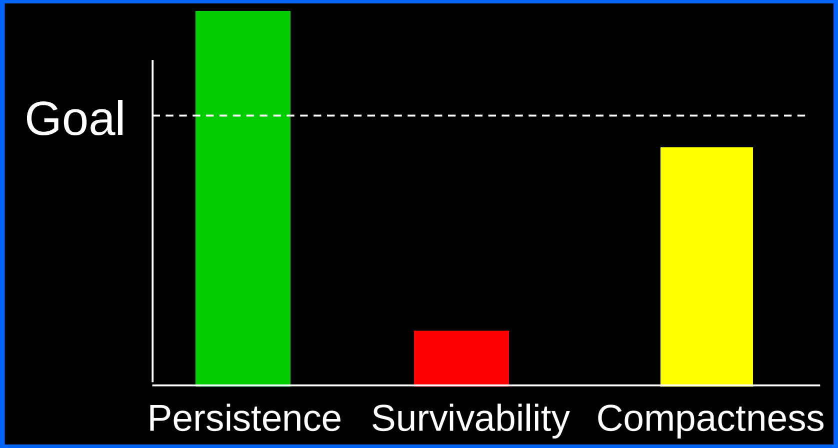
- Low BPR installation provides high specific thrust

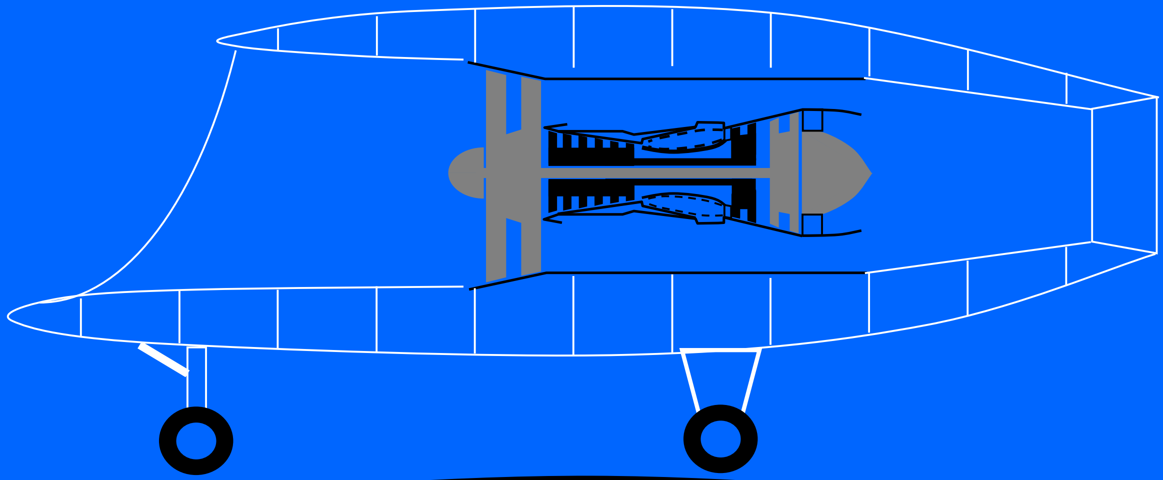


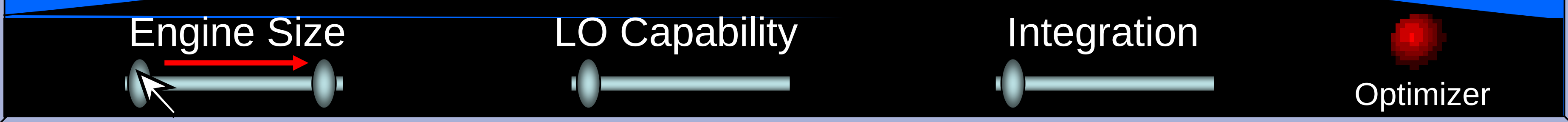


Configuration selected:

- High BPR installation for persistence

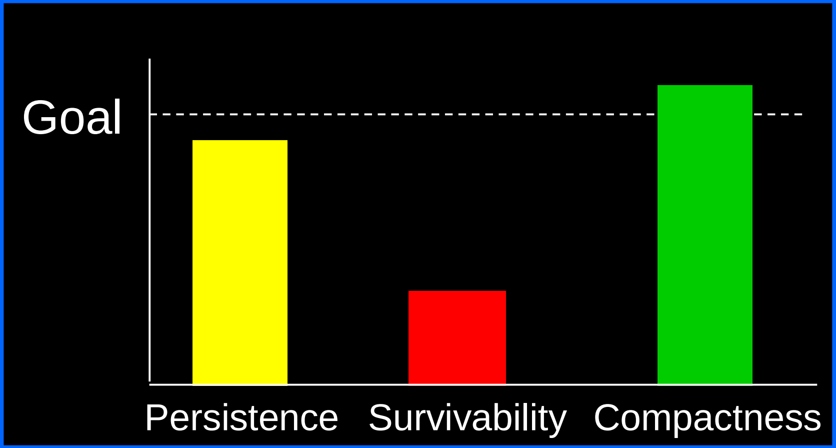


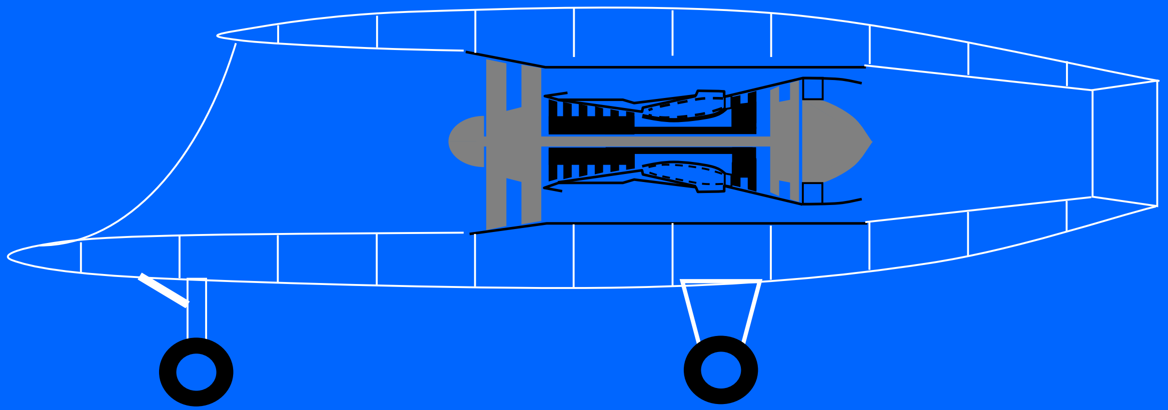


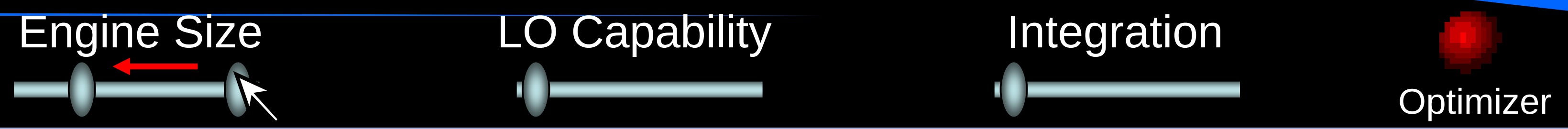


Configuration selected:

- Moderate BPR installation for size reduction

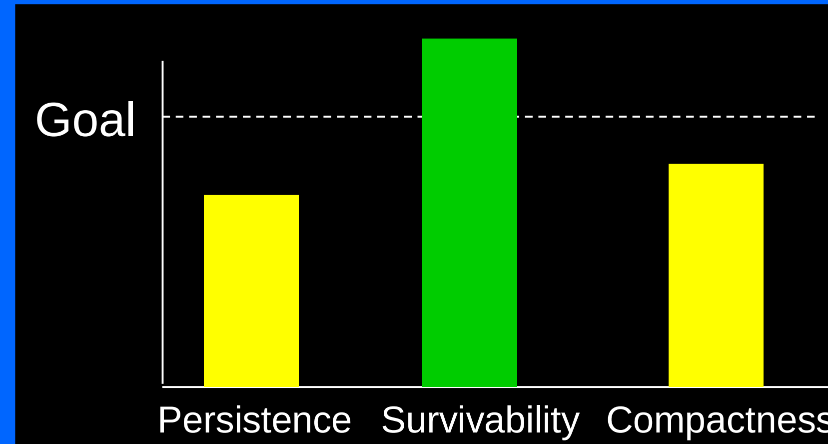


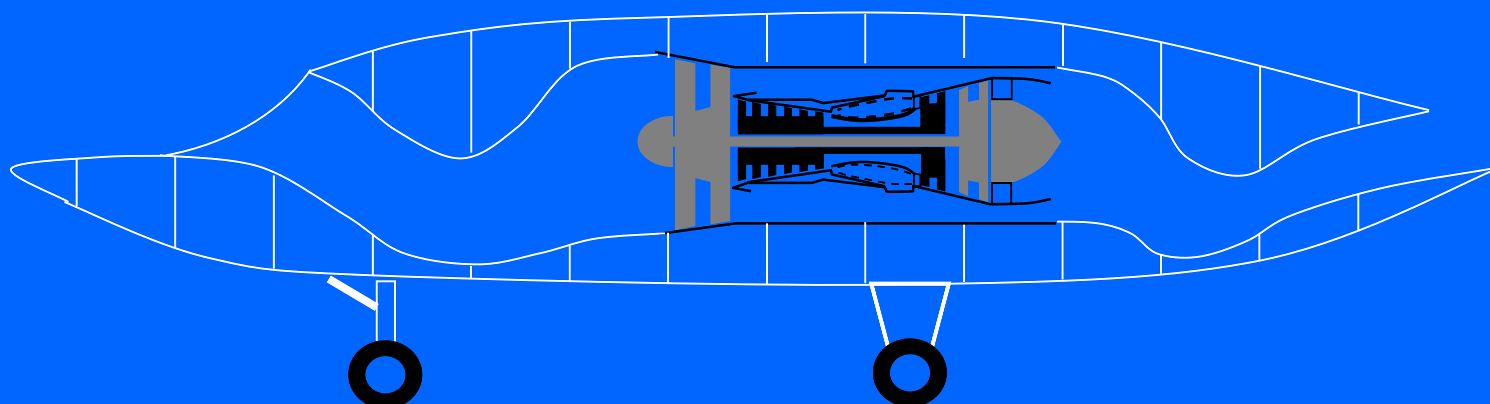




Configuration selected:

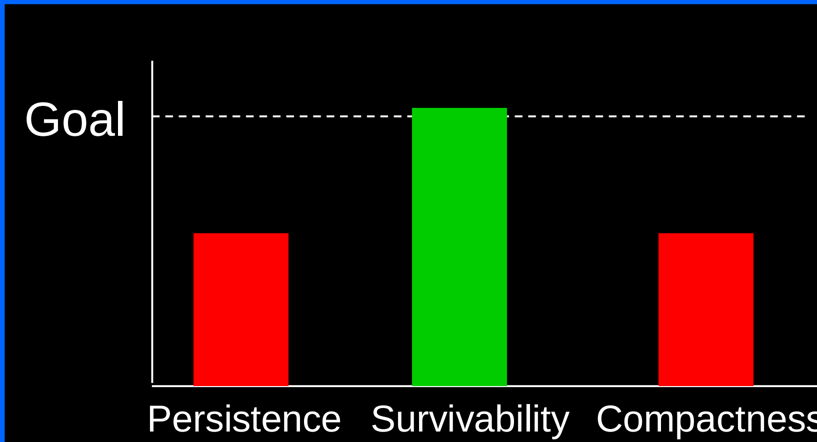
- **LO inlet and exhaust systems for survivability**

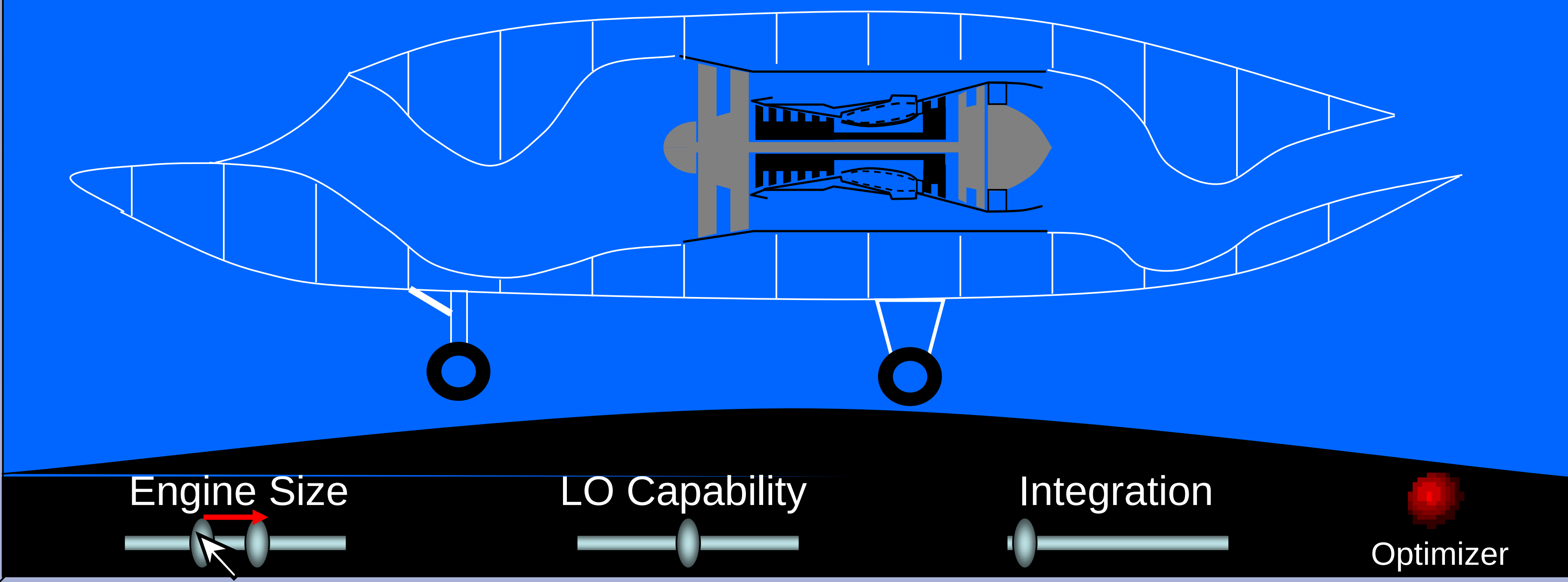




Configuration selected:

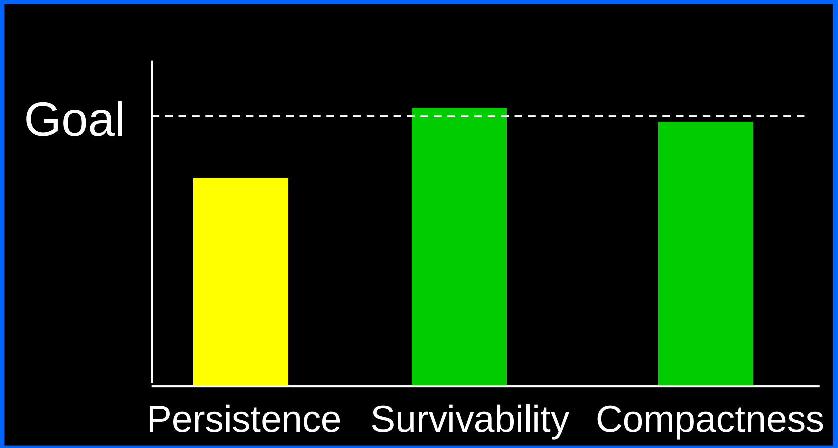
- **Engine size increased to offset LO performance losses**

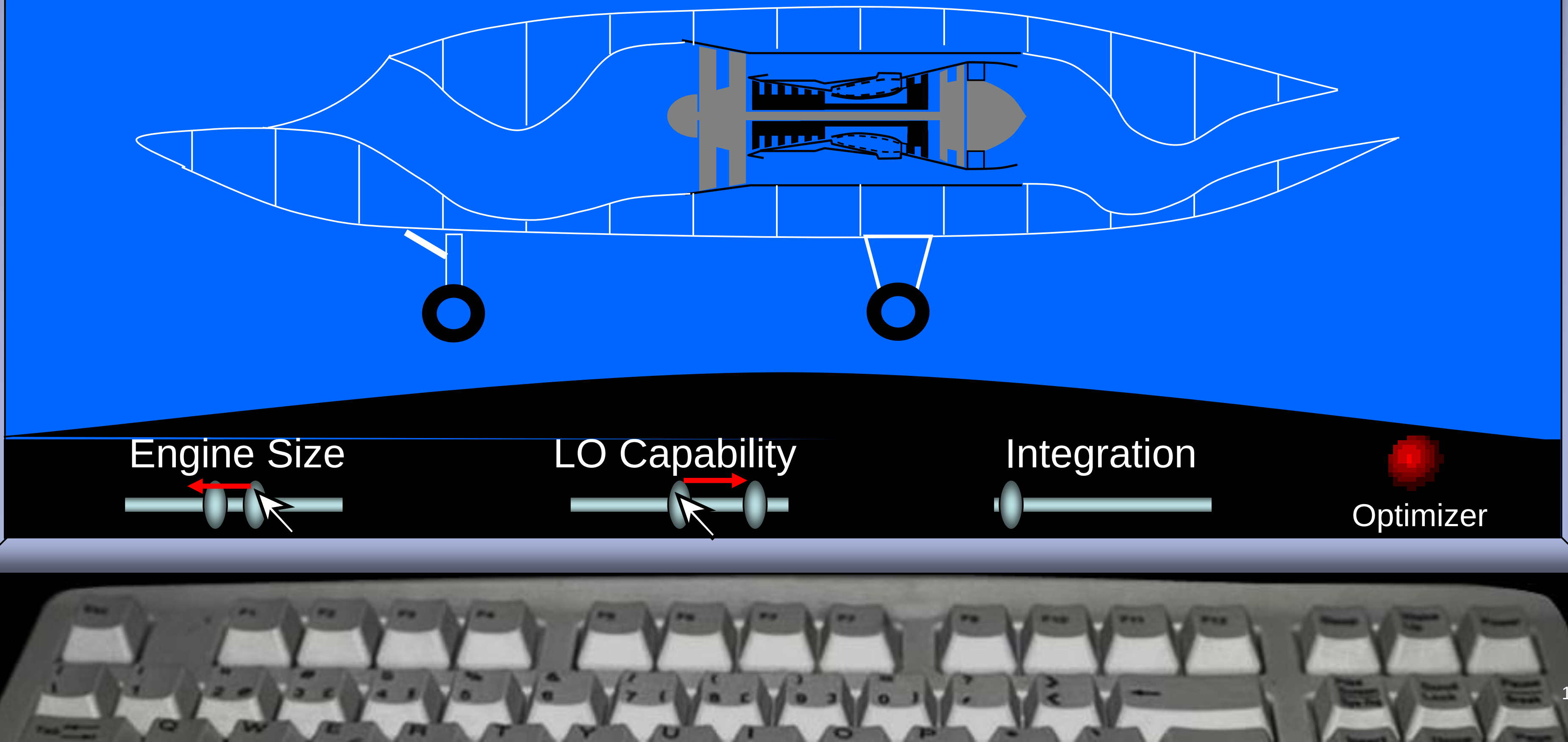




Configuration selected:

- Engine size reduced with application of low loss LO technology





Configuration selected:

- Subsystem integration coupled with an advanced derivative engine improves pe

Congratulations

You met all the parameters

Solution:

- Moderate BPR engine derivative
- Integrated engine, inlet & exhaust systems
- Integrated vehicle subsystems architecture

Engine Size

LO Capability

Integration

Optimizer

PW1030 Propulsion Integration – Test

Questions

True	False	
☑	❑	1. UCAVs have mutually conflicting requirements
☑	❑	2. Survivability significantly drives propulsion system design
☑	❑	3. OTS Commercial engine cannot meet UCAV requirements
☑	❑	4. Derivative moderate BPR engine best meets capability
☑	❑	5. Integrated Vehicle & Propulsion systems improve persistence
☑	❑	6. Engine and LO technology is key to meeting goals

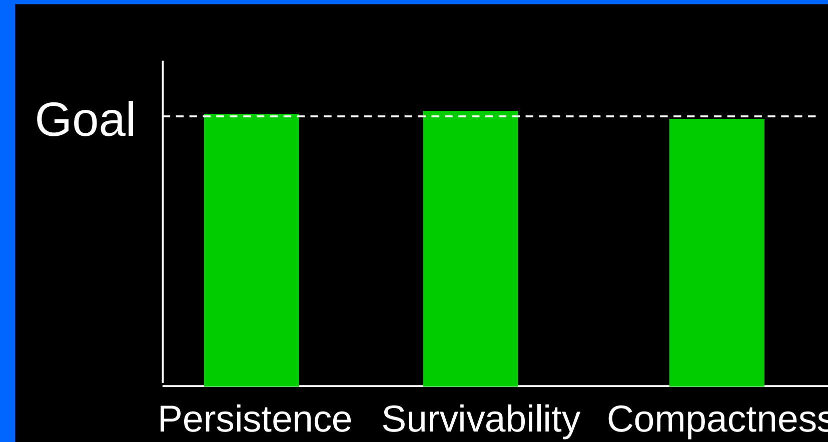
Your score: 6 out of 6 questions answered correctly

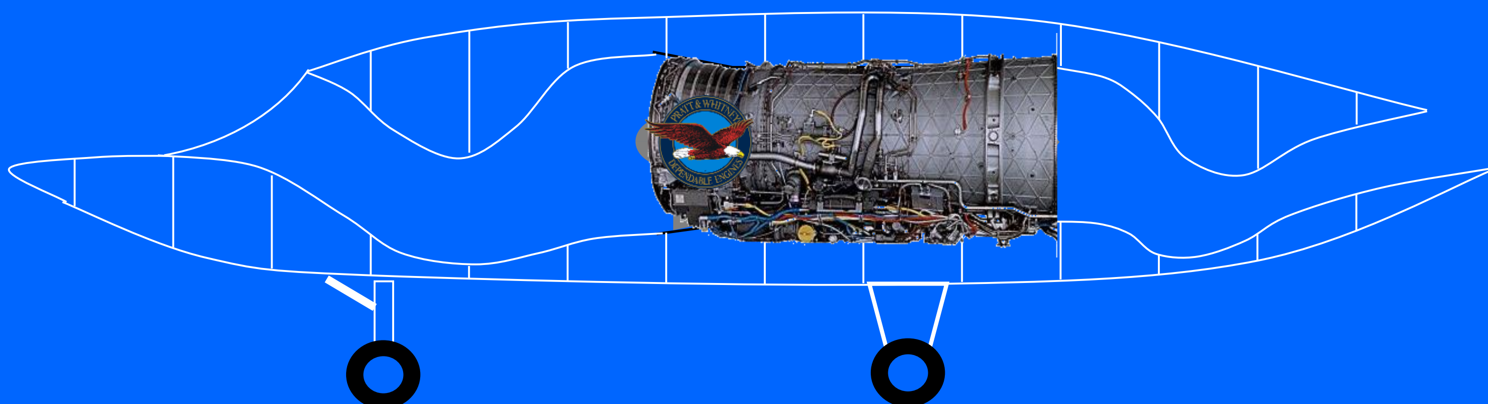
Your training records will automatically be updated

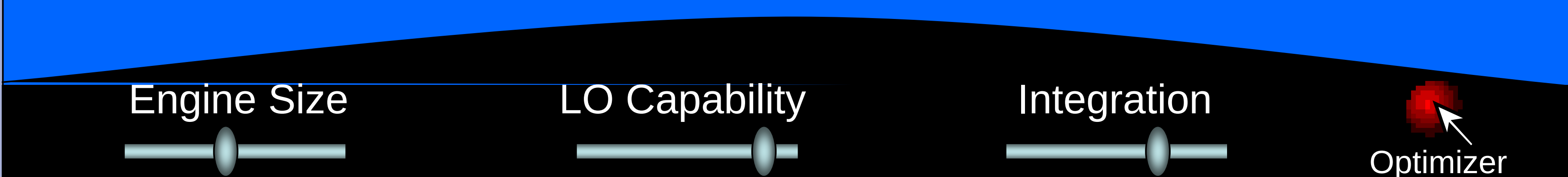
Note: Proceed to the next slide and click on the optimizer button to see the best solution

Configuration selected:

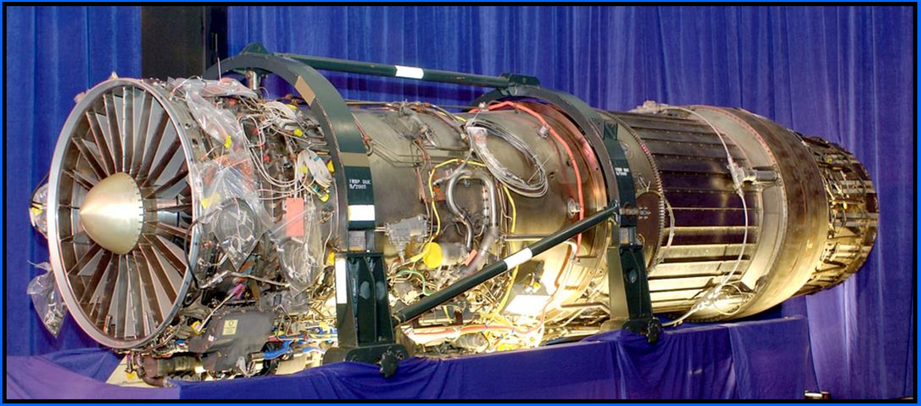
- **Pratt & Whiney integrated propulsion systems**







X-47B Propulsion – F100-PW-220U Engine



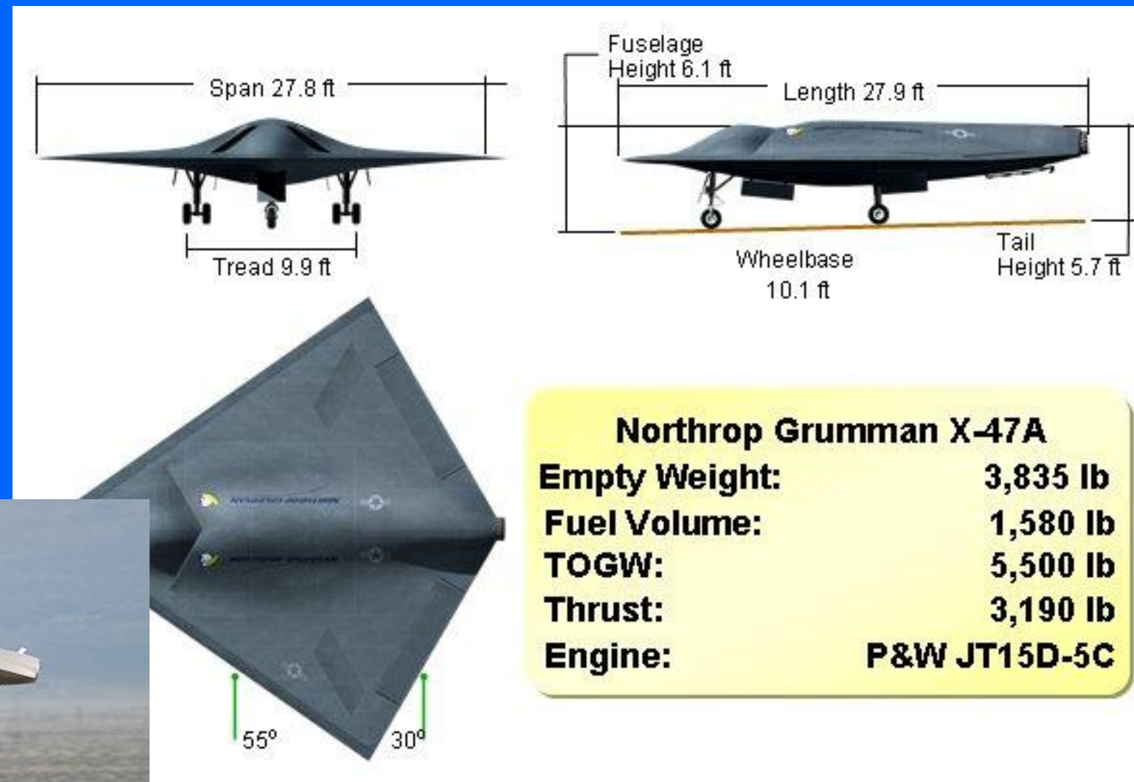
F100-PW-220

- **Unmatched Single Engine Safety**
- **Worldwide Basing Supportability**
- **Excellent Reliability**

- **Type:** Twin-Spool, Non-Augmented Turbofan
- **Thrust:** 16,000 lb Uninstalled Dry Thrust
- **Compression:** Twin Spool, Axial Flow, Moderate Bypass Ratio
  3 Stage Fan, 10-Stage Compressor
- **Combustor:** Annular
- **Turbine:** 2-Stage High-Pressure Turbine
  2-Stage Low Pressure Turbine
- **Nozzle:** Non-Augmented INC

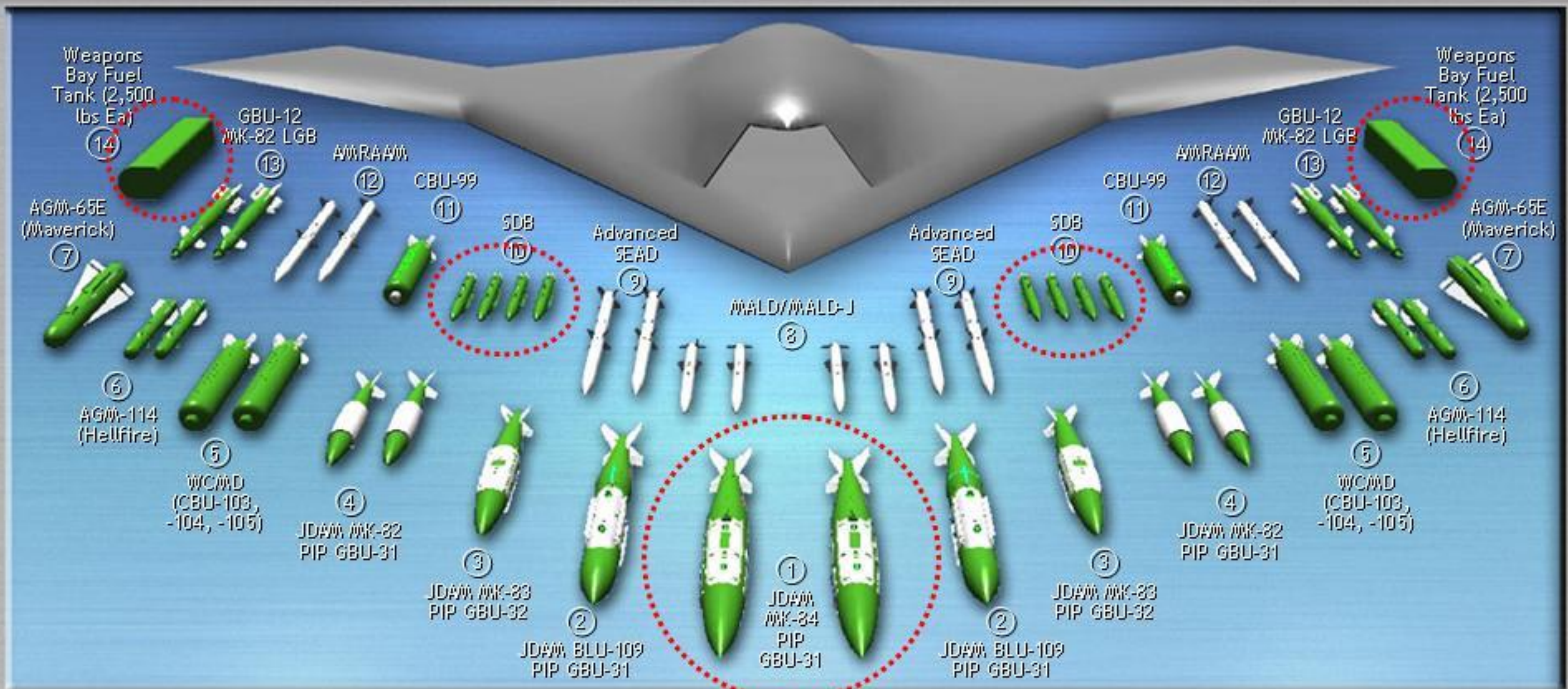
Unmanned Demonstrator Vehicles

Northrop Grumman X-47A



X-47A First Flight February 2003

X-47B Potential Weapon Carriage (4,500 lb Payload)



No.	Weapon	Qty	No.	Weapon	Qty	No.	Weapon	Qty
1	JDAM MK-84 PIP GBU-31	2	6	AGM-114 (Hellfire)	4	11	CBU-99	2
2	JDAM BLU-109 PIP GBU-31	2	7	AGM-65E (Maverick)	2	12	AMRAAM	4
3	JDAM MK-83 PIP GBU-32	2	8	MALD/MALD-J	4	13	GBU-12 MK-82 LGB	4
4	JDAM MK-82 PIP GBU-31	4	9	Advanced SEAD	4	14	Wpns Bay Fuel Tank	1-2
5	WCMD (CBU-103, -104, -105)	4	10	Small Diameter Bomb	8			

Assessing Relative Persistence Capability

Alternative Near- to Medium-Term Surveillance-Strike System Types

System Performance Characteristics	Notional Manned Systems				Unmanned Combat Air System**
	Strike Fighter	Fighter Bomber	Sustained Supersonic Ftr-Bomber	Bomber	
Cruise Speed (kts)	460	460	860	460	460
Unrefueled Range (NM)	1,500	3,300	3,300	5,500	3,700
Vehicle Endurance Limit	N/A*	N/A*	N/A*	N/A*	50
Sustainable Aircrew Total Mission Endurance (hrs)	10	10	10	30	N/A
Aircrew Combat Endurance (hrs)	10	10	10	10	N/A

Aircrew endurance constraints preclude manned aircraft surpassing system endurance limits

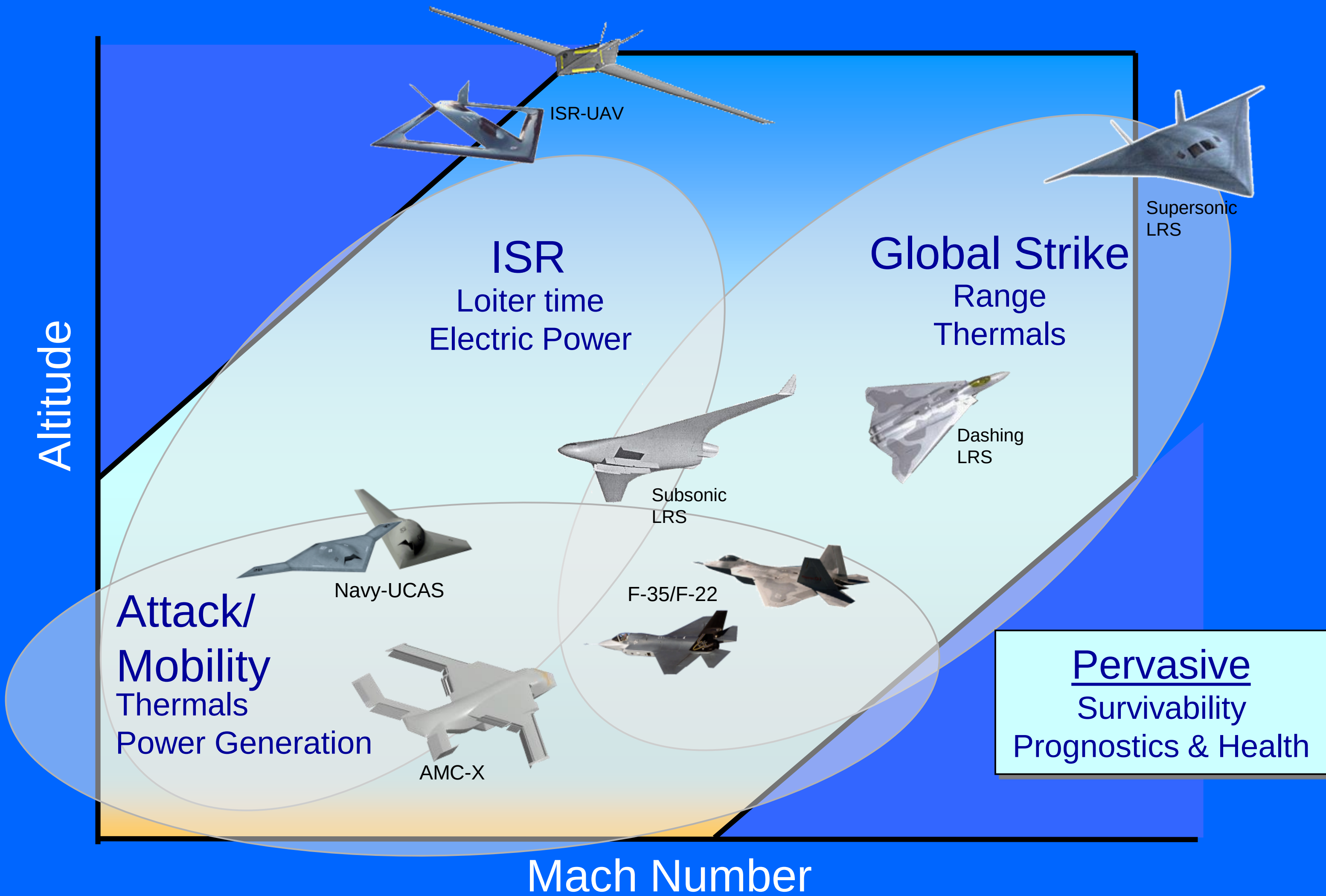
***Approximates projected performance of X-47B demonstration system – a robust precursor for TBD USAF/USN operational systems*

UCAS PERSISTENCE

PUBLIC RELEASE

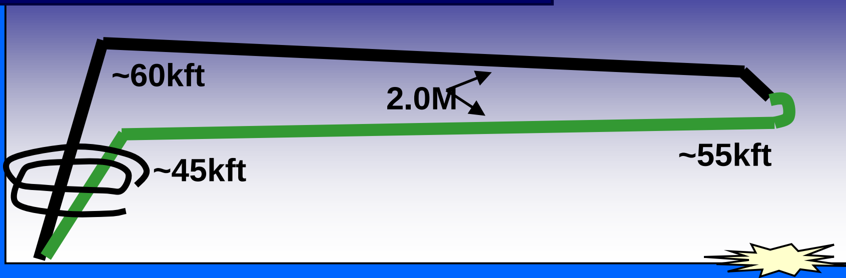
Approved for Public Release Case # 2143 - Distribution A

21st Century "Airspace" *Capability-Based Future*

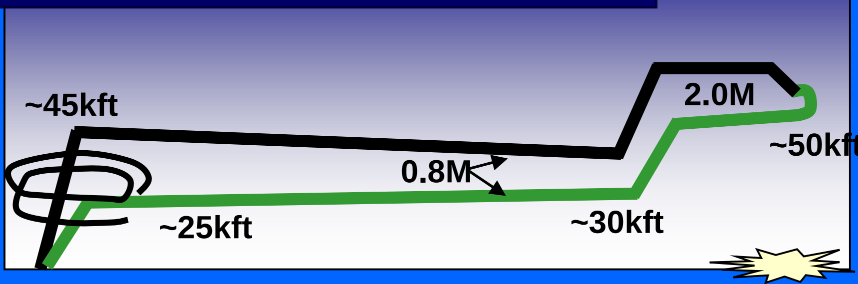


Navy-UCAS Persistence Demanding Longer Life

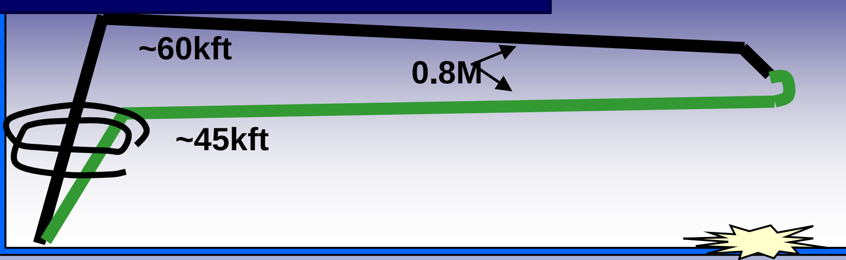
All Supersonic M2.0 Mission



200nmi Supersonic Dash Mission



All Subsonic M0.8 Mission



Current State:

- Fighter designed engine base
- Fighter Engine Life Perspective ~2000hrs
- Mixed T4 mission
- Years between overhaul

Unmanned ISR Impact:

Navy-UCAS ISR mission
Assume:
COD 14 hour missions (commercial-like!)
Life ~2000 hrs (fighter engine base)

Overhaul required every 140 days!!

Technologies need to:

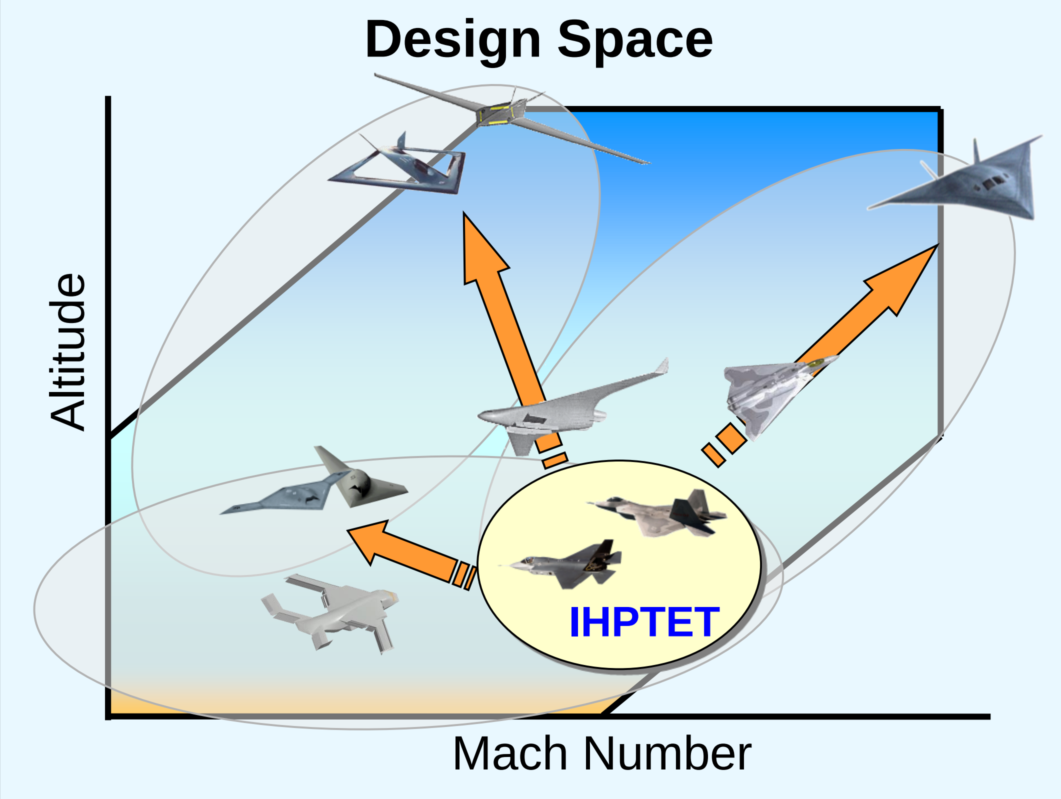
- Approach Commercial Life capability
- At military operational temperatures
- Provides ~4 years continuous duty

Public Access Data

Technology Challenges

Expand Design Space Into Integrated Vehicle-level Systems

Future Capabilities Mandate Cross-Cutting Propulsion Technologies



- High Temperature Durable Cores*
- Flow Controlled Inlet Systems
- Integrated Propulsion and Power
- Integrated High Temperature Fuel Thermal Management Systems
- Adaptive Engine Controls
- High Specific Flow Aerodynamics
- Advanced Materials
- Next Generation LO
- Prognostics and Health Management*

* Special emphasis for UAV's

21st Century Turbofan Propulsion Challenges

Future Capabilities Require:
Vehicle-integrated Derivative Propulsion Systems

- **Integrated thermal systems** are critical for *global strike* range capability
- **Integrated electric power systems** enable *persistent ISR* loiter capability
- Propulsion **integrated inlet & exhaust systems** are key to performance and *survivability*
- **Derivative engine systems** provide *affordable* propulsion approach

NAVY VIDEO

Click here