"New Developments for Military Jet Engines"

The 7th Israeli Symposium on Jet Engines

Technion - Israel Institute of Technology, Haifa, Israel

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Lars Seumenicht, Rolls-Royce Deutschland, Germany

Future Market trends – Stealth

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Our four markets

Power systems for:

Civil Aerospace	Defence Aerospace	Marine	Energy
			
Wide-bodied jets *Narrow-bodied jets* *Corporate & Regional*	*Military aircraft* *Helicopters*	*Commercial* *Naval*	*Oil & Gas* *Power generation*

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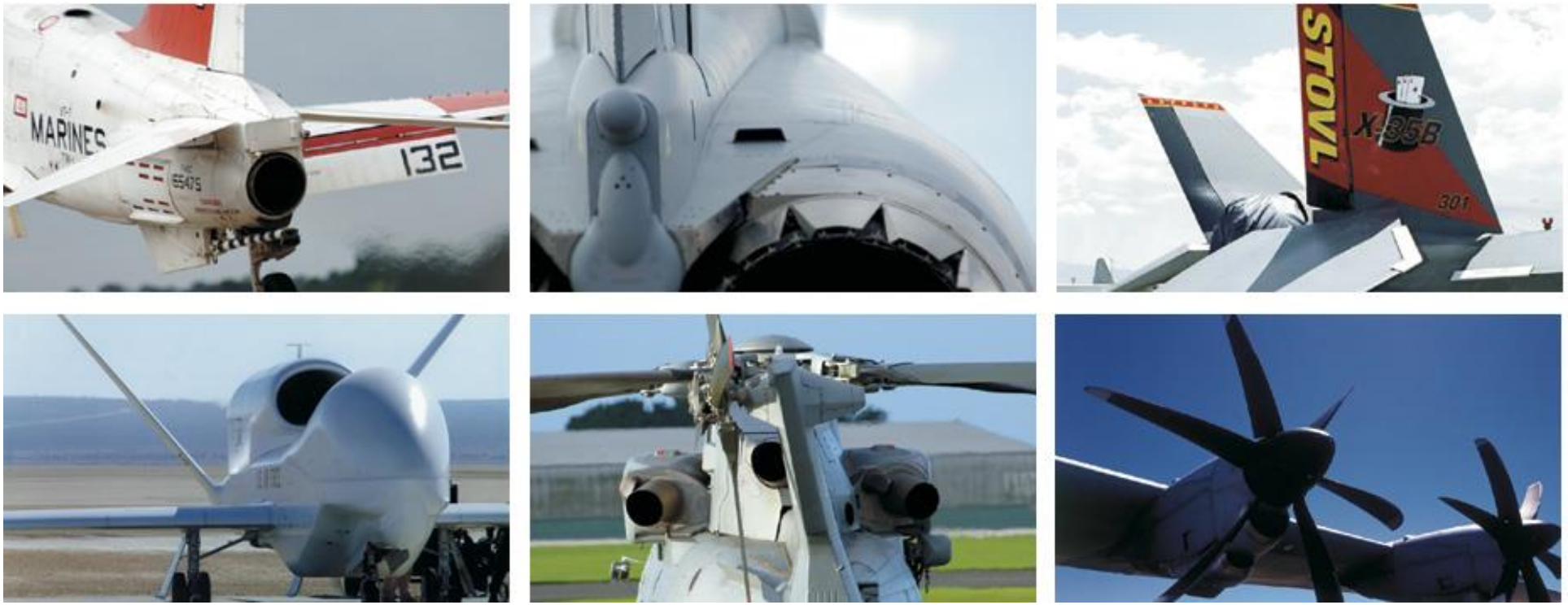
A strong position in all key defence market sectors



Combat, STOVL, light-attack, fast jet trainer, Transport, Helicopters, Maritime reconnaissance, Aerial surveillance

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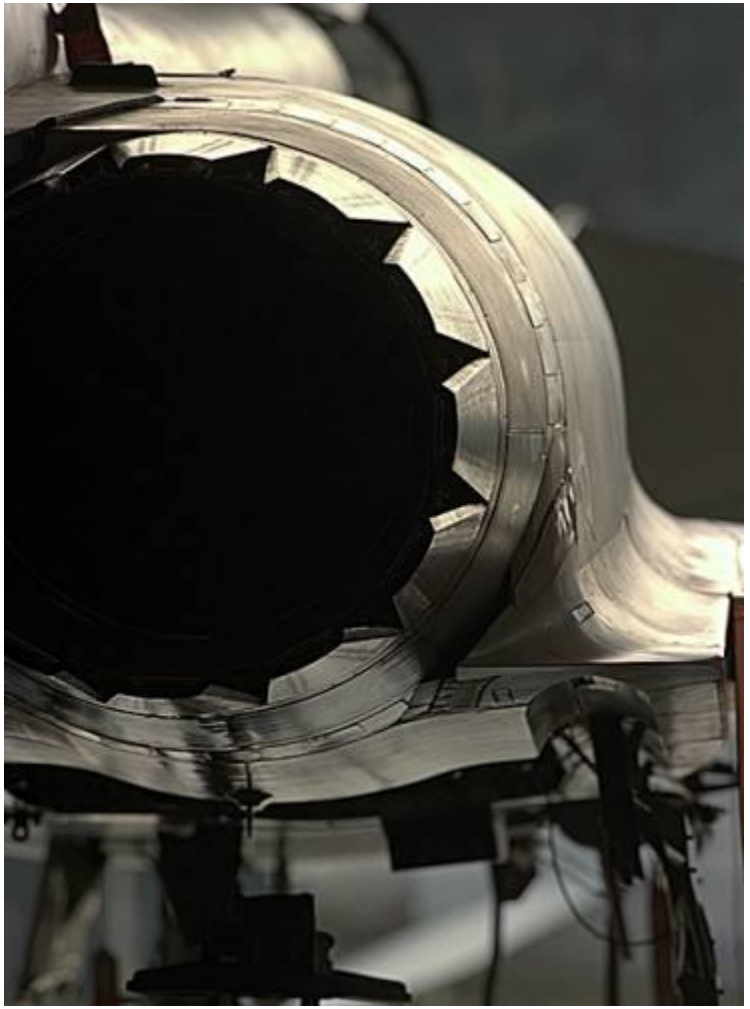
A competitive portfolio

Current Requirements

- World-leading state-o-the-art technology
- Highest performance
- Power for multi-role capability
- Exceptional thrust-to-weight ratio
- Highest operational availability
- Excellent reliability levels
- Low cost of ownership
- Built in growth potential



Today's Leader: EJ200 and F136

- **Critical to fulfil Mission Requirements**
  - *Minimum Time Intercept*
  - *Long Loiter Air Superiority*
  - *Excellent Maneuverability*
- **Excellent Performance**
  - *Supercruise Capability*
  - *Excellent Thrust:Weight Ratio*
  - *Growth Potential*
- **Low Cost of Ownership**
  - *Improved SFC*
  - *High Component Life*
  - *Low Number of Parts*
  - *Excellent Reliability & Maintainability*

Next Generation – What are the key drivers?

- **The nature of military conflict is changing**
  - Longer lower intensity conflicts
  - Homeland security
  - Introduction of “un-manned platforms”
  - Information networking / surveillance / warfare
  - Standoff = High speed, precision strike

- **Changing product requirements**
  - Higher electrical power off-take
  - Survivability / Stealth
  - Affordability - Unit cost and Through-life Cost
  - Persistence
  - Maintainability
  - Continuous emphasis upon reducing fuel consumption

- **Technology acquisition needs new approaches**
  - Commercial-off-the-Shelve
  - Propulsion – a commodity?

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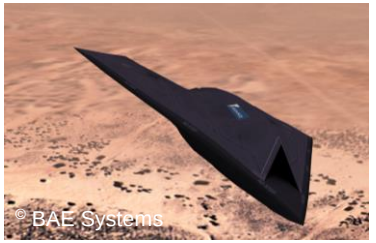
Typical UAV Power System requirement priorities

	MALE	UCAV (Low signature, subsonic)	HALE
			
Requirement	Typical relative priority		
High thrust/weight	**Medium**	**Medium**	**Low**
Low fuel consumption	**Medium**	**Medium**	**High**
Low signatures	**Low**	**High**	**Low**
High power off-take	**Low**	**High**	**High**
Low unit cost	**High**	**Medium**	**Medium**
High reliability	**Medium**	**High**	**High**
Storage capability	**Low**	**High**	**Low**
Autonomous ops	**High**	**High**	**High**
Prognostic EHM	**High**	**High**	**High**
Long life	**Low**	**Medium**	**High**

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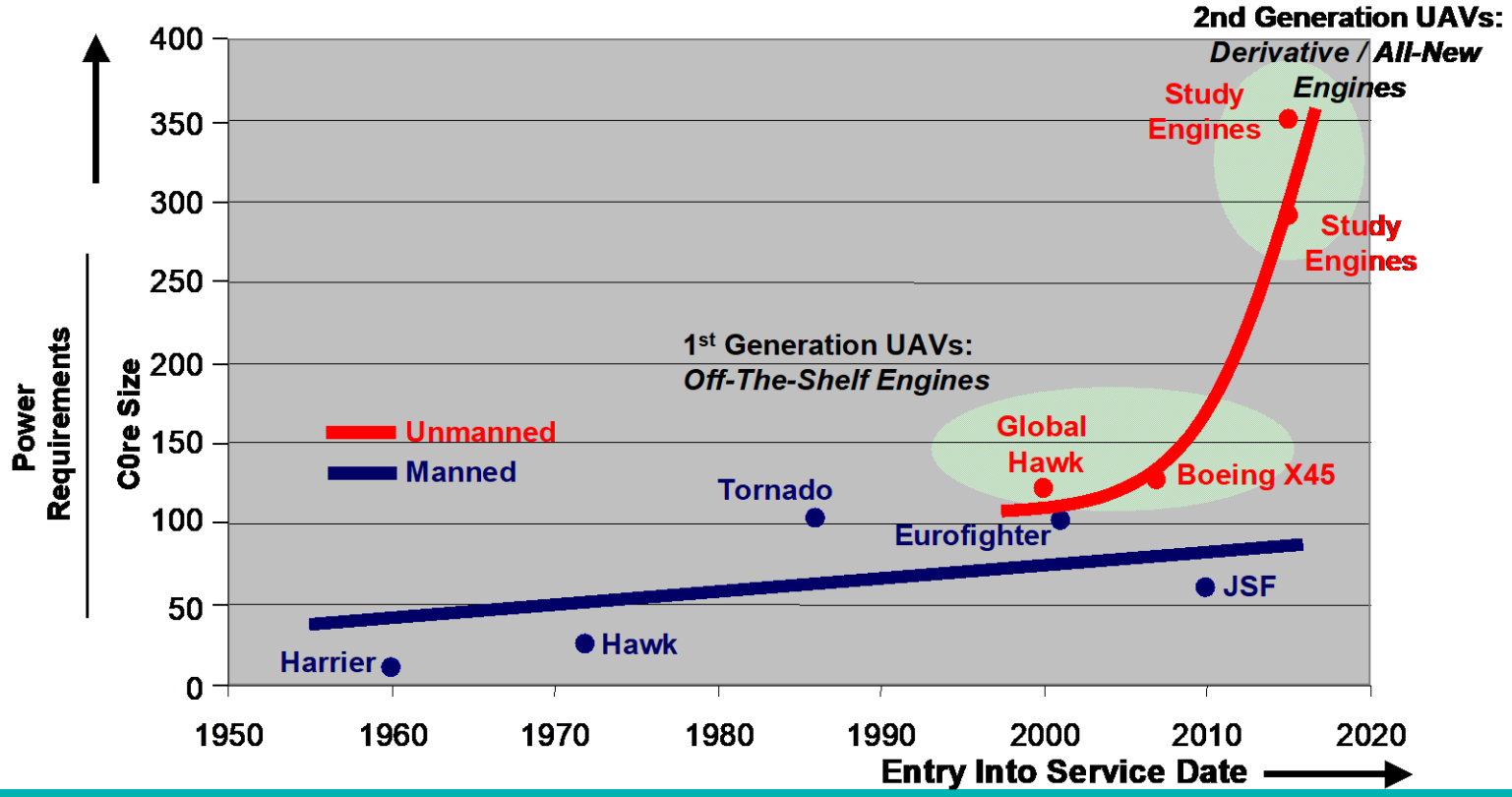
Power Requirements: Manned & Unmanned Vehicles

- **Electrical off-take requirements increase**
  - Surveillance systems
  - Directed energy weapons
  - Increasing electrical control systems

= Fluctuating thrust/electrical power demand



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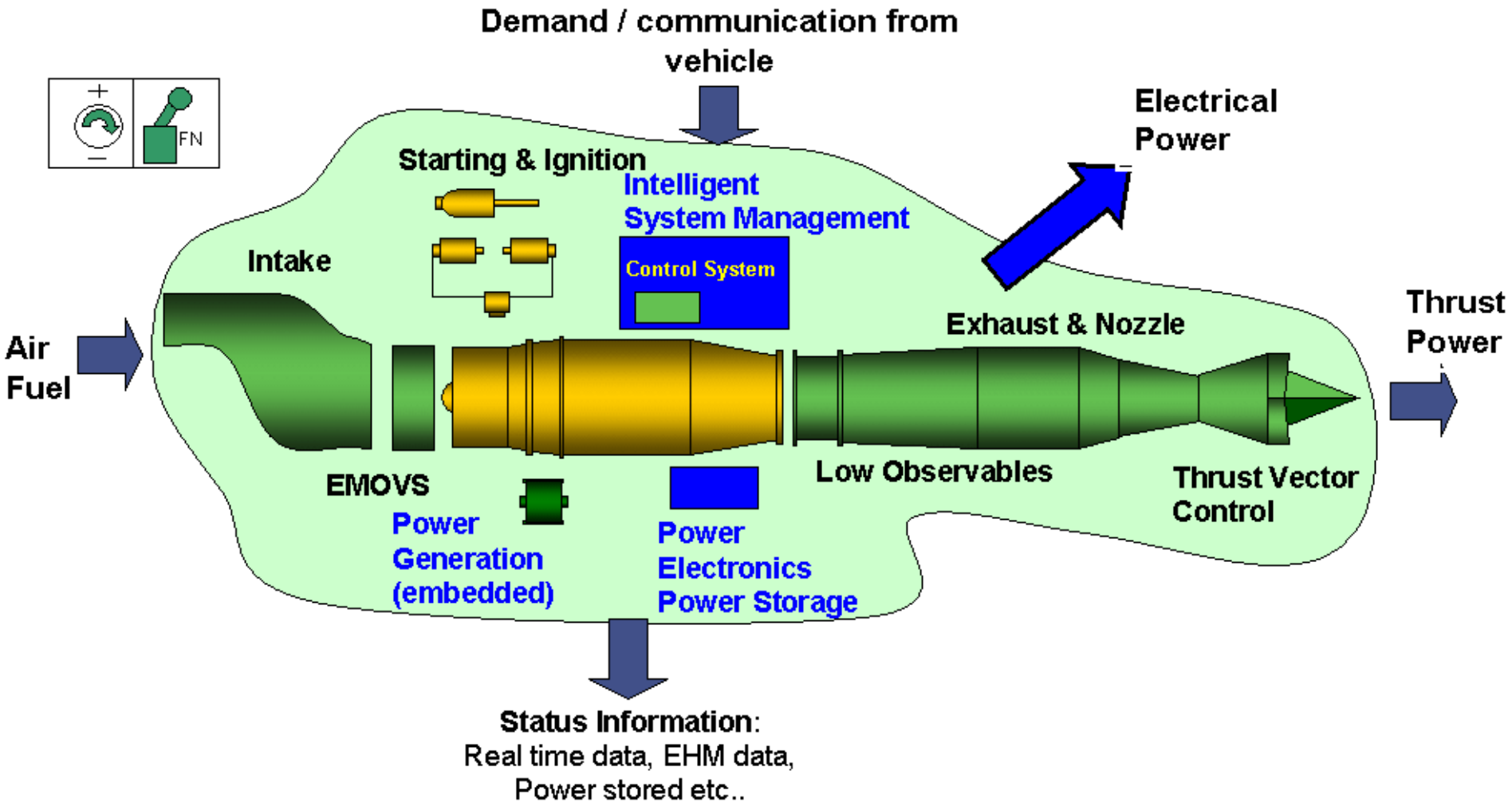
Solution: Integrated Power System



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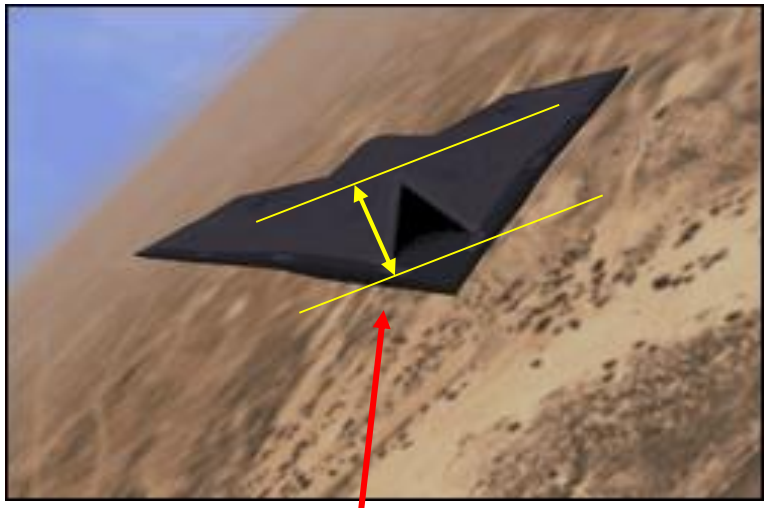
Requirement for “Low Signature” (1)



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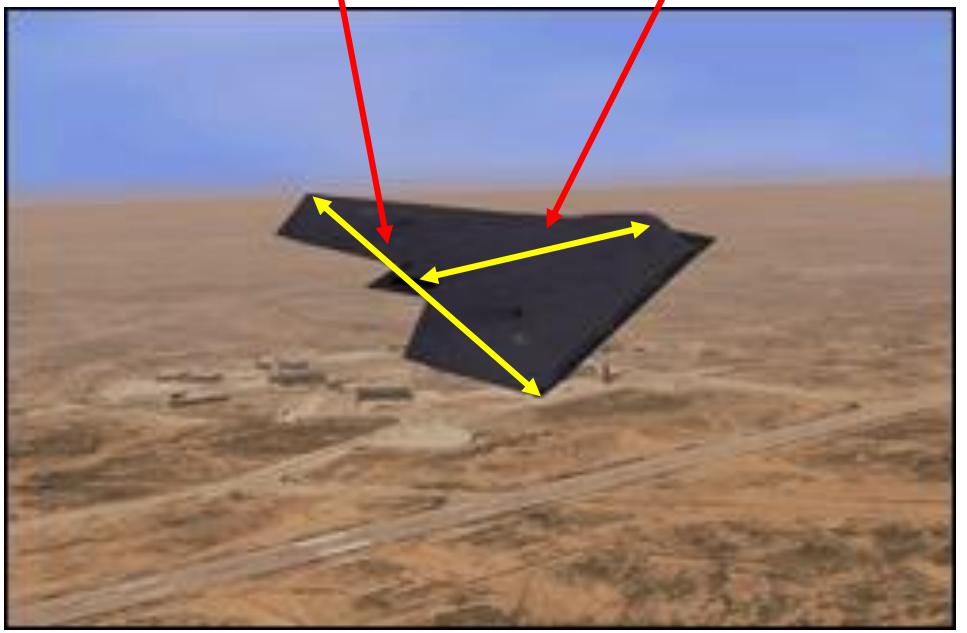
Platform <u>cross-section</u> determined by engine diameter

Platform length determined by powerplant, intake and exhaust

Platform span determined by platform length



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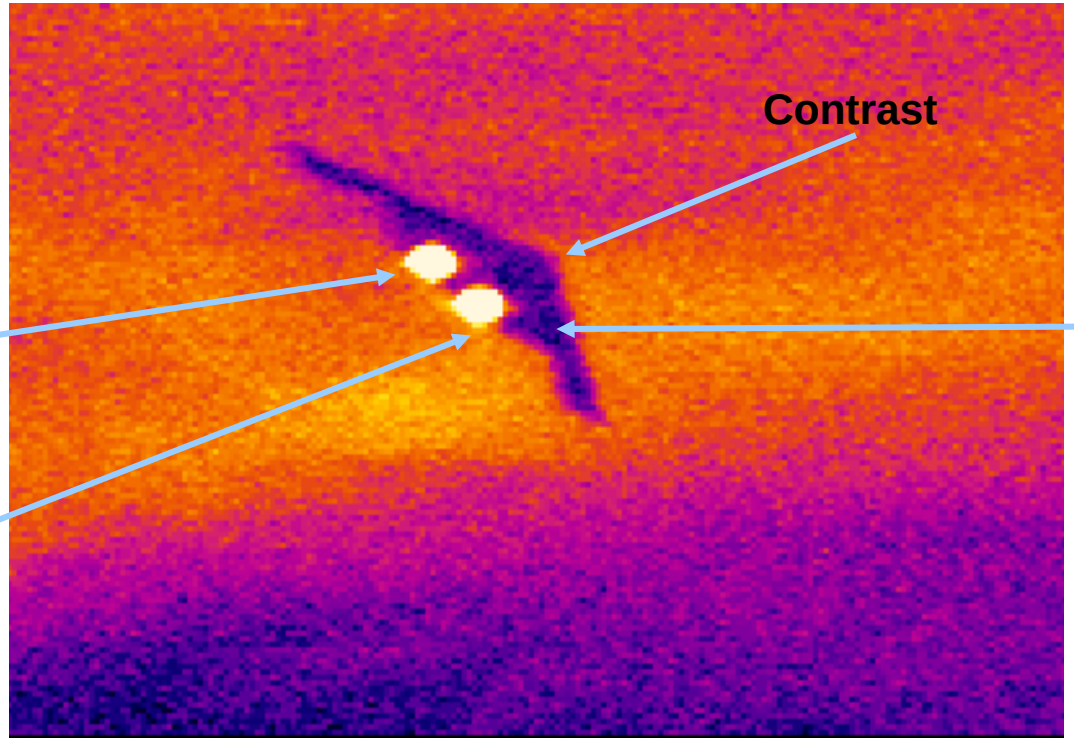
Requirement for “Low Signature” (2)



Exhaust cavity
- Temperature
- Obscuration

Plume
- Temperature
- Extent

Vehicle structure
- Skin temperature
- Surface properties

Propulsion <u>dominates</u> IR Signature in <u>all</u> aspects

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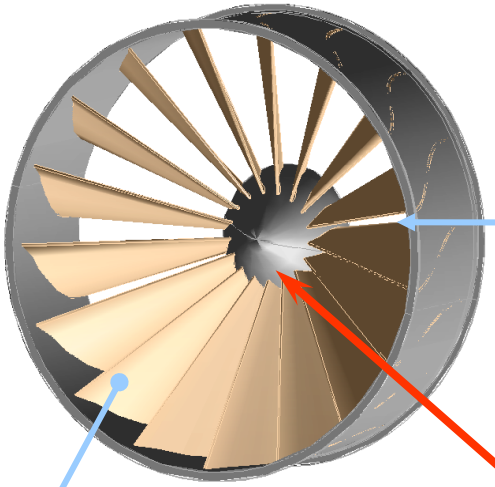
Solution: Installation technology

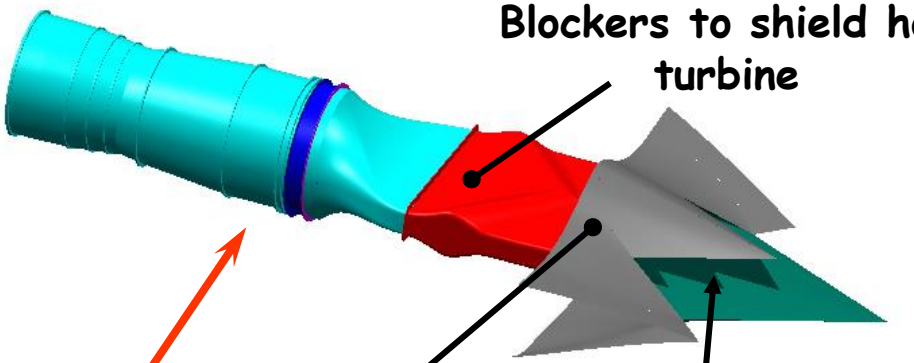
Engine Mounted Obscuration Vanes (EMOVs) in front of fan face



Raked vane leading edges

Radar absorbent material

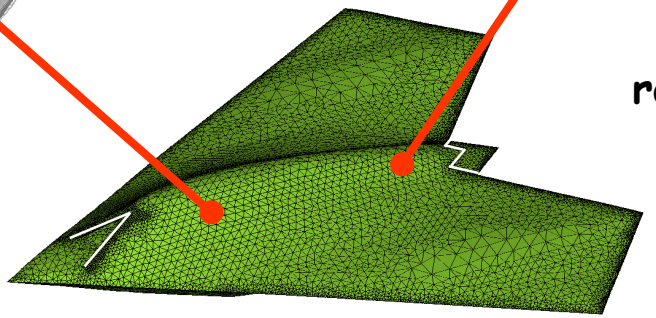
Novel exhaust systems



Blockers to shield hot turbine

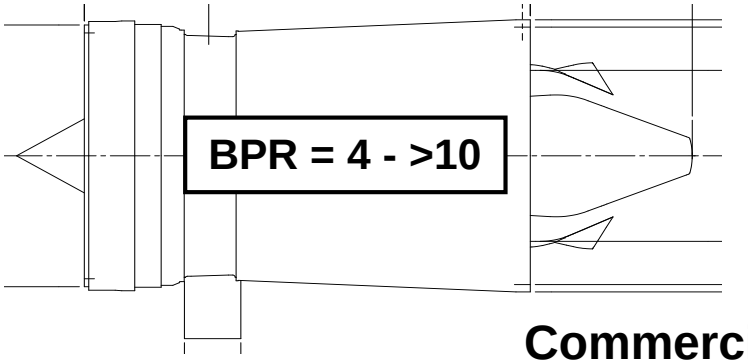
Extensive use of cooling and radar absorbent materials

Scarfed & raked rectangular nozzle



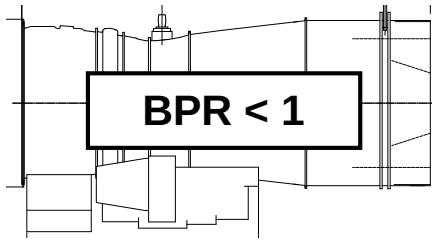
UCAV conceptual design

UCAV propulsion technology



Commercial turbofan

- Low installed SFC
- High bypass ratio
- Cool exhaust
- Large fan diameter
- Low thrust-to-weight



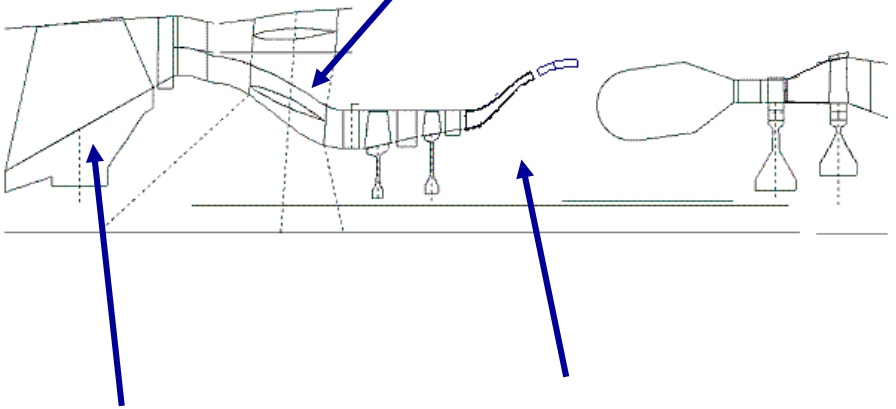
Military combat engine

- Small fan diameter
- High thrust-to-weight
- Low BPR
- Higher installed SFC
- Hot exhaust

Future UCAV

- Variable BPR, e.g. 0.5 – 3
- Low installed SFC
- Small fan diameter
- Cool exhaust
- Moderate/high thrust-to-weight

Variable BPR to provide both high take-off thrust and low cruise SFC & exhaust temperature



Compact high efficiency fan, compatible with LO intake

Small highly efficient, high temperature core

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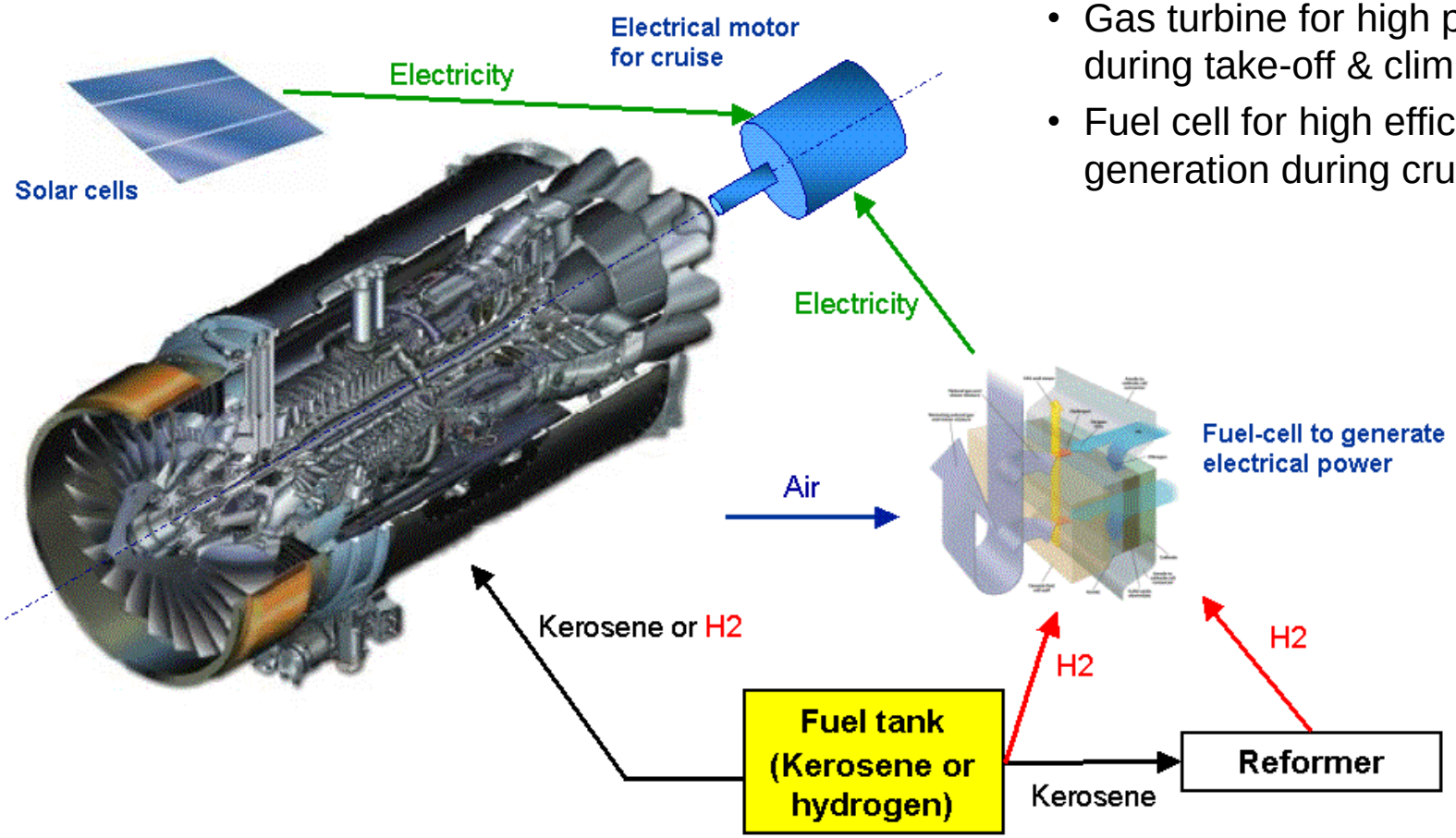
Outlook: Hybrid propulsion for HALE UAV

Potential future HALE hybrid gas turbine & electrical propulsion

- Gas turbine for high power density during take-off & climb
- Fuel cell for high efficient power generation during cruise



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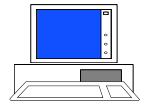
Engine Health Monitoring

Sense

Acquire

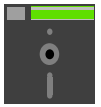


Data Station

Ground
Based information
e.g. Oil Analysis

Flight
Log Sheets

Transfer



Maximum Customer benefit relies on the efficient operation of the complete system

DS&S Engine Health Centre

- Condition monitoring
- Data processing & storage
- Data access / reports
- Forecasting service

Analyse

Customer Ops Center

Repair Depot

Supply Chain

Regional Customer Manager or Field Service Rep

Internet, e-mail, Phone

Act

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Defence Aerospace Operations Centre

- **Established as a key enabler for the delivery of service contracts**
- **Built upon experience in the Rolls-Royce Civil Sector in the delivery of high value competitive service streams**

The Operations Centre delivers value by:

- **Providing rapid containment actions to offset disruption caused by unforeseen operational circumstances**
- **Maintaining a proactive view and mitigating problems before they become operationally disruptive**
- **The Operations Centre is open 24/7, 365 days of the year to accommodate a wide and varied DA customer base:**
  - 160 Customers
  - 9000 Engines

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Conclusions

- Toady's military engines are dedicated to their applications – future systems will again require bespoke technology acquisition
- System integration – within propulsion system and with platform – becomes increasingly important
- Advanced Services (incl. Engine Health Monitoring) are a pre-requisite towards more autonomous operations
- Multi-national co-operations will increase further

Thank you

Any questions?