REACTION ENGINES

Introduction

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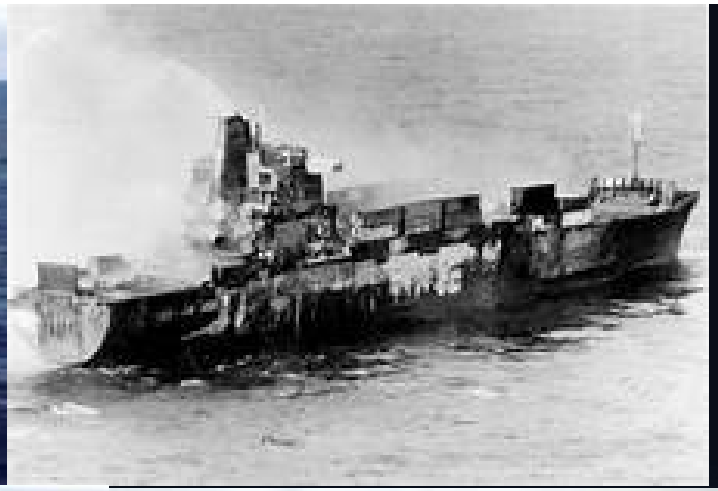


SEAKING AEW. Mk.2A


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REACTION ENGINES

SABRE – A New Approach to Low Cost, High Cadence Space Access

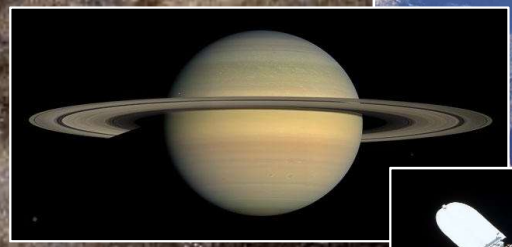
…or how to achieve affordable, effective space access…

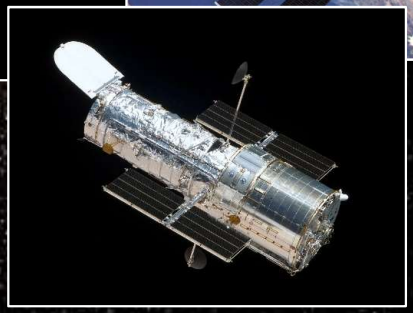
Simon Henley

Reaction Engines

After 60 years of space access….

...some amazing things have been achieved





Tangible benefits to our everyday life

Expansion of our understanding

Accessing Space – The Rocket Launch Vehicle

The rocket has carried us far…however current launchers have some undesirable characteristics:

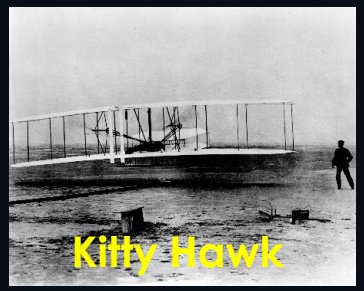
- High cost
- Poor operability
- Low reliability

…which increase the cost of space assets themselves and restrict growth of the space market

…little change in launch vehicle technology in over 60 years…

1957 → **Today**

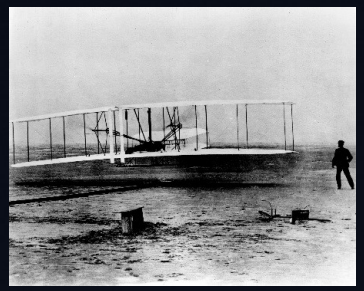
A Few Lessons from 60+ Years of Aircraft Evolution



1903 → 1969

1. Breakthroughs in propulsion technology lead system evolution ★
2. Advantage of air-breathing propulsion
3. Horizontal operations decrease cost and increase operability
4. Reusability allows high flight rate and leads to continuous improvements

A Few Lessons from 60+ Years of Aircraft Evolution





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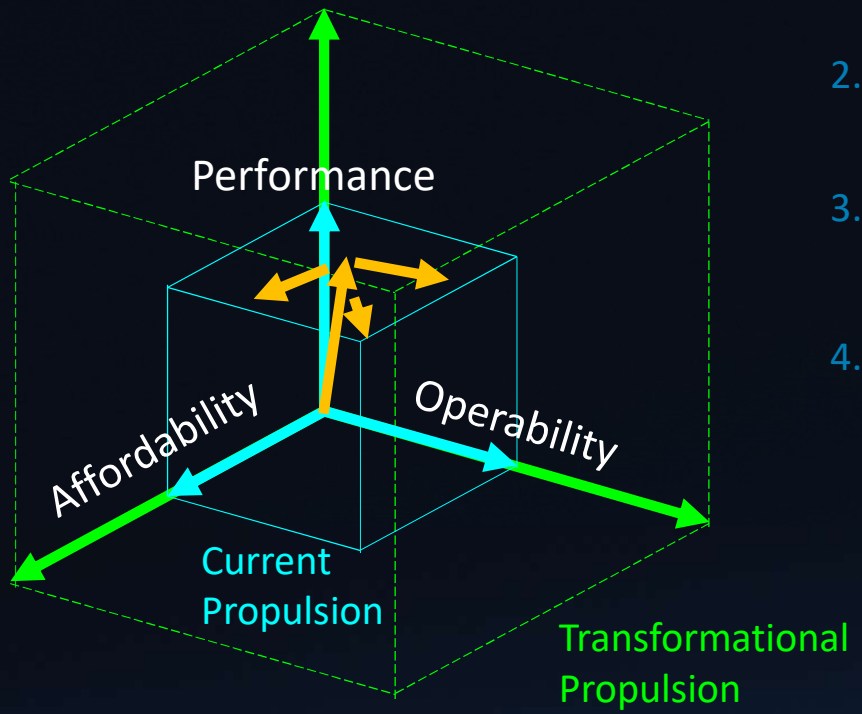
Bringing the Aviation Model to Space Launch

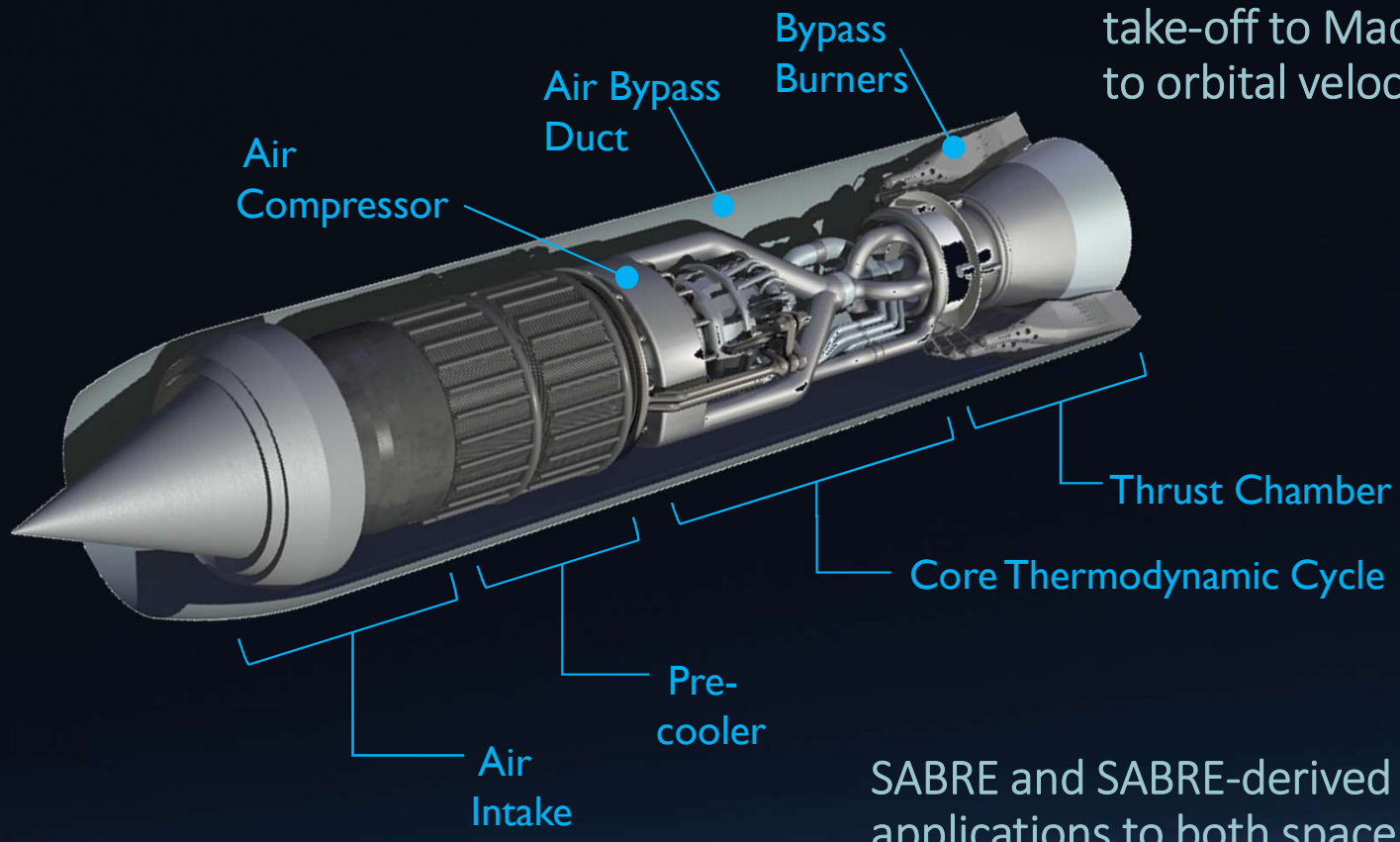


1. Early launchers rapidly pushed the rocket performance boundary
2. Many new rocket-based entrants currently seeking to improve cost and operability – but achievable gains are only moderate
3. New architectures and possibilities require a drastic increase in launch system propulsion performance
4. Rocket-based propulsion systems, on their own, are not able to deliver the performance required to realize a launch system with aircraft-like operability

A Revolution in Launch Systems Requires a Revolution in Propulsion

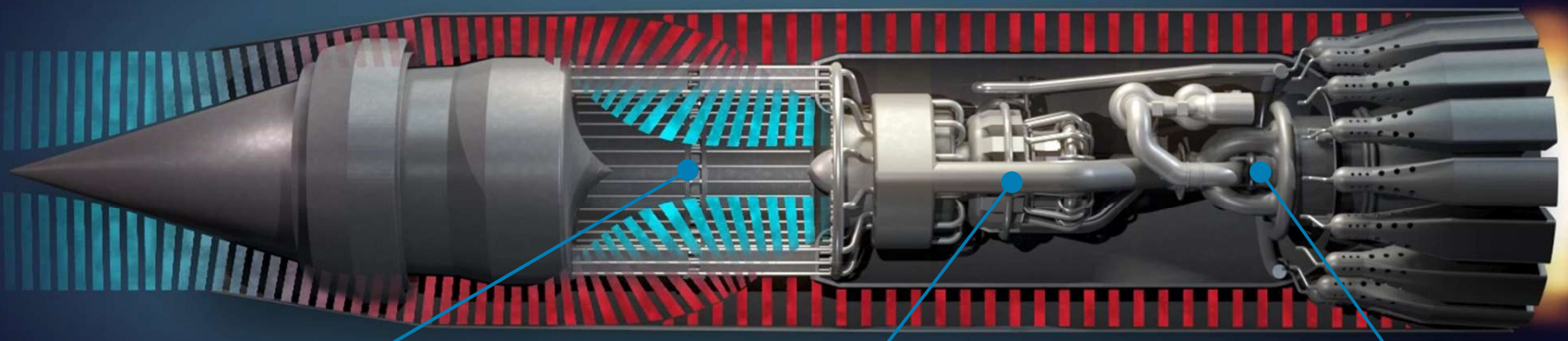
The SABRE Engine

SABRE - Synergetic Air Breathing Rocket Engine – is a new class of engine able to operates from take-off to Mach 5+ in air-breathing mode, and to orbital velocity in rocket mode



SABRE and SABRE-derived technology has potential applications to both space access and high-speed flight

The SABRE Engine



1. Cool
Cool the hot incoming air from 1000°C in 1/20th second (Mach 5)

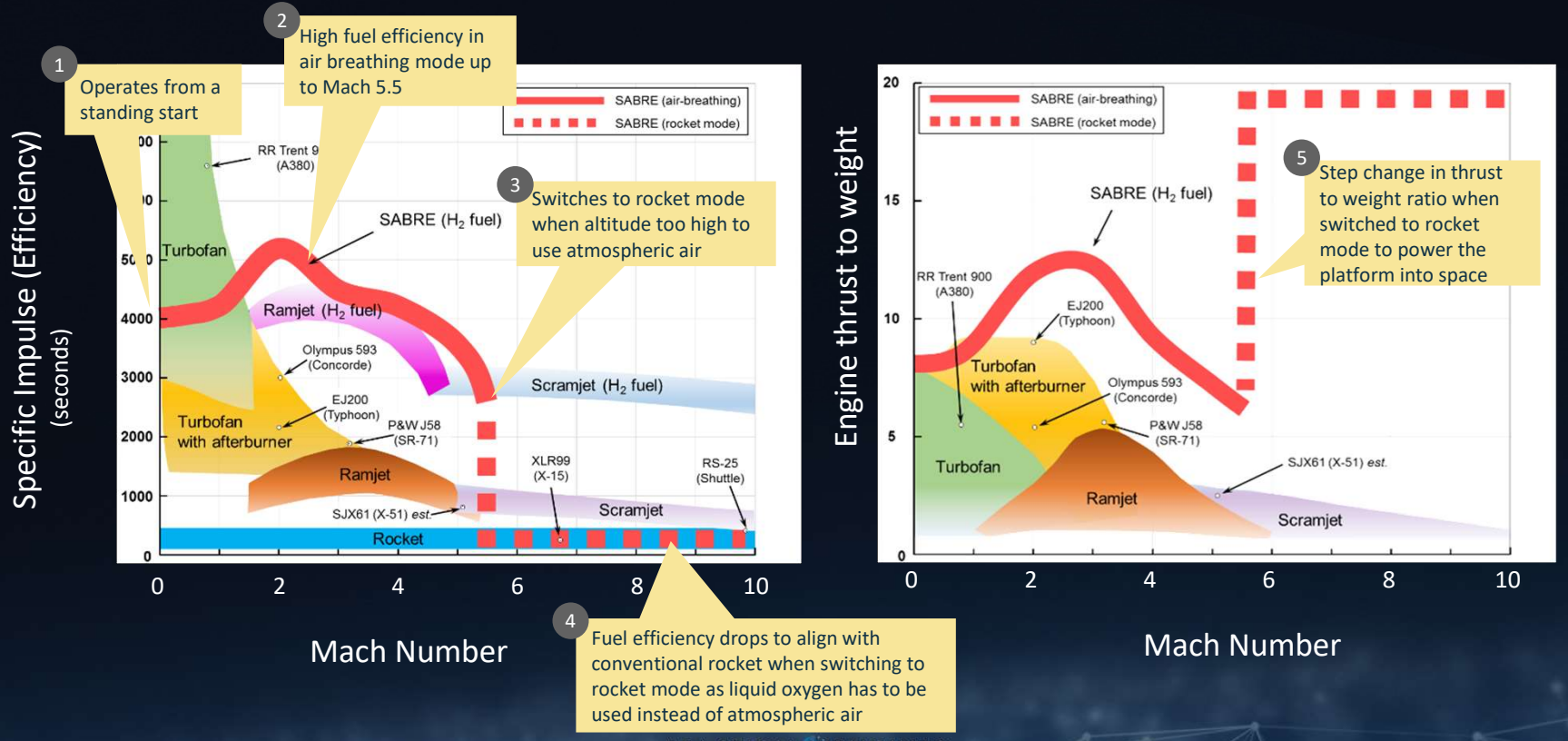
2. Regenerate
Re-inject the heat captured into the engine to drive the turbo-machinery, thereby reducing fuel consumption

3. Integrate
Combine jet and rocket engines to create an engine class capable of high Mach atmospheric and Space flight in a single engine

SABRE

SABRE Performance

SABRE provides improved performance over a wide speed range for thrust and efficiency compared with other propulsion systems



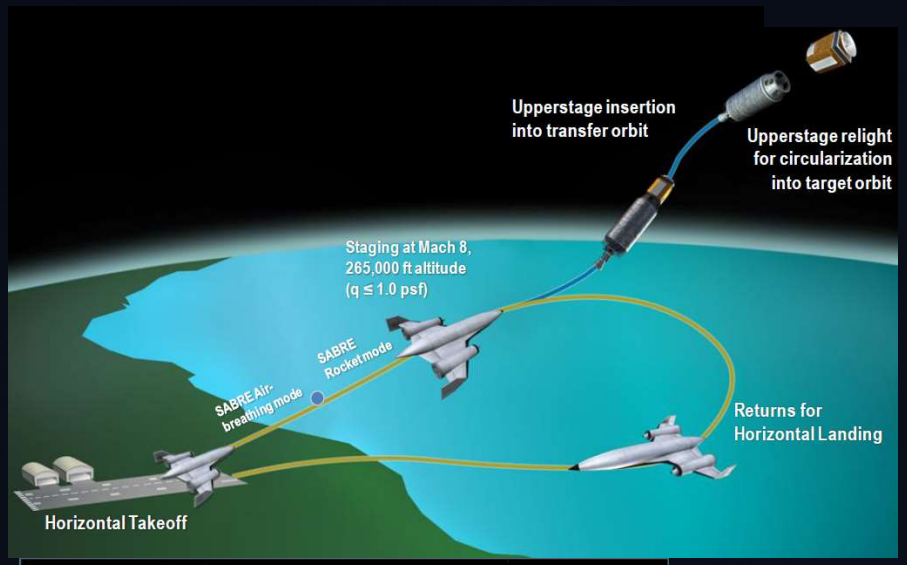
Characteristics of a SABRE-based Launch System

Low Cost driven by reusability and potential for high flight rate

High Operability enabled by horizontal take-off and landing and other aircraft-like operations

High Reliability enabled by reusability and full abort capability

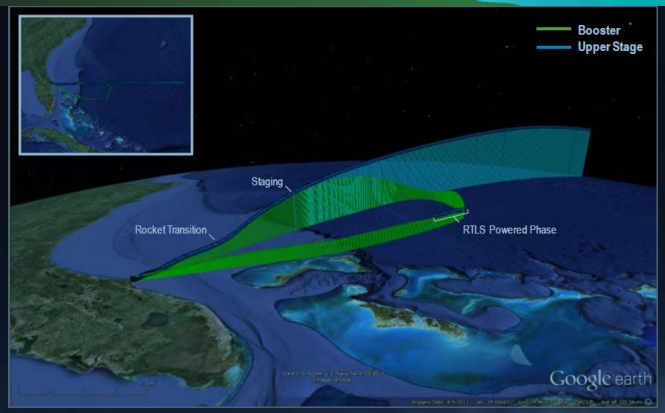
Example Mission Profile – Rapid Response TSTO



Horizontal take-off from conventional runway and return to same location

Air-breathing-to-rocket mode transition at Mach 5

Upper stage places satellite in selected orbit



SABRE-powered booster stage

- Payload: 2.5t to LEO
- Vehicle GTOM: 150t

Example Mission Profile – Rapid Response TSTO

Such a system has potential utility in:

- On-demand deployment of space-based assets
- Rapid reconstitution of satellite networks
- Launch from multiple launch sites
- ISR capability at very high altitude (>100 km) over denied areas without incursion of air-space

Reaction Engines

- Reaction Engines Limited (REL) is a private UK company developing the SABRE advanced combined cycle air-breathing engine (Synergetic Air-Breathing Rocket Engine)
- SABRE and SABRE-derived technologies have application to a variety of space access and high-speed aircraft systems
- Company has raised over £100M from private and strategic investors as well as a UK government grant

A Revolution in Launch Systems Requires a Revolution in Propulsion

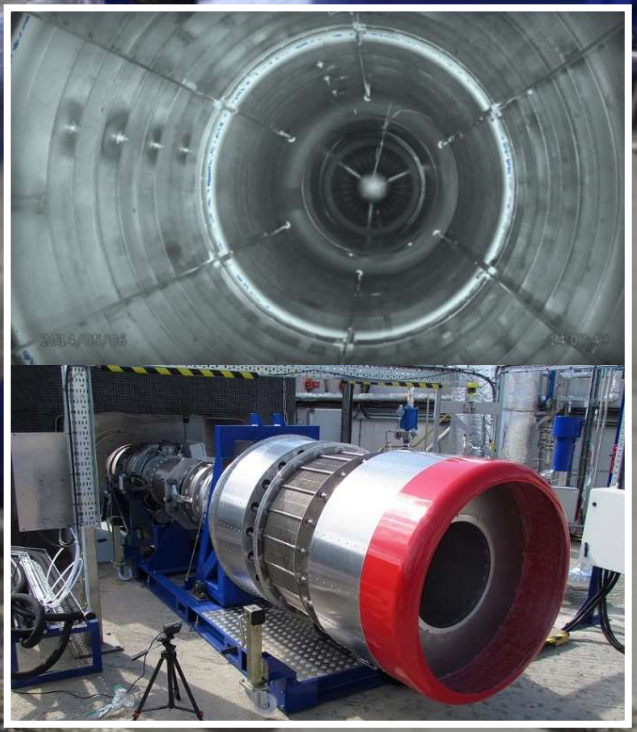
SABRE Technology Development – Heat Exchangers

Requirement

- Cool the airflow over 700°C in 1/20th of a second
- High MW-class heat transfer

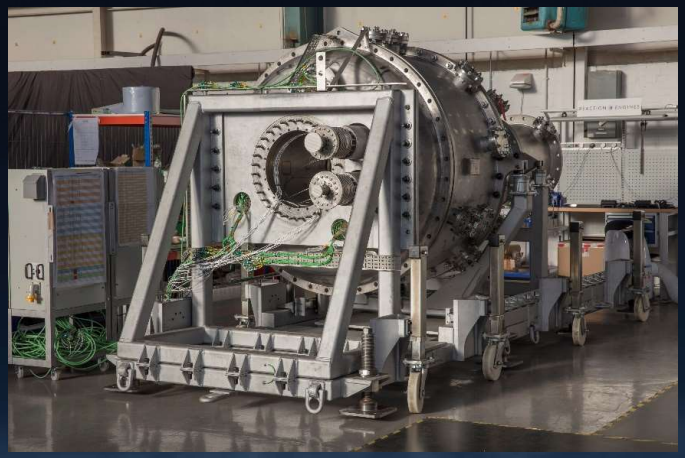
Development

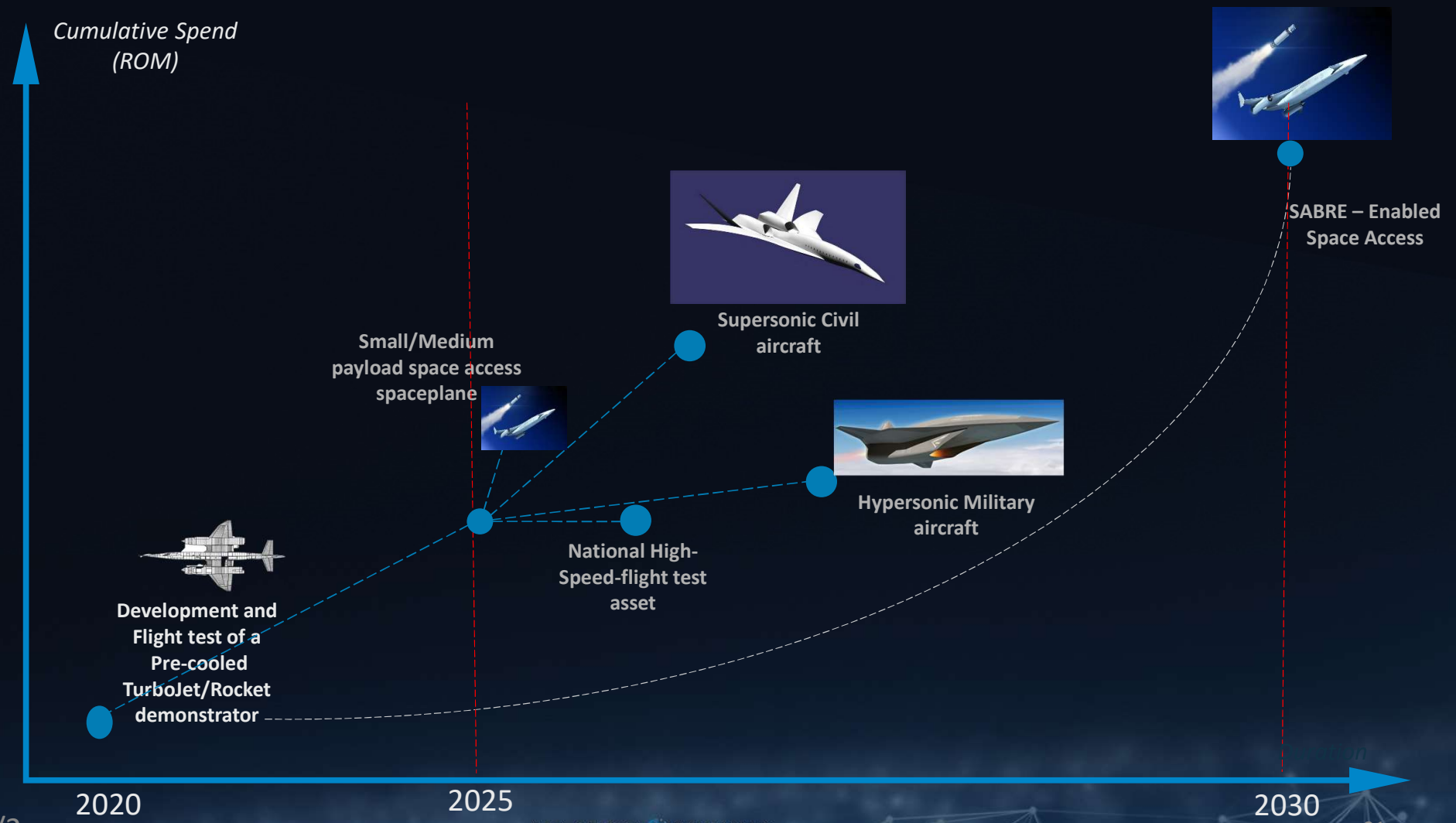
- Manufacturing breakthrough achieved
- Innovative frost control system
- Extensive validation at ambient conditions
- Pre-cooler testing at Mach 5 conditions in 2019



Test Facility TF2 – HTX Testing at Mach 5 Conditions

Located at Spaceport Colorado near Denver, TF2 can provide airflow up to 1000 degC




Cumulative Spend (ROM)
SABRE – Enabled Space Access
Supersonic Civil aircraft
Small/Medium payload space access spaceplane
Hypersonic Military aircraft
National High-Speed-flight test asset
Development and Flight test of a Pre-cooled TurboJet/Rocket demonstrator
2020
2025
2030


REACTION ENGINES