

IPERSONICA: LE ATTIVITA' IN EUROPA E NEL MONDO

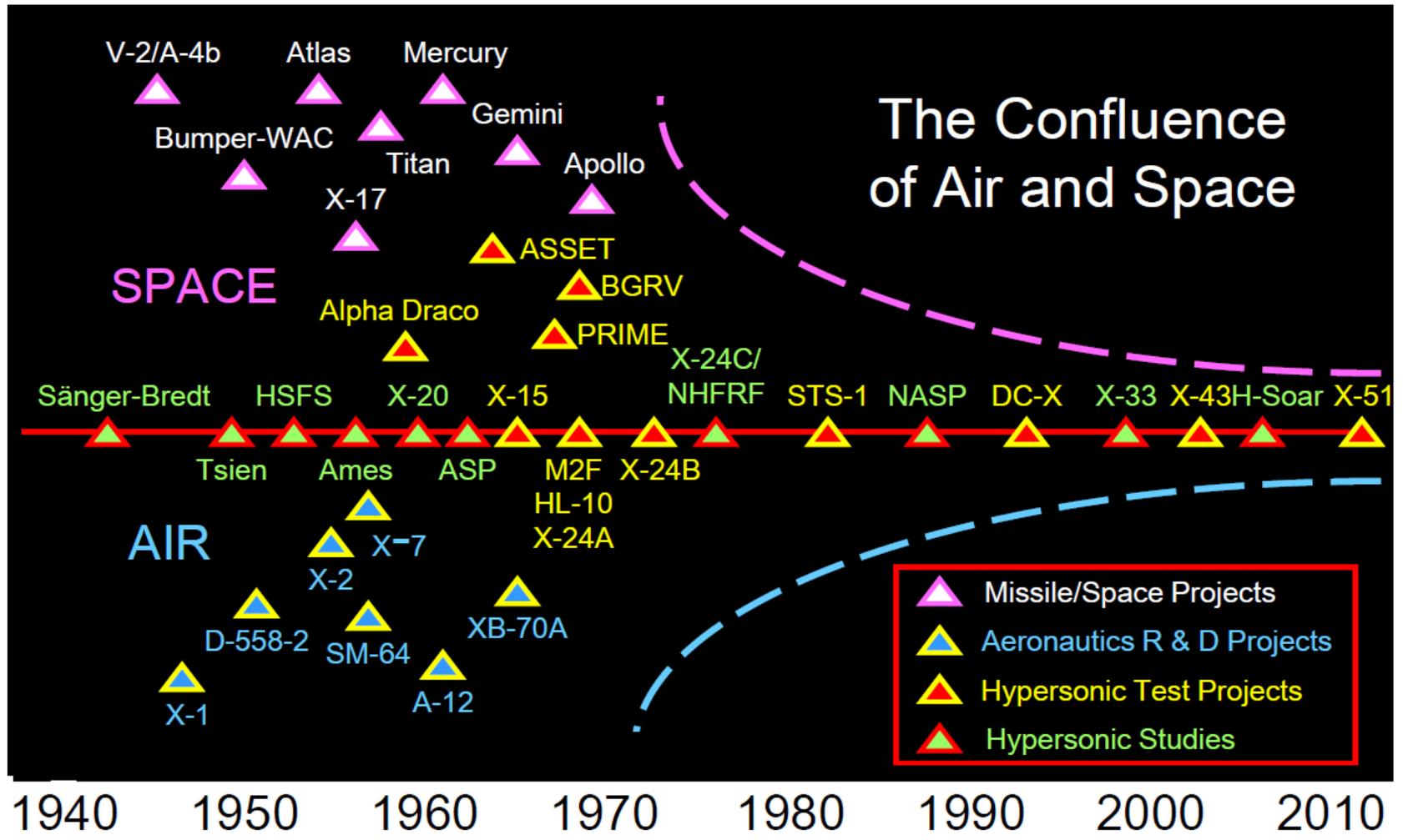
S. Di Benedetto, L. Vecchione

20 Aprile 2016

Contenuti:

- Mappatura dei progetti sull’ipersonica in Europa;
 - Ruolo dell’Italia
- Mappatura dei progetti in USA e nel resto del mondo;
- Tassonomia dei velivoli ipersonici

Velivoli Ipersonici - Tassonomia



Richard P. Hallion, *Hypersonics: A Review of its History and Application*

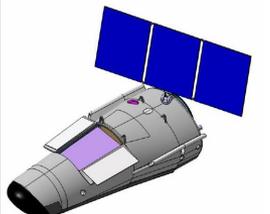
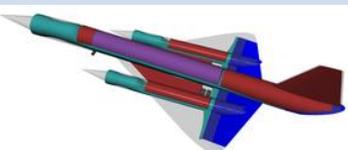
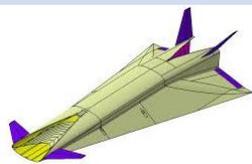
I progetti sull'ipersonica in Europa

Velivoli Ipersonici – Mappatura iniziative europee

Progetti ESA/Comunità Europea

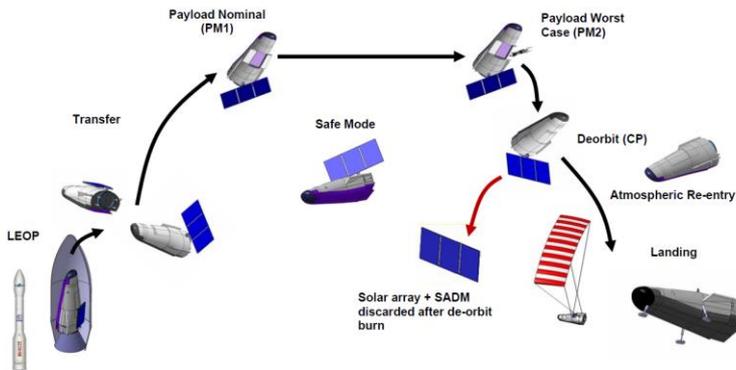
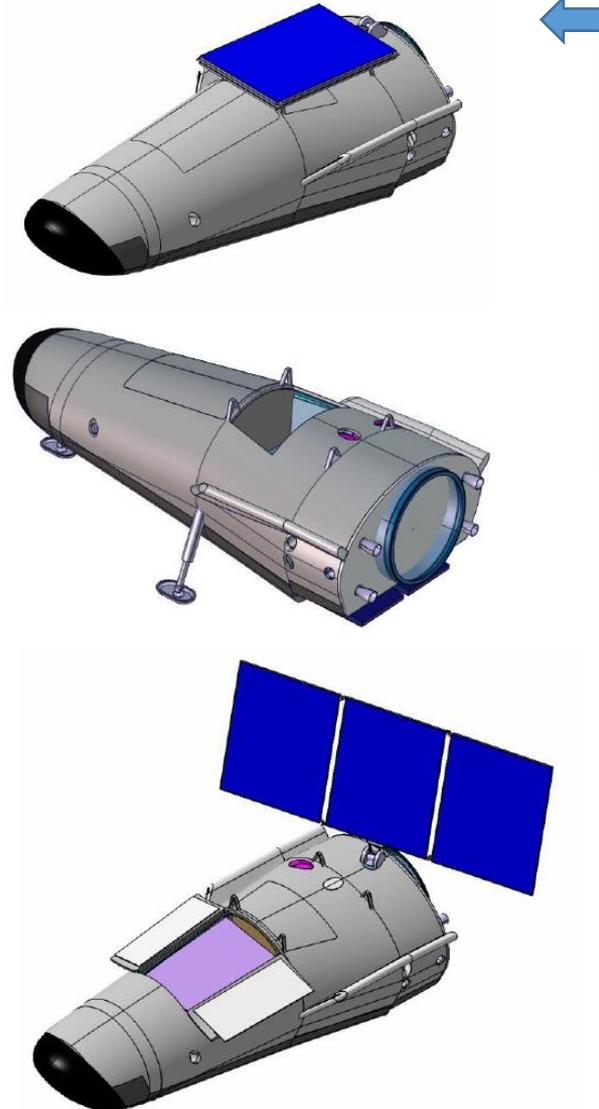


(2000-2015)

<p>Accesso allo spazio</p>	<p>EXPERT</p> 	<p>IXV</p> 	<p>PRIDE →</p> 	
<p>Trasporto atmosferico/trans-atmosferico</p>	<p>SpaceLiner (FAST 20xx) →</p> 	<p>LAPCAT 1 & 2</p> 	<p>ATLLAS I & II</p> 	<p>Hexafly/Hexafly-INT →</p> 

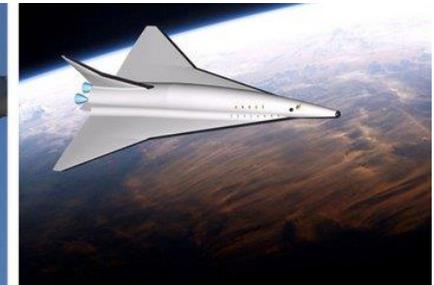
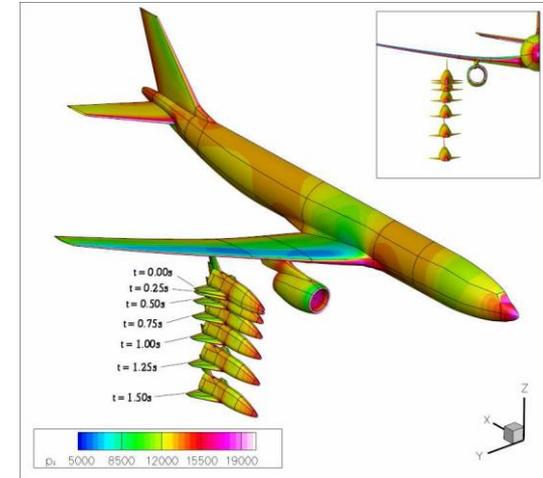
Contributo italiano: PRIDE

- Il Programma dell’ESA PRIDE (Program for Reusable In-Orbit Demonstrator for Europe) prevede la dimostrazione delle capacità Europee di accesso allo spazio e rientro da LEO per effettuare sperimentazione e dimostrazione in orbita.
- L’Italia, attraverso l’Agenzia Spaziale Italiana, è il maggiore contributore.
- Rispetto a quanto già ottenuto con il successo della missione di IXV il programma mira ai seguenti obiettivi:
 - Fase orbitale con rendezvous con ISS, cattura di piccoli payload, osservazione della terra, telecomunicazioni, micro-gravità.
 - Riutilizzabilità
 - Atterraggio su terreno o pista convenzionale.
- CIRA e Thales Alenia Space Italia, in qualità di Co-Prime hanno avuto mandato da ESA per l’implementazione delle fasi A/B1 del progetto, con l’obiettivo di effettuare una System Requirement Review a metà 2017.



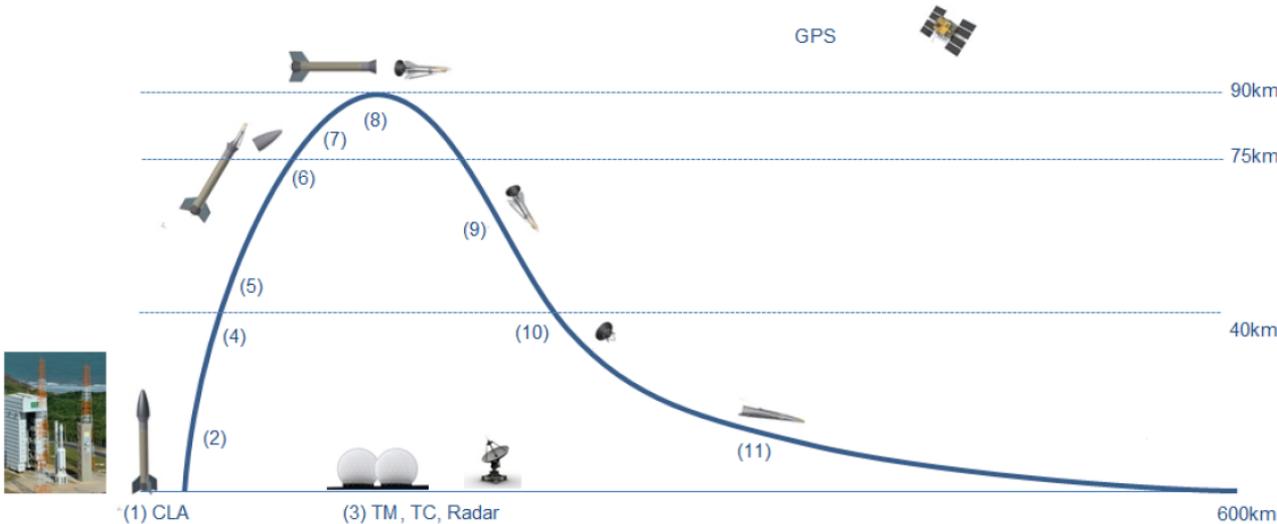
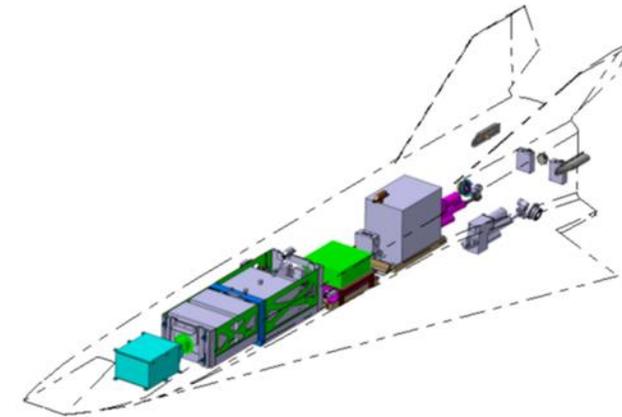
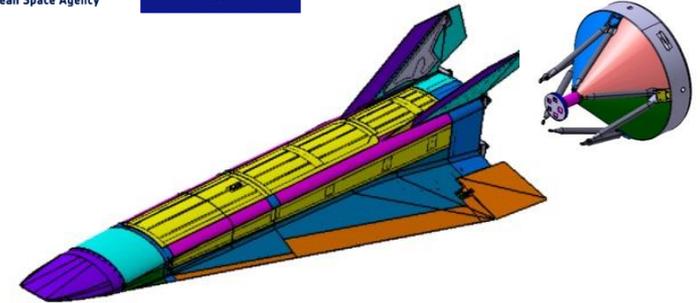
FAST20XX

- EU FP7 Program, coordinato da ESA
- Finalizzato all'identificazione delle principali aree di ricerca e tecnologiche necessarie per lo sviluppo di due diversi concetti di velivolo per il trasporto civile ad alta velocità:
 - ALPHA, concetto low energy, lanciato da un carrier e dotato di un propulsore a razzo ibrido;
 - SpaceLiner, concetto high energy, per il trasporto a lunga distanza. Concetto two stage, con decollo verticale e atterraggio orizzontale. Accelerato con propulsori a razzo a liquido. Completamente riutilizzabile prevede il trasporto di 50 passeggeri.
- Principali tecnologie critiche:
 - Propulsione ibrida;
 - Tecniche di cooling innovative ad alte performance per le aree sottoposte ai maggiori flussi termici (nose e leading edge)
 - Materiali innovativi (light e high temperature);
 - Tecniche di separazione di velivoli alati con passeggeri a bordo;
 - GNC;
 - Safety Analysis.



L'esperimento di volo ipersonico: HEXAFLY-INT

- Il progetto High-Speed Experimental Fly Vehicles – International (HEXAFLY-INT) project ha lo scopo di validare in volo alcune delle tecnologie necessarie per il futuro volo transatmosferico;
- Il progetto vede la partecipazione di Europa, Federazione russa e Australia, con il coordinamento dell'ESA; esso prevede il design, manufacturing, assembly e in-flight testing di un velivolo high-speed senza motore;
- L'Italia attraverso il CIRA copre il ruolo di Design Authority del progetto;
- La CDR è prevista per fine 2016.



Velivoli Ipersonici – Mappatura iniziative europee

Progetti europei nazionali
(2000-2015)



ZEHST, Zero Emission High Speed Technologies

EADS INNOVATION WORKS

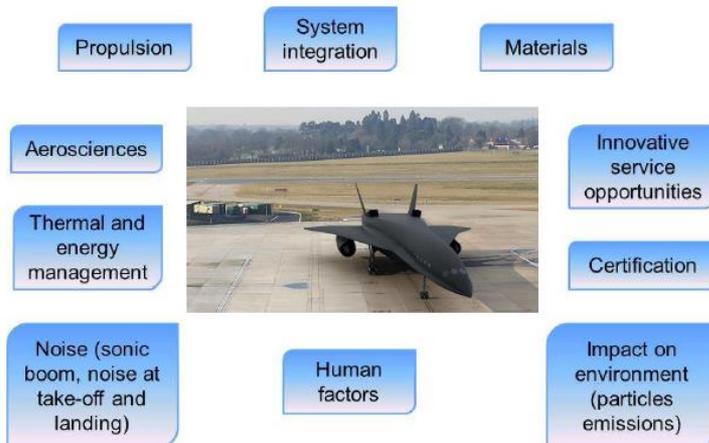
ONERA
THE FRENCH AEROSPACE LAB

MBDA
ROCKET SYSTEMS

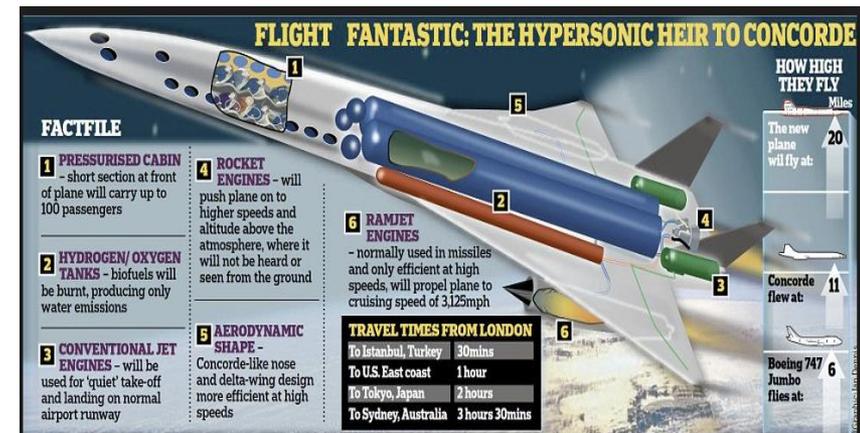
ASTRIUM



- Velivolo supersonico per il trasporto passeggeri, nato da un accordo tra EADS e Giappone;
- Capace di trasportare fino a 100 persone e di volare fino a Mach 4, operando come un aeroplano convenzionale;
- Utilizza tre motori:
 - 2 turbojets operanti con biofuel tra il take-off fino a 5000 metri (Mach 0.8);
 - 3 motori a razzo (idrogeno) fino a 23000 metri;
 - 2 motori ramjet per raggiungere Mach 4 fino a 32000 metri.
- Progettato per ridurre l'impatto ambientale, sia in termini di emissioni che di rumore (sonic boom);
- Presentato all'Airshow di Parigi nel 2011; dimostratore di volo per il 2021;



FLIGHT FANTASTIC: THE HYPERSONIC HEIR TO CONCORDE



FACTFILE

- PRESSURISED CABIN** - short section at front of plane will carry up to 100 passengers
- HYDROGEN/OXYGEN TANKS** - biofuels will be burnt, producing only water emissions
- CONVENTIONAL JET ENGINES** - will be used for 'quiet' take-off and landing on normal airport runway
- ROCKET ENGINES** - will push plane on to higher speeds and altitude above the atmosphere, where it will not be heard or seen from the ground
- AERODYNAMIC SHAPE** - Concorde-like nose and delta-wing design more efficient at high speeds
- RAMJET ENGINES** - normally used in missiles and only efficient at high speeds, will propel plane to cruising speed of 3.125mph

TRAVEL TIMES FROM LONDON

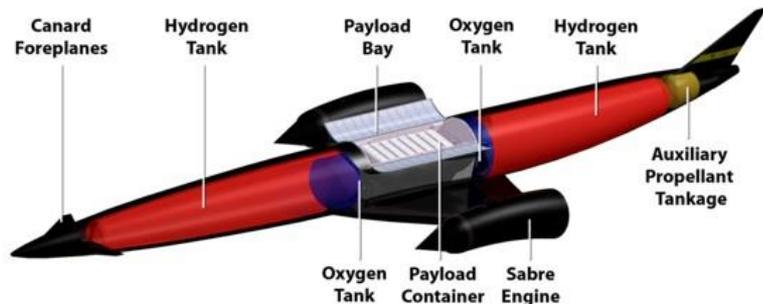
To Istanbul, Turkey	30mins
To U.S. East coast	1 hour
To Tokyo, Japan	2 hours
To Sydney, Australia	3 hours 30mins

HOW HIGH THEY FLY

The new plane will fly at:	20 Miles
Concorde flew at:	11 Miles
Boeing 747 flies at:	6 Miles

SKYLON (Reaction Engines Limited)

- SKYLON è uno spaziplano senza pilota, riutilizzabile, per l'accesso allo spazio.
- Al momento in fase di sviluppo, operativo intorno al 2020, sarà in grado di portare in orbita 15 tonnellate di carico.
- La maggiore innovazione tecnologica è costituita dal motore, SABRE (Synergistic AirBreathing Rocket Engine) un motore a ciclo combinato:
 - airbreathing dal take-off fino a Mach 5.5;
 - rocket (LOx) da 25 km in poi.
- Grazie al motore SABRE, lo SKYLON sarà in grado di raggiungere l'orbita con un solo stadio (SSTO) e decollando e atterrando come un aeroplano convenzionale.



Skylon
Skylon will be a fully-automated, pilotless space plane. Unlike the Space Shuttle, which is less than 30 per cent reusable, Skylon will be totally reusable.

How it sizes up
Shuttle orbiter: 28m
HOTOL: 40m
Skylon: 25m

Inside Skylon
Skylon's fuselage is made from carbon fibre reinforced plastic. Its aluminium fuel tanks are suspended within the frame and are free to move as the aircraft ascends and contracts as it is subjected to heat and pressure fluctuations.

Skylon carries 150 tonnes of liquid oxygen and 66 tonnes of liquid hydrogen (a litre of liquid oxygen weighs 1.1kg, but a litre of liquid hydrogen only weighs 70g, which is why the hydrogen tanks are much bigger despite the oxygen tanks carrying a far greater mass of gas).

The Sabre engine
To minimise the amount of fuel Skylon has to carry, during the first phase of flight, the Sabre engine gathers oxygen from the atmosphere as it flies.
1. At speeds of more than 5,000kph heat created by friction means that air gathered by the intake is a scorching 1,000 C.
2. The hot air passes into a pre-cooler which uses cold, high-pressure helium to chill the air down to 120 C. At 120 C the air is just above the temperature at which it liquefies, which greatly reduces its volume and means the engine doesn't have to carry heavy compressors.
3. This air then flows into the engine, combustion chambers where it is mixed with hydrogen from Skylon's fuel tanks where it is ignited to produce thrust. When the engine starts to 'rocket' only mode, the air intake closes and the engine uses liquid oxygen pumped from its internal tanks.

How Skylon gets into space
1. Skylon takes off in the same manner as a combat jet, but will require a runway about 5.6km long.
2. During the initial climb, Skylon's engines operate in air-breathing mode. During this time the engines collect oxygen from the atmosphere which is used to fuel its ascent.
3. It takes Skylon almost two hours to climb to 28km and reach a speed of almost 5,400kph (3,350mph).
4. At an altitude of 28km, the Sabre engine shifts to rocket mode – the air intake closes and it burns its internal fuel supplies. The rockets accelerate Skylon to more than 26,500kph (16,500mph).
5. Skylon's rockets carry the craft to an altitude of 300km at which point the main engines cut off and it uses smaller engines to manoeuvre into orbit.
6. The craft deploys its payload.
7. Skylon re-enters the Earth's atmosphere. Being much lighter than the Space Shuttle, Skylon can re-enter at a much lower speed – meaning it doesn't need the Shuttle's expensive land flag) heat tiles.
8. Skylon's landing speed is about 240kph (150mph) – compared to the Shuttle which lands at up to 600kph (400mph).

Orbital insertion/payload delivery
Re-entry and descent

At take-off Skylon weighs 275 tonnes but by the time it lands, it will weigh just 55 tonnes.

Graphics: Ben Gilliland

I progetti sull'iperersonica nel resto del mondo

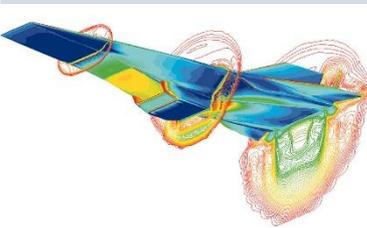
Velivoli Ipersonici – Mappatura principali iniziative Internazionali

Progetti USA (2000-2015)

HyFly
(DARPA)
Hypersonic missile
(Mach 6) with Dual
Combustor Ramjet



X-43
(NASA/Boeing)
unmanned scramjet
(Mach 7-9)



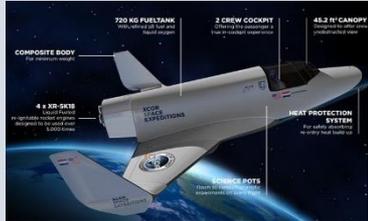
X-51 (WaveRider)
(NASA/Boeing)
unmanned scramjet
(Mach 6)



SR-72 →
(NASA/LockheedM.)
unmanned
hypersonic aircraft
(Mach 6)



Lynx
(XCOR Aerospace)
horizontal-takeoff,
horizontal landing,
rocket powered



Space Shuttle
(NASA)



X-37
(NASA/Boeing)
unmanned flight
demonstrator;
Automated Reentry
and Landing



HTV-2 (Falcon Project)
(DARPA/USAF)
Mach22 in volo sub-
orbitale



SpaceShip Two
(Virgin Galactic)
Suborbital Passenger
spaceplane (Space
Tourism)



Dream Chaser →
(Sierra Nevada
Corporation)
Trasporto passeggeri in
orbita terrestre bassa



SR-72 (Lockheed Martin per USAF)

- Successore del Lockheed SR-71 Blackbird;
- UAV ipersonico (Mach 6) progettato a scopo militare (ricognizione e sorveglianza);
- Utilizza un motore ibrido a ciclo combinato:
 - turbojet fino a Mach 2;
 - motore scramjet fino a Mach 6.
- I materiali sono titanio e fibre di carbonio; il TCS dovrà garantire la sopravvivenza degli equipaggiamenti a condizioni di temperature estreme.
- La costruzione di un dimostratore scalato è prevista per il 2018 con test di volo pianificato per il 2023;





Dream Chaser (Sierra Nevada Corporation)

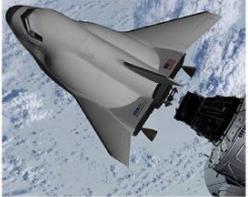
- Spazioplano riutilizzabile progettato per rifornire la Stazione Spaziale Internazionale;
- Previsto sia nella versione cargo che in quella manned, potrà trasportare da 2 a 7 passeggeri;
- Prevede decollo vertical; sarà in grado di rientrare dallo spazio come un glider e di atterrare su pista convenzionale;
- Dotato di motore a razzo ibrido, lo stesso utilizzato sullo SpaceShip Two;
- TPS ablativo sostituibile;
- Il primo test orbitale è pianificato per fine 2016. Verrà utilizzato il razzo ATLAS V.



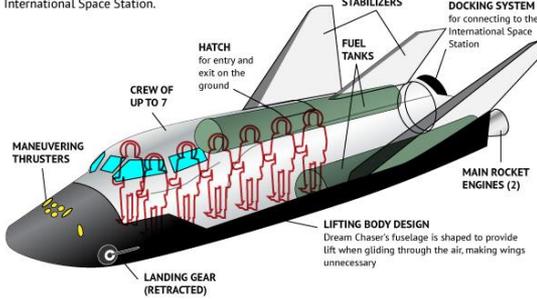
SPACE

COMMERCIAL SPACECRAFT SIERRA NEVADA DREAM CHASER

This small spaceplane is based on designs that NASA and Russian engineers experimented with in the 1980s and 1990s. Dream Chaser would be launched on an Atlas 5 rocket and would be capable of ferrying astronauts and cargo to the International Space Station.

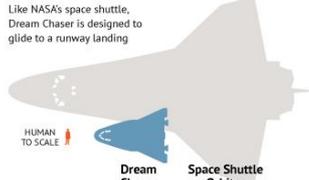


Simulation of Dream Chaser docking with the International Space Station (CREDIT: SIERRA NEVADA)



Labels in diagram: MANEUVERING THRUSTERS, CREW OF UP TO 7, HATCH for entry and exit on the ground, STABILIZERS, FUEL TANKS, AFT HATCH AND DOCKING SYSTEM for connecting to the International Space Station, MAIN ROCKET ENGINES (2), LIFTING BODY DESIGN (Dream Chaser's fuselage is shaped to provide lift when gliding through the air, making wings unnecessary), LANDING GEAR (RETRACTED).

Like NASA's space shuttle, Dream Chaser is designed to glide to a runway landing.



HUMAN TO SCALE

	Dream Chaser	Space Shuttle Orbiter
Builder	Sierra Nevada	Rockwell Int'l.
First crewed flight	to be determined	1981
Crew	up to 7	up to 7
Launch vehicle	Atlas 5	STS
Length overall	29.5 ft (9 m)	122 ft (37 m)
Wingspan	22.9 ft (7 m)	78 ft (24 m)



Dream Chaser's design is based on the HL-20 spaceplane (above) designed by NASA's Langley Research Center in 1990. HL-20 had been inspired by the BOR-4 vehicle tested by the Soviet Union in 1982 (CREDIT: NASA)

SOURCES: SIERRA NEVADA, NASA

KARL TATE / © SPACE.com

Velivoli Iperpersonici – Mappatura principali iniziative Internazionali

<p><i>Australia</i></p>	<p>HyShot (HIFire program) hypersonic waverider Mach 8</p> 	<p>Scramspace (Queenslan University) Scramjet-based Access-to-Space System</p> 
--------------------------------	---	---

<p><i>Giappone</i></p>	<p>SpacePlane (NAL/Mitsubishi) Aerospazioplano Scramjet, 10 passeggeri</p> 	<p>HIKARI Project (JAXA + EC) high speed transport vehicle architecture study</p> 	<p>HOPE-X/HOPE (Jaxa) Exp. Spaceplane, access to ISS</p> 
-------------------------------	---	---	---

Velivoli Ipersonici – Mappatura principali iniziative Internazionali

Progetti Paesi Emergenti: India e Cina

India	<p>HSTDV (Indian Defence Research and Development) unmanned scramjet Mach 6.5</p> 	<p>BrahMos I-II (INDIA/RUSSIA BrahMos Aerospace Private Limited) hypersonic cruise missile System</p> 	<p>Avatar/RLV (Indian Defence Research and Development) Hypersonic Reusable Vehicle for transatmospheric transportation</p> 
--------------	--	---	--

Cina	<p>The Missing Drone Mach 4+ test drone in Sept. 2015 combined cycle turbo-ramjet</p> 	<p>Shadow Dragon Hypersonic Bomber combined turbine/scramjet engine Mach 5+</p> 
-------------	--	--

Velivoli Ipersonici - Tassonomia

