

# ROCKETPLANE GLOBAL



**Manfred Lochs Conference  
on Regulation of Emerging  
Modes of Transportation  
XP Program Briefing  
May 24, 2013**

This Document contains Proprietary Information of Rocketplane Global, Inc.  
Disclosure to others, use or copying without the express written authorization of Rocketplane Global, Inc. is strictly prohibited.

# The Suborbital Markets



<p><b>COMMERCIAL HUMAN SPACEFLIGHT</b></p> <p><i>Human spaceflight experiences for tourism or training</i></p> <ul style="list-style-type: none"> <li>Individuals</li> <li>Corporate</li> <li>Contests and promotions</li> <li>In-space personnel training</li> </ul>	<p><b>BASIC AND APPLIED RESEARCH</b></p> <p><i>Basic and applied research in a number of disciplines, leveraging the unique properties of and access to the space environment and microgravity</i></p> <ul style="list-style-type: none"> <li>Biological and physical research</li> <li>Earth science</li> <li>Space science</li> <li>Human research</li> </ul>
<p><b>AEROSPACE TECHNOLOGY TEST AND DEMONSTRATION</b></p> <p><i>Aerospace engineering to advance technology maturity or achieve space demonstration, qualification, or certification</i></p> <ul style="list-style-type: none"> <li>Demonstrations requiring space/launch environment</li> <li>Hardware qualification and test</li> </ul>	<p><b>MEDIA AND PUBLIC RELATIONS</b></p> <p><i>Using space to promote products, increase brand awareness, or film space-related content</i></p> <ul style="list-style-type: none"> <li>Film and television</li> <li>Media, advertising, and sponsorship</li> <li>Public relations and outreach</li> <li>Space novelties and memorabilia</li> </ul>
<p><b>EDUCATION</b></p> <p><i>Providing opportunities to K-12 schools, colleges, and universities to increase access to and awareness of space</i></p> <ul style="list-style-type: none"> <li>K-12 education</li> <li>University educational missions</li> </ul>	<p><b>SATELLITE DEPLOYMENT</b></p> <p><i>The use of SRVs to launch small payloads into orbit</i></p> <ul style="list-style-type: none"> <li>Very small satellite launches</li> </ul>
<p><b>REMOTE SENSING</b></p> <p><i>Acquisition of imagery of the Earth and Earth systems for commercial, civil government, or military applications</i></p> <ul style="list-style-type: none"> <li>Commercial Earth imagery</li> <li>Civil Earth imagery</li> <li>Military surveillance</li> </ul>	<p><b>POINT-TO-POINT TRANSPORTATION</b></p> <p><i>Future transportation of cargo or humans between different locations</i></p> <ul style="list-style-type: none"> <li>Fast package delivery</li> <li>High-speed passenger transportation (civil)</li> <li>High-speed troop transportation (military)</li> </ul>

Figure 1: SRV market definitions

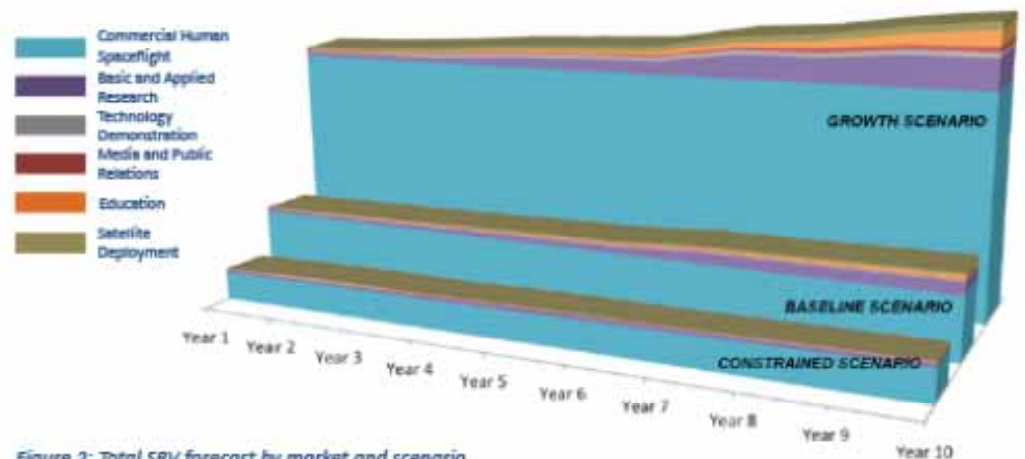


Figure 2: Total SRV forecast by market and scenario

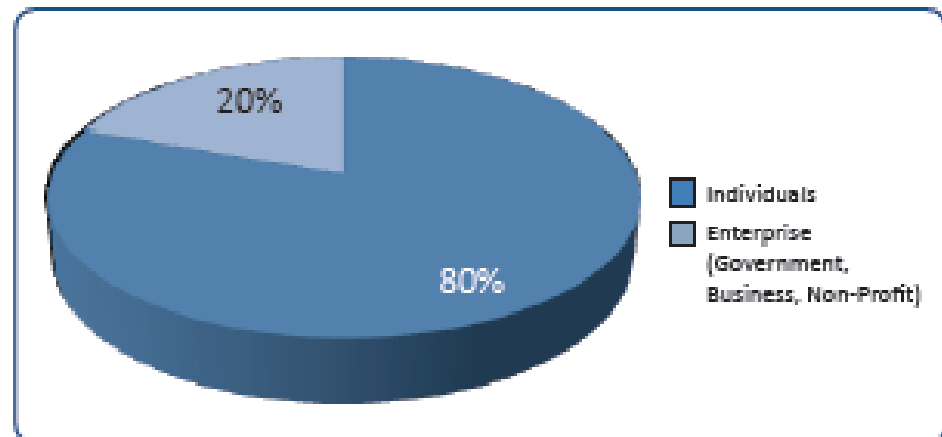
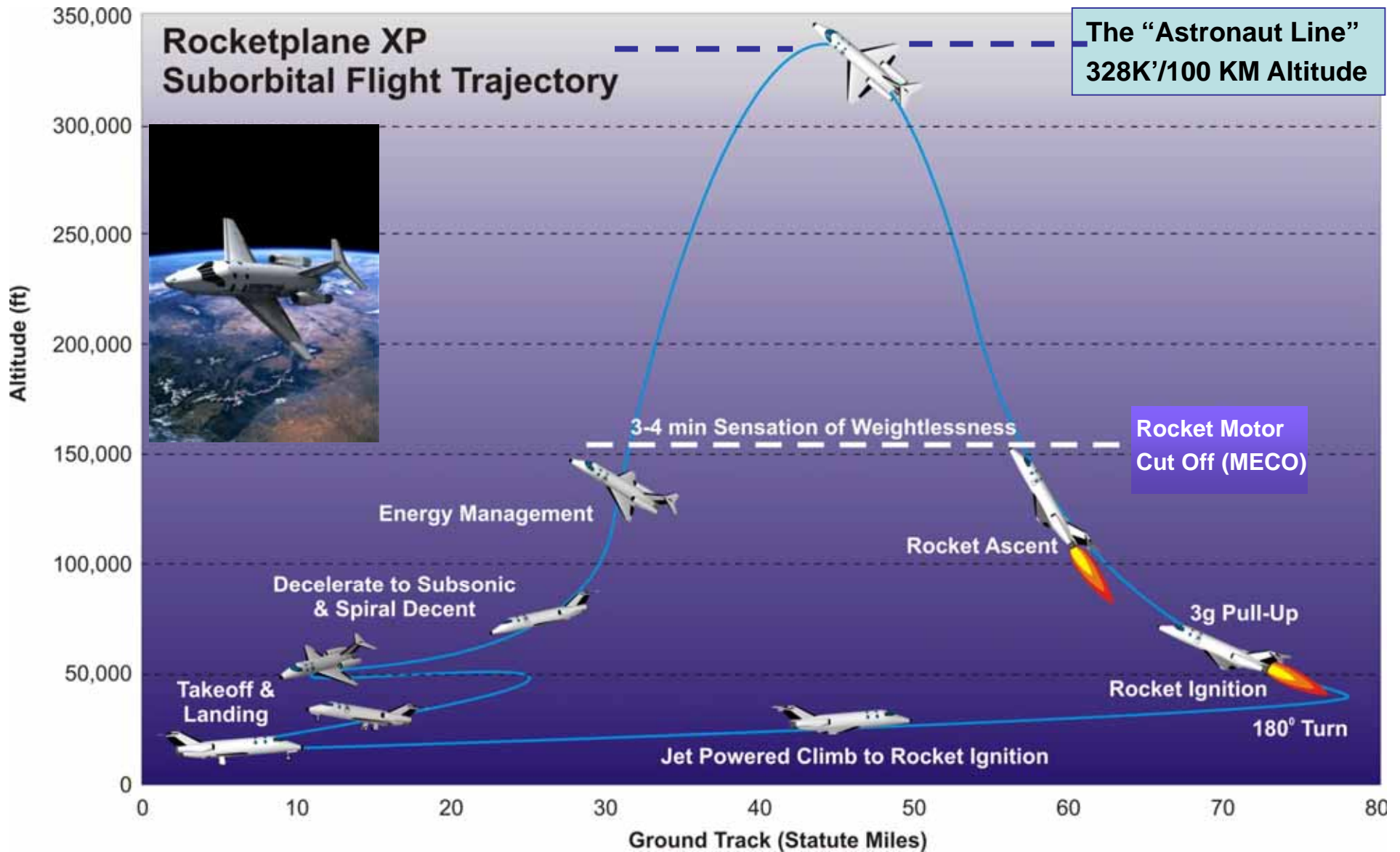


Figure 5: Enterprise demand and individual demand in baseline case

Source: FAA/AST – SpaceFlorida Suborbital Market Study by Tauri Group, July 2012

# The Rocketplane Flight Profile



# The View From 100 km



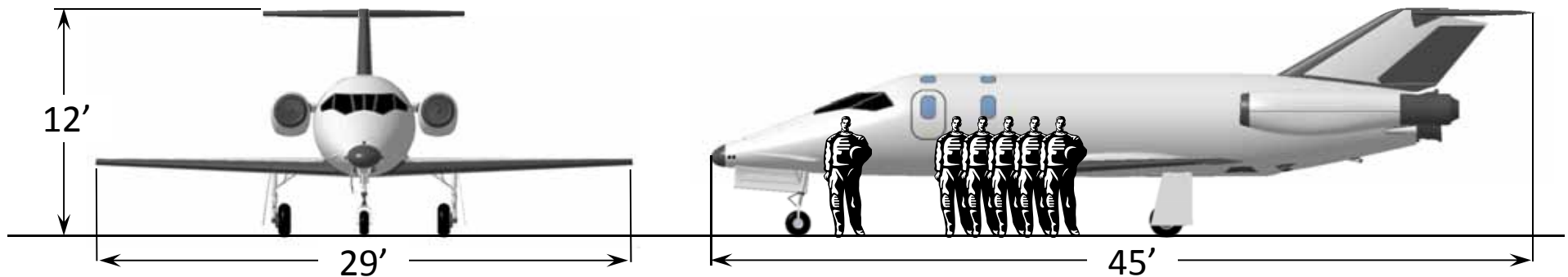
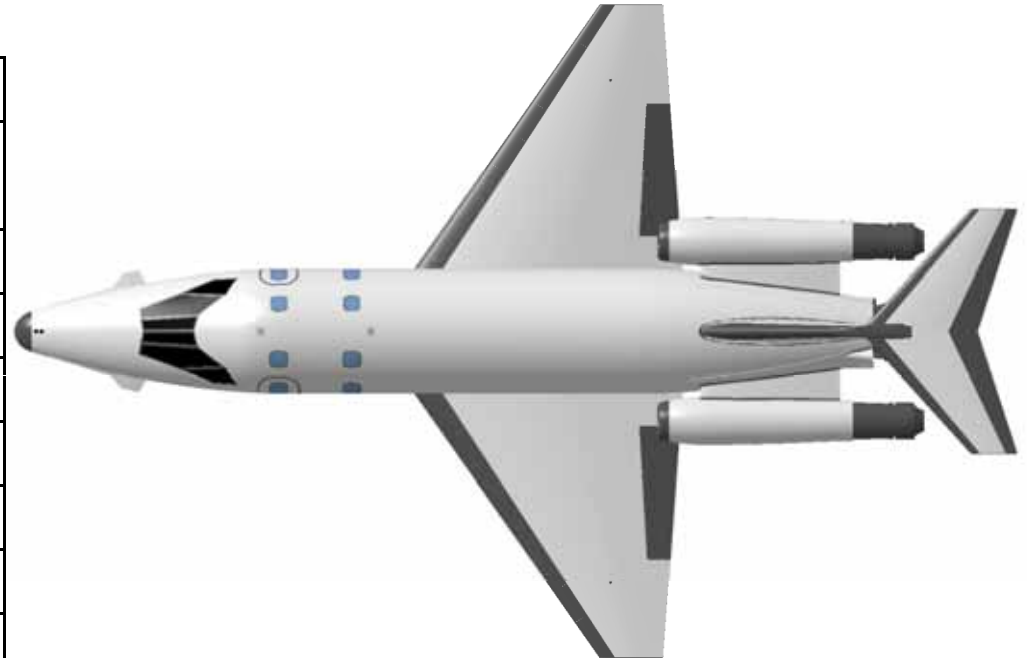
The Blackness of Space  
The Curvature of the Earth  
Weightlessness  
Full-Surround **SPACE VISION**

Interior Designed by Frank Nuovo  
•Chief of Design for Nokia  
•Design Director for BMW/Designworks

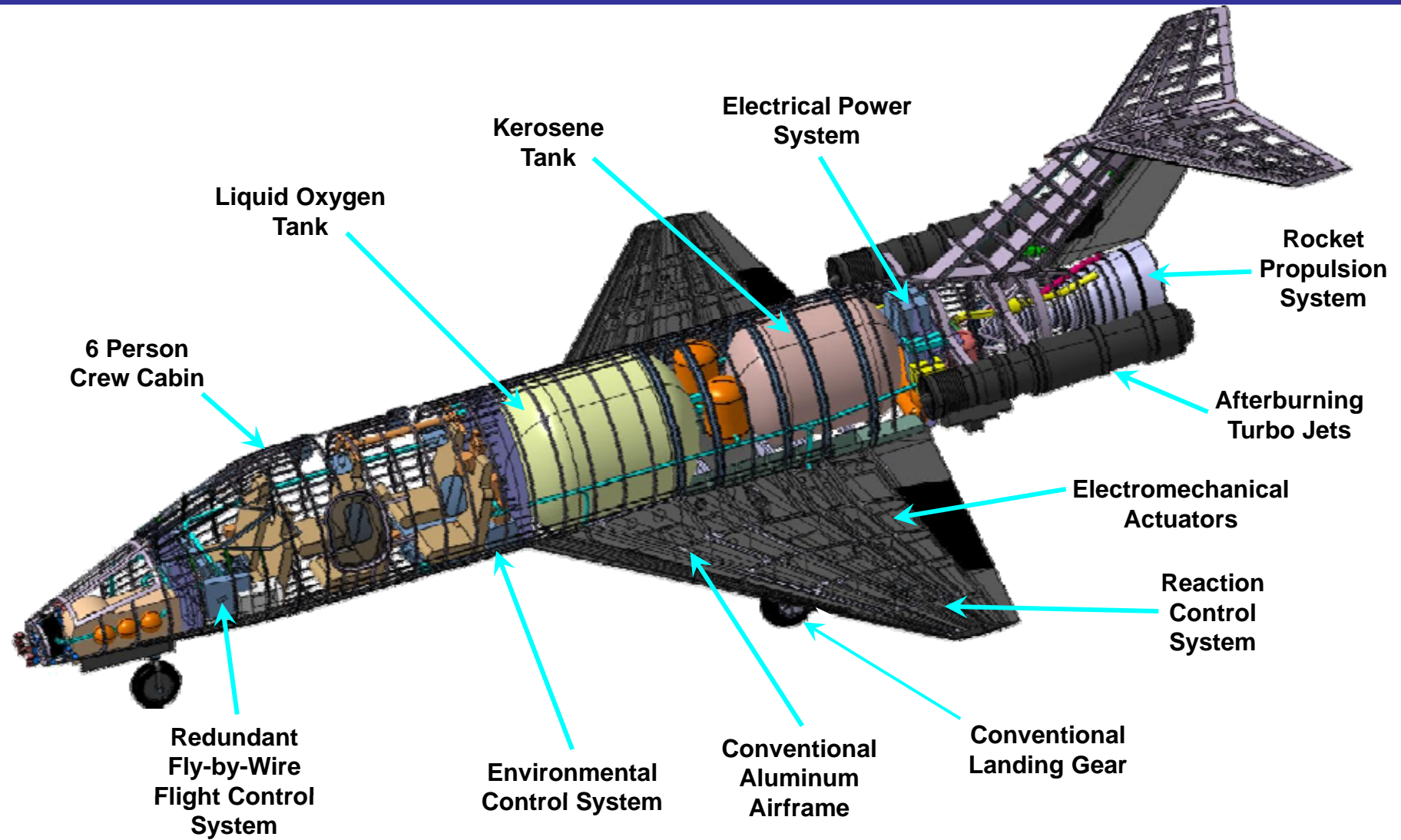
# XP Vehicle Specifications



<b>Cockpit Crew</b>	<b>1</b>
<b>Seating Capacity</b>	<b>6 (5 passengers + pilot)</b>
<b>Seat Pitch</b>	<b>36 in (0.91 m)</b>
<b>Takeoff Field Length</b>	<b>9200 ft (2800 m)</b>
<b>Landing Field Length</b>	<b>4300 ft (1300 m)</b>
<b>Max. Altitude</b>	<b>340,000 ft (104 km)</b>
<b>Mission Time (<math>\mu</math>G Time)</b>	<b>45 min (3+ min)</b>
<b>Jet Engine Type</b>	<b>GE J-85 w/ AB</b>
<b>Rocket Engine Type</b>	<b>Polaris AR-36</b>



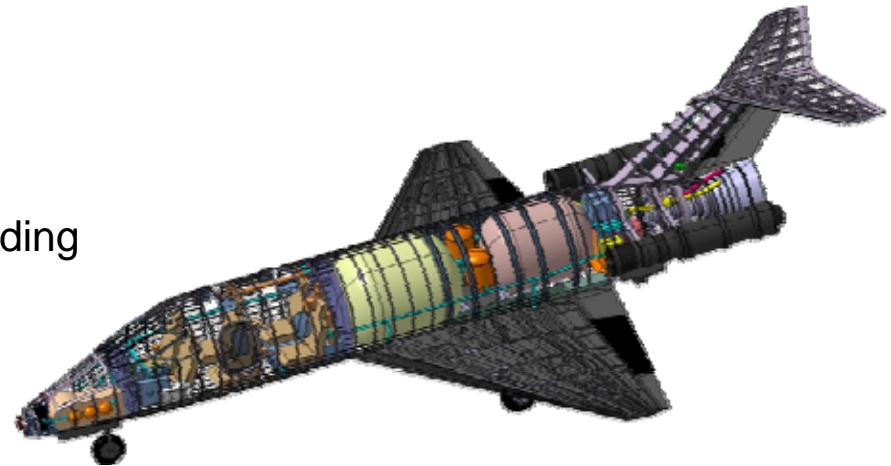
# Systems Overview



# Designed For Safety



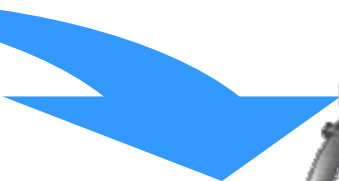
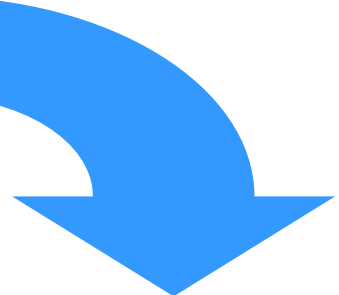
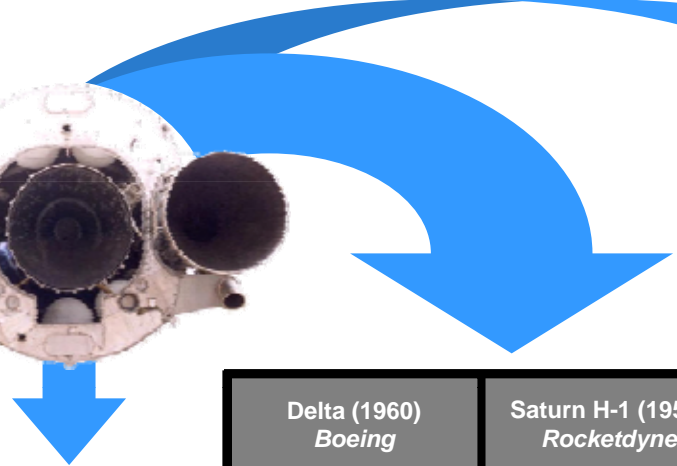
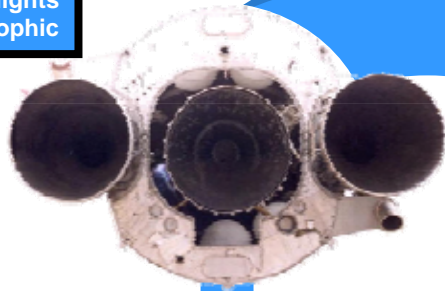
- **Combined Jet-Rocket Architecture Allows More Abort Options**
  - RP is a Fuel Used By Both XP Rocket and Jet Engines
- **Abort Scenarios:**
  - During Jet-Powered Profile
    - Jettison LOX
    - Transfer RP as Required
    - Fly Conventional Aircraft Mode to Landing
  - During Rocket Assent
    - Jettison LOX
    - Transfer RP as Required
    - Fly Conventional Aircraft Mode to Landing
  - During Ballistic Trajectory
    - Continue Unpowered Profile
    - Fly Normal Glide-Assist Aircraft Mode to Landing



# Proven Rocket Technology



**Atlas Sustainer Engine**  
 (1959) *Rocketdyne*  
 Over 550 Successful Flights  
 Only 3 failures all non-catastrophic



**Navajo (1956)**  
*North American Aviation*

**Thor / LR-79 (1958)**  
*Rocketdyne*



**Atlas booster (1959)**  
*Rocketdyne*



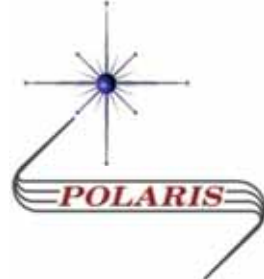
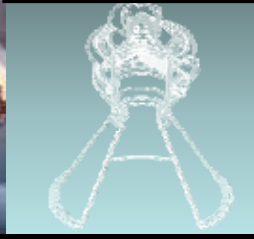
**Delta (1960)**  
*Boeing*



**Saturn H-1 (1959)**  
*Rocketdyne*



**RS-88 (2004)**



<b>Polaris AR-36 (2008)</b>	
Propellants	LOX / RP
Isp (vac)	309 sec
Thrust (vac)	36,000 lbf
Thrust to Weight	80



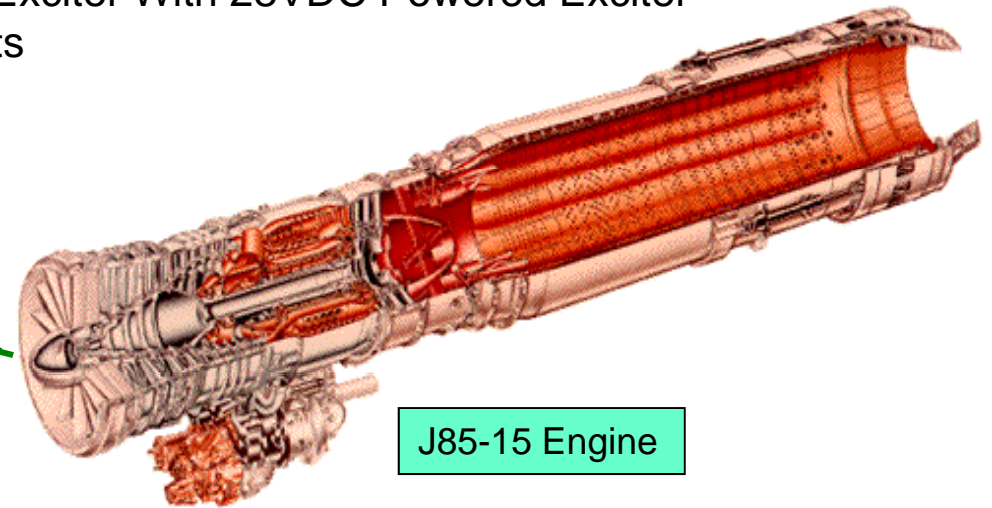
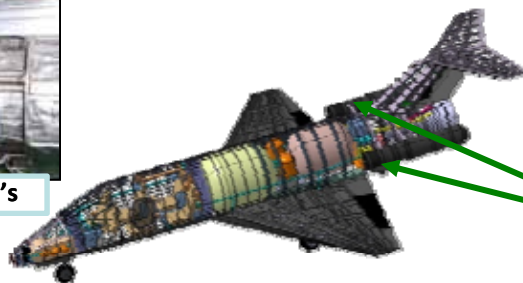
# Jet Propulsion System



- **XP Uses Two J85-15 Turbojet engines**
  - Millions of Operating Hours- Military and Commercial
  - Each provide 4300 lbf of thrust 11 engines Purchased from Canadian Air Force
- **Orenda Turbines Selected Supplier**
  - Subsidiary of Magellan Aerospace Corp
  - Repair, Modification and Testing
- **Modifications:**
  - Replace QEC Kit With Air Start Inlet Check Valve For Ground Start Capability
  - Replace the AC-Powered Ignition Exciter With 28VDC Powered Exciter
  - Blank Off the Customer Bleed Ports



Purchased J-85's



J85-15 Engine

# Flight Control Actuators

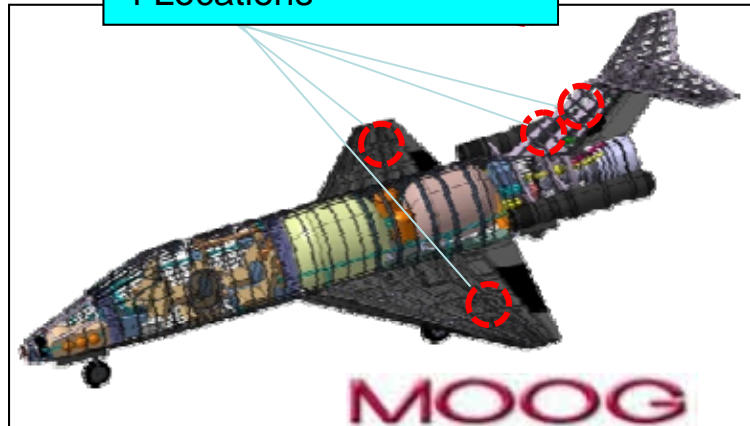


- **Use: Atmospheric Attitude Control and Maneuverability**
- **Design:**
  - Off-The-Shelf, Proven Design
  - Used on Boeing 787
  - Developed by Moog
  - Quality Supplier With Decades of Aerospace Experience Electromechanical Actuators
  - Drive Flaperons, Horizontal Stabilizer, Rudder
  - System is Redundant and Fully Electric (270V)
- **Status**
  - Firm Fixed Price From Moog
  - Conceptual Design Complete



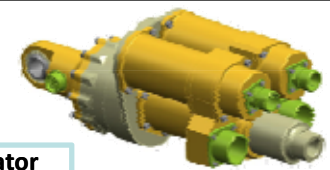
Boeing 787

Common Actuator In All 4 Locations



- Fully Electric
- Redundant Motors

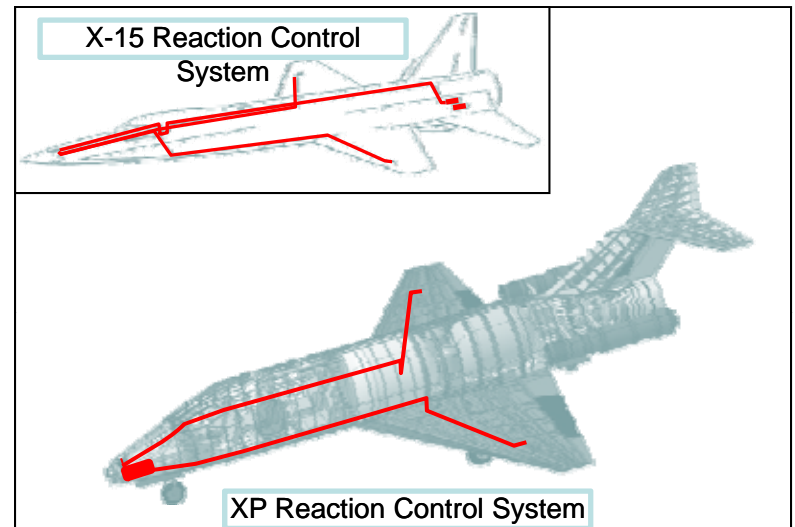
XP Actuator



# Reaction Control System



- **Use: Space Attitude Control and Maneuverability**
- **Design:**
  - Off-The Shelf Components, Proven Design
  - Used For Maneuvering During Space Flight
  - Based on X-15 Flight Control System
  - Hot Gas System Utilizing 90% H<sub>2</sub>O<sub>2</sub>
  - Pitch and Yaw Thrusters: 75 lbf
  - Roll Thrusters: 15lbf
  - Eight Thrusters In Nose
  - Two On Each Wing
  - Redundant For Safety
- **Status:**
  - Conceptual Design Established
  - Notional Routing Layout Complete



# Landing Gear System



**Loud Engineering  
& Manufacturing, Inc.**  
A CIRCOR International company

## Landing Gear System: Simple Design With Off-The-Shelf Components

- **Design**
  - Based on Gear From the F-5 Fighter Jet
  - Features Nose Wheel Steering
  - Features Brakes/Antiskid Functions
  - Self-Contained Electro-Hydraulic Retract/Deploy System
- **Status**
  - Conceptual Design Complete



SR-71



F-117



F-16



F-5



F-18

# ECLSS Preliminary Design Is Mature



## ECLSS Test Chamber

- Complete and Checked Out
- Used For Development & Qualification Testing
- Interim Technical Review completed May 06
- ECLSS design at PDR level
- Components identified
- Schematic complete
- FMECA Completed



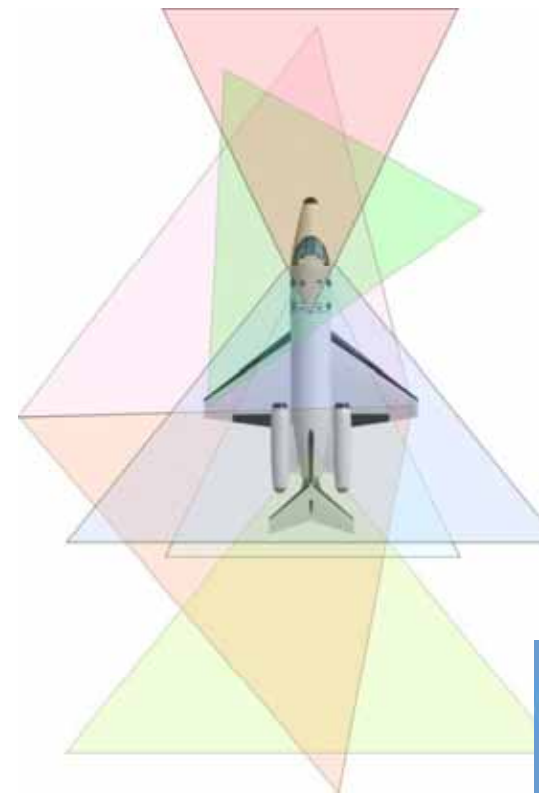
# Camera System



- **XP Camera Uses**
  - Flight Test (Visual and IR (Heat) Capable)
  - Hi-Res Science and Reconnaissance Missions
  - Passenger “SPACE VISION”
- **XP Has 8-Camera System**
  - Part of Data Acquisition System (DAS)
  - 5+ Lenses Available for Tailored Views, Even “Fish-eye”
  - Full Resolution Video Compressed and Stored on Board
  - Variable Frame Rate & Resolution Transmitted to Ground
  - Full Resolution Streamed to Passenger Monitors-”SPACE VISION”
- **Flight Proven Hardware Flown on Shuttle, Multiple NASA and DoD Missions**



Cameras



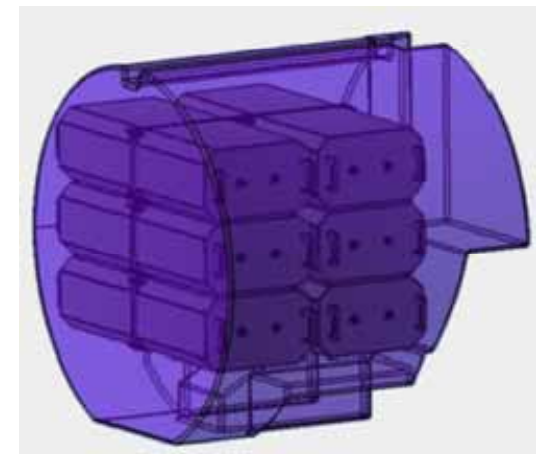
# Contractor Team



# NASA KSC FastRack Program

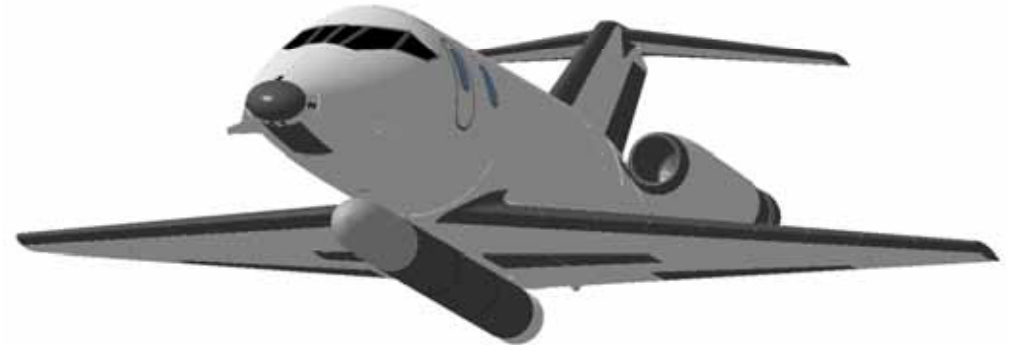


- **GOAL** – bring suborbital microgravity research activity to KSC
- **Modular System**
  - 1 FastRack = 1 passenger seat
- **Prototype Completed**
- **Flight Testing August 2009**
- **Space Life Sciences Lab payload integration support facilities available**
- **XP provide on-board Payload Specialist work station for customers**





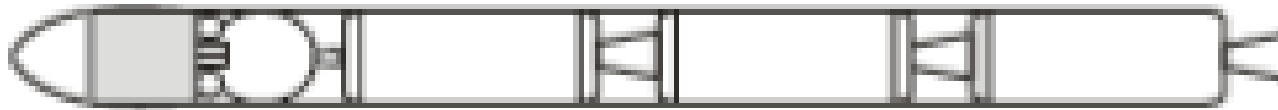
# Small Satellite Launch Missions



- **With Upper Stage:**
  - Micro/NanoSat ~50kg to 100km LEO
- **Reconnaissance/Tech Demo**
  - XP can carry >2000lb payload in lieu of passengers without major modification
  - At apogee horizon approximately **700 miles**
  - Payload mount on seat rails, modified window viewport
  - Tech Demo: Telescopes, Star Trackers, Air Data Systems, IVHMS & other avionics
- **Operational Demonstration: Rapid Turn Around, Rapid Time-To-Launch, etc.**

XP ORS		Upper Stage
Small Sat	~25-50kg 100km	

# Several Upper Stage Options

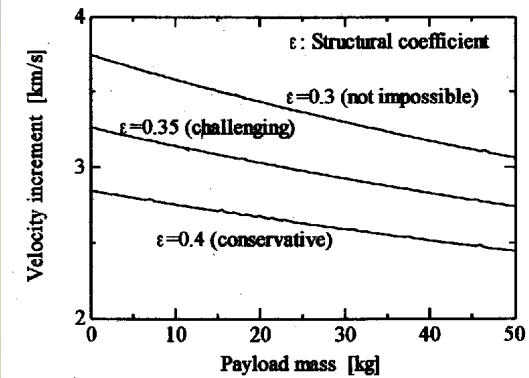
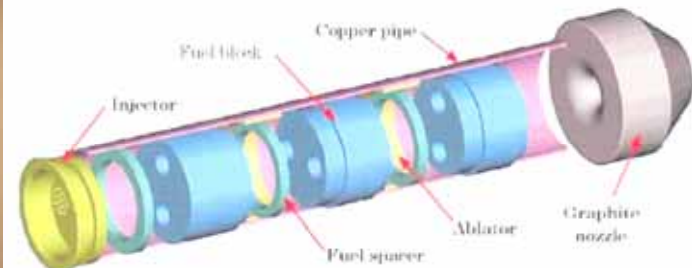


Star 20B Stack – MATRA alternative?

## New Liquid Fuel Upper Stages



## CAMUI Hybrid Rocket



Velocity increment vs. Payload mass (Isp = 317 s)

# A Global Spaceport Network



- **Spaceport Oklahoma (1<sup>st</sup>)**

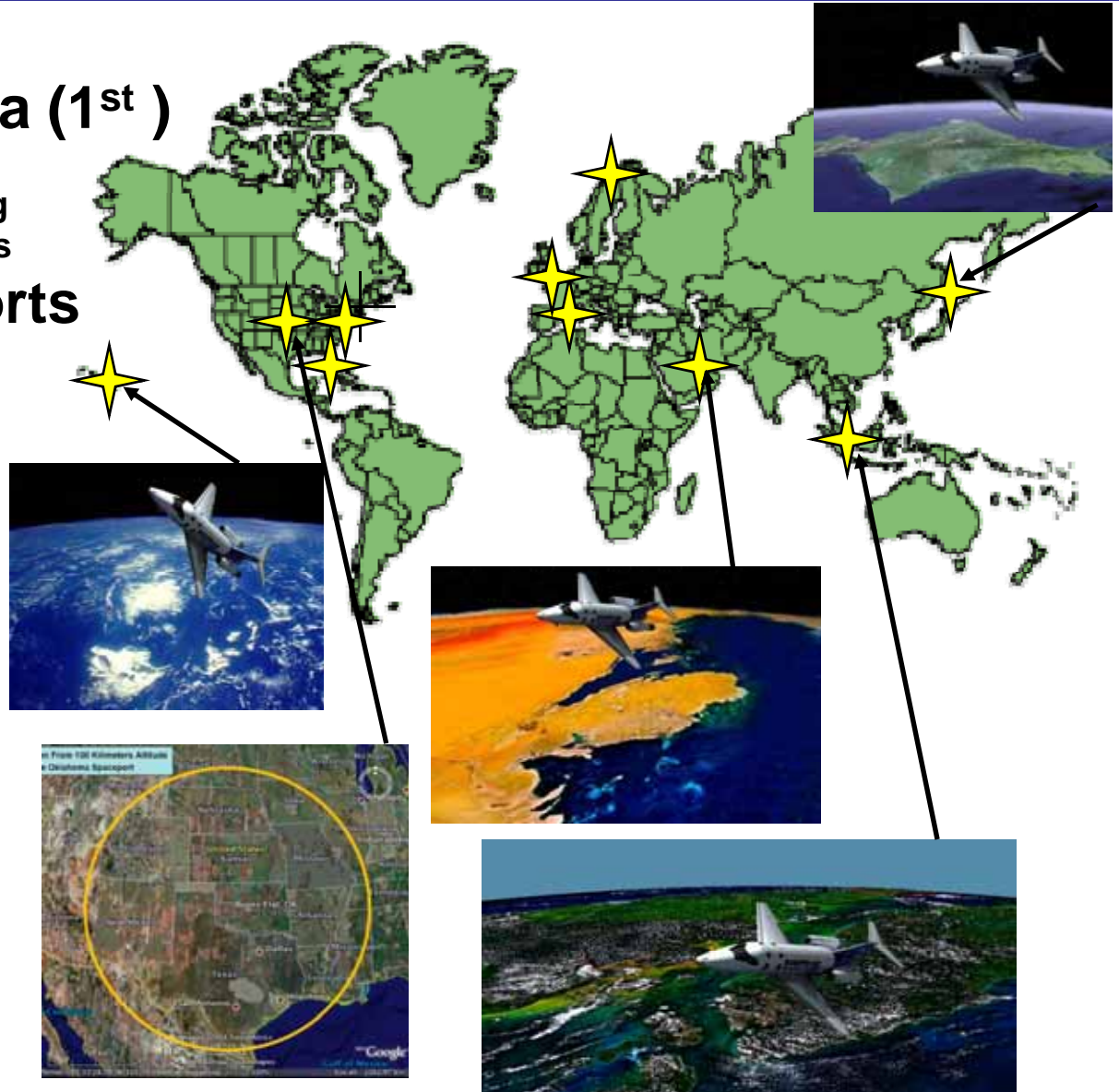
- Licensed Spaceport
- Flight Test and Manufacturing
- Continued 1-2 ship operations

- **Secondary Spaceports**

- Cecil Spaceport FL
- Kennedy Space Center
- Spaceport Hawaii
- Spaceport Barcelona
- EU Spaceport Lelystad
- Singapore Spaceport

- **Future Potentials**

- Hokkaido Spaceport
- Puerto Rico Spaceport
- Swedish Spaceport
- Virginia Spaceport



# Oklahoma Flight Operations



- 2,700 acres of inland property, 168 square-mile Spaceport Territory.
- 13,500 foot runway.
- On-site medical facility with pharmacy and a crash and rescue unit.
- 300 VFR flying days per year.

OSIDA Mission Control

Rocketplane Hangar

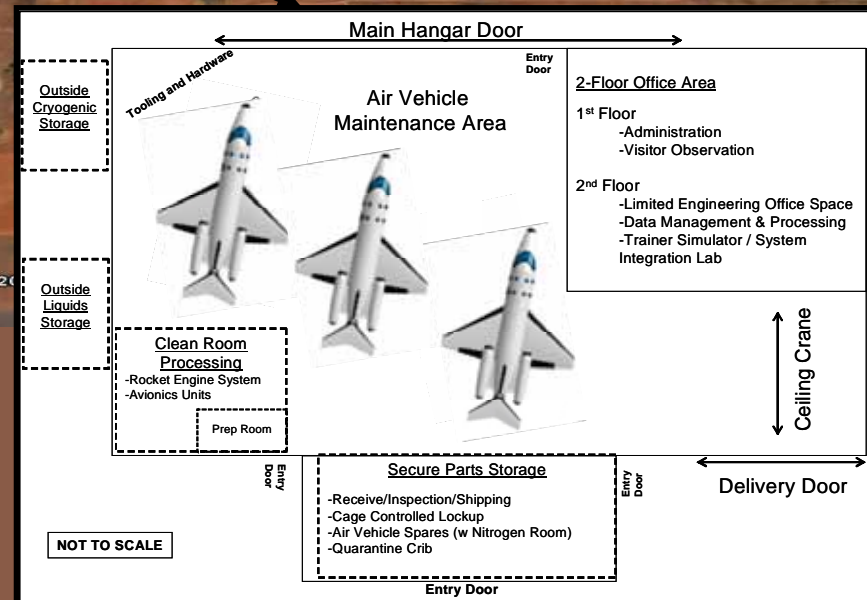
Telemetry Antenna Tower

Planned Rocket Engine Test Site




Pointer 35°20'31.28" N 99°11'48.68" W


Image © 2011



# Cecil Spaceport -JAX Florida FAA/AST License Approved




Federal Aviation  
Administration



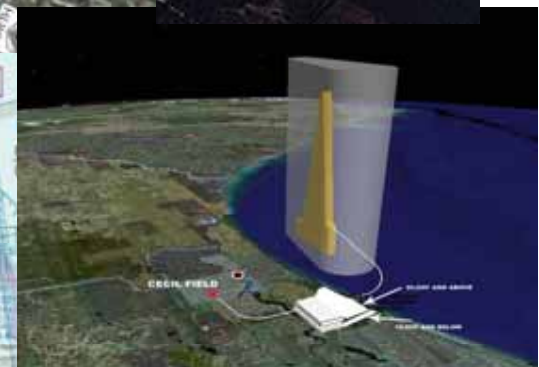
## Draft Environmental Assessment for Jacksonville Aviation Authority Launch Site Operator License at Cecil Field, Florida

April 2009



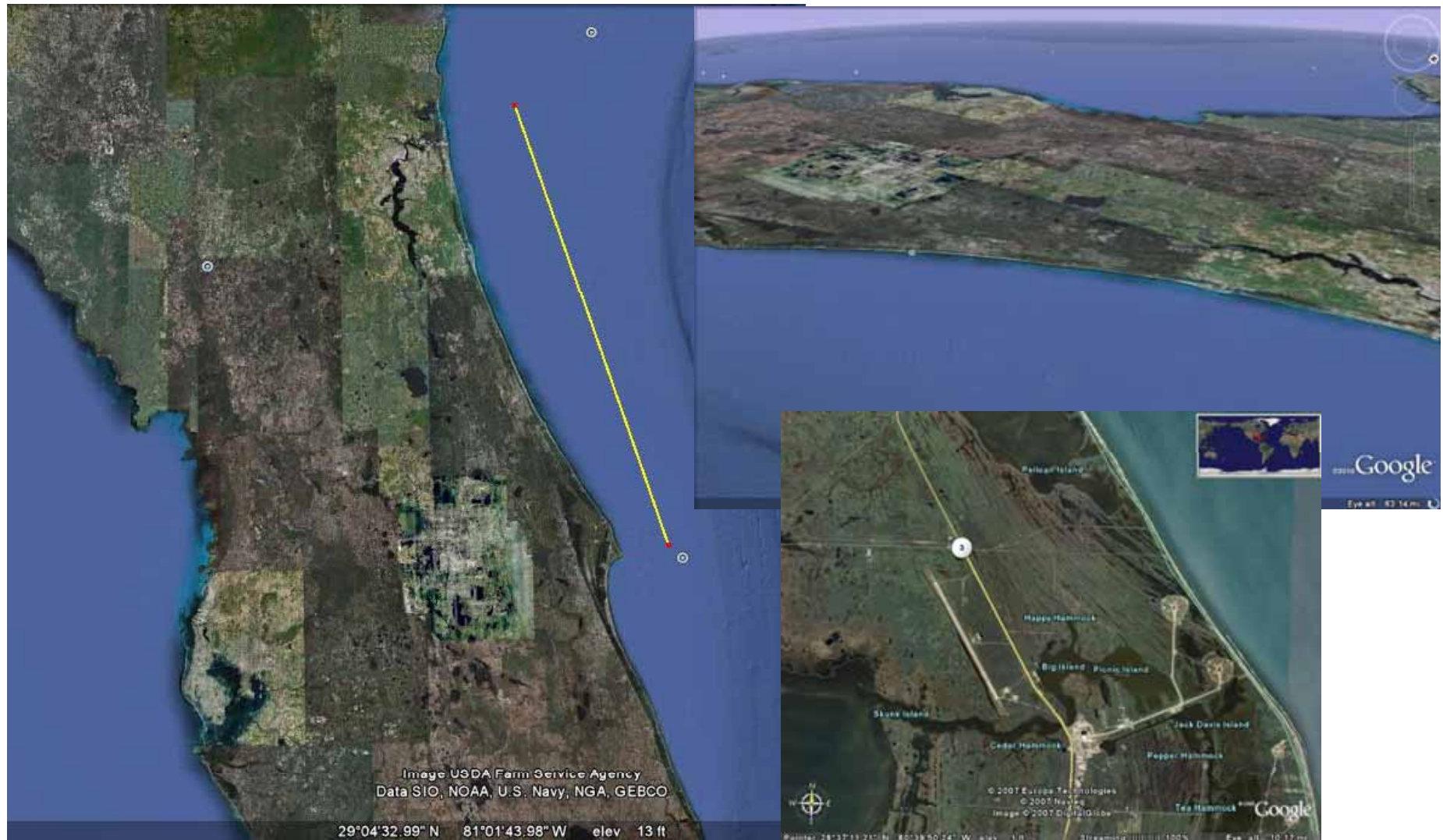
**CECIL  
FIELD**

JACKSONVILLE  
ESTABLISHED 1901



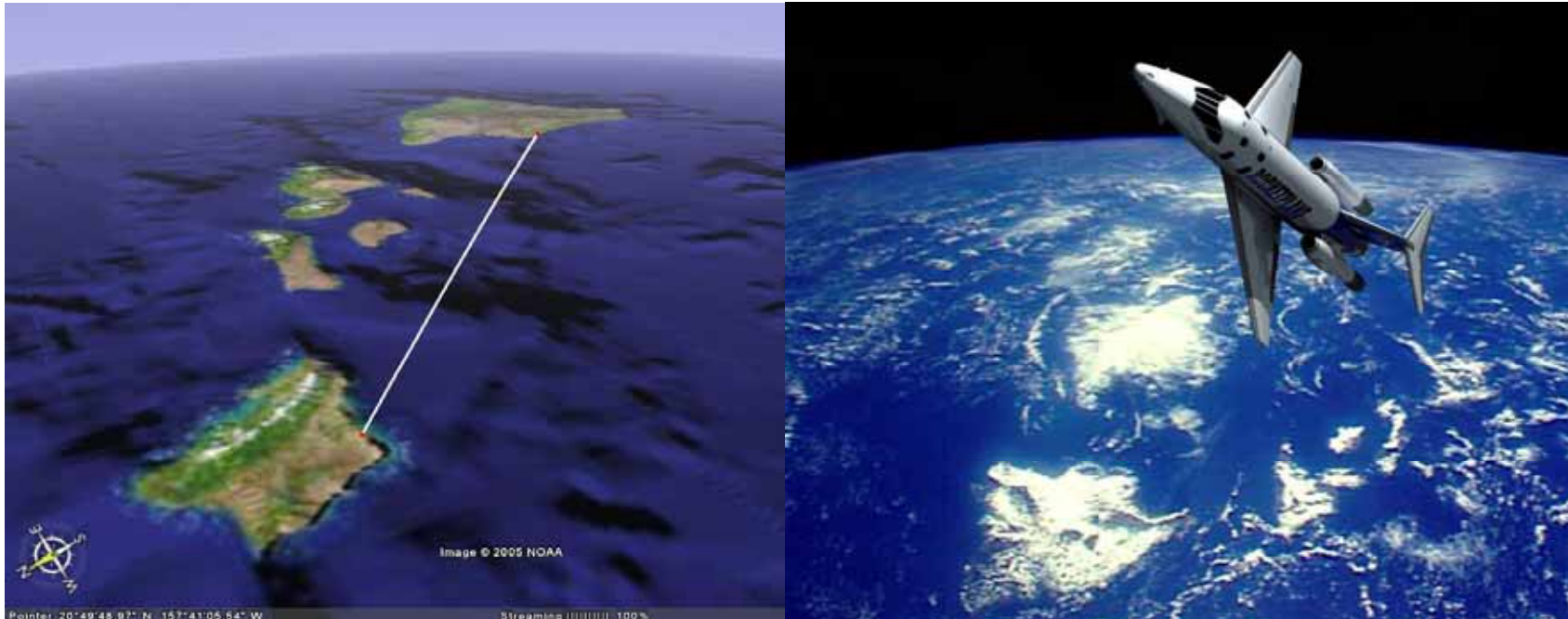
This Document contains Proprietary Information of Rocketplane Global, Inc.  
Disclosure to others, use or copying without the express written authorization of Rocketplane Global, Inc. is strictly prohibited.

# Florida P2P Testbed Corridor



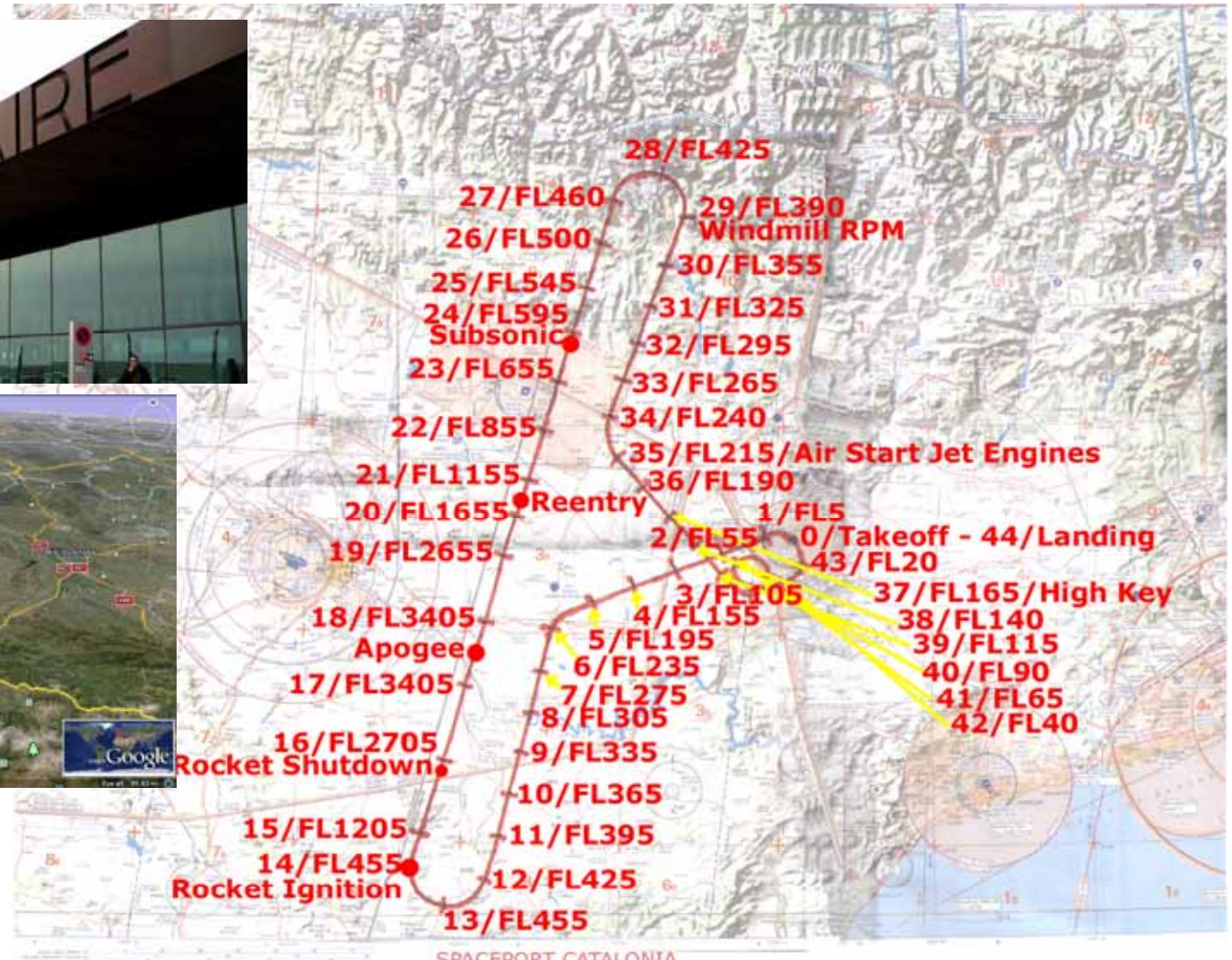
This Document contains Proprietary Information of Rocketplane Global, Inc.  
Disclosure to others, use or copying without the express written authorization of Rocketplane Global, Inc. is strictly prohibited.

# SPACEPORT HAWAII



- A Rocketplane XP Suborbital flight operations base with related space-themed tourist attraction developments
- Prototype business model for global spaceport projects at major tourist destinations around the world
- Use of existing airport infrastructure & 5 Star resort lodging

# Barcelona Spaceport



SPACEPORT CATALONIA



# EU Spaceport Lelystad/NL



- Dual use GA airport + Spaceport
- Becomes a major regional tourist attraction
- Leverages billions in existing tourism & culture investments
- Co-located with NL National Aerospace Museum
- Use of North Sea military restricted areas for spaceflight



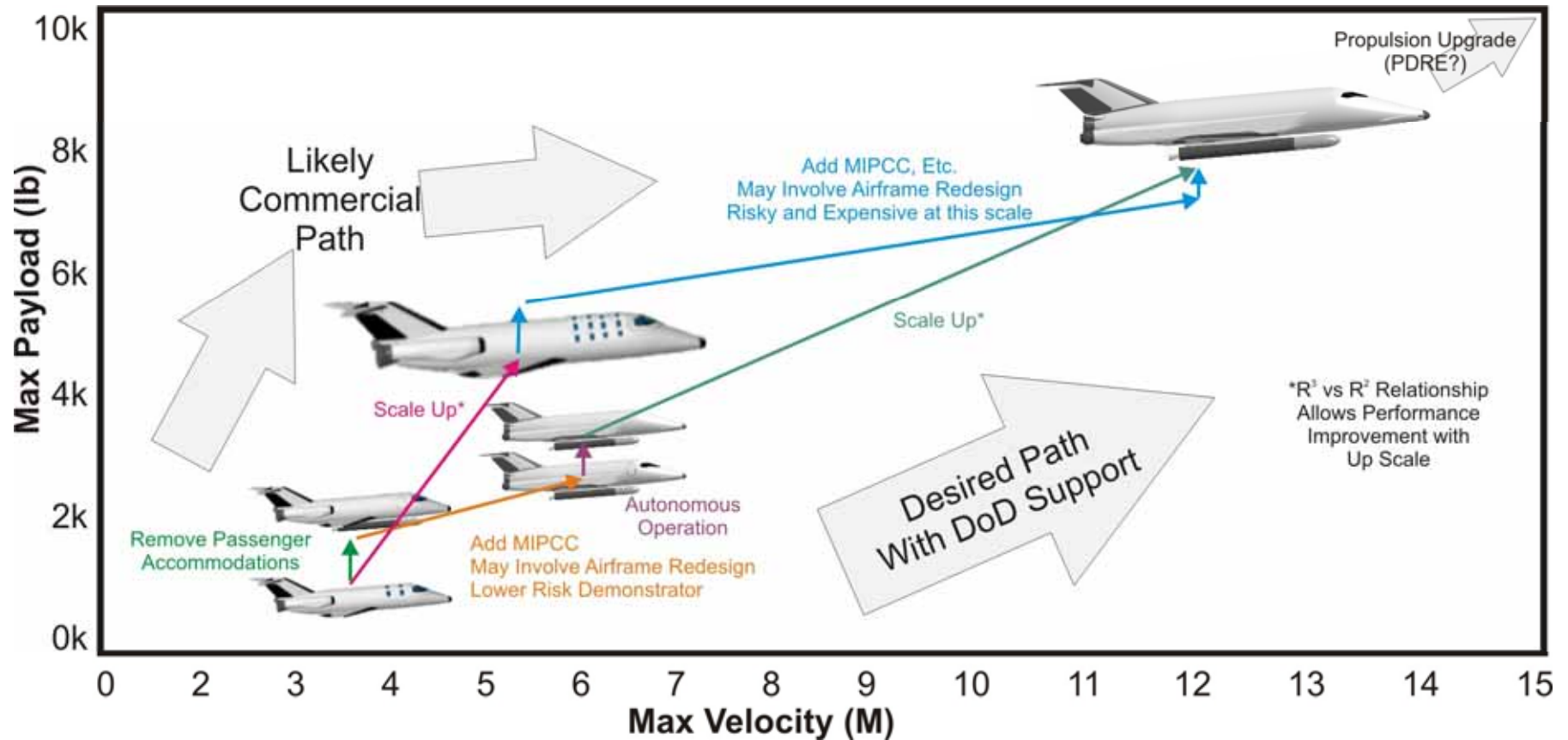
● Abort Landing Site

EU SPACEPORT LELYSTAD / NL  
Suborbital Spaceflight Corridor 1

# Rocketplane Growth Path



- Commercial Path unlikely to allow rapid advances in propulsive capability
- DoD Support Could accelerate development at small scale generating residual capabilities and big dividends for future capability.



This document contains proprietary information of Rocketplane Global, Inc.  
Disclosure to others, use or copying without the express written authorization of Rocketplane Global, Inc. is strictly prohibited.  
Disclosure to others, use or copying without the express written authorization of Rocketplane Global, Inc. is strictly prohibited.

# First EU Suborbital International Passenger and Cargo Hub



Netherlands to Spain Spaceflight Corridor



Netherlands to Doha Spaceflight Corridor



Netherlands to Singapore Spaceflight Corridor

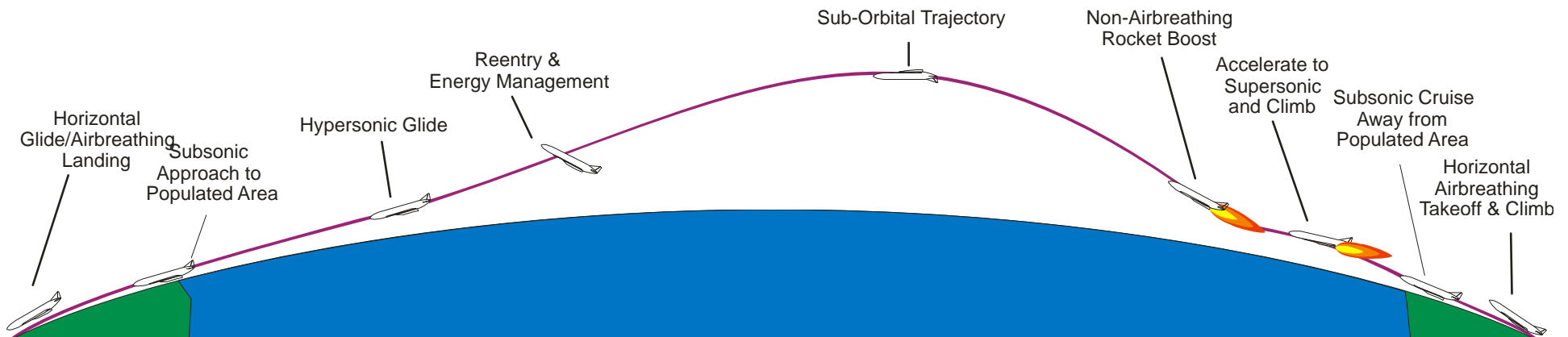
# The Future Vision Is Point-To-Point



- Develop A New Commercial Aerospace Industry
- Develop A World-Wide Network of Spaceports
- World-Wide P2P Service in <2hrs
- Global Same Day Logistics Service as Lead Market



Flight	Distance	Airliner	P2P Rocketplane
New York – Los Angeles	<b>2,500 miles</b>	<b>5 hrs</b>	<b>1.0 hr</b>
Memphis – Paris	<b>4,600 miles</b>	<b>9.25 hrs</b>	<b>1.25 hrs</b>
Los Angeles – Tokyo	<b>5,500 miles</b>	<b>12 hrs</b>	<b>1.5 hrs</b>



- **FAA/AST adopted “Fly at your own risk” regulatory model WITH informed consent and signed waivers of liability**
- **Launch licensing protects public safety but NOT space flight participants**
- **Legislation designed to allow new industry to grow and learn BEFORE moving to higher regulatory standards**
- **Flexible Guidelines promote safety without undue regulatory burden**

# Certification Cost Example



## • Embraer Phenom 300 vs. Learjet 25



- Cruise Speed: 834 km/h Mach 0.78
- Range: 3,650 km
- Passengers: 9 (+1 crew)
- Ceiling: 13,715 m
- Climb Rate: 20.2 m/sec
- Year Certified: 2009
- Price: ~ \$8,000,000



- Cruise Speed: 859 km/h Mach 0.81
- Range: 2,853 km
- Passengers: 8 (+2 crew)
- Ceiling: 13,715 m
- Climb Rate: 30.7 m/sec
- Year Certified: 1967
- Price: ~ \$500,000

- **Quote from Embraer Press Release**
  - “The overall certification campaign involved five aircraft that performed more than 1,200 flight test hours, certifying the aircraft for RVSM (Reduced Vertical Separation Minimum), day and night IFR (Instrument Flight Rules) operations, and flying into known and forecasted icing conditions. In addition, there were full-scale static and fatigue tests, and rigs were used for environmental, avionics, and electrical systems.”
- **400 engineers working for 3 years +**
- **Total investment ~ \$1 billion**