NASA’s Global Reach

458 Agreements: 118 countries and 5 international organizations

Europe
- Austria, Belgium, Bulgaria, Croatia, Cyprus,
- Czech Republic, Denmark, Estonia, EUMETSAT,
- ESA, EU,
- Finland, France, Germany,
- Greece, Hungary, Iceland,
- Ireland, Italy, Latvia,
- Liechtenstein, Lithuania,
- Luxembourg, Macedonia,
- Malta, Moldova, Monaco,
- Netherlands, Norway, Poland,
- Portugal, Romania, Russia,
- Serbia, Spain, Sweden,
- Switzerland,
- Turkey, Ukraine,
- United Kingdom

Central and South America
- Argentina, Bahamas, Bermuda, Bolivia, Brazil,
- Chile, Colombia,
- Costa Rica, Ecuador, El Salvador, Guatemala,
- Honduras, Mexico,
- Panama, Paraguay, Peru,
- Suriname, Trinidad & Tobago, Uruguay

Canada

UN

East Asia
- APCC, China, Japan,
- Mongolia, Korea,
- Taiwan

Africa and the Middle East
- Algeria, Bahrain, Benin,
- Burkina Faso, Cameroon,
- Cape Verde, Chad, Congo, Egypt,
- Ethiopia, Gabon, Gambia, Ghana,
- Guinea, Israel, Jordan, Kenya, Kuwait,
- Lebanon, Madagascar, Mali,
- Morocco, Mozambique, Namibia,
- Niger, Nigeria, Qatar, Rwanda,
- Saudi Arabia, Senegal,
- South Africa, Tanzania, Tunisia,
- Uganda, UAE

South and South East Asia
- Armenia, India,
- Bangladesh, Indonesia,
- Kazakhstan, Kyrgyzstan,
- Maldives, Nepal, Pakistan,
- Philippines, Sri Lanka,
- Thailand, Vietnam

Australia, Fiji,
- Kiribati, Marshall Islands,
- Micronesia, New Zealand,
- Palau
Supporting NASA Grand Challenges

NASA will support technology development and demonstrations that address Grand Challenges by providing a steady cadence of advanced space technology demonstrations allowing the infusion of flexible path capabilities for future exploration.

- Make space access economical
- Provide economical energy on demand
- Develop routine satellite servicing
- Forecast natural disasters
- Manage climate change
- Provide participatory exploration
- Improve spacecraft safety and reliability
- Provide carbon-neutral mobility
- Protect astronaut health
- Engineer faster space vehicles
- Unleash machine intelligence
- Utilize space resources to explore
- Prevent orbital debris
- Secure the planet from space threats
- Understand physics governing the universe
- Establish conditions for permanent humans in space
- Develop personalized STEM learning
- Engineer the tools of scientific discovery
- Discover life beyond earth
- Provide carbon-neutral mobility
Flagship Technology Demonstrations (FTD)

NASA’s Flagship Technology Demonstrations (FTD) would capitalize on the technology maturation and ground test bed activities from both within and external to NASA. FTD demonstrates “transformational capabilities” at the proper scale and performance regime necessary to affordably conduct future human exploration missions to select destinations in the inner solar system.

Beginning in 2014, the first set of FTD missions would focus on:

- **Advanced in-space propulsion**
- **In-Space propellant transfer and storage**
- **Inflatable ISS mission module, with Aero-Assist Entry-Descent-Landing (AEDL)**
- **Automated Rendezvous & Docking AR&D**
- **Closed-loop Environmental Control and Life Support (ECLS)**

FTD-1 Launch: 2014
FTD-2 Launch: 2015
FTD-3 Launch: 2015
FTD-4 Launch: 2016
# Heavy Lift Propulsion

<table>
<thead>
<tr>
<th>Needs</th>
<th>Goals</th>
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<tbody>
<tr>
<td><strong>Affordability</strong></td>
<td>Reduce the annual cost of propulsion and launch vehicles to enable multiple missions within the expected annual human spaceflight budget</td>
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<td>Demonstrate by test and analysis propulsion contribution to system affordability</td>
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<tr>
<td><strong>Capability to Perform Multiple Missions</strong></td>
<td>Provide research and development of chemical propulsion elements to enable heavy space lift, space transfer, rendezvous, proximity maneuvers, descent/ascent for multiple destinations</td>
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<td><strong>Risk Reduction</strong></td>
<td>Mature chemical propulsion technologies to enable system level demonstrations of mission capability in relevant environments</td>
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<td><strong>Transform Industrial Base</strong></td>
<td>Creating a competitive environment of multiple suppliers (across the supply chain), improved capability, and reduced cost</td>
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<td>Ensure world leading national (industry, academia, government) R&amp;T capability for chemical propulsion</td>
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<td><strong>Timeframe (Availability)</strong></td>
<td>Demonstrate RP propulsion leading to Flight certification NLT 2020</td>
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<td>Flight demonstrate LOX/CH4 engine by 2015</td>
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<td>Demonstrate upper stage, ascent/descent, and other propulsion systems to complete development readiness by 2020</td>
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<td>Finalize a LV design no later than 2015 and support a human mission to NEO by 2025</td>
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<td><strong>Partnership</strong></td>
<td>Form a partnership with DoD for the research, technology and development for a large RP booster engine and a high energy upper stage engine</td>
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<td>Listen to industry and provide a low cost propulsion technology to enable growth in the commercial launch industry</td>
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<td>Investigate use of collaborative efforts with internationals in line with domestic goals and objectives</td>
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<td><strong>Innovation</strong></td>
<td>Creating opportunities for new businesses and academia</td>
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<td>Actively engage the public in participating in this journey</td>
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Why Exploration Precursor Robotic Missions?

*Enabling Human Space Flight proactively*…

**HSF Needs**
- Safety
- Sustainability
- Capability
- Planning

**xPRM Provides**
- Hazard Identification
- Resource Characterization
- Engineering Boundary Conditions
- Technology Infusion / Demo
- Destination Selection Reconnaissance
NASA AERONAUTICS RESEARCH ONBOARD
DECADES OF CONTRIBUTIONS TO COMMERCIAL AVIATION

- COMPUTATIONAL FLUID DYNAMICS (CFD) ★
- NASA STRUCTURAL ANALYSIS (NASTRAN) ★
- AIR TRAFFIC MANAGEMENT ★
- COMPOSITE STRUCTURES ★
- AIRBORNE WIND SHEAR DETECTION
- LIGHTNING PROTECTION STANDARDS ★
- DIGITAL FLY-BY-WIRE ★
- WINGLETS ★
- GLASS COCKPIT ★
- AREA RULE ★
- JET ENGINE COMBUSTORS ★
- SUPERCritical AIRFOIL ★
- DAMAGE-TOLERANT FAN CASING
- ENGINE NOZZLE CHEVRONS ★
- ICING DETECTION ★
- RUNWAY GROOVES ★

★ Applies also to general aviation aircraft
✓ Applies also to military aircraft