

National Aeronautics and Space Administration



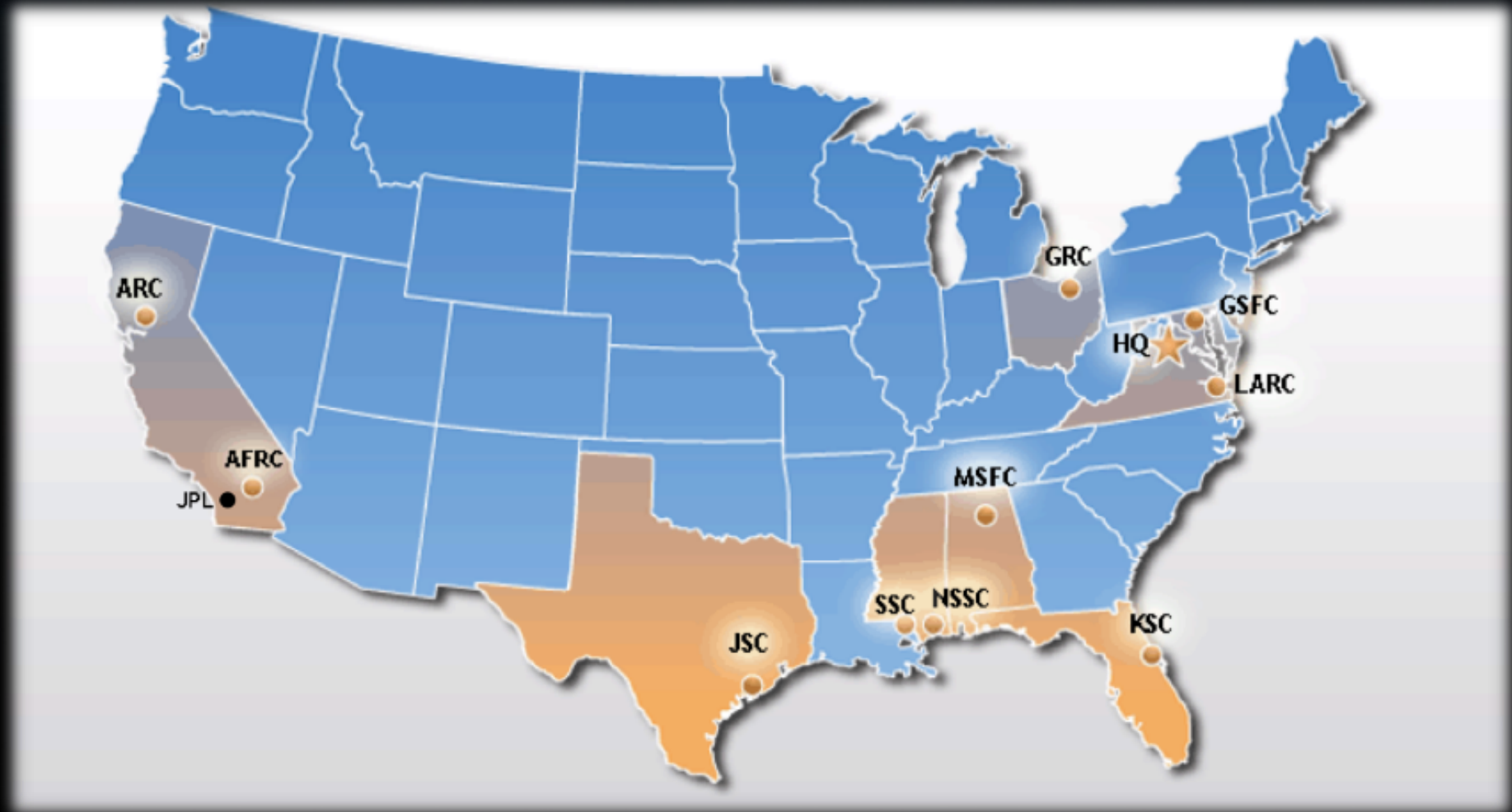
Developing Game Changing Technologies & Bringing Them Down to Earth

David Morse
Chief, Technology Partnerships Office
NASA Ames Research Center

March 16, 2016



Location of NASA Field Centers



NASA Missions and Program Priorities



- Aeronautics - Design, Testing and ATM
- Human Space Exploration and Operation
- Space Technology
- Earth, Life, and Space Science Research

- Innovative Partnerships/Collaborations
- Spin-offs/Technology Transfer
- Spin-ins/Technology Infusion
- Education

NASA Partnering for Public Benefit and Innovation



Under the Space Act of 1958 that created NASA, the Agency is mandated to transfer the technologies that it develops in the conduits of its aeronautics and space missions to the public sector to benefit life on Earth:

“The Congress hereby declares that it is the policy of the United States that activities in space should be devoted to peaceful purposes for the benefit of all mankind.”

NASA Shall...

“Provide for the widest practicable and appropriate dissemination of information concerning its activities and the results thereof.”

This Provides for:

- Access to NASA Technologies
- Access to NASA's Unique Facilities
- Access to NASA's Unique Expertise

Applications and Public Benefits Technology



Applications of NASA-Derived Technology

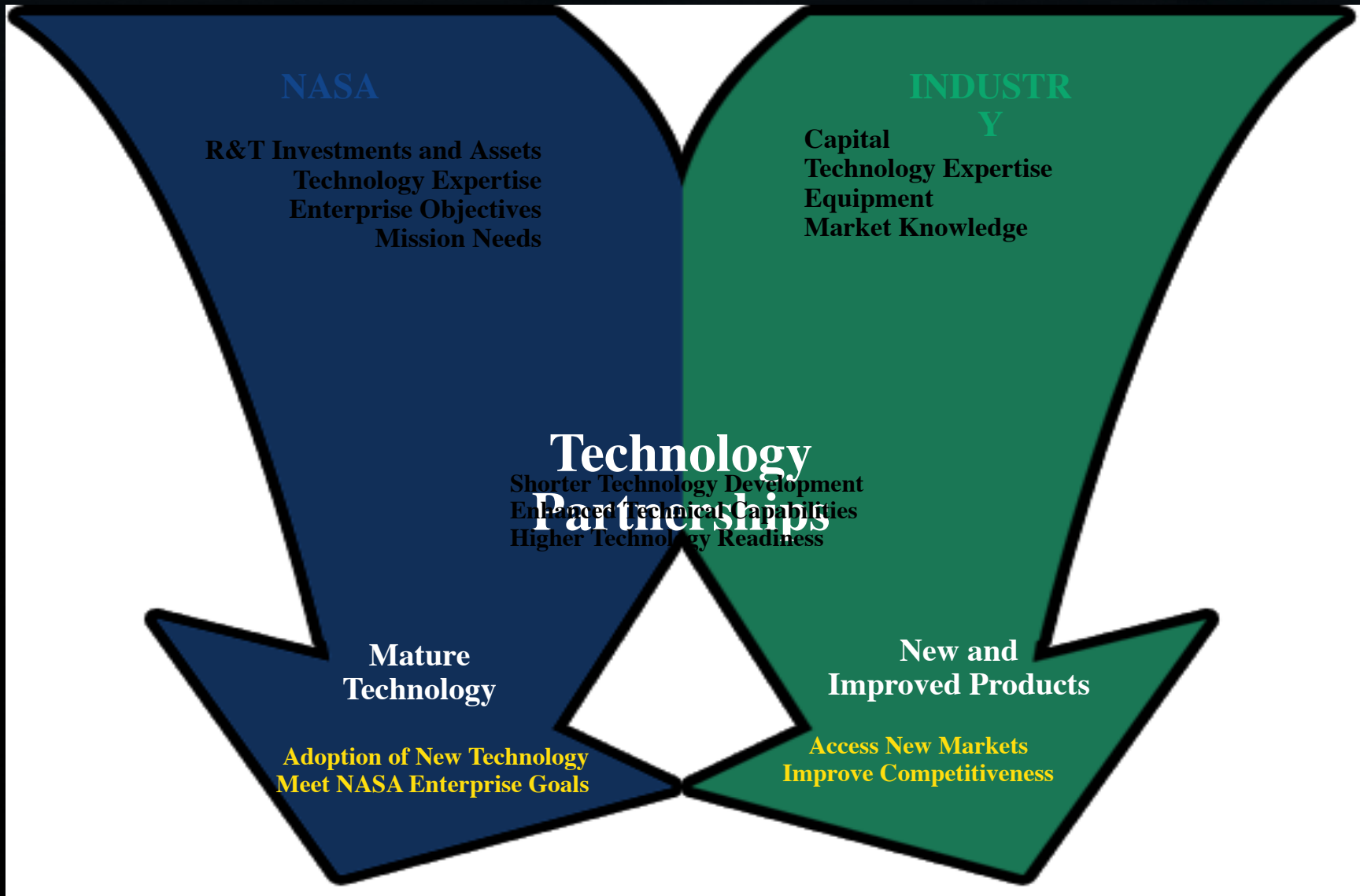
Health and Medicine
Transportation
Public Safety
Consumer, Home &
Recreation
Environmental and
Agricultural Resources
Computer Technology
Industrial Productivity

Public Benefits of NASA-Derived Technology

Economic Growth
New Jobs
New Markets
Increased Efficiency
Improved Competitiveness

Quality of Life
Improved Safety
New Products
Lives Saved or Extended
Green Technologies
Environmental Cleanup

Building Partnerships, Technology Transfer/Infusion



Technology Areas of Common Interest



Self-Driving Cars and UAVs

Diverse human-machine interaction in a structured environment

GPS & map-based navigation

Distributed and cloud-based autonomy

Cyber-security for consumer product

Autonomy

Advanced Planning & Scheduling Algorithms, etc.

Human-Autonomy Teaming

Robotic Supervision including Human/Robotic Interactions, etc.

Networked Operations

Remote Vehicle Management, etc.

Prognostics and Diagnostics

Including State Management, etc.

Sensor Technologies

Data Processing / Fusion Methodologies, etc.

Verification & Validation

Methodologies & Application Experiences, etc.

NASA Missions

Planned human-machine interaction in natural and time delayed environment
Space & planetary nav

Spacecraft autonomy

Cyber-security for "one-off" systems

Space environment

Limited ability to address/recover faults

NASA Partnership Vehicles



There are Many Ways to Partner with NASA



Space Act Agreements

- Non-Reimbursable

- Reimbursable

- Memorandum of Agreement/Understanding

- Interagency

- International

Licensing Agreements

- Exclusive

- Nonexclusive

- Limited Exclusive

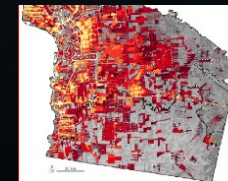
Software Agreements

Selected Key Partnerships



Planetary Skin Initiative and Rainforest Skin Layer

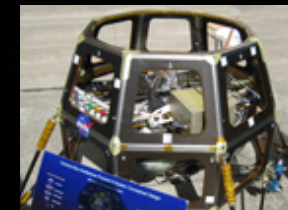
- 1. Quantum Computing
- 2. Planetary Content
- 3. Disaster Response
- 4. Autonomous Vehicles



Worldwide Telescope Project

Direct-To Software for Airplane Flights

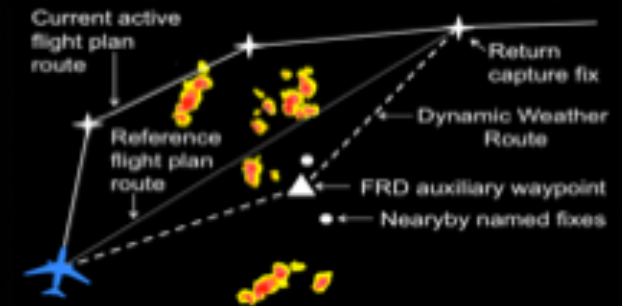
Pipeline Rights-of-Way and Liquid & Gas



Selected Key Partnerships Continued...



- 1. Commercial Crew Dev
 - 2. Risk Analysis
 - 3. TPS Design and Analysis
 - 4. High-End Computing
- Robotics Technologies for Autonomous Vehicles
Wildfire Monitoring and Disaster Response



Selected NASA Ames – Canada Partnerships



Aerosciences/Aerodynamics

Astrobiology/Life Science



Astrobiology/Rover Demonstrations
Human Factors/Adaptive Systems



Nanosatellite Energy Storage




Robotics and Spacecraft Technology

Human Computer Interactions



NASA's Technology Transfer Portal





TECHNOLOGY TRANSFER PROGRAM

BRINGING NASA TECHNOLOGY DOWN TO EARTH

NASA Technology Transfer Features



The 2016 issue of Spinoff has launched! See how NASA technology benefits our nation and world.

Features Archive

Welcome to the T2 Portal




NASA's Technology Transfer Program ensures that technologies developed for missions in exploration and discovery are broadly available to the public, maximizing the benefit to the Nation.

Contact Us

Visit the [T2 Program Needs](#) page to find out who we are and how you can reach us.


T2 Social Media



Search for NASA technologies

Patents Search

Discover Technologies for your Business

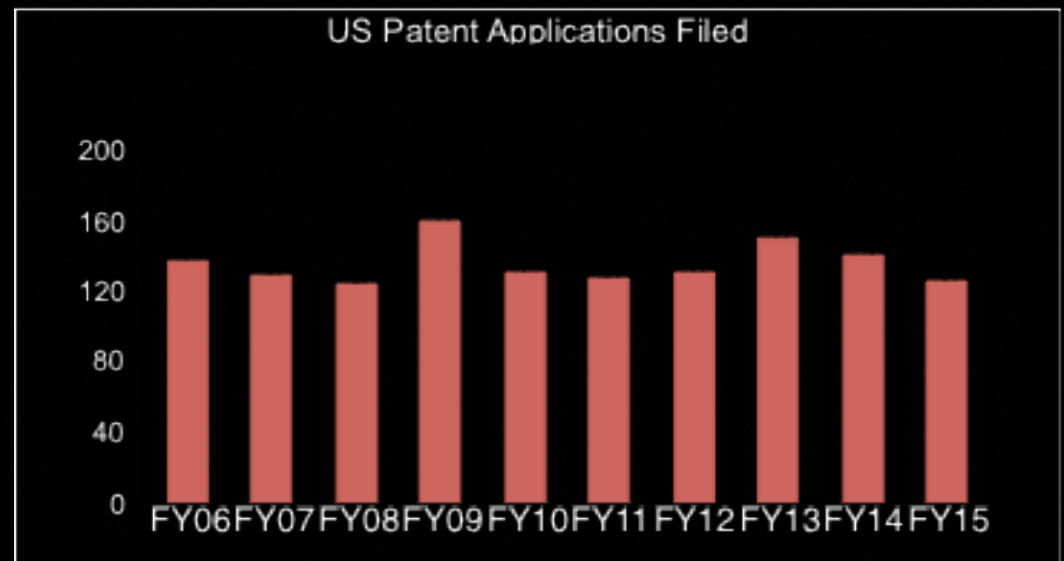


Patent Strategy and Application Areas



Why does NASA Patent?

- **Technology has Commercial Potential**
- **Will Actively and Aggressively Market**
- **Best Way to Transfer the Technology**

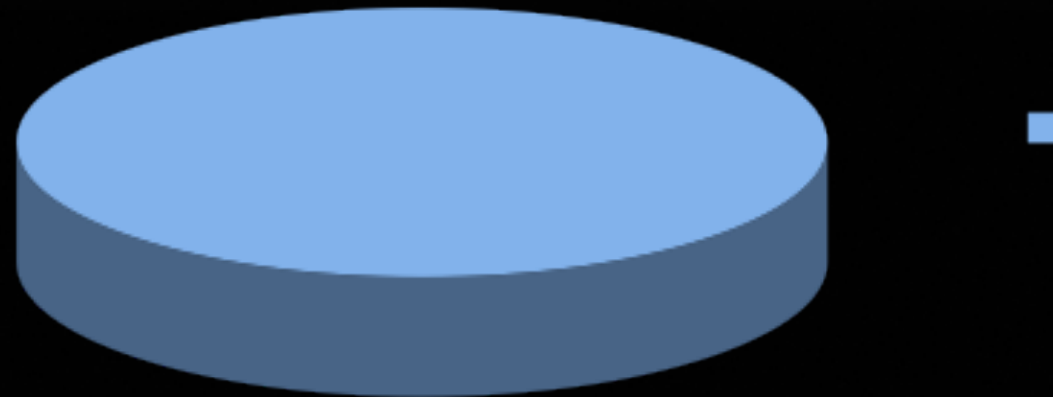


NASA Patent Portfolio Analysis



Total Patents Available for Licensing as of Jan. 2016

- 759 Issued
- 372 Applications



Software Catalog and Categories



National Aeronautics and Space Administration



software 2015-16 catalog

Browse by Category



business systems and
project management



system testing



operations



design and
integration tools



vehicle management



data servers
processing and handling



propulsion



structures and
mechanisms



crew and life support



data and image
processing



materials
and processes



electronics and
electrical power



environmental
science



autonomous
systems



aeronautics

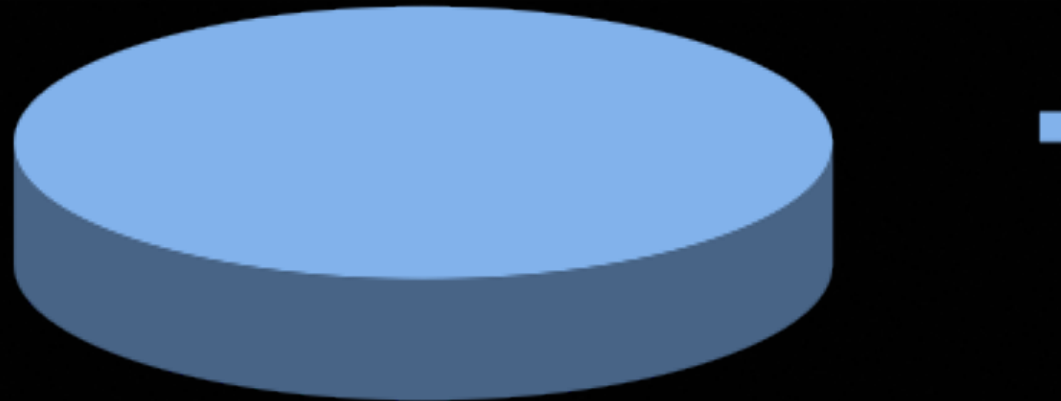
BRINGING NASA TECHNOLOGY



NASA Software Catalog



Total Software Available for Licensing as of Feb. 2016



40 Years of NASA Spinoffs



Some of the best of over 2,000 recorded Spinoffs



CMOS camera-on-a-chip technology used in nearly all digital cameras, including smartphones



International search-and-rescue system has saved 40k lives worldwide since 1982



Ubiquitous aerodynamic innovations in airplanes and trucks



Voltage controller saves energy in nearly all load-bearing electrical machines



Precision GPS enabled self-driving tractors that are now used to work the majority of the world's farmland.

NASA Technologies Enabling a Sustainable Earth



Assistance to Developing Countries

- Clean Drinking Water
- Improved Agriculture
- Telemedicine and wireless networks
- Improved Environmental Decision Making

Environmental Cleanup

Groundwater Remediation
Land Mine Cleanup
Landfill Cleanup
Oil Spill Cleanup

Use of Green Technologies

Aeronautics Technologies
Green Buildings
Encouraging Green Technologies
Solar Power Applications
Paint Stripping
Global Research into Energy and the Environment at NASA (GREEN)

Disaster Warning and Relief

Earthquake relief
Tsunami Warning
Wildfire Response
Hurricane Warning

NASA-Derived Tech Contributing to Security



Improving Operational Systems

- Health & Performance Monitoring for Aviation Security
- Safe Composite Over-wrap Pressure Vessels
- Fire-Protective Fabrics & Smoke Masks
- Intumescent Materials
- Neutralizing Land Mines
- Secure Networks for First Responders and Military

Inspection Technologies

Crack Detection in Nuclear Power Systems
Hyperspectral Imaging for Food Safety
Inspection of Suspicious Liquid/Solid Substances

Threat Detection

Detection/Warning of Chem/Bio Attack
Hyperspectral Imaging for Counter-Terrorism
Anthrax Smoke Detectors
Fiber Optic Chemical Agent Sensing

Identification & Investigation

Pattern Recognition for Security Applications
Video Enhancement Supporting Criminal Investigations

NASA-Derived Technologies Used in Homes



Bathrooms

- Infrared Ear Thermometer
- Ingestible Toothpaste
- Cosmetics
- Memory Metal Alloys
- Polished Brass Finish
- Bacteriostatic Water Softeners
- Reflective Insulation
- Environmentally Safe Sewage Treatment

Living Rooms

- Audio Equipment
- Insulated Paint
- Wireless Headset
- Carbon Monoxide Detection
- Environmental Cleansing
- Scratch Resistance and UV Blocking
- Portable X-Ray Device for Carpet Cleaning

Bedrooms/Sports

- Work Surface Light Bulbs
- Temper Foam
- Phase Change Materials
- Better Software
- Improved Footwear
- Liquid Glass for Tennis Rackets
- Sport Helmets

Kitchens

- Water Purification
- Portable Cordless Vacuum Cleaners
- Freeze Dried Technology
- Advanced Solar Cells
- Space Garden
- Enriched Baby Food
- Refrigerator Internet Connected Wall

NASA-Derived Technologies Used in Cities



Aircraft and Airports

- Collision Avoidance Systems
- Clean Burning Engines
- Nitrogen Oxide Reduction
- Anti-Icing Systems
- Optics for High-speed Ticket Processing
- Pilot Stress Tests
- Cabin Pressure Devices
- Parachute Systems

Medical

Light Emitting Diodes
Automatic Insulin Pumps
Artificial Limbs
Diamond Coatings and Artificial Hip
Corneal Refractive Therapy
Precision Dialysis Pumps and Filters
Ventricular Assist Device

Automotive

Improved Radial Tires
Cleaner Burning Cars
Advanced Lubricants
Crash and Structural Analyses
Highway Safety
Air Conditioning
Refrigerant Enhancer
Car Chassis & Brake Systems

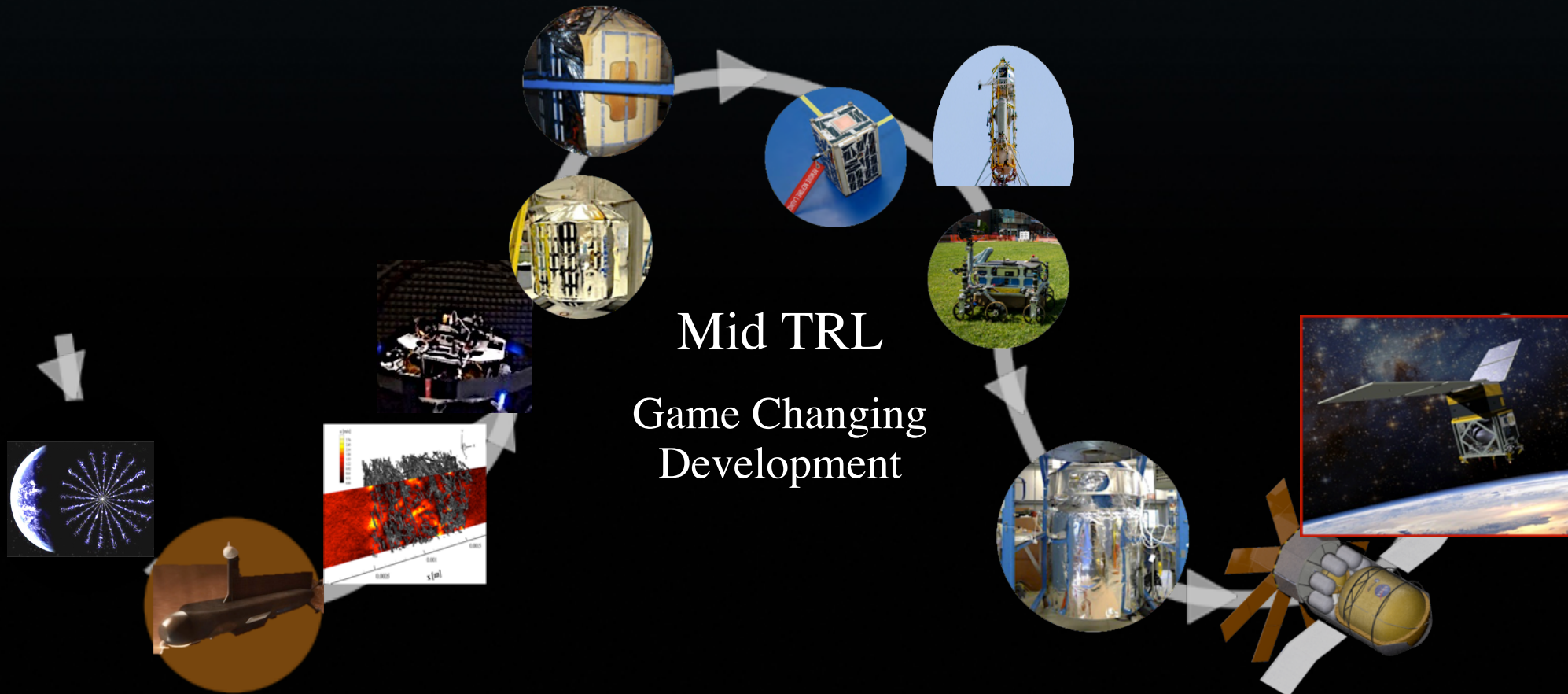
Manufacturing

Powdered Lubricants
Improved Welding
Power Plant Design and Monitoring
Smokestack Monitors
Chemical Detection
Rapid Prototyping
Improved Mine Safety
Quick Fasteners

Space Technology Pipeline



Approach for Maturing Promising Low-TRL Technologies



Space Technology – An Investment for the Future



Enables a **new class of NASA missions** beyond low Earth Orbit.

Delivers innovative solutions that dramatically improve technological capabilities for NASA and the Nation.

Develops technologies and capabilities that make NASA's missions **more affordable and more reliable.**

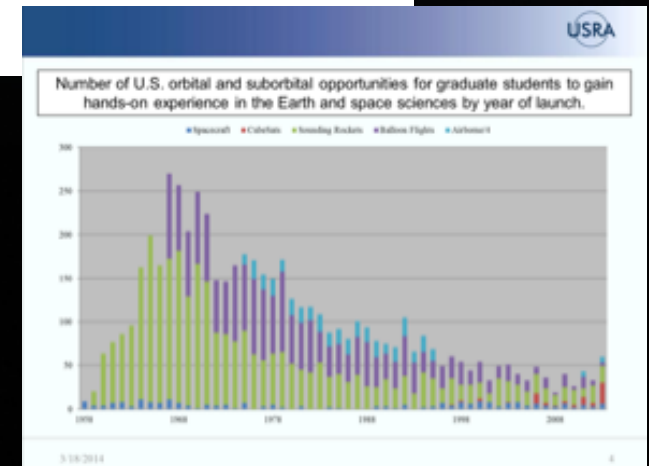
Invests in the economy by **creating markets and spurring innovation** for traditional and emerging aerospace business.

Engages the brightest minds from

Bringing NASA Technology Down to Earth
academia in solving NASA's toughest

Addresses National Needs

A generation of studies and reports (40+ since 1980) document the need for regular investment in new, transformative space technologies.



Guiding Principles of the Space Technology Investments



- **Adhere to a Stake-holder Based Investment Strategy**

- **Invest in a Comprehensive Portfolio**

- **Advance Transformative and Crosscutting Technologies**

- **Develop Partnerships to Leverage Resources**

- **Select Using Merit-Based Competition**

- **Execute with Lean Structured Projects**

- **Infuse Rapidly or Terminate Promptly**

- **Place NASA at Technology's Forefront**

- **Create Pipeline of NASA and Public Inventors**

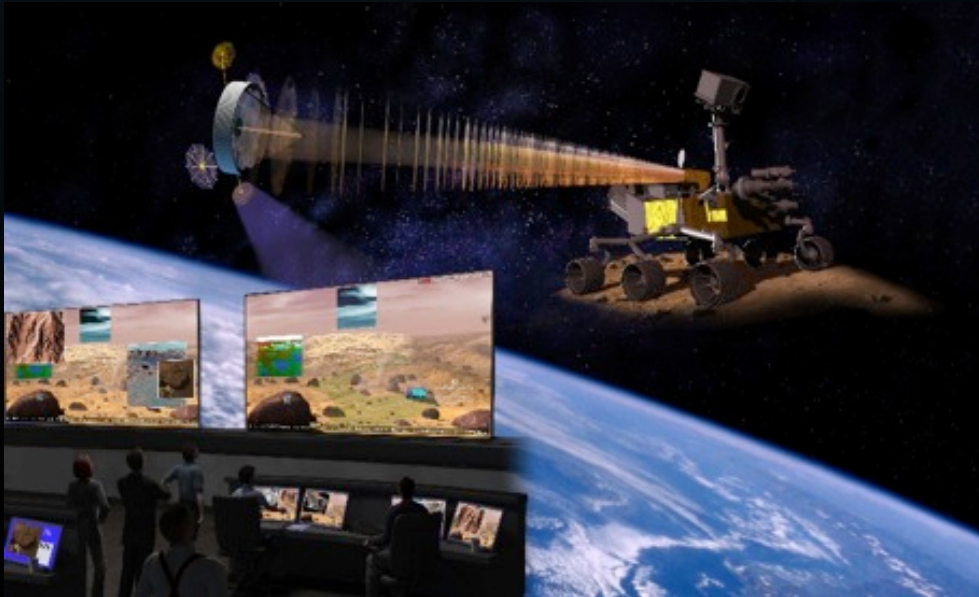
NASA's Game Changing Technology Focus Areas



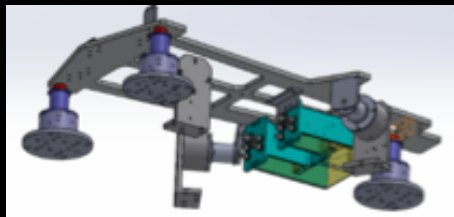
- High Data Rate Communications
- Space Instruments and Sensors
- Robotics and Autonomous Systems
- Space Radiation
- Launch and In-Space Propulsion
- Lightweight Space Structures
- Entry, Descent and Landing
- Energy Storage
- Environmental Control and Life Support

High Data Rate Communications

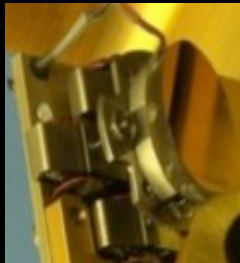
Optical Space Communication



**Spacecraft
Disturbance
Isolation**



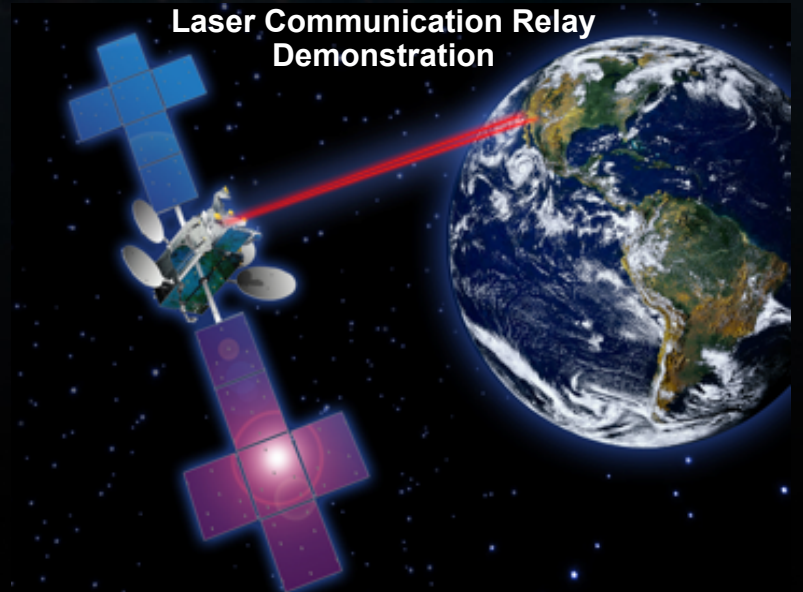
**Point-
Ahead
Mirror**



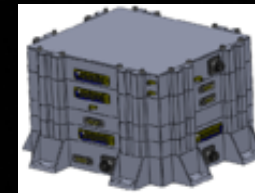
**Flight Laser
Transceiver**



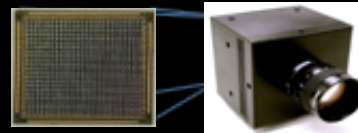
**Laser Communication Relay
Demonstration**



**Electronics
& Control**



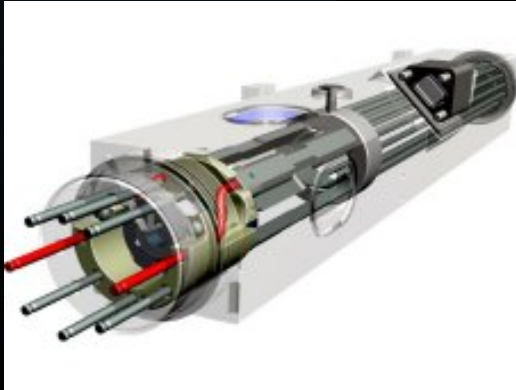
**Photon-
Counting
Camera**



**Laser
Transmitter**

Space Instruments and Sensors

Deep Space Atomic Clock



Bringing NASA Technology Down to Earth

nasa.gov/spacetech

Robotics and Autonomous Systems



Self-Driving Cars at NASA Ames

- Aligned with NASA autonomy development priorities
- Enables NASA to gain valuable knowledge and lessons learned from extensive real-world testing
- Enables joint development and demonstration of high-impact vehicle applications
 - Mobility, transport, remote ops, and cyber-physical systems
- Facilitates spin-off of NASA technologies to the private sector
 - Robot navigation, perception, user interface
 - Dual-use in energy, environment, security, and other terrestrial domains.

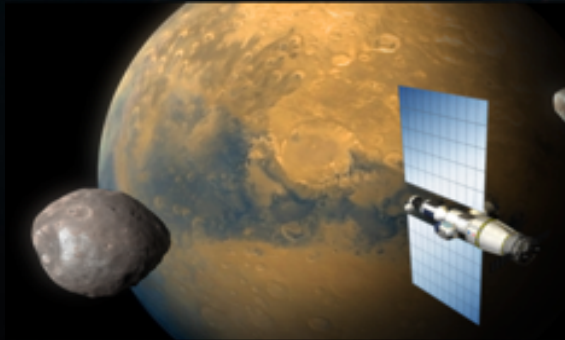
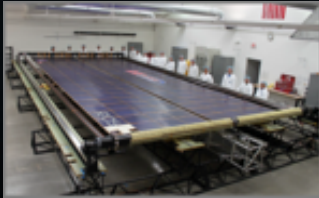
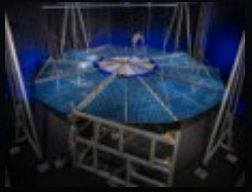


Launch and In-Space Propulsion



High Power Solar Electric Propulsion

Solar Arrays



SEP
"Space Tugboat"

Power Processing Units (PPUs)



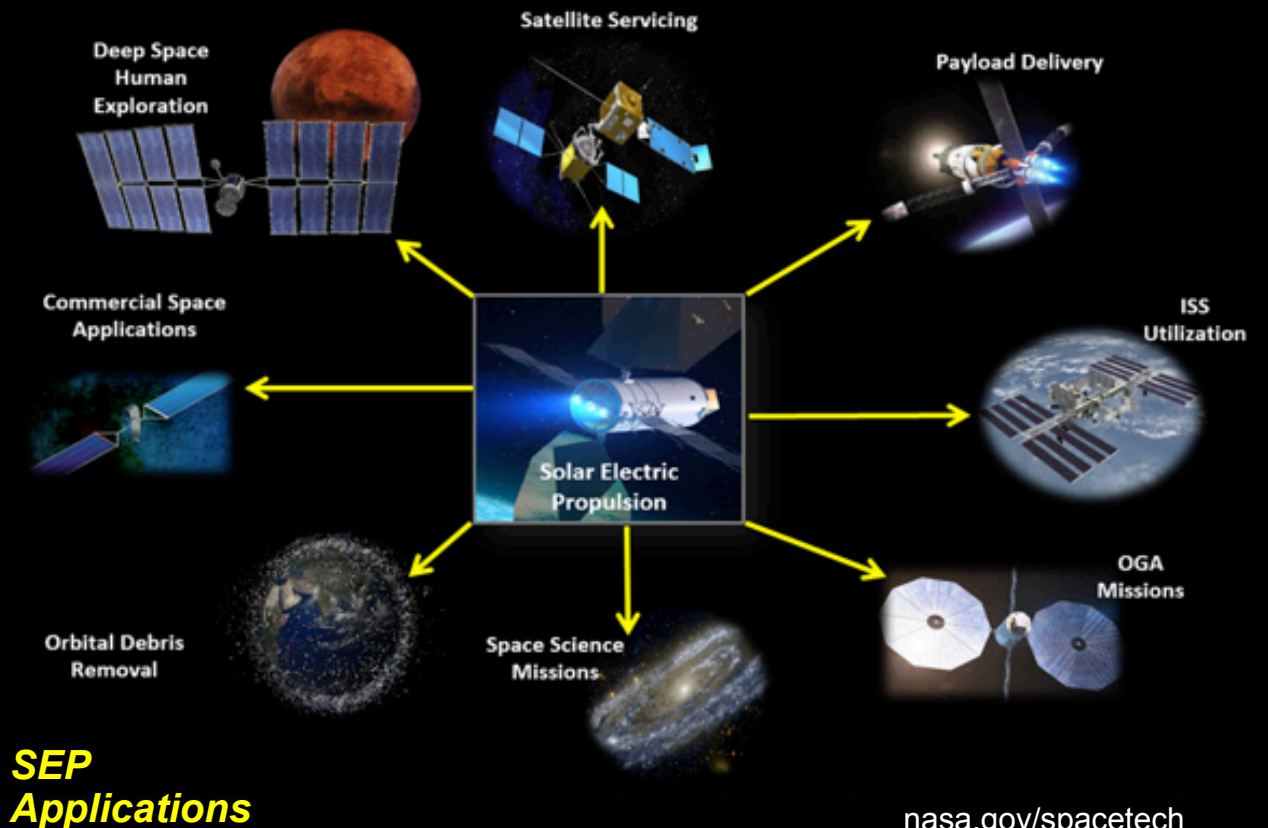
Thrusters



Propellant Feed System & Storage Tanks



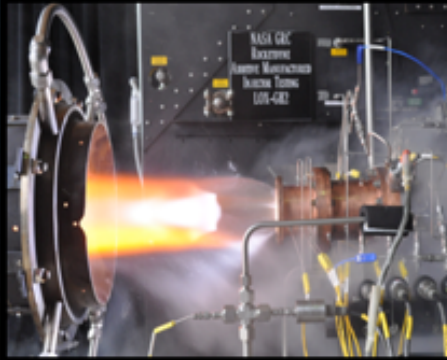
Bechtel Technology Down to Earth



Lightweight Space Structures



Advance Launch Systems



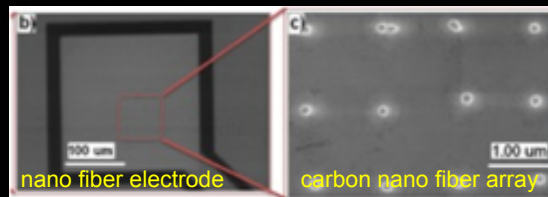
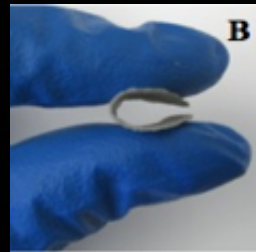
Additive Manufacturing for combustion chambers and nozzles



Composite Cryotank and dry structures



eCryo for upper stage

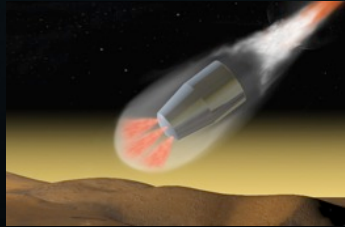


Nanotechnology

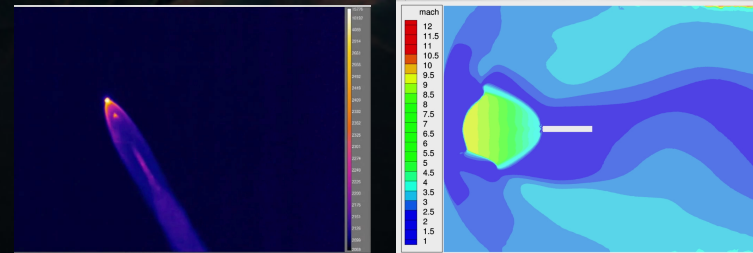


Composites for upper stage

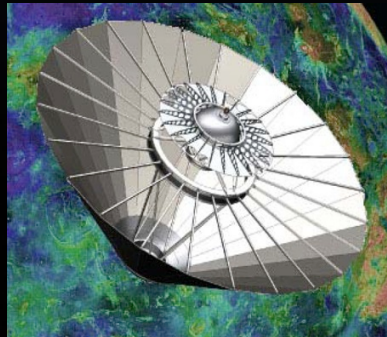
Entry, Descent, and Landing



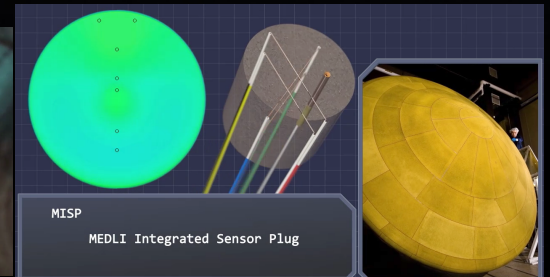
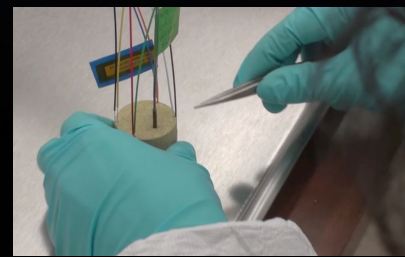
Supersonic Retro Propulsion



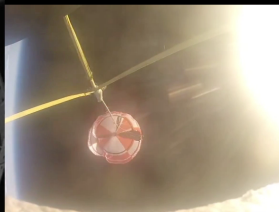
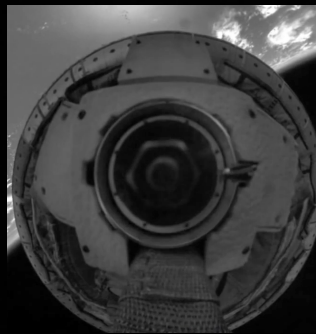
Computer Modeling and Data



Inflatable (THOR) or Mechanically Deployable (ADEPT) Entry Systems



Instrumentation



Low Density Supersonic Decelerator

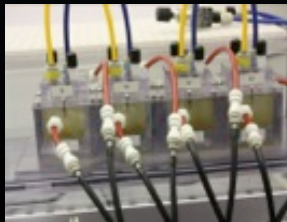


3-D, multi-layer preform weaving technology for thermal protection

Environmental Control and Life Support

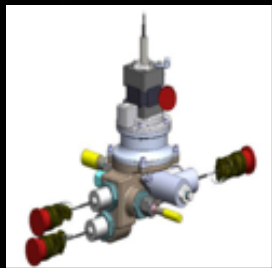


Life Support aboard ISS

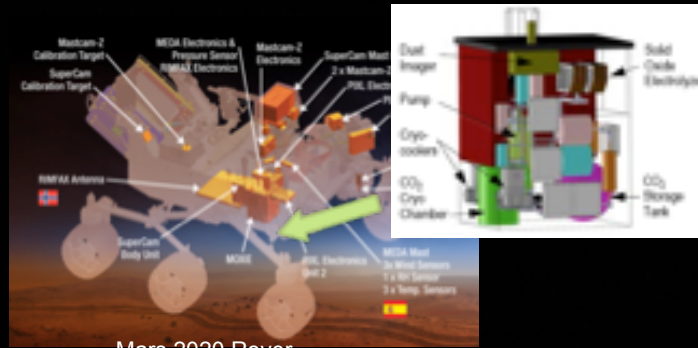


Alternate Water Processor

Advanced Oxygen Recovery



Variable Oxygen Regulator 3.0



Mars 2020 Rover
Mars Oxygen ISRU Experiment (MOXIE)



Portable Life Support System Integrated Test



Finding Technologies



There are many searchable databases available to help identify technologies of interest. Some of these are summarized below:

NASA Technology Transfer Portal: <http://technology.nasa.gov/>

NASA Game Changing Technology: <http://nasa.gov/spacetech>

NASA Software Catalog: <http://software.nasa.gov/>

NASA Tech-Briefs: <http://www.techbriefs.com/>

NASA Spinoff: <http://spinoff.nasa.gov/>

Partnerships Points of Contact at NASA Ames



Licensing: Trupti Sanghani

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Software: Martha Del Alto

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(650) 604-4865 International: Terry

Pagaduan terence.pagaduan@nasa.gov

(650) 604-1181

Technology Transfer: David R. Morse david.r.morse@nasa.gov

(650) 604-4724

Space Technology Drive Exploration

