HUMAN EXPLORATION
NASA’s Path to Mars

EARTH RELIANT
MISSION: 6 TO 12 MONTHS
RETURN TO EARTH: HOURS
Mastering fundamentals aboard the International Space Station

PROVING GROUND
MISSION: 1 TO 12 MONTHS
RETURN TO EARTH: DAYS
Expanding capabilities by visiting an asteroid redirected to a lunar distant retrograde orbit

MARS READY
MISSION: 2 TO 3 YEARS
RETURN TO EARTH: MONTHS
The next step: traveling beyond low-Earth orbit with the Space Launch System rocket and Orion spacecraft

Developing planetary independence by exploring Mars, its moons and other deep space destinations

www.nasa.gov
Develop advanced manufacturing technologies that enable the development of more capable and lower-cost spacecraft and launch vehicles.

Collaborate with the National Manufacturing Initiative and partnering with other government agencies (DOD, DOE, DOC/NIST, NSF), Industry, and Academia.

**NASA Advanced Manufacturing Technology Portfolio**

**ADDITIVE**  **COMPOSITES**  **DIGITAL**  **METALS**  **IN-SPACE**

*Advanced Manufacturing is Critical to all NASA Mission Areas.*
Advanced Manufacturing Partnership 2.0: “Accelerating U.S. Advanced Manufacturing” - Manufacturing drives knowledge production and innovation in the United States by supporting two-thirds of private sector research and development and by employing the vast majority of U.S. scientists, engineers, and technicians to invent and produce new products.

NNMI - The Start of a Network...
Launch Vehicle Stage Adapter: Contract awarded in February 2014.

MPCV-to-Stage Adapter: First flight hardware in Florida for Exploration Flight Test-1 in Dec 2014.

Avionics: Avionics “first light”; currently testing most powerful flight system computer processor ever.

Core Stage: Vertical Assembly Center and initial confidence barrels, domes completed.

Boosters: Forward Skirt test completed; proceeding toward Quality Motor-1.

Engines: Preparing for RS-25 testing at Stennis Space Center; renovations underway to B-2 stand.
The National Institute for Rocket Propulsion Systems (NIRPS) is an office at NASA’s MSFC that serves to maintain and advance U.S. leadership in all aspects of rocket propulsion for defense, civil, and commercial uses.

NIRPS supports the Joint Army-Navy-NASA-Air Force Interagency Propulsion Committee (JANNAF).

Formulated in 2011 as directed by the NASA Administrator.

NIRPS Organizations by Sector
October 2014

- 11 Government
- 65 Industry
- 9 Academic

236 Individuals Representing 85 Organizations
Nuclear Thermal Propulsion (NTP)

Current Focus on three areas:

1. Fuel element design and fabrication
   - Graphite composite development at Oak Ridge National Laboratory (ORNL)
   - CERMET development at Marshall Space Flight Center
   - All fabrication facilities licensed to work with depleted uranium (DU)

   - Test facilities capable of testing at high temperature, in flowing hydrogen environment
   - Designed to screen materials and examine thermal hydraulic performance
   - Licensed to work with DU
   - Small samples tested in the Compact Fuel Element Environmental Test (CFEET) System
   - Full scale elements tested in the Nuclear Thermal Rocket Element Environmental Simulator (NTREES)

3. Determine affordable development and qualification strategies for human-rated NTP systems

Current Goals for the Future

- Continue developing key technologies related to NTP
- Build confidence in affordability and viability of NTP
Space Weather: Research to Applications at Marshall
Marshall’s Commitment to Commercial Partnerships

• NASA technologies, capabilities, and assets available to support growing commercial space industry
• More than 300 ongoing collaborative agreements
• Partnerships Office created as entry point and advocate

Marshall is ready for future challenges – adapting and building mutually beneficial partnerships to develop new and innovative technologies.