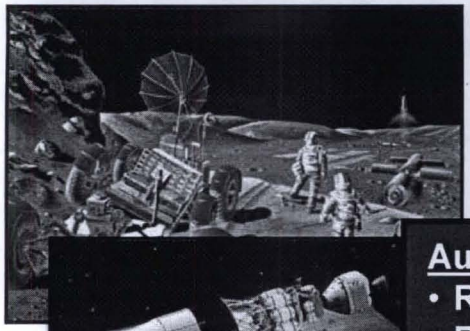
NASA & Army Collaboration on Unmanned Systems Presentation to (SE)3

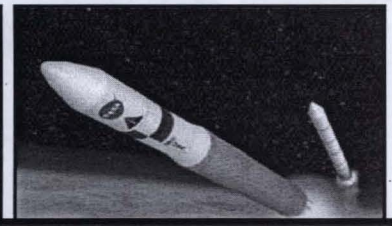
Dr. Ken Fernandez

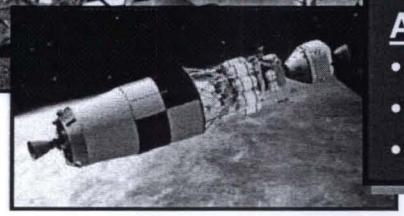
May 12, 2008

Robotic/Autonomous Systems Architecture Development

Lunar Exploration Infrastructure

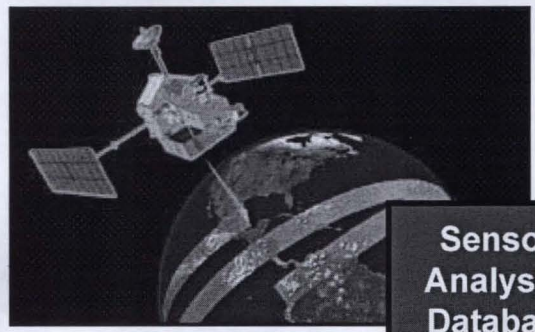


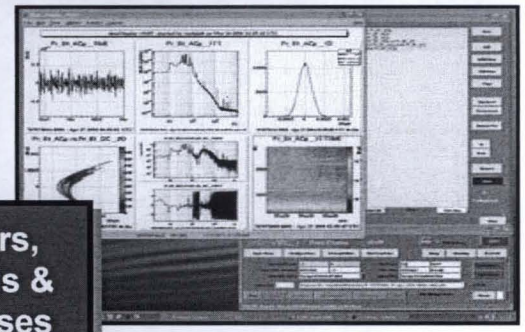




Autonomous Operations:
- Remote Assembly
- Robotic Exploration
- Scheduled Maintenance

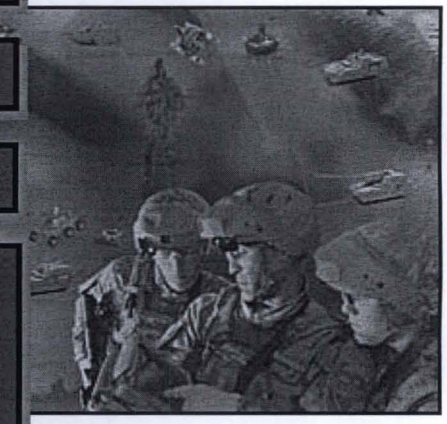
Elements Of Robotic/Autonomous Systems Infrastructure





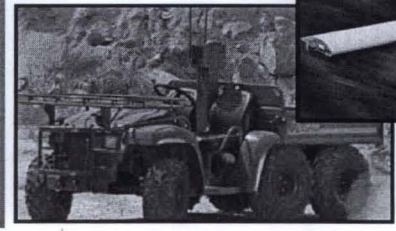
Sensors, Analysis & Databases

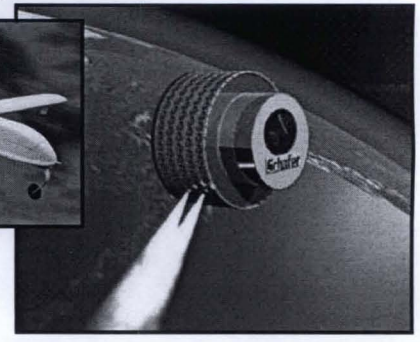
C3I



Networks

Mobility Platforms
- UGVs
- UAVs
- MicroSat





Challenges Involving Robots:

- NASA - Autonomous Local/Remote Operation, Command & Control of Multiple Robotic Vehicles, Sensor Networks, Lunar Resource Utilization And Repair, Lunar Environment, Distributed Users
- DoD – Autonomous Operation, Platform Integration, Networks, Deconfliction, Affordability, Durability, Weaponization, Security, Multiple Users, Common Operating System

Robotic Requirements Are Synergistic Between NASA and DoD

Synergy In Robotics/Autonomous Systems Development

NASA ⟷ Collaborative Effort For Common Systems & Technology ⟷ **DoD Robotic Systems**

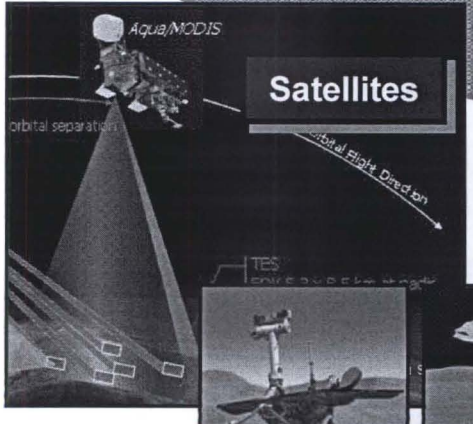
Big Network Demonstration

Battlefield Whiteboard Demonstration

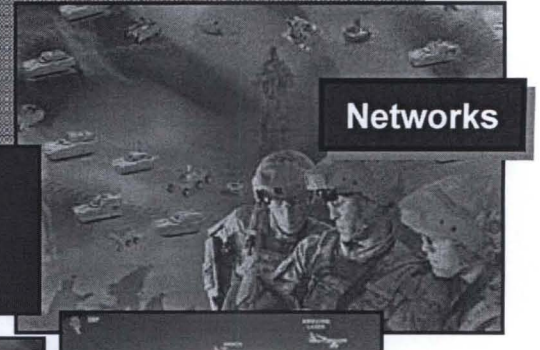
Collaboration With Astronauts
In Situ Resource Utilization
In-Space Operations

Mapping & Locating
Collaborative Operations
Sensing & Reconnaissance
Infrastructure Maintenance
Cargo/Materiel Transport & Logistics
Maneuvering/Power Systems
Scientific Measurements
Medical/Emergency
Satellite Servicing
Security

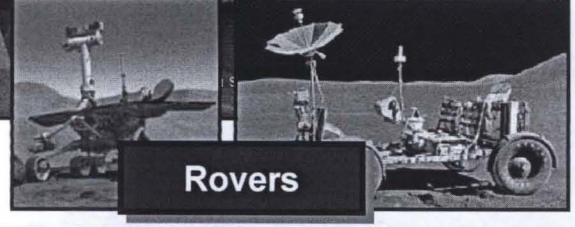
Offensive Operations
Maneuver
Common Operating System
Weapons

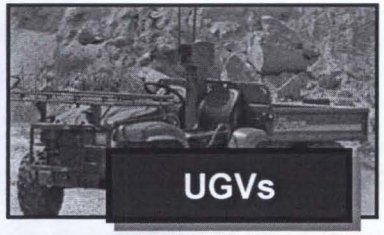


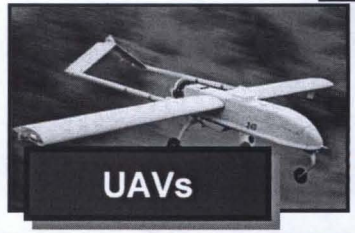
Satellites

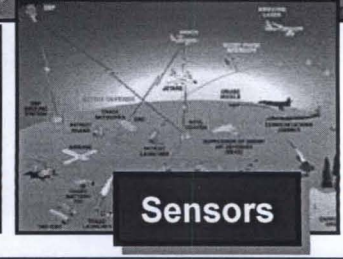

Networks

Develop and demonstrate technology and integrate into systems of common interest to several agencies


Rovers

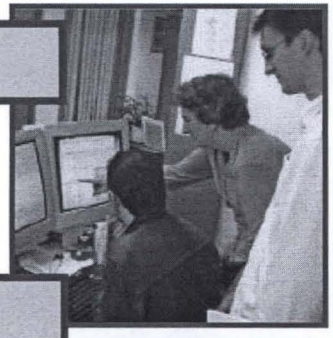

UGVs


UAVs


Sensors

Concentrate On Developing And Demonstrating Capabilities That Are Common Between NASA Lunar Infrastructure And DoD Robotic Systems

Surface Mobility Systems: Lunar Pylon Network Project



Master Node

- *Command & Control*
- *Auto Pilot*

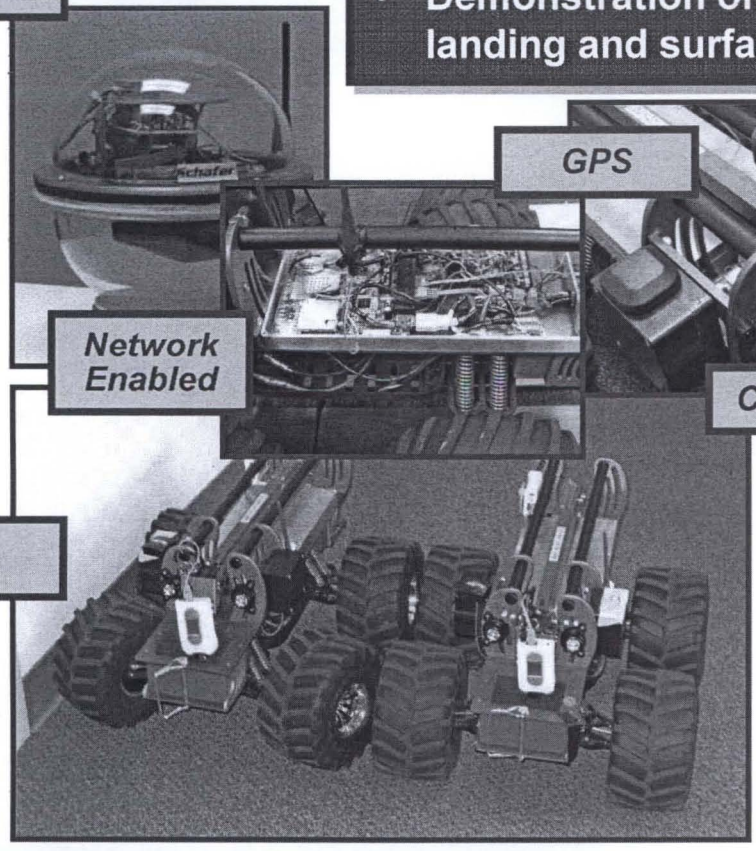
COM/NAV Node

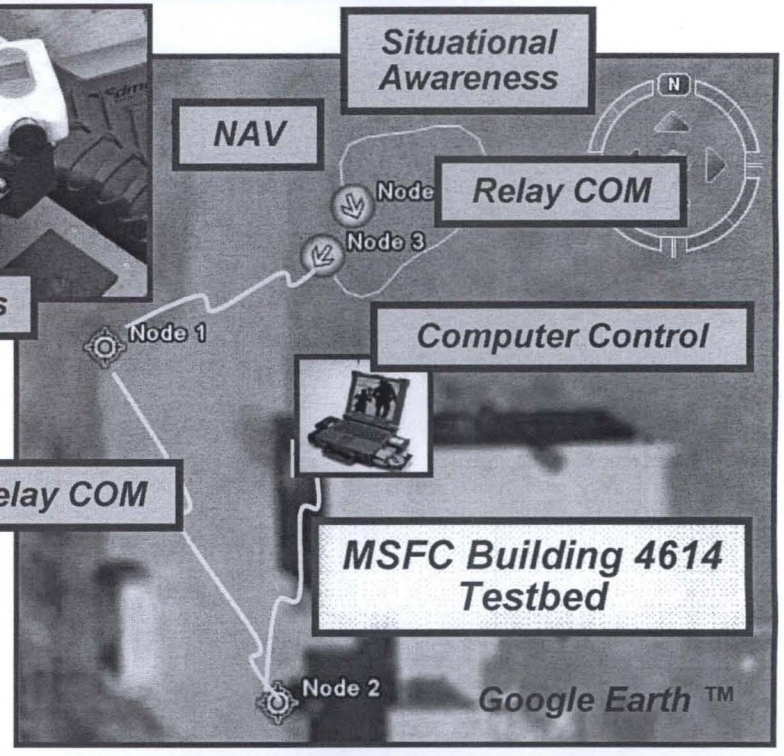
- *Encrypted Communication Relay Network*
- *GPS For Location*
- *Sensor Interface*
- *Situational Awareness*
- *Platform Independent*

Vehicle Node

- *COM/NAV Node*
- *Monitor & Control Autonomous Way-Point Navigation*

- **Lunar Pylon Network: Self-aware, self-healing navigation and communication network for surface exploration and science**
- **Demonstrate autonomous waypoint navigation using a variety of surface mobility platforms**
- **Collect sensory data and perform mapping including hazard detection and avoidance**
- **Demonstration of navigation beacons to support automated landing and surface operations**

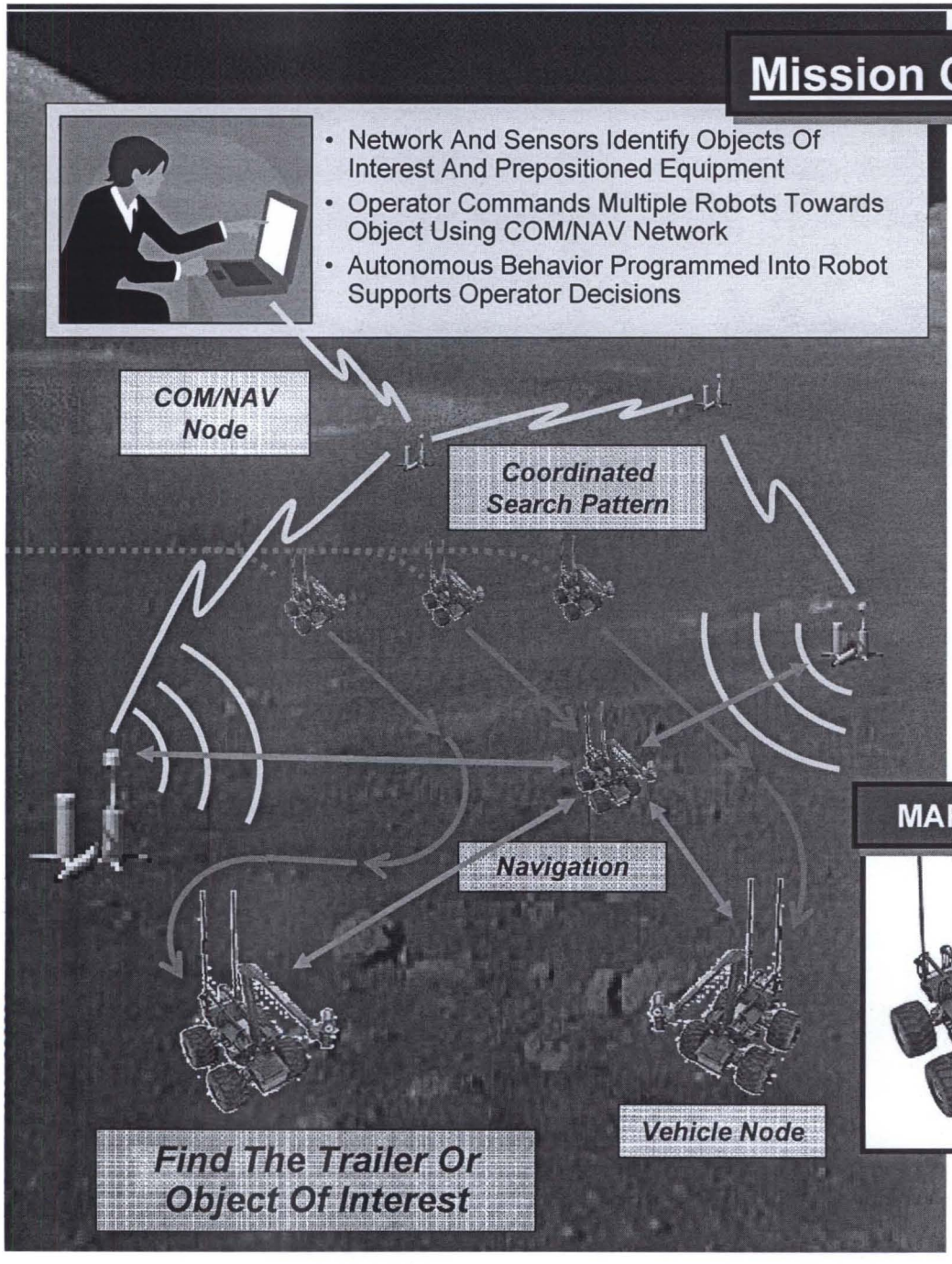




Demonstration Of Precision Navigation With Communication Between Multiple Vehicles Simultaneously Operating Within A Network

Lunar Pylon Network Enables Multiple Vehicle Operations & Logistics

Mission Concept: Search For Objects Of Interest



- **Modify MARCbots IV From RS-JPO With Node To Provide Interface To Network And Control**
  - Network Gives MARCbot Position Sensing And Communications Capability
- **Explore Operations Schemes**
  - Using Simulations, Develop Approaches To Have One Operator Control Multiple Vehicles To Accomplish A Task
  - Combine Network And Robot Sensors To Generate Situational Awareness (Find Trailer)

MARCbot IV

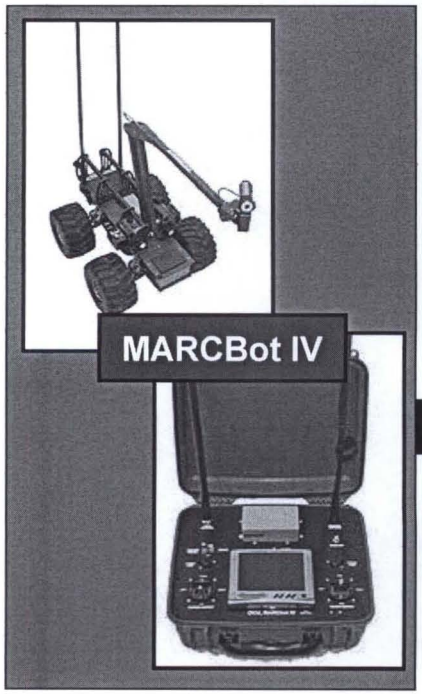
Modified MARCbot IV Offers Economical Approach To Exploring Multiple Vehicle Operations, Control Schemes, And Sensor Suites

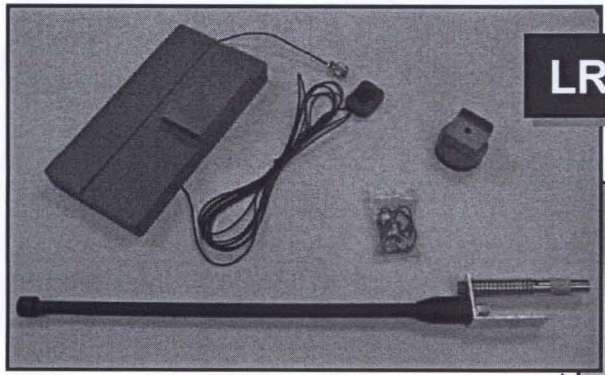
MARCbot IV-N

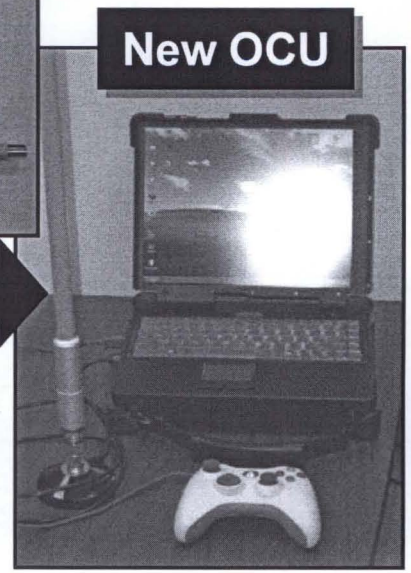
Surface Mobility Systems: MARCbot IV-N Project Overview

Transition NASA Development Effort To Support RS-JPO:

- Add navigation and communication capability to support situational awareness with FalconView
- Computer based OCU and Line Replaceable Unit with secure communications
- Enhanced imaging and provide digital video recording
- Provide autonomous waypoint navigation
- Demonstrate affordable system with extended range





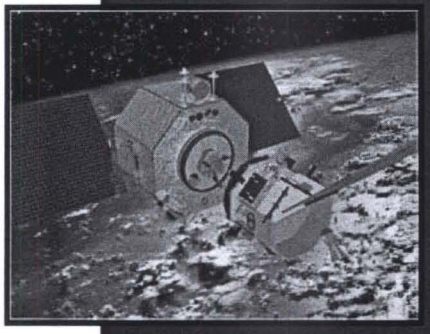


Reused Hardware:

- Robot Chassis
- Robotic Arm
- Electrical Power Supply

Autonomous Logistics Support Demonstration

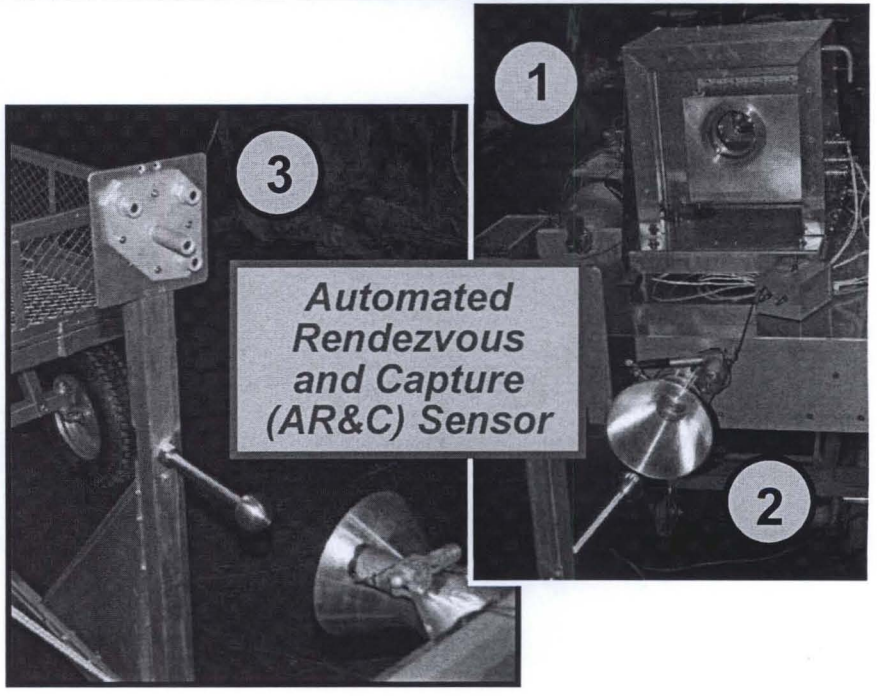
1. **Advanced Video Guidance Sensor (VGS) Technology was used to perform the first Autonomous Docking in US history on Orbital Express**

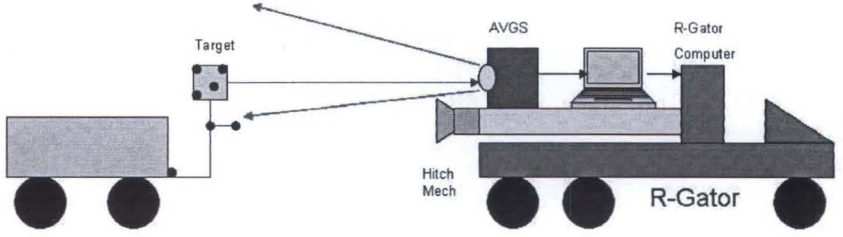


- Measures relative range, bearing, and attitude between the sensor and its target with no moving parts
- Nominal range: 1 meter to 300 meters

2. **The Hitch is a MSFC developed Ball Joint Docking Mechanism for passive latching**
   - Hitch is retained by radial force of 3 balls pushing against locking ring
   - Align the locking ring's release grooves with balls by linear actuator cam action to unhitch
   - Integrated Proximity sensor provides feedback of hitch position to vehicle
3. **The demonstration trailer was modified with a target pattern and a hitch fixture**

Mission Concept: Search For And Retrieve Prepositioned Equipment





Lunar Network Demonstration And Collaborative Effort

Lunar Network Demonstration Has Synergistic Goals With The AMRDEC Battlefield Whiteboard

- Meet a critical astronaut (warfighter) and mission control (field commander) need – enhanced situational awareness from information convergence – by integrating critical assets at Redstone, both NASA and DoD.
- Develop and deploy a technology platform to test and validate the underlying technologies and systems.
- Capitalize on prior technology initiative and industry investments to enable deployment of a concept demonstrator in less time and at lower risk and cost.
- Validate a model that enables government, industry, and the university research community to share their technical strengths.