

Video Guidance Sensor for Surface Mobility Operations

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Robotic systems and surface mobility will play an increased role in future exploration missions. Unlike the LRV during Apollo era which was an astronaut piloted vehicle future systems will include teleoperated and semi-autonomous operations. The tasks given to these vehicles will run the range from infrastructure maintenance, ISRU, and construction to name a few. A common task that may be performed would be the retrieval and deployment of trailer mounted equipment. Operational scenarios may require these operations to be performed remotely via a teleoperated mode or semi-autonomously. This presentation describes the on-going project to adapt the Automated Rendezvous and Capture (AR&C) sensor developed at the Marshall Space Flight Center for use in an automated trailer pick-up and deployment operation. The sensor which has been successfully demonstrated on-orbit has been mounted on an iRobot/John Deere RGATOR autonomous vehicle for this demonstration which will be completed in the March 2008 time-frame.

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- **Robotic Technology Demonstration**
 - Identify requirements through analysis and demonstration which also supports TRL determination
 - Survey Technologies and platforms to develop concepts and identify partners
 - Collaborate with other NASA centers, industry, and academia to capitalize on research activities to find synergy with NASA missions
- **Surface Mobility Systems of Systems Integration**
 - Investigate interactions, interfaces, and operations between elements and components for Surface Infrastructure
- **Support Future Exploration Projects and Programs**
 - Technical experts to Robotic Precursor Missions, Project Constellation, etc.
 - Act as smart-buyers to support future procurements

Surface Mobility Systems Project: Trailer Demonstration



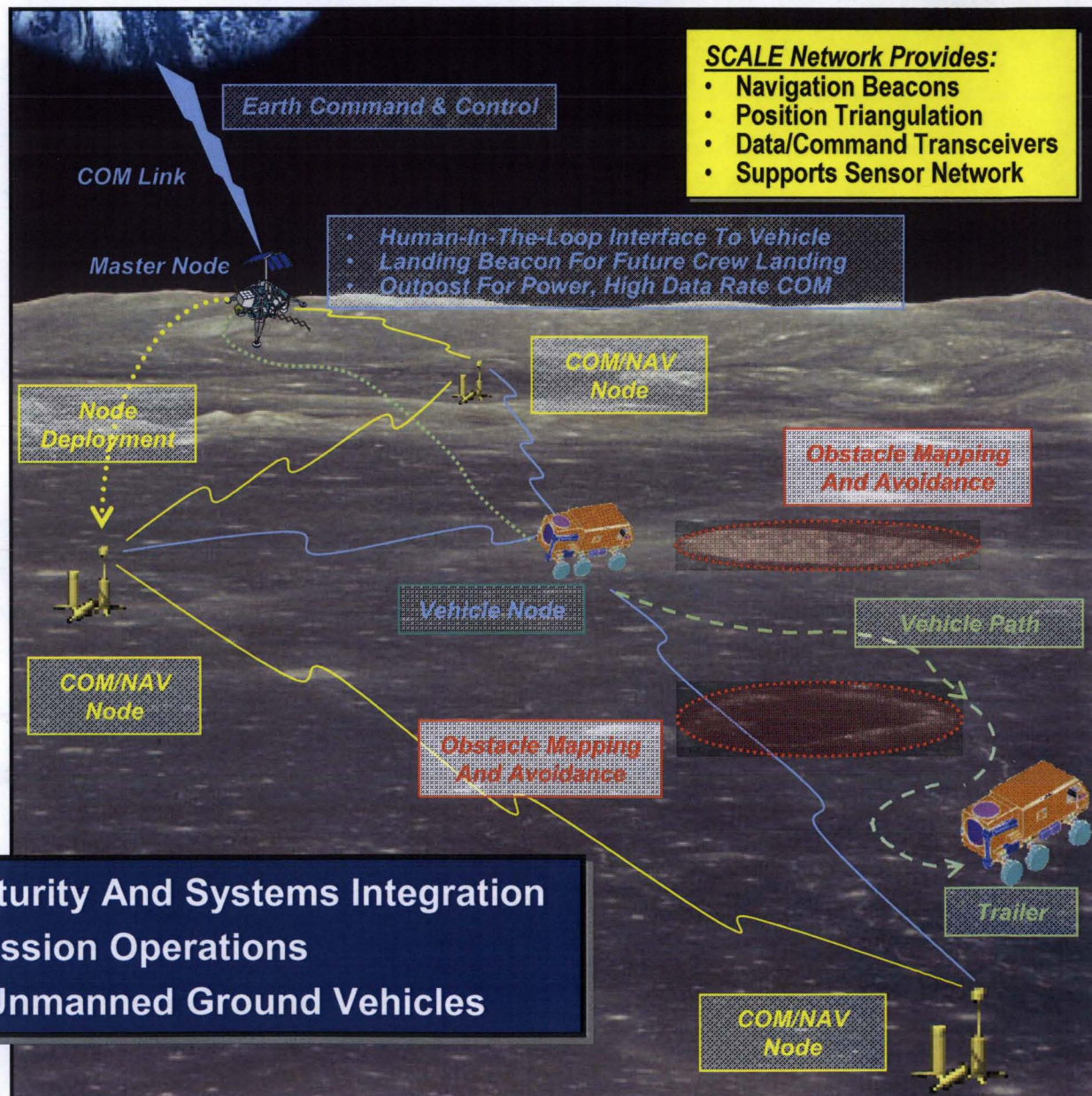
Objectives:

- Technology Evaluation
- Systems Integration
- Demonstration Of Concepts Of Operations And Mission Planning

Systems-Of-Systems Approach

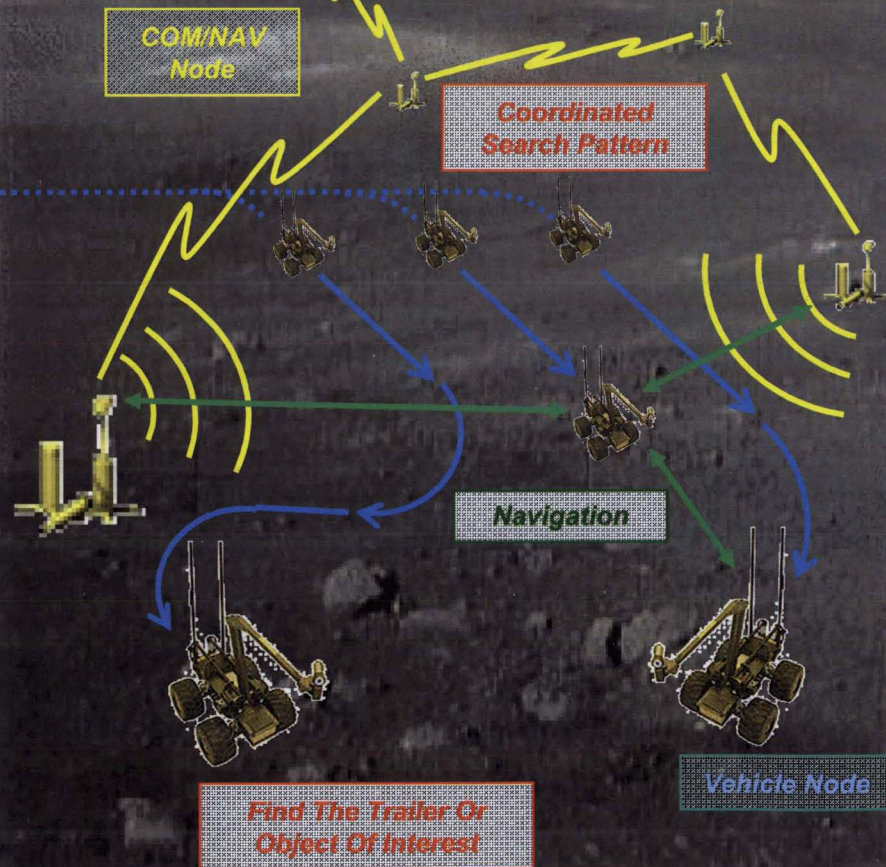
- Communication/Navigation Network
- Multiple Mobility Platforms
 - *Platform Independent*
- Human And Robotic Interactions
- Integration Of Onboard Sensors With Distributed Sensor Network

- Demonstrate Technology Maturity And Systems Integration
- Provide Understanding Of Mission Operations
- Apply MSFC Experience To Unmanned Ground Vehicles





- Network And Sensors Identify Objects Of Interest
- Operator Commands Multiple Robots Towards Object Using COM/NAV Network
- Autonomous Behavior Programmed Into Robot Supports Operator Decisions



- **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 Offers Economical Approach To Exploring Multiple Vehicle Operations, Control Schemes, And Sensor Suites



Network Operation Of Robotic Vehicles

Master Node

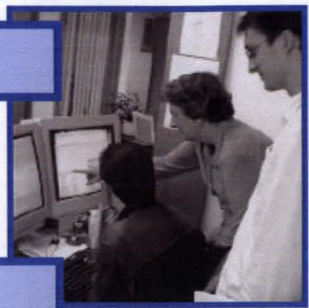
- Command & Control
- Auto Pilot

COM/NAV Node

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

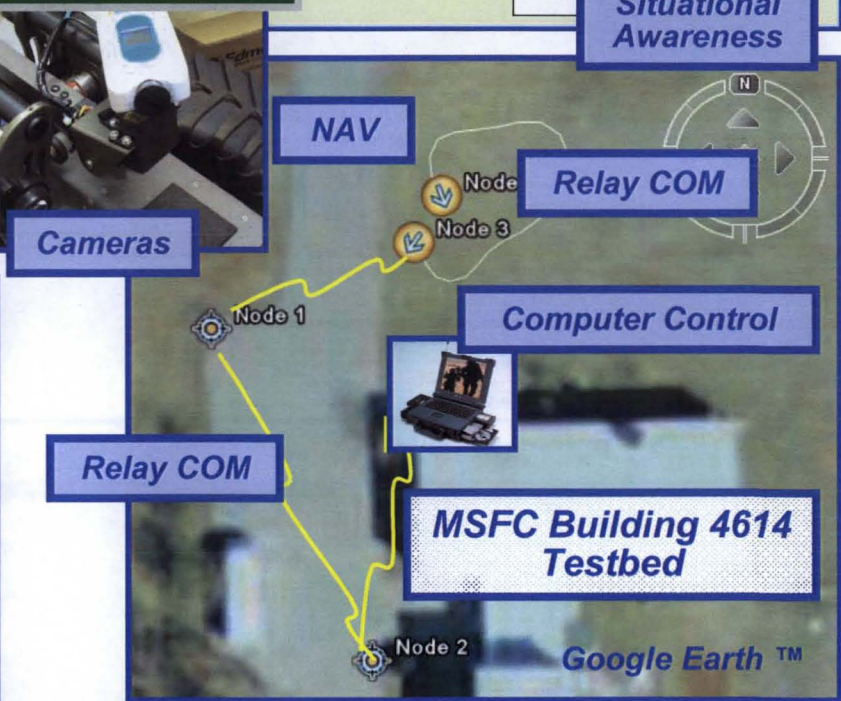
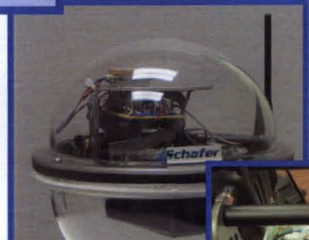
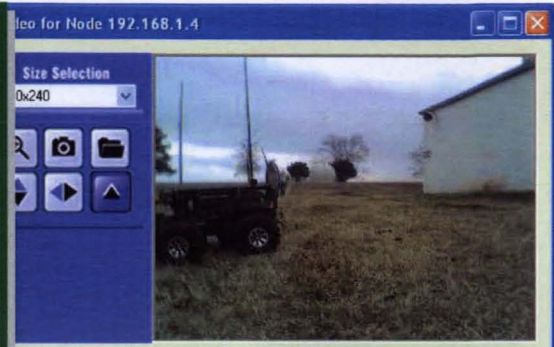
Vehicle Node

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



Accomplishments

- ✓ Situational Awareness
- ✓ Integrated GPS Location
- ✓ Monitor & Control Vehicle Path
- ✓ Tele-Operation Of Vehicle
- ✓ Common X-Box Controller (OCU)
- ✓ Autonomous Way-Point Navigation
- ✓ Simultaneous Multiple Vehicles

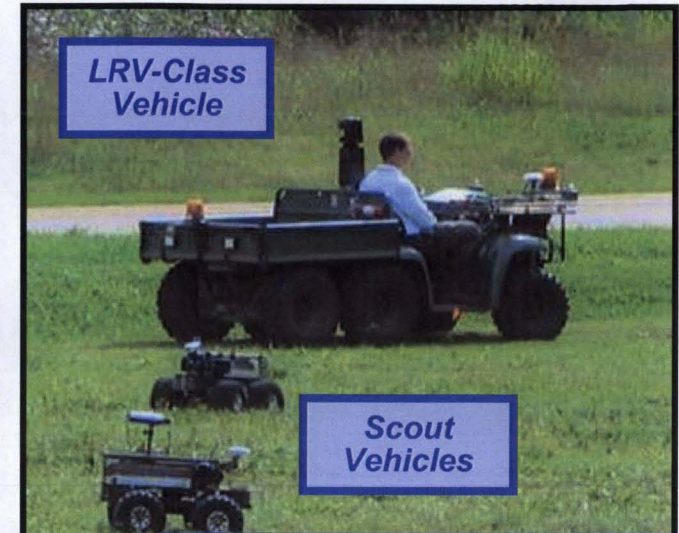


Demonstration Of Precision Navigation With Communication Between Multiple Vehicles Simultaneously Operating Within A Network

Surface Mobility Systems Project Trailer Demonstration



- Lunar Pylon Network: A self-aware, self-healing navigation and communication network to support surface exploration and science
- Using the lunar pylon network, demonstrate autonomous waypoint navigation with a variety of surface mobility platforms
- Demonstration of sensory data collection and mapping to locate objects of interest (trailer) and perform hazard detection and avoidance
- Autonomous operation to locate trailer
- Sensor determines orientation of trailer for autonomous linkage



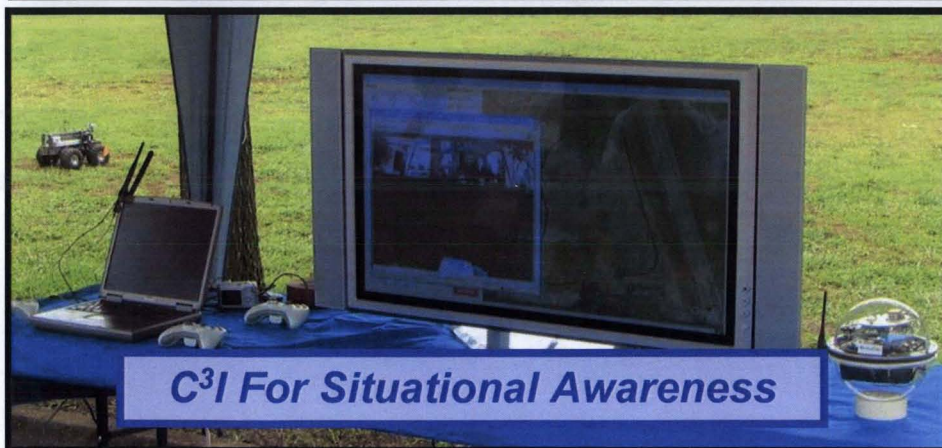
LRV-Class Vehicle

Scout Vehicles

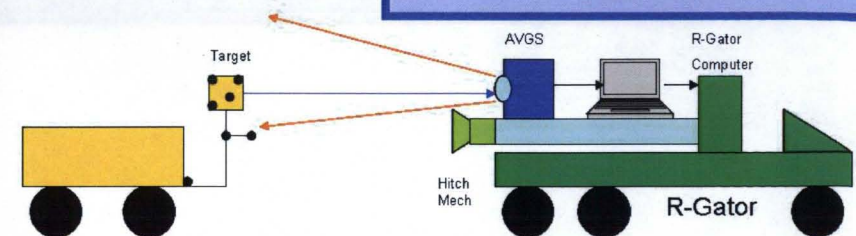
Operation Of Multiple Robotic Vehicles



Automated Rendezvous and Capture (AR&C) Sensor



C³I For Situational Awareness



- 1 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
 - Robust operation despite lighting variations
 - Laser beam divergence becomes eye-safe beyond 2 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**

