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

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Robotic/Autonomous Systems Architecture Development

Lunar Exploration Infrastructure

Elements Of Robotic/Autonomous Systems Infrastructure

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

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

- Big Network Demonstration
- Collaboration With Astronauts
- In Situ Resource Utilization
- In-Space Operations

DoD Robotic Systems

- Battlefield Whiteboard Demonstration
- Offensive Operations
- Maneuver
- Common Operating System
- Weapons

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

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

Concentrate on developing and demonstrating capabilities that are common between NASA Lunar Infrastructure and DoD Robotic Systems

Satellites

Rovers

UGVs

UAVs

Sensors

Networks
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

- Network And Sensors Identify Objects Of Interest And Prepositioned Equipment
- 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)

Find The Trailer Or Object Of Interest
**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

**LRU**

**New OCU**

**MARCBot IV-N**
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

Automated Rendezvous and Capture (AR&C) Sensor
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.