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METERON

Demonstrate concepts and technologies that are being considered for use in future human exploration in the areas of:

- Communications: Issues such as disruption tolerance, delays caused by distance, hard real-time communications (video, haptic data, etc.) and multiple asset communications will be demonstrated.

- Operations: Issues such as human-in-the-loop rover/robot operations, multi-rover operations, multi-operator interaction, and monitoring and control of systems-of-systems will be demonstrated.

- Robotics: Issues such as haptic telerobotics, operations of multiple autonomous rovers (at different locations or at the same site), and human/rover collaboration will be demonstrated.
The Role of Generic Robotic Services

- Encapsulate the proprietary interfaces of different robotic elements
- Facilitate provision of a common M&C system for different robotic elements
- Abstract from implementation and communication technology (encoding and transport) at each node
- Facilitate coordinated and parallel M&C of multiple robotic elements
- Comply to existing CCSDS MO M&C specifications for services which are not specific for tele-robotics
Prototype Robotic Services

- **Direct Commanding Service** follows the CCSDS MO Action Service specification
- **Telemetry Monitoring Service** follows the CCSDS MO Parameter Service specification
  - Uses a generic publish-subscribe Broker Service for multicasting parameter updates
- **Activity Status Monitoring** Service follows the CCSDS MO Activity Service Specification
  - This is a evening pattern rather than a unique service implementation
  - Used for monitoring the status of multi-hub transfer and execution of telecommands
- **Robotic Motion Control Service** with operations for moving and rotating
- **Imaging Service** with basic operations for taking images
- **File Management Service** for management and transfer of files
- **Configuration Service** for setting and retrieving any configuration parameter
- **Authorisation Service** for management of coordinated operations
- **Broker Service:** For Multi-Casting of any information (Publish-Subscribe)
Scenario 1

- One single HTTP endpoint for each robotic service is published
- No modification of service consumers
- Single DTN node on ground and on-board
  - Simpler configuration
  - Compression implemented only there
  - Custom Encoding applied centrally
- Generic proxy for robotic services needed
Scenario 2

- Two endpoints for each robotic service is published (a DTN and an HTTP endpoint)
- Service consumers can choose the endpoint by configuration
- Fully DTN-based ground segment
  - MOE nodes can relay on DTN functionality for reliable messaging
  - TCP convergence layer on ground
- No Proxy is needed
- Transport and encoding is fully transparent to service provider and consumer implementations
- Based on JAX-WS standard API for custom transport implementation
- OMG FastInfoset binary encoding of SOAP messages
• Non-real-time monitoring and control of various robotic elements through a harmonised M&C System
  • Standardised Robotic Services
  • Standardised M&C Clients

• Monitoring of HK TM from METERON Infrastructure

• Monitoring of Network Parameters

• Following Activities performed on Robotic Workstation (specific to each Robotic Element)
  • Astronaut Activities on ISS
  • Robotic Experts at MREC

• Coordinated Operations of METERON Experiments as a system

• Traditional S/C M&C look and feel extended with robotic MMIs, e.g. map view and image viewer
• MOE supports **multi-hop action execution** and activity status monitoring

• MOE incorporates a publish-subscribe broker for multi-casting of information (TM, activity status, events, etc.) to all MOE nodes

• Prototype Robotic Services specified in compliance to W3C/OASIS WS-* standards

• Robotic Services for action execution, parameter and activity status monitoring are specified in compliance with CCSDS MO M&C services specifications

• JAVA Web Services specs (JAX-WS) and its Reference Implementation (part of the standard Java Virtual Machine) is extendable with custom encoding and transport

• DTN (BP) Transport implemented as pluggable custom transport to JAX-WS RI

• OMG FastInfoSet Binary Encoding is part of standard JAX-WS RI

• SOAP is used as canonical message format rather than a protocol

• MOE M&C components are customisation of EGOS infrastructure (GSTVI, DARC, ...)

• PUS to CCSDS MO MAL mapping works ok for mentioned services
Thank you

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