Introducing CCSDS MO Services to the METERON Operations Environment

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Outline

1. Introduction
2. The METERON Operations Environment
3. CCSDS Mission Operations Framework
4. Migration Work
5. Proof-of-Concept
6. Conclusion & Outlook
Introduction

METERON – Multi-purpose End-To-End Robotic Operations Network

- Demonstrate concepts and technologies that are being considered for use in future human exploration in the areas of Communications, Operations and Robotics
- SUPVIS-M (Session 8A)

Generic Data Systems infrastructure

- Monitoring and Control of distributed systems
- Abstract Plug&Play interface

Objective: Standardisation by CCSDS

- MO Services
- Telerobotic Operations
The Meteron Operations Environment

MOE as flexible and customisable Mission Control System

- Based on the Ground Segment Test And Validation infrastructure (GSTVi)
- Monitor robot telemetry
- Send commands
- Track command execution
- Health and Status of hardware
- ION DTN network status

Pub-Sub broker architecture

- Minimising space-ground traffic
A service oriented M&C interface for robotic systems

- M&C of robotic systems often requires a lot of custom development effort
- Early attempt to increase interoperability → CCSDS MO concepts
- Prototyped as Web Services in 2012
- Expose high-level API abstracting from proprietary software interfaces
- Successful usage in multiple METERON experiments with different rovers
CCSDS Mission Operations Framework

Standardised and interoperable communication framework for mission operations

- Primarily for S/C operations
- Service oriented rather than TM/TC based
- MAL provides messaging infrastructure and separation to the transport layer
- Service specifications are implementation and communication agnostic
- COM and M&C Services
- Open Source (https://github.com/esa)
Migration Work

- Small 2 month project at the beginning of 2016
- Turning MRS from initial prototype design into CCSDS MO compliant services
- Favourable point in time:
  - MAL, COM, M&C: Blue Book
  - Telerobotic Operations: Green Book
- Most of the MRS have direct equivalents in one of the service sets
- Reusage: Apply generic M&C Services to the domain of Telerobotics
- Create dedicated services for robotics
- Provide input for Telerobotic Operations standard
MRS vs. CCSDS Services

Parameter Service
Notification Service
Action Service

Robotic Motion Control Service
Camera Service
Manipulation Service
Video Service
Authorisation Service
File Transfer Service
Plan Service
Status Service

Parameter Service
Aggregation Service
Event/Activity Tracking Service
Action Service

Archive Service
Wheeled Mobility Service
Imaging Service
Manipulation Service

Video Service
Transfer of Control Service
Async. File Transfer Service
Plan Service
Status Service

Reused CCSDS MO M&C Services

Telerobotic Operations Green Book

METERON specific
Integration of MO Services

- Using ESA’s reference implementations of MAL, COM and M&C Services developed as part of OPS-SAT mission
- External API kept untouched
- Prototyped ION DTN transport binding
- Developed PubSub-Broker application
Creation of Robotic Services

- CCSDS MO Graphical Editor to create XML service specification
- Functionality of MRS was fully reconstructed from WSDL files
- Automatic generation of Stubs and Skeletons
- Little specific input from Telerobotic Operations Green Book
- Aim to provide input to Telerobotic Operations
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Proof-of-Concept

- Collaborative demo with ESTEC’s Automation and Robotics Section (TEC-MMA)
- Remote monitoring and control of the ExoMars Test Rover (ExoTeR)
- Service API integrated into Local Control Computer
- ExoTeR’s on-board SW untouched
- Relay of data to MOE at ESOC
- Commanding from ESOC and ESTEC
- Rather small and development effort
Challenges & Results

- MO Services can be applied to robotics as proven by PoC
- But: Message body designed for typical S/C operations not always ideal for distributed systems of METERON
- In general message sizes could be reduced to 1/3 (SOAP vs MAL)
- But: Still room for optimisations (Archive interactions)
- Creation of new services dedicated to robotics worked fine with Graphical Editor
- Automatic code generation speeds up the implementation process a lot
Outlook

- Implementation of additional services: Video Service, Transfer of Control Service, File Transfer Service (CFDP?)
- Look further into Telerobotic Operations Green Book
  Consider refinement/rework/extension of API
- Preparing for operational use in future METERON activities
- MOE as MCS for robotic systems in virtual reality
Thank you!

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