



METERON Operations Environment and Prototype Robotic Services

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METERON



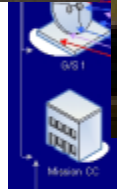
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human-in-the-loop
multi-rover
interaction
systems-oriented

-

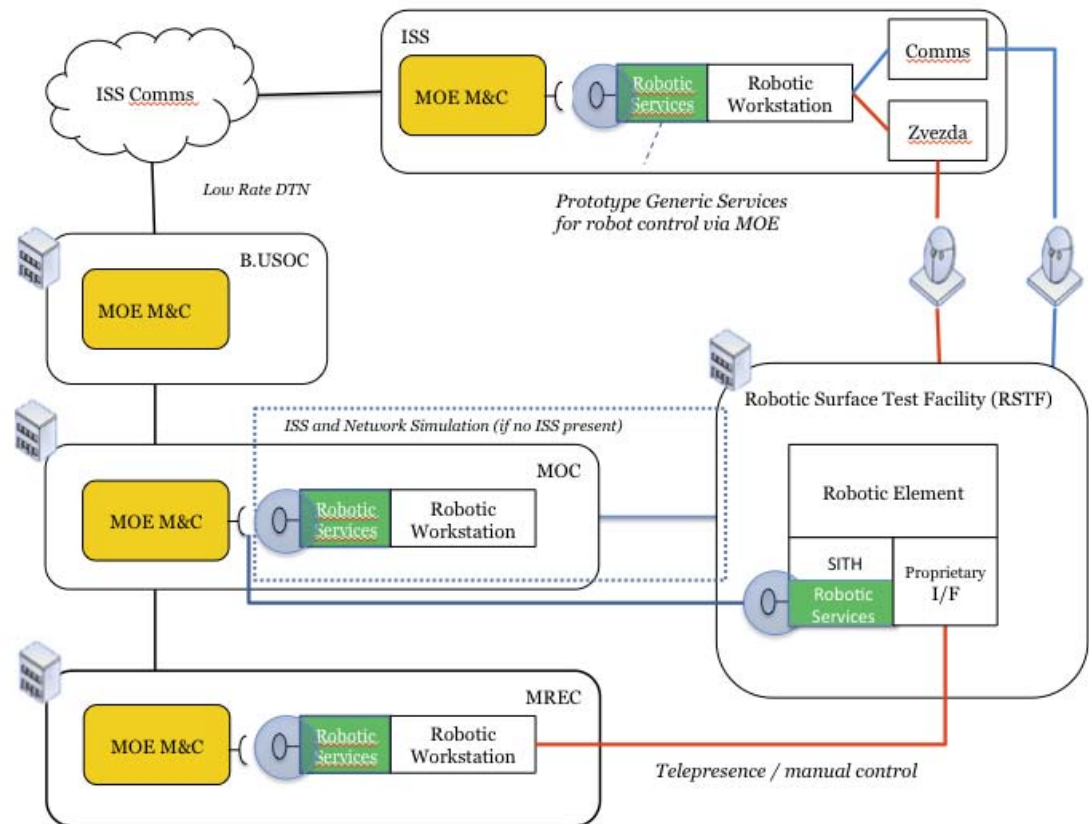
autonomous
multiple
different local
human/robot
interacted



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

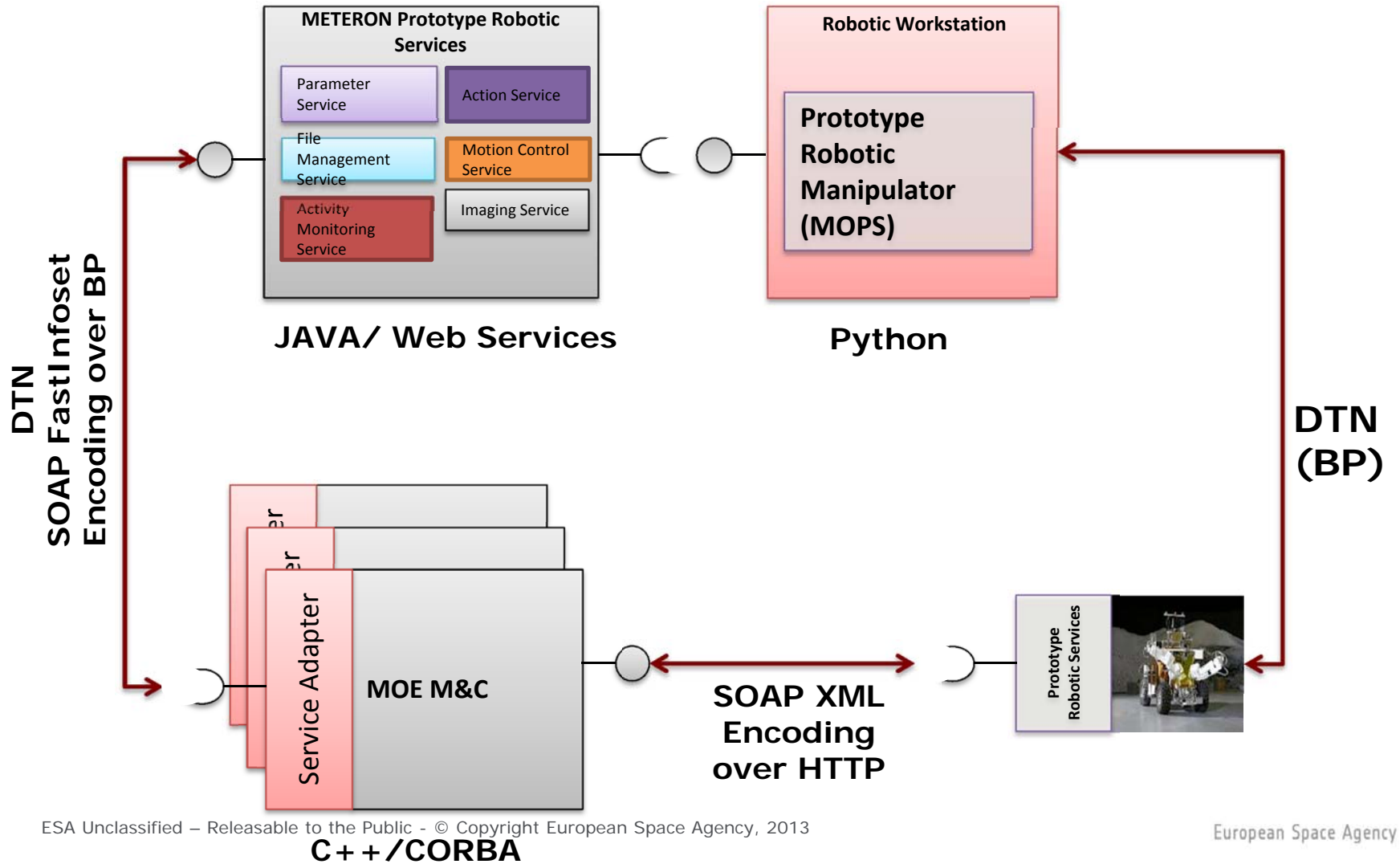


Prototype Robotic Services



- **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 an 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)

Simplified Deployment View

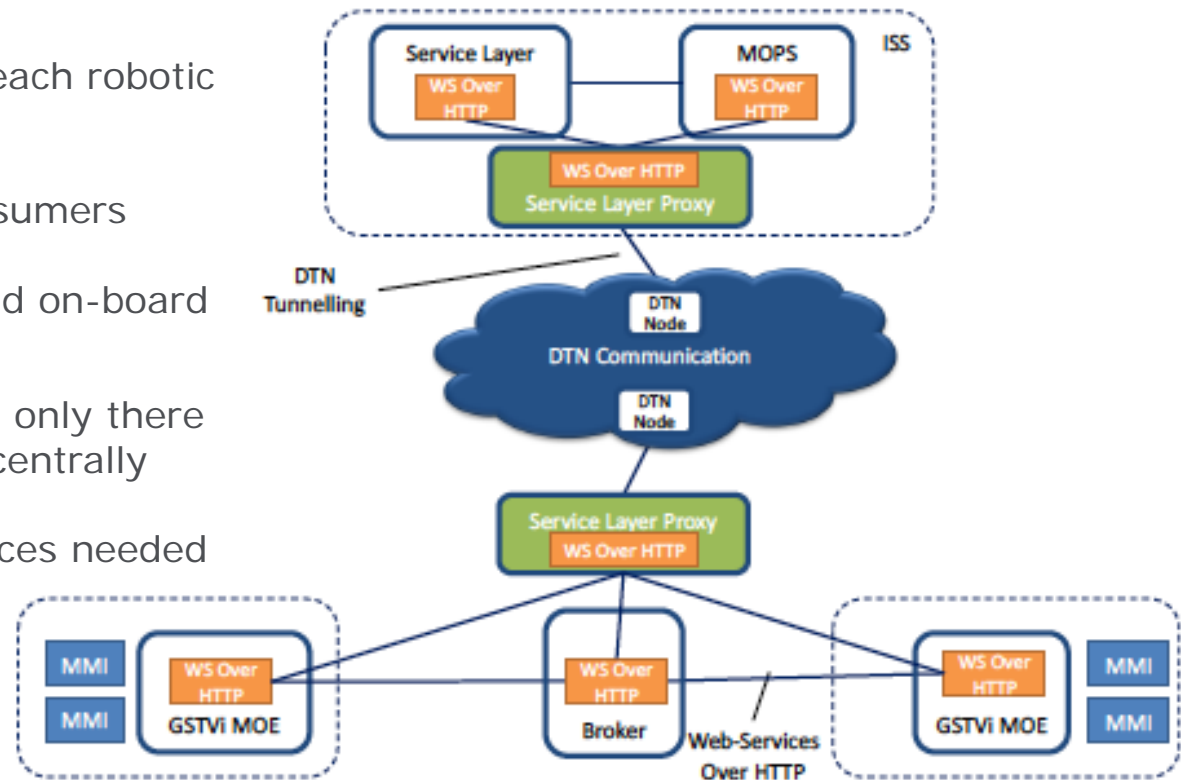


Single DTN Node Option Non-DTN MOE Nodes

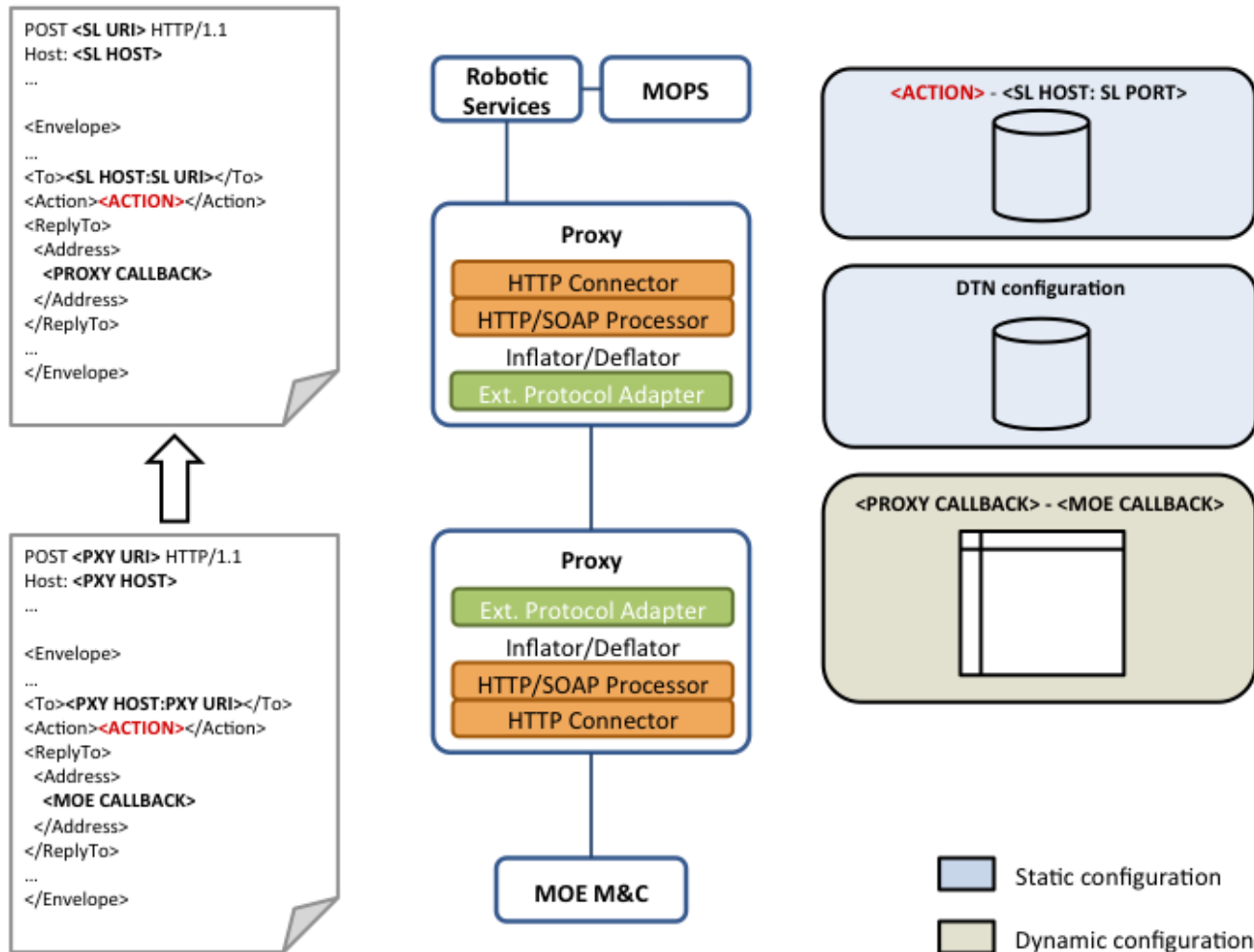


Scenario 1

- 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



Single DTN Node Option Non-DTN MOE Nodes

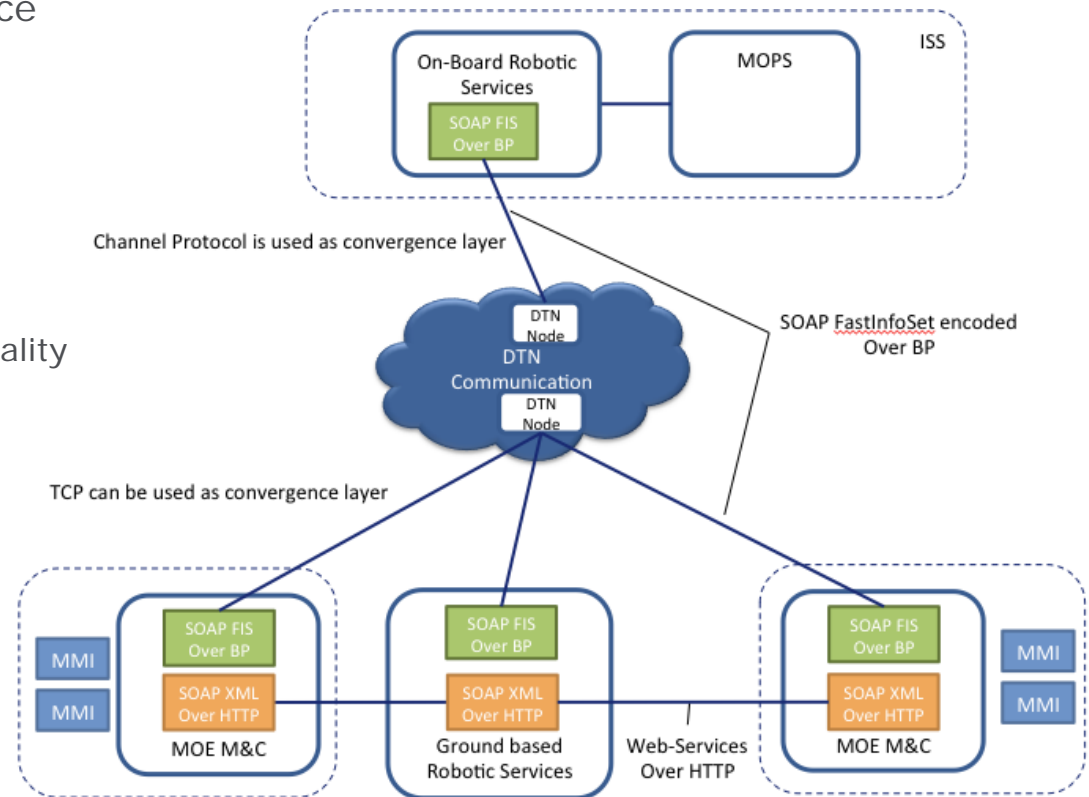


Fully DTN Based Ground Segment Option



Scenario 2

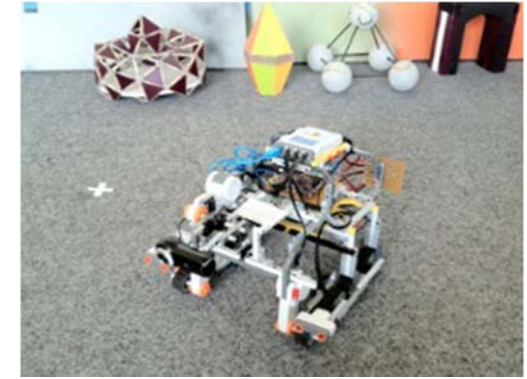
- Two endpoints for each robotic service is published (a DTN and an HTTP endpoint)
- service consumers can choose the endpoint by configuration
- Fully DTN-based ground segment
 - MOE nodes can relay on DTN functionality for reliable messaging
 - TCP convergence layer on ground
- No Proxy is needed
- 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



METERON Operational Environment M&C



- 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



The screenshot shows the METERON software interface. On the left, there is a sidebar with system information: Daemon: moeus, Assembly: GSTV, Spacecraft: MET, S/C Version: 1.0.0, GSTV Version: 1.0.1. Below this are buttons for 'Open Assembly', 'Select Spacecraft', 'Maintenance: OFF', and 'Control Mode: Local'. The main window is titled 'Manual Stack: Packet Replay' and contains a 'Manual Stack' table with columns: Num, Name, Description, MD, Release Time, B, Execution Time, and Parameters. Below the table are buttons for 'Dispatch', 'Dispatch All', 'Manual Stack State: Active', and 'Stop'. At the bottom, there is a 'Command Verification' table with columns: Index, Name, Description, Release Time, Execution Time, B, VC, FC, R, R, F1, A1, F2, A2, S, P, C. The table contains several rows of command data.

Index	Name	Description	Release Time	Execution Time	B	VC	FC	R	R	F1	A1	F2	A2	S	P	C
	ROTATE	Rotate command	2012-09-14T18:14:22.439		0	0	0	S	S	S	S	S	S	S	S	S
	GOTO	GoTo command	2012-09-14T18:15:06.033		0	0	0	S	S	S	S	S	S	S	S	S
	TAKEIMAGE	TakePicture command	2012-09-14T18:16:54.102		0	0	0	S	S	S	S	S	S	S	S	S
	GETFILE	GetFile command	2012-09-14T18:19:20.973		0	0	0	S	T	U	U	U	U	U	U	U
	TAKEIMAGE	TakePicture command	2012-09-14T18:21:25.139		0	0	0	S	T	U	U	U	U	U	U	U
	GOTO	GoTo command	2012-09-14T18:22:03.472		0	0	0	S	T	U	U	U	U	U	U	U

Key Points



- 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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