METERON SUPVIS-M

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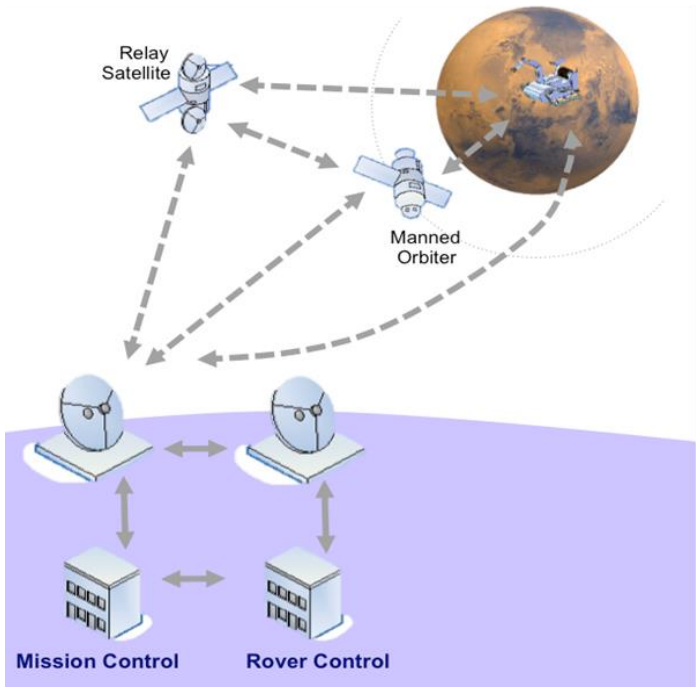
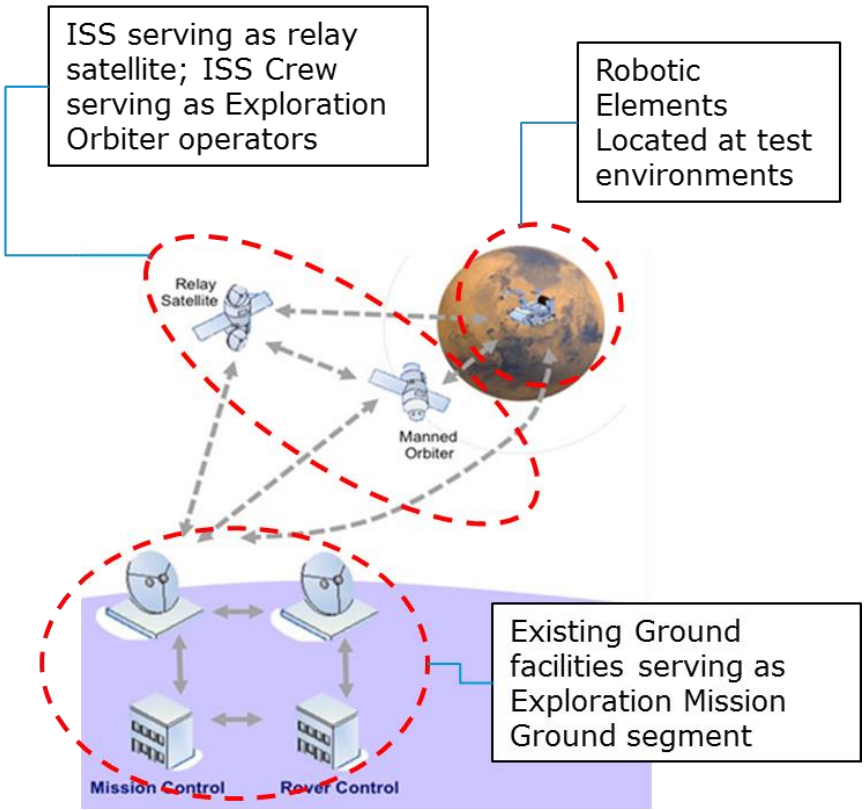
The Multi-purpose End-To-End Robotic Operations Network (METERON)

Reference Exploration Mission Architecture



Simulated Exploration Mission Architecture



The METERON Project

- Stepwise approach
  - OPSCOM-1: Crew activity controlling MOCUP rover
  - OPSCOM-2: Crew activity controlling EUROBOT
  - SUPVIS-E: Supervisory control of EUROBOT - Enhanced network capabilities, realistic tasks and scenario
  - **SUPVIS-M**: investigate various robotics and operations strategies – Bridget rover a

SUPVIS-M Objectives

1. Assessment of key scenarios where human tele-operation would be required (e.g. at the Moon):
   - Explore science-rich hazardous areas in time-limited operations where the use of **autonomous systems may not provide the required performance** for the mission or where energy availability may drive **a "need for speed"**
     - Low-light caves, canyons, or shaded craters
     - Harsh-lighting
     - Slopes, range of rock sizes, unexpected obstacles in unknown environment
   - **Gather experience on rover operations**, both from robotic and operational aspects.

2. Obtain data on **humans performing path planning** and evaluate the differences, in terms of speed of execution / reactivity:

   Direct control from the **ground** in traditional manner (Earth-moon round-trip delay <5 sec)

   vs.

   Supervisory control from **orbit** (here: the ISS by ISS crew members ~1 sec delay)

SUPVIS-M Objectives

3. Provide **metrics to allow comparison / expansion** of results from ground-based experiments vs. a Human-operator in the supervisory control loop.

4. Provide / Expand further **human factors metrics on using a simple user interface** for robotic control by non- specialists (crew).

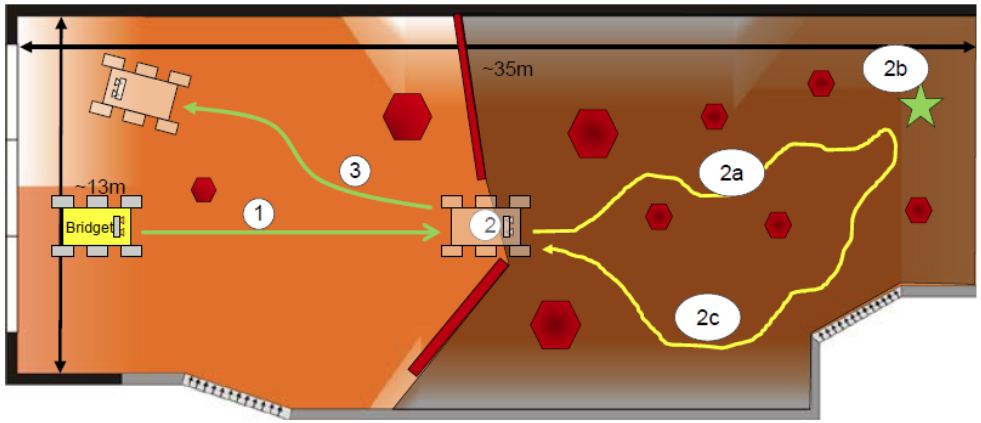
5. Expand the METERON infrastructure capability by **adding Airbus Defence & Space Mars Yard (Stevenage UK) to the METERON Network.**

Stevenage Mars Yard (Airbus D&S UK)

SUPVIS-M scenario

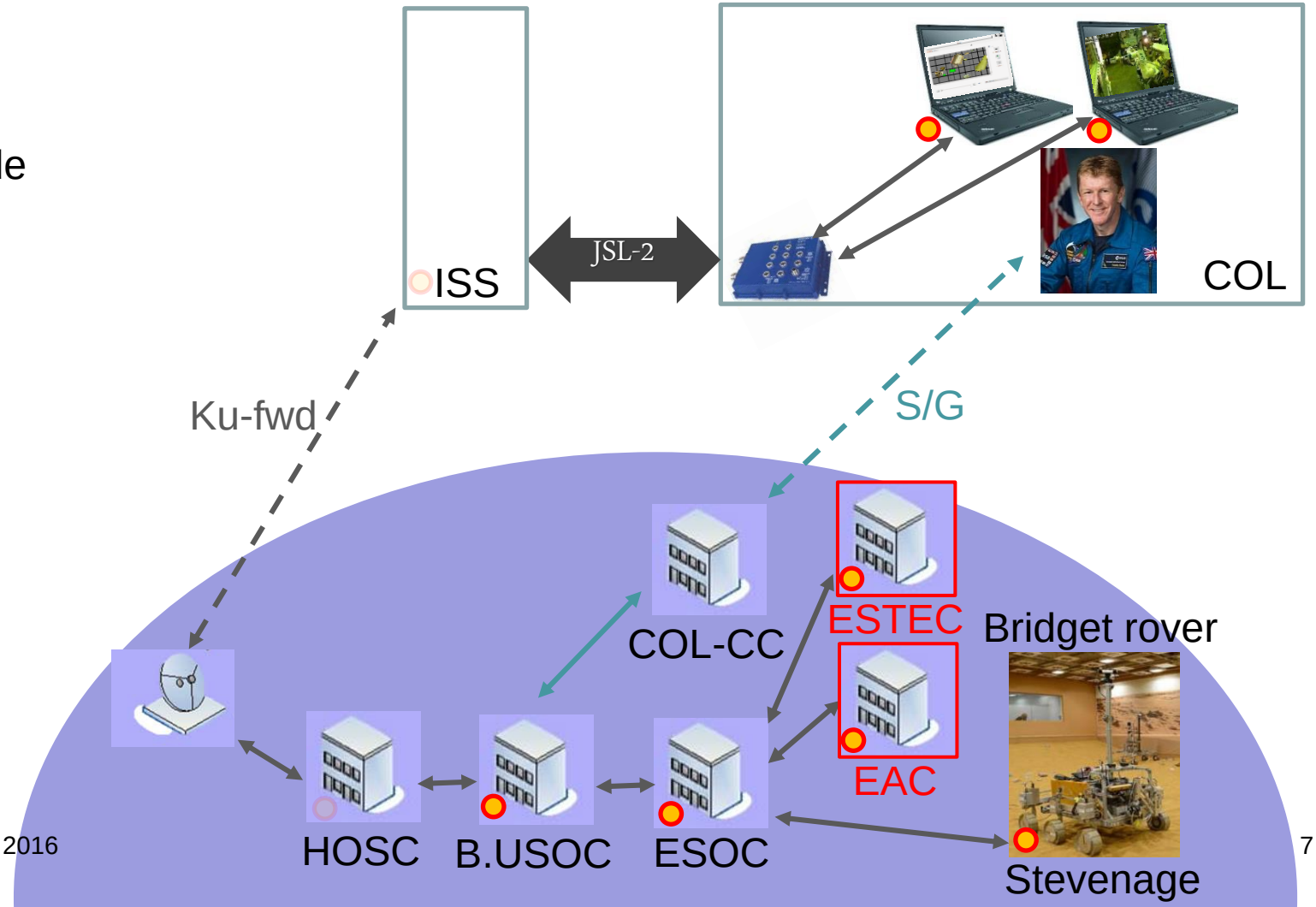
Simulate a scenario were humans are orbiting the Moon and a rover is deployed on the lunar surface

- The rover has been commanded by **Ground** to arrive at the edge of a zone in shadow or harsh lighting conditions.
- **Crew** will take over control and
  - **perform inspection of the zone in penumbra, identify a safe path**
  - **identify a number of science targets and map their location**
  - **get out of the penumbra.**
- **Ground** control will then take back control over the rover.

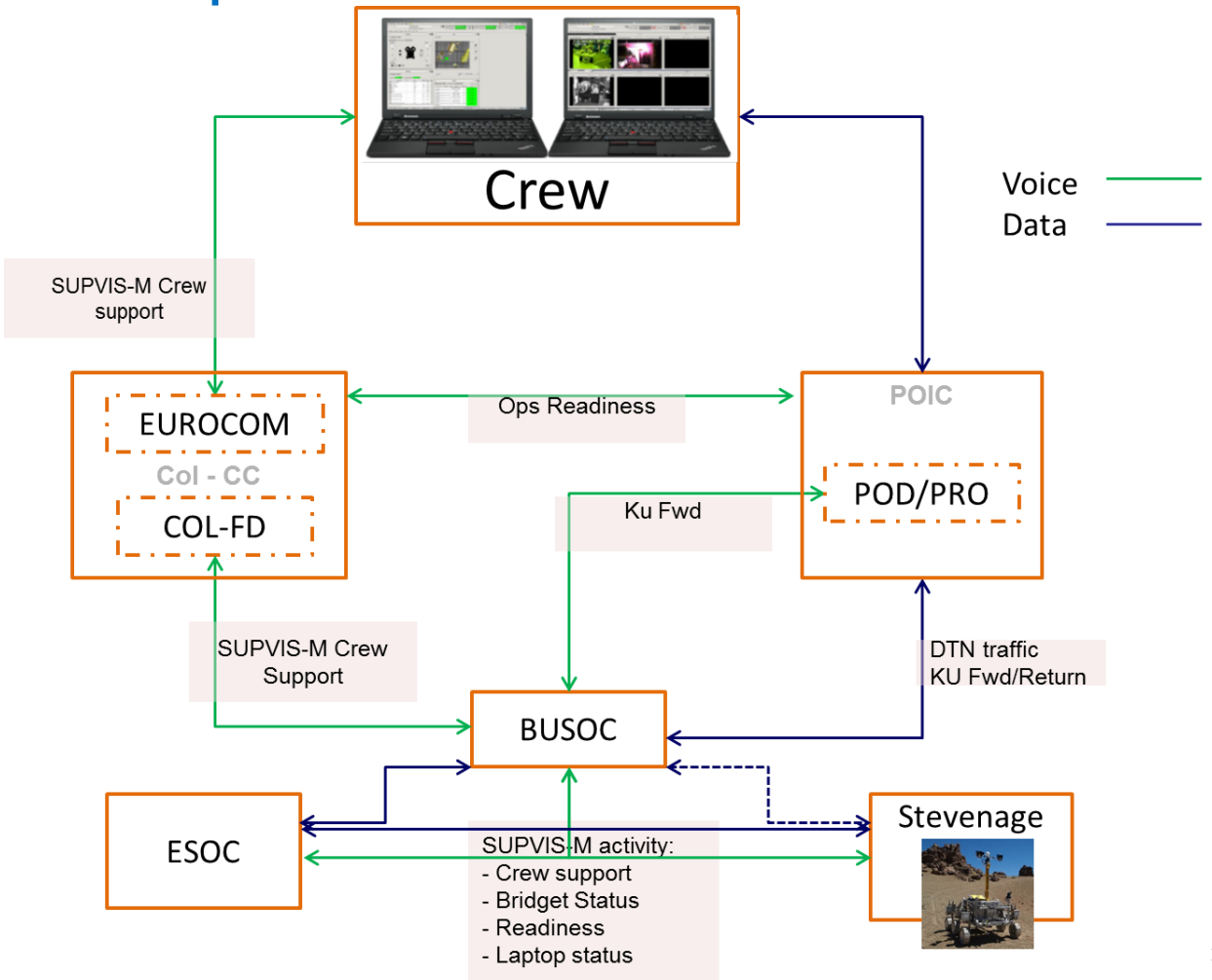


SUPVIS-M Setup

- DTN node



SUPVIS-M operations



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SUPVIS-M Requirements

- Resources:
  - 2 T61p laptops, with max. of 80W each
  - laptop control via Ku-Fwd
  - 1 Mbps uplink/downlink per laptop (Ku-Fwd, DTN) over HOSC resources
  - video streaming uplink (over DTN)
- Ground operations start ~ 1 month prior to crew session
- On Board Training is a prerequisite (20 min)
- Crew session (2 hrs):
  - Tim Peake as mandatory crew, to be performed before end of Inc47
  - Details for the goal based activity via Crew Message; questionnaire at end of session
  - Minimum of LOS periods
  - 5-min video message recorded by the crew shortly after session (nice-to-have)
- stowage of laptops at end of session (+/- 20 min) (TBC – depends on schedule for SUPVIS-E)

SUPVIS-M status

- PIA available
- Ground infrastructure ready at BUSOC (same as for SUPVIS-E)
- Operations concept defined
- Scenario for crew drafted
- Payload developer:
  - Rover control software under development
  - Additional functionalities for Bridget to be implemented
- OBT to be developed

Extra: Remaining SUPVIS-E activities

- **Session 1**: Solar array extraction & small payload retrieval
  - Trouble with the grasp command
  - Workaround has been found -> Manual arm control widget
  - Additional Malfunction PODF needed
  - Not ready to be executed in Inc46
  - Possible rollover candidate for Inc47/48
  - Can be performed by any crew member
- **Session 3**: Antenna deployment
  - Proposed to rollover to Inc49
  - Permanent fix for SPR-1431 required (automatic grasp function)

Questions?

Backup Slides

The METERON Project

- Multi-purpose End-To-End Robotic Operations Network
- Goals:
  - Providing end-to-end in-orbit demonstration of **potential future exploration scenarios, involving humans and robots** (operations)
  - Validate the concept of **real-time control of a robot** on a planetary surface, from an manned orbiter with force and stereo vision feedback (robotics)
  - In-orbit testing and validation of novel communication techniques, such as **Disruption/Delay Tolerant Network** (communication)

SUPVIS-M ground requirements

- Rover:
  - Bridget rover at Stevenage
  - Rover will be upgraded with camera system (video feedback and localisation)
- Ground sites:
  - DTN nodes
  - MOE software for end-to-end monitoring and rover commanding from ground
- Voice communication:
  - S/G communication: Voice forwarding to Stevenage using the PABX system

SUPVIS-M HW & SW

- Re-use of hardware and communication infrastructure of SUPVIS-E
  - 2x T61p laptop (1 for Rover control SW, 1 for Video)
  - Use of Ku-FWD for command and telemetry

- Rover control SW:
  - Reuse of MOPS software of OPSCOM-2
  - Already installed on the laptops
  - A SW upgrade will be needed

- Ground SW: MOE (METERON Operations Environment)

SUPVIS-M Bridget

-Built by Astrium UK
-representative of the size, actuation capability and speed of a typical Martian rover platform (ExoMars prototype)
-6 wheel drive, 4 wheel steering