Mobile Procedure Viewer Short Duration Mission

mobiPV-SDM

4000110425/14/NL/AT

Final Presentation

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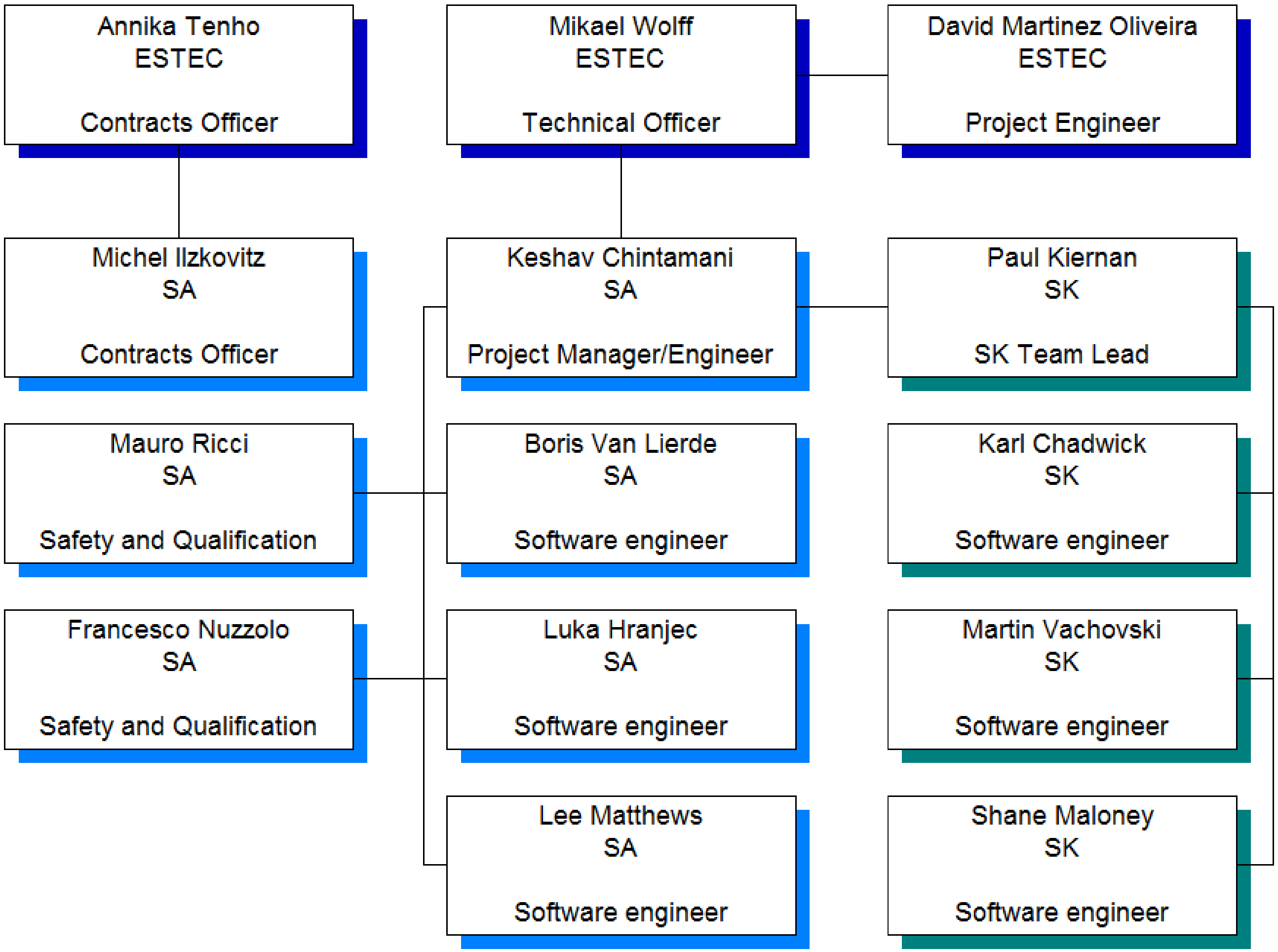
Aim

- Demonstrate the benefits of mobiPV for standalone and crew-ground collaboration in the ISS environment
- Target : ESA Short Duration Mission (SDM), aka IRISS in September 2015
- Previous activity ***mobiPV*** - GSTP funded for baseline system implementation
- Related objectives:
  - Raise mobiPV GSTP prototype to TRL 7 for software and hardware
  - Validate mobiPV space-ground communication
  - Prepare Engineering, Training and Flight Models of COTS hardware
  - Crew evaluation of all mobiPV features and configurations on ISS
- Project Start: December 2013 Project End: November 2015

Team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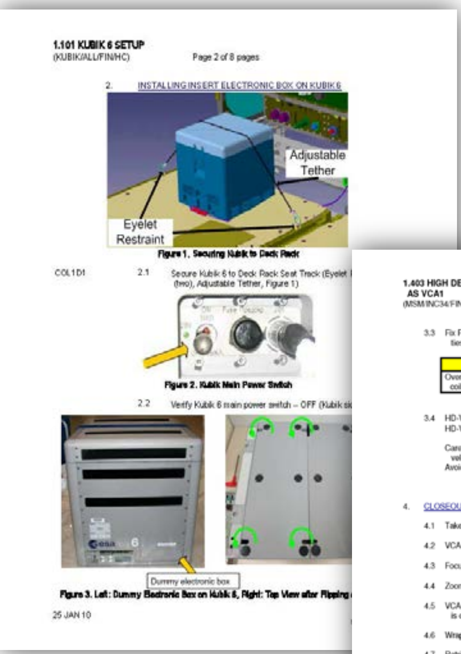
The Operations Data File (ODF)



1.101 KUBIK 6 SETUP
(KUBIK/ALL/FIN/HC) Page 2 of 8 pages

2. INSTALLING INSERT ELECTRONIC BOX ON KUBIK 6

Figure 1. Securing Kubik to Deck Rack

COL1D1 2.1 Secure Kubik 6 to Deck Rack Seat Track (Eyelet (two), Adjustable Tether, Figure 1)

Figure 2. Kubik Main Power Switch

2.2 Verify Kubik 6 main power switch – OFF (Kubik si

Figure 3. Left: Dummy Electronic Box on Kubik 6, Right: Top View after Flipping

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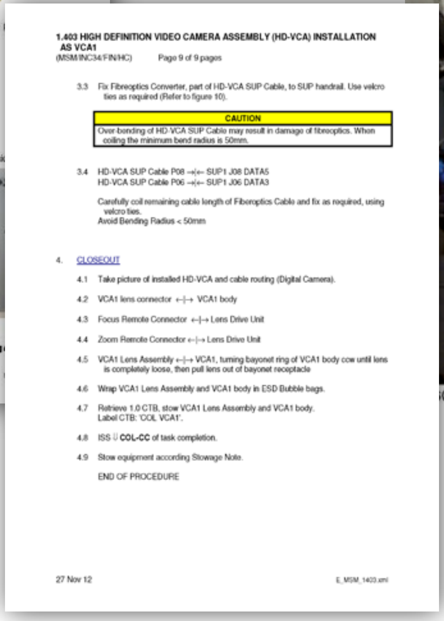

1.403 HIGH DEFINITION VIDEO CAMERA ASSEMBLY (HD-VCA) INSTALLATION AS VCA1
(MSM/INC34/FIN/HC) Page 9 of 9 pages

3.3 Fix Fibreoptics Converter, part of HD-VCA SUP Cable, to SUP handrail. Use velcro ties as required (Refer to figure 10).

CAUTION
Over-bending of HD-VCA SUP Cable may result in damage of fibreoptics. When coiling the minimum bend radius is 50mm.

3.4 HD-VCA SUP Cable P08 →|← SUP1 J08 DATA5
HD-VCA SUP Cable P06 →|← SUP1 J06 DATA3

Carefully coil remaining cable length of Fiberoptics Cable and fix as required, using velcro ties.
Avoid Bending Radius < 50mm

4. CLOSEOUT

4.1 Take picture of installed HD-VCA and cable routing (Digital Camera).

4.2 VCA1 lens connector ←|→ VCA1 body

4.3 Focus Remote Connector ←|→ Lens Drive Unit

4.4 Zoom Remote Connector ←|→ Lens Drive Unit

4.5 VCA1 Lens Assembly ←|→ VCA1, turning bayonet ring of VCA1 body ccw until lens is completely loose, then pull lens out of bayonet receptacle

4.6 Wrap VCA1 Lens Assembly and VCA1 body in ESD Bubble bags.

4.7 Retrieve 1.0 CTB, stow VCA1 Lens Assembly and VCA1 body.
Label CTB: 'COL VCA1'.

4.8 ISS ⇓ **COL-CC** of task completion.

4.9 Stow equipment according Stowage Note.

END OF PROCEDURE

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On-board Limitations

- Crew mobility
  - No mobile procedure solutions on-board
  - Crew cannot be “tethered” to laptops
- Collaborate needed at many levels
  - Troubleshooting
  - Status of procedure (current step is?)
  - Shared control of procedures
  - Media file exchange to support tasks
  - Telepresence (video, audio)
- Ground views live “video” of crew – difficult to get “first person” view of workspace
- Dedicated real-time space-ground audio

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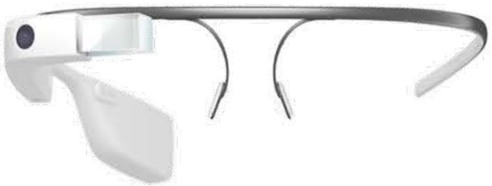
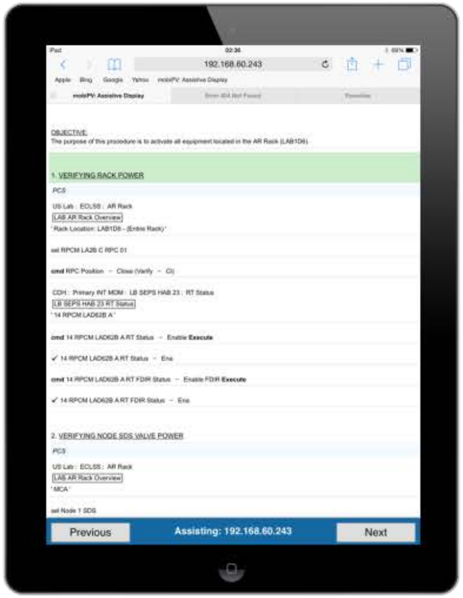
mobiPV Flight and Ground Segment

Smartphone



Google Glass



iPad

* iPad is NASA supplied hardware

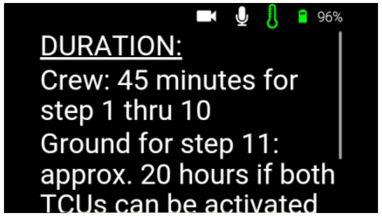
mobiPV Laptop

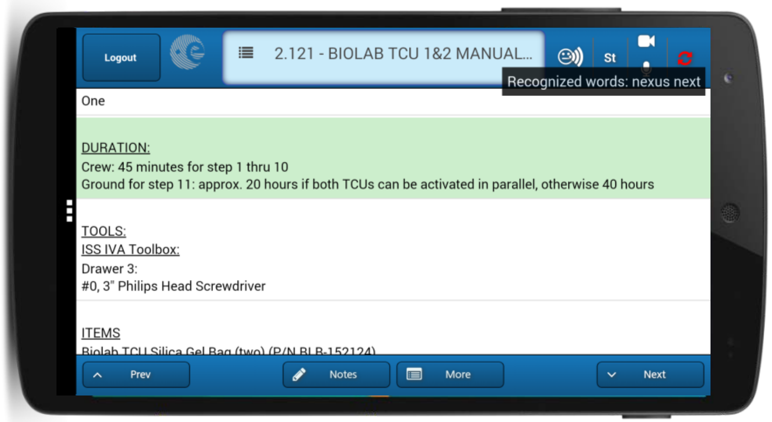
mobiPV Standalone Features

- Procedure Viewing on
  - Wrist mounted smartphone
  - Heads-up on Google Glass
  - iPad

- Image, audio, video, text notes

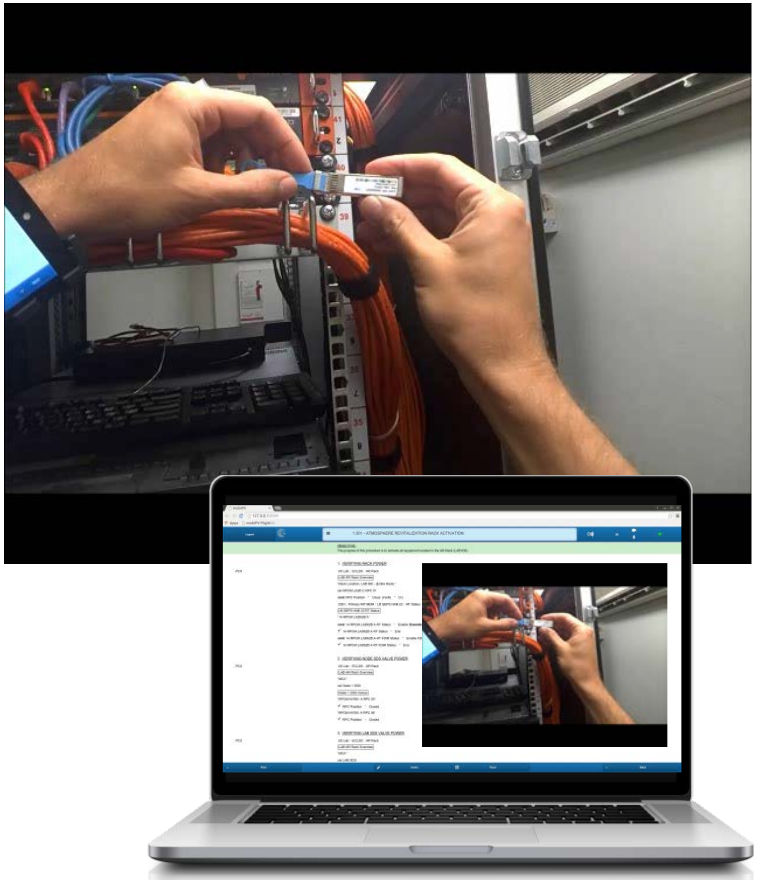
- Speech recognition for procedure navigation





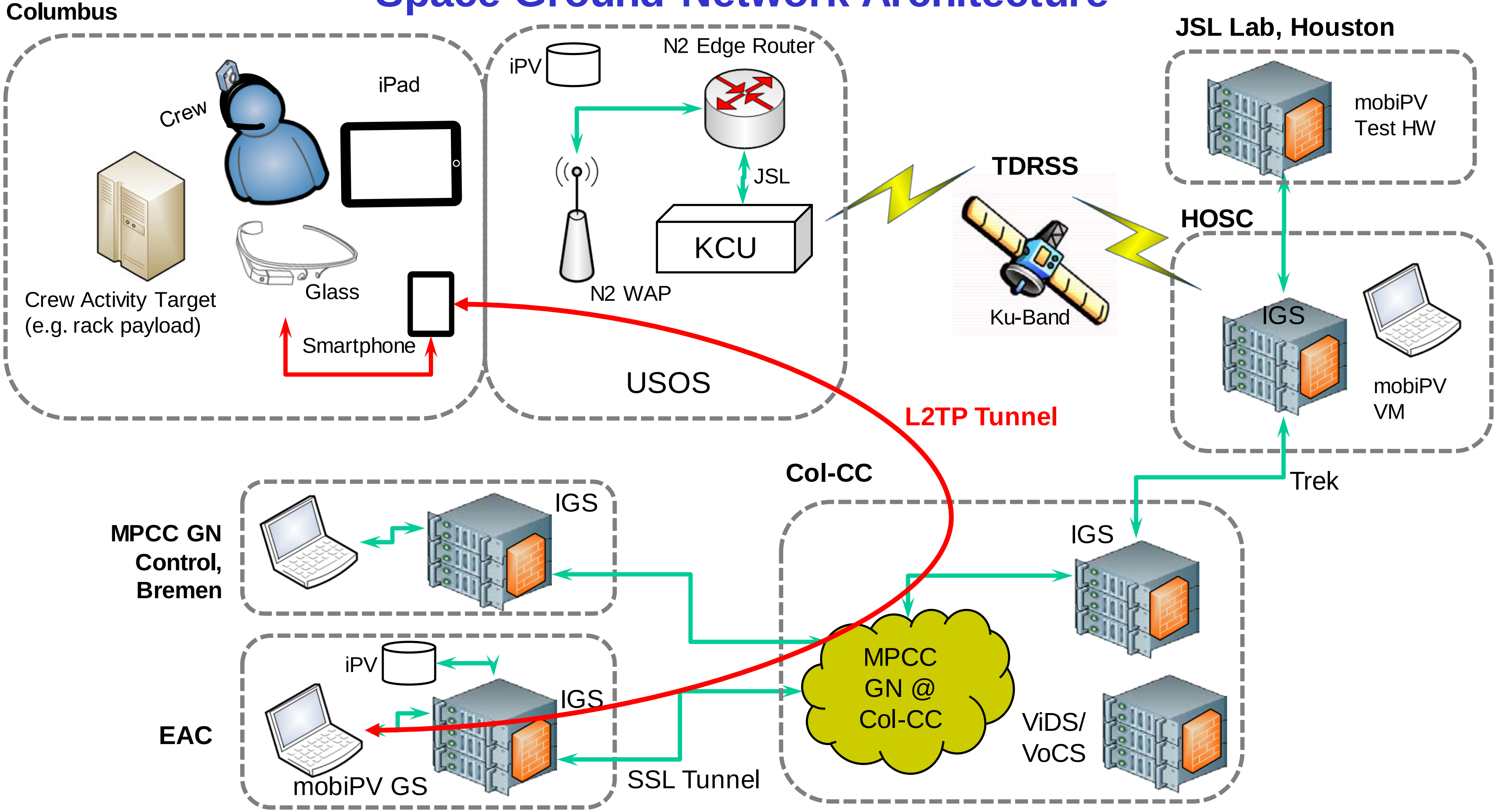
mobiPV Collaborative Features

- Live streaming of audio and video between space and ground
- Real-time follow of flight procedure step on ground
  - The “Master-Slave” mode
- Remote control of procedures
- Sharing of notes associated to procedure step between flight and ground



mobiPV Laptop

Space Ground Network Architecture

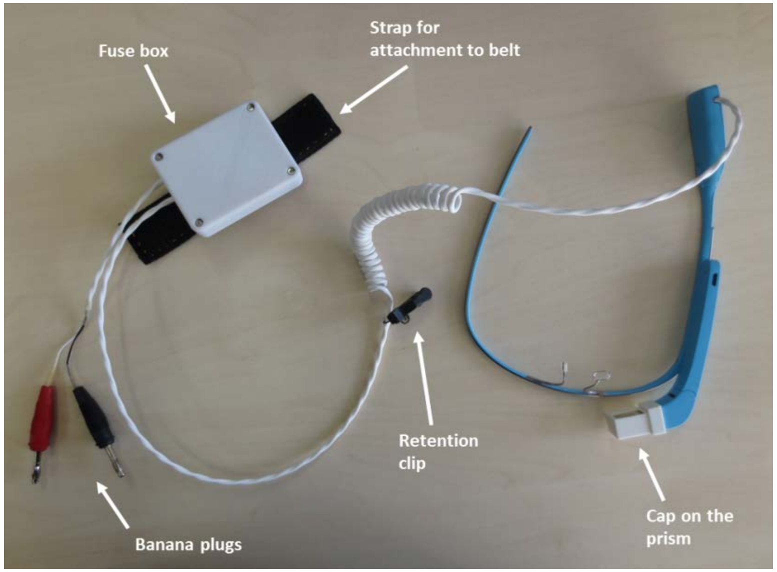


Network Testing and Challenges

- Architecture had to be updated quite late due to new constraints in MPCC
  - TCP connections cannot be made from space to ground
- Solved by encapsulating all traffic inside L2TP tunnel between FS and GS
- E2E network tests had mixed success (EAC to HOSC, EAC to JSL Lab, local tests in Bremen)
  - GS to FS connectivity over tunnel verified
  - Disconnections, insufficient bandwidth for real-time video

Hardware Qualification

- All hardware COTS
- Major challenges
  - RF (Bluetooth, WiFi, GSM)
  - Internal batteries
  - Materials – glass, plastics
  - Charging
- LG provided a lot of support
- Limited support for Google Glass
  - ESTEC modified Glass with external NASA rechargeable battery



Flight Hardware

LG Nexus 5

Launch Container

Google Glass

User Evaluations

- mobiPV benefited from end-user involvement!!
  - Crew-members, EuroCom, Crew Instructors, USOC
- Various user workshops and evaluations organized (>5)
- Tested in Neemo20!
- Tested on the ISS!

Neemo20

- NASA Extreme Environment Mission Operations (NEEMO)
- Series of analog missions conducted in underwater NASA Aquarius habitat
- mobiPV tested by ESA, NASA and JAXA astronauts during Neemo20
- Successfully tested all features between MCC and Aquarius

Photo credits: NASA/ESA

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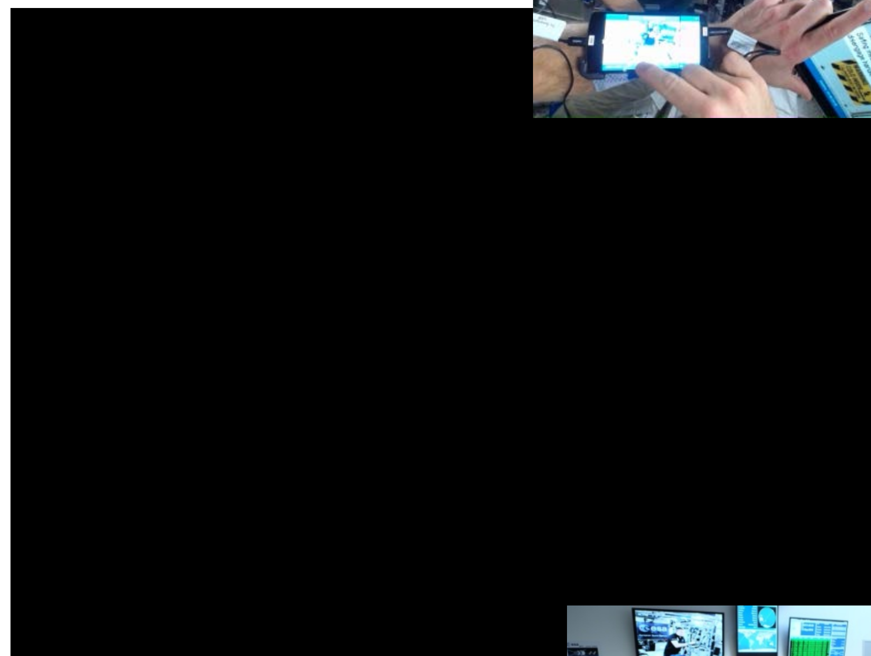
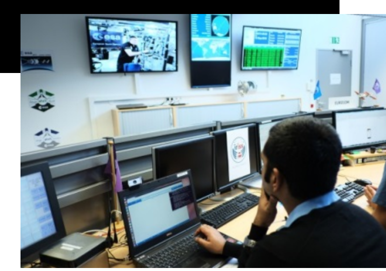
IRISS On-board Demonstration

- Limited to 1 hour due to mission priorities
- Only tested smartphone and iPad (backup configuration)
- Results
  - Procedure & sync worked
  - Note sharing worked
  - iPad worked
  - Video streaming partially worked
  - Audio did not work
  - Network bandwidth limitations



Video and Photo credits: ESA



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Main Findings and Feedback from Crew

- Most liked the concept of a lightweight, hand-held procedure viewer
- Nobody liked the cabling setup for the wired configuration
- Personal preferences for a tablet display vs a smartphone
- Voice recognition still a major issue – reliability
- Mixed opinions on Google Glass (**no on-board data available**)
  - Limited display room, heating issues
  - Setup time induced by modifications
- All liked the ability to quickly sync procedures, share pictures, videos
- Real-time first-person video – Ground specialists love it. Crew find its more useful for ground than flight

Future Work

- Potential improvements to the baseline:
  - Separate audio and video streams –multi-user voice loops
  - Remove “dialing” feature and have drop-down lists of all available cameras
  - Reduce video streaming latency & bandwidth – Hardware H264
  - Swap wired camera and audio for wireless
  - More “synchronization” with Google Glass and Smartphone GUIs
- Future use-cases
  - Assembly, integration and testing (AIT)
  - Robotics -> Rover control
  - Telemetry and tele-commanding
  - Space medicine (telemedicine included)

Questions?

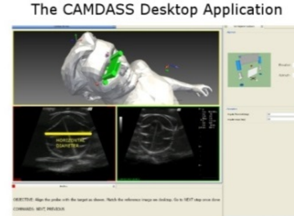
THANK YOU!

Related Demonstrators and Experiments

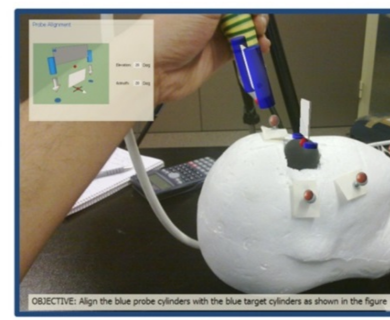
WEAR++: Augmented Reality System for procedures

CRUISE: speech recognition technology for procedure navigation

The CAMDASS Desktop Application



CAMDASS Hardware



AR guidance for probe positioning

CAMDASS: AR for crew health diagnosis