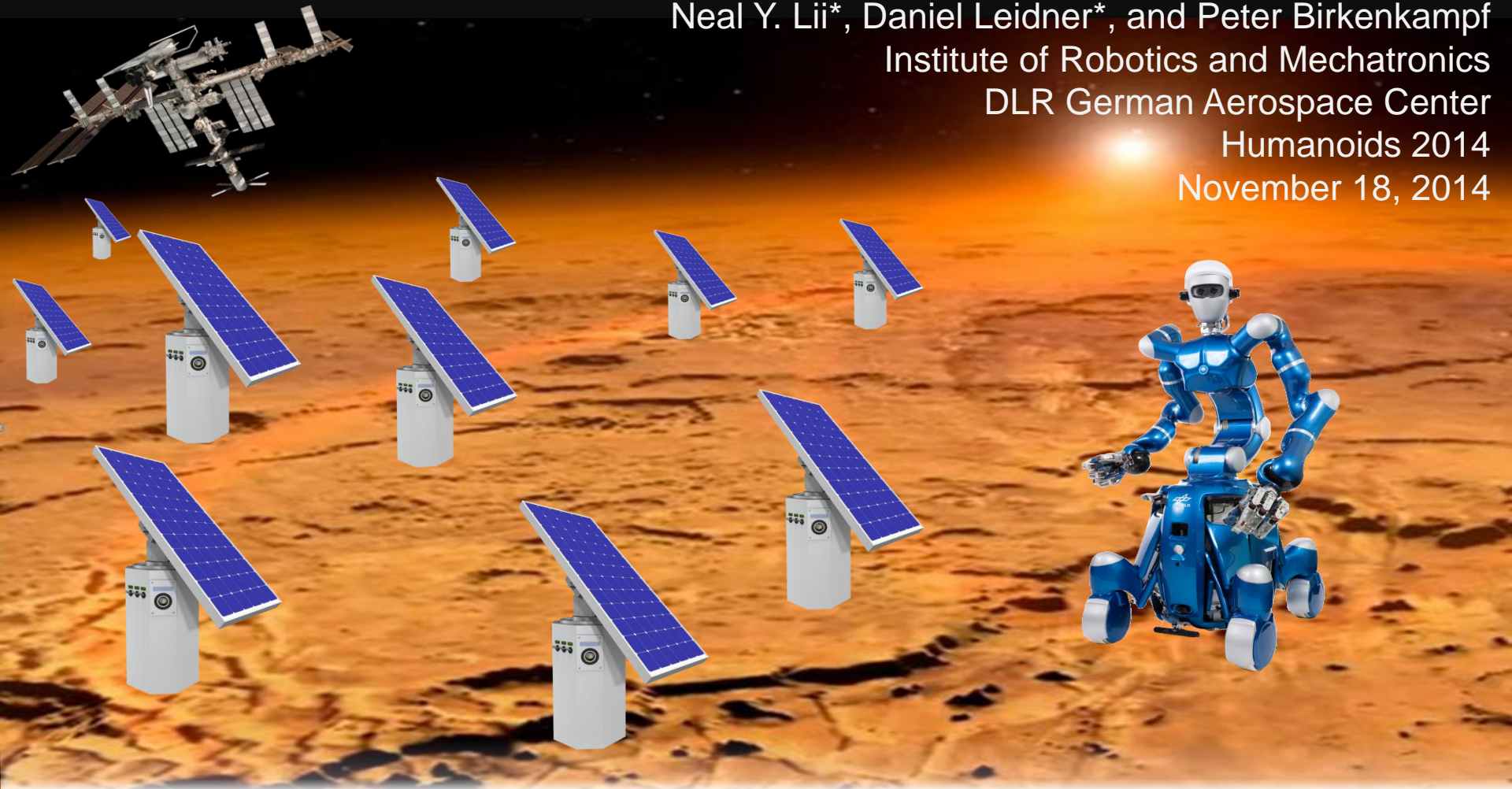# METERON SUPERVISED AUTONOMY EXPERIMENT
SUPVIS-JUSTIN

Neal Y. Lii*, Daniel Leidner*, and Peter Birkenkampf
Institute of Robotics and Mechatronics
DLR German Aerospace Center
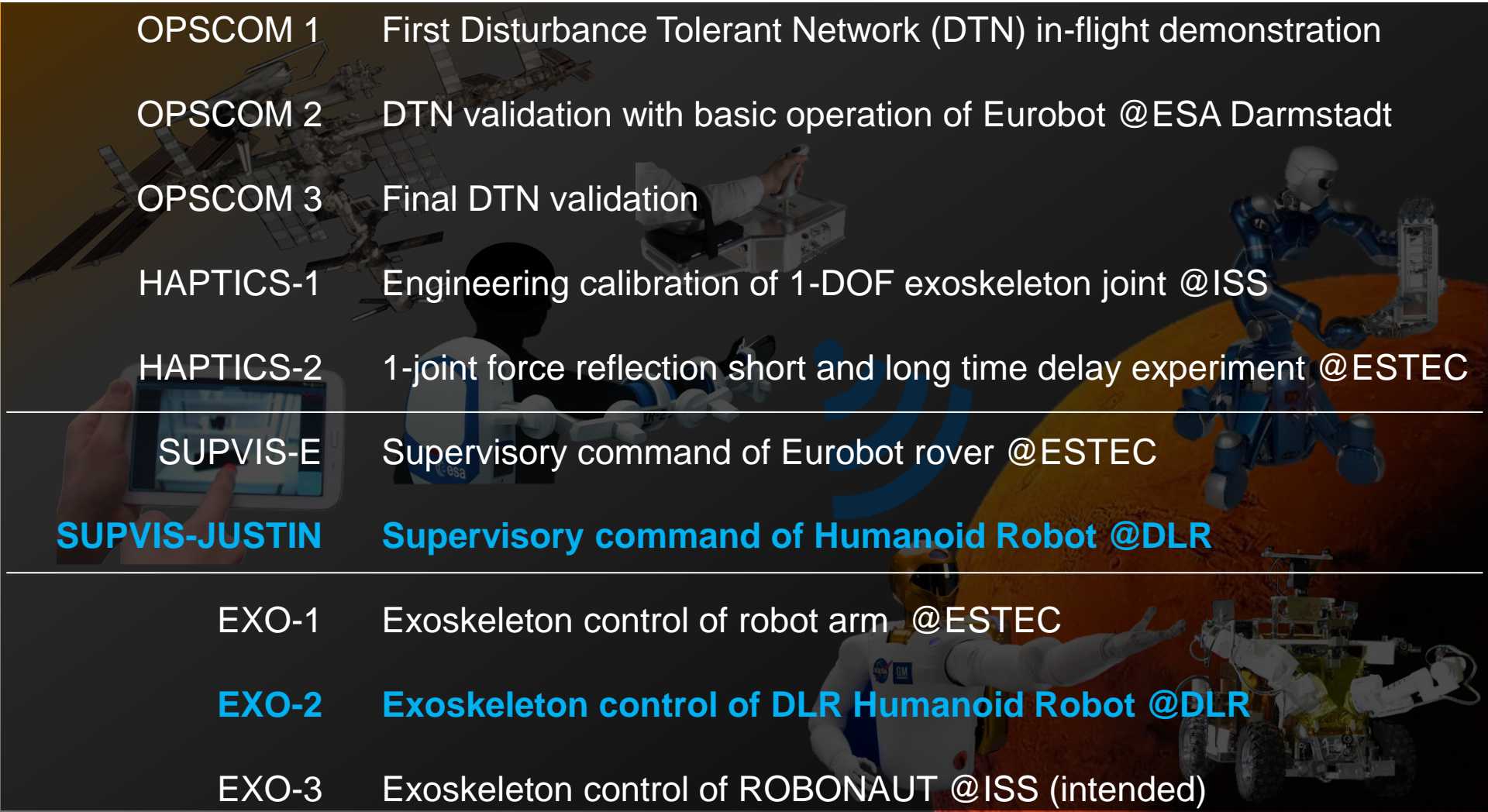Humanoids 2014
November 18, 2014

Website: http://meteron.dlr.de/
Contact: Neal.Lii@dlr.de

Multi-purpose End-To-End Robotic Operations Network
An overview of the Meteron experiments

Real-time, low bandwidth or

~seconds delay, high bandwith

DLR

http://meteron.dlr.de/
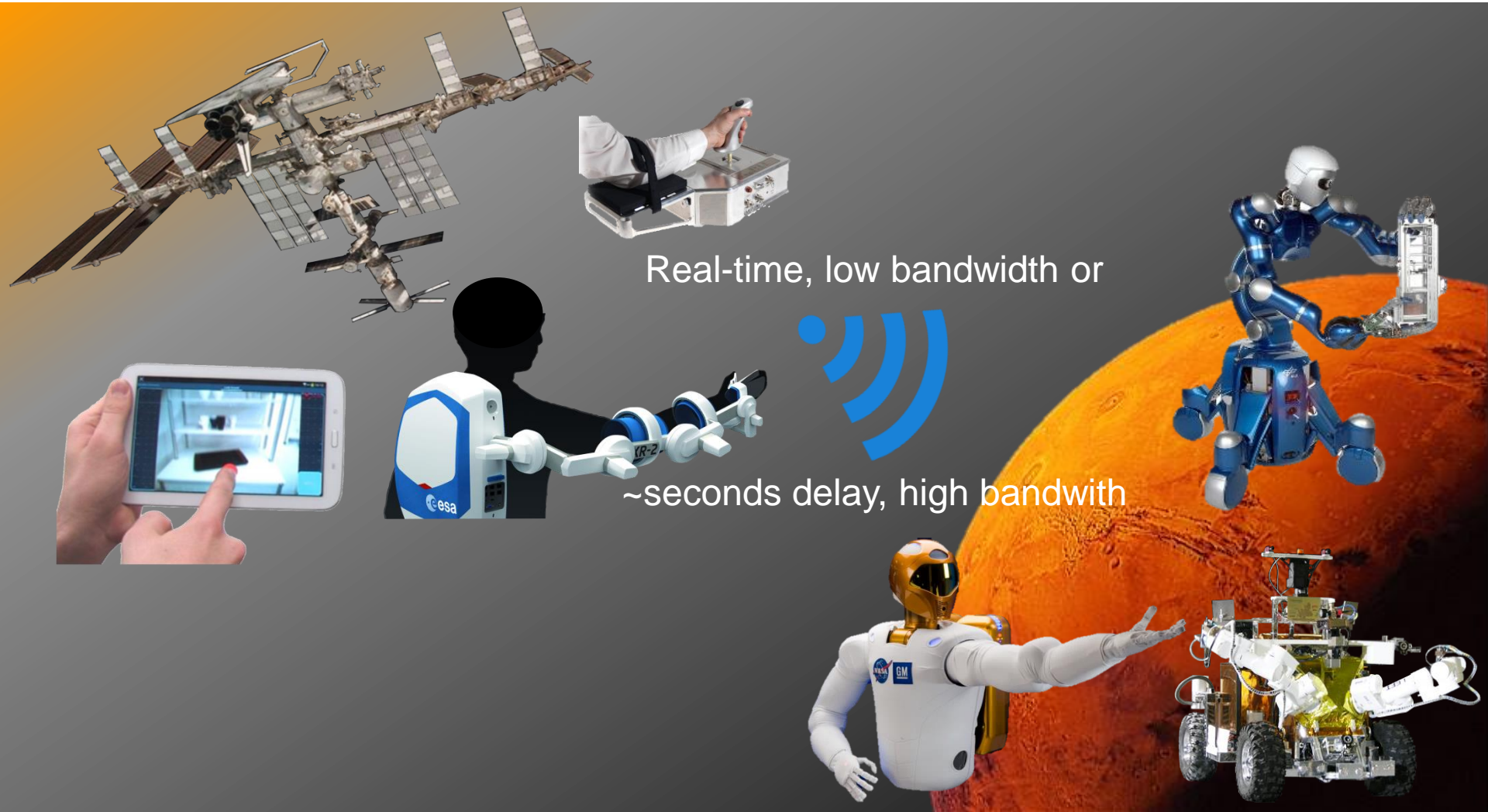
Multi-purpose End-To-End Robotic Operations Network
An overview of the Meteron experiments

OPSCOM 1	First Disturbance Tolerant Network (DTN) in-flight demonstration
OPSCOM 2	DTN validation with basic operation of Eurobot @ESA Darmstadt
OPSCOM 3	Final DTN validation
HAPTICS-1	Engineering calibration of 1-DOF exoskeleton joint @ISS
HAPTICS-2	1-joint force reflection short and long time delay experiment @ESTEC
SUPVIS-E	Supervisory command of Eurobot rover @ESTEC
SUPVIS-JUSTIN	**Supervisory command of Humanoid Robot @DLR**
EXO-1	Exoskeleton control of robot arm @ESTEC
EXO-2	**Exoskeleton control of DLR Humanoid Robot @DLR**
EXO-3	Exoskeleton control of ROBONAUT @ISS (intended)

http://meteron.dlr.de/

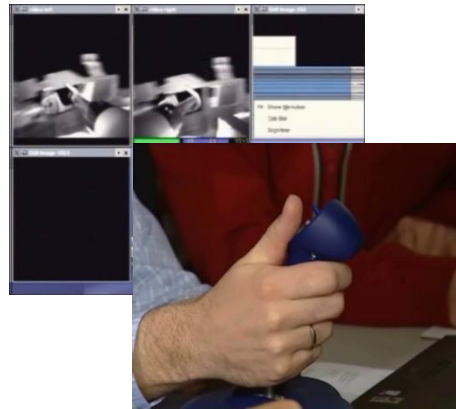# From Rotex to Meteron
DLR-RM teleoperation in space missions
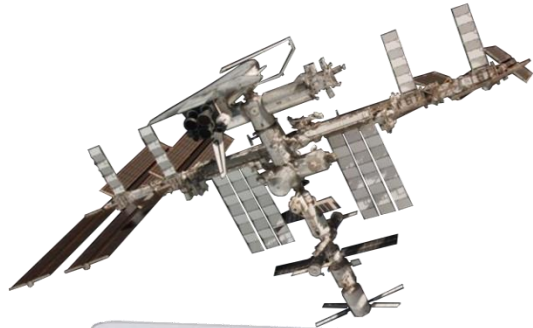

Rotex (1993)
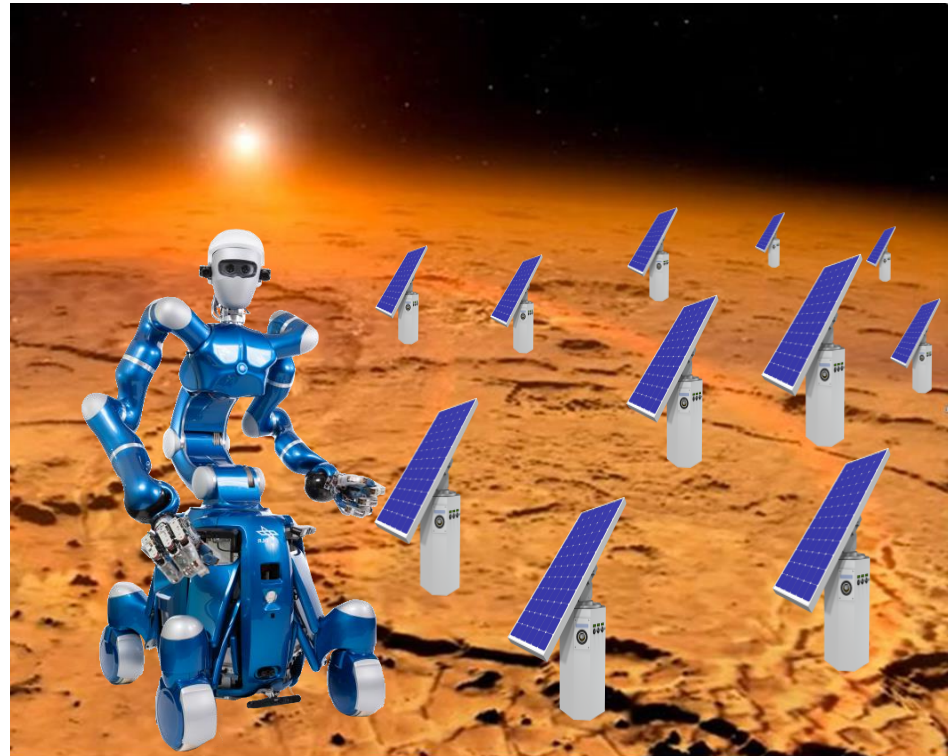
RokVISS (2004-2010)

Kontur (on-going)

Meteron (on-going)

http://meteron.dlr.de/

Meteron SUPVIS-JUSTIN
Supervised autonomy for a service robot in space

Abstract task level
robot commands

http://meteron.dlr.de/
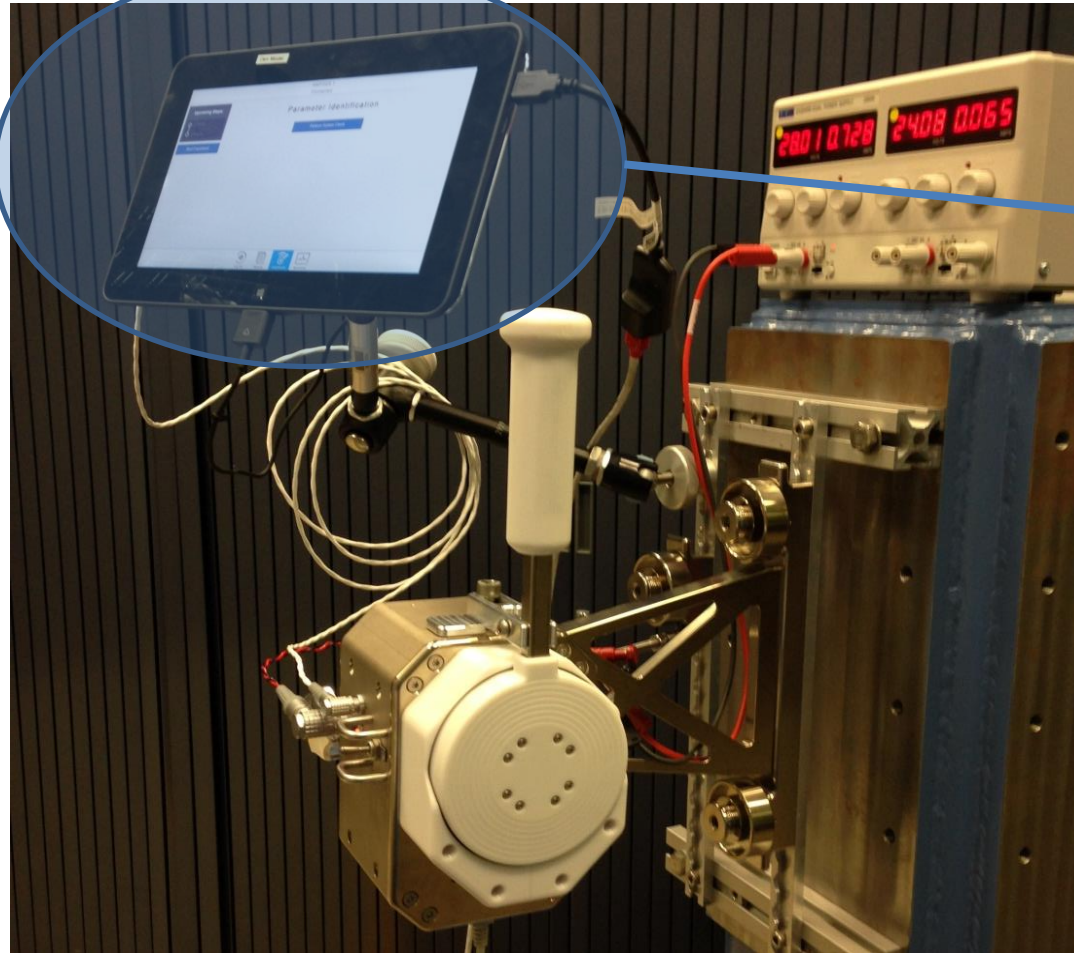
SUPVIS-JUSTIN: ISS on-board hardware
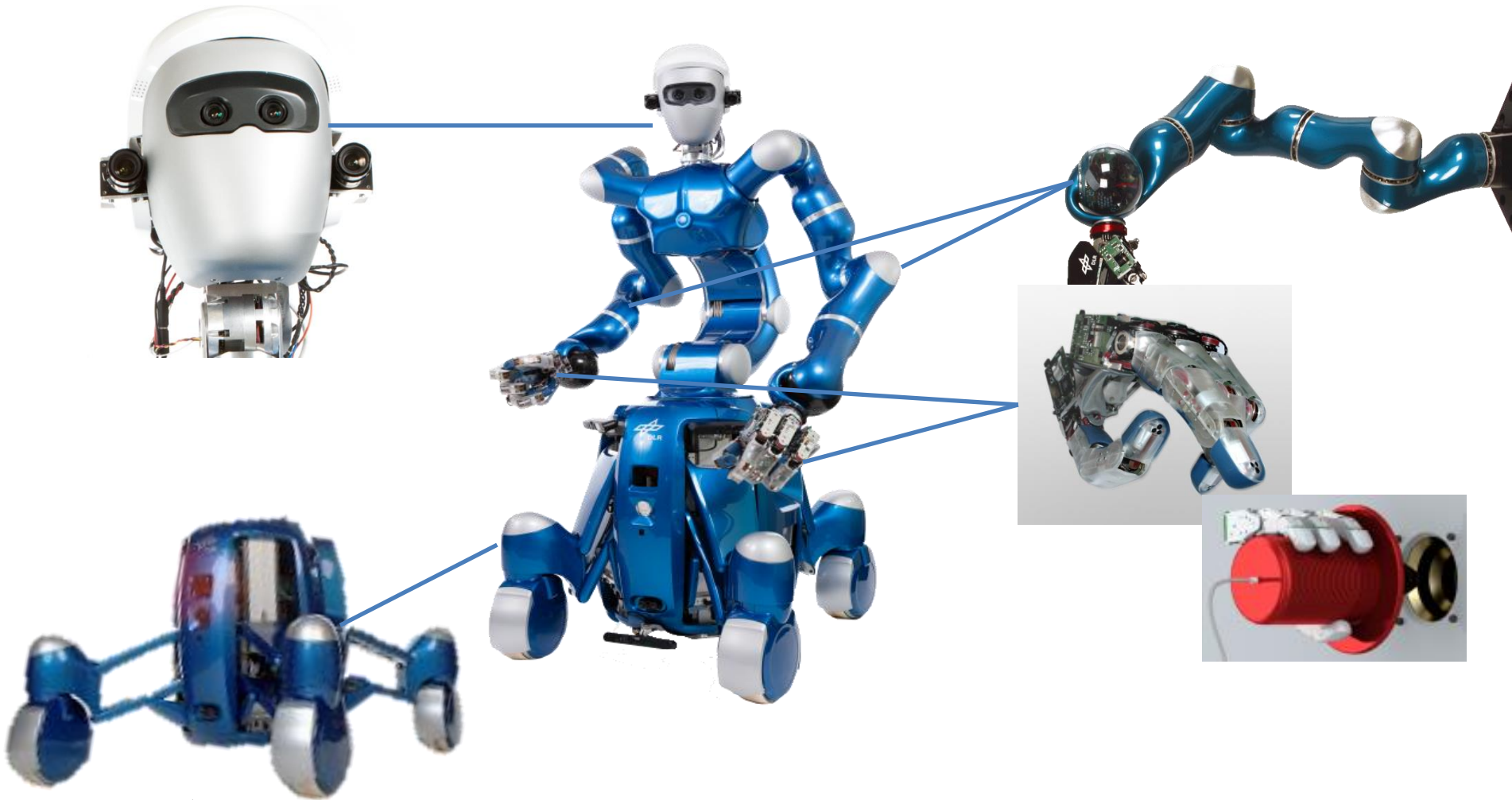## Tablet user interface

- Dell Latitude 10
- Tablet PC
- Removable battery
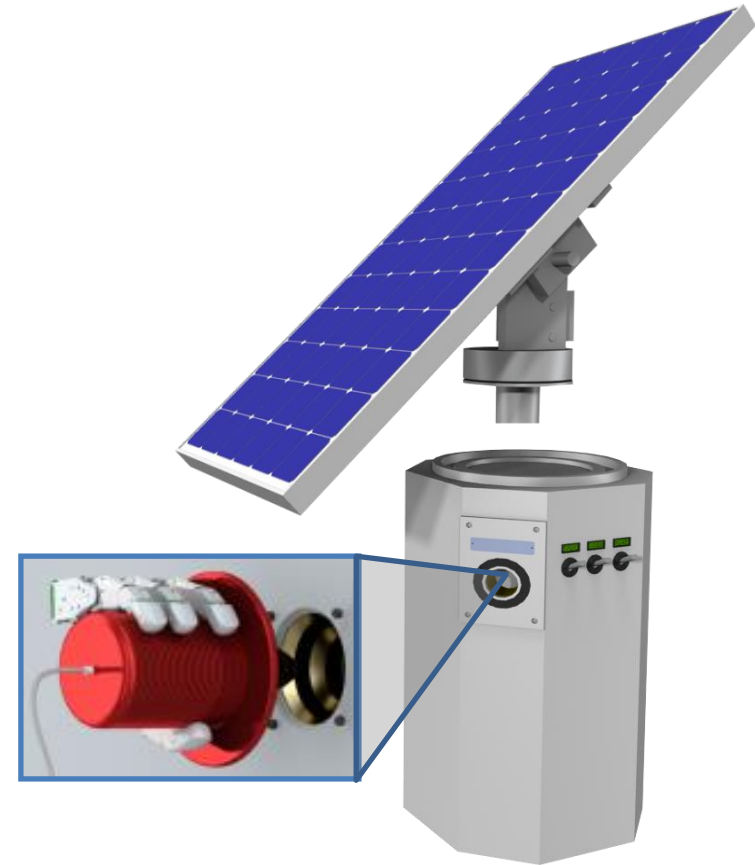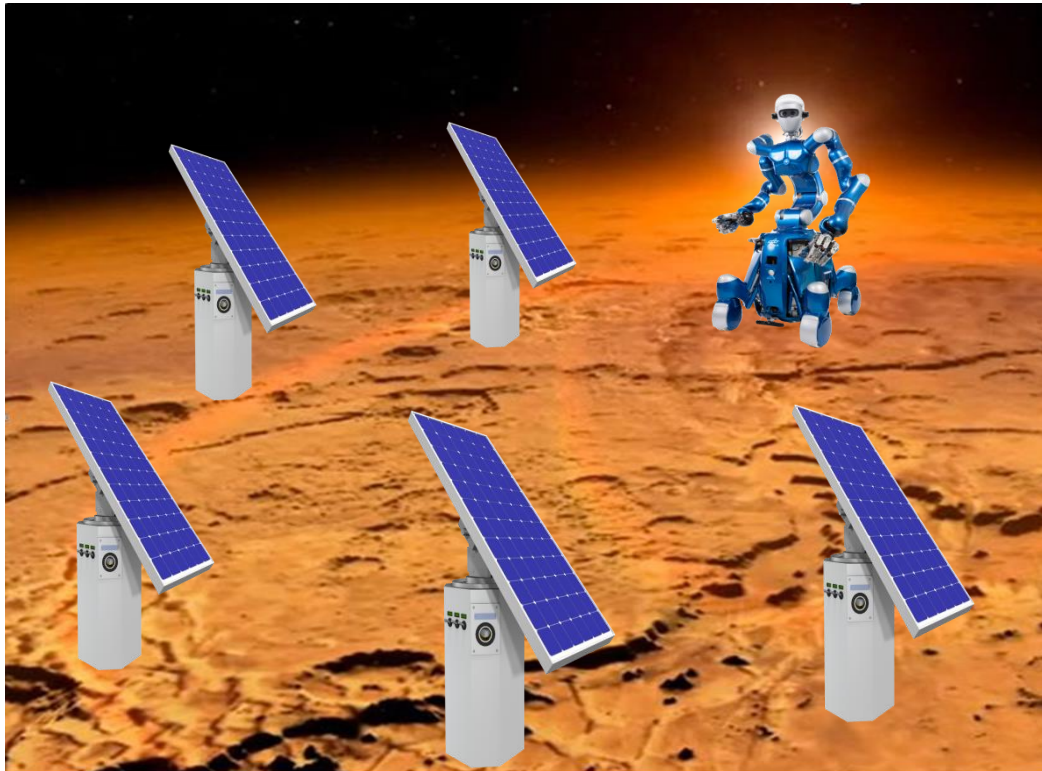- Windows 8.0

SUPVIS-JUSTIN: on-ground hardware
DLR dexterous mobile robot: Rollin' Justin

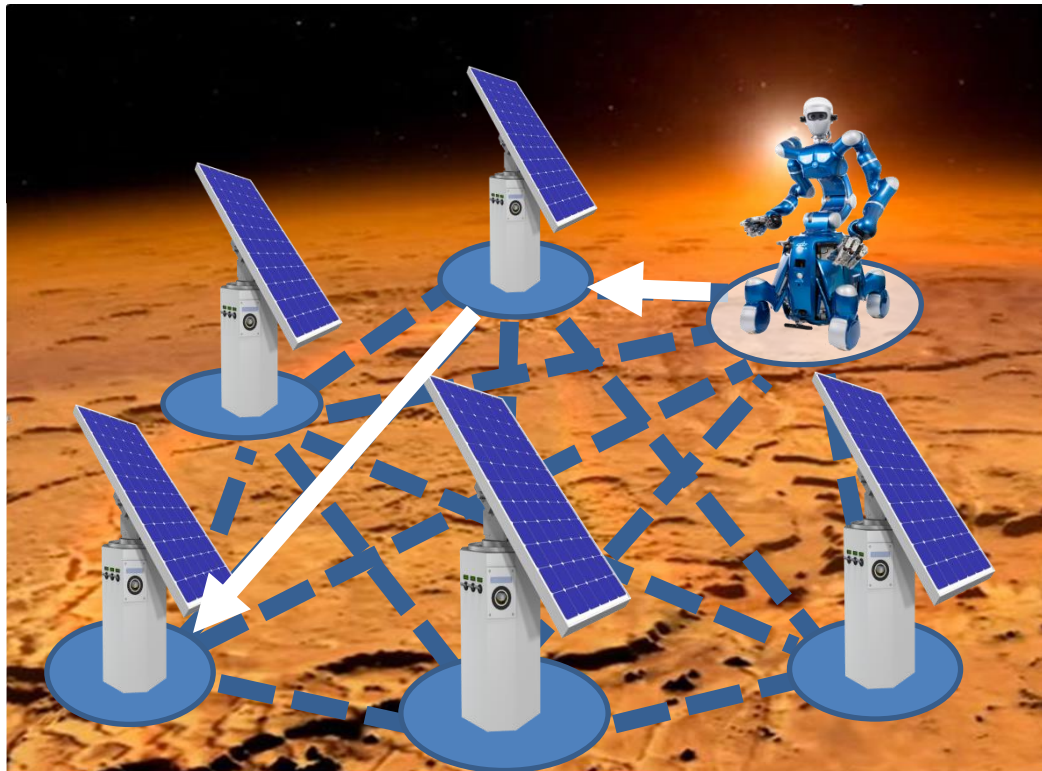# SUPVIS-JUSTIN: on-ground hardware
Mars on earth: the SOLEX experiment environment

Supervised autonomy experiment protocol I and III
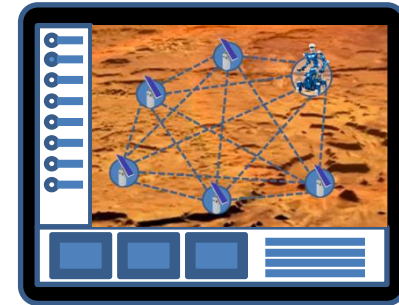## Survey surrounding and mobile navigation

SOLEX Experiment Environment (@DLR-RM)

1.
Survey destination and environment

2.
Select path

3.
Navigate to target

Tablet (@ISS)

http://meteron.dlr.de/
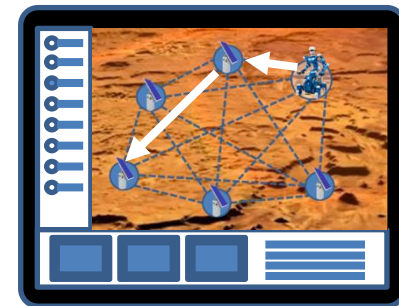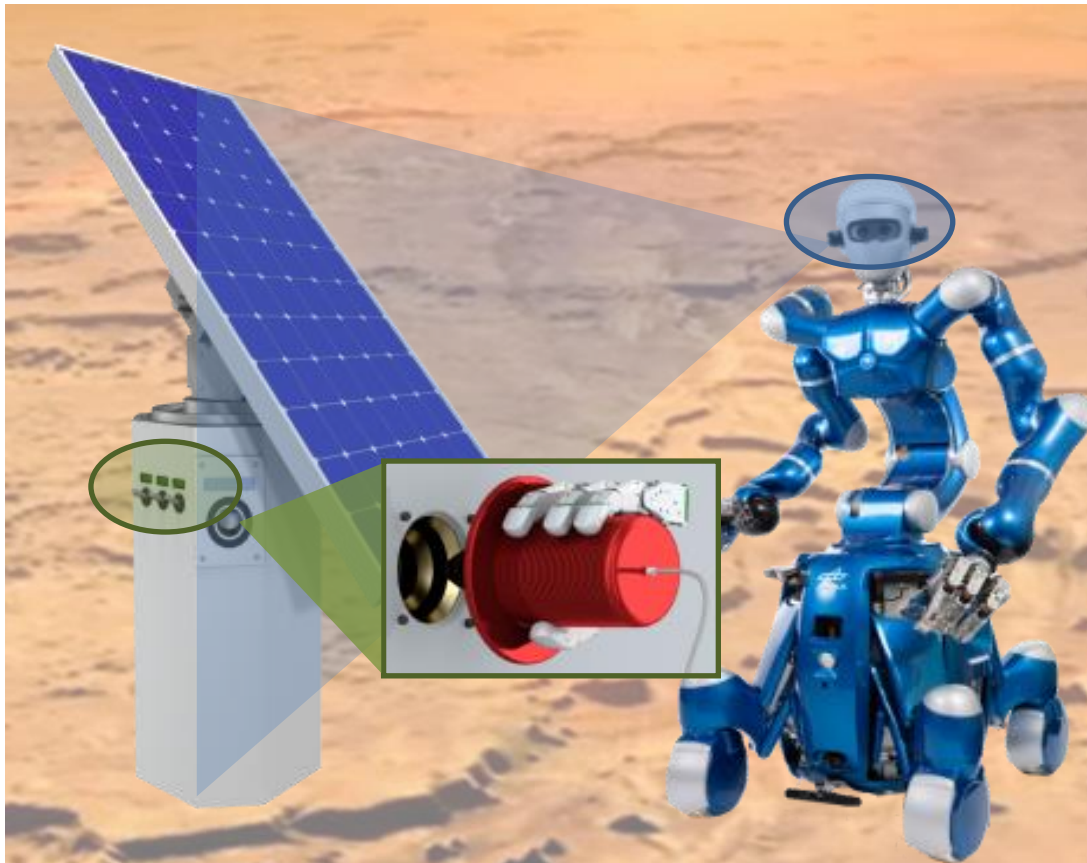
Supervised autonomy experiment protocol II
Solar panel unit inspection and repair

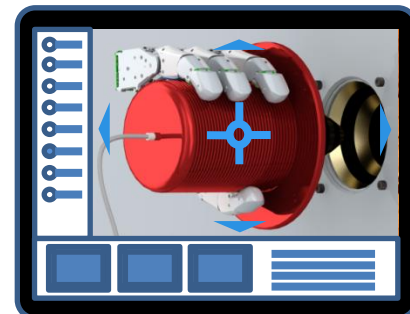
SOLEX Experiment Environment (@DLR-RM)

1.
Inspect SPU

↓

2.
Shutdown
SPU

↓

3.
Connect DIP
and establish
data link

Tablet (@ISS)

http://meteron.dlr.de/
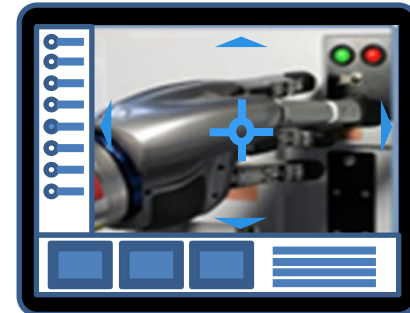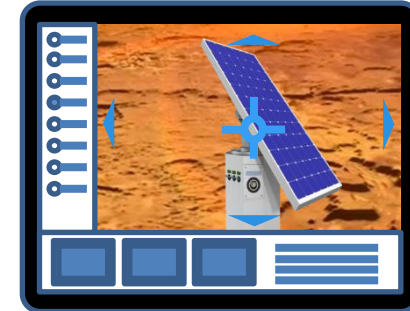
SUPVIS-JUSTIN goals
What do we hope to learn

- Tablet user interfaces design for use in space
    - Effectiveness
    - Usability
    - Astronaut immersability through a tablet UI

- On supervised autonomy:
    - Effects of time delay on communication between the operator and robot
    - Robotic terrain navigation
    - Dexterous robotic tasks
    - Supervised-autonomy in the space setting

- Better understand the crossover between supervised autonomy and real-time telepresence

DLR's future experiments in Meteron
EXO-2: from supervised autonomy to haptic feedback

Real-time
Communication
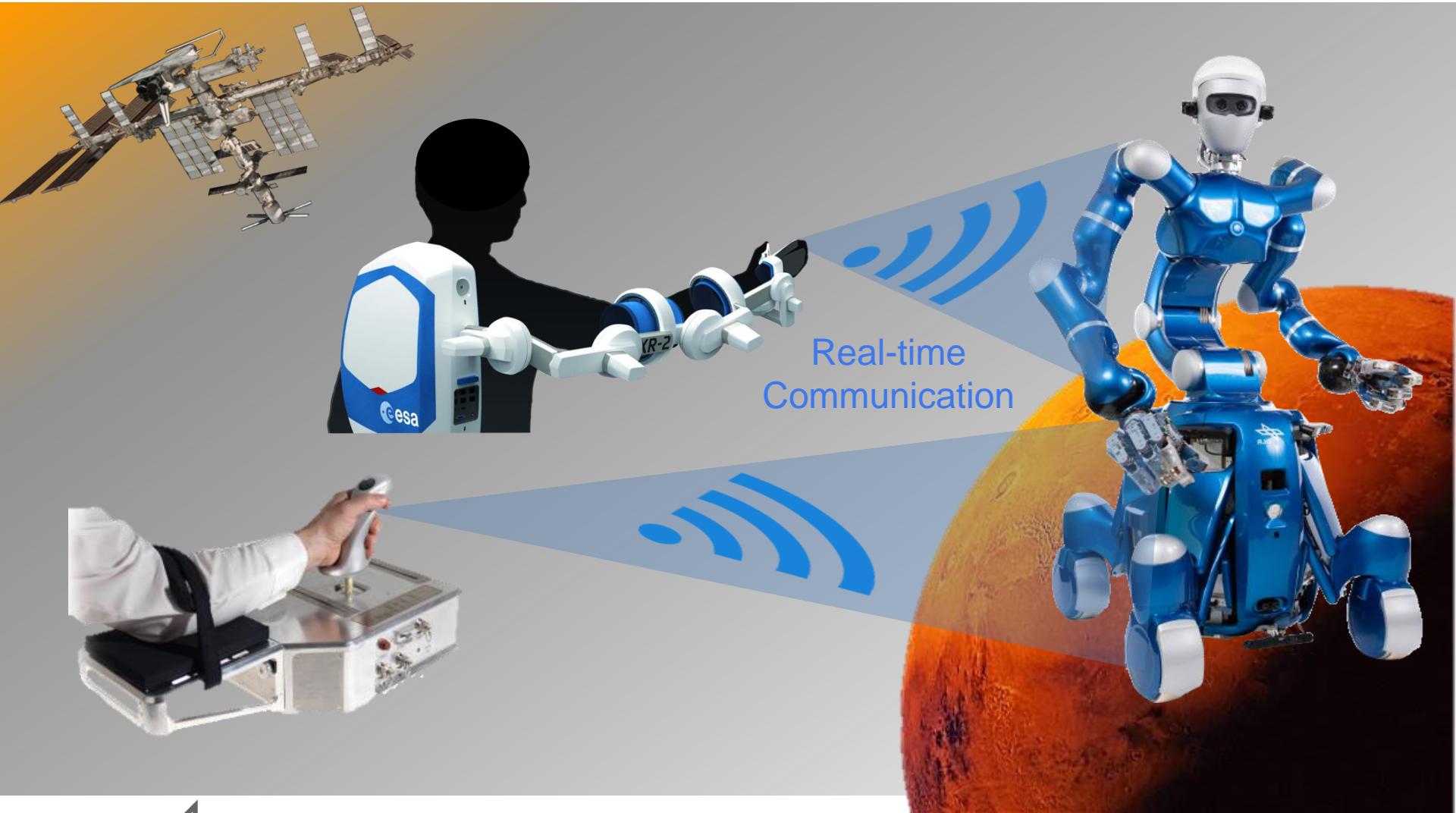
Toward supervised autonomy for a service robot
On-going DLR development
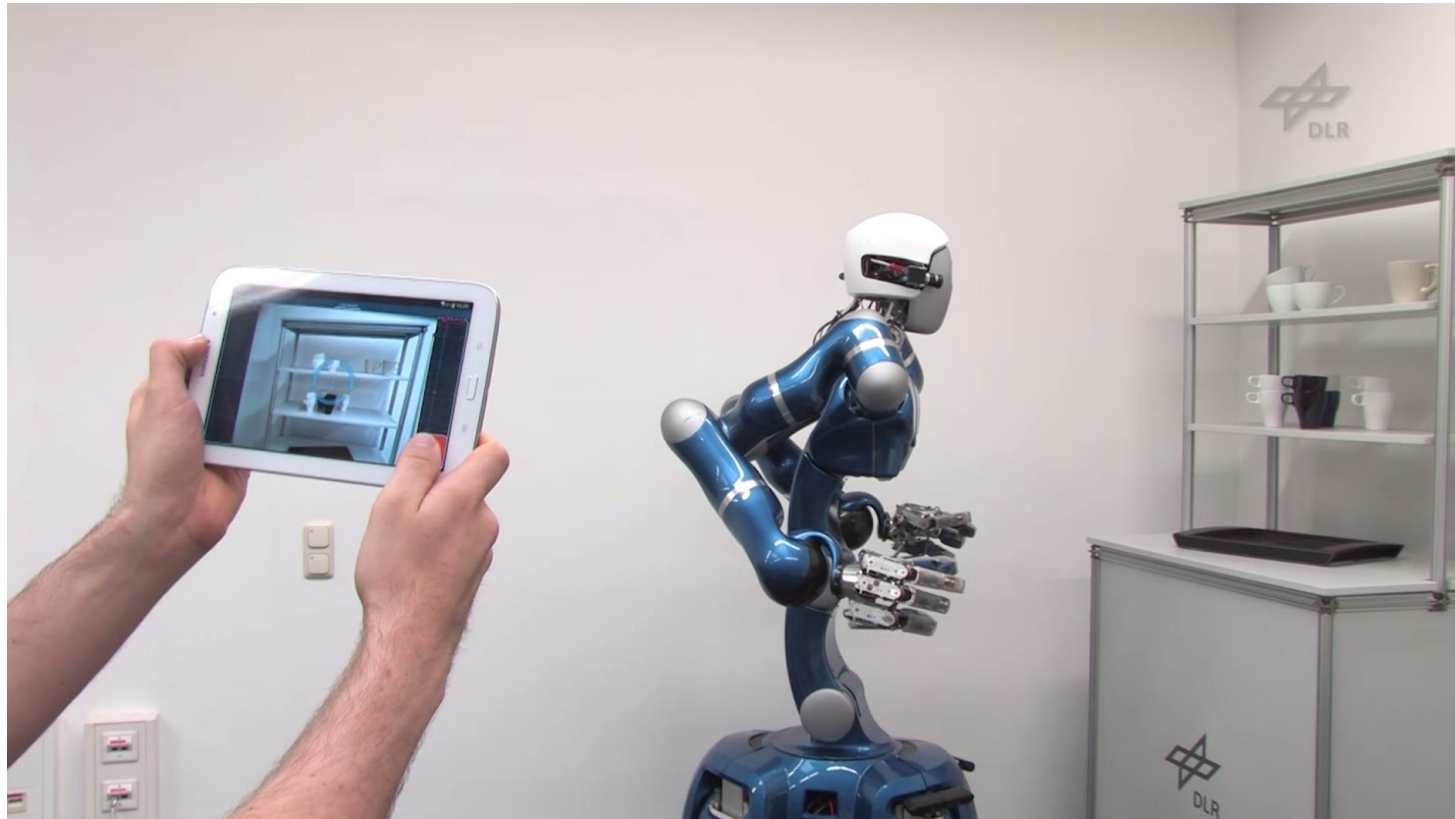
Courtesy P. Birkenkampf
Development of a human-robot interface for visualization of internal world states
and controlling potential manipulation capabilities of semi-autonomous robot
Technical University of Munich, 2013

http://meteron.dlr.de/

Meteron SUPVIS-JUSTIN
Timeline and milestones

Initial ESA-DLR Meteron presentation of interest	2010
Initial Supvis-Justin experiment conception	2012-07
Supvis-Justin experiment development	2013-08
Supvis-Justin requirements definition	2014-07
Supervisory tablet UI test:	2015-01
Ground hardware test (single unit):	2015-03
Full experiment ground tests:	2015-05~06
Astronaut training center:	2015-07~09
Planned mission date:	2015-10 (short duration flight)

http://meteron.dlr.de/

DLR Meteron SUPVIS-JUSTIN team (in alphabetical order)
Principal Investigator: Neal Y. Lii
Co-Investigator Daniel Leidner

Dr. A. Albu-Schäffer
Dr. J. Artigas
Mr. A. Balzer
Mr. R. Bayer
Mr. P. Birkenkampf
Mr. C. Borst
Mr. M. Breu
Mr. B. Brunner
Dr. Z. Chen
Mr. J. Dietl
Mr. O. Eiberger
W. Friedl
Mr. H. Gmeiner
Mr. J. Gräf
Dr. M. Grebenstein
Mr. R. Gruber

Mr. K. Jöhl
Mr. E. Krämer
Mr. P. Kremer
Mr. K. Landzettel
Mr. D. Leidner
Dr. N. Y. Lii
Mr. A. Meißner
Mr. B. Pleintinger
Mr. H.-J. Sedlmayr
Mr. N. Seitz
Mr. F. Schmidt
Mr. M. Stelzer
Dr. M. Suppa
Mr. B. Vodermayer
Dr. B. Weber
Dr. A. Wedler

ESA Meteron SUPVIS-JUSTIN team (in alphabetical order)

Co-Investigator André Schiele

Mr. M. Aiple
Dr. T. Krueger
Mr. F. v.d. Hulst
Mr. T. Sednaoui
Mr. R. Schonenborg
Mr. J. Rebelo
Mr. J. Smisek
Mr. E. den Exter
Mr. S. Kimmer
Mr. W. Van
Dr. M. Nestoridi
Mr. R. Holloway
Mr. N. Klein
Dr. A. Schiele
Mr. J. Wolf

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