

# Project CIMON<sup>®</sup> – the Intelligent Astronaut Assistant CREW INTERACTIVE MOBILE COMPANION



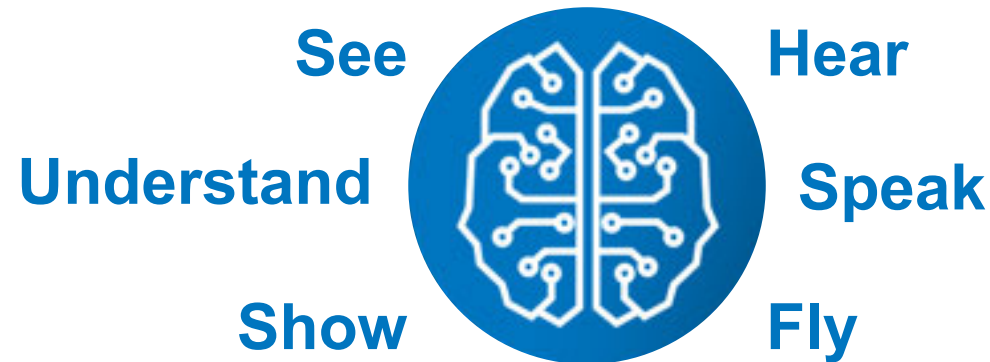
Knowledge for Tomorrow

## CIMON<sup>®</sup> in a Nutshell

- Autonomous acting **astronaut assistant**
- World's first flying **artificial intelligence** (AI) on the International Space Station ISS (2018)
- **Technology demonstrator** during horizons mission of ESA astronaut Alexander Gerst

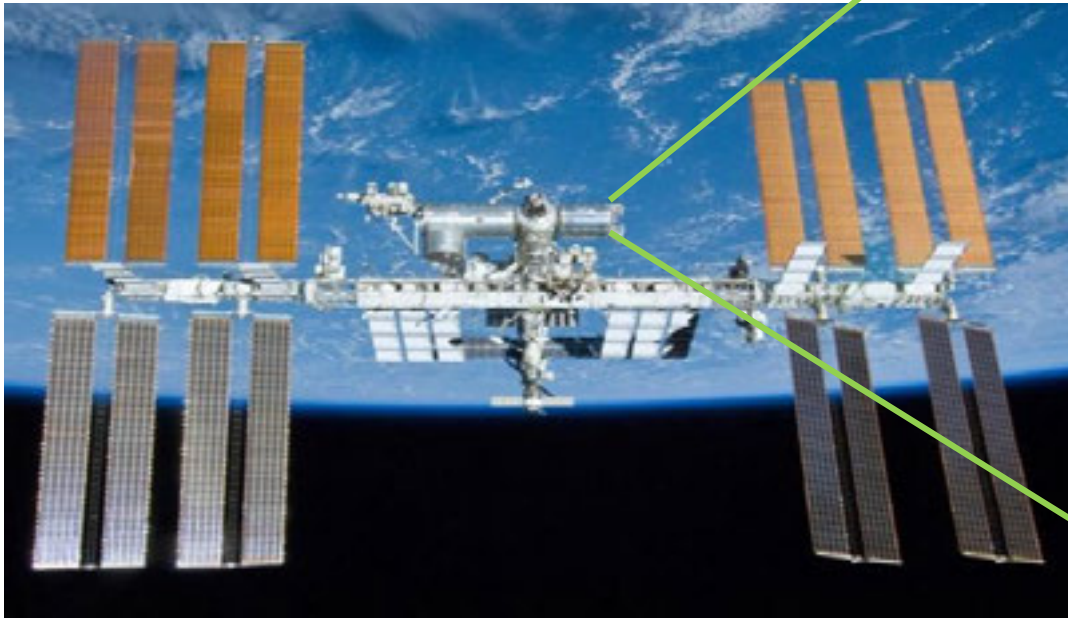
Focal points: Industry 4.0, Artificial Intelligence, Human Spaceflight,  
Human-machine interaction, Internet of Things

CIMON<sup>®</sup> can...



## CIMON<sup>®</sup>'s Place of Use

International Space Station (ISS) in  
the European Columbus Module



## Team behind CIMON®: More than 50 people...



Christian

**DLR Project Lead / Payload Owner**



Judith

**Principal Investigator (PI)  
LMU München**



Till

**AIRBUS Project Manager /  
Payload Developer**



Matthias

**IBM Lead Watson Architect**



Gwendolyne

**HSLU BIOTESC Operations**



## Robots on ISS

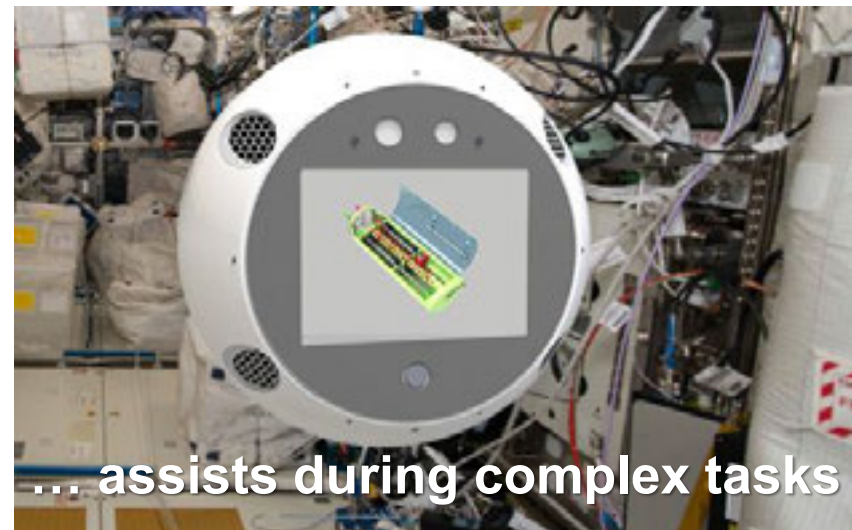
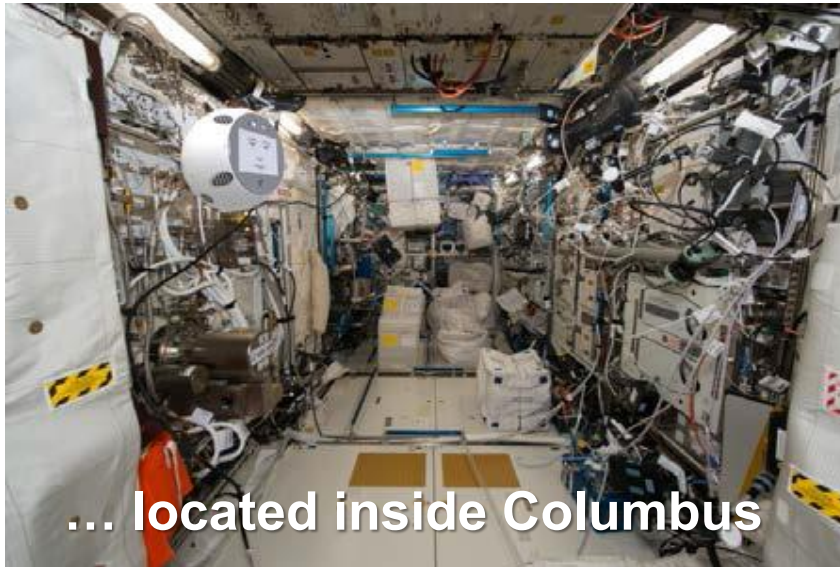


**Human-Machine  
Interaction**

**Autonomous & Remote Controlled**

**Autonomous & Intelligent**

# Vision of Project CIMON



# Technology Demonstration (14./15. November 2018)

## CIMON-1 Commissioning by ESA Astronaut Alexander Gerst on the ISS



Source: DLR/F. Oprean/ESA

- **Knowledge:** Voice-controlled navigation through experiment instructions and background information
- **Mobile Video Camera:** Experiment Documentation
- **Dialog partner** (Small Talk)
- **Training Partner** unknown complex tasks
- **Media Playback** (Videos, Procedures, Music)



**Increment 57 (Nov. 2018)**

**ESA Astronaut  
Alexander Gerst  
Geophysicist**

**CIMON-1**

**→ Human + Machine = Team**

# World Premiere of Artificial Intelligence in Space – 14<sup>th</sup>/15<sup>th</sup> November 2018



## CIMON-1

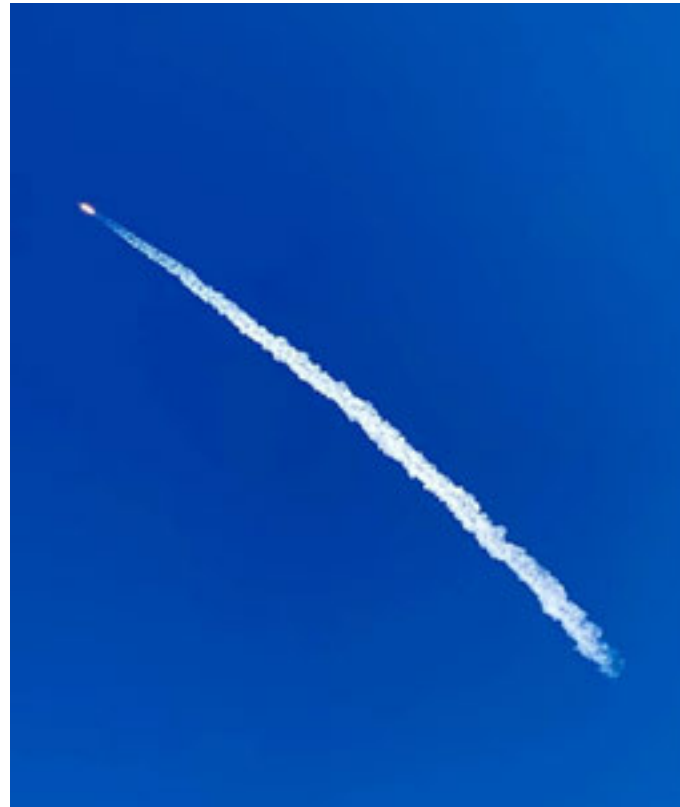
- ✓ Software-Update
- ✓ **Human-Interaction with Artificial Intelligence**
- ✓ Station Keeping
- ✓ Face-Recognition and Eye-Contact
- ✓ Camera Check-Out with Photo / Videostream
- ✓ Music
- ✓ Procedure & Video-Instruction



# CIMON-2

New Version launched with SpaceX CRS-19 on 5<sup>th</sup> December 2019

- ➔ Improved GNC
- ➔ More robust Computers
- ➔ Improved Microphones
- ➔ ...



Source: Airbus, DLR



Increment 61 (Feb. 2020)



→ CIMON-2

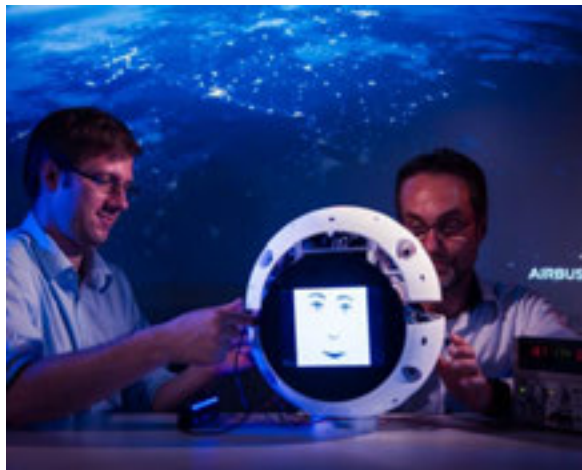
# Project Walkthrough

2014/15



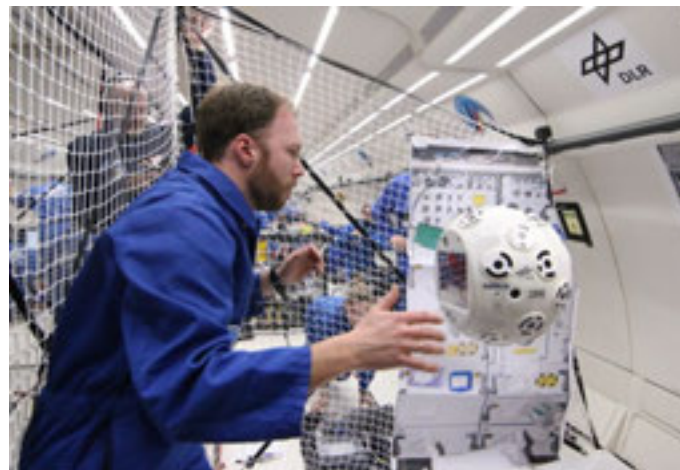
**Study Breadboard**

2016



**Mark 1 Prototype  
Development Tests**

2017/18



**Elegant Breadboard eBB  
Ground and Parabolic-Flight  
Tests**

2018



**Proto-Flight Model PFM**  
Mission on ISS:  
Launched with SpaceX-15  
(29<sup>th</sup> June 2018)

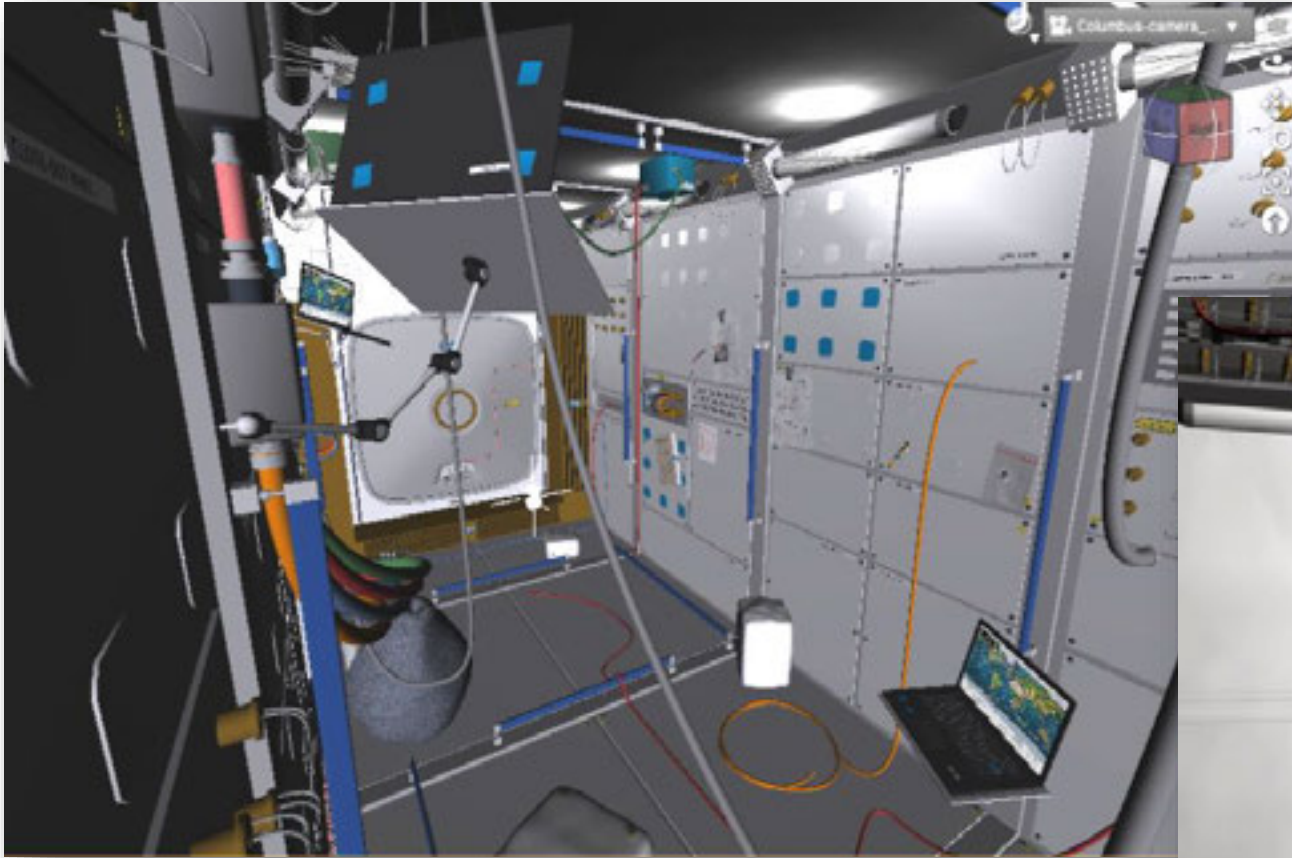
*Source: Airbus, Novespace, DLR*



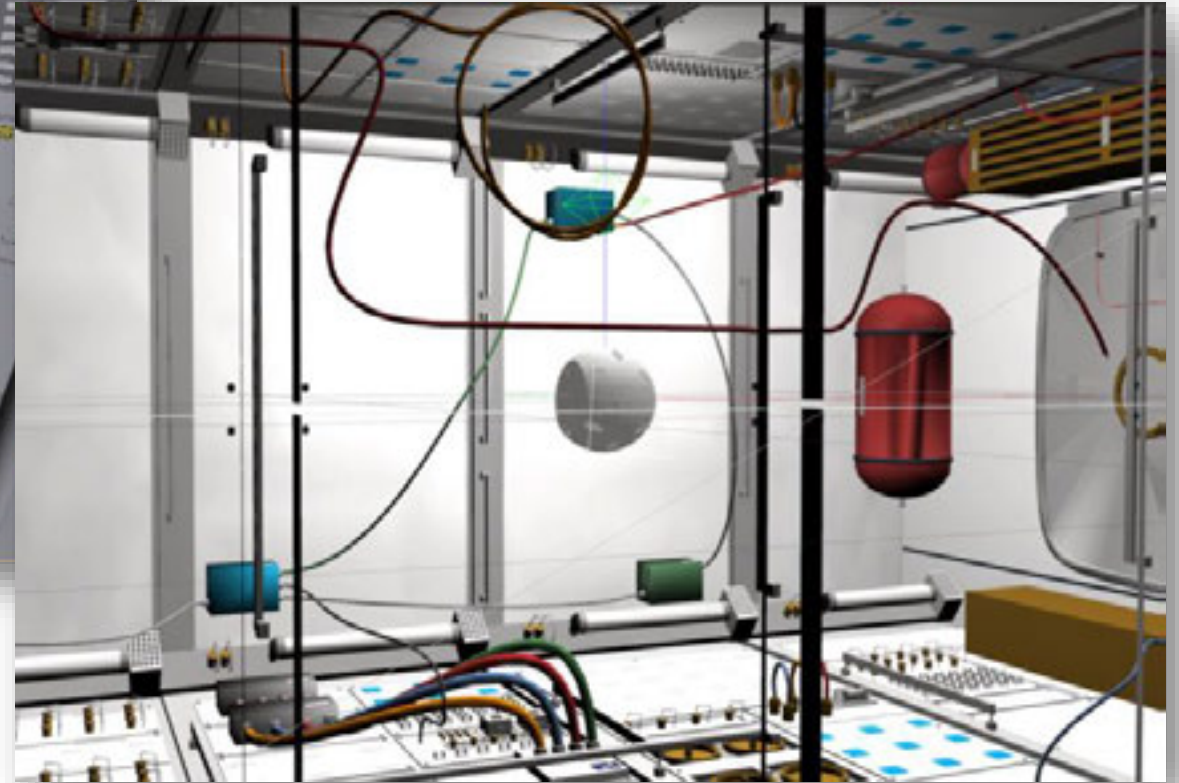
## Beforehand on Ground – Development & Testing, Testing, Testing...



# Test and Development Environment – Simulation



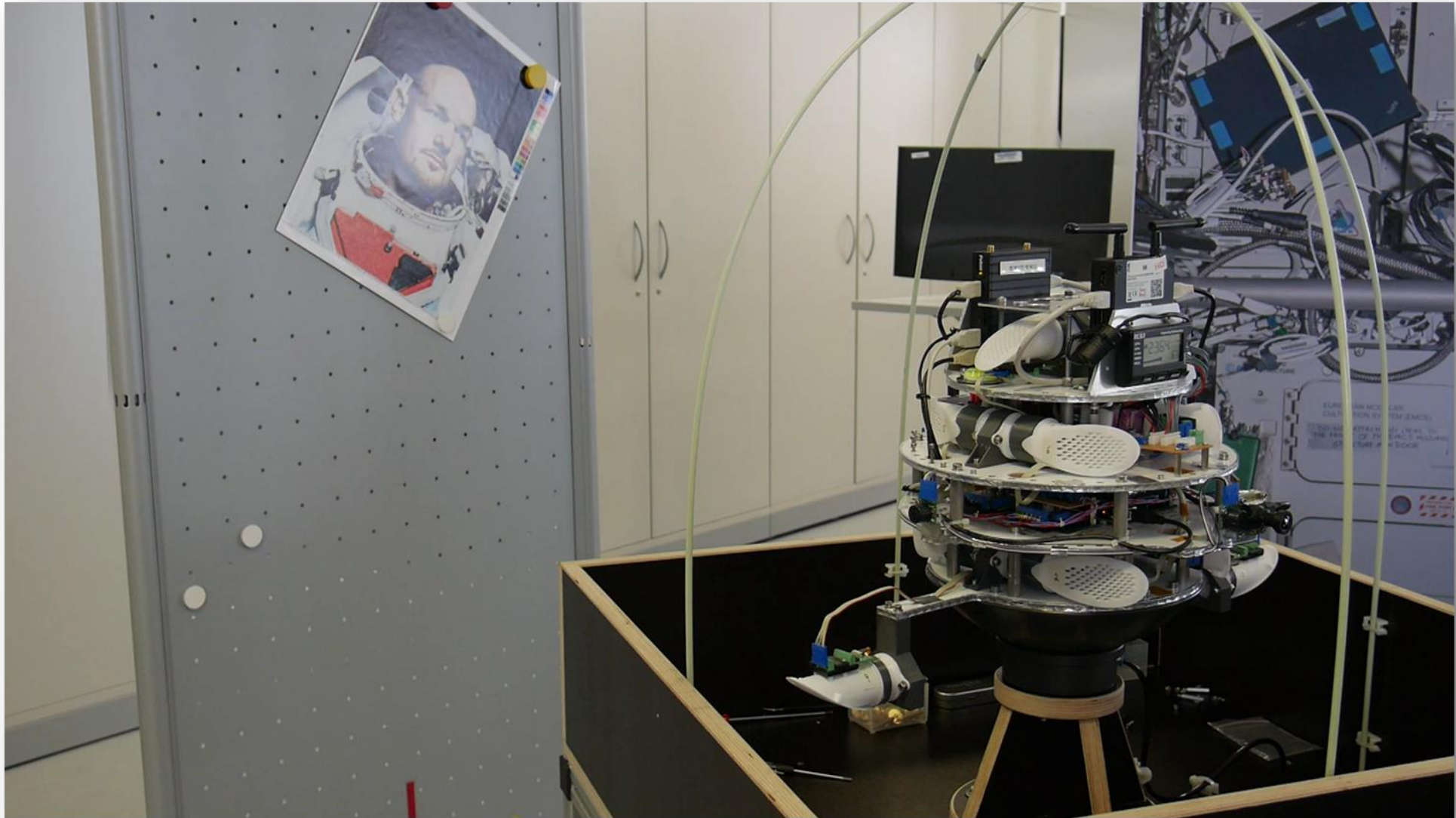
3D-(Almost)Realtime-Simulation with PIL in Gazebo



Source: Airbus



## Test and Development – Prototype on an air-bearing/table

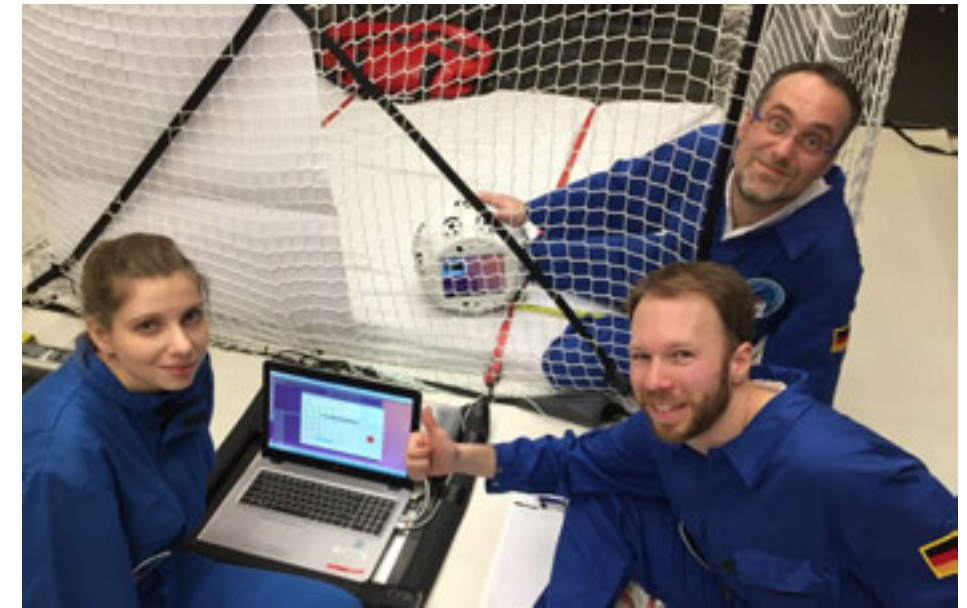


Source: Airbus



# Test at the 31<sup>st</sup> DLR parabolic flight (ZERO-G) campaign in March 2018

## Navigation and flight characteristics in weightlessness



## ✓ SpaceX CRS-15 (Falcon-9) 29<sup>th</sup> June 2018





Source: NASA, SpaceX



## Technical Overview

- 3D printed structure
- Air jet propulsion
- Autonomous Navigation
- Object and face recognition
- Voice control
- Audio and voice output

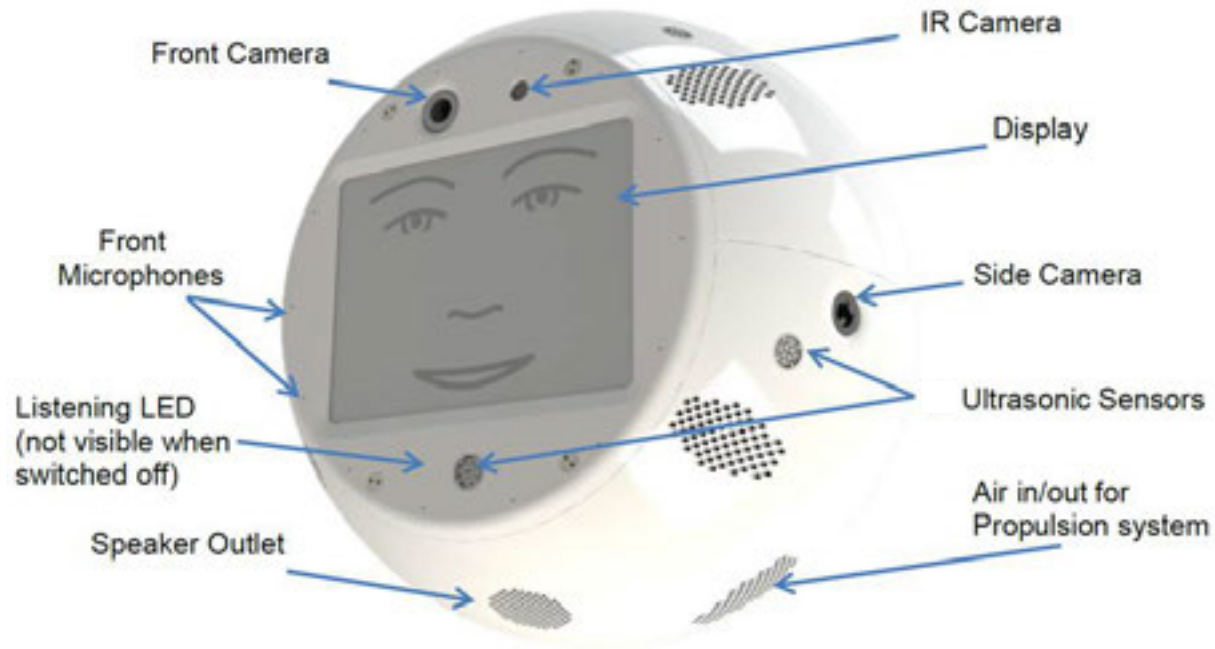
➔ **CIMON says:** Thank you for the batteries,  
SPHERES / Astrobeer Team!



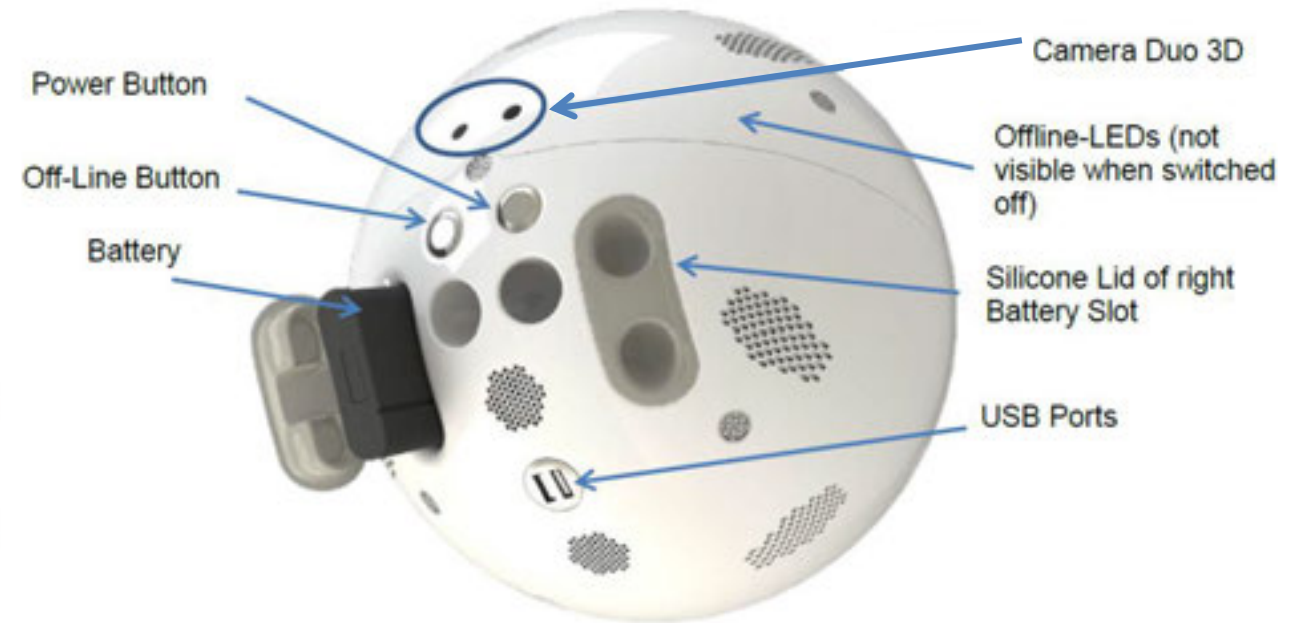
## Technical details

- **Diameter:** 32 cm
- **Weight:** approx. 5 kg
- **Battery runtime:** approx. 2 h

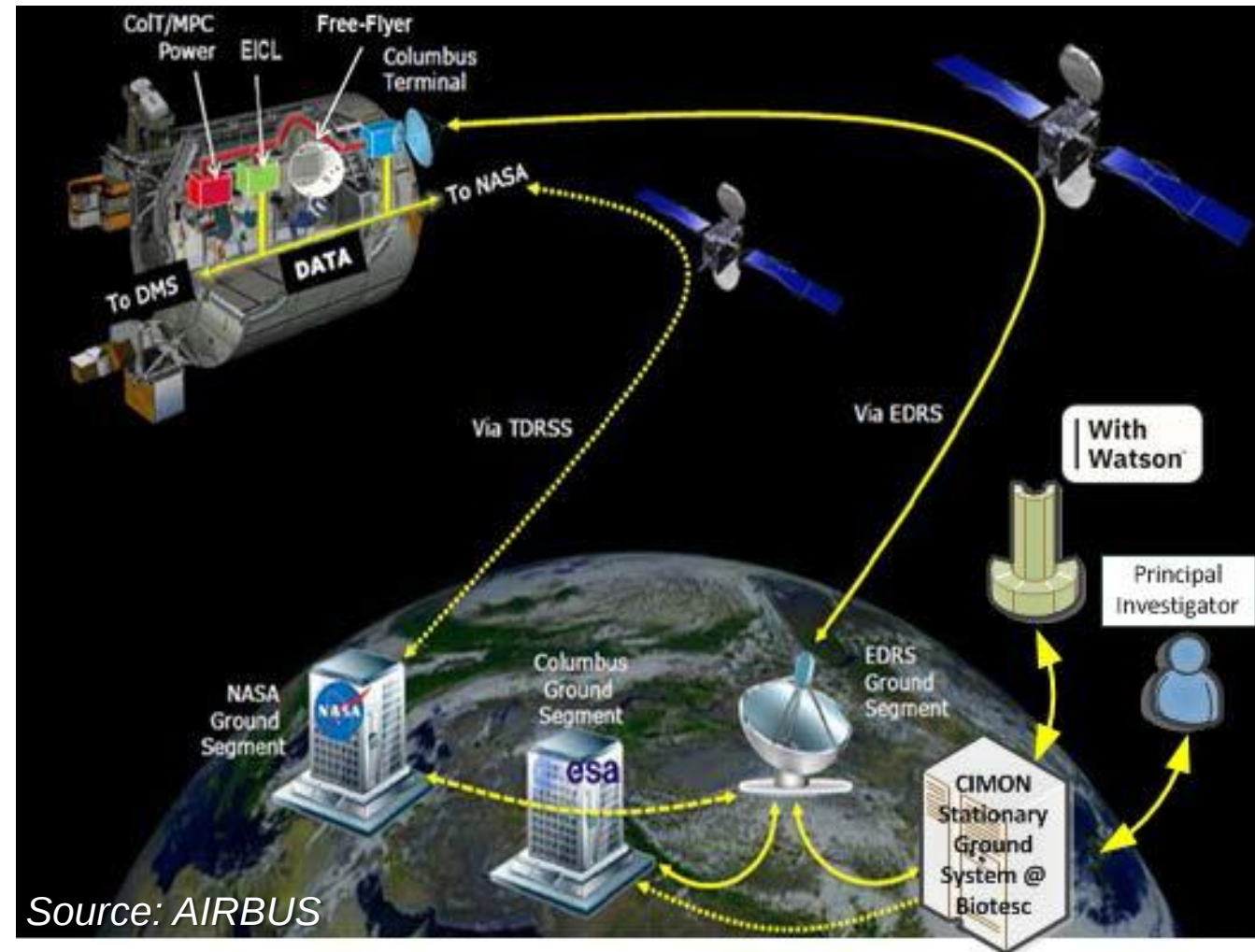
Front view:



Back view:



# Productive Environment



# CIMON's Artificial Intelligence and other components

- **“Ears”** (IBM Watson Speech to Text)
- **“Brain”** (IBM Watson Assistant)
- **“Mouth”** (IBM Watson Text to Speech)
- **“Eyes”** (IBM Watson Visual Recognition)
- **“Feelings”** (IBM Watson Tone Analyzer)
- **“Body & Movement”** (Airbus GNCS)
- **“Nervous System”**  
(Airbus Ground Station and IBM Cloud)



# IBM Watson Visual Recognition

- Methods:
  - ✓ Classify Image
  - ✓ Face Detection
- Training with Alexander's Face & Negatives
- Testing Classifier



[JSON](#) 

| Classes | Score                                                                                    |
|---------|------------------------------------------------------------------------------------------|
| person  | 1.00  |

---

Type Hierarchy

/people

[JSON](#) 

| Faces       | Score                                                                                      |
|-------------|--------------------------------------------------------------------------------------------|
| age 35 - 44 | 0.51    |
| male        | 0.99  |

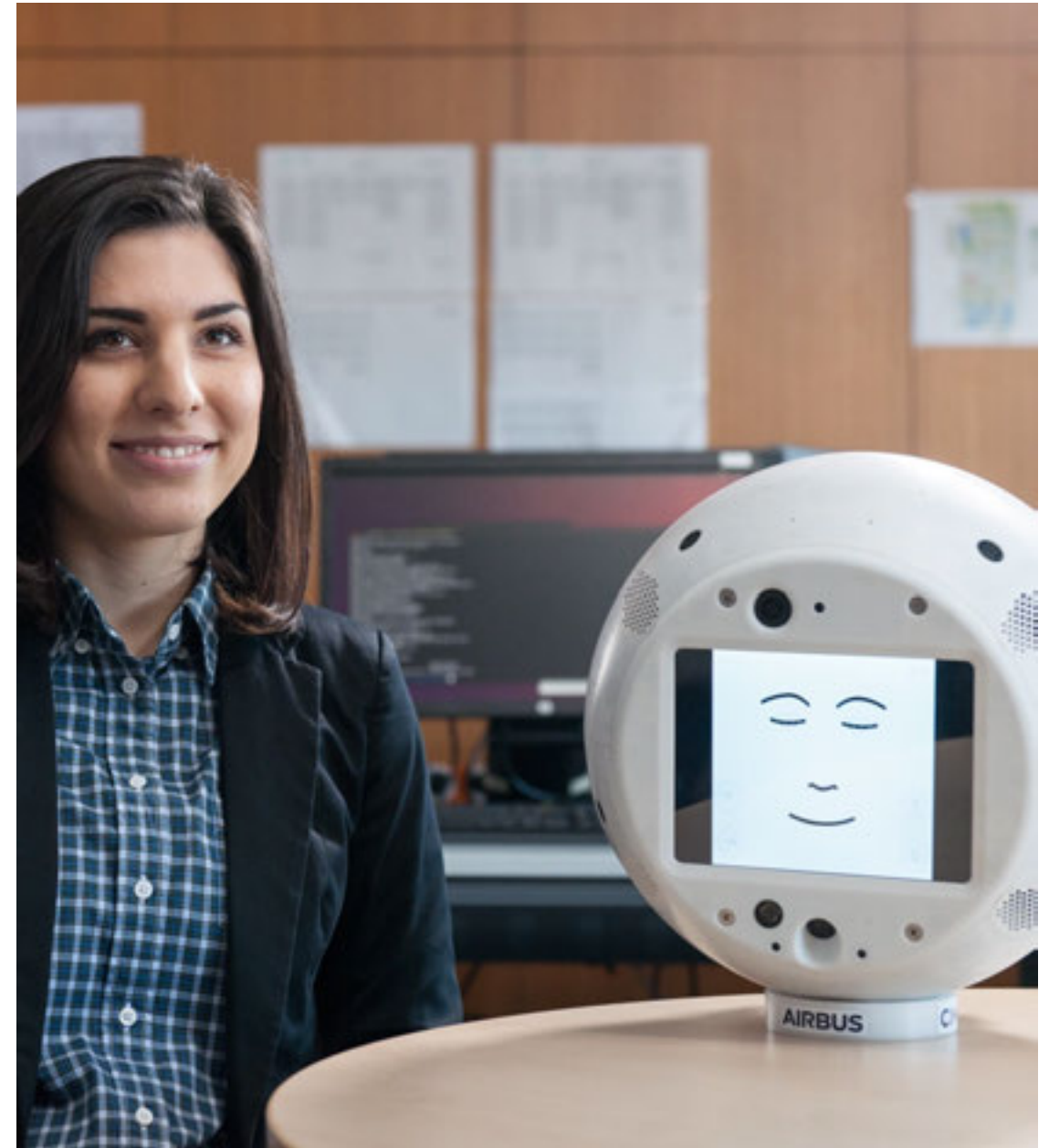
Source: Airbus, IBM



# Human-Machine Interaction:

## CIMON's Personality

- Language & Linguistics
- Context Awareness
- Voice & Intonation
- Facial Expressions
- Movement



Source: Airbus, IBM



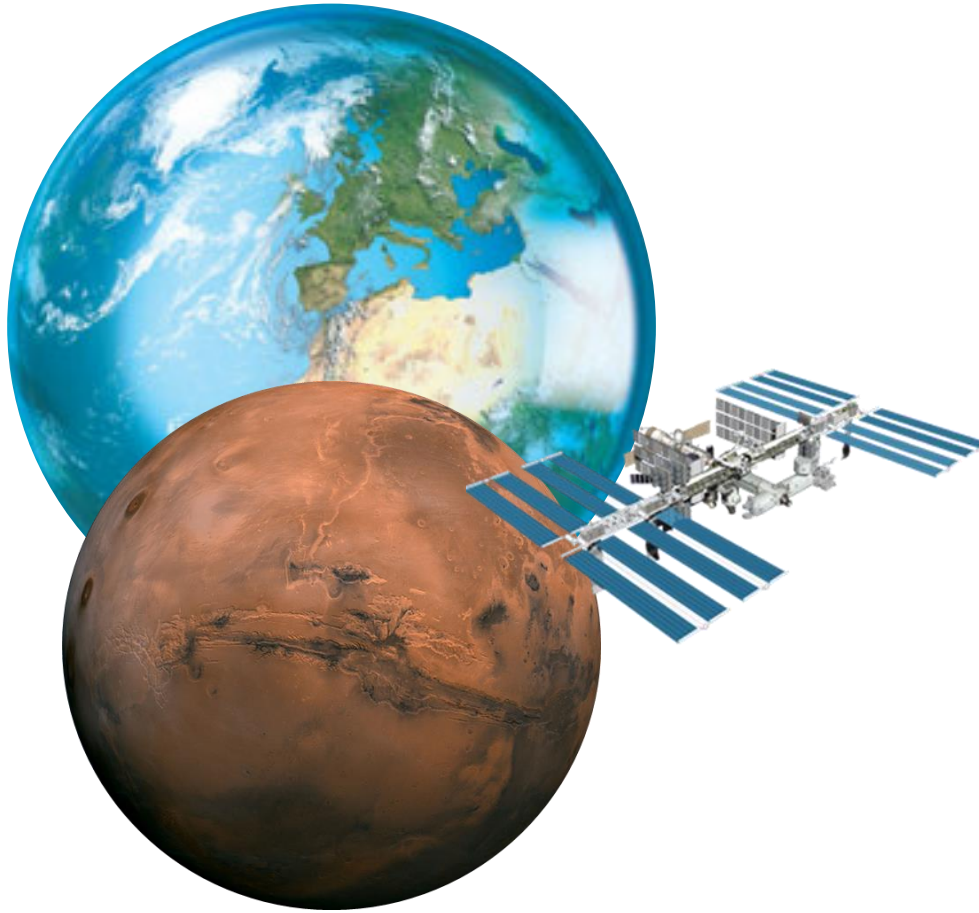
## Human-machine interaction

CIMON has a "character", various facial expressions, and emotional moods

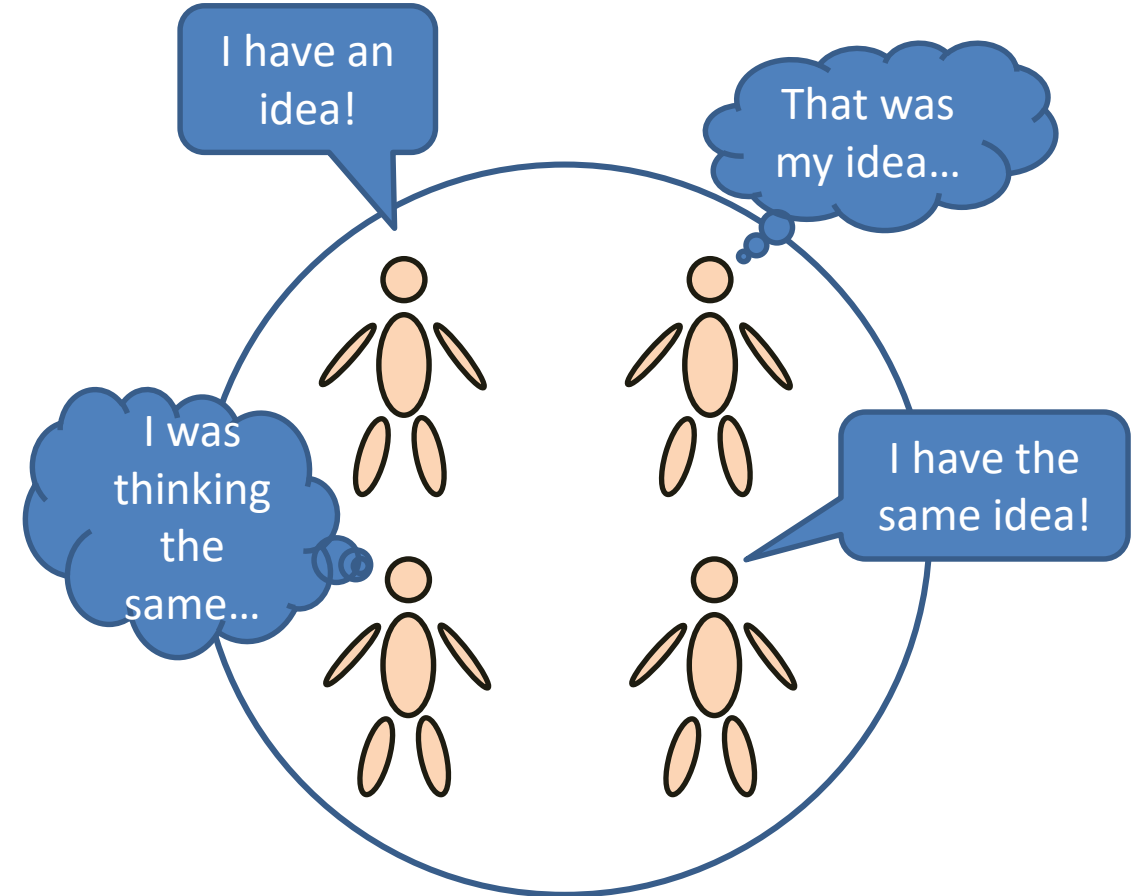


# Beyond CIMON – Challenges for Long-Term Missions: Psychological Effects

## „Earth out of View“



## „Groupthink“



Source: Airbus, DLR

(after psychologist Irving Janis)

# Scientific Background and Outlook

CIMON as a "countermeasure to reduce stress"

→ Facilitating and increasing the efficiency of the work of physicians/astronauts



## Earth

**Patient in intensive care:**

→ Bed rest



Source: <http://www.rettungsdienst-blog.com/dokumentarfilm-intensivstation> © lemmefilm

### ← Similarities →

Isolation

Unfamiliar environment

Noise pollution

Immune dysregulation

Infection

Decrease in bone density

Muscle loss

Shifted day and  
night rhythm

Sleep disorder



## Space

**Astronaut in space:**

→ weightlessness  
(complex tasks under difficult  
working conditions)



Source: [https://www.flickr.com/photos/astro\\_alex/15290008269/](https://www.flickr.com/photos/astro_alex/15290008269/)



# CIMON

Your deep space companion



Source: NASA

It's just the first step



Source: ThoughtCo



Source: express.co.uk

Source: space.com



Source: Luc Viatour



Source: NASA



Source: Leonard David

Source: Google Earth



**CIMON says:  
Thank you NASA Astrobee for the batteries!**

Scientific Project CIMON®  
awarded by



using funds from the



developed by



scientifically supported by



implemented by



using batteries from

