

On Robotic Applications and AI in Future Space Missions

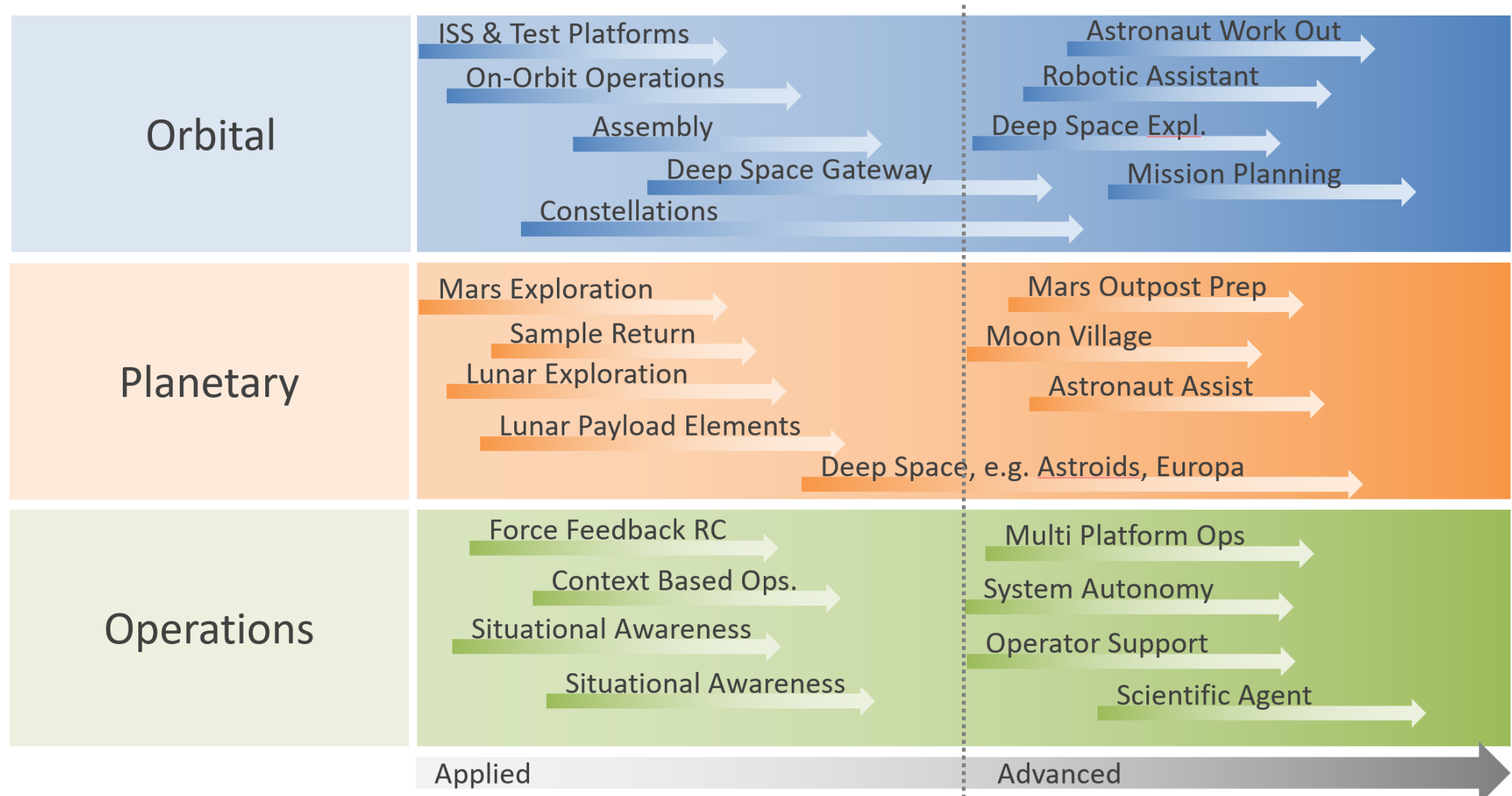
Roland U. Sonsalla[†], Alexander Dettmann[†] and Frank Kirchner^{†,‡}

[†] German Research Center for Artificial Intelligence (DFKI), Robotics Innovation Center, Bremen, Germany

[‡] University of Bremen, FB3 – Mathematics and Computer Science, Robotics Research Group, Bremen, Germany
Email: {roland.sonsalla, alexander.dettmann, frank.kirchner}@dfki.de

Introduction

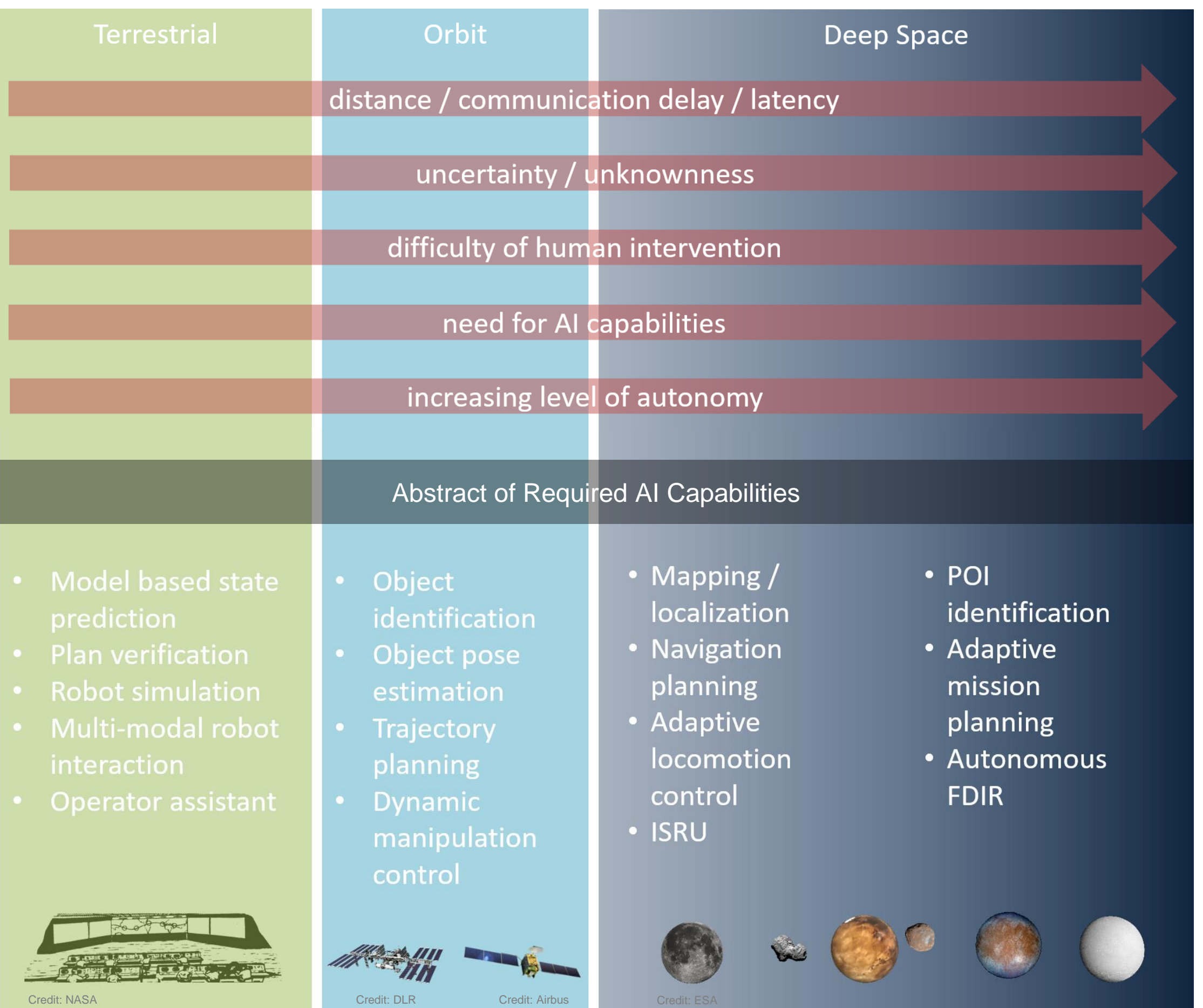
Space robotics is an emerging field of research and application asking for advanced artificial intelligence (AI) concepts to cope with challenging requirements for future missions. In order to increase the value of a mission while lowering its cost, future mission concepts for orbital applications as well as for exploration demand an increasing performance in space robotics and AI.



Examples of upcoming applications for robotics and AI in space

Need for AI in Future Missions

Distance, latency, or uncertainty are examples for parameters that need to be taken into consideration to define and shape the level of autonomy. An increase of complexity in future mission scenarios add to the need of advanced and applicable AI methods, which is the case for long range exploration, multi-robot missions, or tasks that require cooperation between astronauts and robots.



Schematical view on key factors and the arising need of AI to cope with increasing level of autonomy and mission scenario complexity

Robotic concepts for future Missions

Human access to space is still very difficult, and astronaut missions are linked to high risks and financial cost. Therefore, robots play a crucial role for all tasks that arise in space, such as the construction and maintenance of large structures and satellites in the Earth's orbit, or the sampling on planetary surfaces.

Orbital

- Maintenance & support
- Debris removal
- Assembly & reconfiguration
- Manufacturing

Planetary Exploration

- Long range exploration
- Traversing extremely rough and inclined terrains
- Autonomous scientific mission planning and execution
- Heterogenous multi-robot systems
- Exploration of confined spaces
- Mobile manipulation
- Assembly of infrastructure

Mission Operations

- Force-feedback operations
- Virtual and augmented reality
- Sliding autonomy
- Multi-modal robot interaction
- Interactive multi-projection control center

Conclusion and Outlook

- Mission scenarios are getting more ambiguous and complex
- Increasing need for robotic applications and hence for advanced robotic systems
- Need for high level of autonomy and hence for advanced AI methods
- Increasing confidence and verifiability of AI methods while allowing low performant hardware

