

IAF SPACE OPERATIONS SYMPOSIUM (B6)  
New Space Operations Concepts and Advanced Systems (2)

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TOWARDS AUTOMATED CONSTELLATION MANAGEMENT OF SPACECRAFT – CHALLENGES  
AND APPROACHES**Abstract**

Recent developments have seen a trend towards larger constellations of spacecraft, with some proposals featuring swarms of more than a thousand of satellites. While similar concepts for large constellations already existed in the past, today's satellite deployments hardly ever feature groups of more than 100 satellites: The world's largest constellation by Planet currently operates 200+ Dove spacecraft.

This trend towards considerably larger swarms originates from non-traditional design and operations of spacecraft by non-traditional space companies. The evolution in the space sector, precipitated by new players, is often referred to as "Space 4.0" or "New Space". It necessitates a rethinking of the way satellites and satellite constellations are planned, designed, and operated. The satellite cannot be considered and operated as an individual anymore, and the management of the system as a whole—with a significant increase in automation—has to come to the fore.

There are crucial qualitative challenges that arise when moving from moderately-sized groups of individual spacecraft to large-scale constellations. The consequences of this paradigm shift include higher complexity of (i) basic communication tasks and ground resources allocation, (ii) coordination and higher probability of anomalies, (iii) of mission objectives, and (iv) space situational awareness functionalities.

New operational paradigms are needed to enable automatic, optimal task definition, and scheduling in a holistic approach. This paper shows the fundamental challenges that arise when large constellations have to be efficiently operated and automation levels have to be increased. The different automation levels

(L1 basic sequential automation, L2 distributed automation, L3 adaptive automation, and L4 mission-aware automation) and their impact on mission operations will be evaluated.

The paper shows first results of the ASIMOV study (Automated constellation Management Of space Vehicles) with ESA/ESOC and depicts initial approaches for developing appropriate automation strategies by the ASIMOV consortium, consisting of the Institute of Space Systems at TU Braunschweig (TUBS), the Algorithms Group of the Institute of Operating Systems and Computer Networks at TUBS, and Planet Germany.