DISTRIBUTED SATELLITE SYSTEMS AN APPROACH TO CLASSIFICATION

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The trend to smaller satellites was and is supported by the improvements in diverse fields of technology as for instance optics, mechanics and materials, electronics, signal processing, communication and navigation. Mass, volume and power consumption of the spacecrafts and the instruments followed the trend to miniaturization allowing at the same time significant increases of performance. These trends can be observed for passive optical space borne systems as well as for active micro wave systems, e. g. SAR systems. They all benefit from the technology improvements.

The manifold application areas of space borne systems for Earth observation and surveillance cover very large ranges in terms of ground resolution, spectral resolution and time resolution. Especially the improvements in the fields of data processing (for instance data fusion), navigation and communication allow to go for applications which need to be implemented using distributed satellite systems like constellations or formations. Distributed satellite systems provide a number of advantages like:

- Increase of time resolution depending on the number of satellites within a constellation
- Easy replacement of a satellite within a constellation or formation due to the relative low costs of a single satellite
- Soft degradation of the system performance caused by the malfunction of one satellite.

Thinking about distributed space systems, we may distinguish between different systems based on the distance between the satellites and the requirements concerning the control of their distance . With this approach we get the following categories:

- Constellations
- Formations
- Swarms
- Inspection and docking systems.

Distributed space systems can be distinguished by means of intersatellite distances: local systems with separations between the spacecrafts of a few meters, regional separations of typically a few ten meters to several hundreds of kilometres, and global systems with separations of more than thousand kilometres. The demands concerning attitude and position control can be used as another parameter for classification.

Inspection and docking involves two objects in space in close vicinity. This is obvious for an inspector micro- or nano-satellite orbiting for instance the International Space Station (ISS). Another example is ESA's Automated Transfer Vehicle (ATV) docking the ISS. This poses very high demands on the control accuracy.

Formation flying of satellites is typically associated with a small number of spacecraft flying in a concerted way at regional intersatellite separations. The mission objectives determine the requirements on the control accuracy. A Science mission using interferometry may have high control demands. A formation of two satellites with different instruments can have relaxed control requirements.

To achieve global coverage on Earth with high time resolution requires a satellite constellation. While docking, formation flying and constellations are well established implementations of distributed space systems, swarms of spacecraft consisting of several ten or thousands of satellites have not been deployed yet. Swarms of satellites can characterize for instance the local, regional or global Earth environment making in situ measurements of the atmosphere or the radiation conditions.

Session 4. Projects and missions of small spacecraft

After introducing the approach for classification of the different types of distributed space systems, their widespread possibilities are presented by means of example mission.