Paper ID: 28582
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SPACE SYSTEMS SYMPOSIUM (D1)
Hosted Payloads - Concepts, Techniques and Challenges, Missions and Applications (7)

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# A DESIGN FRAMEWORK FOR SPACE RESOURCE-SHARING SATELLITE FEDERATIONS

**Abstract**

System of Systems (SoS) architectures such as satellite fractionations, satellite swarms, space sensor networks and Federated Satellite Systems (FSS) are based upon the concept of cooperation among autonomous or fully independent systems. SoS rely on the sharing of resources and functions among component systems. This paper describes and demonstrates a general framework to support the design of new systems that are to be deployed within a Space System of Systems. The proposed framework illustrates the effect on individual mission performance and cost of the resources and functions exchange, for different degrees of inter-systems cooperation. While the design characteristics of systems of systems already deployed are known and fixed, and only its operation procedures can be adapted to some degree, the characteristics of a new system component are under the designer's control. Both influence the benefits to be gathered from the in-orbit exchange of functions and resources. The paper presents a Federated Satellite Systems case study to demonstrate the framework. FSS are networks of independent, heterogeneous spacecraft which exchange resources such as bandwidth, processing or on-board storage on an opportunistic and voluntary basis. The case study considers the deployment of a new Earth Observation (EO) small satellite mission in a scenario where a Low Earth Orbit (LEO) federation of 40 spacecraft is present. By including the capability in the new mission to connect to FSS, an additional design trade space emerges: system functions such as Earth downlink, data processing or satellite ranging can be allocated to other federates, with impacts on performance and cost for all missions involved. The application of the considered design framework to this case study illustrates the design of a stripped-down small space mission taking advantage of existing resources in-orbit. This concept shows the path to reduce or share costs and shorten integration schedule by eliminating the ground segment and spacecraft downlink subsystems and relieving power and OBDH subsystem requirements for a new mission.