Introduction

The concept of FSS was introduced by Professor A. Golkar in [1]. FSS are spacecraft that engage in opportunistic collaboration throughout their mission lifecycle, allowing them to share resources, capabilities, and data in a manner that enhances their overall operational efficiency and mission success. The concept, enhances the collaboration between satellites designed for different purposes, with the aim of enhancing mission capabilities. However, this new paradigm not only seeks to promote cooperation between satellites to improve mission capacities but also proposes a novel business model based on the opportunistic consumption of resources by different satellites. Nevertheless, the scope of this thesis relays on the technical aspects of the FSS.

It is essential to understand the various steps required to create a federation. The three main processes are Negotiation, Consumption, and Closure. Additionally, in, three types of FSS are defined according to the satellite architecture and the functions they perform within the aforementioned processes: (1) centralized FSS, consist of satellites acting as nodes exclusively dedicated to the negotiation and distribution of resources, as well as the process of terminating the federation. (2) negotiated FSS, consist of satellites acting as intermediary Unlike the former, these nodes only manage the negotiation process. And (3) distributed FSS: This architecture does not require nodes dedicated to any specific process. This means that the satellites themselves, which have the capability to federate, are responsible for managing all three processes. This thesis focus on the last architecture. Figure 1 illustrates the three architectures.

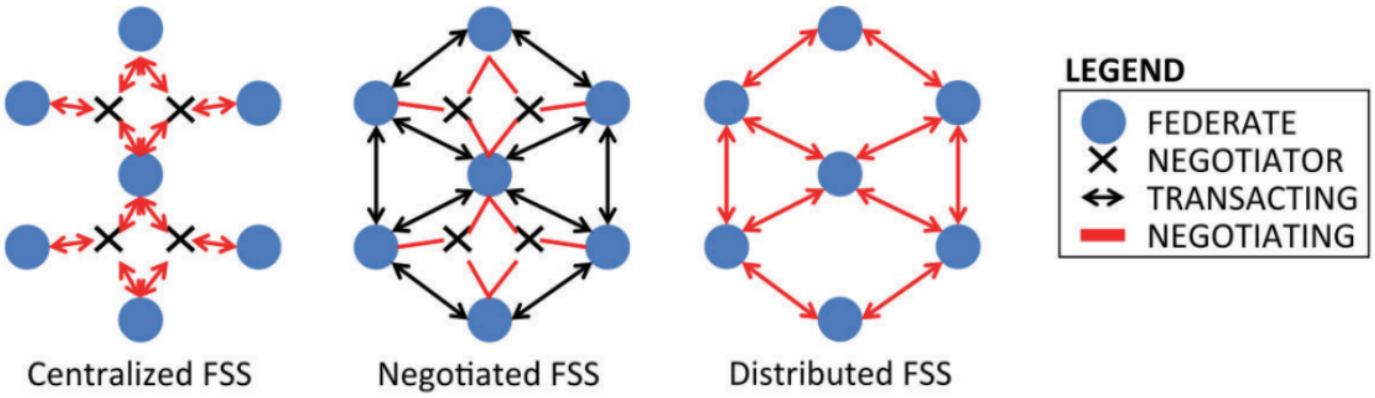

Figure 1: FSS Architectures. Reproduced from [1].

Given the processes described above and the various architectures, the need to define the necessary protocols to ensure their correct development arises. The Distributed FSS architecture require that all the nodes shall be able to manage the three processes (Negotiation, Consumption, and Termination). Two protocols are defined in [2] and [3]: OSADP and FeDeCoP. OSADP aims to efficiently manage the dissemination and handling of publications of available resources. On the other hand, FeDeCoP is designed to be in charge of managing the negotiation phase once a publication is received, manage the consumption o the resources published, and close the federation.

To validate the feasibility of the FSS, first simulation tools were developed. An implementation of the protocols was developed for the DSS-SIM simulator [2]. After obtaining satisfactory results on simulated scenarios, the Federated Satellite Systems Experiment (FSSExp) was conducted. This experiment consisted of creating a federation using stratospheric balloons equipped with payloads that integrated the OSADP and FeDeCoP protocols [3].

After the successful results from the FSSExp [3], the technology demonstration in orbit was carried out with the FSSCat mission. This mission was a precursor to a constellation of federated small satellites for Earth observation. The mission was equipped with a multi-spectral optical payload and a dual microwave payload, which included a GNSS-Reflectometer and an L-band radiometer with interference detection and mitigation capabilities. These satellites were capable to measure soil moisture, ice extent, and ice thickness, as well as detecting melting ponds on ice. Furthermore, they were equipped with radio/optical inter-satellite links to test key technologies and techniques for future satellite federations [4], [5].

Now that the context has been introduced, it is time to present the experiment of this mission. Reproduce the FSSExperiment as shown in Figure 2, consist of create a federation between two PocketQube platforms in order to download data. This data will be either telemetry or the one generated by the PL.

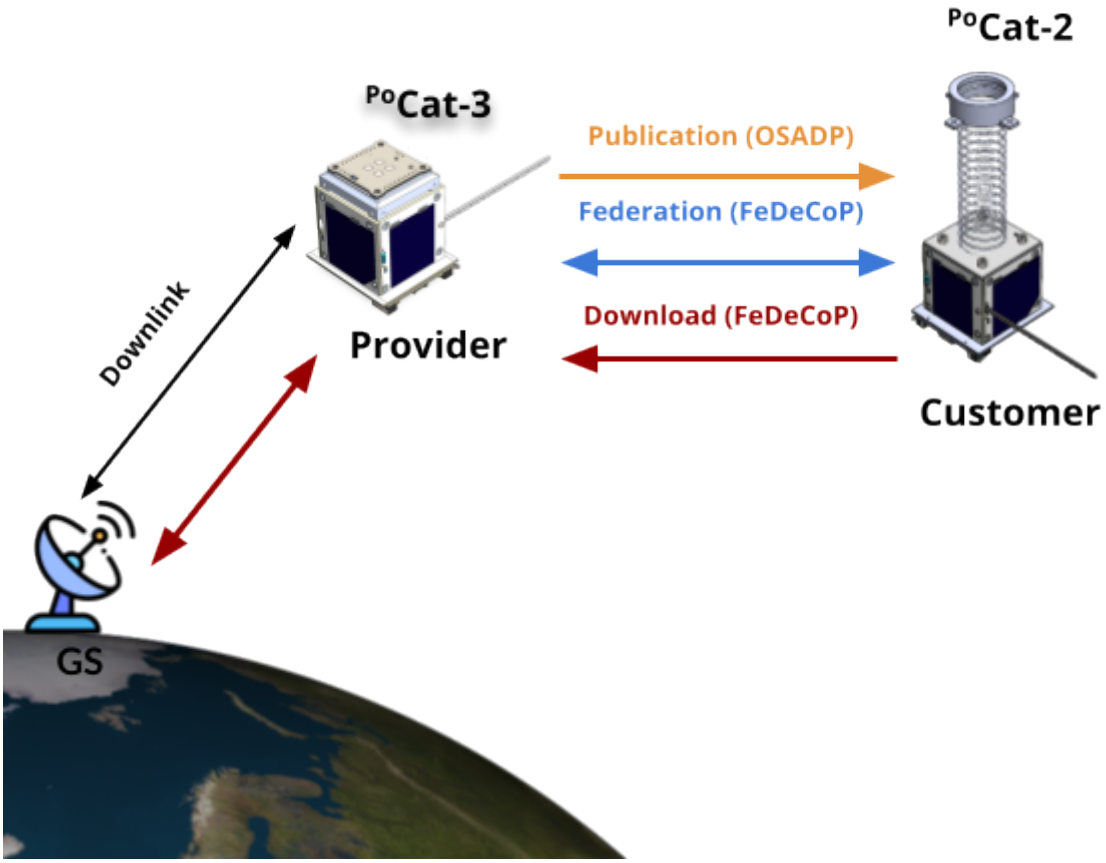

Figure 2: FSSExperiment using PocketQube Platforms.

References

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