StarLight - Formation Flying Control Architecture

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Abstract

Starlight mission is designed to demonstrate a number of key Formation Flying (FF) technologies enabling a new class of future separated spacecraft missions. The scope of these technologies include the development of a unique RF sensor system for inter-spacecraft range and bearing sensing, and the design of the an FF avionics system to enable precise control of the two spacecraft Starlight formation meeting prescribed performance to enable first-ever space based separated spacecraft optical interferometry. Starlight FF Avionics system is also required to be scaleable to future separated spacecraft missions with more than two spacecrafts in the constellation.

The StarLight constellation consists of two three-axis stabilized spacecraft buses with integrated interferometer and an RF based autonomous formation flying (AFF) sensor subsystem on each spacecraft for inter-spacecraft relative range and bearing measurement.

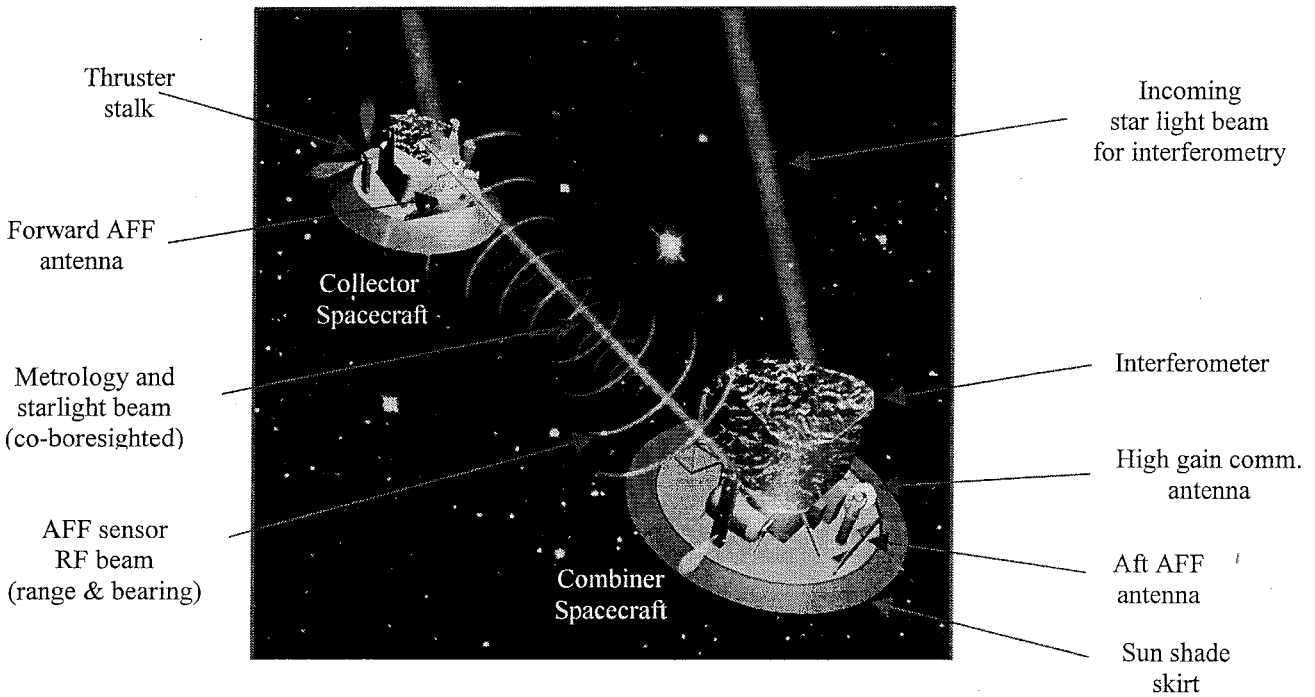

Figure 1 StarLight Spacecrafts conducting separated spacecraft Interferometry

This paper describes the overall architecture of the distributed spacecraft formation flying control system for the Starlight mission.

Formation Flying Control Architecture

The FF avionics architecture requires a number of architectural features to support the distributed nature of separated spacecraft formations, as well as, the need for enhanced on-board autonomy and robustness. One of the key Starlight requirement for the FF Avionics architecture to be scaleable to a future five spacecrafts mission (Terrestrial Planet Finder -TPF), requiring special considerations for the Starlight Avionics architecture. Starlight FF architecture is shown in Figure 2.

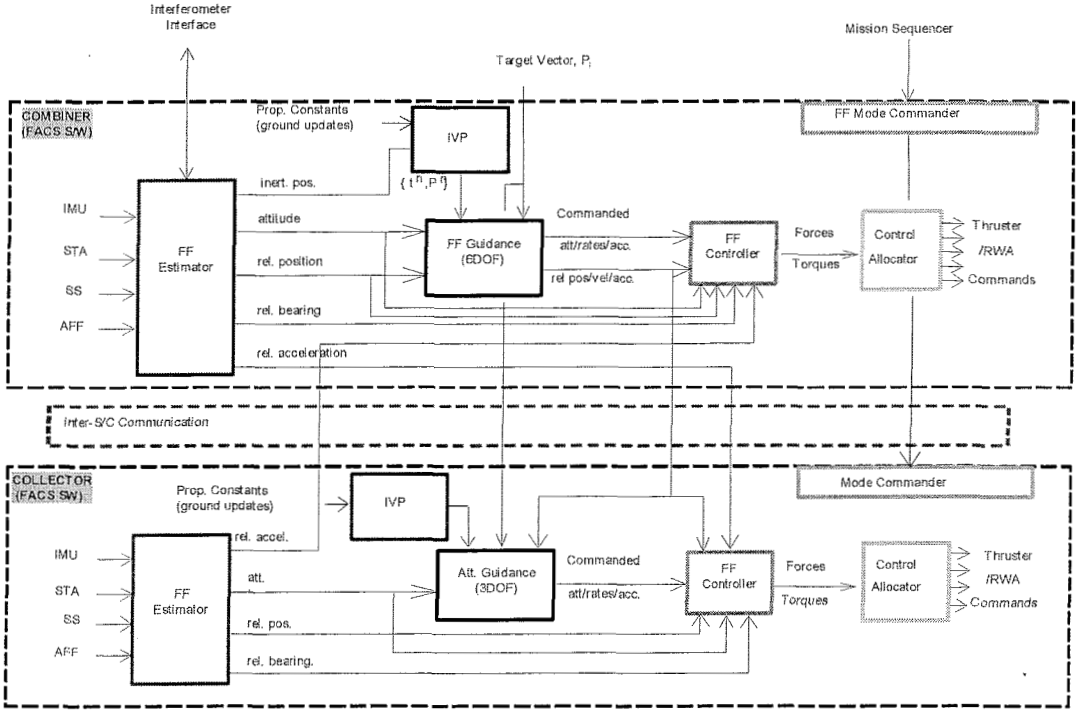

Figure 2: StarLight Formation & Attitude Control System (FACS) Architecture

Considering the intrinsically distributed nature of separated spacecraft systems, such as StarLight, the avionics architecture needs to accommodate a distributed sensing, estimation, and control architecture.

In the case of Starlight, the two spacecraft have functionally identical FF avionics system. As such a peer-to-peer architecture would be the natural choice. However the differences due to the interferometer payload and configuration (hardware, optics, functions) makes it suitable to adopt a master-slave architecture, where combiner spacecraft is designated as the formation master. This would largely be true for most of the future separated

spacecraft interferometer missions. Overall system robustness to faults and mission design considerations also requires a level of local (for each spacecraft) autonomy and operability. These consideration introduce a certain level of decentralized capability in each spacecraft guidance, estimation, and command/control architecture. This paper describes the control architecture and highlights the control architectural design issues within the two spacecraft Starlight mission context.