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UNIVERSAL DOCKING INTERFACES: PIONEERING SUSTAINABLE ON-ORBIT SERVICING IN  
SPACE HUB OPERATIONS**Abstract**

The creation of new infrastructure and technologies is necessary to support the growth of space activities as well as the goal of sustainable exploration and settlement. In order to support the operations of a proposed Space Hub, this paper presents the idea of Universal Docking Interfaces (UDIs), a crucial piece of technology for sustainable on-orbit servicing. The Space Hub, a conceptual unmanned megastructure in geostationary orbit, is designed to facilitate efficient and sustainable on-orbit servicing by hosting payloads, and providing them power, telecommunication and thermal drain.

The goal of developing UDIs is to establish a standardized, interoperable docking system that can handle a broad range of spacecraft, including manned exploration vehicles and cargo ships. By eliminating the need for numerous, mission-specific docking systems, this standardization seeks to improve the safety of docking operations, minimize environmental impact, and lower the complexity and costs related to on-orbit servicing. The techniques used include designing interfaces, integrating cutting-edge materials and technologies to guarantee dependability and durability in the harsh environment of space, and putting in place systems that facilitate autonomous docking procedures to boost operational effectiveness.

According to preliminary results from design studies and simulations, UDIs can greatly increase the sustainability of space operations. UDIs help to lessen space debris and the carbon footprint of space exploration operations by enabling the reuse of spacecraft components and lowering the frequency of launches necessary for servicing missions. Adoption of UDIs is also anticipated to be critical in enabling robotic and human operations in space that are sustainable, economical, and extremely effective, supporting the exploration and colonization of the Moon, Mars, and beyond.

In summary, the creation of a sustainable space infrastructure requires the implementation of Universal Docking Interfaces. The larger objectives of sustainable space development and colonization are supported by universal docking interfaces, which provide effective, secure, and ecologically friendly in-orbit services. This paper emphasizes the significance of universal docking interfaces and related technologies in building a sustainable framework for space exploration and utilization in the future, and calls for continued investment in their research and development.