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NanoSat MO Framework: Simulating a Constellation of Satellites with Docker Containers

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Abstract : The advancement of nanosatellite technology has opened new avenues for cost-effective and faster space missions. The NanoSat MO Framework (NMF) from the European Space Agency (ESA) provides a modular and simpler approach to the development of flight software and operations of small satellites. This paper presents a methodology using the NMF together with Docker for simulating constellations of satellites. By leveraging Docker containers, the software environment of individual satellites can be easily replicated within a simulated constellation. This containerized approach allows for rapid deployment, isolation, and management of satellite instances, facilitating comprehensive testing and development in a controlled setting. By integrating the NMF lightweight simulator in the container, a comprehensive simulation environment was achieved. A significant advantage of using Docker containers is their inherent scalability, enabling the simulation of hundreds or even thousands of satellites with minimal overhead. Docker's lightweight nature ensures efficient resource utilization, allowing for deployment on a single host or across a cluster of hosts. This capability is crucial for large-scale simulations, such as in the case of mega-constellations, where multiple traditional virtual machines would be impractical due to their higher resource demands. This ability for easy horizontal scaling based on the number of simulated satellites provides tremendous flexibility to different mission scenarios. Our results demonstrate that leveraging Docker containers with the NanoSat MO Framework provides a highly efficient and scalable solution for simulating satellite constellations, offering not only significant benefits in terms of resource utilization and operational flexibility but also enabling testing and validation of ground software for constellations. The findings underscore the importance of taking advantage of already existing technologies in computer science to create new solutions for future satellite constellations in space.

Keywords : containerization, docker containers, NanoSat MO framework, satellite constellation simulation, scalability, small satellites
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