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Critical Vulnerabilities in the Space Domain

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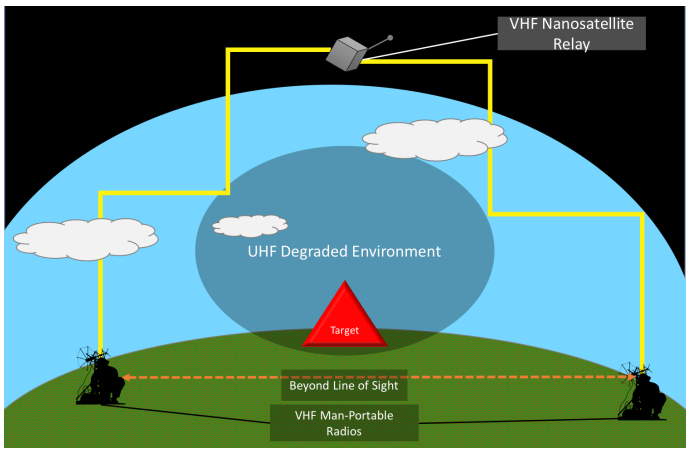
Critical Vulnerabilities in the Space Domain

Naval Postgraduate School

Using Nanosatellites as an Alternative to Traditional Satellite Communications

The U.S. military relies on space-based technology for a myriad of functions from precision navigation and timing to Satellite Communications (SATCOM). As a safeguard against the U.S. military's dependence on space-based technology, nanosatellites are a low cost and expedient near-term solution to support the U.S. military and in particular U.S. Special Operations Forces (SOF) across the globe. Furthermore, nanosatellites offer unique solutions in a degraded or resource-limited space environment as an alternative to traditional SATCOM architectures. Specifically, a constellation of nanosatellites in low earth orbit with a payload consisting of a simple Software Defined Radio (SDR) operating as a Very High Frequency (VHF) relay would provide an alternative method for satellite voice communications. Building a low-cost payload utilizing emerging SDR technology and testing the payload in both the laboratory environment and on a high-altitude balloon will demonstrate the feasibility and utility of such a payload for protecting against current U.S. military vulnerabilities.



Concept of Operations

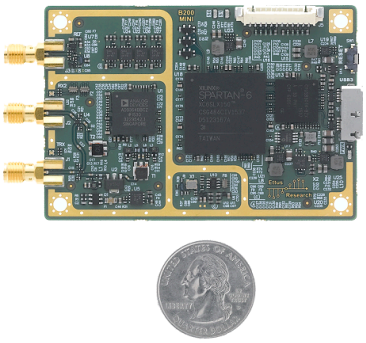
Method and Approach

In-depth research, coupled with scientific testing and modeling, will illuminate the depth of the problem, while providing a potential solution.

- Illuminate the depth of the U.S. military's reliance on space-based technology.
- Research nanosatellite applications.
- Build a model nanosatellite constellation.
- Develop a prototype payload to act as relay for VHF radios using a software defined radio.
- Iteratively test the payload in the laboratory to ensure the communications link will close.
- Test the payload using a high altitude balloon to simulate in-flight operations.

Research Question: Given that the American way of war is now inexorably linked to space-based technology and thus increasingly vulnerable, how can nanosatellites be utilized as an alternative to traditional satellite communications architectures to protect against adversaries capable of exploiting such vulnerabilities?

Hypothesis: Nanosatellites are a low cost and expedient near-term solution for this vulnerability. A constellation of nanosatellites in low earth orbit with a payload consisting of a software defined radio programmed as a VHF relay will provide an alternative method for satellite communications.



Ettus Corporation's B205-mini Software Defined Radio

The payload will enable non-SATCOM capable VHF radios in a degraded space environment—a solution to a critical vulnerability.

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Thesis Sponsor: Space and Naval Warfare Systems Center-Pacific (SSC-PAC)