FPGA Platform for Satellite Observations of VLF Emissions

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Transient Luminous Events (TLEs) are unique high-altitude phenomena which have been the subject of study because they provide insight into energy exchange and electromagnetic coupling of Earth's atmosphere and ionosphere. Observation of TLEs is difficult due to their rare occurrence and low signal levels. Recent research indicates a potential correlation between TLE optical emissions and Very Low Frequency (VLF) radio emissions of a particular signature. Therefore, automatic detection of certain VLF radio signals is a novel method to identify TLE optical events.

Two opportunities present themselves for unique instrumentation development: first, a low-order "always-on" sensor placed in-situ on board an observational satellite can record all VLF emissions and gather statistical data on the correlation and rate of occurrence of these VLF signatures. Secondly, such a sensor can serve as a triggering mechanism to activate high-fidelity optical instruments to catch the TLE events in real time.

Real-time signal detection requires fast computations; and the space-environment requires both low-power consumption and high resilience to radiation. In light of these constraints, a specialized digital signal processor (DSP) was implemented on a Field Programmable Gate Array (FPGA). Using highly parallel data processing and specialized digital hardware, VLF emissions can be categorized and identified as likely matches for TLE incidence. Early prototypes have been tested using data from the DEMETER satellite, and have been effective at detecting signals.