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Next Generation Space Interconnect Research and Development in Space Communications

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Interconnect or "bus" is one of the critical technologies in design of spacecraft avionics systems that dictates its architecture and complexity. MIL-STD-1553B has long been used as the avionics backbone technology. As avionics systems become more and more capable and complex, however, limitations of MIL-STD-1553B such as insufficient 1 Mbps bandwidth and separability have forced current avionics architects and designers to use combination of different interconnect technologies in order to meet various requirements: CompactPCI is used for backplane interconnect; LVDS or RS422 is used for low and high-speed direct point-to-point interconnect; and some proprietary interconnect standards are designed for custom interfaces. This results in a very complicated system that consumes significant spacecraft mass and power and requires extensive resources in design, integration and testing of spacecraft systems.

In the meantime, next generation space missions and advanced mission concepts demand a much more capable avionics interconnect technology well beyond those available in current technologies: (1) high-speed instruments of multiple Gbps-bandwidth; (2) on-board sensor data processing; (3) guaranteed real-time determinism with sub-microsecond latency/jitter for tight control loops in space optical interferometry instruments; (4) new systems paradigms, including plug-and-play architectures, vehicle undoc/re-doc fractionated spacecraft, sample return missions with seperability and modularity; (5) more suitable physical layer technology like fiber optical or photonic.

To meet these emerging and future needs, AFRL and JPL, in collaboration with NASA and other agencies including USAF, NRL, SMC, have started development of an advanced intra-spacecraft interconnect standard called Next Generation Spacecraft Interconnect Standard (NGSIS) since March 2011. An organizing committee, comprising representatives from USAF, NASA, SMC and other space-going agencies was formed to provide overall coordination and to act as a ratifying body for the anticipated standard. In particular, the NGSIS Requirements Subcommittee has worked continuously for 10 months under the governing of the NGSIS Executive Committee to result in a set of spacecraft interconnect requirements agreed upon by all members based on various use cases inputs.

In parallel with these collaborative efforts, a small group at the Space Vehicles directorate at Kirtland Air Force Base has been pursuing research and development into advancing the state of the art in integrated photonic components, sub-systems, and systems. This includes a combination of small business research and in-house optical network research. The end result is to successfully design and develop a SWaP viable all optical network utilizing commercially available communications protocols.