N252-084: 400 Gigabit High Speed Data and Video Communications

ADDITIONAL INFORMATION
N/A

TECHNOLOGY AREAS:
None

MODERNIZATION PRIORITIES:
Advanced Computing and Software | Integrated Network Systems-of-Systems | Integrated Sensing and Cyber

KEYWORDS:
Transceiver; Ethernet; 100 Gbt; Network; Fiber; Multi-mode; Single mode

OBJECTIVE:
Increase the speed of military aircraft digital data links to 100 Gigabits (Gbts) per second (Gbps) per lane and demonstrate with a 400 Gbps link over one fiber made up of 4 x 100 Gbps per lane.

DESCRIPTION:
The growing use of direct digitization receivers and transmitters on military aircraft is leading to high-speed data rate requirements that are outpacing current aircraft datalink development efforts. Presently, naval aircraft fiber datalinks utilize Vertical Cavity Surface Emitting Laser (VCSEL) technology over multimode fiber, which is both cost-effective and temperature-insensitive at low-data rates. However, as data rates rise, the effects of modal dispersion over temperature are causing VCSEL technology development to reach its maximum achievable performance. Recent NAVAIR receiver designs that employ multiple channels of direct digitization are demanding data transport rates in excess of 700 Gbps. To meet this requirement, the existing 10 Gbps/fiber datalinks would need to be bundled with 70 fibers, while current development of 50 Gbps data links would necessitate 14 fibers for one link.
The objective of this SBIR topic is to develop and demonstrate a 4 x 100 Gbts solution that is hardened to meet the environmental requirements for military aircraft. Ideally the technology would have the potential to achieve 200 Gbts in future development programs. This would fulfill a 700 Gbps requirement with only 2 fibers and would generate technology margin for future data speed increases up to terabit data rates. The current state-of-the-art commercial data link solutions use 100 Gbps data lanes with ongoing research and development into 200 Gbts data lanes; however, the primary application is indoor data center operations. These devices are unable to meet the extreme temperature and vibration requirements for military aircraft.
Key Performance Parameters for this topic are:
Demonstrate a maximum BER of 10^-12 between two TX/Rx transceivers under the following conditions:
Data Rate: 400Gbt using 4 x 100 Gbt data lanes
Operating Environment:
Operational Temperature: -55°C to 70°C Continuous, +85°C for 10 min
Thermal Shock: 70°C to -55°C at a rate of 35°C/min
Data transport: distance: 50 m Power Budget: > 15 dB
Vibration: To be provided after award
Technical challenges include:

1. The rate of modal dispersion in multimode fiber increases significantly with temperature, posing a difficulty in maintaining a 100 Gbt link performance at extreme temperatures. VCSEL technology has been the leading choice for aircraft datalinks due to its minimal size, weight, and power (SWaP) and wide temperature operation. However, as the demand for higher speed at high temperatures grows, better performance requires adding increasingly complex and power-hungry digital equalization to achieve marginal speed improvement. As a result, other technologies are sought that meet current and future performance requirements in a similar SWaP to VCSL transceivers and offer a clear performance growth potential to adding additional lanes and faster lanes (200 Gbts).
2. 100 Gbt waveforms require a higher signal to noise ratio (SNR) than slower waveforms. However, due to the presence of multiple bulkhead connections in an aircraft datalink, the power budget must be designed to >

15 decibels (dB). The higher SNR requirements of 100 Gbt combined with the power budget may be difficult to achieve with existing VESCL technology.
3. Data links on current aircraft are exclusively multimode; there is a legacy of deployed support equipment for multimode fiber that makes multimode solutions more likely to be adopted but does not preclude single mode solutions with a compelling performance improvement.

PHASE I:

Design and model the link, and if possible, demonstrate the key technologies that will enable the data link to function over temperature. Develop and demonstrate the feasibility of a 4 x 100 Gbts solution that is hardened to meet the environmental requirements for military aircraft and ideally with the potential to achieve 200 Gbts in future development programs. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II:

Develop and deliver six transceivers. Test two packaged transceivers and use these transceivers to demonstrate acceptable performance over the full range of thermal shock and vibration.

PHASE III DUAL USE APPLICATIONS:

Support the DoD in transitioning the proposed receiver to include working with a program office to develop a final packaging design that meets the platform SWaP and environmental requirements and developing systems specifications for the associated analog photonic links.

Development of this receiver has widespread commercial applications for high-speed commercial networks in stressing environments.

REFERENCES:

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