AVIONICS FIBER OPTICS AND PHOTONICS CONFERENCE PROBLEM STATEMENT

WDM LAN SUPERNODE

Problem Statement Background

WDM local area networking has not been deployed to any significant extent on military or commercial aircraft to date. You are a seventh generation Jetson and have just completed your college education at Jupiter Global University (JGU) in Stratosphere, OutThere, JUPITER. You are now working as a Post-Doctorate Fellow at JGU, and you have received a grant to travel to EARTH to present your recent work at the *Avionics Fiber Optics and Photonics Conference*.

At the conference you strike up a number of conversations with a variety of aerospace photonics and fiber optics engineers interested in utilizing your academic training in the astrospace industry. The *Grubolok Astrospace Corporation* is particularly interested in your doctoral thesis work, and has agreed to fly you to their corporate headquarters located in Oshkosh, Wisconsin, USA, EARTH, for a job interview the following month.

After arriving at the *Grubolok* corporate and research and development campus for a full-day tour, you are asked to report to the SuperHuman Resources Office at 0900 the following morning. Upon arriving at the SuperHuman Resources Office you are informed that your credentials have been checked, and the *Grubolok Astrospace* new-hire clearance committee has recommended you for hiring and job offer. But before doing so, the Managing Director of Astro/Aero-Optical Networking Engineering would like to speak with you to discuss a new program that may be of interest to you.

The program, *WDM Local Area Network SUPERNODE,* is aimed at development of an optical supernode technology capable of upgrading and/or replacing all previous avionics architecture network interface nodes on MIL/AERO/ASTRO platforms ranging from narrow and wide body commercial jet platforms equipped with the latest in gaming and satellite interstellar networking technology, to habited and uninhabited military network-centric mobile platforms equipped with the latest in military communications, computing, and warfighting technology.

WDM LAN SUPERNODE Problem Statement

You have the opportunity to join the *WDM LAN SUPERNODE* design team at *Grubolok Astrospace*. The team is tasked with creating the technological specifications that will enable 32-256 digital avionics circuit card assemblies to communicate with one another in a redundant, fault tolerant fashion onboard a wide body commercial jet platform used for military communications. Your *WDM SUPERNODE* design should include:

- **Fail-OP** (1st failure; continue to operate), **Fail-OP** (2nd failure; continue to operate), **Fail SAFE** (3rd failure; safe completion of mission) functionality**.**
- **Redundancy** (two or more independent connection paths to each node).
- **Reconfigurability** (N X N where N = 32-256).
- **2.5 Gb/s** data transmission, Bit Error Ratio 1E-12.
- **Low Latency** < 1 microsecond (or minimum to satisfy selected protocol requirements).
- **Determinism –** the ability for each momentary state of the node to entail all of its future states.
- **Protocol Independence** - the node's operation should permit transmission and reception of both legacy and emerging avionics COTS network protocols.

There are a number of cost-effective off-the-shelf photonics and fiber optics technologies that operate in the 1550 nm ITU grid C-Band (100 GHz/0.8 nm channel spacing) available to construct many aspects of the SUPERNODE. These are:

- -55 to +125 °C 2.5 Gb/s tunable connectorized laser transmitter with 0 dBm coupled power into a 9 micron core bend and clamp insensitive singlemode fiber. The transmitter is 3 mm high and includes a tunable laser chip control integrated circuit.

- -55 to +125 °C 2.5 Gb/s widebandwidth receiver (0 dBm saturation, -20 dBm sensitivity). The receiver is 3 mm high with LVDS electrical outputs.

- -55 to +125 °C Astro/Aero qualified single mode fiber fusion splice with 0.15 dB maximum loss. This splice is only 5 mm long and 1.5 mm in diameter.

- -55 to +125 °C Astro/Aero qualified bend insensitive singlemode fiber pigtailed semiconductor optical amplifier/attenuator with +/- 30 dB variable gain and a noise figure of 5 dB.

- -55 to +125 °C fiber pigtailed 32 wavelength mux/de-mux device. Fiber-to-fiber insertion loss no more that 6 dB. The mux/de-mux device acts as an arrayed waveguide grating, but only occupies a 1 cm X 1 cm footprint.

- Singlemode connector loss is 1.5 dB max over the relevant air vehicle environment. Connector backreflection (return loss) is –20 dB over the relevant air vehicle environment.

- Fiber dispersion is found to be negligible (assume zero dispersion) up to 100 meters at 2.5 Gb/s.

- All photonic devices listed above operate with polarization independence (i.e., PMD is zero).

- Maximum link distance is 100 meters.

- Photonic lightguide circuit hybrid integration packaging enables precision die bonding of SOAs, laser chips, receiver chips, and Mux/DeMux chips with no more than 3 dB coupling loss between the devices and the waveguides.

The mission of the team is to define a *WDM SUPERNODE* whereby the above listed devices are available as off-the-shelf items. In addition to the items listed above, you are also allowed to **invent up to 3 devices** or **device integration technologies** to create the *WDM SUPERNODE*.

The *WDM SUPERNODE* design should be demonstrated in a WDM LAN architecture for aircraft applications. The WDM LAN architecture may be configured using **one additional device or device integration invention** to connect the WDM LAN supernodes for subsequent demonstration in a flight test environment.

WORKSHOP TEAM DELIVERABLES

One *WDM SUPERNODE design* (with up to 3 additional device or device integration inventions).

One *WDM Network Architecture design* (with up to one additional device or device integration invention).

One *Wish List* of device technologies needed to create an optimized avionics WDM LAN.