PHOTONIC TECHNOLOGIES FOR AN INTEGRATED OPTICAL NODE FOR AVIONIC NETWORKS

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Introduction

Increasingly sophisticated aerospace sensors and weapons systems are driving the demand for bandwidth in avionics backbone networks. Aerospace communication system platforms pose stringent requirements on the size, weight, power consumption and operating environment of network components. Fiber optics provide incomparable performance advantages relative to other technologies, with Terabit information capacity, enormous weight and space reduction, immunity to electromagnetic interference, and reduction in power consumption of the link, thereby significantly reducing the costs per bit of information carrying capacity on board of an avionic platform. Multi-node Dense Wavelength Division Multiplexed (DWDM) optical networks are emerging as a leading solution for data communication links in avionic systems. These DWDM networks provide the promise of upgrade capability to hundreds of independent wavelengths.

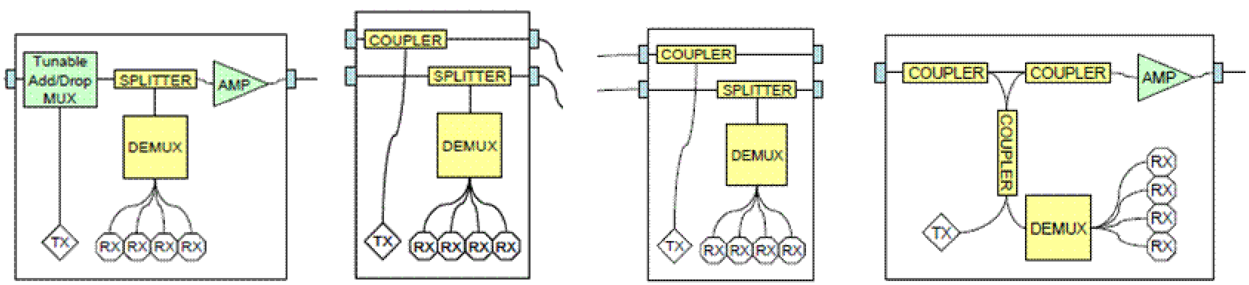

Figure 1 - Different Connection architectures based on different network topologies: from left to right (1) Ring topology connection (2) Unidirectional bus (3) Star/switch topology (4) Bidirectional bus topology

In order to meet the size, weight, power, cost and performance requirements of the avionic platforms, it is envisioned that the avionic DWDM network nodes will be realized using high level of photonic integration of the required components. Some of the key components under development include tunable transmitters, wavelength converters and tunable filters. Additionally, for the fully integrated node implementation, both research demonstrations [1,2] and commercial deployment [3] of high-density PICs have recently occurred.

In this paper, we will discuss our recent work on some key technologies for avionic DWDM networks, based on Indium Phosphide photonic integrated circuits. Those are tunable wavelength converters and monolithic tunable optical routers on chip. We will also analyze the implications of these results to possible architectures of the avionic DWDM network node.

Tunable Wavelength Converters

Tunable wavelength converters are of critical importance to perform the essential functions of optical switching, wavelength routing and add/drop multiplexing in any WDM network. For avionic applications the main challenges are to meet the requirements for performance while minimizing size, weight and power consumption, and achieving low profile packaging and thermal stability. We have performed an experimental study of different device architectures for Navair. From the results of the study, we have determined the most promising approach for tunable wavelength converter implementation – a photocurrent-driven wavelength converter architecture, found to have lower power consumption and smaller footprint than all other architectures.

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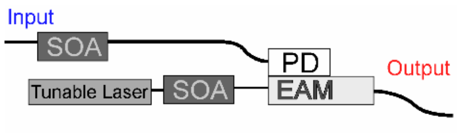

	Gain	Back Mir.	Front Mir.	Preamp	Booster	PD/MOD	Termination	Total Power
Current (mA)	120	60	20	45	240	50	50	
Voltage (V)	2.2	1.8	1.6	2	2.4	3	1.5	
Power (W)	0.264	0.108	0.032	0.09	0.576	0.15	0.075	**1.295W**

Figure 2 – (left) Photocurrent driven wavelength converter chip (right) Total chip power consumption

Integration of switching and routing elements on the same chip

Optical routing and switching technologies offer the potential for reduced footprint and power requirements in the future optical networks. As part of DARPA's DOD-N program at UCSB, the world's first monolithic tunable optical router chip (MOTOR) was recently demonstrated. The MOTOR chip consists of an array of eight, 40 Gbps RZ, widely-tunable wavelength converters (WC) and an arrayed-waveguide grating router (AWGR) (Fig. 2). The wavelength converters operate using cross phase modulation effects in a carrier- based, differential Mach-Zehnder interferometer (MZI). This approach to wavelength conversion uses an integrated differential-delay line to overcome carrier recovery time limits in semiconductor optical amplifiers (SOA) in the MZI at 40 Gbps. This demonstration required further refinement of the integration platform in order to realize both active and passive components on the same chip, with 3 different waveguide architectures.

The MOTOR technological platform is one of several that can be used to implement the avionic network node. Several options for node integration will be presented, and their respective benefits and drawbacks will be discussed. On the architectural side, given that the final node design has not been defined yet, we will discuss options of developing required building blocks that can be utilized in a variety of architectures.

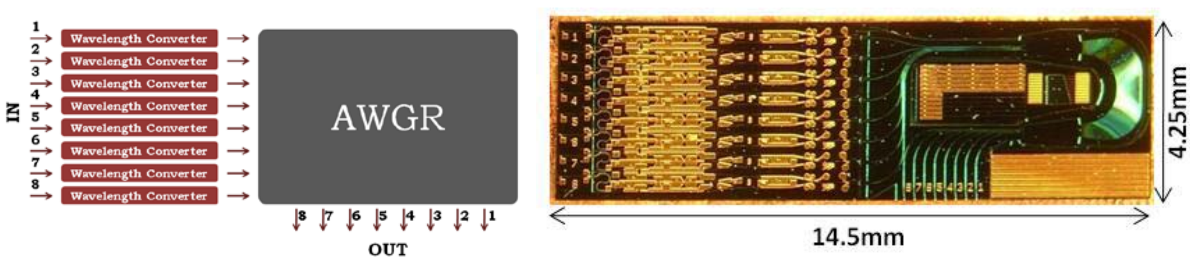

Figure 3 – (left) Schematic of MOTOR chip (right) Photograph of the fabricated device

Conclusion

Recent advances in the field of photonic integration have made compact, small form factor, robust realizations of the avionic network components and subsystems a reality. In this paper, we discussed the recent progress in large scale photonic integration and its implications on realization of integrated avionic DWDM node technologies.

Acknowledgements

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