Programs and Applications

Since its inception, APIC has focused on applying complementary optics and electronics to a range of critical defense needs. Most recently, it has concentrated its efforts on three related programs invested in by the Defense Advanced Research Projects Agency (DARPA), the US Navy (Naval Air Systems Command (NAVAIR)), and another US government agency.

Highly Integrated Photonics (HIP)

NAVAIR recognized the limits of copper and potential of photonics in 2004, tasking APIC with creating an enhancement to the Navy's EA-6B and EA-18G electronic attack platforms. The objective of the HIP program was to devise a common optical backplane to take the place of the existing point-to-point data links on these aircraft. In the course of this effort, APIC successfully demonstrated key integrated chip components for WDM avionics networks.

Network Enabled WDM—Highly Integrated Photonics (NEW-HIP)

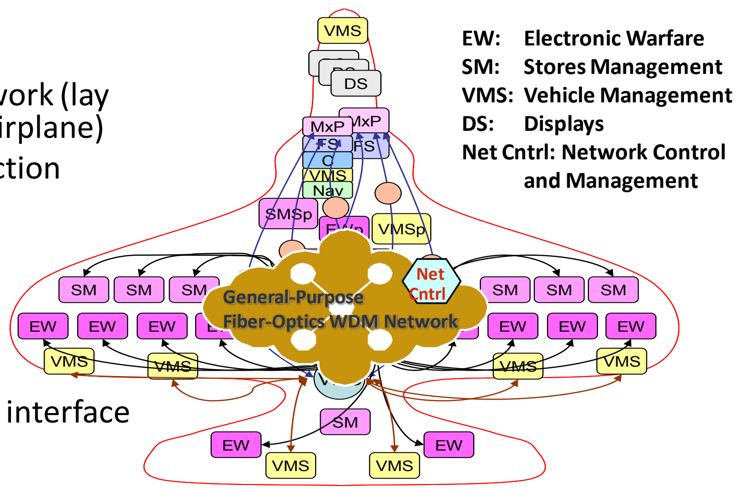
Following the successful completion of the Navy HIP program, APIC was tasked with facilitating the building or upgrading of avionics platforms with a WDM, single-mode fiber-optical network designed to supersede current copper and multimode fiber architectures. Originally intended to provide specific technologies for application on the EA-6B Prowler, the DARPA- sponsored NEW-HIP program was broadened in scope to provide a universal solution for advanced photonic capabilities on all military aircraft, using the Joint Strike Fighter as the most demanding case. APIC has taken as its goal the provision of a "future-proof" network architecture that can be readily adapted to a host of defense needs at minimal cost.

Overall Vision of the Navy HIP/E Program

Replace the special-purpose, copper-based, avionics links and networks with **one**, future-proof, general-purpose, single-mode, fiber-optics, wavelength-division multiplexed (**WDM**), local area network (**LAN**) with highly-integrated photonics (**HIP/E**) components and subsystems

Objectives

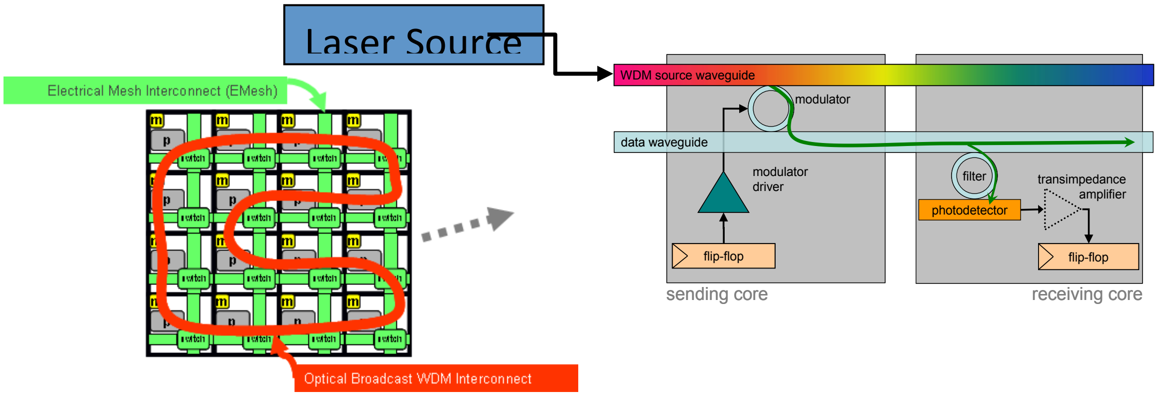
- Transparent, all-purpose network (lay fiber once for the life of the airplane)
- Cable and system SWaP reduction
- Bandwidth scalability
- Increased reliability
- Reduced life cycle costs
- Navy owned network
- Multi level security
- Standardize sensor-processor interface



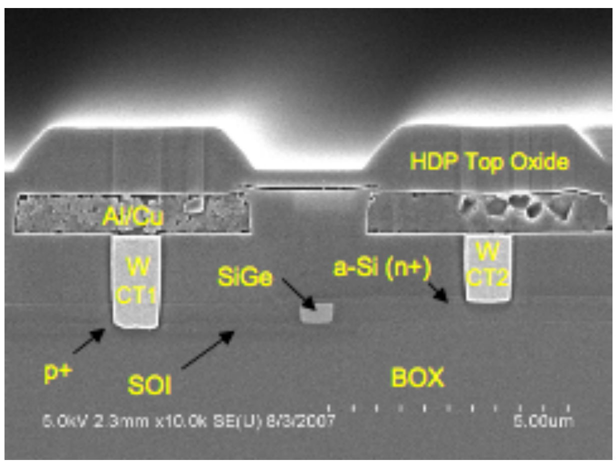
A totally networked approach – not just a one-for-one cable swap-out

Fully Laser Integrated Processor (FLIP)

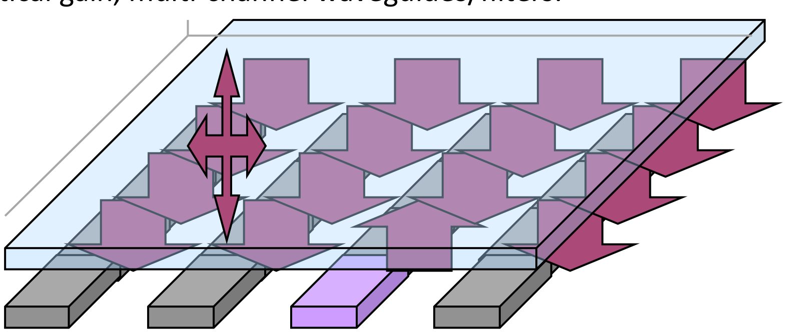
The objective of the FLIP program, initiated in 2010, is to extend the advances brought about by NEW-HIP through the development of on-chip optical networks for onboard processors. To accomplish this goal, APIC uses on-chip optical interconnects to allow data to be transmitted from one component to another within a single chip. A product being developed for the US Government is a1024 core optically connected non blocking processor. This will enable true parallel processing, since optical interconnects solve the latency problem associated with electrical interconnects. Parallelism has replaced clock speed as the scaling paradigm (basic energy physics).



- Enables optically interconnected processor network
- Significant reduction in energy required per bit
- Improved programmability
- Improved average/peak performance



Silicon microphotonic components by seamless CMOS integration and demonstrated lowest energy modulators, photodetectors, optical gain, multi-channel waveguides/filters.



Every core directly communicates with *every* other core; No energy intensive routers; reduced high energy/power/latency memory calls.

Chip-to-Chip Interconnect Applications

Silicon Optical Backplane Interconnects for Data Centers

"Bandwidth-hungry applications such as real-time video processing are expected to strain data center networking infrastructure."

— M. Glick, IEEE

Power consumed by data centers is doubling every five years. This has enormous impact on national energy consumption. Demand for wide-bandwidth services is exhausting the capabilities of interconnection technologies currently employed in enterprise data centers, particularly at the level of backplane interconnections. Optical solutions have the potential to solve this problem by virtue of their significant data transmission rates and low power consumption. APIC Corporation's CMOS-compatible manufacturing technology allows for the seamless integration of optical and electronic components on a single substrate, thereby answering the need for high-speed, low-cost, low-power solutions.

Conventional copper-based data center server.

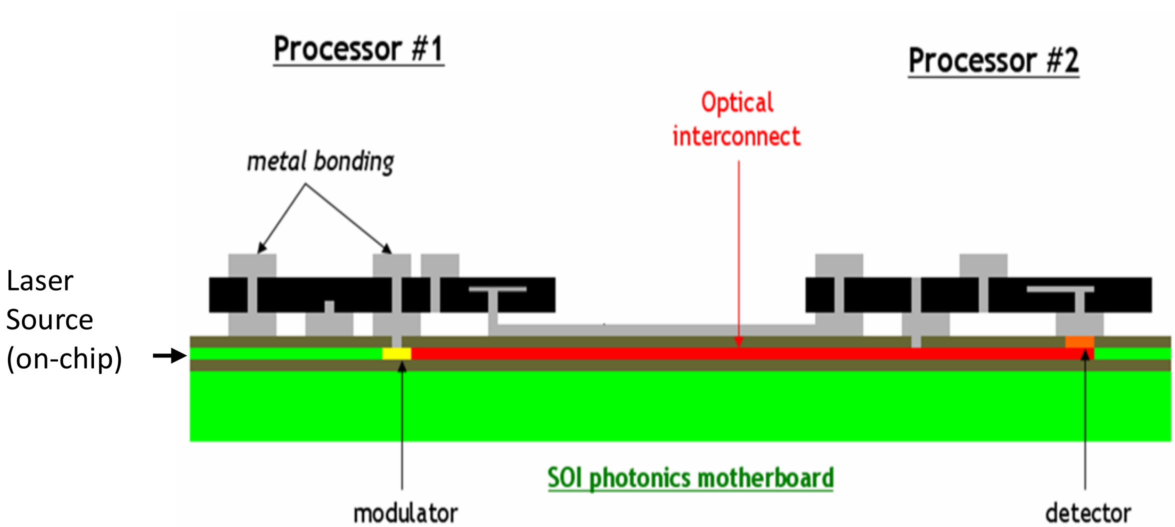
On-Chip Interconnect Applications

Intelligence Surveillance Reconnaissance 3D Video Graphics Chip Processor

"NVIDIA set the thermal limits of Fermi, its latest GPU, at a vaporizing 105 degrees Celsius."
— www.techpowerup.com

The meteoric growth of the graphics chip market has been driven largely by increasing demand for 3D computer graphics, particularly in the high-end gaming and "smart phone" markets. Military ISR requirements need the same kind of fidelity. To meet this need, NVIDIA, a market leader in the manufacture and production of graphics processing units, recently introduced Fermi, a graphics processing architecture that features up to 512 cores per chip. However, Fermi's electrically interconnected cores have been associated with high power consumption and heat dissipation, placing a limit on additional performance improvements.

By harnessing on-chip optical interconnects linked by an ultra-high-bandwidth, high-speed optical bus, APIC Corp.'s proprietary technology would mitigate heat dissipation while allowing for the integration of up to twice as many cores on a chip, resulting in enhanced functionality and performance.



- Processor core optical interconnects require integrated, on-chip laser sources and detectors
- Dense wavelength division multiplexing for separation and isolation of data traffic
- CMOS-compatible integration for volume manufacturability

OCDMA for Data Encryption

Code-division multiple-access (CDMA) technologies have long been known for their multiple-access capability as well as for their capacity to provide enhanced security for data communications, as evidenced by their widespread use in wireless networks. APIC's Optical CDMA (OCDMA) can coexist with conventional WDMA channels in fiber channels, and would utilize 256 bits encryption in the optical spectral domain while data rate remains 40 Gbps; RF/electrical CDMA would require an impractical 10.24 Tbps bit rate. APIC has can do this because of our expertise in integrated Si photonics, and our ability to produce very compact optical components such as ring-resonator-based de-multiplexers, combiners and on-chip detectors.