BROCHURE

Optical Innovation Center

Delivering Breakthrough Innovation Through Multi-discipline Opto-electronic R&D

THE INFINERA OPTICAL INNOVATION CENTER

The Optical Innovation Center (OIC) comprises a world-class team of scientists and engineers with a proven track record of taking disruptive component technologies from vision to network disruption. Responsible for driving Infinera's opto-electronic R&D, core OIC disciplines include coherent ASIC/DSP design, photonic integrated circuit (PIC) design and manufacture, analog ASIC design, advanced packaging design and manufacture, and holistic co-design, including the RF interconnect. The OIC has been responsible for many industry firsts, including the first large-scale PIC, the first coherent PIC, the first commercial super-channels, the first Nyquist subcarriers, and the first point-to-multipoint coherent technology. Additional innovation highlights include SD-FEC gain sharing and long-codeword probabilistic constellation shaping (LC-PCS). These innovations enabled the fourth-generation Infinite Capacity Engine (ICE4) optical engine to set multiple subsea spectral efficiency records, and they are also behind the industry-leading 800G reach of Infinera's latest optical engine, ICE6, as well as Infinera's game-changing XR optics.

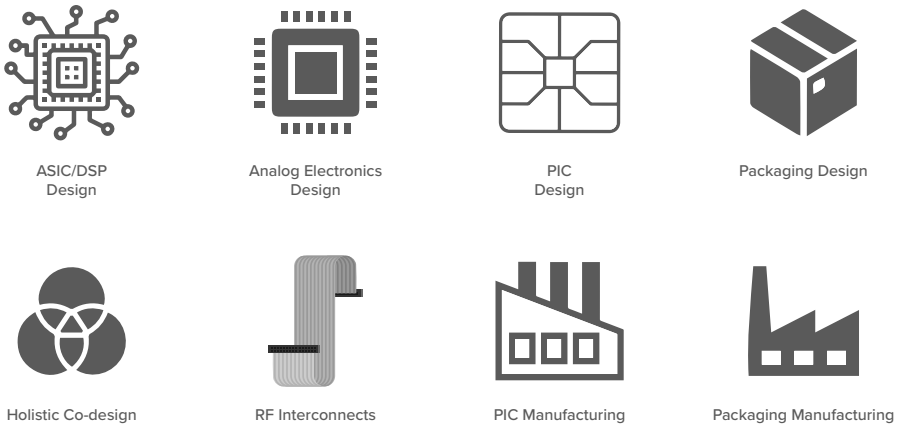

Figure 1: ICE6: Infinera Optical Innovation Center core disciplines

WORLD-CLASS COHERENT ASIC/DSP DESIGN

The digital ASIC/DSP plays a critical role in coherent transceivers. In addition to coherent signal processing, including impairment compensation, it is responsible for analog-to-digital and digital-to-analog conversions, forward error correction (FEC), performance monitoring, and encryption. Advanced functions such as Nyquist subcarriers, probabilistic constellation shaping, SD-FEC gain sharing, and dynamic bandwidth allocation are all performed in the ASIC/DSP. Infinera's DSP design team has been responsible for multiple generations of ASIC/DSP, including the 500 Gb/s Gen 3 engine, ICE4, and ICE6.

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- **ASIC/DSP design** that delivers advanced functionality, including Nyquist subcarriers, SD-FEC gain sharing, long-codeword PCS, and point-to-multipoint subcarriers
- **PIC design** that maximizes performance while reducing cost, power, and footprint
- **PIC manufacturing** that ensures supply security, tight quality control, and fast ramps to volume
- **Analog electronics design** that leverages the latest technology to maximize the performance of critical analog functions, including drivers and transimpedance amplifiers
- **Advanced packaging** for coherent optical engines that uses the latest materials, design methodologies, and manufacturing techniques
- **Holistic co-design**, including the critical RF interconnect, that optimizes trade-offs in order to maximize performance

PIONEERING PHOTONIC INTEGRATED CIRCUIT DESIGN AND MANUFACTURING

Infinera pioneered photonic integration with the industry's first large-scale PIC in 2005 and continues to lead the industry with its sixth-generation PIC in ICE6. Leveraging high-performance indium phosphide (InP), Infinera's PICs integrate a wide range of optical functions on a single chip. This reduces cost, footprint, and power consumption while improving performance and reliability. In addition, Infinera has invested heavily to build its own state-of-the-art indium phosphide PIC fab and is the only equipment manufacturer to have done so. In addition to the obvious cost advantages of this vertical integration, this enables fast redesigns to optimize performance, tight quality control, and a faster ramp to volume for new technologies and products such as ICE6.

STATE-OF-THE-ART ANALOG ELECTRONICS

In addition to the DSP and PIC, coherent transceivers also require high-performance analog electronics. These include drivers that convert the low voltages from the ASIC/DSP to the higher voltages required by the modulators, as well as transimpedance amplifiers (TIAs) that convert current from the photodetectors to the voltages required by the ASIC/DSP. In-house design of the critical analog ASICs is an additional core discipline of the OIC.

INNOVATIVE PACKAGING DESIGN AND MANUFACTURING

Packaging plays an important role in high-performance optical engines, and can be even more important in cost- and footprint-sensitive compact pluggable coherent transceivers such as XR optics. An additional area of OIC expertise is the packaging of coherent transceivers leveraging the latest materials, design methodologies, and manufacturing techniques.

HOLISTIC CO-DESIGN, INCLUDING RF INTERCONNECTS

With the ASIC/DSP, PIC, analog electronics, and packaging all designed and manufactured in-house, holistic co-design allows the optimization of any trade-offs in order to maximize performance. This includes the critical electrical/radio frequency (RF) interconnects between the ASIC/DSP, analog electronics, and PIC.

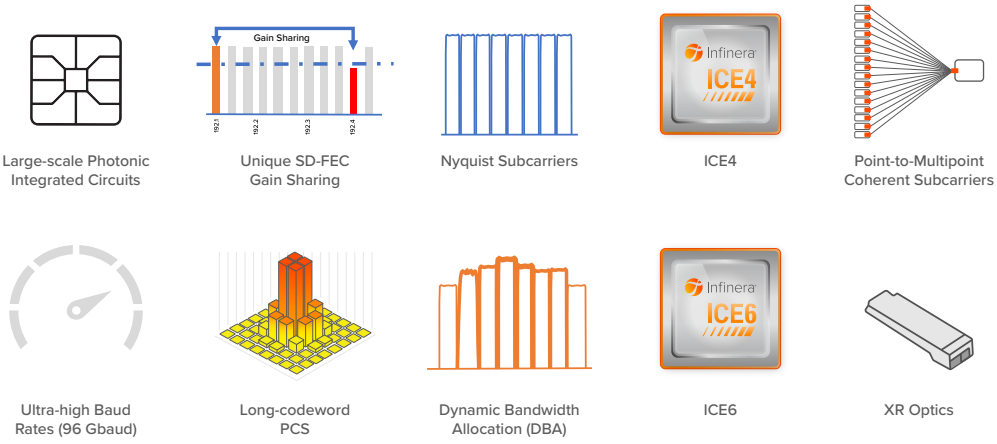

Figure 2: Key OIC innovations and products

BREAKTHROUGH INNOVATIONS AND PRODUCTS

Together these core disciplines have enabled the OIC to deliver multiple breakthrough innovations and class-leading products. SD-FEC gain sharing enables the errors of a more challenged wavelength to be shared with a less challenged wavelength to equalize the FEC gain, thus maximizing the capacity of the more challenged wavelength. Nyquist subcarriers significantly reduce sensitivity to nonlinearities and chromatic dispersion. Ultra-high baud rates, 96 Gbaud with ICE6, enable a step-change increase in wavelength capacity-reach. Infinera's long codeword implementation (LC-PCS) brings PCS gain close to its theoretical maximum. Dynamic bandwidth allocation (DBA) brings Nyquist subcarriers and LC-PCS together in order to maximize capacity-reach. Breaking the point-to-point shackles of conventional optics, point-to-multipoint coherent subcarriers enable radically lower aggregation network TCO. These innovations are brought to market in the form of Infinera's Infinite Capacity Engine optical engines, ICE4 and ICE6, and XR optics.

Infinera