

ICE6 Optical Engine

Minimize Total Cost of Ownership with 800G Generation Coherent

800G GENERATION OPTICAL ENGINE LEVERAGING ADVANCED DSP AND PIC TECHNOLOGY

Developed by the Infinera Optical Innovation Center (OIC), the sixth-generation Infinite Capacity Engine (ICE6) is a single 1.6 Tb/s optical engine that delivers two wavelengths at up to 800 Gb/s each. It leverages advanced technology with a 7 nm process node DSP/ASIC, a highly integrated indium phosphide (InP) photonic integrated circuit (PIC), high-performance analog electronics, and advanced packaging. As all the components and packaging are designed in-house, holistic co-design enables optimized performance. A compact DCO package enables the ICE6 optical engine to be integrated into multiple Infinera platforms, including Groove Series compact modular platforms, DTN-X Series transport switching platforms, and DRX disaggregated routers.

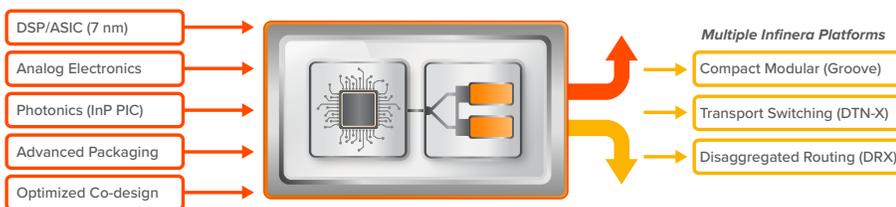


Figure 1: ICE6: Advanced technology, multiple platforms

MAXIMIZE WAVELENGTH CAPACITY-REACH WITH ULTRA-HIGH BAUD RATES

Higher baud rates enable significantly increased wavelength capacity-reach, and therefore provide a key lever for reducing the cost per bit, power, and footprint of coherent optical transport. With a state-of-the-art maximum baud rate of 96 Gbaud, ICE6 delivers industry-leading reach over a wide range of wavelength speeds, including 800 Gb/s wavelengths to 950+ km, 600 Gb/s wavelengths to 2,500+ km, and 400 Gb/s wavelengths to 6,500+ km. While the highest baud rates are the best choice for many scenarios, ICE6’s flexible baud rate (32-96 Gbaud) enables use cases for sub-maximum baud rates, such as maximum 800 Gb/s spectral efficiency, transport over fixed-grid networks, trans-oceanic subsea, and operationally simple flexible grid based on 100 GHz increments.

LEVERAGE A RANGE OF INNOVATIVE FEATURES INCLUDING NYQUIST SUBCARRIERS AND LC-PCS

Having pioneered the use of Nyquist subcarriers with ICE4, ICE6 doubles the number of subcarriers per wavelength to eight, enabling ICE6 to reduce the effect of chromatic dispersion, as compared to single-carrier wavelengths, by a factor of 64 due to the squared relationship between baud rate and chromatic dispersion. Nyquist shaping also contributes to tight channel spacing with minimized wavelength roll-off. Probabilistic constellation shaping (PCS) provides benefits in terms of almost unlimited modulation granularity and improved OSNR tolerance, with Infinera’s unique long codeword implementation (LC-PCS) bringing PCS gain close to its theoretical maximum.

BENEFITS OF ICE6

- **Minimize** cost per bit by boosting wavelength capacity-reach with ultra-high baud rates
- **Leverage** unique features, including long-codeword probabilistic constellation shaping, dynamic bandwidth allocation, and SD-FEC gain sharing
- **Maximize** spectral efficiency and fiber capacity with innovative features including Nyquist subcarriers, enabling 42.4 Tb/s in the C-band and more than 80 Tb/s C+L
- **Reduce** power consumption and footprint with an optimized 1.6 Tb/s optical engine that leverages the latest 7-nm ASIC technology and a highly integrated PIC
- **Simplify** operations with a smaller number of high-capacity wavelengths to provision and manage

ICE6 PERFORMANCE PROOF POINTS

ICE6 has demonstrated industry-leading performance across a range of network scenarios:

North American Network (March 2020)

- 800 Gb/s: 950 km
- *Third-party OLS with live traffic*
- *G.652 fiber*

Windstream, USA (June 2020)

- 800 Gb/s: 730 km
- 700 Gb/s: 1,460 km
- *G.652 fiber*

Verizon, USA (July 2020)

- 800 Gb/s: 667 km
- 600 Gb/s: 2,283 km
- 400 Gb/s: 4,091 km
- *G.655 LEAF fiber*

Another unique Infinera innovation, dynamic bandwidth allocation brings Nyquist subcarriers and LC-PCS together with the ability to decrease the data rate of the more challenged subcarriers while increasing the data rate of the less challenged subcarriers in order to maximize capacity-reach. ICE6's dual-wavelength DSP enables an additional unique feature, SD-FEC gain sharing, where the errors of a more challenged wavelength are shared with a less challenged wavelength to equalize the FEC gain, thus maximizing the capacity of the more challenged wavelength. Additional features include high-performance FEC, advanced telemetry, wire-speed encryption, and the ability to load-balance clients over the two wavelengths (e.g., three 400 GbE clients over two 600 Gb/s wavelengths or five 100 GbE clients over two 250 Gb/s wavelengths).

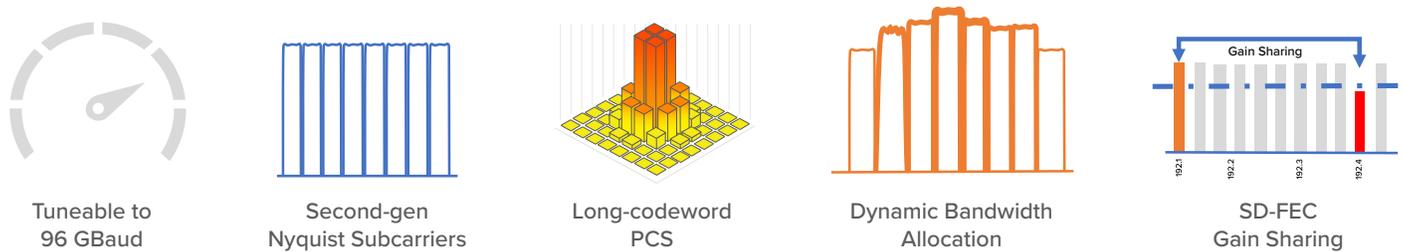


Figure 2: Key ICE6 advanced features

INCREASE SPECTRAL EFFICIENCY AND FIBER CAPACITY

ICE6 has a number of features that maximize spectral efficiency and fiber capacity, enabling network operators to avoid, or at least delay, the substantial costs of having to acquire and light new fibers. These features include the tight channel spacing enabled by Nyquist subcarriers and a shared wavelength locker for the two wavelengths that enables them to move in unison. Spectral efficiency of 8.833 bits/s/Hz and total C-band capacity of 42.4 Tb/s can be achieved with 800G wavelengths, with C+L band enabling more than 80 Tb/s per fiber pair. LC-PCS, DBA, and SD-FEC gain sharing also contribute to increased spectral efficiency at longer distances.

REDUCE OPEX RELATED TO POWER, FOOTPRINT, PROVISIONING, AND MANAGEMENT

ICE6 also lowers operations costs related to power consumption, footprint, and the provisioning and management of wavelengths. ICE6 enables platform power consumption of less than 0.2 W/Gb/s and can deliver up to 3.2 Tb/s of coherent bandwidth in one rack unit. Its extended reach further avoids the space and power of intermediate electrical regeneration. Operational costs are further reduced with a small number of high-capacity wavelengths to provision and manage, as opposed to a larger number of lower-capacity wavelengths.

ADDRESSING MULTIPLE APPLICATIONS, INCLUDING DCI, METRO, LONG-HAUL, AND SUBSEA

The ICE6 optical engine is ideal for a wide range of optical transport applications, including data center interconnect, terrestrial metro and long-haul, and subsea. ICE6 delivers industry-leading 800G wavelength reach of 950+ km, significantly reducing DCI cost per bit over metro, regional, and even national distances. ICE6 also delivers industry-leading 600G and 400G reach with over 2,500+ km and over 6,500+ km respectively, substantially raising the bar for terrestrial long-haul, while extreme lightning tolerance makes it ideal for aerial fiber scenarios as well. Furthermore, ICE6 delivers subsea reach of over 16,000 km. Key subsea features include Nyquist subcarriers, a tuneable baud rate, LC-PCS, and a range of additional modulation formats optimized for different subsea scenarios.