Celebrating 50 Years of Light-speed Connections

In 1970, two significant technical achievements led to the development of practical fiber optical communications: the demonstration of low-loss fibers (16dB/km) and the first room-temperature semiconductor lasers. Since then, numerous other breakthroughs have resulted in increasing the bandwidth and reach of fiber links, enabling the World Wide Web, video streaming, trans-oceanic, high-capacity links, high-capacity wireless communications and many other data services. This timeline captures milestones from the past 50 years since the commercialization of fiber optics.

OFC

1970

Continuous-wave room-temperature semiconductor lasers first demonstrated. (Alferov, Ioffe Physical Institute and Hayashi, Panish, Bell Labs)

Corning unveils low-loss single-mode optical fiber (16dB/km). (Maurer, Keck, Schultz, Corning Incorporated)

1972

First DFB laser announced.

LiNbO3 waveguide modulator.

Modified Chemical Vapor Deposition (MCVD) fiber fabrication process developed. (MacChesney, Bell Labs)

1974

Bell Labs settles on graded-index fiber with 50- to 100μm cores for transmission at 850 nm.

1975

Introduction of first commercial continuous-wave diode laser operating at room temperature.

First topical meeting on optical fiber transmission.

1976

First low loss fibers at long wavelengths developed, offering 0.47 decibel/km at 1.2 micrometers. Discovery of the 1.55 μm window. (Horiguchi, NTT and Osanai, Fujikura Cable)

Introduction of the first diode lasers in the second window, InGaAsP diode lasers emitting at 1.25 μm. These were soon followed by InGaAsP diode lasers emitting at 1.3 and 1.55 μm. (Hsieh)

1977

First fiber transmission of live telephone traffic. (GTE, Bell Laboratories)

100-year diode-laser lifetime achieved in accelerated aging tests. (Bell Laboratories)

1978

First live demonstration of fiber to the home in Japan. (Hi-OVIS)

Agreement to co-develop a single-mode transatlantic submarine fiber cable using the 1.3 μm window. (AT&T, British Post and STL)

Creation of single-mode fiber with record 0.2 dB/km loss at 1.55 μm, close to the theoretical limit. (NTT)

1979

Demonstration of first electrically pumped VCSEL.

1980

First major long-haul transmission system, from Boston to Washington, initially planned for wavelength-division multiplexing of three wavelengths at 45 Mb/s through each of 144 fibers. (AT&T)

1981

Transmission of 140 Mb/s through 49 kilometers of single-mode fiber at 1.3 μm, setting the stage for the switch to single-mode. (British Telecom)

1982

Single-mode 1.3μm fiber link planned from New York to Washington with capacity of 400 Mb/s on each fiber. (MCI)

Volume production of single-mode fiber launched. (Corning Incorporated)

1985

Single-mode fiber becomes the backbone of the North American telephone network.

1986

Passive planar silicon waveguides first demonstrated.

1987

Presentation of first 1.55μm erbium-doped optical fiber amplifier, matching the lowest loss window in fused silica fiber.

SONET standard published (synchronous optical network for circuit-switched communications over optical fibers from 155 Mb/s to 10 Gb/s).

1988

First room-temperature CW VCSEL

TAT-8, first transatlantic optical fiber cable, begins service at circa 276 Mb/s per fiber.

1990

First coherent transmission over 2.2 million meters using erbium-doped fiber amplifiers at 2.5 Gb/s. (Saito et al., NTT)

Arrayed waveguide router developed. (Takahashi, Dragone)

1991

5 Gb/s transmission through 9000 km of fiber using fiber amplifiers. This design was later selected for TAT-12 transatlantic fiber. (Bell Laboratories)

1993

Dispersion management first proposed, paving way for 10 Gb/s transmission.

1995

World Wide Web reaches 16 million users as of December 1995.

First commercial amplified WDM systems with capacity of 8x2.5 Gb/s. (Ciena)

First commercial 10 Gb/s terminal equipment. (Nortel)

1996

At OFC, Fujitsu, NTT and Bell Laboratories all send one Tb/s through single-mode WDM in "hero experiments."

First commercial DWDM 10G wavelength-division multiplexing systems.

TAT-12 transatlantic fiber cable first to offer optical amplifiers and 5 Gb/s line rate.

APON (ATM-PON) Standard established.

1997

The Wavelength Selective Switch (WSS) is introduced.

1998

TAT-13 long-distance submarine fiber cables are upgraded with WDM with 3 wavelengths, increasing capacity to 15 Gb/s per cable.

Wavelength Selective Switch (WSS) with gain flattening introduced.

1999

Gigabit-Ethernet Standard established.

2000

Wall Street analysts flock to OFC 2000 as optics and communications stocks push NASDAQ average above 5000.

First small-form factor pluggable (SFP) transceiver multi-source agreement.

2000/2001

Photonics bubble peaks, deflates, and then bursts, resulting in massive excess of dark fibers, which later spurs industry growth.

2001

Tunable lasers first used in fiber optic systems.

Fiber transmission technology plateaus in the Dense Wavelength Division Multiplexing (DWDM) of dozens of optical channels at 10 Gb/s per channel. SONET/SDH incorporated in networks.

OFC 2001 attracts a record crowd of 38,015. Over 970 companies exhibit.

2004

First InP photonic integrated circuits deployed.

Japan becomes first country to connect optical fiber to one million households.

Verizon is first major carrier in the United States to offer optical fiber to customers.

First E-PON (Ethernet-PON) and 10 GbE standards established.

2005

Commercial systems with digital compensation of chromatic dispersion deployed.

2006

QPSK coherent transmission with DSP.

Gridless WDM with LCOS WSS reported at OFC.

2007

First silicon integrated photonic modulator deployed, able to operate at 40 gigabits. (Intel)

Standardized small-form-factor pluggable (SFP) using VCSELs to transmit 10-Gb/s signals.

2008

First digital coherent optical system transmitting at 40 Gb/s introduced. (Nortel)

2009

Dr. Charles Kao awarded Nobel Prize.

100G compact form factor pluggable (CFP) multi-source agreement (MSA) announced.

2010

100 Gigabit Ethernet (802.3ba) standard established.

2011

Open Flow standard for Software Defined Networking introduced.

2012

100-gigabit transmitters in standardized pluggable form factors are first introduced.

1Pb/s transmission capacity achieved in multi-core fiber. (NTT)

Flex-Grid WDM standardized. (ITU-T)

2013

WDM introduced in data centers.

2014

100G PSM4 MSA (Parallel Single Mode 4-lane Multi-Source Agreement) developed specifications that ultimately lead to use of interoperable 100 gigabit interfaces over single-mode fiber for data centers.

Introduction of OpenConfig as vendor-independent API for network control.

2015

3 Tb/s Superchannel, reported at OFC, nets spectral efficiency 5.97 bit/s/Hz over 359 km. (British Telecom and Huawei)

2016

16 Tb/s single fiber capacity reached.

400G QSFP-DD module MSA announced.

2017

Corning celebrates delivery of over 1 billion kilometers of fiber.

Commercialization of Silicon Photonics starts in earnest.

China, South Korea and Japan connect fiber to more than 50% of residential buildings.

2018

3456 fiber count high-density ribbon cables introduced.

159 Tb/s C+L Band Transmission over 1045 km 3-Mode multi-core fiber laboratory link.

600 Gb/s commercial line rates with DP-64QAM modulation achieved.

2019

400 Gb/s transport made available on interoperable equipment. (Optical Internetworking Forum)

24 Tb/s single fiber data rate achieved over 12,800 kmin Pacific Light Cable Network undersea link.

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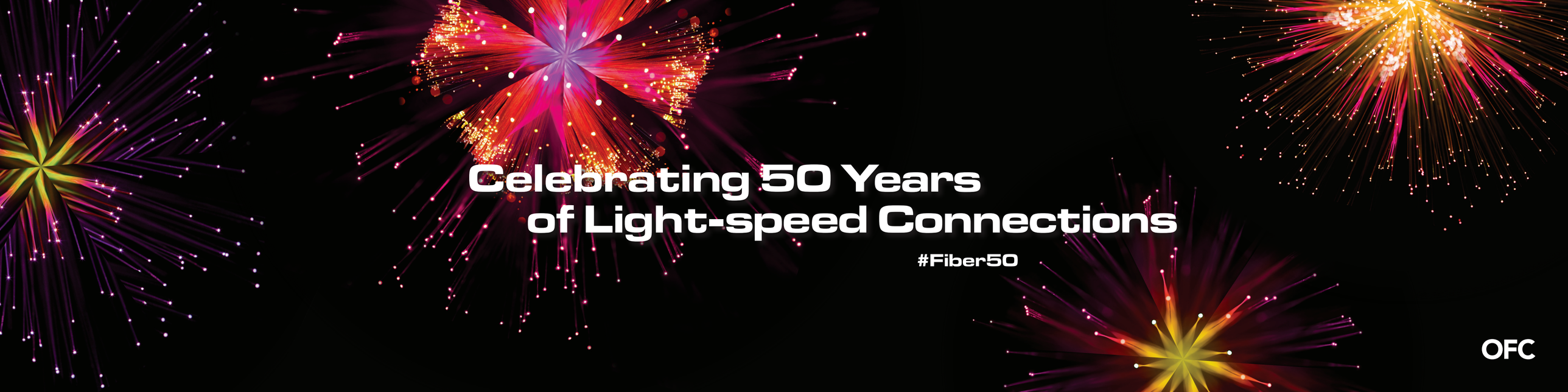
Celebrating 50 Years
of Light-speed Connections
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OFC