IN THE UNITED STATES DISTRICT COURT
FOR THE NORTHERN DISTRICT OF TEXAS
WICHITA FALLS DIVISION

XTERA, INC., NEPTUNE SUBSEA ACQUISITIONS LTD., and NEPTUNE SUBSEA IP LTD., Plaintiffs, v. NEC CORPORATION, and NEC CORPORATION OF AMERICA, Defendants.	Civil Action No. ___________ **JURY TRIAL DEMANDED**

COMPLAINT FOR PATENT INFRINGEMENT

Plaintiffs Xtera, Inc., Neptune Subsea Acquisitions Ltd., and Neptune Subsea IP Ltd. (collectively, "Xtera") demand a trial by jury on all issues so triable and, for their complaint against Defendants NEC Corporation ("NEC JP"), and NEC Corporation of America ("NEC US") (collectively, "NEC" or "Defendants"), allege as follows:

THE PARTIES

1. Plaintiff Xtera, Inc. is a Delaware Corporation and a wholly owned subsidiary of Neptune Subsea Holdings Ltd., a UK corporation with its headquarters at Bates House, Church Road, Harold Wood, Essex, RM3 0SD, England, which is a wholly-owned subsidiary of Neptune Subsea Acquisitions Ltd. Xtera, Inc. is the successor to Xtera Communications, Inc. ("Xtera Communications"), which was founded in 1998. The principal place of business of Xtera, Inc. is in Allen Texas.

2. Plaintiff Neptune Subsea Acquisitions Ltd. is a UK corporation with its headquarters at Bates House, Church Road, Harold Wood, Essex, RM3 0SD, England.

3. Plaintiff Neptune Subsea IP Ltd. is a wholly owned subsidiary of Neptune Subsea Holdings Ltd., a UK corporation with its headquarters at Bates House, Church Road, Harold Wood, Essex, RM3 0SD, England, which is a wholly-owned subsidiary of Neptune Subsea Acquisitions Ltd. Neptune Subsea IP Ltd. is a UK corporation with its headquarters at Bates House, Church Road, Harold Wood, Essex, RM3 0SD, England. Neptune Subsea IP Ltd. is a holding company for intellectual property assets owned by Neptune Subsea Holdings Ltd. and its subsidiaries.

4. On information and belief, NEC JP is a Japanese corporation with its headquarters in 7-1, Shiba 5-chome, Minato-ku, Tokyo 108-8001, Japan.

5. On information and belief, NEC US is a wholly owned subsidiary of NEC JP. On information and belief, NEC JP directs or controls the actions of NEC US. NEC US is a Nevada corporation with its principal place of business at 3929 W. John Carpenter Freeway, Irving, TX 75063-2909. NEC US can be served with process via its registered agent, National Registered Agents, at 1999 Bryan St., Ste. 900, Dallas, TX 75201.

JURISDICTION AND VENUE

6. This lawsuit is an action for patent infringement arising under the patent laws of the United States, Title 35 of the United States Code.

7. This Court has subject matter jurisdiction over this action pursuant to 28 U.S.C. §§ 1331 and 1338(a).

8. This Court has personal jurisdiction over Defendants in that they have, directly or through agents and/or intermediaries, committed acts within the State of Texas and this District

giving rise to this action and/or have established minimum contacts with the State of Texas and this District such that the exercise of jurisdiction would not offend traditional notions of fair play and justice. Further, on information and belief, Defendant NEC US is headquartered in this District in Irving, Texas. *See, e.g.,* http://www.nec.com/en/global/office/usa.html.

NEC US

9. This Court has personal jurisdiction over NEC US as, on information and belief, NEC US regularly conducts business in the State of Texas and this District, and purposefully avails itself of the privileges of conducting business in Texas, including through its corporate headquarters in Irving, Texas. In particular, on information and belief, NEC US, directly and/or through its agents and/or intermediaries, makes, uses, imports, offers for sale, sells, and/or advertises its products and affiliated services in the State of Texas and this District that infringe Xtera's Asserted Patents, identified *infra* in paragraphs 17–23. NEC US has placed, and continues to place, these infringing products into the stream of commerce via established distribution channels, with the knowledge and/or understanding that such products are sold in the State of Texas and this District.

10. On information and belief, NEC US has derived substantial revenue from its infringing activity occurring within the State of Texas and this District and should reasonably expect its actions to have consequences in the State of Texas and this District, including through its corporate headquarters in Irving, Texas. In addition, NEC US has, and continues to transact business with persons in the State of Texas and this District, directly and/or through third parties, by (1) importing, offering to sell, and/or selling into and within the State of Texas and this District products and services that infringe Xtera's Asserted Patents, and (2) using in the State of Texas and this District, and/or encouraging and supporting the deployment and use in the State

of Texas and this District of products that infringe Xtera's Asserted Patents. These acts by NEC US have and continue to cause foreseeable harm and injury to Xtera, Inc., a Delaware Corporation with its principal place of business in Allen, Texas.

11. Venue is proper as to NEC US in this judicial district pursuant to 28 U.S.C. §§ 1391 and 1400.

NEC JP

12. This Court has personal jurisdiction over NEC JP because, *inter alia*, and on information and belief, NEC JP has established the minimum contacts with the State of Texas and this District for the Court to exercise personal jurisdiction over it.

13. NEC JP is also subject to personal jurisdiction in this Court under the Texas Long Arm Statute, Tex. Civ. Prac. & Rem. Code § 17.042, and under the U.S. Constitution, because, on information and belief, NEC JP regularly conducts business in the State of Texas and this District, and purposefully avails itself of the privileges of conducting business in the State of Texas and this District, including through its wholly-owned subsidiary, NEC US, headquartered in Irving, Texas. In particular, on information and belief, NEC JP, directly and/or through its agents, intermediaries, and/or subsidiaries including NEC US, makes, uses, imports, offers for sale, sells, and/or advertises its products and affiliated services in the State of Texas and this District. Through its agents, intermediaries, and/or subsidiaries NEC JP has placed, and continues to place, infringing products into the stream of commerce via established distribution channels, with the knowledge and/or understanding that such products are sold in the State of Texas and this District.

14. On information and belief, NEC JP has derived substantial revenue from its infringing activity occurring within the State of Texas and this District and should reasonably

expect its actions to have consequences in the State of Texas and this District. In addition NEC JP has, and continues to transact business with persons in the State of Texas and this District, directly through third parties, and/or through its subsidiary NEC US, by (1) importing, offering to sell, and/or selling into and within the State of Texas and this District products and services that infringe Xtera's Asserted Patents, and (2) using in the State of Texas and this District, and/or encouraging and supporting the deployment and use in the State of Texas and this District of products that infringe Xtera's Asserted Patents. These acts by NEC JP have and continue to cause foreseeable harm and injury to Xtera, Inc., a Delaware Corporation with its principal place of business in Allen, Texas.

15. NEC JP is also subject to jurisdiction in the United States, and specifically in the State of Texas and this District, pursuant to Rule 4(k)(2) of the Federal Rules of Civil Procedure. NEC JP has contacts with the United States that include, *inter alia*, advertising, importing, offering to sell, and/or selling its products throughout the United States, including the State of Texas and this District.

16. Venue is proper as to NEC JP in this judicial district pursuant to 28 U.S.C. § 1391(c)(3).

THE PATENTS-IN-SUIT

17. On February 19, 2013, the U.S. Patent and Trademark Office duly and lawfully issued U.S. Patent No. 8,380,068 ("the '068 patent"), entitled "Distinct Dispersion Compensation for Coherent Channels" naming Do-Il Chang and Wayne S. Pelouch as the inventors. Neptune Subsea IP Ltd. is the owner by assignment of all right, title and interest in the '068 patent and has exclusive right to bring suit to enforce the patent. Evidence of such

assignment has been recorded with the U.S. Patent and Trademark Office at Reel/Frame 042586/0916. A true and correct copy of the ’068 patent is attached hereto as Exhibit 1.

18. On December 28, 2010, the U.S. Patent and Trademark Office duly and lawfully issued U.S. Patent No. 7,860,403 (“the ’403 patent”), entitled “Data Format for High Bit Rate WDM Transmission” naming Sergei Turitsyn, Mickail Fedoruk, and Elena G. Shapiro as the inventors. Neptune Subsea IP Ltd. is the owner by assignment of all right, title and interest in the ’403 patent and has exclusive right to bring suit to enforce the patent. Evidence of such assignment has been recorded with the U.S. Patent and Trademark Office at Reel/Frame 042586/0916. A true and correct copy of the ’403 patent is attached hereto as Exhibit 2.

19. On March 3, 2015, the U.S. Patent and Trademark Office duly and lawfully issued U.S. Patent No. 8,971,171 (“the ’171 patent”), entitled “Reduced FEC Overhead in an Optical Transmission System” naming Stuart Barnes, Martin Chown, and Stephen M. Webb as the inventors. Neptune Subsea IP Ltd. is the owner by assignment of all right, title and interest in the ’171 patent and has exclusive right to bring suit to enforce the patent. Evidence of such assignment has been recorded with the U.S. Patent and Trademark Office at Reel/Frame 042586/0916. A true and correct copy of the ’171 patent is attached hereto as Exhibit 3.

20. On January 8, 2013, the U.S. Patent and Trademark Office duly and lawfully issued U.S. Patent No. 8,351,798 (“the ’798 patent”), entitled “Phase Shift Keyed High Speed Signaling” naming Sumudu Geethika Edirisinghe, Jörg Erich Schwartz, and Wai Mun Wong as the inventors. Neptune Subsea IP Ltd. is the owner by assignment of all right, title and interest in the ’798 patent and has exclusive right to bring suit to enforce the patent. Evidence of such assignment has been recorded with the U.S. Patent and Trademark Office at Reel/Frame 042586/0916. A true and correct copy of the ’798 patent is attached hereto as Exhibit 4.

21. On March 26, 2013, the U.S. Patent and Trademark Office duly and lawfully issued U.S. Patent No. 8,406,637 ("the '637 patent"), entitled "Automatic Pre-emphasis" naming Stephen Michael Webb, David Winterburn, and Stephen Desbruslais as the inventors. Neptune Subsea IP Ltd. is the owner by assignment of all right, title and interest in the '637 patent and has exclusive right to bring suit to enforce the patent. Evidence of such assignment has been recorded with the U.S. Patent and Trademark Office at Reel/Frame 042586/0916. A true and correct copy of the '637 patent is attached hereto as Exhibit 5.

22. On April 7, 2009, the U.S. Patent and Trademark Office duly and lawfully issued U.S. Patent No. 7,515,331 ("the '331 patent"), entitled "Twin Optical Amplifier with Dual Pump Power Control" naming Alan Olway as the inventor. Neptune Subsea IP Ltd. is the owner by assignment of all right, title and interest in the '331 patent and has exclusive right to bring suit to enforce the patent. Evidence of such assignment has been recorded with the U.S. Patent and Trademark Office at Reel/Frame 042586/0916. A true and correct copy of the '331 patent is attached hereto as Exhibit 6.

23. Collectively, the '068 patent, the '403 patent, the '171 patent, the '798 patent, the '637 patent, and the '331 patent are referred to herein as the "Asserted Patents" or the "patents-in-suit."

BACKGROUND

24. Xtera is a global communications company and has a substantial United States presence through its wholly-owned subsidiary Xtera, Inc. Xtera, Inc. is Neptune Subsea Acquisitions Ltd.'s primary operating arm for its optical networking solutions, including its subsea telecommunication systems. Xtera, Inc. sells its optical networking solutions directly or indirectly to telecommunications service providers, content service providers, enterprises, and

government entities worldwide to support deployments of submarine fiber-optic networks. Xtera, Inc.'s subsea telecommunications products include unrepeatered systems, repeatered systems, end-to-end turnkey solutions, and submarine system upgrades. Xtera, Inc.'s subsea telecommunication systems are deployed in five continents and sixty countries across the globe.

25. Xtera pioneered the use of all-Raman optical amplification to improve the capacity and reach of long span terrestrial and subsea telecommunication networks, deploying the first commercial all-Raman optical network in 2004. Through development of advanced optical amplifiers, repeaters, remote monitoring and control equipment, and other subsea optical networking components, Xtera, Inc. has become an industry leader in subsea telecommunication systems, and offers disruptive and industry leading solutions that optimize the performance and reduce the cost of deploying, upgrading, and managing subsea telecommunication systems.

26. Xtera, Inc. has employees across the globe, including in the United States. Its domestic employees provide manufacturing and operation support, sales and marketing, technical support and customer care, research and development, and general and administrative functions. Research and development for Xtera, Inc.'s subsea telecommunication systems occurs primarily in its Allen, Texas headquarters and also in its England offices.

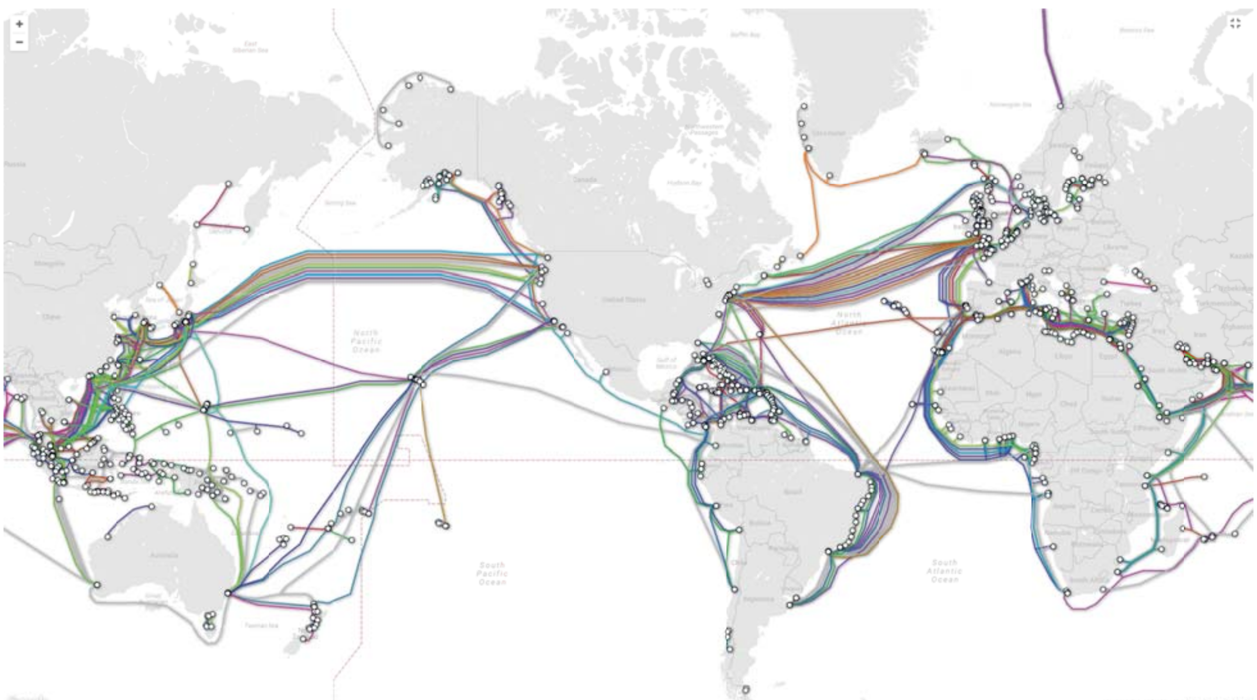
27. Through its continued technological innovation, Xtera, Inc., itself and through its predecessor Xtera Communications, has obtained more than 120 patents worldwide, many directed to foundational subsea optical networking technologies involved in this investigation. Xtera Subsea IP Ltd. is the assignee of Xtera Communications' Asserted Patents, with the right to sue for infringement of those patents.

28. Defendant NEC develops, manufactures, sells, and/or uses in the United States the NEC NS Series – Submarine Repeatered Systems (the "Accused Products"). NEC's Accused

Products incorporate—without license from Xtera—many technologies developed by Xtera, Inc. and protected by Xtera's Asserted Patents.

29. The products at issue in this action are subsea telecommunication systems used to carry digital data, such as telephone, Internet and private data traffic across the ocean.

30. Subsea telecommunication systems connect terrestrial data networks across bodies of water, allowing the transmission of data between continents. As shown below, dozens of state- and privately-owned submarine networks span every major ocean, connecting data networks across the globe. *See generally*, Telegeography's Submarine Cable Map, *available at* http://www.submarinecablemap.com.



31. Subsea telecommunication systems are designed to address the challenge of transmitting data signals across thousands of miles of ocean waters, where installation, operating conditions, and maintenance present difficulties not necessarily present for terrestrial data networks. To address these challenges, subsea communication systems rely on specialized

equipment and components, such as: (i) optical "repeaters," which boost the intensity of light signals traveling through the fiber optic cable at certain intervals so that the signals do not become too attenuated, or faint, before they reach their destination, (ii) submarine line terminal equipment, which amplify the optical signals that are transmitting across the fiber optic cable using high-powered lasers, provide optical signal control, monitoring, and other functionality, and connect the subsea telecommunication systems to terrestrial data networks, and (iii) reinforced fiber optic cable, which can transmit light waves containing data across great distances at high speeds and withstand the tremendous atmospheric pressures present at ocean floor depths.

32. The products at issue are the systems and components of these long-haul subsea telecommunication systems that transmit, receive, and transport data along the ocean floor to connect terrestrial data networks across the globe. One important component of these subsea telecommunication systems is the optical amplifiers contained within the submarine line terminal equipment that boost the intensity of the optical signal so that it can be transported across thousands of miles of fiber optic cable. The line terminal equipment is also a critical component of these subsea systems, as they allow the monitoring of signals containing data transmitted around the world.

33. At a high level, optical amplifiers make long-haul data transmission possible by boosting the intensity of light, *i.e.*, increasing the gain of an optical signal. This allows an optical signal to travel longer distances over fiber optic cable before it needs to be boosted again by an optical repeater, or "repeatered." Traditional optical amplifiers increase the gain of an optical signal by combining the signal with beams from high-powered lasers and sending the combined

signal through a section of erbium-doped fiber optic cable. These erbium doped fiber amplifiers ("EDFAs") were introduced in the mid-1980s and are still used in optical networks today.

34. In the 1990's, researchers began focusing on amplifying optical signals with stimulated Raman scattering, which takes advantage of the effects of scattering photons from molecules. Groundbreaking research at the University of Michigan by Xtera Communications' founder demonstrated that Raman amplification could increase the gain of a larger spectrum of light over longer distances than traditional EDFAs. Xtera, Inc. was founded on this groundbreaking Raman amplifier research.

A. Xtera Communications' and/or Xtera, Inc.'s Subsea Telecommunication Systems

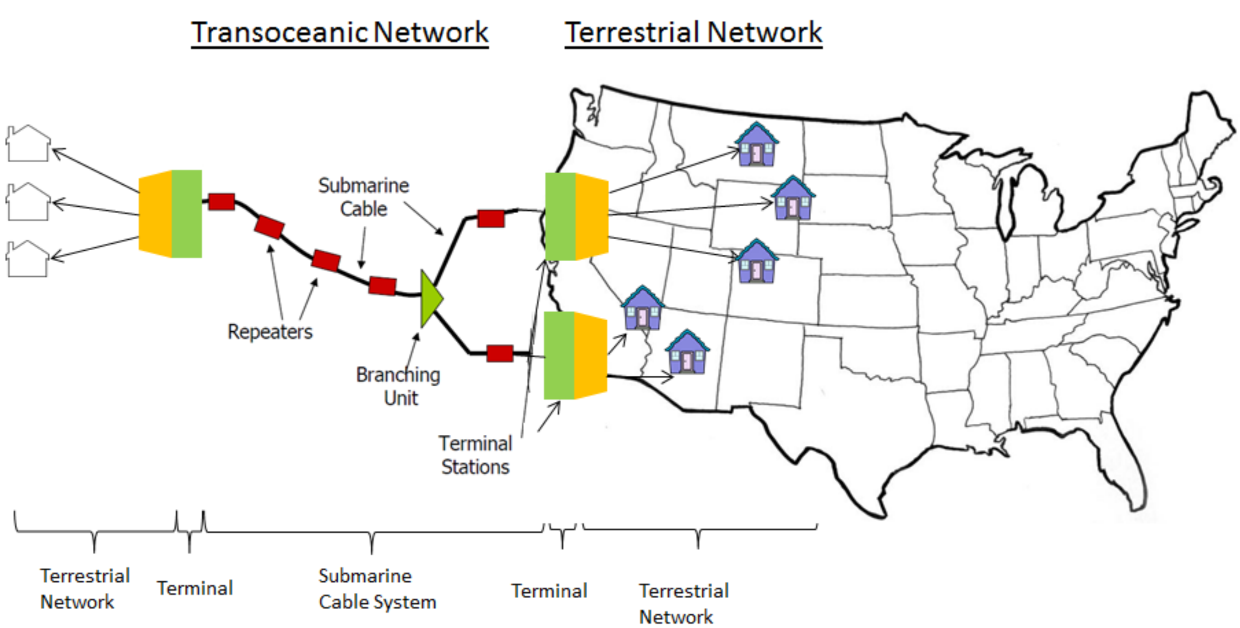
35. In 2004, Xtera Communications deployed its first commercial all-Raman optical platform in a terrestrial network in Europe. At the time, the network was the highest capacity and longest distance all-optical network in Europe. Xtera Communications then expanded its offerings from terrestrial to submarine networks, introducing its Nu-Wave NXT SLTE (submarine line terminal equipment) in 2007, which provided a dedicated platform for long-haul subsea telecommunication systems.

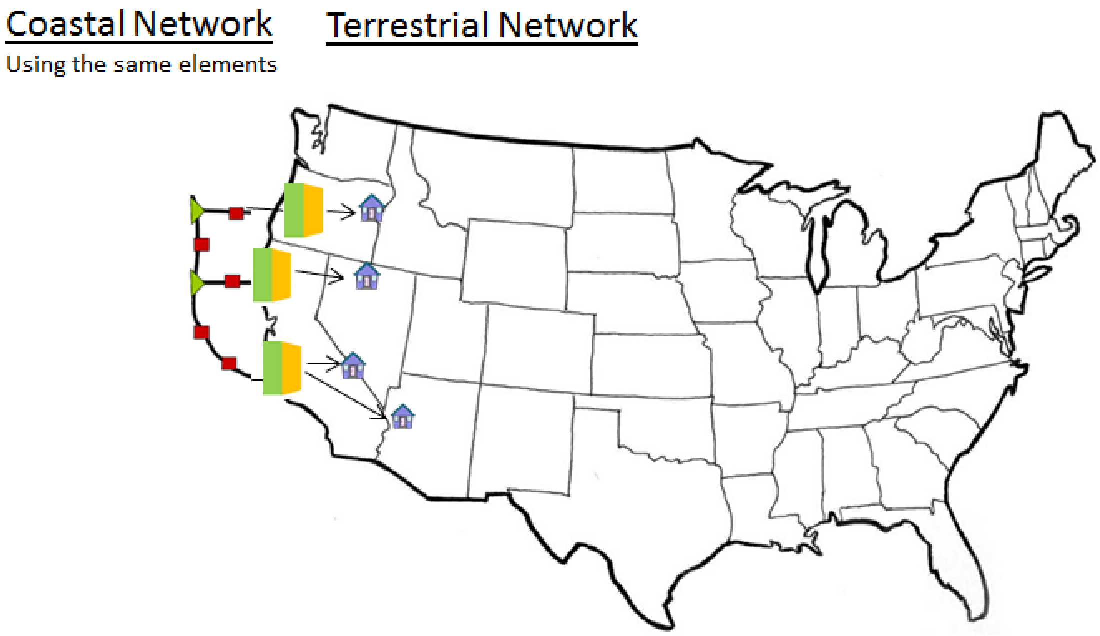
36. Xtera Communications introduced its current generation of products designed to improve the performance of subsea telecommunication systems, the Nu-Wave Optima platform, in October 2010, with its first deployment in early 2011. The Nu-Wave Optima platform can be configured with combinations of discrete and distributed Raman amplifiers and can be used to power and extend both terrestrial and submarine optical networks. The Nu-Wave Optima platform provides almost three times the capacity and twice the reach of its competitors for 100 Gb/s optical networks.

37. Xtera, Inc. sells and has sold its subsea telecommunication systems, including its Nu-Wave Optima platform, directly or indirectly to telecommunications service providers, content service providers, data center operators, enterprises, and government entities worldwide. Xtera, Inc. has deployed its Nu-Wave optical networking platforms in more than fifty optical networks including: GlobeNet, ECFS, Americus 1- Columbus 2, Project Aqua, and ARCOS in the United States and around the world—spanning sixty countries and five continents.

B. NEC's Accused Products

38. NEC's Accused Products include terminals, also known as dry plants because of their placement on dry land typically near the ocean. As shown in the annotated figures below, the terminals (green) connect terrestrial networks (orange) separated by great distances such as across the ocean and across the U.S. coastline.

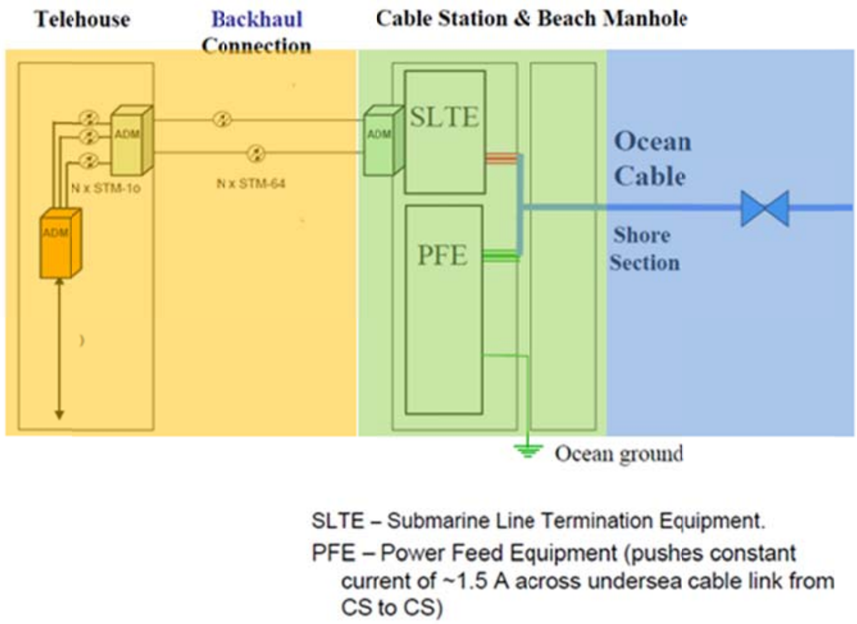




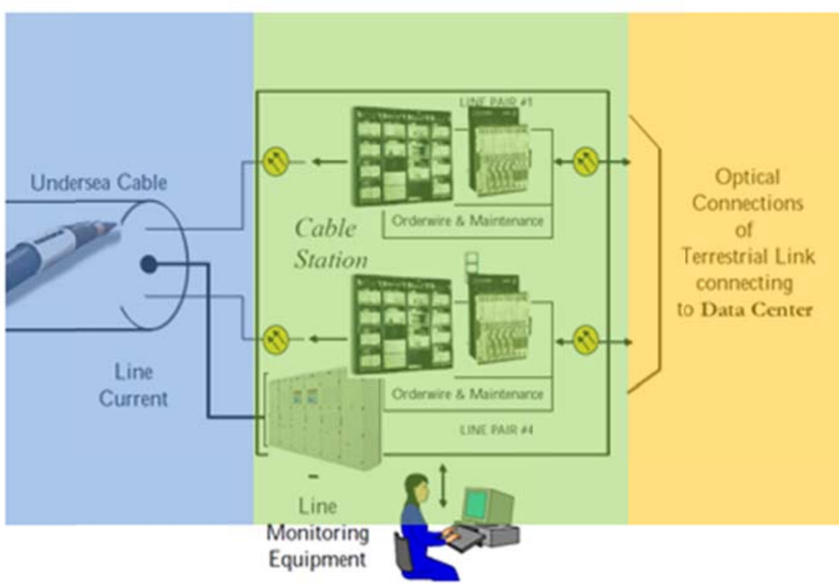
See, e.g., Adam Markow, *Summary of Undersea Fiber Optic Network Technology and* Systems, 3 (last accessed on Dec. 20, 2017), http://www.hmorell.com/sub_cable/documents/Basics%20of%20Submarine%20System%20Installation%20and%20Operation.pdf. A terminal is able to send and receive large amounts of data to other terminals. For example, when a terminal sends data, it combines terrestrial network data signals from various sources, *e.g.*, internet data from homes and businesses, into an optical data signal that is sent over a fiber optic cable to another terminal. Similarly, when a terminal receives an optical data signal sent from another terminal, it splits apart the optical data signal into constituent data signals that are then passed onto a terrestrial network and directed toward their destination. Terminals typically provide, among other things, a variety of functionalities that aid in signal processing, such as error correction, avoidance of cross talk, improvement or boosting of the strength of signals to avoid signal dissipation and other performance- related monitoring benefits.

39. The annotated figures below illustrate the relationship between a terminal and its corresponding terrestrial network and fiber optic cable. Specifically, the back end of the terminal

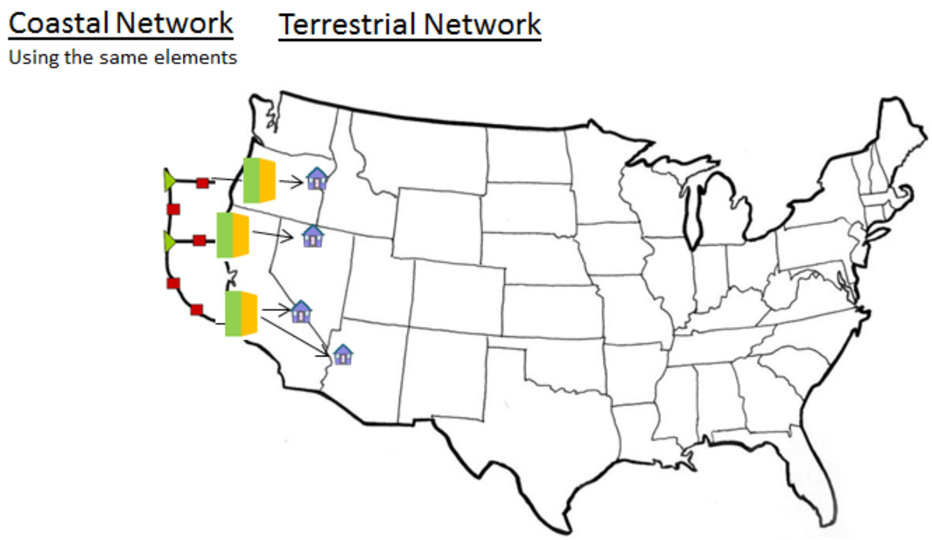
(green) is connected to a terrestrial network (orange) and the front end of the terminal (green) is connected to a fiber optic cable (blue) that connects the terminal to other terminals.



Id. at 5.



Id. at 7. In effect, terminals are used for connecting terrestrial networks that are typically separated by large bodies of water, such as the ocean, or large amounts of land as shown in the annotated figure below.



Id. at 3.

40. Given the vast distances between terminals, the optical data signal sent by one terminal attenuates or becomes weaker during transit to another terminal. High-powered lasers are often used to address this issue and strengthen the optical data signal so that it reaches its destination intact. A terminal monitors and adjusts the strength of an optical data signal as needed to ensure arrival at its intended location with sufficient strength. In systems covering vast distances, such as between Asia and North America or Northern and Southern California, "repeaters" at various points along the fiber-optic cable boost the optical data signal so that the signal reaches its destination terminal with sufficient strength to recover the data carried by the signal that is passed on to the terrestrial network. *See id.* (showing repeaters as red squares).

41. The Accused Products include terminals provided by NEC. NEC's Accused Products include a number of features for improving and optimizing the performance of subsea telecommunication systems. For example, relevant to this action, NEC's Accused Products are designed for coherent optical transmission, dense wavelength-division multiplexing ("DWDM"), control of wavelength channel spacing, and multiple modulation schemes. This allows the Accused Products to increase the capacity of the subsea telecommunication systems by fitting

more separate wavelength signals into a single optical signal transmitted between terminals. The Accused Products also provide automatic wavelength dispersion compensation, which, among other things, allows the Accused Products to transmit optical signals over increased distances. NEC's Accused Products also implement forward error correction, which can improve the performance and reliability of their subsea telecommunication systems. All of these features greatly improve the capacity and technical capabilities of subsea telecommunication systems, thus enhancing data distribution over telecommunication networks in the United States and throughout the world.

COUNT ONE – INFRINGEMENT OF THE '068 PATENT

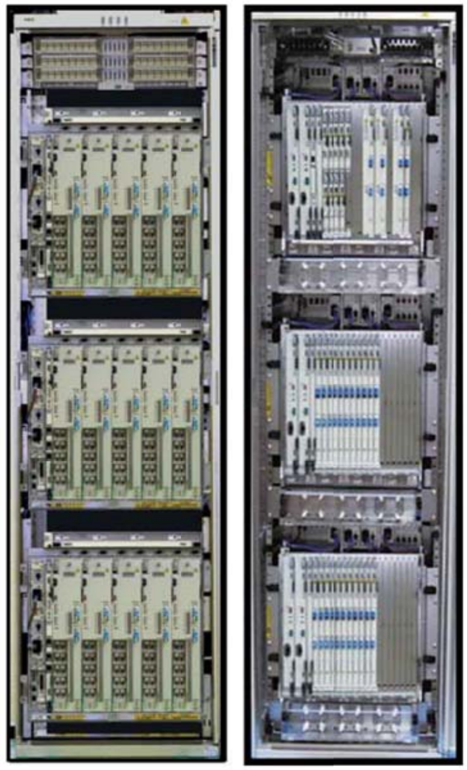
42. Xtera incorporates by reference its allegations in Paragraphs 1-41 as if fully restated in this paragraph.

43. On information and belief, NEC has been and is now directly and/or indirectly infringing, literally and/or under the doctrine of equivalents, the '068 patent by making, using, selling, and/or offering for sale in the United States, and/or importing into the United States, the Accused Products.

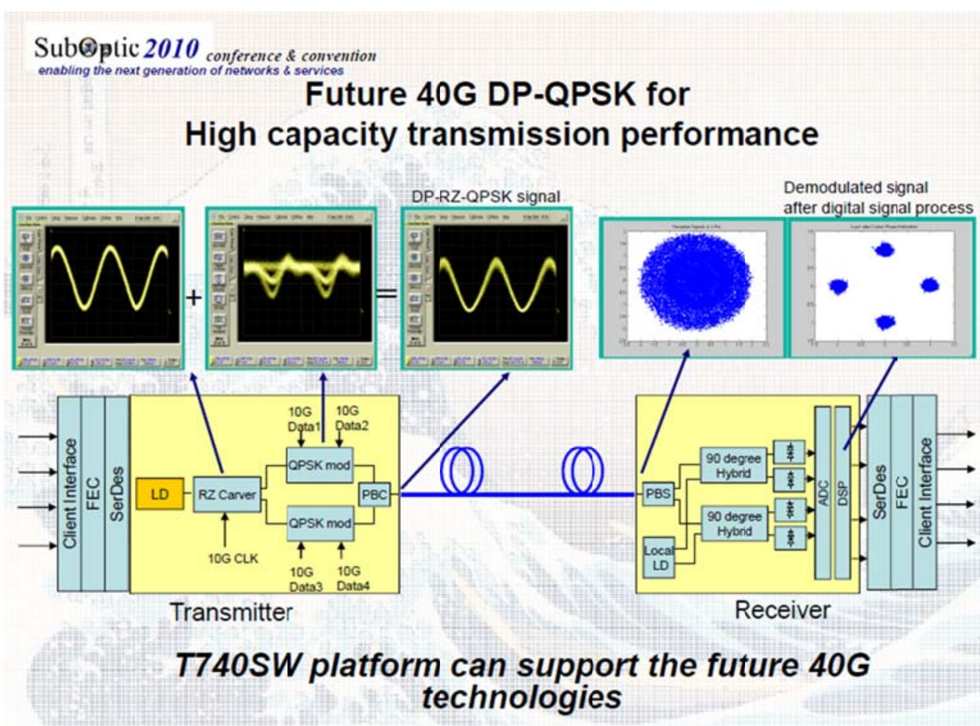
44. The '068 patent is generally directed to addressing the technical challenges of transmitting optical signals on separate channels over long distances. Claim 1 of the '068 patent recites an optical assembly comprising: an input optical port for receiving a mixed optical signal containing a combination of coherent optical wavelength channels and non-coherent optical wavelength channels; an optical demultiplexer configured to separate the combination of optical wavelength channels present on the input optical port such that a plurality of coherent optical wavelength channels and no non-coherent optical wavelength channels are provided onto a coherent optical path, and such that a plurality of non-coherent optical wavelength channels and

no coherent optical wavelength channels are provided onto a non-coherent optical path; a dispersive element disposed in one or both of the coherent and non-coherent optical paths and that operates such that a different amount of dispersion is applied to the plurality of non-coherent optical wavelength channels traveling through the non-coherent optical path than the amount of dispersion, if any, that is applied to the coherent optical path; and an optical multiplexer configured to receive and combine the optical wavelength channels from the coherent and non-coherent optical paths to form a mixed coherent and non-coherent optical output signal on an output of the optical multiplexer.

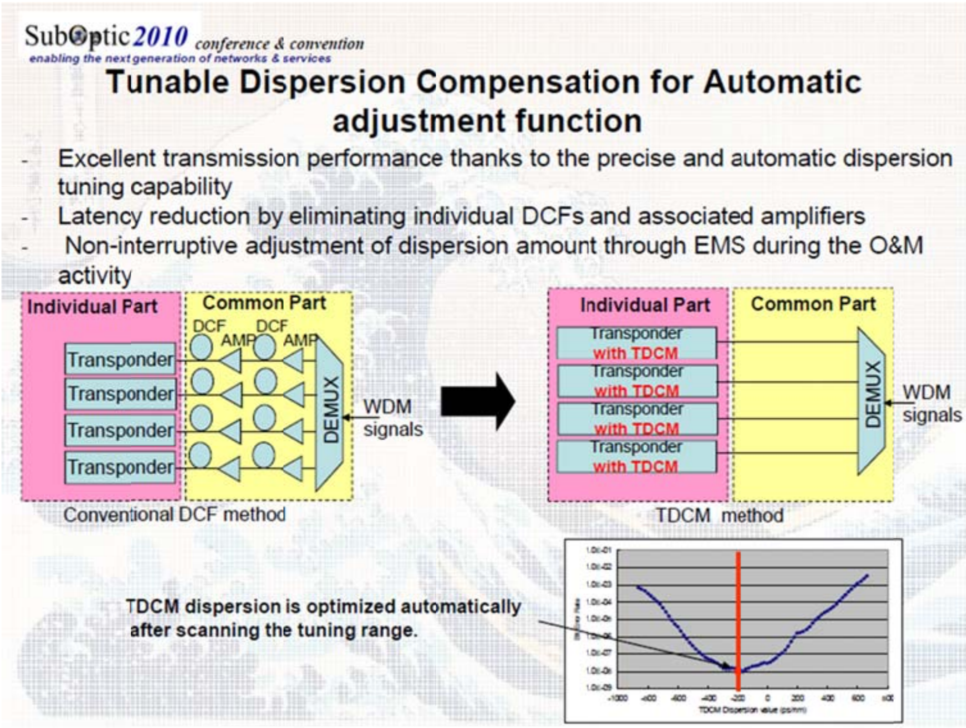
45. Upon information and belief, NEC's Accused Products infringe at least claim 1 of the '068 patent. For example, NEC's Accused Products provide an input optical port for receiving a mixed optical signal containing a combination of coherent optical wavelength channels and non-coherent optical wavelength channels; an optical demultiplexer configured to separate the combination of optical wavelength channels present on the input optical port such that a plurality of coherent optical wavelength channels and no non-coherent optical wavelength channels are provided onto a coherent optical path, and such that a plurality of non-coherent optical wavelength channels and no coherent optical wavelength channels are provided onto a non-coherent optical path; a dispersive element disposed in one or both of the coherent and non-coherent optical paths and that operates such that a different amount of dispersion is applied to the plurality of non-coherent optical wavelength channels traveling through the non-coherent optical path than the amount of dispersion, if any, that is applied to the coherent optical path; and an optical multiplexer configured to receive and combine the optical wavelength channels from the coherent and non-coherent optical paths to form a mixed coherent and non-coherent optical output signal on an output of the optical multiplexer as shown, for example, below.



See NEC Corp., Telecommunications Cable Solutions Submarine Systems at (2014), *available at* http://www.nec.com/en/global/prod/nw/submarine/pdf/submarine-brochure.pdf.



See, e.g., Nakada, NEC Corp., Fully Flexible and Automated Submarine Line Terminating Equipment for Advanced DWDM Systems, SubOptic Conf., May 11, 2010, *available at* http://suboptic.org/wp-content/uploads/2014/10/Presentation-241-Nakada-v1_SubOptic-2010-Oral-Presentation_LTE_20100511-2.pdf.



Id.

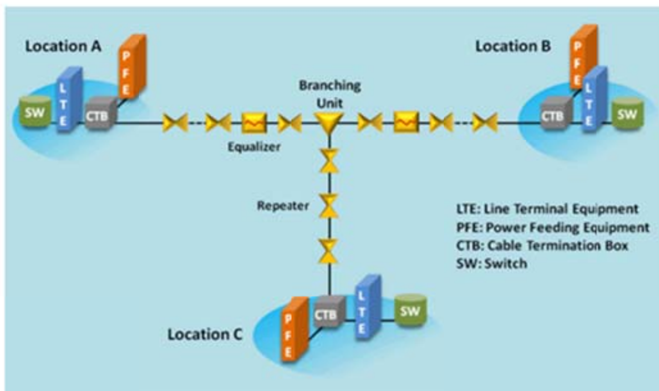
NS Series — Submarine Repeatered Systems

Contact

Key benefits

- DWDM technology enables transmission up to 100Gbps x 100 wavelengths with 10Tbps total capacity per fiber pair
- Up to 80Tbps capacity is achieved over a cable of 8 fiber pairs
- Transmission distances in excess of 12,000km for trans-oceanic networks
- Extremely reliable submarine network over 25 years life
- Highly agile and flexible solution for growing capacity demands

Example solution



See, e.g., NEC product literature at *http://www.nec.com/en/global/prod/nw/submarine/product/ns-series.html* (last visited November 14, 2017).

NS Series Lineup

Line Terminal Equipment T740SW

To meet the needs of transporting high-capacity DWDM signals over transoceanic distances, specialized Line Terminal Equipment is required. This equipment provides the function of translation between the terrestrial network and the undersea network.

Key features

- Highly Dense WDM Multiplexing and Demultiplexing
- Transmission capacity of up to 10Tbps (100 wavelengths @ 100Gbps) or 7.04Tbps (176 wavelengths @ 40Gbps) per fiber pair
- Up to 80Tbps (10Tbps x 8 fiber pairs) of cross-sectional capacity
- Various channel spacing designs (25GHz/33GHz/50GHz)
- Various and flexible tributary interfaces:
  - 100GbE, OTU4 (software switchable)
  - STM-256, OC-768, OTU3 (software switchable)
  - STM-64, OC-192, OTU2/2e, 10GbE LAN-PHY/WAN PHY (software switchable)
  - STM-16, OC-48
- Advanced soft decision forward error correction function
- Digital Coherent transponders provide automatic dispersion compensation and polarization demultiplexing
- Multiple modulation schemes available to optimize system capacity
- Simplified maintenance by plug and play scheme
- Extremely small footprint: up to 15 x 100G, 16 x 40G or 32 x 10G transponders per rack
- 100G, 40G and 10G transponders can be mixed in the same rack to optimize floor space and use of optical spectrum
- In-service upgrade without traffic interruption

Id.

Newly Built Systems since 2001

Project	System Length	Total/Partial	In Service
APCN2	19,000 km	Total	2001
AJC	12,000 km	Total	2001
EAC2	7,800 km	Total	2002
Algiers-Palma Cable	310 km	Partial	2002
HMC	280 km	Total	2002
TIS	1,100 km	Total	2003
AUFS-West	2,500 km	Total	2004
DMCS	150 km	Total	2004
JASUKA	1,800 km	Total	2006
BLCS	320 km	Total	2006
EAC1 Qingdao Extension	350 km	Total	2006
DSCN	1,100 km	Total	2007
Russia-Japan Cable Network	1,800 km	Total	2008
Trans-Pacific Express	17,200 km	Partial	2008
Hokkaido Sakhalin Cable System	560 km	Total	2007
Batam Singapore Cable System (BSCS)	98 km	Total	2009
Jakabare	1,400 km	Total	2009
Asia America Gateway	20,000 km	Partial	2009
Unity	9,500 km	Partial	2010
I-ME-WE	12,000 km	Partial	2011
Dhiraagu Domestic Submarine Cable (DDSCN)	1,000 km	Total	2012
Asia Submarine-cable Express (ASE)	7,200 km	Partial	2013
South-East Asia Japan Cable System (SJC)	8,900 km	Partial	2013
Sulawesi Maluku Papua Cable System (SMPCS) Packet-2	3,500 km	Total	2015
FASTER Cable System	11,500 km	Total	2016
Asia Pacific Gateway (APG)	10,400 km	Total	Ongoing
TPKM3	500 km	Total	Ongoing
SEA-ME-WE 5 Cable System (SMW5)	20,000 km	Partial	Ongoing
SOUTHEAST ASIA UNITED STATES Cable System (SEA-US)	14,500 km	Total	Ongoing
Asia Africa Europe 1 (AAE-1) S-1H Hong Kong Extension	2,900 km	Total	Ongoing
South Atlantic Cable System (SACS)	6,200 km	Total	Ongoing
System Kabel Rakyat 1 Malaysia (SKR1M)	3,700 km	Total	Ongoing
ATISA	279 km	Total	Ongoing
Indonesia Global Gateway (IGG)	5,300 km	Total	Ongoing

Newly Built Ocean Bottom Sensor Systems

Project	System	Total/Partial	In Service
DONET II (JAMSTEC)	Node System	Total	Ongoing
Japan Trench OBSS (NIED)	In-line System	Total	Ongoing
Eastern Taiwan OBSS (CWB, Taiwan)	Node System	Total	2011
DONET (JAMSTEC)	Node System	Total	2010
Omaezaki OBSS (JMA)	In-line System	Total	2008
(Before 2001)			
Kushiro OBSS (JAMSTEC)	In-line System	Total	1999
Muroto OBSS (JAMSTEC)	In-line System	Total	1997
Hiratsuka OBSS (NIED)	In-line System	Total	1996
Kamaishi OBSS (NIED)	In-line System	Total	1996
Ito OBSS (ERI-University of Tokyo)	In-line System	Total	1993
Katsuura OBSS (JMA)	In-line System	Total	1986
Omaezaki OBSS (JMA)	In-line System	Total	1979

Capacity Upgrades since 2001

Project	In Service	Project	In Service	Project	In Service
APCN2 Upgrade	2001	JASUKA 2008 Upgrade	2009	DMCS Upgrade	2013
FEA Upgrade	2003	SUB 2008 Upgrade	2009	AUFS Upgrade	2013
JIH Upgrade	2004	MDSCS Upgrade	2009	HMC Upgrade	2013
HMC Upgrade	2004	AUFS Upgrade	2009	JIH Upgrade	2013
JIH Upgrade	2005	JIH Upgrade	2009	APCN2 Stage 2e Upgrade	2013
AUFS-East Upgrade	2005	PamAm Upgrade#1	2010	JSSC#1	2013
MDSCS Upgrade	2005	AUFS Upgrade	2010	JAKABARE Upgrade#1	2013
HMC Upgrade	2005	JASUKA 2009 Upgrade (PO#1)	2010	JASUKA 2012 Upgrade (PO#1)	2013
TJP-PTK Upgrade	2006	JASUKA 2009 Upgrade (PO#3)	2010	EAC Pacific 2nd Upgrade 2013	2013
EAC1 Qingdao Upgrade	2006	JASUKA 2009 Upgrade (PO#5)	2010	APCN2 Stage 2f Upgrade	2014
Maya-1 Upgrade#2	2006	AJC 30G Upgrade	2010	SJC Upgrade#1	2014
EAC2 Upgrade	2006	JIH Upgrade	2010	AUFS-East/West Upgrade	2014
APCN2 Upgrade	2006	HMC Upgrade	2010	JASUKA 2012 Upgrade (PO#2)	2014
JIH Upgrade	2006	EAC1 & EAC2 Upgrade	2011	SUB Upgrade (PO#1 and PO#2)	2014
APCN2 Upgrade	2007	APCN2 Stage1e/2b Upgrade	2011	JASUKA 2012 Upgrade (PO#3 and PO#4)	2014
JASUKA 2007 Upgrade	2007	MOC Upgrade	2011	JASUKA 2012 Upgrade (PO#5)	2014
SUB Upgrade	2007	APCN2 Stage 2c Upgrade	2011	APCN2 Stage 2g Upgrade	2014
JIH Upgrade	2007	JIH Upgrade	2011	SUB Upgrade (PO#3)	2015
HMC Upgrade	2007	EAC PACIFIC Upgrade	2011	PanAm Upgrade#2	2015
APCN2 Upgrade	2008	JASUKA 2009 Upgrade (PO#7)	2011	AUFS East and West 100Gbps Upgrade	2015
AJC Upgrade	2008	JIH Upgrade	2012	APCN2 Stage 2h Upgrade	2015
Azores Upgrade	2008	MOC Upgrade	2012	SUB Upgrade (PO#4)	2016
Maya-1 Upgrade#3	2008	APCN2 Stage 1g/2d Upgrade	2012	JSSC#2	Ongoing
AUFS-East Upgrade	2008	AUFS Upgrade	2012	JAKABARE Upgrade#2	Ongoing
AUFS-West Upgrade	2008	HMC Upgrade	2012		
JIH Upgrade	2008	Russia Japan Cable Network Upgrade	2012		

See, e.g., NEC's listing of its subsea systems at *http://www.nec.com/en/global/prod/nw/submarine/aboutus/record/index.html* (last visited November 14, 2017).

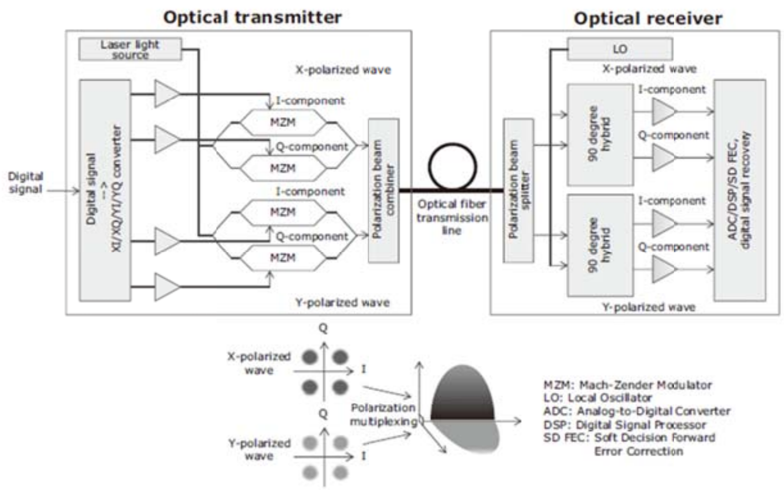


Fig. 2 Example of digital coherent optical transmission system configuration.

See, e.g., Junichiro, et al., NEC Corp., *Development of the Digital Coherent Optical Transmission Technology*, NEC Tech. J., Vol. 10 No. 3 (2015) at 68.

3.2 Digital coherent detection

The digital coherent detection technology is the breakthrough technology in the next generation submarine cable systems with ultra-high speed signal such as 40Gb/s and 100Gb/s or more. It is adapted to the line side receiver of the transponder, and performs the polarization demultiplexing, the chromatic dispersion compensation, the polarization mode dispersion compensation and the frequency/phase tracking between the incoming signal and the local oscillator light in the coherent detection. These features provide the full compensation capability of linear distortion in the transmission line. They also provide the high receiver sensitivity, which overcomes the OSNR degradation in the transmission line.

See, e.g., Koga, et al., Submarine Network Division, NEC Corp., *High Performance and High Flexibility Submarine Line Terminating Equipment for New Build and Capacity Upgrade Applications*, SubOptic Conf., April 24, 2013, *available at* http://suboptic.org/?dl_id=213.

5.4. CHROMATIC DISPERSION COMPENSATION FUNCTION

The compensation of chromatic dispersion accumulated in the transmission line is an essential function in the SLTE. The SLTE provides two kinds of chromatic dispersion (CD) compensation function. One is based on the dispersion compensation fiber with fixed CD value, and is adopted for all the WDM signals and/or the sub-band WDM signals to roughly cancel the accumulated CD. The other is the tuneable chromatic dispersion compensation function accommodated in each transponder, and is adopted for each optical wavelength to make a precise compensation. The CD value of tunable chromatic dispersion compensation module can be automatically adjusted to achieve the optimum transmission performance per wavelength. The adjustment work in the installation can be greatly reduced thanks to the automated feature.

See, e.g., Nakada et al., Submarine Network Division, NEC Corp.¸ *Fully Flexible and Automated Submarine Line Terminating Equipment for Advanced DWDM Systems*, SubOptic Conf., May 12, 2010, *available at* http://suboptic.org/?dl_id=281.

Table 1: SLTE Specification

Item		Specification
Submarine Interface		
	Maximum Wavelength	180
	Channel Spacing	25GHz/33.3GHz/50GHz/100 GHz Grid
	Wavelength	1530-1566nm(Tunable)
	Stability	better or equal to +/-0.02nm
	Transmission Speed	12.4Gb/s(10G) 43Gb/s(40G)
	Modulation	RZ/NRZ/RZ-DPSK(10G) RZ-DQPSK(40G)
Terrestrial interface		STM64/OC-192 STM16/OC-48 10GBASE-R 10GBASE-W STM256/OC-768
Supply voltage		-57.0V to -40.5V
Environmental condition		Temperature 5 to 40degreeC Humidity 5% to 85%
Cooling system		Forced convection air-cooling system with FAN in the shelf
Dimensions		2200mm(H) x 600mm(W) x 300mm(D)
Automatic adjustment function		Dispersion compensation Pre-emphasis control Dummy light power control
Redundancy		N:1 Wavelength redundancy (N=max 32)

See, e.g., Nakada et al., Submarine Network Division, NEC Corp., *Fully Flexible and Automated Submarine Line Terminating Equipment for Advanced DWDM Systems*, SubOptic Conf., May 12, 2010.

46. NEC has had knowledge of the ’068 patent at least since the filing this Complaint.

47. NEC also has been and is now actively inducing infringement of one or more claims of the ’068 patent, either literally or under the doctrine of equivalents.

48. On information and belief, NEC JP alone and/or acting in concert with, directing and/or authorizing NEC US to make, use, sell or offer for sale in the United States or import into the United States the Accused Products, possesses an affirmative intent to actively induce infringement by others.

49. On information and belief, NEC US alone and/or acting in concert with, directing and/or authorizing NEC JP to make, use, sell or offer for sale in the United States the Accused Products, possesses an affirmative intent to actively induce infringement by others, including purchasers and end users who deploy and make use of the Accused Products.

50. NEC has intended, and continues to intend to induce infringement of the ’068 patent by others and has knowledge, with specific intent, that the inducing acts would cause infringement or has been willfully blind to the possibility that its inducing acts would cause the infringing acts. For example, NEC knowingly and actively induces infringement of the ’068 patent by encouraging, instructing, and aiding end users to use one or more of the Accused Products and/or by selling the Accused Products to others. NEC induces such infringement by, at a minimum, providing manuals, white papers, training, and/or other technical support with specific intent to induce purchasers and end users of the Accused Products to perform acts intended by NEC to cause direct infringement of the ’068 patent in the United States.

51. NEC also has been and is now contributing to the infringement of one or more claims of the ’068 patent, either literally or under the doctrine of equivalents.

52. On information and belief, NEC has actively, knowingly, and intentionally contributed and continues to actively, knowingly, and intentionally contribute to the infringement of the ’068 patent by having sold or offered to sell and continuing to sell or offer for sale the Accused Products within in the United States and/or by importing the Accused Products into the United States, with knowledge that the infringing technology in the Accused Products is especially made and/or especially adapted for use in infringement of the ’068 patent. NEC has contributed to the infringement by others with knowledge that the infringing technology in the Accused Products is a material part of the patented invention, and with

knowledge that the infringing technology in the Accused Products is not a staple article of commerce suitable for substantial non-infringing use, and with knowledge that others including, but not limited to, resellers, distributors, customers, and/or other end users of the Accused Products, infringe and will continue to infringe the ’068 patent because, due to their specific designs, the Accused Products and components thereof do not have any substantial noninfringing uses. NEC has such knowledge at least because the claimed features of the ’068 patent are used by others including, but not limited to, resellers, distributors, customers, and/or other end users of the Accused Products.

53. On information and belief, NEC knew or should have known of the ’068 patent and has acted, and continues to act, in an egregious and wanton manner by infringing the ’068 patent. On information and belief, NEC's infringement of the ’068 patent has been and continues to be willful and deliberate. The market for subsea telecommunication systems is small and contains a limited number of competitors, with Xtera being a known pioneer with whom NEC has great familiarity. Upon information and belief, NEC used the technology in the ’068 patent to develop and its Accused Products without permission from Xtera.

54. On information and belief, despite knowing that its actions constituted infringement of the ’068 patent and/or despite knowing that that there was a high likelihood that its actions constituted infringement of the patent, NEC nevertheless continued its infringing actions, and continues to make, use and sell its Accused Products.

55. NEC's acts of infringement have injured and damaged Xtera. NEC's wrongful conduct has caused Xtera to suffer irreparable harm resulting from the loss of its lawful patent rights to exclude others from making, using, selling, offering to sell and importing the patented

inventions. Upon information and belief, NEC will continue these infringing acts unless enjoined by this Court.

COUNT TWO – INFRINGEMENT OF THE ’403 PATENT

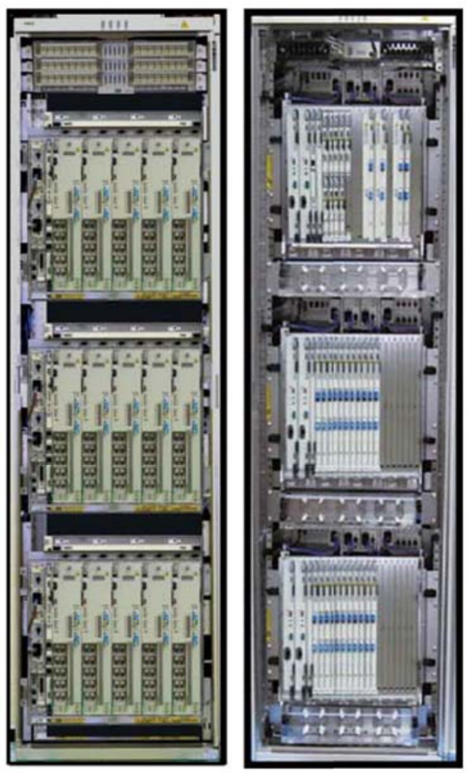
56. Xtera incorporates by reference its allegations in Paragraphs 1-55 as if fully restated in this paragraph.

57. On information and belief, NEC has been and is now directly and/or indirectly infringing, literally and/or under the doctrine of equivalents, the ’403 patent by making, using, selling, and/or offering for sale in the United States, and/or importing into the United States, the Accused Products.

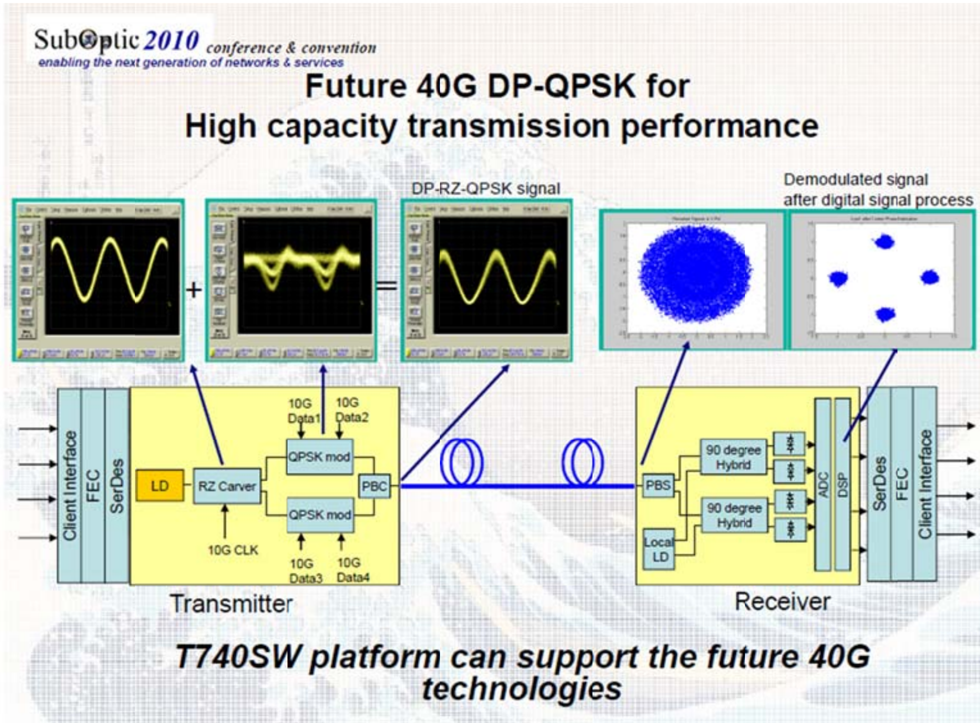
58. The ’403 patent is generally directed to optically encoding data for transmission over a wavelength division multiplexed optical communication system. Claim 1 of the ’403 patent recites a method of optically encoding data for transmission over a wavelength division multiplexed optical communications system comprising the steps of: generating a periodic series of optical pulses defining a series of time slots, wherein one pulse appears in each time slot; filtering the pulses by way of a filter to produce carrier pulses extending over more than one time slot; and modulating the pulses with data for transmission; wherein for each of at least some of the carrier pulses, the filter gives rise to the corresponding carrier pulse having a temporal profile with a minimum substantially in the center of each of the time slots adjacent to the time slot for that corresponding carrier pulse, the temporal profile of the corresponding carrier pulse further having an oscillating tail that extends from the minimum into at least one time slot that is even further from the time slot for the corresponding carrier pulse.

59. Upon information and belief, NEC’s Accused Products infringe at least claim 1 of the ’403 patent. For example, NEC’s Accused Products generate a periodic series of optical

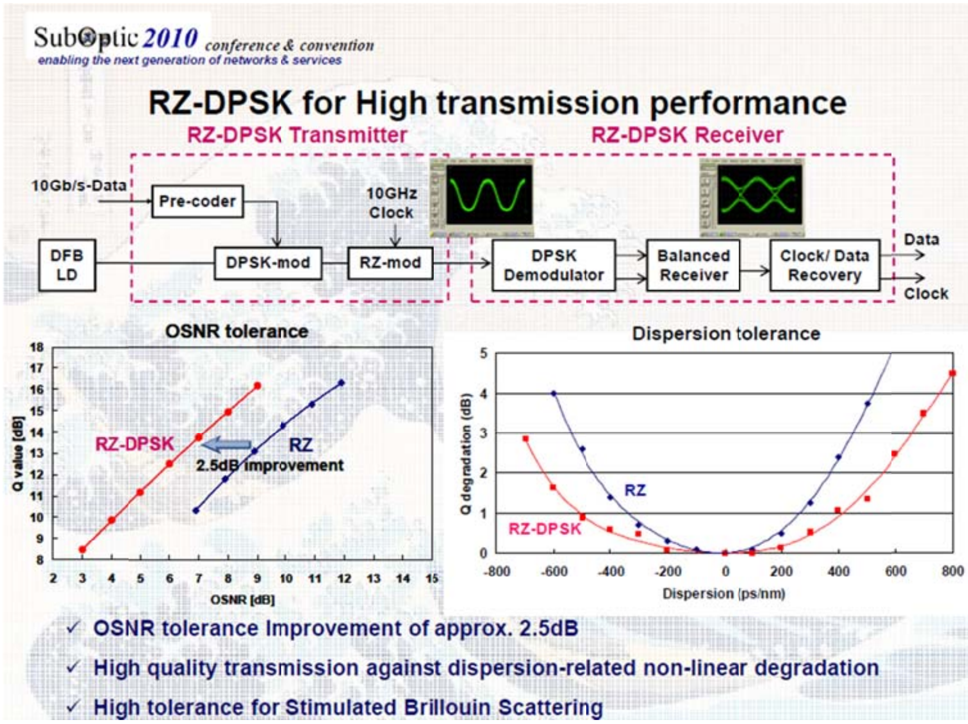
pulses defining a series of time slots, wherein one pulse appears in each time slot; filter the pulses by way of a filter to produce carrier pulses extending over more than one time slot; and modulate the pulses with data for transmission; wherein for each of at least some of the carrier pulses, the filter gives rise to the corresponding carrier pulse having a temporal profile with a minimum substantially in the center of each of the time slots adjacent to the time slot for that corresponding carrier pulse, the temporal profile of the corresponding carrier pulse further having an oscillating tail that extends from the minimum into at least one time slot that is even further from the time slot for the corresponding carrier pulse as shown, for example, below.



See NEC Corp., Telecommunications Cable Solutions Submarine Systems at (2014), *available at* http://www.nec.com/en/global/prod/nw/submarine/pdf/submarine-brochure.pdf.



See, e.g., Nakada, NEC Corp., Fully Flexible and Automated Submarine Line Terminating Equipment for Advanced DWDM Systems, SubOptic Conf., May 11, 2010, *available at* http://suboptic.org/wp-content/uploads/2014/10/Presentation-241-Nakada-v1_SubOptic-2010-Oral-Presentation_LTE_20100511-2.pdf.



SubOptic 2010 conference & convention
enabling the next generation of networks & services
RZ-DPSK for High transmission performance
RZ-DPSK Transmitter
RZ-DPSK Receiver
10Gb/s-Data
Pre-coder
10GHz Clock
DFB LD
DPSK-mod
RZ-mod
DPSK Demodulator
Balanced Receiver
Clock/ Data Recovery
Data
Clock
OSNR tolerance
Q value [dB]
OSNR [dB]
RZ-DPSK
RZ
2.5dB improvement
Dispersion tolerance
Q degradation (dB)
Dispersion (ps/nm)
RZ
RZ-DPSK
✓ OSNR tolerance Improvement of approx. 2.5dB
✓ High quality transmission against dispersion-related non-linear degradation
✓ High tolerance for Stimulated Brillouin Scattering

Id.

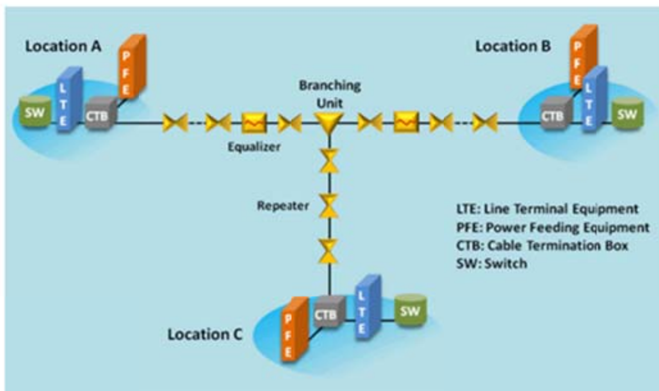
NS Series — Submarine Repeatered Systems

Contact

Key benefits

- DWDM technology enables transmission up to 100Gbps x 100 wavelengths with 10Tbps total capacity per fiber pair
- Up to 80Tbps capacity is achieved over a cable of 8 fiber pairs
- Transmission distances in excess of 12,000km for trans-oceanic networks
- Extremely reliable submarine network over 25 years life
- Highly agile and flexible solution for growing capacity demands

Example solution



See, e.g., NEC product literature at *http://www.nec.com/en/global/prod/nw/submarine/product/ns-series.html* (last visited November 14, 2017).

NS Series Lineup

Line Terminal Equipment T740SW

To meet the needs of transporting high-capacity DWDM signals over transoceanic distances, specialized Line Terminal Equipment is required. This equipment provides the function of translation between the terrestrial network and the undersea network.

Key features

- Highly Dense WDM Multiplexing and Demultiplexing
- Transmission capacity of up to 10Tbps (100 wavelengths @ 100Gbps) or 7.04Tbps (176 wavelengths @ 40Gbps) per fiber pair
- Up to 80Tbps (10Tbps x 8 fiber pairs) of cross-sectional capacity
- Various channel spacing designs (25GHz/33GHz/50GHz)
- Various and flexible tributary interfaces:
  - 100GbE, OTU4 (software switchable)
  - STM-256, OC-768, OTU3 (software switchable)
  - STM-64, OC-192, OTU2/2e, 10GbE LAN-PHY/WAN PHY (software switchable)
  - STM-16, OC-48
- Advanced soft decision forward error correction function
- Digital Coherent transponders provide automatic dispersion compensation and polarization demultiplexing
- Multiple modulation schemes available to optimize system capacity
- Simplified maintenance by plug and play scheme
- Extremely small footprint: up to 15 x 100G, 16 x 40G or 32 x 10G transponders per rack
- 100G, 40G and 10G transponders can be mixed in the same rack to optimize floor space and use of optical spectrum
- In-service upgrade without traffic interruption

Id.

Submarine Repeater R640SW

The NEC R640SW Submarine Repeater has been specially designed for fDWDM applications including 980nm pumped Erbium Doped Optical Amplifiers (EDFAs). This technology enables high power amplification for optimized repeater spacing, wide and flat amplification gain to allow for efficient channel packing density, and a lower noise figure which results in more capacity over longer distances with the highest reliability. Each standard repeater is designed to accommodate up to 8 amplifier systems.

Key features

- Specially designed for highly reliable DWDM applications
- Employs 980nm pumped ErbiumDoped Fiber Amplifiers
- Extremely reliable pumping with 4 pump laser diodes per amplifier pair
- Extremely reliable power circuits
- Wide and flat amplifier gain
- Low noise figure
- Accommodates up to 8 amplifier systems (fiber pairs)
- Ultra pressure-resistant housing for water depths up to 8,000m
- Compact size to facilitate deployment and shipboard handling

Id.

Newly Built Systems since 2001

Project	System Length	Total/Partial	In Service
APCN2	19,000 km	Total	2001
AJC	12,000 km	Total	2001
EAC2	7,800 km	Total	2002
Algiers-Palma Cable	310 km	Partial	2002
HMC	280 km	Total	2002
TIS	1,100 km	Total	2003
AUFS-West	2,500 km	Total	2004
DMCS	150 km	Total	2004
JASUKA	1,800 km	Total	2006
BLCS	320 km	Total	2006
EAC1 Qingdao Extension	350 km	Total	2006
DSCN	1,100 km	Total	2007
Russia-Japan Cable Network	1,800 km	Total	2008
Trans-Pacific Express	17,200 km	Partial	2008
Hokkaido Sakhalin Cable System	560 km	Total	2007
Batam Singapore Cable System (BSCS)	98 km	Total	2009
Jakabare	1,400 km	Total	2009
Asia America Gateway	20,000 km	Partial	2009
Unity	9,500 km	Partial	2010
I-ME-WE	12,000 km	Partial	2011
Dhiraagu Domestic Submarine Cable (DDSCN)	1,000 km	Total	2012
Asia Submarine-cable Express (ASE)	7,200 km	Partial	2013
South-East Asia Japan Cable System (SJC)	8,900 km	Partial	2013
Sulawesi Maluku Papua Cable System (SMPCS) Packet-2	3,500 km	Total	2015
FASTER Cable System	11,500 km	Total	2016
Asia Pacific Gateway (APG)	10,400 km	Total	Ongoing
TPKM3	500 km	Total	Ongoing
SEA-ME-WE 5 Cable System (SMW5)	20,000 km	Partial	Ongoing
SOUTHEAST ASIA UNITED STATES Cable System (SEA-US)	14,500 km	Total	Ongoing
Asia Africa Europe 1 (AAE-1) S-1H Hong Kong Extension	2,900 km	Total	Ongoing
South Atlantic Cable System (SACS)	6,200 km	Total	Ongoing
System Kabel Rakyat 1 Malaysia (SKR1M)	3,700 km	Total	Ongoing
ATISA	279 km	Total	Ongoing
Indonesia Global Gateway (IGG)	5,300 km	Total	Ongoing

Newly Built Ocean Bottom Sensor Systems

Project	System	Total/Partial	In Service
DONET II (JAMSTEC)	Node System	Total	Ongoing
Japan Trench OBSS (NIED)	In-line System	Total	Ongoing
Eastern Taiwan OBSS (CWB, Taiwan)	Node System	Total	2011
DONET (JAMSTEC)	Node System	Total	2010
Omaezaki OBSS (JMA)	In-line System	Total	2008
(Before 2001)			
Kushiro OBSS (JAMSTEC)	In-line System	Total	1999
Muroto OBSS (JAMSTEC)	In-line System	Total	1997
Hiratsuka OBSS (NIED)	In-line System	Total	1996
Kamaishi OBSS (NIED)	In-line System	Total	1996
Ito OBSS (ERI-University of Tokyo)	In-line System	Total	1993
Katsuura OBSS (JMA)	In-line System	Total	1986
Omaezaki OBSS (JMA)	In-line System	Total	1979

Capacity Upgrades since 2001

Project	In Service	Project	In Service	Project	In Service
APCN2 Upgrade	2001	JASUKA 2008 Upgrade	2009	DMCS Upgrade	2013
FEA Upgrade	2003	SUB 2008 Upgrade	2009	AUFS Upgrade	2013
JIH Upgrade	2004	MDSCS Upgrade	2009	HMC Upgrade	2013
HMC Upgrade	2004	AUFS Upgrade	2009	JIH Upgrade	2013
JIH Upgrade	2005	JIH Upgrade	2009	APCN2 Stage 2e Upgrade	2013
AUFS-East Upgrade	2005	PamAm Upgrade#1	2010	JSSC#1	2013
MDSCS Upgrade	2005	AUFS Upgrade	2010	JAKABARE Upgrade#1	2013
HMC Upgrade	2005	JASUKA 2009 Upgrade (PO#1)	2010	JASUKA 2012 Upgrade (PO#1)	2013
TJP-PTK Upgrade	2006	JASUKA 2009 Upgrade (PO#3)	2010	EAC Pacific 2nd Upgrade 2013	2013
EAC1 Qingdao Upgrade	2006	JASUKA 2009 Upgrade (PO#5)	2010	APCN2 Stage 2f Upgrade	2014
Maya-1 Upgrade#2	2006	AJC 30G Upgrade	2010	SJC Upgrade#1	2014
EAC2 Upgrade	2006	JIH Upgrade	2010	AUFS-East/West Upgrade	2014
APCN2 Upgrade	2006	HMC Upgrade	2010	JASUKA 2012 Upgrade (PO#2)	2014
JIH Upgrade	2006	EAC1 & EAC2 Upgrade	2011	SUB Upgrade (PO#1 and PO#2)	2014
APCN2 Upgrade	2007	APCN2 Stage1e/2b Upgrade	2011	JASUKA 2012 Upgrade (PO#3 and PO#4)	2014
JASUKA 2007 Upgrade	2007	MOC Upgrade	2011	JASUKA 2012 Upgrade (PO#5)	2014
SUB Upgrade	2007	APCN2 Stage 2c Upgrade	2011	APCN2 Stage 2g Upgrade	2014
JIH Upgrade	2007	JIH Upgrade	2011	SUB Upgrade (PO#3)	2015
HMC Upgrade	2007	EAC PACIFIC Upgrade	2011	PanAm Upgrade#2	2015
APCN2 Upgrade	2008	JASUKA 2009 Upgrade (PO#7)	2011	AUFS East and West 100Gbps Upgrade	2015
AJC Upgrade	2008	JIH Upgrade	2012	APCN2 Stage 2h Upgrade	2015
Azores Upgrade	2008	MOC Upgrade	2012	SUB Upgrade (PO#4)	2016
Maya-1 Upgrade#3	2008	APCN2 Stage 1g/2d Upgrade	2012	JSSC#2	Ongoing
AUFS-East Upgrade	2008	AUFS Upgrade	2012	JAKABARE Upgrade#2	Ongoing
AUFS-West Upgrade	2008	HMC Upgrade	2012		
JIH Upgrade	2008	Russia Japan Cable Network Upgrade	2012		

See, e.g., NEC's listing of its subsea systems at *http://www.nec.com/en/global/prod/nw/submarine/aboutus/record/index.html* (last visited November 14, 2017).

Table 2 The SLTM Performance

Items	Performance
Terrestrial Interface	ITU-T STM-64 I64.2, S64.2b SONET OC-192 SR-2, IR-2 9.95328Gbit/s NRZ, Optical
Submarine system Interface	DWDM system applicable 12.4Gbit/s RZ, Optical
Power Supply	DC -40.5 to -57V
Power Consumption	Typical 130W
Dimensions	H450xW150xD330mm
Weight	18kg

See, e.g., Hara et al., *All-In One Box Type Submarine Line Terminal Equipment With Plug-And-Play And Advanced FEC Functions For 10GB/S DWDM Systems*, NEC Tech. J., Vol. 5 No. 1 (2010) at 25.

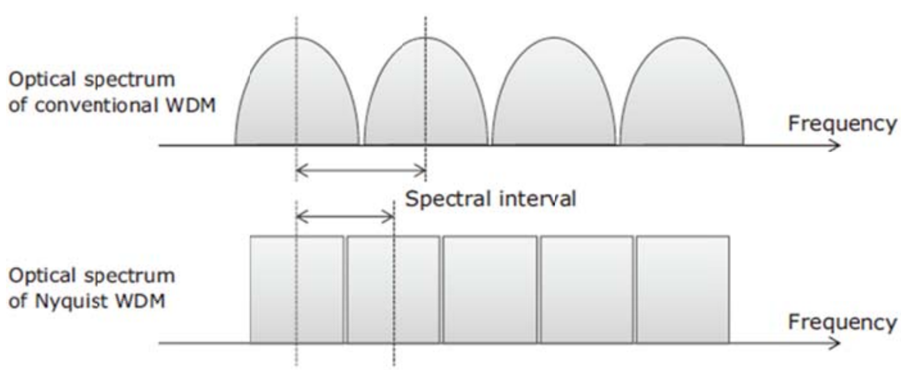


Fig. 3 Nyquist WDM.

See, e.g., Junichiro, et al., NEC Corp., *Development of the Digital Coherent Optical Transmission Technology*, NEC Tech. J., Vol. 10 No. 3 (2015) at 68.

described in Section 2. Four different tributaries generated from the pseudo-random bit sequence (PRBS) of length 2^{15}-1 were uploaded into a PatternPro® pulse pattern generator (PPG) (Model 12072) which has four independent channels operating at 32Gb/s. The delay of these

See, e.g., Zhang et al., *A novel Architecture of Flexible-Bit-Rate Transponder via Polarization Manipulation*, SubOptic Conf., 2013.

60. NEC has had knowledge of the ’403 patent at least since the filing this Complaint.

61. NEC also has been and is now actively inducing infringement of one or more claims of the ’403 patent, either literally or under the doctrine of equivalents.

62. On information and belief, NEC JP alone and/or acting in concert with, directing and/or authorizing NEC US to make, use, sell or offer for sale in the United States or import into the United States the Accused Products, possesses an affirmative intent to actively induce infringement by others.

63. On information and belief, NEC US alone and/or acting in concert with, directing and/or authorizing NEC JP to make, use, sell or offer for sale in the United States the Accused Products, possesses an affirmative intent to actively induce infringement by others, including purchasers and end users who deploy and make use of the Accused Products..

64. NEC has intended, and continues to intend to induce infringement of the ’403 patent by others and has knowledge, with specific intent, that the inducing acts would cause infringement or has been willfully blind to the possibility that its inducing acts would cause the infringing acts. For example, NEC knowingly and actively induces infringement of the ’403 patent by encouraging, instructing, and aiding end users to use one or more of the Accused Products and/or by selling the Accused Products to others. NEC induces such infringement by,

at a minimum, providing manuals, white papers, training, and/or other technical support with specific intent to induce purchasers and end users of the NEC's Accused Products to perform acts intended by NEC to cause direct infringement of the '403 patent in the United States.

65. NEC also has been and is now contributing to the infringement of one or more claims of the '403 patent, either literally or under the doctrine of equivalents.

66. On information and belief, NEC has actively, knowingly, and intentionally contributed and continues to actively, knowingly, and intentionally contribute to the infringement of the '403 patent by having sold or offered to sell and continuing to sell or offer for sale the Accused Products within in the United States and/or by importing the Accused Products into the United States, with knowledge that the infringing technology in the Accused Products is especially made and/or especially adapted for use in infringement of the '403 patent. NEC has contributed to the infringement by others with knowledge that the infringing technology in the Accused Products is a material part of the patented invention, and with knowledge that the infringing technology in the Accused Products is not a staple article of commerce suitable for substantial non-infringing use, and with knowledge that others including, but not limited to, resellers, distributors, customers, and/or other end users of the Accused Products, infringe and will continue to infringe the '403 patent because, due to their specific designs, the Accused Products and components thereof do not have any substantial noninfringing uses. NEC has such knowledge at least because the claimed features of the '403 patent are used by others including, but not limited to, resellers, distributors, customers, and/or other end users of the Accused Products.

67. On information and belief, NEC knew or should have known of the '403 patent and has acted, and continues to act, in an egregious and wanton manner by infringing the '403

patent. On information and belief, NEC's infringement of the '403 patent has been and continues to be willful and deliberate. The market for subsea telecommunication systems is small and contains a limited number of competitors, with Xtera being a known pioneer with whom NEC has great familiarity. Upon information and belief, NEC used the technology in the '403 patent to develop and its Accused Products without permission from Xtera.

68. On information and belief, despite knowing that its actions constituted infringement of the '403 patent and/or despite knowing that that there was a high likelihood that its actions constituted infringement of the patent, NEC nevertheless continued its infringing actions, and continues to make, use and sell its Accused Products.

69. NEC's acts of infringement have injured and damaged Xtera. NEC's wrongful conduct has caused Xtera to suffer irreparable harm resulting from the loss of its lawful patent rights to exclude others from making, using, selling, offering to sell and importing the patented inventions. Upon information and belief, NEC will continue these infringing acts unless enjoined by this Court.

COUNT THREE – INFRINGEMENT OF THE '171 PATENT

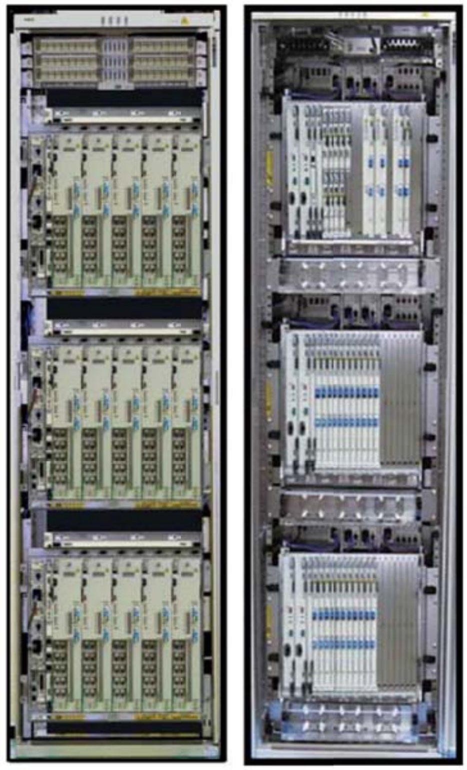
70. Xtera incorporates by reference its allegations in Paragraphs 1-69 as if fully restated in this paragraph.

71. On information and belief, NEC has been and is now directly and/or indirectly infringing, literally and/or under the doctrine of equivalents, the '171 patent by making, using, selling, and/or offering for sale in the United States, and/or importing into the United States, the Accused Products.

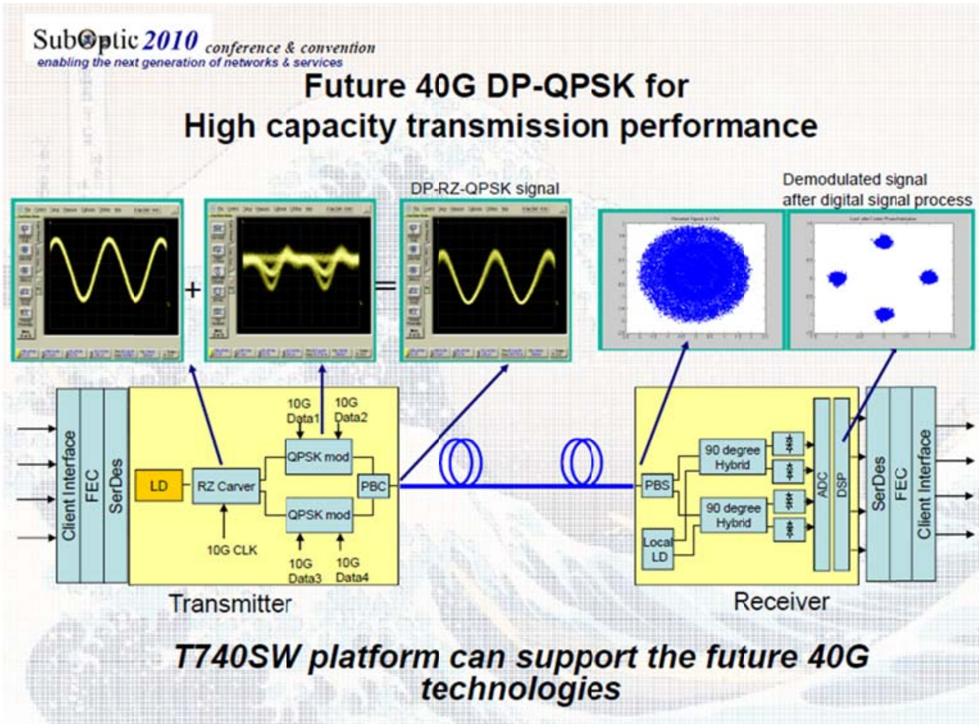
72. The '171 patent is generally directed to improving the transmission of optical signals over long distances by dividing an encoded sequence between two or more separate

channels. Claim 1 of the ’171 patent recites a transmission system for transmitting data in a form of a digital signal including an information sequence, the data being transmitted at a predetermined rate, the system comprising: a FEC encoder for transforming the information sequence into a FEC encoded sequence comprising the information sequence and coding overhead; a partitioner for partitioning the encoded sequence into a plurality of sequence portions, so that the encoded sequence is transmitted as a plurality of separate channels, wherein the partitioner partitions the encoded sequence between two channels such that one part of the encoded sequence is identical to the information sequence and the other part is equivalent to coding overhead; wherein the sequence portions are transmitted at a rate which is lower than, and not equal to, the predetermined rate.

73. Upon information and belief, NEC’s Accused Products infringe at least claim 1 of the ’171 patent. For example, NEC’s Accused Products provide a FEC encoder for transforming the information sequence into a FEC encoded sequence comprising the information sequence and coding overhead; a partitioner for partitioning the encoded sequence into a plurality of sequence portions, so that the encoded sequence is transmitted as a plurality of separate channels, wherein the partitioner partitions the encoded sequence between two channels such that one part of the encoded sequence is identical to the information sequence and the other part is equivalent to coding overhead; wherein the sequence portions are transmitted at a rate which is lower than, and not equal to, the predetermined rate as shown, for example, below.



See NEC Corp., Telecommunications Cable Solutions Submarine Systems at (2014), *available at* http://www.nec.com/en/global/prod/nw/submarine/pdf/submarine-brochure.pdf.



See, e.g., Nakada, NEC Corp., Fully Flexible and Automated Submarine Line Terminating Equipment for Advanced DWDM Systems, SubOptic Conf., May 11, 2010, *available at* http://suboptic.org/wp-content/uploads/2014/10/Presentation-241-Nakada-v1_SubOptic-2010-Oral-Presentation_LTE_20100511-2.pdf.

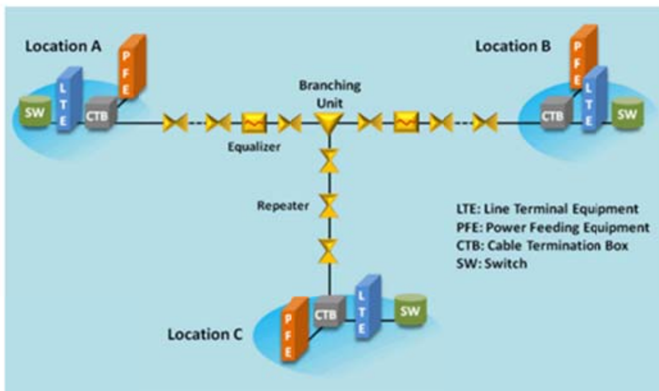
NS Series — Submarine Repeatered Systems

Contact

Key benefits

- DWDM technology enables transmission up to 100Gbps x 100 wavelengths with 10Tbps total capacity per fiber pair
- Up to 80Tbps capacity is achieved over a cable of 8 fiber pairs
- Transmission distances in excess of 12,000km for trans-oceanic networks
- Extremely reliable submarine network over 25 years life
- Highly agile and flexible solution for growing capacity demands

Example solution



See, e.g., NEC product literature at *http://www.nec.com/en/global/prod/nw/submarine/product/ns-series.html* (last visited November 14, 2017).

NS Series Lineup

Line Terminal Equipment T740SW

To meet the needs of transporting high-capacity DWDM signals over transoceanic distances, specialized Line Terminal Equipment is required. This equipment provides the function of translation between the terrestrial network and the undersea network.

Key features

- Highly Dense WDM Multiplexing and Demultiplexing
- Transmission capacity of up to 10Tbps (100 wavelengths @ 100Gbps) or 7.04Tbps (176 wavelengths @ 40Gbps) per fiber pair
- Up to 80Tbps (10Tbps x 8 fiber pairs) of cross-sectional capacity
- Various channel spacing designs (25GHz/33GHz/50GHz)
- Various and flexible tributary interfaces:
  - 100GbE, OTU4 (software switchable)
  - STM-256, OC-768, OTU3 (software switchable)
  - STM-64, OC-192, OTU2/2e, 10GbE LAN-PHY/WAN PHY (software switchable)
  - STM-16, OC-48
- Advanced soft decision forward error correction function
- Digital Coherent transponders provide automatic dispersion compensation and polarization demultiplexing
- Multiple modulation schemes available to optimize system capacity
- Simplified maintenance by plug and play scheme
- Extremely small footprint: up to 15 x 100G, 16 x 40G or 32 x 10G transponders per rack
- 100G, 40G and 10G transponders can be mixed in the same rack to optimize floor space and use of optical spectrum
- In-service upgrade without traffic interruption

Id.

Newly Built Systems since 2001

Project	System Length	Total/Partial	In Service
APCN2	19,000 km	Total	2001
AJC	12,000 km	Total	2001
EAC2	7,800 km	Total	2002
Algiers-Palma Cable	310 km	Partial	2002
HMC	280 km	Total	2002
TIS	1,100 km	Total	2003
AUFS-West	2,500 km	Total	2004
DMCS	150 km	Total	2004
JASUKA	1,800 km	Total	2006
BLCS	320 km	Total	2006
EAC1 Qingdao Extension	350 km	Total	2006
DSCN	1,100 km	Total	2007
Russia-Japan Cable Network	1,800 km	Total	2008
Trans-Pacific Express	17,200 km	Partial	2008
Hokkaido Sakhalin Cable System	560 km	Total	2007
Batam Singapore Cable System (BSCS)	98 km	Total	2009
Jakabare	1,400 km	Total	2009
Asia America Gateway	20,000 km	Partial	2009
Unity	9,500 km	Partial	2010
I-ME-WE	12,000 km	Partial	2011
Dhiraagu Domestic Submarine Cable (DDSCN)	1,000 km	Total	2012
Asia Submarine-cable Express (ASE)	7,200 km	Partial	2013
South-East Asia Japan Cable System (SJC)	8,900 km	Partial	2013
Sulawesi Maluku Papua Cable System (SMPCS) Packet-2	3,500 km	Total	2015
FASTER Cable System	11,500 km	Total	2016
Asia Pacific Gateway (APG)	10,400 km	Total	Ongoing
TPKM3	500 km	Total	Ongoing
SEA-ME-WE 5 Cable System (SMW5)	20,000 km	Partial	Ongoing
SOUTHEAST ASIA UNITED STATES Cable System (SEA-US)	14,500 km	Total	Ongoing
Asia Africa Europe 1 (AAE-1) S-1H Hong Kong Extension	2,900 km	Total	Ongoing
South Atlantic Cable System (SACS)	6,200 km	Total	Ongoing
System Kabel Rakyat 1 Malaysia (SKR1M)	3,700 km	Total	Ongoing
ATISA	279 km	Total	Ongoing
Indonesia Global Gateway (IGG)	5,300 km	Total	Ongoing

Newly Built Ocean Bottom Sensor Systems

Project	System	Total/Partial	In Service
DONET II (JAMSTEC)	Node System	Total	Ongoing
Japan Trench OBSS (NIED)	In-line System	Total	Ongoing
Eastern Taiwan OBSS (CWB, Taiwan)	Node System	Total	2011
DONET (JAMSTEC)	Node System	Total	2010
Omaezaki OBSS (JMA)	In-line System	Total	2008
(Before 2001)			
Kushiro OBSS (JAMSTEC)	In-line System	Total	1999
Muroto OBSS (JAMSTEC)	In-line System	Total	1997
Hiratsuka OBSS (NIED)	In-line System	Total	1996
Kamaishi OBSS (NIED)	In-line System	Total	1996
Ito OBSS (ERI-University of Tokyo)	In-line System	Total	1993
Katsuura OBSS (JMA)	In-line System	Total	1986
Omaezaki OBSS (JMA)	In-line System	Total	1979

Capacity Upgrades since 2001

Project	In Service	Project	In Service	Project	In Service
APCN2 Upgrade	2001	JASUKA 2008 Upgrade	2009	DMCS Upgrade	2013
FEA Upgrade	2003	SUB 2008 Upgrade	2009	AUFS Upgrade	2013
JIH Upgrade	2004	MDSCS Upgrade	2009	HMC Upgrade	2013
HMC Upgrade	2004	AUFS Upgrade	2009	JIH Upgrade	2013
JIH Upgrade	2005	JIH Upgrade	2009	APCN2 Stage 2e Upgrade	2013
AUFS-East Upgrade	2005	PamAm Upgrade#1	2010	JSSC#1	2013
MDSCS Upgrade	2005	AUFS Upgrade	2010	JAKABARE Upgrade#1	2013
HMC Upgrade	2005	JASUKA 2009 Upgrade (PO#1)	2010	JASUKA 2012 Upgrade (PO#1)	2013
TJP-PTK Upgrade	2006	JASUKA 2009 Upgrade (PO#3)	2010	EAC Pacific 2nd Upgrade 2013	2013
EAC1 Qingdao Upgrade	2006	JASUKA 2009 Upgrade (PO#5)	2010	APCN2 Stage 2f Upgrade	2014
Maya-1 Upgrade#2	2006	AJC 30G Upgrade	2010	SJC Upgrade#1	2014
EAC2 Upgrade	2006	JIH Upgrade	2010	AUFS-East/West Upgrade	2014
APCN2 Upgrade	2006	HMC Upgrade	2010	JASUKA 2012 Upgrade (PO#2)	2014
JIH Upgrade	2006	EAC1 & EAC2 Upgrade	2011	SUB Upgrade (PO#1 and PO#2)	2014
APCN2 Upgrade	2007	APCN2 Stage1e/2b Upgrade	2011	JASUKA 2012 Upgrade (PO#3 and PO#4)	2014
JASUKA 2007 Upgrade	2007	MOC Upgrade	2011	JASUKA 2012 Upgrade (PO#5)	2014
SUB Upgrade	2007	APCN2 Stage 2c Upgrade	2011	APCN2 Stage 2g Upgrade	2014
JIH Upgrade	2007	JIH Upgrade	2011	SUB Upgrade (PO#3)	2015
HMC Upgrade	2007	EAC PACIFIC Upgrade	2011	PanAm Upgrade#2	2015
APCN2 Upgrade	2008	JASUKA 2009 Upgrade (PO#7)	2011	AUFS East and West 100Gbps Upgrade	2015
AJC Upgrade	2008	JIH Upgrade	2012	APCN2 Stage 2h Upgrade	2015
Azores Upgrade	2008	MOC Upgrade	2012	SUB Upgrade (PO#4)	2016
Maya-1 Upgrade#3	2008	APCN2 Stage 1g/2d Upgrade	2012	JSSC#2	Ongoing
AUFS-East Upgrade	2008	AUFS Upgrade	2012	JAKABARE Upgrade#2	Ongoing
AUFS-West Upgrade	2008	HMC Upgrade	2012		
JIH Upgrade	2008	Russia Japan Cable Network Upgrade	2012		

See, e.g., NEC's listing of its subsea systems at *http://www.nec.com/en/global/prod/nw/submarine/aboutus/record/index.html* (last visited November 14, 2017).

(3)Code Error Correction Technology

To attenuate the signal quality degradation of optical submarine cable systems that results from increases in the distance and transmission capacity, NEC has developed a high-gain code error correction FSI compliant to the ITU-T G.975.1 (Advanced FEC LSI) and has installed it in the transponder block. Advanced FEC has a code error correction capability as shown in **Fig. 1** .

By applying the concatenated BCH code, Advanced FEC can correct a signal with a bit error rate (BER) of 3.3×10^{-3} to an error-free signal with BER below 1×10^{-12} , thus achieving an error correction gain of about 8.5 dB.

See, e.g., Sato et al., *T640SW LTE Terminal Equipment for Optical Submarine Cable Systems*, NEC Tech. J., Vol. 5 No. 1 (2010) at 24, *available at* http://www.nec.com/en/global/techrep/journal/g10/n01/pdf/100106.pdf.

Table 1 Parameters of an Advanced FEC LSI

Items	Specifications
Process	0.18um CMOS
Package	672pin BGA
Power Consumption	3.6W (typical)
Throughput	10Gbit/s
Correction Code	RS(255,239)+CSOC R=6/7
Main Functions	"RS(255,239)+CSOC R=6/7" Encoder/Decoder FEC Overhead Insertion/Termination SDH/SONET B1 Monitor

See, e.g., Hara, et al., NEC Corp., *All-In One Box Type Submarine Line Terminal Equipment With Plug-And-Play And Advanced FEC Functions For 10GB/S DWDM Systems*.

5.2. FOWARD ERROR CORRECTION FUCTION

In order to improve the signal quality for the optical submarine cable systems with a long transmission distance over several thousand kilometers, the SLTE is provided with the enhanced forward error correction (FEC) function compliant to the ITU-T G.975.1. **Figure 4** shows the error correction performance of the enhanced FEC adopted in the SLTE. The FEC can correct a degraded signal with a bit error rate (BER) of 1.2×10^{-2} to an error-free condition with BER below 1×10^{-12}. The coding gain is 10dB. The adoption of enhanced FEC enables to increase the transmission capacity beyond the design capacity for the existing systems, and/or enables to expand the repeater spacing drastically for the new-build system.

See, e.g., Nakada et al., Submarine Network Division, NEC Corp.¸ *Fully Flexible and Automated Submarine Line Terminating Equipment for Advanced DWDM Systems*, SubOptic Conf., May 12, 2010, *available at* http://suboptic.org/?dl_id=281.

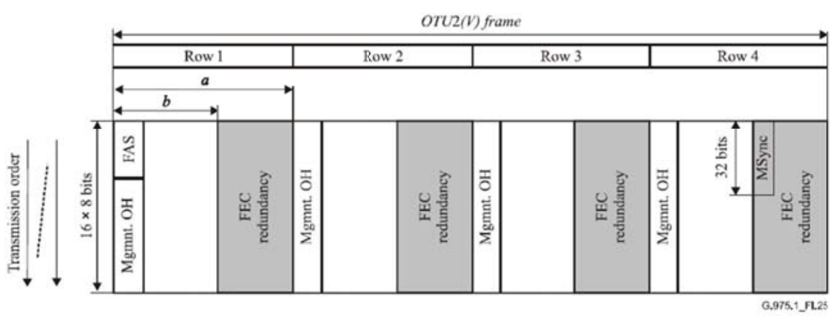
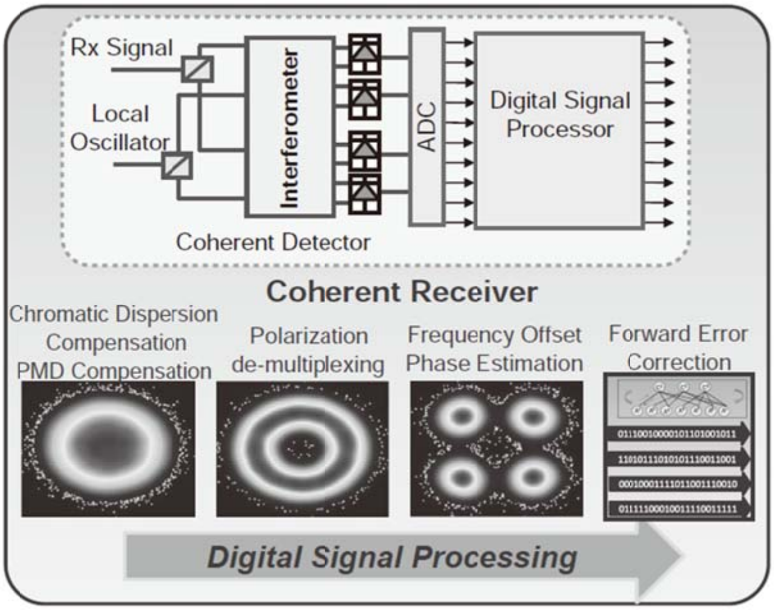


Figure I.25/G.975.1 – Used ITU-T Rec. G.975 compliant framing

See, e.g., Int'l Telecommc'n Union ITU-T G.975.1 at 33, *available at* https://www.itu.int/rec/dologin_pub.asp?lang=e&id=T-REC-G.975.1-200402-I!!PDF-E&type=items.



(*See, e.g.*, Inoue et al., *Enabling International Communications – Technologies for Capacity Increase and Reliability Improvement in Submarine Cable Networks*, NEC Tech. J., Vol. 8 No. 1 (2013), available at http://www.nec.com/en/global/techrep/journal/g13/n01/pdf/130104.pdf.)

74. NEC has had knowledge of the '171 patent at least since the filing this Complaint.

75. NEC also has been and is now actively inducing infringement of one or more claims of the '171 patent, either literally or under the doctrine of equivalents.

76. On information and belief, NEC JP alone and/or acting in concert with, directing and/or authorizing NEC US to make, use, sell or offer for sale in the United States or import into the United States the Accused Products, possesses an affirmative intent to actively induce infringement by others.

77. On information and belief, NEC US alone and/or acting in concert with, directing and/or authorizing NEC JP to make, use, sell or offer for sale in the United States or import into the United States the Accused Products, possesses an affirmative intent to actively induce

infringement by others, including purchasers and end users who deploy and make use of the Accused Products.

78. NEC has intended, and continues to intend to induce infringement of the ’171 patent by others and has knowledge, with specific intent, that the inducing acts would cause infringement or has been willfully blind to the possibility that its inducing acts would cause the infringing acts. For example, NEC knowingly and actively induces infringement of the ’171 patent by encouraging, instructing, and aiding end users to use one or more of the Accused Products and/or by selling the Accused Products to others. NEC induces such infringement by, at a minimum, providing manuals, white papers, training, and/or other technical support with specific intent to induce purchasers and end users of the Accused Products to perform acts intended by NEC to cause direct infringement of the ’171 patent in the United States.

79. NEC also has been and is now contributing to the infringement of one or more claims of the ’171 patent, either literally or under the doctrine of equivalents.

80. On information and belief, NEC has actively, knowingly, and intentionally contributed and continues to actively, knowingly, and intentionally contribute to the infringement of the ’171 patent by having sold or offered to sell and continuing to sell or offer for sale the Accused Products within in the United States and/or by importing the Accused Products into the United States, with knowledge that the infringing technology in the Accused Products is especially made and/or especially adapted for use in infringement of the ’171 patent. NEC has contributed to the infringement by others with knowledge that the infringing technology in the Accused Products is a material part of the patented invention, and with knowledge that the infringing technology in the Accused Products is not a staple article of commerce suitable for substantial non-infringing use, and with knowledge that others including,

but not limited to, resellers, distributors, customers, and/or other end users of the Accused Products, infringe and will continue to infringe the ’171 patent because, due to their specific designs, the Accused Products and components thereof do not have any substantial noninfringing uses. NEC has such knowledge at least because the claimed features of the ’171 patent are used by others including, but not limited to, resellers, distributors, customers, and/or other end users of the Accused Products.

81. On information and belief, NEC knew or should have known of the ’171 patent and has acted, and continues to act, in an egregious and wanton manner by infringing the ’171 patent. On information and belief, NEC’s infringement of the ’171 patent has been and continues to be willful and deliberate. The market for subsea telecommunication systems is small and contains a limited number of competitors, with Xtera being a known pioneer with whom NEC has great familiarity. Upon information and belief, NEC used the technology in the ’171 patent to develop and its Accused Products without permission from Xtera.

82. On information and belief, despite knowing that its actions constituted infringement of the ’171 patent and/or despite knowing that that there was a high likelihood that its actions constituted infringement of the patent, NEC nevertheless continued its infringing actions, and continues to make, use and sell its Accused Products.

83. NEC’s acts of infringement have injured and damaged Xtera. NEC’s wrongful conduct has caused Xtera to suffer irreparable harm resulting from the loss of its lawful patent rights to exclude others from making, using, selling, offering to sell and importing the patented inventions. Upon information and belief, NEC will continue these infringing acts unless enjoined by this Court.

COUNT FOUR – INFRINGEMENT OF THE ’798 PATENT

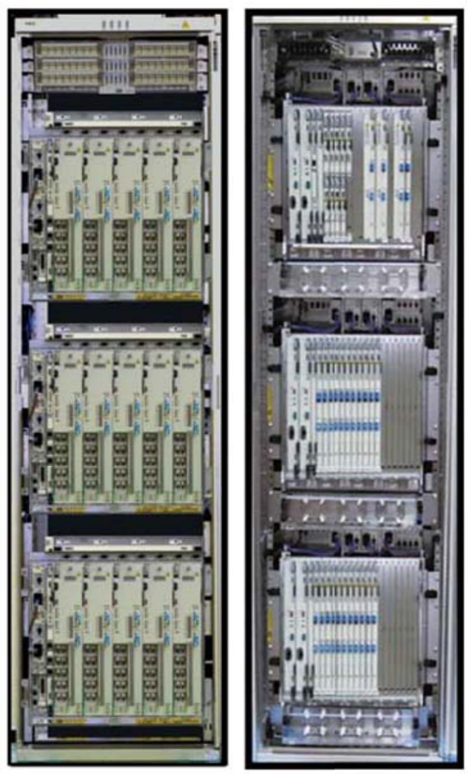
84. Xtera incorporates by reference its allegations in Paragraphs 1-83 as if fully restated in this paragraph.

85. On information and belief, NEC has been and is now directly and/or indirectly infringing, literally and/or under the doctrine of equivalents, the ’798 patent by making, using, selling, and/or offering for sale in the United States, and/or importing into the United States, the Accused Products.

86. The ’798 patent is generally directed to fixing the issue of signal loss by causing the minimum accumulated dispersion to occur approximately halfway along the intended transmission distance. Claim 13 of the ’798 patent recites a method for configuring an optical system that includes at least in one direction a transmit terminal, a receive terminal, and an optical fiber link coupled there between to allow a transmit optical signal to be transmitted by the transmit terminal, through the optical fiber link, and to the receive terminal, the method comprising: an act of adjusting a tunable pre-compensation mechanism at the transmit terminal such that at least a majority of a plurality of wavelength division multiplexed channels of the transmit optical signal at least initially reaches a minimum accumulated dispersion within a central distance of the length of the optical fiber link, wherein the act of adjusting is performed using a closed control loop that measures bit error rate at the receive terminal, and further adjusts the tunable pre-compensation mechanism until an acceptable bit error rate is achieved.

87. Upon information and belief, NEC’s Accused Products infringe at least claim 13 of the ’798 patent. For example, NEC’s Accused Products provide an act of adjusting a tunable pre-compensation mechanism at the transmit terminal such that at least a majority of a plurality of wavelength division multiplexed channels of the transmit optical signal at least initially

reaches a minimum accumulated dispersion within a central distance of the length of the optical fiber link, wherein the act of adjusting is performed using a closed control loop that measures bit error rate at the receive terminal, and further adjusts the tunable pre-compensation mechanism until an acceptable bit error rate is achieved as shown, for example, below.



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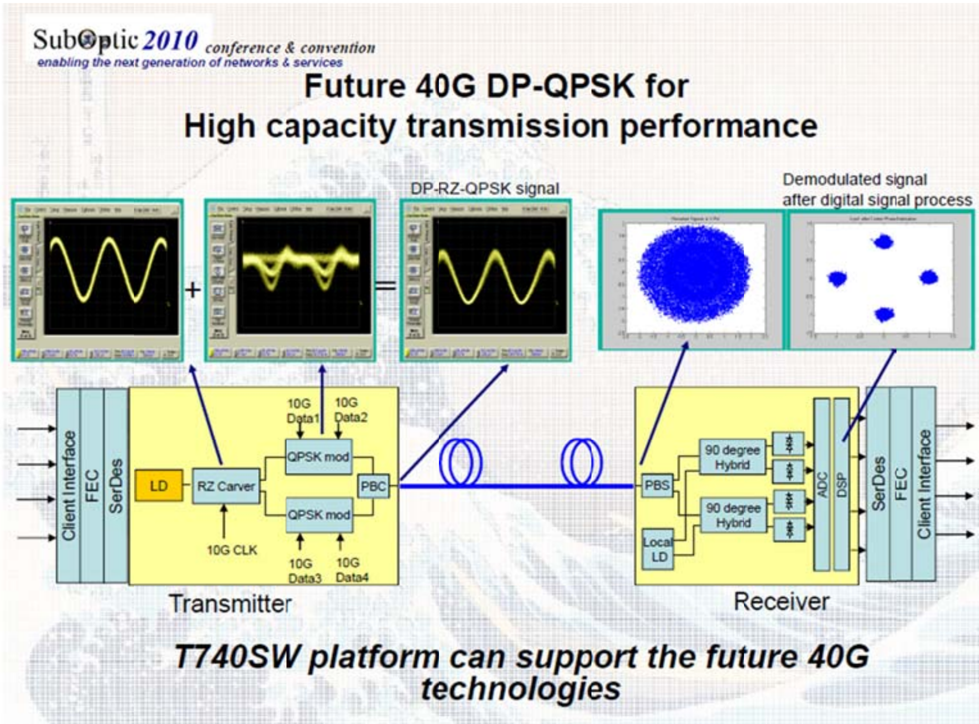

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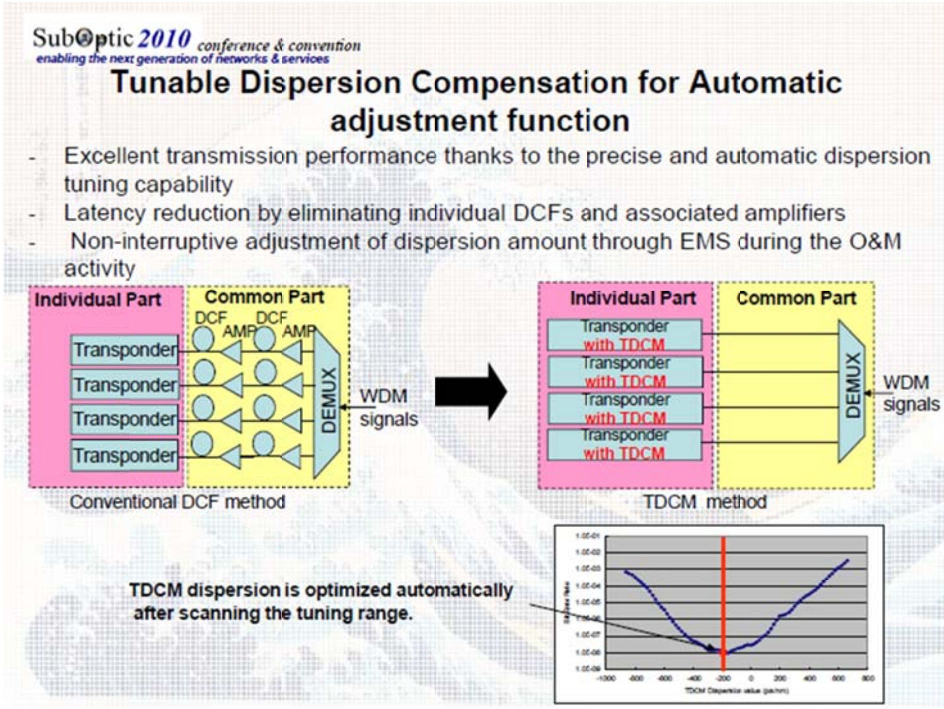
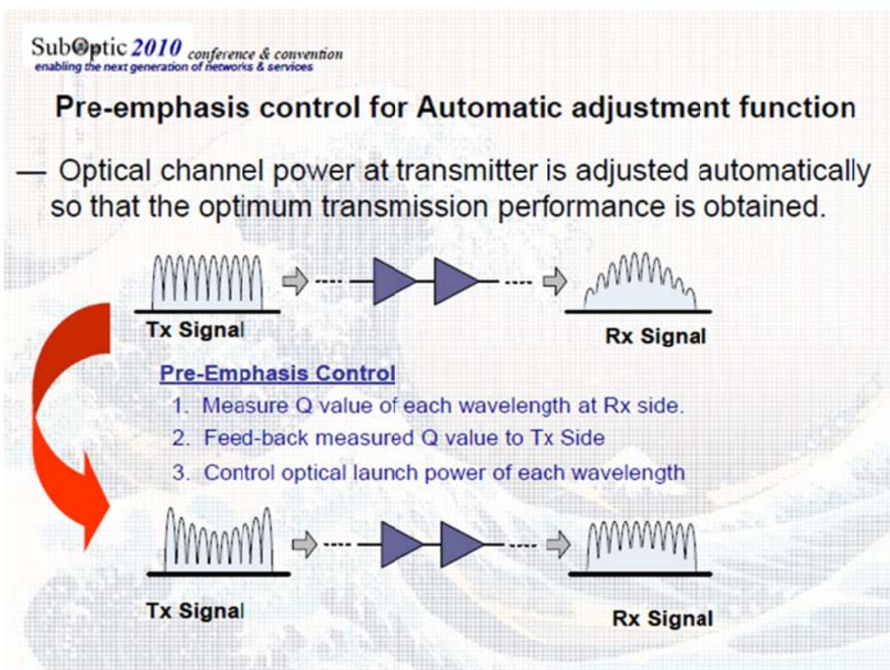


SubOptic 2010 conference & convention
enabling the next generation of networks & services
Tunable Dispersion Compensation for Automatic adjustment function
- Excellent transmission performance thanks to the precise and automatic dispersion tuning capability
- Latency reduction by eliminating individual DCFs and associated amplifiers
- Non-interruptive adjustment of dispersion amount through EMS during the O&M activity
Individual Part
Common Part
DCF
AMP
Transponder
DEMUX
WDM signals
Conventional DCF method
Transponder with TDCM
TDCM method
TDCM dispersion is optimized automatically after scanning the tuning range.

Id.



SubOptic 2010 conference & convention
enabling the next generation of networks & services
Pre-emphasis control for Automatic adjustment function
— Optical channel power at transmitter is adjusted automatically so that the optimum transmission performance is obtained.
Tx Signal
Rx Signal
Pre-Emphasis Control
1. Measure Q value of each wavelength at Rx side.
2. Feed-back measured Q value to Tx Side
3. Control optical launch power of each wavelength
Tx Signal
Rx Signal

Id.

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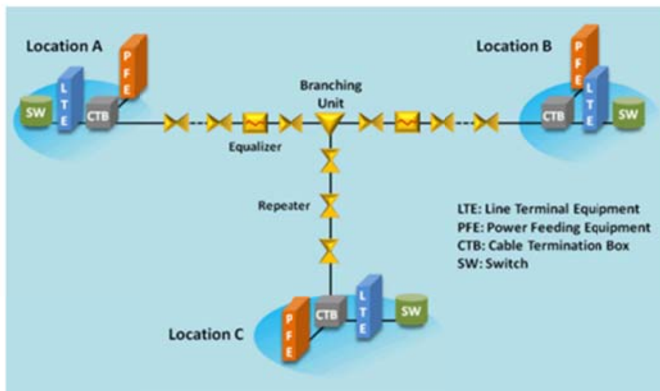
Example solution



See, e.g., NEC product literature at *http://www.nec.com/en/global/prod/nw/submarine/product/ns-series.html* (last visited November 14, 2017).

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- 100G, 40G and 10G transponders can be mixed in the same rack to optimize floor space and use of optical spectrum
- In-service upgrade without traffic interruption

Id.

Submarine Repeater R640SW

The NEC R640SW Submarine Repeater has been specially designed for fDWDM applications including 980nm pumped Erbium Doped Optical Amplifiers (EDFAs). This technology enables high power amplification for optimized repeater spacing, wide and flat amplification gain to allow for efficient channel packing density, and a lower noise figure which results in more capacity over longer distances with the highest reliability. Each standard repeater is designed to accommodate up to 8 amplifier systems.

Key features

- Specially designed for highly reliable DWDM applications
- Employs 980nm pumped ErbiumDoped Fiber Amplifiers
- Extremely reliable pumping with 4 pump laser diodes per amplifier pair
- Extremely reliable power circuits
- Wide and flat amplifier gain
- Low noise figure
- Accommodates up to 8 amplifier systems (fiber pairs)
- Ultra pressure-resistant housing for water depths up to 8,000m
- Compact size to facilitate deployment and shipboard handling

(*Id*.)

Block Equalizer Q640

The Block Equalizer equalizes gain differences among channels in a long haul Dense Wavelength Division Multiplex (DWDM) system. When the DWDM signals are transmitted over a long distance, gain undulation is accumulated. The Block Equalizer has been developed to obtain flat characteristics across all wavelengths and to maintain high quality transmission in long haul DWDM systems.

- Precise equalization of accumulated gain differences between wavelengths
- Applicable to any repeater gain profile using slanted fiber grating and/or thin film filter
- Ultra pressure-resistant housing for water depths up to 8,000m

Note:
The Q640 Block Equalizer can perform two types of equalization function: tilting and shaping, achieved using the TEQ (Tilt Equalizer) and SEQ (Shape Equalizer) respectively. Using both types of equalizer, a flat transmission line profile can be maintained, accurately compensating repeater and cable characteristics.

Id.

Remote Fiber Test Equipment (RFTE) M640SW

This equipment is used to identify and isolate any faults in the wet plant, providing full visibility of both repeaters and span cable while the system is in-service.

Key features

- Monitors up to 8 fiber pairs with one RFTE
- Simultaneous in-service monitoring from both stations
- Determines the faulty repeater / cable location
- Estimation of faults from cable loss and repeater gain
- Records the history of repeater output over a long period of time

Management System WebNSV

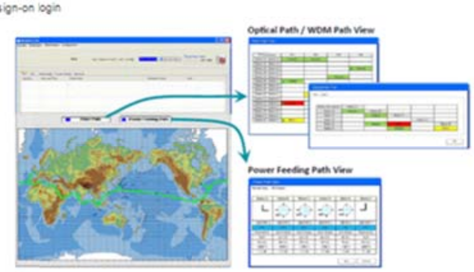
WebNSV is the submarine management system to monitor and control the LTE, RFTE, PFE and their associated networks, utilizing web-based technology. It consists of an Element Management System (WebNSV EMS) for individual station management and a Unified Management System (WebNSV UMS) for centralized system management.

WebNSV EMS Functions

- Fault Management
- Performance Monitoring
- Configuration Management
- Security Management

WebNSV UMS Functions

- Integrated Fault Management
- End-to-end Optical Path Management
- Power Feeding Path View and BU Control
- Single sign-on login



Id.

Newly Built Systems since 2001

Project	System Length	Total/Partial	In Service
APCN2	19,000 km	Total	2001
AJC	12,000 km	Total	2001
EAC2	7,800 km	Total	2002
Algiers-Palma Cable	310 km	Partial	2002
HMC	280 km	Total	2002
TIS	1,100 km	Total	2003
AUFS-West	2,500 km	Total	2004
DMCS	150 km	Total	2004
JASUKA	1,800 km	Total	2006
BLCS	320 km	Total	2006
EAC1 Qingdao Extension	350 km	Total	2006
DSCN	1,100 km	Total	2007
Russia-Japan Cable Network	1,800 km	Total	2008
Trans-Pacific Express	17,200 km	Partial	2008
Hokkaido Sakhalin Cable System	560 km	Total	2007
Batam Singapore Cable System (BSCS)	98 km	Total	2009
Jakabare	1,400 km	Total	2009
Asia America Gateway	20,000 km	Partial	2009
Unity	9,500 km	Partial	2010
I-ME-WE	12,000 km	Partial	2011
Dhiraagu Domestic Submarine Cable (DDSCN)	1,000 km	Total	2012
Asia Submarine-cable Express (ASE)	7,200 km	Partial	2013
South-East Asia Japan Cable System (SJC)	8,900 km	Partial	2013
Sulawesi Maluku Papua Cable System (SMPCS) Packet-2	3,500 km	Total	2015
FASTER Cable System	11,500 km	Total	2016
Asia Pacific Gateway (APG)	10,400 km	Total	Ongoing
TPKM3	500 km	Total	Ongoing
SEA-ME-WE 5 Cable System (SMW5)	20,000 km	Partial	Ongoing
SOUTHEAST ASIA UNITED STATES Cable System (SEA-US)	14,500 km	Total	Ongoing
Asia Africa Europe 1 (AAE-1) S-1H Hong Kong Extension	2,900 km	Total	Ongoing
South Atlantic Cable System (SACS)	6,200 km	Total	Ongoing
System Kabel Rakyat 1 Malaysia (SKR1M)	3,700 km	Total	Ongoing
ATISA	279 km	Total	Ongoing
Indonesia Global Gateway (IGG)	5,300 km	Total	Ongoing

Newly Built Ocean Bottom Sensor Systems

Project	System	Total/Partial	In Service
DONET II (JAMSTEC)	Node System	Total	Ongoing
Japan Trench OBSS (NIED)	In-line System	Total	Ongoing
Eastern Taiwan OBSS (CWB, Taiwan)	Node System	Total	2011
DONET (JAMSTEC)	Node System	Total	2010
Omaezaki OBSS (JMA)	In-line System	Total	2008
(Before 2001)			
Kushiro OBSS (JAMSTEC)	In-line System	Total	1999
Muroto OBSS (JAMSTEC)	In-line System	Total	1997
Hiratsuka OBSS (NIED)	In-line System	Total	1996
Kamaishi OBSS (NIED)	In-line System	Total	1996
Ito OBSS (ERI-University of Tokyo)	In-line System	Total	1993
Katsuura OBSS (JMA)	In-line System	Total	1986
Omaezaki OBSS (JMA)	In-line System	Total	1979

Capacity Upgrades since 2001

Project	In Service	Project	In Service	Project	In Service
APCN2 Upgrade	2001	JASUKA 2008 Upgrade	2009	DMCS Upgrade	2013
FEA Upgrade	2003	SUB 2008 Upgrade	2009	AUFS Upgrade	2013
JIH Upgrade	2004	MDSCS Upgrade	2009	HMC Upgrade	2013
HMC Upgrade	2004	AUFS Upgrade	2009	JIH Upgrade	2013
JIH Upgrade	2005	JIH Upgrade	2009	APCN2 Stage 2e Upgrade	2013
AUFS-East Upgrade	2005	PamAm Upgrade#1	2010	JSSC#1	2013
MDSCS Upgrade	2005	AUFS Upgrade	2010	JAKABARE Upgrade#1	2013
HMC Upgrade	2005	JASUKA 2009 Upgrade (PO#1)	2010	JASUKA 2012 Upgrade (PO#1)	2013
TJP-PTK Upgrade	2006	JASUKA 2009 Upgrade (PO#3)	2010	EAC Pacific 2nd Upgrade 2013	2013
EAC1 Qingdao Upgrade	2006	JASUKA 2009 Upgrade (PO#5)	2010	APCN2 Stage 2f Upgrade	2014
Maya-1 Upgrade#2	2006	AJC 30G Upgrade	2010	SJC Upgrade#1	2014
EAC2 Upgrade	2006	JIH Upgrade	2010	AUFS-East/West Upgrade	2014
APCN2 Upgrade	2006	HMC Upgrade	2010	JASUKA 2012 Upgrade (PO#2)	2014
JIH Upgrade	2006	EAC1 & EAC2 Upgrade	2011	SUB Upgrade (PO#1 and PO#2)	2014
APCN2 Upgrade	2007	APCN2 Stage1e/2b Upgrade	2011	JASUKA 2012 Upgrade (PO#3 and PO#4)	2014
JASUKA 2007 Upgrade	2007	MOC Upgrade	2011	JASUKA 2012 Upgrade (PO#5)	2014
SUB Upgrade	2007	APCN2 Stage 2c Upgrade	2011	APCN2 Stage 2g Upgrade	2014
JIH Upgrade	2007	JIH Upgrade	2011	SUB Upgrade (PO#3)	2015
HMC Upgrade	2007	EAC PACIFIC Upgrade	2011	PanAm Upgrade#2	2015
APCN2 Upgrade	2008	JASUKA 2009 Upgrade (PO#7)	2011	AUFS East and West 100Gbps Upgrade	2015
AJC Upgrade	2008	JIH Upgrade	2012	APCN2 Stage 2h Upgrade	2015
Azores Upgrade	2008	MOC Upgrade	2012	SUB Upgrade (PO#4)	2016
Maya-1 Upgrade#3	2008	APCN2 Stage 1g/2d Upgrade	2012	JSSC#2	Ongoing
AUFS-East Upgrade	2008	AUFS Upgrade	2012	JAKABARE Upgrade#2	Ongoing
AUFS-West Upgrade	2008	HMC Upgrade	2012		
JIH Upgrade	2008	Russia Japan Cable Network Upgrade	2012		

See, e.g., NEC's listing of its subsea systems at *http://www.nec.com/en/global/prod/nw/submarine/aboutus/record/index.html* (last visited November 14, 2017).

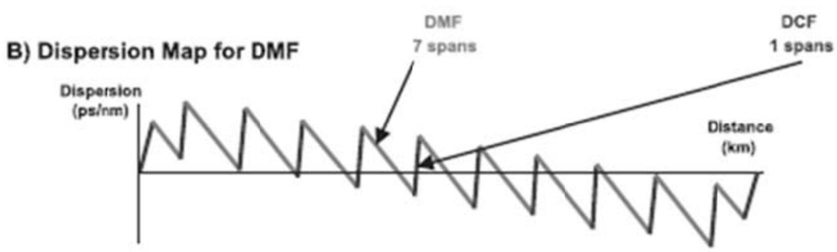


Fig. 4 Gain equalization and dispersion management of submarine plant.

See, e.g., Yoneyama et al., *Construction Technology for Use in Repeatered Transoceanic Optical Submarine Cable Systems*, NEC Tech. J., Vol. 5 No. 1 (2010) at 43–44, *available at* http://www.nec.com/en/global/techrep/journal/g10/n01/pdf/100110.pdf.

B) System Dispersion Map (An example)

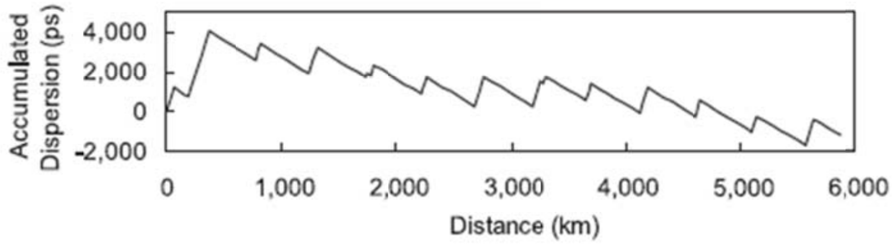


Fig. 5 Examples of the characteristics of a manufactured 5,800-km submarine plant section.

Id.

5.4. CHROMATIC DISPERSION COMPENSATION FUNCTION

The compensation of chromatic dispersion accumulated in the transmission line is an essential function in the SLTE. The SLTE provides two kinds of chromatic dispersion (CD) compensation function. One is based on the dispersion compensation fiber with fixed CD value, and is adopted for all the WDM signals and/or the sub-band WDM signals to roughly cancel the accumulated CD. The other is the tuneable chromatic dispersion compensation function accommodated in each transponder, and is adopted for each optical wavelength to make a precise compensation. The CD value of tunable chromatic dispersion compensation module can be automatically adjusted to achieve the optimum transmission performance per wavelength. The adjustment work in the installation can be greatly reduced thanks to the automated feature.

See, e.g., Nakada et al., Submarine Network Division, NEC Corp.¸*Fully Flexible and Automated Submarine Line Terminating Equipment for Advanced DWDM Systems*, SubOptic Conf., May 12, 2010, available at http://suboptic.org/?dl_id=281.

Table 1: SLTE Specification

Item	Specification
Submarine Interface	
Maximum Wavelength	180
Channel Spacing	25GHz/33.3GHz/50GHz/100 GHz Grid
Wavelength	1530-1566nm(Tunable)
Stability	better or equal to +/-0.02nm
Transmission Speed	12.4Gb/s(10G) 43Gb/s(40G)
Modulation	RZ/NRZ/RZ-DPSK(10G) RZ-DQPSK(40G)
Terrestrial interface	STM64/OC-192 STM16/OC-48 10GBASE-R 10GBASE-W STM256/OC-768
Supply voltage	-57.0V to -40.5V
Environmental condition	Temperature 5 to 40degreeC Humidity 5% to 85%
Cooling system	Forced convection air-cooling system with FAN in the shelf
Dimensions	2200mm(H) x 600mm(W) x 300mm(D)
Automatic adjustment function	Dispersion compensation Pre-emphasis control Dummy light power control
Redundancy	N:1 Wavelength redundancy (N=max 32)

Id.

88. NEC has had knowledge of the ’798 patent at least since the filing this Complaint.

89. NEC also has been and is now actively inducing infringement of one or more claims of the ’798 patent, either literally or under the doctrine of equivalents.

90. On information and belief, NEC JP alone and/or acting in concert with, directing and/or authorizing NEC US to make, use, sell or offer for sale in the United States or import into the United States the Accused Products, possesses an affirmative intent to actively induce infringement by others.

91. On information and belief, NEC US alone and/or acting in concert with, directing and/or authorizing NEC JP to make, use, sell or offer for sale in the United States or import into

the United States the Accused Products, possesses an affirmative intent to actively induce infringement by others, including purchasers and end users who deploy and make use of the Accused Products.

92. NEC has intended, and continues to intend to induce infringement of the ’798 patent by others and has knowledge, with specific intent, that the inducing acts would cause infringement or has been willfully blind to the possibility that its inducing acts would cause the infringing acts. For example, NEC knowingly and actively induces infringement of the ’798 patent by encouraging, instructing, and aiding end users to use one or more of the Accused Products and/or by selling the Accused Products to others. NEC induces such infringement by, at a minimum, providing manuals, white papers, training, and/or other technical support with specific intent to induce purchasers and end users of the Accused Products to perform acts intended by NEC to cause direct infringement of the ’798 patent in the United States.

93. NEC also has been and is now contributing to the infringement of one or more claims of the ’798 patent, either literally or under the doctrine of equivalents.

94. On information and belief, NEC has actively, knowingly, and intentionally contributed and continues to actively, knowingly, and intentionally contribute to the infringement of the ’798 patent by having sold or offered to sell and continuing to sell or offer for sale the Accused Products within in the United States and/or by importing the Accused Products into the United States, with knowledge that the infringing technology in the Accused Products is especially made and/or especially adapted for use in infringement of the ’798 patent. NEC has contributed to the infringement by others with knowledge that the infringing technology in the Accused Products is a material part of the patented invention, and with knowledge that the infringing technology in the Accused Products is not a staple article of

commerce suitable for substantial non-infringing use, and with knowledge that others including, but not limited to, resellers, distributors, customers, and/or other end users of the Accused Products, infringe and will continue to infringe the ’798 patent because, due to their specific designs, the Accused Products and components thereof do not have any substantial noninfringing uses. NEC has such knowledge at least because the claimed features of the ’798 patent are used by others including, but not limited to, resellers, distributors, customers, and/or other end users of the Accused Products.

95. On information and belief, NEC knew or should have known of the ’798 patent and has acted, and continues to act, in an egregious and wanton manner by infringing the ’798 patent. On information and belief, NEC’s infringement of the ’798 patent has been and continues to be willful and deliberate. The market for subsea telecommunication systems is small and contains a limited number of competitors, with Xtera being a known pioneer with whom NEC has great familiarity. Upon information and belief, NEC used the technology in the ’798 patent to develop and its Accused Products without permission from Xtera.

96. On information and belief, despite knowing that its actions constituted infringement of the ’798 patent and/or despite knowing that that there was a high likelihood that its actions constituted infringement of the patent, NEC nevertheless continued its infringing actions, and continues to make, use and sell its Accused Products.

97. NEC’s acts of infringement have injured and damaged Xtera. NEC’s wrongful conduct has caused Xtera to suffer irreparable harm resulting from the loss of its lawful patent rights to exclude others from making, using, selling, offering to sell and importing the patented inventions. Upon information and belief, NEC will continue these infringing acts unless enjoined by this Court.

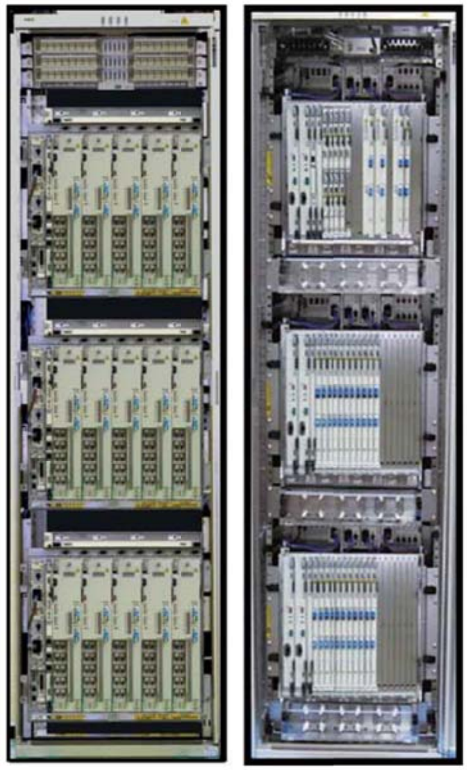
COUNT FIVE – INFRINGEMENT OF THE ’637 PATENT

98. Xtera incorporates by reference its allegations in Paragraphs 1-97 as if fully restated in this paragraph.

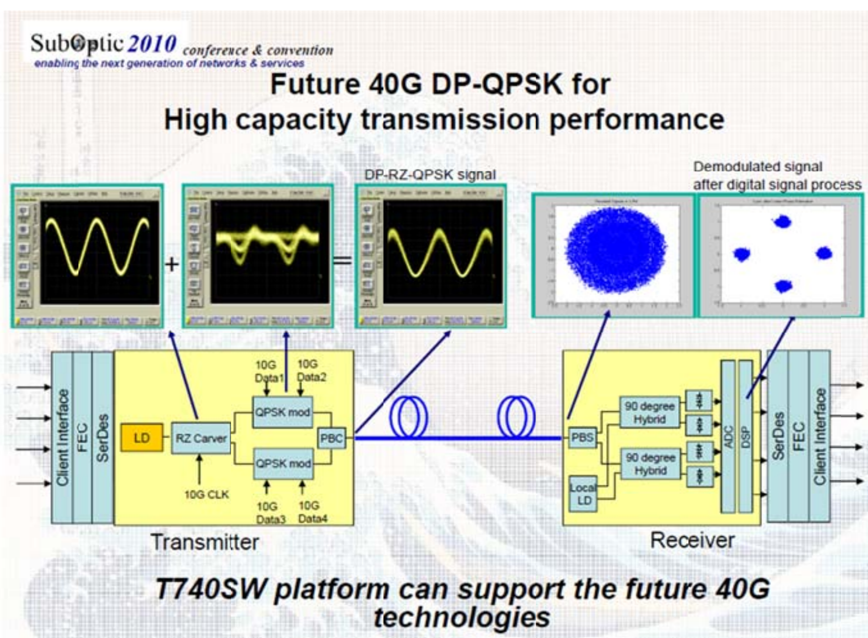
99. On information and belief, NEC has been and is now directly and/or indirectly infringing, literally and/or under the doctrine of equivalents, the ’637 patent by making, using, selling, and/or offering for sale in the United States, and/or importing into the United States, the Accused Products.

100. The ’637 patent is generally directed to improving the quality and effectiveness of the entire communication system. Claim 1 of the ’637 patent recites an optical system comprising: a wavelength division multiplexed (WDM) transmitter comprising a plurality of transmitters for transmitting a plurality of optical signals; and a control processor for calculating a desired value of a quality metric for each optical signal of the plurality of optical signals, and for transmitting the desired value to each transmitter; wherein each transmitter comprises: an optical source for transmitting a corresponding optical signal of the plurality of optical signals; an interface for receiving a measured value of a quality metric of the corresponding optical signal and for receiving the calculated desired value of the quality metric from the control processor so that a drive power of the optical source is adjusted within a region of linear operation such that the measured value equals the desired value, wherein the transmitters are arranged into one or more bands, each band comprising one or more transmitters and comprising a band gain amplifier, and wherein the control processor is adapted to apply a centralization signal to the one or more transmitters in a given band in order to maintain an average drive power for that band, and the band gain amplifiers are configured to compensate for the effect of the centralization signal.

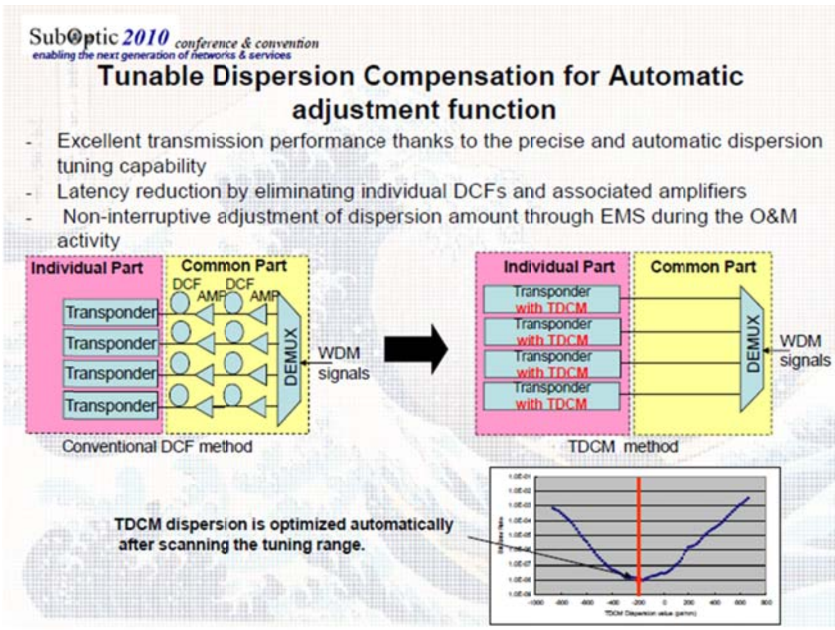
101. Upon information and belief, NEC's Accused Products infringe at least claim 1 of the '637 patent. For example, NEC's Accused Products provide a wavelength division multiplexed (WDM) transmitter comprising a plurality of transmitters for transmitting a plurality of optical signals; and a control processor for calculating a desired value of a quality metric for each optical signal of the plurality of optical signals, and for transmitting the desired value to each transmitter; wherein each transmitter comprises: an optical source for transmitting a corresponding optical signal of the plurality of optical signals; an interface for receiving a measured value of a quality metric of the corresponding optical signal and for receiving the calculated desired value of the quality metric from the control processor so that a drive power of the optical source is adjusted within a region of linear operation such that the measured value equals the desired value, wherein the transmitters are arranged into one or more bands, each band comprising one or more transmitters and comprising a band gain amplifier, and wherein the control processor is adapted to apply a centralization signal to the one or more transmitters in a given band in order to maintain an average drive power for that band, and the band gain amplifiers are configured to compensate for the effect of the centralization signal as shown, for example, below.



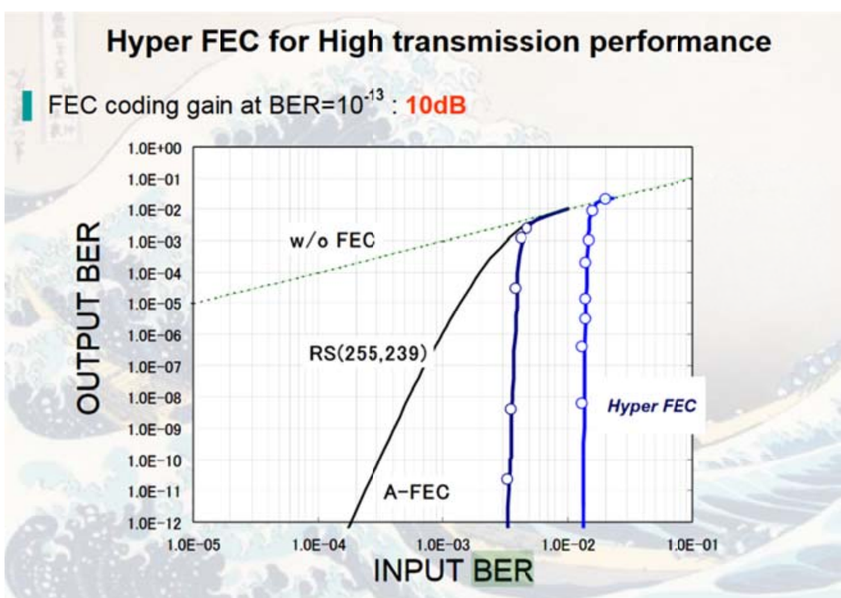
See NEC Corp., Telecommunications Cable Solutions Submarine Systems at (2014), *available at* http://www.nec.com/en/global/prod/nw/submarine/pdf/submarine-brochure.pdf.



See, e.g., Nakada, NEC Corp., Fully Flexible and Automated Submarine Line Terminating Equipment for Advanced DWDM Systems, SubOptic Conf., May 11, 2010, *available at* http://suboptic.org/wp-content/uploads/2014/10/Presentation-241-Nakada-v1_SubOptic-2010-Oral-Presentation_LTE_20100511-2.pdf.



Id.



Id.

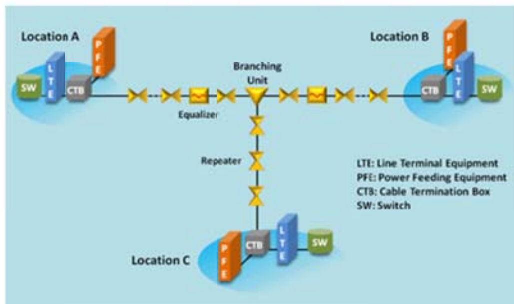
NS Series — Submarine Repeatered Systems

Contact

Key benefits

- DWDM technology enables transmission up to 100Gbps x 100 wavelengths with 10Tbps total capacity per fiber pair
- Up to 80Tbps capacity is achieved over a cable of 8 fiber pairs
- Transmission distances in excess of 12,000km for trans-oceanic networks
- Extremely reliable submarine network over 25 years life
- Highly agile and flexible solution for growing capacity demands

Example solution



See, e.g., NEC product literature at *http://www.nec.com/en/global/prod/nw/submarine/product/ns-series.html* (last visited November 14, 2017).

NS Series Lineup

Line Terminal Equipment T740SW

To meet the needs of transporting high-capacity DWDM signals over transoceanic distances, specialized Line Terminal Equipment is required. This equipment provides the function of translation between the terrestrial network and the undersea network.

Key features

- Highly Dense WDM Multiplexing and Demultiplexing
- Transmission capacity of up to 10Tbps (100 wavelengths @ 100Gbps) or 7.04Tbps (176 wavelengths @ 40Gbps) per fiber pair
- Up to 80Tbps (10Tbps x 8 fiber pairs) of cross-sectional capacity
- Various channel spacing designs (25GHz/33GHz/50GHz)
- Various and flexible tributary interfaces:
  - 100GbE, OTU4 (software switchable)
  - STM-256, OC-768, OTU3 (software switchable)
  - STM-64, OC-192, OTU2/2e, 10GbE LAN-PHY/WAN PHY (software switchable)
  - STM-16, OC-48
- Advanced soft decision forward error correction function
- Digital Coherent transponders provide automatic dispersion compensation and polarization demultiplexing
- Multiple modulation schemes available to optimize system capacity
- Simplified maintenance by plug and play scheme
- Extremely small footprint: up to 15 x 100G, 18 x 40G or 32 x 10G transponders per rack
- 100G, 40G and 10G transponders can be mixed in the same rack to optimize floor space and use of optical spectrum
- In-service upgrade without traffic interruption

Id.

Submarine Repeater R640SW

The NEC R640SW Submarine Repeater has been specially designed for fDWDM applications including 980nm pumped Erbium Doped Optical Amplifiers (EDFAs). This technology enables high power amplification for optimized repeater spacing, wide and flat amplification gain to allow for efficient channel packing density, and a lower noise figure which results in more capacity over longer distances with the highest reliability. Each standard repeater is designed to accommodate up to 8 amplifier systems.

Key features

- Specially designed for highly reliable DWDM applications
- Employs 980nm pumped ErbiumDoped Fiber Amplifiers
- Extremely reliable pumping with 4 pump laser diodes per amplifier pair
- Extremely reliable power circuits
- Wide and flat amplifier gain
- Low noise figure
- Accommodates up to 8 amplifier systems (fiber pairs)
- Ultra pressure-resistant housing for water depths up to 8,000m
- Compact size to facilitate deployment and shipboard handling

Id.

Block Equalizer Q640

The Block Equalizer equalizes gain differences among channels in a long haul Dense Wavelength Division Multiplex (DWDM) system. When the DWDM signals are transmitted over a long distance, gain undulation is accumulated. The Block Equalizer has been developed to obtain flat characteristics across all wavelengths and to maintain high quality transmission in long haul DWDM systems.

- Precise equalization of accumulated gain differences between wavelengths
- Applicable to any repeater gain profile using slanted fiber grating and/or thin film filter
- Ultra pressure-resistant housing for water depths up to 8,000m

Note:
The Q640 Block Equalizer can perform two types of equalization function: tilting and shaping, achieved using the TEQ (Tilt Equalizer) and SEQ (Shape Equalizer) respectively. Using both types of equalizer, a flat transmission line profile can be maintained, accurately compensating repeater and cable characteristics.

Id.

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Newly Built Ocean Bottom Sensor Systems

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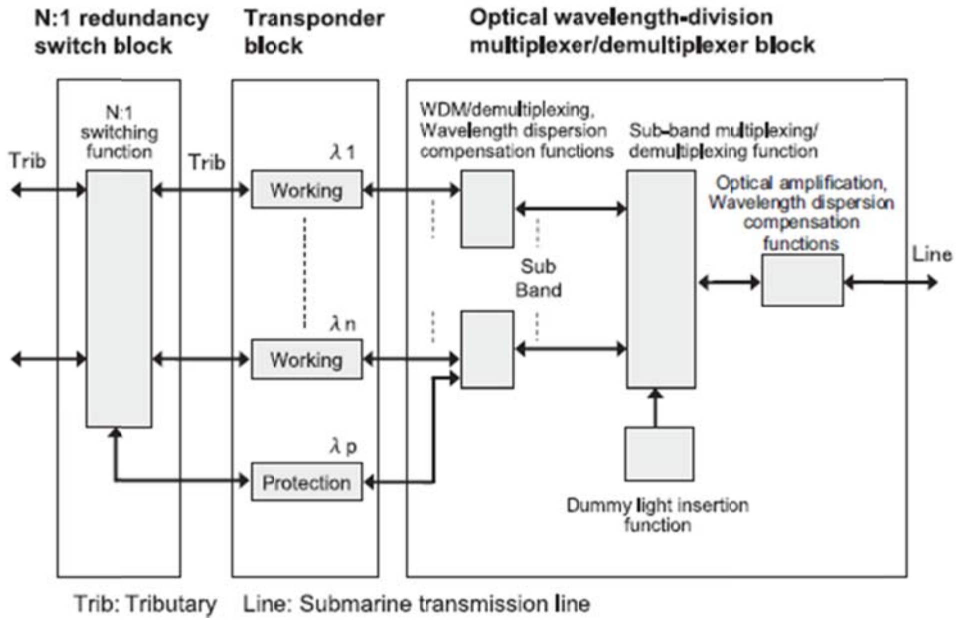
FEA Upgrade	2003	SUB 2008 Upgrade	2009	AUFS Upgrade	2013
JIH Upgrade	2004	MDSCS Upgrade	2009	HMC Upgrade	2013
HMC Upgrade	2004	AUFS Upgrade	2009	JIH Upgrade	2013
JIH Upgrade	2005	JIH Upgrade	2009	APCN2 Stage 2e Upgrade	2013
AUFS-East Upgrade	2005	PamAm Upgrade#1	2010	JSSC#1	2013
MDSCS Upgrade	2005	AUFS Upgrade	2010	JAKABARE Upgrade#1	2013
HMC Upgrade	2005	JASUKA 2009 Upgrade (PO#1)	2010	JASUKA 2012 Upgrade (PO#1)	2013
TJP-PTK Upgrade	2006	JASUKA 2009 Upgrade (PO#3)	2010	EAC Pacific 2nd Upgrade 2013	2013
EAC1 Qingdao Upgrade	2006	JASUKA 2009 Upgrade (PO#5)	2010	APCN2 Stage 2f Upgrade	2014
Maya-1 Upgrade#2	2006	AJC 30G Upgrade	2010	SJC Upgrade#1	2014
EAC2 Upgrade	2006	JIH Upgrade	2010	AUFS-East/West Upgrade	2014
APCN2 Upgrade	2006	HMC Upgrade	2010	JASUKA 2012 Upgrade (PO#2)	2014
JIH Upgrade	2006	EAC1 & EAC2 Upgrade	2011	SUB Upgrade (PO#1 and PO#2)	2014
APCN2 Upgrade	2007	APCN2 Stage1e/2b Upgrade	2011	JASUKA 2012 Upgrade (PO#3 and PO#4)	2014
JASUKA 2007 Upgrade	2007	MOC Upgrade	2011	JASUKA 2012 Upgrade (PO#5)	2014
SUB Upgrade	2007	APCN2 Stage 2c Upgrade	2011	APCN2 Stage 2g Upgrade	2014
JIH Upgrade	2007	JIH Upgrade	2011	SUB Upgrade (PO#3)	2015
HMC Upgrade	2007	EAC PACIFIC Upgrade	2011	PanAm Upgrade#2	2015
APCN2 Upgrade	2008	JASUKA 2009 Upgrade (PO#7)	2011	AUFS East and West 100Gbps Upgrade	2015
AJC Upgrade	2008	JIH Upgrade	2012	APCN2 Stage 2h Upgrade	2015
Azores Upgrade	2008	MOC Upgrade	2012	SUB Upgrade (PO#4)	2016
Maya-1 Upgrade#3	2008	APCN2 Stage 1g/2d Upgrade	2012	JSSC#2	Ongoing
AUFS-East Upgrade	2008	AUFS Upgrade	2012	JAKABARE Upgrade#2	Ongoing
AUFS-West Upgrade	2008	HMC Upgrade	2012		
JIH Upgrade	2008	Russia Japan Cable Network Upgrade	2012		

See, e.g., NEC's listing of its subsea systems at *http://www.nec.com/en/global/prod/nw/submarine/aboutus/record/index.html* (last visited November 14, 2017).

3.6 Wavelength multiplex/demultiplex function

The SLTE can multiplex and demultiplex maximum 180 optical signals with minimum channel spacing of 25GHz. It can support various channel spacing depending on various modulation formats.

See, e.g., Koga, et al., Submarine Network Division, NEC Corp., *High Performance and High Flexibility Submarine Line Terminating Equipment for New Build and Capacity Upgrade Applications*, SubOptic Conf., April 24, 2013, *available at* http://suboptic.org/?dl_id=213.



See, e.g., Ultra-long Span Repeaterless Transmission System Technologies, NEC Tech. J., Vol. 5 No. 1 (2010) at 25.

Table 2 The SLTM Performance

Items	Performance
Terrestrial Interface	ITU-T STM-64 I64.2, S64.2b SONET OC-192 SR-2, IR-2 9.95328Gbit/s NRZ, Optical
Submarine system Interface	DWDM system applicable 12.4Gbit/s RZ, Optical
Power Supply	DC -40.5 to -57V
Power Consumption	Typical 130W
Dimensions	H450xW150xD330mm
Weight	18kg

See, e.g., Hara et al., *All-In One Box Type Submarine Line Terminal Equipment With Plug-And-Play And Advanced FEC Functions For 10GB/S DWDM Systems*, NEC Tech. J., Vol. 5 No. 1 (2010) at 25.

102. NEC has had knowledge of the ’637 patent at least since the filing this Complaint.

103. NEC also has been and is now actively inducing infringement of one or more claims of the ’637 patent, either literally or under the doctrine of equivalents.

104. On information and belief, NEC JP alone and/or acting in concert with, directing and/or authorizing NEC US to make, use, sell or offer for sale in the United States or import into the United States the Accused Products, possesses an affirmative intent to actively induce infringement by others.

105. On information and belief, NEC US alone and/or acting in concert with, directing and/or authorizing NEC JP to make, use, sell or offer for sale in the United States or import into the United States the Accused Products, possesses an affirmative intent to actively induce infringement by others, including purchasers and end users who deploy and make use of the Accused Products.

106. NEC has intended, and continues to intend to induce infringement of the ’637 patent by others and has knowledge, with specific intent, that the inducing acts would cause infringement or has been willfully blind to the possibility that its inducing acts would cause the infringing acts. For example, NEC knowingly and actively induces infringement of the ’637 patent by encouraging, instructing, and aiding end users to use one or more of the Accused Products and/or by selling the Accused Products to others. NEC induces such infringement by, at a minimum, providing manuals, white papers, training, and/or other technical support with specific intent to induce purchasers and end users of the Accused Products to perform acts intended by NEC to cause direct infringement of the ’637 patent in the United States.

107. NEC also has been and is now contributing to the infringement of one or more claims of the ’637 patent, either literally or under the doctrine of equivalents.

108. On information and belief, NEC has actively, knowingly, and intentionally contributed and continues to actively, knowingly, and intentionally contribute to the infringement of the ’637 patent by having sold or offered to sell and continuing to sell or offer for sale the Accused Products within in the United States and/or by importing the Accused Products into the United States, with knowledge that the infringing technology in the Accused Products is especially made and/or especially adapted for use in infringement of the ’637 patent. NEC has contributed to the infringement by others with knowledge that the infringing technology in the Accused Products is a material part of the patented invention, and with knowledge that the infringing technology in the Accused Products is not a staple article of commerce suitable for substantial non-infringing use, and with knowledge that others including, but not limited to, resellers, distributors, customers, and/or other end users of the Accused Products, infringe and will continue to infringe the ’637 patent because, due to their specific designs, the Accused Products and components thereof do not have any substantial noninfringing uses. NEC has such knowledge at least because the claimed features of the ’637 patent are used by others including, but not limited to, resellers, distributors, customers, and/or other end users of the Accused Products.

109. On information and belief, NEC knew or should have known of the ’637 patent and has acted, and continues to act, in an egregious and wanton manner by infringing the ’637 patent. On information and belief, NEC’s infringement of the ’637 patent has been and continues to be willful and deliberate. The market for subsea telecommunication systems is small and contains a limited number of competitors, with Xtera being a known pioneer with whom NEC has great familiarity. Upon information and belief, NEC used the technology in the ’637 patent to develop and its Accused Products without permission from Xtera.

110. On information and belief, despite knowing that its actions constituted infringement of the ’637 patent and/or despite knowing that that there was a high likelihood that its actions constituted infringement of the patent, NEC nevertheless continued its infringing actions, and continues to make, use and sell its Accused Products.

111. NEC’s acts of infringement have injured and damaged Xtera. NEC’s wrongful conduct has caused Xtera to suffer irreparable harm resulting from the loss of its lawful patent rights to exclude others from making, using, selling, offering to sell and importing the patented inventions. Upon information and belief, NEC will continue these infringing acts unless enjoined by this Court.

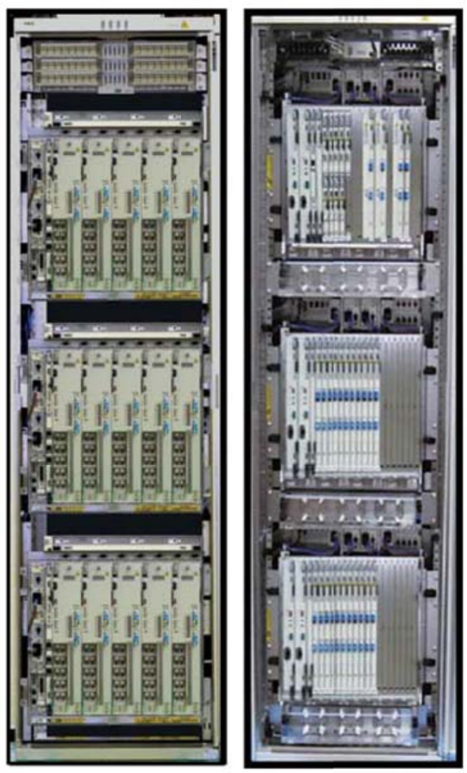
COUNT SIX – INFRINGEMENT OF THE ’331 PATENT

112. Xtera incorporates by reference its allegations in Paragraphs 1-111 as if fully restated in this paragraph.

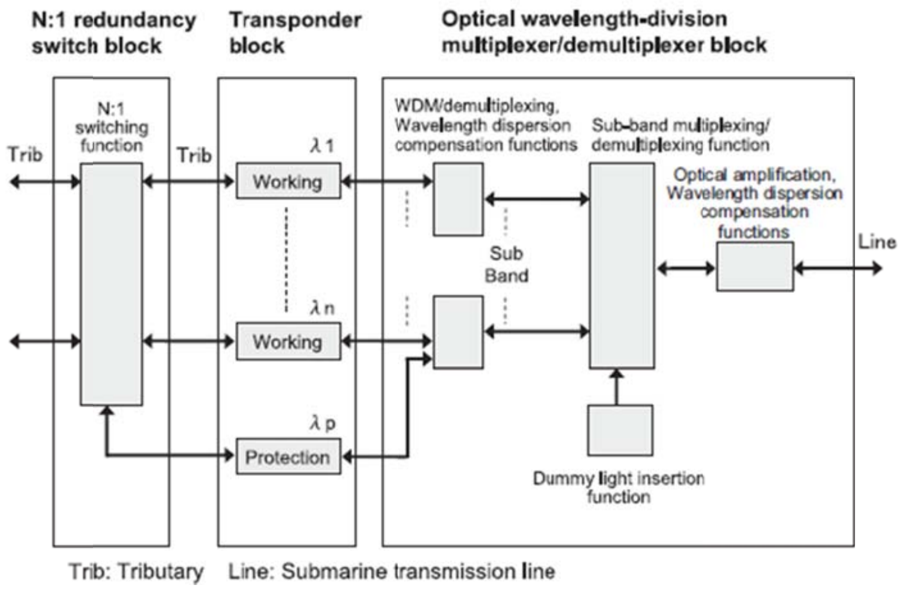
113. On information and belief, NEC has been and is now directly and/or indirectly infringing, literally and/or under the doctrine of equivalents, the ’331 patent by making, using, selling, and/or offering for sale in the United States, and/or importing into the United States, the Accused Products.

114. The ’331 patent is generally directed to an optical amplifier module where the pump lasers and control electronics are not integral. Claim 1 of the ’331 patent recites an apparatus for amplifying optical communication signals, comprising: at least two amplifier modules, each amplifier module comprising an optical amplifier and a plurality of plump lasers for each amplifier; and, a plurality of control modules separate from the amplifier modules, each control module adapted to control the output of a respective one of the pump lasers in each of the amplifier modules.

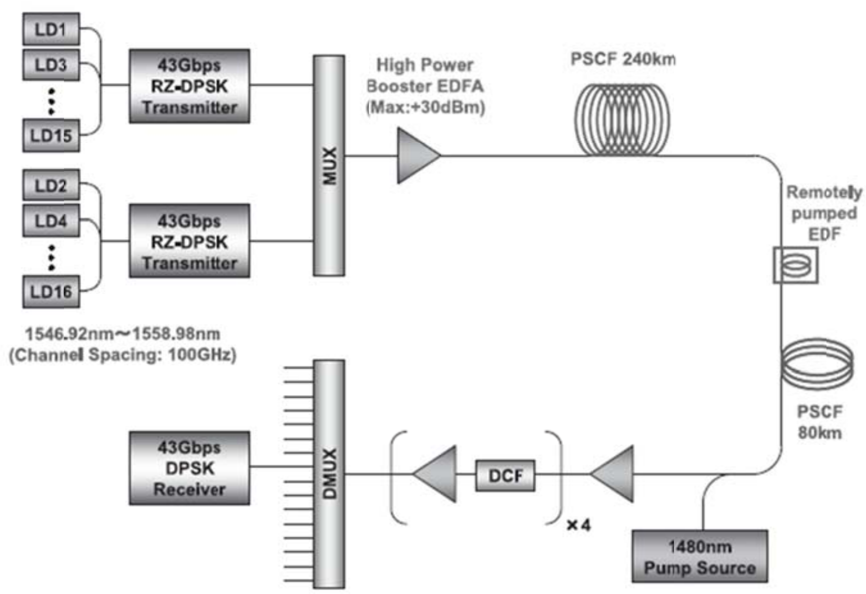
115. Upon information and belief, NEC's Accused Products infringe at least claim 1 of the '331 patent. For example, NEC's Accused Products provide at least two amplifier modules, each amplifier module comprising an optical amplifier and a plurality of plump lasers for each amplifier; and, a plurality of control modules separate from the amplifier modules, each control module adapted to control the output of a respective one of the pump lasers in each of the amplifier modules as shown, for example, below.



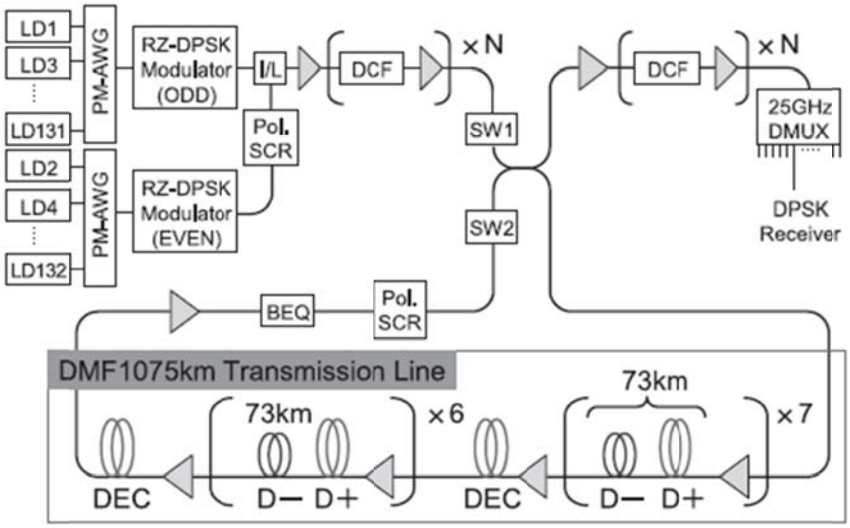
See NEC Corp., Telecommunications Cable Solutions Submarine Systems at (2014), *available at* http://www.nec.com/en/global/prod/nw/submarine/pdf/submarine-brochure.pdf.



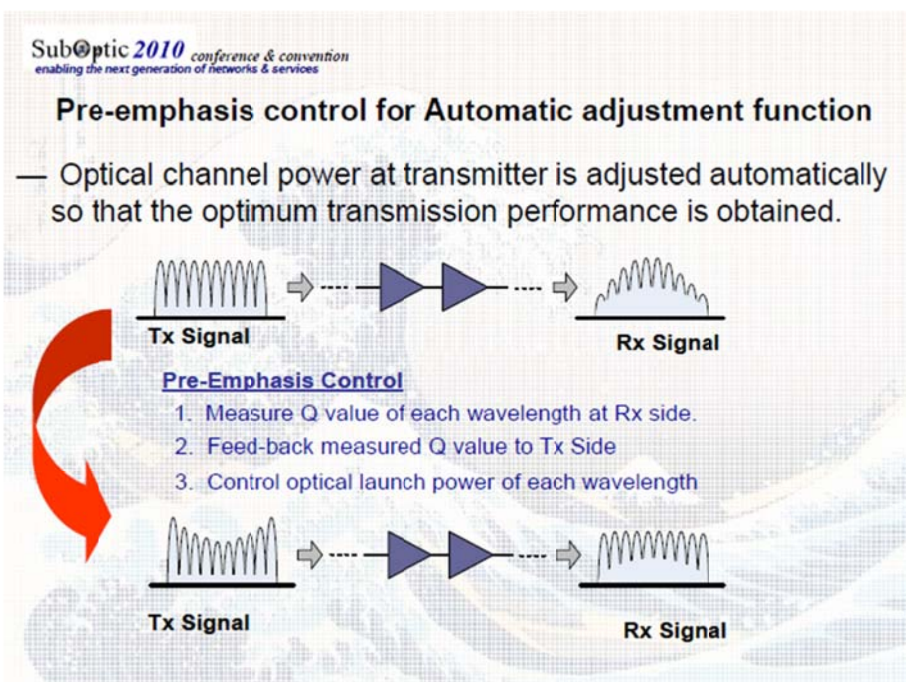
See, e.g., Sato et al., *Ultra-long Span Repeaterless Transmission System Technologies*, NEC Tech. J., Vol. 5 No. 1 (2010) at 25.



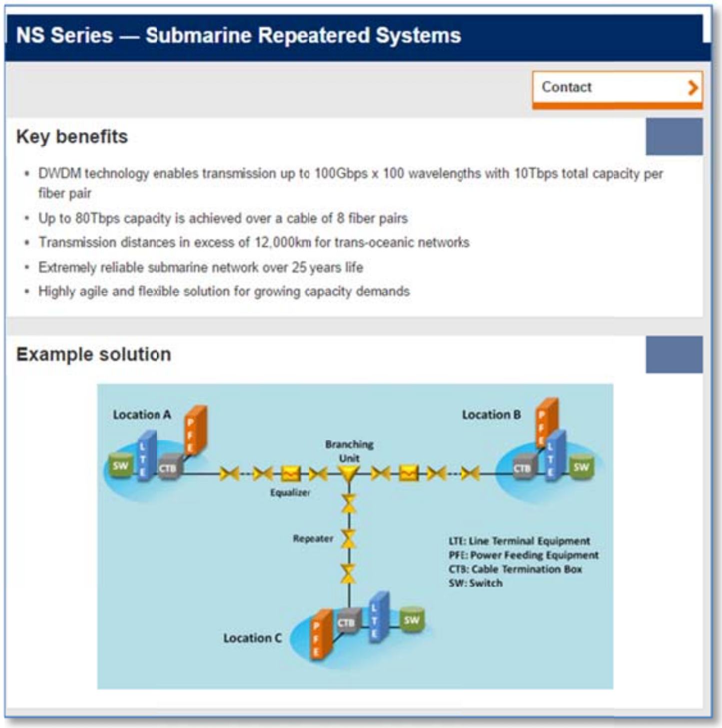
See, e.g., Inada, *Ultra-long Span Repeaterless Transmission System Technologies*, NEC Tech. J., Vol. 5 No. 1 (2010) at 53–54, *available at* http://www.nec.com/en/global/techrep/journal/g10/n01/pdf/100112.pdf.



See, e.g., Takanori, *Large-Capacity Optical Transmission Technologies Supporting the Optical Submarine Cable System*, NEC Tech. J., Vol. 5 No. 1 (2010) at 10.



See, e.g., Nakada, NEC Corp., Fully Flexible and Automated Submarine Line Terminating Equipment for Advanced DWDM Systems, SubOptic Conf., May 11, 2010, *available at* [http://suboptic.org/wp-content/uploads/2014/10/Presentation-241-Nakada-v1_SubOptic-2010-Oral-Presentation_LTE_20100511-2.pdf.](http://suboptic.org/wp-content/uploads/2014/10/Presentation-241-Nakada-v1_SubOptic-2010-Oral-Presentation_LTE_20100511-2.pdf)



See, e.g., NEC product literature at *http://www.nec.com/en/global/prod/nw/submarine/product/ns-series.html* (last visited November 14, 2017).

NS Series Lineup

Line Terminal Equipment T740SW

To meet the needs of transporting high-capacity DWDM signals over transoceanic distances, specialized Line Terminal Equipment is required. This equipment provides the function of translation between the terrestrial network and the undersea network.

Key features

- Highly Dense WDM Multiplexing and Demultiplexing
- Transmission capacity of up to 10Tbps (100 wavelengths @ 100Gbps) or 7.04Tbps (176 wavelengths @ 40Gbps) per fiber pair
- Up to 80Tbps (10Tbps x 8 fiber pairs) of cross-sectional capacity
- Various channel spacing designs (25GHz/33GHz/50GHz)
- Various and flexible tributary interfaces:
  - 100GbE, OTU4 (software switchable)
  - STM-256, OC-768, OTU3 (software switchable)
  - STM-64, OC-192, OTU2/2e, 10GbE LAN-PHY/WAN PHY (software switchable)
  - STM-16, OC-48
- Advanced soft decision forward error correction function
- Digital Coherent transponders provide automatic dispersion compensation and polarization demultiplexing
- Multiple modulation schemes available to optimize system capacity
- Simplified maintenance by plug and play scheme
- Extremely small footprint: up to 15 x 100G, 18 x 40G or 32 x 10G transponders per rack
- 100G, 40G and 10G transponders can be mixed in the same rack to optimize floor space and use of optical spectrum
- In-service upgrade without traffic interruption

Id.

Submarine Repeater R640SW

The NEC R640SW Submarine Repeater has been specially designed for fDWDM applications including 980nm pumped Erbium Doped Optical Amplifiers (EDFAs). This technology enables high power amplification for optimized repeater spacing, wide and flat amplification gain to allow for efficient channel packing density, and a lower noise figure which results in more capacity over longer distances with the highest reliability. Each standard repeater is designed to accommodate up to 8 amplifier systems.

Key features

- Specially designed for highly reliable DWDM applications
- Employs 980nm pumped ErbiumDoped Fiber Amplifiers
- Extremely reliable pumping with 4 pump laser diodes per amplifier pair
- Extremely reliable power circuits
- Wide and flat amplifier gain
- Low noise figure
- Accommodates up to 8 amplifier systems (fiber pairs)
- Ultra pressure-resistant housing for water depths up to 8,000m
- Compact size to facilitate deployment and shipboard handling

Id.

Newly Built Systems since 2001

Project	System Length	Total/Partial	In Service
APCN2	19,000 km	Total	2001
AJC	12,000 km	Total	2001
EAC2	7,800 km	Total	2002
Algiers-Palma Cable	310 km	Partial	2002
HMC	280 km	Total	2002
TIS	1,100 km	Total	2003
AUFS-West	2,500 km	Total	2004
DMCS	150 km	Total	2004
JASUKA	1,800 km	Total	2006
BLCS	320 km	Total	2006
EAC1 Qingdao Extension	350 km	Total	2006
DSCN	1,100 km	Total	2007
Russia-Japan Cable Network	1,800 km	Total	2008
Trans-Pacific Express	17,200 km	Partial	2008
Hokkaido Sakhalin Cable System	560 km	Total	2007
Batam Singapore Cable System (BSCS)	98 km	Total	2009
Jakabare	1,400 km	Total	2009
Asia America Gateway	20,000 km	Partial	2009
Unity	9,500 km	Partial	2010
I-ME-WE	12,000 km	Partial	2011
Dhiraagu Domestic Submarine Cable (DDSCN)	1,000 km	Total	2012
Asia Submarine-cable Express (ASE)	7,200 km	Partial	2013
South-East Asia Japan Cable System (SJC)	8,900 km	Partial	2013
Sulawesi Maluku Papua Cable System (SMPCS) Packet-2	3,500 km	Total	2015
FASTER Cable System	11,500 km	Total	2016
Asia Pacific Gateway (APG)	10,400 km	Total	Ongoing
TPKM3	500 km	Total	Ongoing
SEA-ME-WE 5 Cable System (SMW5)	20,000 km	Partial	Ongoing
SOUTHEAST ASIA UNITED STATES Cable System (SEA-US)	14,500 km	Total	Ongoing
Asia Africa Europe 1 (AAE-1) S-1H Hong Kong Extension	2,900 km	Total	Ongoing
South Atlantic Cable System (SACS)	6,200 km	Total	Ongoing
System Kabel Rakyat 1 Malaysia (SKR1M)	3,700 km	Total	Ongoing
ATISA	279 km	Total	Ongoing
Indonesia Global Gateway (IGG)	5,300 km	Total	Ongoing

Newly Built Ocean Bottom Sensor Systems

Project	System	Total/Partial	In Service
DONET II (JAMSTEC)	Node System	Total	Ongoing
Japan Trench OBSS (NIED)	In-line System	Total	Ongoing
Eastern Taiwan OBSS (CWB, Taiwan)	Node System	Total	2011
DONET (JAMSTEC)	Node System	Total	2010
Omaezaki OBSS (JMA)	In-line System	Total	2008
(Before 2001)			
Kushiro OBSS (JAMSTEC)	In-line System	Total	1999
Muroto OBSS (JAMSTEC)	In-line System	Total	1997
Hiratsuka OBSS (NIED)	In-line System	Total	1996
Kamaishi OBSS (NIED)	In-line System	Total	1996
Ito OBSS (ERI-University of Tokyo)	In-line System	Total	1993
Katsuura OBSS (JMA)	In-line System	Total	1986
Omaezaki OBSS (JMA)	In-line System	Total	1979

Capacity Upgrades since 2001

Project	In Service	Project	In Service	Project	In Service
APCN2 Upgrade	2001	JASUKA 2008 Upgrade	2009	DMCS Upgrade	2013
FEA Upgrade	2003	SUB 2008 Upgrade	2009	AUFS Upgrade	2013
JIH Upgrade	2004	MDSCS Upgrade	2009	HMC Upgrade	2013
HMC Upgrade	2004	AUFS Upgrade	2009	JIH Upgrade	2013
JIH Upgrade	2005	JIH Upgrade	2009	APCN2 Stage 2e Upgrade	2013
AUFS-East Upgrade	2005	PamAm Upgrade#1	2010	JSSC#1	2013
MDSCS Upgrade	2005	AUFS Upgrade	2010	JAKABARE Upgrade#1	2013
HMC Upgrade	2005	JASUKA 2009 Upgrade (PO#1)	2010	JASUKA 2012 Upgrade (PO#1)	2013
TJP-PTK Upgrade	2006	JASUKA 2009 Upgrade (PO#3)	2010	EAC Pacific 2nd Upgrade 2013	2013
EAC1 Qingdao Upgrade	2006	JASUKA 2009 Upgrade (PO#5)	2010	APCN2 Stage 2f Upgrade	2014
Maya-1 Upgrade#2	2006	AJC 30G Upgrade	2010	SJC Upgrade#1	2014
EAC2 Upgrade	2006	JIH Upgrade	2010	AUFS-East/West Upgrade	2014
APCN2 Upgrade	2006	HMC Upgrade	2010	JASUKA 2012 Upgrade (PO#2)	2014
JIH Upgrade	2006	EAC1 & EAC2 Upgrade	2011	SUB Upgrade (PO#1 and PO#2)	2014
APCN2 Upgrade	2007	APCN2 Stage1e/2b Upgrade	2011	JASUKA 2012 Upgrade (PO#3 and PO#4)	2014
JASUKA 2007 Upgrade	2007	MOC Upgrade	2011	JASUKA 2012 Upgrade (PO#5)	2014
SUB Upgrade	2007	APCN2 Stage 2c Upgrade	2011	APCN2 Stage 2g Upgrade	2014
JIH Upgrade	2007	JIH Upgrade	2011	SUB Upgrade (PO#3)	2015
HMC Upgrade	2007	EAC PACIFIC Upgrade	2011	PanAm Upgrade#2	2015
APCN2 Upgrade	2008	JASUKA 2009 Upgrade (PO#7)	2011	AUFS East and West 100Gbps Upgrade	2015
AJC Upgrade	2008	JIH Upgrade	2012	APCN2 Stage 2h Upgrade	2015
Azores Upgrade	2008	MOC Upgrade	2012	SUB Upgrade (PO#4)	2016
Maya-1 Upgrade#3	2008	APCN2 Stage 1g/2d Upgrade	2012	JSSC#2	Ongoing
AUFS-East Upgrade	2008	AUFS Upgrade	2012	JAKABARE Upgrade#2	Ongoing
AUFS-West Upgrade	2008	HMC Upgrade	2012		
JIH Upgrade	2008	Russia Japan Cable Network Upgrade	2012		

See, e.g., NEC's listing of its subsea systems at *http://www.nec.com/en/global/prod/nw/submarine/aboutus/record/index.html* (last visited November 14, 2017).

116. NEC has had knowledge of the '331 patent at least since the filing this Complaint.

117. NEC also has been and is now actively inducing infringement of one or more claims of the '331 patent, either literally or under the doctrine of equivalents.

118. On information and belief, NEC JP alone and/or acting in concert with, directing and/or authorizing NEC US to make, use, sell or offer for sale in the United States or import into the United States the Accused Products, possesses an affirmative intent to actively induce infringement by others.

119. On information and belief, NEC US alone and/or acting in concert with, directing and/or authorizing NEC JP to make, use, sell or offer for sale in the United States or import into the United States the Accused Products, possesses an affirmative intent to actively induce infringement by others, including purchasers and end users who deploy and make use of the Accused Products.

120. NEC has intended, and continues to intend to induce infringement of the '331 patent by others and has knowledge, with specific intent, that the inducing acts would cause infringement or has been willfully blind to the possibility that its inducing acts would cause the infringing acts. For example, NEC knowingly and actively induces infringement of the '331 patent by encouraging, instructing, and aiding end users to use one or more of the Accused Products and/or by selling the Accused Products to others. NEC induces such infringement by, at a minimum, providing manuals, white papers, training, and/or other technical support with specific intent to induce purchasers and end users of the Accused Products to perform acts intended by NEC to cause direct infringement of the '331 patent in the United States.

121. NEC also has been and is now contributing to the infringement of one or more claims of the '331 patent, either literally or under the doctrine of equivalents.

122. On information and belief, NEC has actively, knowingly, and intentionally contributed and continues to actively, knowingly, and intentionally contribute to the infringement of the '331 patent by having sold or offered to sell and continuing to sell or offer for sale the Accused Products within in the United States and/or by importing the Accused Products into the United States, with knowledge that the infringing technology in the Accused Products is especially made and/or especially adapted for use in infringement of the '331 patent. NEC has contributed to the infringement by others with knowledge that the infringing

technology in the Accused Products is a material part of the patented invention, and with knowledge that the infringing technology in the Accused Products is not a staple article of commerce suitable for substantial non-infringing use, and with knowledge that others including, but not limited to, resellers, distributors, customers, and/or other end users of the Accused Products, infringe and will continue to infringe the ’331 patent because, due to their specific designs, the Accused Products and components thereof do not have any substantial noninfringing uses. NEC has such knowledge at least because the claimed features of the ’331 patent are used by others including, but not limited to, resellers, distributors, customers, and/or other end users of the Accused Products.

123. On information and belief, NEC knew or should have known of the ’331 patent and has acted, and continues to act, in an egregious and wanton manner by infringing the ’331 patent. On information and belief, NEC’s infringement of the ’331 patent has been and continues to be willful and deliberate. The market for subsea telecommunication systems is small and contains a limited number of competitors, with Xtera being a known pioneer with whom NEC has great familiarity. Upon information and belief, NEC used the technology in the ’331 patent to develop and its Accused Products without permission from Xtera.

124. On information and belief, despite knowing that its actions constituted infringement of the ’331 patent and/or despite knowing that that there was a high likelihood that its actions constituted infringement of the patent, NEC nevertheless continued its infringing actions, and continues to make, use and sell its Accused Products.

125. NEC’s acts of infringement have injured and damaged Xtera. NEC’s wrongful conduct has caused Xtera to suffer irreparable harm resulting from the loss of its lawful patent rights to exclude others from making, using, selling, offering to sell and importing the patented

inventions. Upon information and belief, NEC will continue these infringing acts unless enjoined by this Court.

PRAYER FOR RELIEF

WHEREFORE, Xtera respectfully requests that this Court:

a. enter a judgment that Xtera is the owner of all right, title, and interest in and to the Asserted Patents, together with all the rights of recovery under such patents for past and future infringement thereof;

b. enter a judgment that NEC has infringed each of the Asserted Patents;

c. enter a judgment that the Asserted Patents are valid and enforceable;

d. permanently enjoin NEC, their parents, subsidiaries, affiliates, agents, servants, employees, attorneys, representatives, successors and assigns, and all others in active concert or participation with them from infringing the Asserted Patents;

e. order an award of damages to Xtera in an amount adequate to compensate Xtera for NEC's infringement, said damages to be no less than a reasonable royalty;

f. enter a judgment that the infringement was willful and treble damages pursuant to 35 U.S.C. § 284;

g. order an accounting to determine the damages to be awarded to Xtera as a result of NEC's infringement, including an accounting for infringing sales not presented at trial and award additional damages for any such infringing sales;

h. assess pre-judgment and post judgment interest and costs against NEC, together with an award of such interest and costs, in accordance with 35 U.S.C. § 284;

i. render a finding that this case is "exceptional" and award to Xtera its costs, expenses and reasonable attorneys' fees, as provided by 35 U.S.C. § 285; and

j. grant such other and further relief as the Court may deem proper and just.

DEMAND FOR A JURY TRIAL

Xtera hereby respectfully requests a trial by jury of all issues so triable, pursuant to Rule 38 of the Federal Rules of Civil Procedure.

Dated: December 29, 2017

Respectfully submitted,

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