I had a glass of wine the other day at Covent Garden with a business customer and friend.

He had recently procured an Apple iPhone, and was telling me about all the neat things he could now do on the fly; my Android seemed to pale in comparison.

He then mentioned how, at the behest of one of his children, he had added Twitter to his applications, but had spent a fair amount of time trying to find areas of real interest. The social nature of the system didn't really excite him. One day he searched, "s u b m a r i n e c a b l e s," and was surprised when SubTel Forum's Twitter feed came up.

"It's brilliant," he confided. "I can keep up on things without really working."

I tried my best not to look surprised, but probably failed. All I could utter was that I preferred RSS feeds tied to my laptop, and that was where I got most of my info.

But I sure am happy the boys in the backroom got that one covered. And maybe the next time someone mentions Twitter or some other cool medium I'll look a little more composed and sure-footed.
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Microsoft to buy Skype for $8.5 billion
MTN Ghana to unveil WACs cable Friday
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New Variable Attenuator and Optical Switch Products
NTT Com Services Gradually Restored
Offshore Marine Management to install Greater Gabbard array cabling
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Pacific Fibre appoints Bank and Investment Banks
Pacific Fibre Invites Tenders for N.Z. Undersea Cable Project
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Pacnet to Enhance Connectivity to India through New Partnership
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Seacom expands Pan-African Network
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WACS to double SA’s broadband capacity
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Subsea Capacity Analytics

Average Added Global Capacity 2009-2013

Total Added Global Capacity 2009-2013
The Benefits of Remotely Operated OTDRs
For Submarine Cable Deployment, Fiber Monitoring and Restoration

Olivier Plomteux
This article discusses application and use of classical OTDRs for remote control of submarine cable installation and fault management-related activities. It presents an out-of-the-box monitoring and remote test solution that can be installed at the terminal stations of unrepeated links of up to 400 km. For links equipped with repeaters, the solution tests up to the first repeater, or up to 250 km if a fiber is passively dedicated to OTDR-testing purposes. An attenuation decrease of a few tenths of a decibel can be detected and localized and tracked down, and cuts can be localized with meter-level accuracy in terms of cable/fiber sheath length. Extra loss incurred to a section can also be detected and reported in seconds following the event.

Close to the shore requires more attention

For network operators, waterways represent a cost-effective alternative to terrestrial routes when a route has to be constructed for linking two cities or any two landing points—either a festoon-style path connecting two points along the coast, a connection from an island to the mainland, or a connection from platform at sea to the continent. Such cables remain relatively close to the coast, and rest at seabed levels, typically a few meters to a few hundred meters deep. Keeping these cables free from any major defect becomes challenging due to human activities such as fishing, trawling and anchoring. The worst locations are heavy traffic areas like channels and straits.

As depicted above, most cable damages occur close to the coast, and likely can be repaired quickly, with an optimized selection of equipment and resources. Despite the availability of a good quantity of effective technologies and tools, the repair process of a cable remains quite long, stretching from days to weeks in some cases. Although the solution presented here will not dramatically improve these figures on its own, it can be used in association with these other technologies in order to cut the overall time-to-repair, likely reduce the manpower involved mainly for optical testing and, in some cases, even increase the number of situations where preventive actions can be conducted before the whole cable is lost.

Unrepeated links and the evolution of submarine cable design

Unrepeated submarine links, by design, do not require copper sheath nor power feed equipment (PFE); this creates a situation where fault localization techniques based on shunt fault cannot be used. Most cables will nevertheless integrate an electrically conductive material, copper sheath or tape, to propagate high-voltage injection of tones in order to track the cable route from the vessel, and help localize the actual point of failure, used in a submarine remotely operated vehicle (ROV) or by divers in shallow waters. OTDRs are likely to become a more common means of measuring optical continuity in repeater-less cable systems, due to the intrinsic nature of cable designs for this application.

Remote stations and monitoring requirements

It may often be advantageous to bring the cable back on the shore to optically regenerate the signals, and this is particularly true on coastal routes. Remote stations are subject to damage either from thieves or from vandalism, especially in cases where the cables cannot be totally hidden and protected. A remotely
accessible optical test instrument such as an onsite OTDR, which can continuously check one or many fibers in one or many cables, can make a huge difference in terms of reaction and restoration time in case of malicious attacks. Not only must this equipment be able to detect and determine the sheath length of the fault, but it must also be able to quickly alert one or many individuals that a cable outage has occurred—or even better, is soon to occur. EXFO’s Fiber Guardian is a test and network maintenance solution that can be deployed at strategic points of the submarine cable network, providing direct and remote access to fiber condition from virtually anywhere.

**Typical implementation**

In the scenario below (two fictive cable routes), we have three landing points: Roma, Napoli and Palermo. The Roma to Napoli section is approximately 300 km long and can be managed with a repeater-less system. The Napoli to Palermo section is less than 400 km long and can also be deployed without the use of repeaters. Test units will be located at each terminal station, incorporating a 1 x n optical switch for path switching. In an ideal case, one fiber per cable is reserved to be connected directly to the test unit through the optical distribution frame (ODF). We will identify it as the “dark” fiber. All other live fibers can be connected to the test unit through a multiplexer (FWDM) to avoid the need to go onsite when a test path must be created to any fiber of the cable. The live fiber testing can be done while transmission signals are “on” or “off.”

In this example, the entire cable can be tested from both sides. This requires the OTDR to use a longer pulse width and test durations of about 1 minute per fiber for measuring a fiber end/cut at 40 dB attenuation. The dark fiber can be used to monitor the cable and in case of cut, the cable length at which the fiber is broken can be measured with a precision that will vary according to distance from the unit, as per values presented in table 1.

In the above implementation, the dark fiber is tested at 1550 nm in one direction and at 1625 nm in the other, because one unit cannot test much beyond 40 dB attenuation. The graph below presents a baseline trace taken with a best-in-class ultra-long-haul OTDR over a submarine link of about 300 km. Taking into account the injection loss induced by the optical switch and jumper cable, the graph clearly shows the capability to cover a length of more than 200 km from a single-end OTDR instrument.

Rejection of the 1550 nm OTDR signal on the opposite side enables testing of the same fiber from both sides—without any consideration if the opposite side unit is testing or not. For live fibers possibly carrying traffic, the test is performed at 1625 nm from both sides; in this case, measurements therefore should be taken by a single operator or application, so that the test is running from one side at
a time. Obviously, for links of up to 200 km, single-ended testing is possible, but without the resolution that dual-ended testing would provide.

Table 1. Typical fault location uncertainty in terms of fiber distance to a point of failure, based on the distance from the OTDR unit.

<table>
<thead>
<tr>
<th>Fiber length to fault (km)</th>
<th>1.25</th>
<th>10</th>
<th>40</th>
<th>200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fault location uncertainty (typ) m +/-</td>
<td>1</td>
<td>2</td>
<td>5</td>
<td>18</td>
</tr>
</tbody>
</table>

Although the measurement range performance can be impaired when testing live fiber compared to dark, due to the increased level of Raman-generated spontaneous noise scattered back to the OTDR wavelength band, there is a major advantage in being able to test all fibers from the station without having to send anyone onsite for optical connection; this way, measurements can be performed totally remotely, from the ship, from the network operation center or from elsewhere.

The above fault location uncertainty figures assume the individual-fiber-to-cable-length “scale factor” is known and specified as part of the OTDR test parameters. This factor must be “calibrated” when the cable is constructed; otherwise it can be done when the cable is actually laid, so that the OTDR’s reach from start to end of each cable section is referenced to a location on the ship route, and then by computation on the seabed. For submarine routes, an important difference may exist between the actual cable position on the seabed and the position of the ship where the cable touches water. Computation of ship route and actual cable position when it touches down (in latitude, longitude and depth) assuredly represents a critical aspect—to some extent a precondition—for the valuable use of any optical-based fault localization method.

**Remote connectivity enables effective cable testing**

Once installed and hooked to the cable to be tested or monitored, if the unit supports Web access, it is connected to a LAN/WAN over Ethernet/TCP/IP. This enables the NOC or remote users to access the unit for configuration or testing purposes from virtually anywhere. If a monitoring routine on one or many fibers is started, users can receive programmed alerts, should the fiber(s) degrade or break. Those alerts can be short-messaging service (SMS) text messages sent from a modem on the unit directly to any type of mobile phone for immediate notification—within seconds from the time the unit detects fault conditions. Testing and configuration functions are accessible through a Web browser. The type of instrument can typically be interfaced over SNMP to provide integration with network management or supervision systems.
Figure 4. A remote optical fiber test and monitoring unit can connect to one or many cables from a terminal station and become a tool that any installation and maintenance team member can use.

Verification and measurements when cable is laid down

As the test unit is typically equipped with an internal optical switch unit, it can test all the fibers while the cable ship is laying down the cable. From the terminal station to where the cable hits water, monitoring on all fibers can be done to ensure the process can be stopped and cable integrity verified, if cable conditions, from an optical quality standpoint, change significantly. Fault detection thresholds as small as 0.05 dB can be applied while the cable is being buried. Access to fault informations such as raw OTDR measurements can be gained from the ship or from the network operation center, as depicted above, using a simple Web browser.

Typical remote OTDR test and monitoring applications in submarine cable systems

As discussed in the previous chapter, an OTDR and optical switch installed at the terminal station of a cable can serve numerous needs and applications.

- Monitor a cable of up to 200 km and alert one or many team members of possible issues with the cable
- Help measure actual fiber to cable length “scale factor” if cable spans are spliced on the cable ship before immersion
- When supporting a repair crew, test splice quality in real time from the terminal station
- Test a fiber that was dark for a long time prior to service activation
- More accurately measure time-to-repair and decrease dependence on repair crews
- Speed up reaction in case of malicious attacks on coastal cables

Outer-diameter sensory fibers for early warning of cable stress

The cost of submarine cable repairs, the huge manpower involved and the number of such events worldwide will force operators to look into new ways to reduce their submarine cable installation and maintenance expenses. The OTDR surveillance of a few sensory fibers in the outer sheath of the cable—e.g., one per quadrant—would provide early warnings for possible cable intrusion in a more preventive approach. The health and condition of these fibers would assuredly be representative of the overall cable condition. In such a case, choosing commercially available remote test and monitoring equipment based on OTDR technology traditionally developed for terrestrial applications could serve even better.
Figure 5. The remote optical fiber test and monitoring unit can support cable installation, especially for the buried portion.

Figure 6. Added to classical submarine cable construction, very standard optical fibers added into the cable polyethylene outer sheath could serve as sensors, and work in conjunction with OTDR remote test systems to provide early warnings of cable outages.

Olivier Plomteux, the Product Line Manager for EXFO Inc., has been managing optical cable and fiber monitoring products & solutions for past 5 years. He joined EXFO in 1997 and occupied various positions in product line management always in close connection with test and measurement technologies. He holds a master degree in laser physics from Quebec University Laval.
Check Your Mail Box this Month!
2011 SubTel Forum Awards

The Nominees
In March, we asked our readers to submit nominations for the 1st Annual SubTel Forum Awards. Our readers have responded in force. The following companies and individuals have been nominated:

**Innovation Award**

**Ciena**

Ciena has been on the forefront of innovation in submarine networking since 2008, providing operators with its market leading 40Gbit/s and 100Gbit/s technology – already deployed the world over in high-capacity terrestrial optical networks – to increase submarine network capacity without any major change to service providers’ existing infrastructure and, in fact, allowing service providers to get more leverage out of depreciating network solutions. Its broad portfolio of solutions feature innovations in key submarine-enabling technology development, such as volume-deployable 40G/100G interfaces, FEC, automated control plane mesh restoration, Raman application and ROADM. Solutions include the ActivFlex 6500, the ActivFlex 5400 series, CoreDirector FS and ActivSpan Common Photonic Layer. Ciena also provides submarine edge termination series with the ActivSpan 4200, ActivFlex 6500 and ActivSpan 565. Applications include:

- **40G/100G Capacity**: in certain cases, submarine fiber cable is already in place, carrying 2.5G and/or 10G channels which are nearing full capacity. Ciena’s optical submarine transport solutions are used to expand network capacity, providing the ability to upgrade to 40G or 100G without extensive network re-engineering or massive re-cabling costs. Ciena’s 40G/100G Adaptive Optical Engine interfaces employ advanced modulation techniques, coherent detection, and advanced digital signal processing to allow for 10Gbps-like transmission performance at 40Gbp and 100Gbps line rates, resulting in simple optical span engineering, strong performance over lossy spans, and highest capacity per cable.

- **Undersea mesh protection**: Ciena’s CoreDirector FS Packet-Optical Switch and ActivEdge 5430 Reconfigurable Switching System enable resilient submarine and terrestrial end-to-end worldwide networks with automated control plane-based mesh restoration. Ciena’s “FastMesh” technology on these packet-optical switching platforms can aggregate capacity from multiple cable systems into a bandwidth pool and optimize usage and automate restoration decisions, lowering resource costs, providing greater levels of flexibility, and creating the highest level of network survivability.

In the last year alone, Ciena has signed 10 submarine networking deployments based on its vision and innovation in the market in terms of cost-effective ways to deliver increased capacity from existing networks while maximizing network reliability. For example, in January 2011, the company announced it is working with international operator Reliance Globalcom to deploy a 40Gbit/s optical solution on a cable route that connects the U.K., Spain, Italy and Egypt. Reliance deployed Ciena’s ActivFlex 6500 Packet-Optical Platform with 40Gbit/s interfaces to increase the submarine network capacity without disrupting existing customer traffic or adding cost and complexity to the network.
And in February 2011, Ciena announced a deal with SEA-ME-WE 4, where the company is providing optical switching equipment for all 16 cable landing sites as well as for 100G transport for an upgrade of the terrestrial link connecting Alexandria to Suez in Egypt. Ciena is providing its multi-terabit ActivFlex 5430 Reconfigurable Switching System at cable landing stations and ActivFlex 6500 Packet-Optical Platform, equipped with coherent 100G optics, for the upgrade to 100G of the terrestrial link in Egypt and part of the terrestrial SDH.

In terms of survivable optical mesh networks, Ciena has been the market leader for years. Verizon Business’ transatlantic and transpacific mesh networks, based on Ciena’s intelligent control plane technology, were built to survive multiple failures while simultaneously increasing wavelength utilization compared to traditional ring-based architectures. This was very successfully put to the test in August of 2009 when an earthquake hit the Luzon Strait south of Taiwan, and earlier this year with the earthquake and tsunami in Japan. Within milliseconds of this catastrophes causing cable faults for customers, Ciena’s mesh networking technology rerouted traffic around the issues.

Ciena’s intelligent control plane-based mesh restoration solution is used in other transatlantic mesh networks and in transpacific and regional submarine networks routes operated by other carriers. Furthermore, in an effort to improve global resiliency, these carriers are combining both terrestrial and submarine mesh domains to create one large, resilient, mesh-based global network.

EASSy
The East African Submarine System (EASSy) is a wonderful example of a successful public-private partnership, bringing together the financial backing of Developmental Finance Institutions - including the World Bank, African Development Bank and European development banks - with the expertise and stability of 26 international and African telecommunications carriers and licence holders.

EASSy is a 10,000km submarine cable system that is interconnecting 9 countries along the east coast of Africa – running between Mtunzini, South Africa and Port Sudan, Sudan. The system, which cost US$263 million, went live on 30th July 2010.

At 4.72 Tbps, EASSy is the highest capacity submarine cable serving Africa and it is interconnecting with multiple international submarine cable networks for diverse, seamless, onward connectivity to Europe, USA, the Middle East and Asia. It is the first submarine system to deliver direct connectivity between eastern Africa and Europe, and it offers the lowest latency
routing of any east coast system to the key internet content in Europe and North America. EASSy consortium members in Africa are also linking together their own national fibre-optic networks to create the most comprehensive fibre network in sub-Saharan Africa, with the aim of interconnecting 21 countries across the region to the EASSy system. The arrival of EASSy has brought submarine system diversity to a region that two years ago was only reachable by satellite.

The EASSy system was completed on time and within budget – representing a huge success given the complexity of the project. Permits were secured and surveys undertaken across 9 separate administrations. Over 10,000km of optical fibre - together with the subsea equipment (repeaters and branching units) that is key to its functionality - was manufactured, integrated and deployed (over nearly five months) on or under the seabed. Nine landing stations were constructed or refurbished, fitted out with leading-edge optical and power equipment and management systems, and interconnected with terrestrial fibre-optic networks and the EASSy cable. Even after the deployment itself was complete, two months of testing were undertaken to ensure the integrity and performance of the system before launch at end-July 2010. EASSy is now providing high-quality, high-performance internet, voice and data connectivity to businesses and consumers across a growing number of locations and markets throughout eastern and southern half of Africa.

**IHS Fairplay**

IHS Fairplay aims to be the preferred global provider of maritime information to the shipping industry and strives to achieve the highest standards of product quality and customer service. IHS Fairplay invest time and resource to identify new data sources with the purpose of continually improving the quality and scope of the data and to seek partnerships with key sectors of the industry with the aim of delivering higher added-value to its range of products and services.

AISLive was the first global Automatic Identification System (AIS) network providing access to real-time ship movements data since 2004, and is currently the ONLY source of satellite and terrestrial AIS information. Today, the award-winning service provides coverage across five continents, up to 54,000 vessels covered every day and the latest positions for over 80,000 ships and is relied upon by communications companies, charterers, civil authorities, port authorities, ship agents, brokers, and owners for timely and accurate information. IHS Fairplay have built up an excellent working relationship with British Telecommunications Plc since 2006, collaborating to assist with developing the AISLive network.

British Telecommunications rely on the AISLive data to protect both national and international connectivity of the UK and other important regions of the world. Using the live data has greatly assisted their work practices, to help protect the submarine cables from damage from passing or anchored vessels.

IHS Fairplay have replicated this great working relationship with other communication companies who also use the AISLive data for similar purposes.

Trevor Taylor, Senior Cable Engineering Manager states: “BT have enjoyed working with IHS Fairplay in developing the AISLive network and data feed service that is used to protect both national and international connectivity of the UK and other regions of the world. The technical service provided by IHS Fairplay has exceeded our expectations with assistance given to local telco’s worldwide in successfully setting up receivers and connecting to the server. The reliability of the service has been excellent with an almost 100% record of availability.”

**Achievement**
GlobeNet
Within one year, GlobeNet, who owns and manages its own lowest latency, submarine fiber-optic cable system connecting North and South America, has been expanding into new markets, as well as upgrading its network in anticipation of its customers' rising bandwidth needs.

In September 2010, GlobeNet announced its expansion into Colombia. This expansion includes diverse rings providing secure connectivity to the wholesale carrier market, as well as direct routes to Brazil, Bermuda, the US and Venezuela. GlobeNet's expanded reach was also marked by the opening of GlobeNet's first office and International Point of Presence (iPoP) in Bogota. GlobeNet also became the only global carrier to offer a diverse route to and from Colombia by providing services via the eastern border.

Additionally, the company recently extended its reach into Manaus, Brazil, the capital of the free-trading Amazon. GlobeNet's high-performance capacity will support the area's need for new and advanced Internet services and technologies, to greatly improve data communications in this region. As a free trade zone and the largest city in Northern Brazil, Manaus attracts many Brazilian and multi-national companies, creating an industrial center in the heart of the Amazon. The additional fiber infrastructure to this area will improve communications, increase trade opportunities and could attract further investment, both locally and internationally.

This March, GlobeNet announced the completion of its 200 Gbps upgrade of its submarine fiber optic cable system. This upgrade increased the company's total lit capacity to 560 Gbps, in order to support increased bandwidth demand due to the widespread adoption of advanced technologies and telecommunications services, especially in South America's quickly-growing markets. This demand has been driven by the increased use of high-end services, such as streaming media, online gaming, high-definition (HD) video, social media applications and other bandwidth-intensive services. Additionally, the GlobeNet network is preparing to handle the data and transmission for upcoming Global sporting events, such as the 2014 World Cup in Brazil and the 2016 Olympics to be hosted in Rio de Janeiro.

Lastly, GlobeNet is planning an additional network upgrade later this year that will offer more than 1 Terabyte of total capacity.
John Hibbard
I wish to nominate Mr John Hibbard of Hibbard Consulting Limited (author of an article the most recent addition of your magazine) for this award. To provide you with some background for this nomination: I am the founder and CEO of Interchange Limited - a company with a mandate to install and operate Vanuatu’s first submarine telecommunications cable that will link Port Vila to Suva, Fiji.

I have (literally today) signed a submarine cable supply contract with ASN, and our cable is scheduled for completion mid 2012. John Hibbard has been the principal consultant for the duration of the cable project, and I can credit him with being a key reason for the success of the venture to date.

John initiated regional negotiations and assisted with most of the meetings that took place to get the ball rolling and keep it rolling over the past 2 years. His professional expertise allowed for the successful and trouble-free coordination of the RFT process. And as the project has been progressing, Mr Hibbard’s input into the strategic direction that should be taken has proven to be of immense value.

The Interchange Submarine Cable project will be expanding according to plan (developed with John’s assistance) to provide for network diversity in Vanuatu, and we will continue to call upon John’s input. Not only is he a professional with unparalleled experience in the submarine telecommunications field, but he is a diligent and considerate team player that enhances any project with which he is involved.

I wish to voice my strong support for Mr Hibbard and put forward a unanimous vote for his prowess from the team at Interchange Limited.

Hibernia Atlantic
Hibernia Atlantic’s Global Financial Network is continuing to push its borders with lowest latency routing options and extended reach. Hibernia just announced its plans to construct the lowest latency transAtlantic submarine fiber optic cable network, with sub 60 ms latency, connecting New York to London. This will be a first in transAtlantic cable history. We call this Project Express.

A state-of-the-art submarine network build, Express will be the shortest route from New York to London that will initially be lit with 40G technology and can be upgraded to 100G technology in the future. Express includes an entirely new, all marine, four-fiber pair, transAtlantic optic cable system. This new route, which will be the first new transAtlantic cable in nearly ten years, is significantly lower latency than all other transAtlantic cable systems.

“Demand for low latency routes has grown exponentially over the past several years,” states Bjarni Thorvardarson, CEO of Hibernia Atlantic. "Project Express will offer the lowest latency from New York to London and provide demanding customers..."
the speed and accuracy they require.” Furthermore, the new Express transatlantic cable will allow customers to reach other key financial cities and will offer lowest latency connections between Frankfurt and London and into Chicago, New York City and Toronto.

Main One
Main One was the first undersea submarine fiber optic cable to land in Ghana and Nigeria to accelerate Internet penetration in West Africa. It provides an open access (no commercial discrimination) business model that our customers have found very attractive.

The company has a strong focus on service delivery and has maintained 100% uptime on the network since operations started in July last year (actual traffic started to be transmitted in April 2010 for some pre-sales customers). It continues to innovate by being proactive in the development of new products and services such as our IP Transit and IP Internet Access service offerings scheduled for deployment in June 2011.

Main One introduced vast broadband capacity to the marketplace which has resulted in a reduction in prices (for CPE and Internet access costs) for service providers subscribed to the Main One network. They executed two successful experiential promotions called “Feel the Impact” in Lagos and Ghana in December 2010 and March 2011 respectively; the Lagos promotion resulted in over 2,100 visitors to the mall where this promotion was held with very positive feedback resulting from this from customers, end users and the press. Their intent was to give Nigerians and Ghanaians a taste of what they should look forward to experiencing with more capacity in the market.

Main One partnered with a technical partner to deploy their IP – NGN project in Q2 2011, and they are now exploring collaboration with other technical partners to deploy value added services such as cloud computing to the marketplace ahead of impending competition.
At submarine depths, Nexans goes deeper

Nexans was the first to manufacture and install a 384 fibre submarine cable. Nexans has qualified and installed their URC-1 cable family for fibre counts up to 384 fibres.

For further information please contact:
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Erik Ryning Sales & Project Manager Offshore:
“We produced the so far world’s deepest umbilical which was installed at 2350 metre in the Gulf of Mexico.”

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Because so much of your performance runs through cables

Nexans
Global expert in cables and cabling systems
Survivable Submarine Optical Networks

Chuck Kaplan
Globalization has changed the nature and relevance of communication networks dramatically. This change is evidence that communications systems have become the most significant element of mission-critical infrastructure for consumer, business, and government market segments worldwide. While carrier-class service has become a minimum network requirement for delivering services, its limitations become clear when disrupted by human error, acts of war, terrorism, or natural disasters.

Minimizing the risk of such disruptions requires a new approach to building survivable submarine optical networks and, ultimately, in an effort to improve global resiliency, carriers are combining both terrestrial and submarine mesh domains to create one large, resilient, mesh-based global network.

**The Challenge of Architecting Resilient Submarine Networks**

Network globalization has been an ongoing strategic goal for carriers and network operators worldwide. Government-funded research and education networks rely on submarine and terrestrial infrastructures for global data interchange during bandwidth-intensive experiments, many of which share supercomputers and cannot tolerate service interruptions. Likewise, large financial organizations transacting in world markets depend on global telecommunications infrastructures and require low latency with close to 100 percent uptime, as even a few seconds of network failure can cost millions of dollars. Distance radiology is becoming a commonplace method for handling off-hour emergencies. Submarine networks transport medical imaging scans to radiologists halfway around the world. In addition, public and private cloud service providers are offering data center consolidation services at facilities around the world to take advantage of different time zones and wages around the world. Consequently, submarine networks play an increasingly critical role to the stability, longevity, and, in some cases, survival of global companies and even human beings.

High-profile natural disasters, such as the April 2011 earthquake off the coast of Japan and resulting tsunamis and the December 2006 Hengchun earthquake off the coast of Taiwan, as well as the January and February 2008 cable cuts in the Mediterranean Sea and Persian Gulf believed to be caused by ship anchors, all underscore the need for increased resiliency in global networks. Due to the critical nature of international bandwidth, many operators are looking toward mesh restoration instead of relying...
on pre-existing submarine cable network restoration plans that offer limited protection, slow restoration and associated high costs.

Unlike most terrestrial networks, geographies with a high propensity for cable faults and the lack of route diversity characteristic of submarine networks make architecting carrier-class resiliency in submarine networks challenging. Traditional transoceanic and terrestrial ring protection schemes typically do not protect against multiple failures, which are more likely to occur during natural disasters when cable routes have limited route diversity. In the case of the Hengchun earthquake, seven of the nine cables went out of service for an extended time. The last repair was not completed until 35 days after the earthquake occurred. The lack of route diversity for the size of the earthquake meant the loss of both legs of many of the rings, resulting in traffic loss throughout the region.

Traffic was also severely affected over a two-week period in the Middle East and India when ship anchors allegedly cut as many as four cables in the Mediterranean Sea and Persian Gulf. Cable cuts, mainly from ship anchors and fishing trawlers, are common, with approximately 50 undersea cuts every year. Due to these risks, submarine networks are migrating towards shared protection paths over multiple geographically-separated routes to significantly improve resiliency and reliability.

**Enabling Mesh Networking through the Intelligent Optical Control Plane**

The lack of routes and route diversity provides a unique challenge in architecting resilient submarine networks. Mesh architectures have proven more resilient than traditional ring architectures in terrestrial networks, improving availability to 99.999 percent—a factor of 10—and equating to roughly a total of 31 seconds in a year. The proven resiliency has led operators of several large submarine networks to deploy mesh architectures in transatlantic, transpacific, and regional submarine routes.

Intelligent control plane enables the creation of a fully automated mesh optical network, the single most important feature of a survivable optical network. An intelligent control plane, in very simple terms, is software that controls all configurable features of a network element and/or an entire network.

This capability includes the simple configuration, activation, and deactivation of circuits—from individual circuits to a full mesh—that make up an entire network. Fully meshed networks enable
interconnection of a single node to every other node. Managing such a complex network requires a control plane that, given some parameters, can make decisions on its own.

This embedded software-based automation helps improve network survivability, scalability, and cost. For example, when a network is expanded, the inventory of available circuits and ports is discovered automatically and placed into context within the entire network in which it functions. Once installed, the new capacity is made available for new services, and any new circuits are added automatically to the pool of circuits that may be used for restoration.

The International Telecommunications Union (ITU) established the Automatically Switched Optical Network (ASON) standard to guide the development of common optical control planes for intelligent optical networks. G.ASON requirements and recommendations describe how a suite of control plane protocols should react to service requests, automatically provisioning end-to-end network resources across a multi-technology, multi-vendor optical network. This provisioning allows the network’s scope and capabilities to be increased without a corresponding increase in manpower.

This level of automation also improves network resource utilization, manages equipment, automates provisioning, and manages inventory real-time, lowering CAPEX, reducing provisioning and/or change intervals from months to minutes, and allowing carriers to optimize time-to-revenue.

In fact, customers leveraging an intelligent control plane for mesh networking have seen reductions of up to 70 percent in CAPEX and 85 percent in OPEX. So while resiliency is often the primary reason for deploying submarine mesh networks, these savings provide key benefits as well and only improve as the network scale – with the largest single global mesh network today operating with more than 700 nodes.

**Global Mesh Networks with intelligent control plane technology**

Figure 1 shows an example transatlantic mesh network that is based on intelligent control plane technology. In traditional ring protections, a double fiber cut on the north and south routes of a transatlantic cable on the east side would put the network out of service. However, because the mesh network employs automated control plane-based restoration, the carrier can share restoration capabilities across all six undersea cables that it accesses in the Atlantic basin in this example. This capability allows the network to survive multiple failures—including the one shown on the east side—while simultaneously increasing wavelength
utilization compared to traditional ring-based architectures.

The success of a control plane-based mesh networking was put to the test in August of 2009 when an earthquake hit the Luzon Strait south of Taiwan again. Within milliseconds of this major earthquake, which in total caused 20 faults on 10 cables, all of one carrier’s traffic was safely rerouted without impacting customers.

Globalization Requires Survivable Networks

Networks in need of near-zero downtime include educational entities, large enterprises, multi-national corporations, medical services, and large financial institutions, among others. Operators rely on global infrastructures even more during catastrophic failures to sustain and grow high-margin revenue streams, such as those associated with global voice and data services.

An intelligent control plane expands carrier-class operator networks to help operators thrive, scale new service, lower costs, and—most importantly—survive single, multiple, or even catastrophic failures (see Figure 2).

As communication networks continue to grow, businesses that implement survivable optical networks will garner higher margins for services, reduce CAPEX and OPEX, and retain the best customers.

Chuck Kaplan is vice president of industry marketing for Ciena.
Undersea cables transiting the Indonesian archipelago historically have faced significant challenges from natural disasters: volcanoes, earthquakes, cyclones, and tsunamis. The 1883 eruption of Krakatoa—a volcanic island in Indonesia’s Sunda Strait—destroyed the telegraph cable connecting the Sunda Strait town of Anjer to the colonial capital of Batavia (now known as Jakarta), even as undersea telegraph cables helped to make Krakatoa’s eruption a worldwide media event. Although the risks of the Sunda Strait remain—Anak Krakatau (“Child of Krakatoa”) emerged from the sea in 1927, with periodic eruptions continuing into 2011, and earthquakes remain common—the Strait is now home to modern fiber-optic undersea cables. Indeed, the Indonesian archipelago as a whole is home to many fiber-optic cables providing connectivity within Indonesia; directly to Australia, India, Malaysia, Myanmar (Burma), Singapore, South Africa, and Thailand; and indirectly to the rest of the world.

Undersea cables transiting Indonesia’s waters now face a very different kind of threat, however: cabotage restrictions in Indonesia’s 2008 Shipping Law. Although not targeted at the undersea telecommunications industry, the Shipping Law and its implementing instruments, if left unamended, will in effect greatly disfavor and eventually prohibit foreign-flagged cable ships from operating in Indonesian waters. (Indonesia, like most other countries, does not have a domestically-flagged cable ship.) The restrictions’ unintended effects threaten create significant delays and costs for deploying cable ships to install, maintain, and repair the undersea cables on which Indonesia and its neighbors depend. Any resulting extended network outages and limited connectivity could harm economic productivity. Undersea cable operators, their customers and suppliers, and neighboring governments therefore have a strong interest in persuading Indonesia to address these unintended effects of the Shipping Law and to exempt cable ships from the Shipping Law’s cabotage restrictions.

Overview of Indonesian Shipping Law of 2008

Starting with a presidential decree in 2005, Indonesia has sought to protect and strengthen Indonesia’s domestic shipping industry. Indonesia’s Ministry of Transportation followed with a “Cabotage Road Map,” which set out deadlines for using Indonesian-flagged vessels to transport specific types of commodities.
In 2008, Indonesia adopted the new Shipping Law, requiring that all domestic sea transportation be performed by Indonesian-flagged vessels crewed by Indonesian citizens. The law prohibits foreign-flagged vessels from carrying passengers or cargoes within Indonesian waters. The law’s cabotage provisions have been phased in over time and are due to take full effect on May 7, 2011, when a 2008 exemption for foreign-flag vessels operating in Indonesia expires. Although it does not expressly reference cable ships, undersea cables, or even telecommunications, the Shipping Law—absent amendment or an exemption granted thereunder—is interpreted by Indonesia’s Ministry of Transportation to cover cable ships. The Ministry of Transportation may grant exemptions from the cabotage provisions of the Shipping Law and its implementing regulations, although the law does not specify exemption criteria.

April 2011 Implementing Regulation and Decree

On April 4, 2011, the Indonesian President issued an implementing regulation allowing foreign-flagged vessels used in six business classifications to continue operation in Indonesia: (1) oil and gas exploration; (2) offshore drilling; (3) offshore construction; (4) offshore support activity; (5) dredging; and (6) salvage and underwater works. This general flag exemption raised hopes but required further clarification. On April 18, 2011, the Indonesian Ministry of Transportation issued a decree further implementing GR 22/2011, identifying specifically the kinds of foreign-flagged vessels within each of GR 22/2011’s six business classifications that are permitted to continue operation in Indonesian waters. Most of the vessel types relate to the oil and gas industries, though the “offshore construction” classification is defined to include “derrick/crane, pipe/cable/subsea umbilical riser flexible (SURF) laying barge/vessel” and therefore appears to cover cable ships.

Decree 48/2011 nevertheless rendered short-lived those hopes of a workable flag exemption. First, it requires that a foreign-flagged vessel must first attempt to procure an Indonesian-flagged vessel and, assuming it is unable to do so, enter into a chartering arrangement with the national shipping company. Second, it established a three-month term for such permits, although the Ministry of Transportation’s Director General of Sea Communications may extend them. Third, it established a sunset date of December 2013 for the flag exemption for offshore construction, after which time the cabotage restrictions will again apply. Decree 48/2011 effectively prevents timely cable repair activities and significantly complicates new cable installations.

Cable Installation and Maintenance vs. Cabotage

Recognizing the critical economic and political importance of timely installation and repair of undersea fiber-optic cables, most coastal nations exclude cable ships from cabotage restrictions. They understand that cable ships are unique, scarce, and fundamentally not transport vessels.
Unlike traditional targets of cabotage restrictions—such as transport barges and passenger ferries—cable ships do not compete in the market for coastal transport. They are complex, purpose-built vessels used to install and repair undersea fiber-optic cables on the sea floor. They carry equipment (such as sea plows, remote submersible vehicles, cable, repeaters, and other tools) used by specialized crews to install and repair undersea cables. Their highly-trained crews operate as an integrated whole to perform both navigation and telecommunications engineering tasks. Undersea fiber-optic telecommunications networks are manufactured, installed, and maintained by only a handful of companies worldwide. Most countries—including even the United States—do not have commercial cable-laying vessels flagged by their own governments.

Effective and timely repair of undersea fiber-optic cables requires that cable ships be able to sail with spare plant without delay in order to remedy damage from a variety of sources. Under maintenance contracts with cable owners, cable ship operators typically sail within 24 hours in order to commence repairs. The longer repair is delayed, the longer the disruption in communications, and the longer the reliance on expensive and inferior back-up satellite circuits.

The Potential Impact on Indonesia and Its Neighbors

Indonesia and its neighbors face particular risks to the undersea cable infrastructure on which they depend. Indonesia’s waters are prone to natural hazards such as volcanic eruptions, earthquakes, cyclones, and tsunamis, all of which can cause severe damage to cables. The Malacca and Singapore Straits are two of the world’s busiest sea lanes and, along with the Java Sea, also important fishing grounds. The anchors and nets of these transport and fishing vessels pose hazards to undersea cables. Consequently, cable owners require timely access for cable ships in these waters to ensure effective repairs, as evidenced in the aftermath of the 2011 Tohoku earthquake and resulting tsunami, and the December 2006 Hengchun earthquake in the Luzon Strait, off of Taiwan’s south coast. Delays can damage economic and national security interests.

As applied to undersea cables, the Shipping Law’s cabotage restrictions could undermine Indonesia’s broadband and economic development policies. The Indonesian Government has specifically recognized the importance of broadband connectivity to Indonesia’s economic development and social and political integration. Indonesia’s President Susilo Yudhoyono has noted that increased broadband connectivity can help resolve many of the country’s concerns, including poverty, corruption, conflict, violence, deadly diseases, and natural disasters. Harnessing broadband and information
and communications technologies for national development remains challenging. The Palapa Ring system, connecting all 440 districts across the Indonesian archipelago, is a demonstration of the government’s commitment to increasing Indonesia’s connectivity.

The impact of the Shipping Law on cable ships is not limited to Indonesia, but also has consequences for Indonesia’s neighbors, particularly Singapore. Just as Changi Airport and Singapore’s seaport make Singapore one of the world’s principal transport hubs, the multiplicity of undersea cable landings in Singapore reinforce Singapore’s preeminence as one of the world’s communications hubs. Among other things, these undersea cables provide Singapore’s significant financial services industry with reliable, secure, and low-latency communications. They also provide critical interconnectivity for third countries that do not have direct connections to each other, reinforcing Singapore’s role as a center for offshore enterprises.

To maintain its role as an undersea cable hub, Singapore must ensure that undersea cable operators can both land new cables and maintain and repair existing cables serving Singapore. To do so, however, Singapore must depend in large part on cooperation with its neighbors, particularly Indonesia. Virtually all of the cables landing in Singapore from the west (directly connecting Indonesia, Malaysia, Thailand, Burma, India, and South Africa, and indirectly connecting the Middle East, Europe, and the remainder of Africa) or the south (directly connecting Indonesia and Australia) transit Indonesia’s waters.

Indonesia Should Minimize Barriers to Undersea Cable Installation and Maintenance

Indonesia’s Ministry of Transportation should reconsider its implementation of the Shipping Law and construe it not to apply to cable ships. Fundamentally, cable ships are not transport vessels. They are instead highly-specialized, technologically advanced vessels built and deployed for infrastructure development. The law nowhere references cable ships or even telecommunications. To the contrary, Indonesia has recognized elsewhere that "[t]he Indonesian Government respects/honours the installation of a sea cable and shall permit the maintenance and replacement of already existing cables by prior appropriate notification." In the alternative, Indonesia should grant a permanent exemption for cable ships. Such an exemption—whether issued by regulation or decree—is appropriate here. There is a complete absence of comparable Indonesian vessels. Exemption would serve projects of national importance, as timely installation and repair of undersea cables are critical to Indonesia’s economic and political development goals.

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Madeleine Findley is a senior associate with Wiltshire & Grannis LLP in Washington, D.C., and practices principally in the area of telecommunications law. She regularly advises undersea cable operators and suppliers on a wide variety of legal and regulatory issues arising from cross-border operations.

20. Id.
"Wednesday morning, April 10, 1912, the $7.5 million, 46,328-ton Titanic, the world’s largest vessel, equipped with the latest model Marconi wireless, pulled away from her Southampton berth with 2,340 people aboard." If not for a quirk of fate—Guglielmo Marconi, the father of Wireless and the great-grandfather of the cell phone, would have been aboard as well.

In Marconi: The Story of the Race to Control Long-Distance Wireless, Calvin D. Trowbridge has crafted an excellent biography about one of the most influential and fascinating figures of the early 20th century. The story of Marconi’s narrow escape from almost certain death on board the Titanic, along with the groundbreaking use of Marconi’s invention during the sinking of that great ship, are both compelling elements in the life of a man who still influences the way the world works to this day.

Another significant element of this biography is the exploration of Marconi’s business interests. As a man intent on bringing wireless to the world, Marconi’s chief competition was the submarine cable industry.

"Submarine cable coporations had laid extensive underwater connection between land-based telegraph systems. Cable operated on the same scientific principles as telegraph. The expense of submerging and maintaining waterproof line was far greater Wireless might penetrate this business. Airborne transmission should have significant cost advantages. A WTS engineer spelled it out:

"Judge for yourself. Every mile of deep-sea cable costs about $750; every mile of land end (land connection) is about $1,000. All that we save, aso the great expense of keeping a cable steamer constantly in commission making repairs and laying new lengths. All we need is a couple of masts and a little wire. The wear and tear is practically nothing. The cost of running, simply for home batteries and operators' keep."

I found Mr. Trowbridge’s writing to be both compelling and evocative, and I’m sure that most readers of SubTel Forum will feel the same way.
The Long-Awaited Connectivity in Japan
The first Submarine Cable to the Ogasawara Islands

Motoyoshi Tokioka
If you have seen the 2006 film “Flags of Our Fathers” or the sequel “Letters from Iwo Jima” – both directed by Clint Eastwood – the Ogasawara Islands may sound familiar to you: the battleground of Iwo Jima depicted in the films is a part of these islands. Dubbed “the Galapagos of the Orient”, these subtropical islands have preserved a unique ecosystem and are home to a wide variety of rare species. Among some thirty islands in this group, only four are inhabited today. Of these, Chichi Jima (literally “Father Island”) and Haha Jima (“Mother Island”) are the largest with a total population of just 2,400.

The Southernmost Front of Japan – Distant in Two Ways
The main islands of the Ogasawara Group, Chichi Jima and Haha Jima, are located in the Pacific Ocean some 1,000km south of Tokyo, and 1,500km north of Guam. While the island group is officially part of the municipality of Tokyo, the only available transportation that links mainland Japan and the islands is the ferry Ogasawara-Maru, which sails once or twice a week depending on time of the year, the one-way cruise taking 25½ hours in good weather.

Not only physically distant, the islands have also been digitally distant. Direct dialing telephone service was only introduced in 1983, television broadcasting in 1984, while mobile phone service is just a recent phenomenon to the island people with its introduction in 1999. High-speed internet services as enjoyed in most parts of the country for a fixed charge has not been available to the island people. All communications services have been provided by satellites such as N-STAR b, JCSAT-3A and JCSAT-5A, though the available capacities for those services have obviously been restrictive.

Tireless Initiatives by the Island Government
Being acutely aware of the remoteness in geography as well as in communications with the rest of the country and the world, people living on the Ogasawara Islands and its government have actively been seeking ways of bringing broadband capabilities to the islands. In the early 2000s, the Ogasawara Government leaders had already developed plans to turn the islands into a digitally advanced community, equipped with an extensive intra-island fiber network which would enable such useful services as distance learning and telemedicine in addition to high-speed internet and digital television. By the end of fiscal year 2006, intra-island fiber to the home (FTTH) had been rolled out to all households on the islands. The only missing element was the submarine cable connectivity to the mainland.
Getting Attention from the Japanese Government

After many years of petitions by the Island municipal government, in the spring of 2006 the Ministry of Internal Affairs and Communications organized a committee to study “Development of Broadband Services to Ogasawara”. The members of the committee included the Tokyo Metropolitan Government, the Ogasawara Municipal Government, the Ministry of Land, Infrastructure, Transport and Tourism, telecommunications service providers such as NTT East and KDDI, and also submarine cable system suppliers such as Fujitsu and NEC. Other governmental organizations who were interested in using the future broadband capacity in Ogasawara participated as observers. After many months of discussions by experts on various aspects including the needs of the island community, how satellite communications compare with submarine cables, viable technologies and their cost of construction, operation and maintenance among others, a report summarizing the study results was published by the committee in late 2006. In the report the pros and cons of both satellite and submarine cable system were presented in terms of available capacities, future upgradeability, initial construction costs and running/maintenance costs for the particular case of Ogasawara. While a number of technical advantages that submarine cable systems offer over satellite communications were emphasized in the report, the higher initial cost including the construction of a 1,000km cable system was identified as the principal obstacle. In the mind of the Ogasawara leaders, the preference for a submarine cable system over satellite communications was always clear from the early stages of planning, but the construction cost always remained the hurdle.

Continuing Efforts

It is always difficult for remote islands to economically justify initial construction costs when the building of new connectivity is considered, because of the evidently small population who would benefit as a result of a large expense, and also because of the difficulty in quantifying the benefits that the island community and other people and organizations may enjoy. More than two years passed without notable progress after the study report was made public. However, efforts by Ogasawara leaders did not diminish. They continued their efforts in reiterating to their Tokyo Metropolitan Government counterparts...
and relevant organizations how important it was for the islands to have submarine cable connectivity. As asked, NEC happily supported such efforts on various occasions through presenting lower cost construction options and innovative approaches to cable ownership.

Rapid Progress after Many Difficult Years
In early 2009, matters concerning the potential submarine cable to Ogasawara Islands started to progress rapidly. By May of that year, it was agreed that the Japanese Government would fund 67% of the budget required for submarine cable construction as well as for the digitalization of television broadcasting to Ogasawara, while the Tokyo Metropolitan Government would be responsible for the rest. With this commitment of budget, The Tokyo Metropolitan Government called for a public tender in the late summer. The requirements included to construct a submarine cable between the Ogasawara Islands and the island of Hachijo Jima some 700km further north, to provide digital television broadcasting infrastructure, and to provide high-speed internet, digital television broadcast and other advanced telecommunications services to the people of Ogasawara. Hachijo Jima was selected as a landing point since the island had already been linked by a submarine cable with mainland Japan. The final route was decided as shown on the map above. What is unique about the program is that the Tokyo Metropolitan Government is the owner of the submarine cable and relevant infrastructure assets, while providing an IRU to a service provider to use these assets.

Lessons for Locations Looking for Connectivity
Looking back, there were several key drivers for the submarine cable to Ogasawara. The first key was to promote the need for a submarine cable while preparing from within. By this I mean that the Ogasawara people developed and completed 37km of fiber to the home (FTTH) well before a plan for submarine cable construction started to get serious attention, and in doing so they created a situation in which a submarine cable was recognized as the only missing link to bring broadband capabilities to the islands. The second key was the nationwide agenda for digitalization of television broadcasting. It has been decided that analogue television broadcasting will end in July 2011 and totally shift to digital broadcasting. In order for the government of Japan to make this transition for Ogasawara – where normal digital television signals do not reach – use of submarine cable was the most efficient way of solving the problem. One may not always have this sort of good timing, but carefully searching may uncover an effective driver. And the third and very important key is to work on innovative ways to turn the plan into reality. In the case of Ogasawara, the leaders were not only looking for different funding sources from the Government, they were actively seeking sources of income to fund the project over a number of years by involving potential long-term capacity user organizations such as the National Astronomical Observatory, the Geospatial Information Authority and the Japan Aerospace Exploration Agency.”

Welcome News
As I write this article, some welcome news has arrived – the Ogasawara Islands have been endorsed to be listed as a UNESCO World Heritage Site. When approved, the Ogasawara Islands will be the first World Heritage Natural Site for the capital city of Tokyo. Tourism to the islands is already getting very popular, and tourists will further benefit from the broadband services provided using the submarine cable. I am looking forward to seeing the Ogasawara Islands continue to benefit from the newly constructed submarine cable in so many ways.

Motoyoshi Tokioka has over twenty years of experience in the international telecommunications system supply market, always working closely with world-class telecommunications operators. He is a Senior Manager with NEC.
Happy Birthday EDFA

May 4th was the 25th Anniversary of the first international fibre optic submarine cable system (UK – Belgium N0. 5). However, perhaps of much greater significance and importance to our industry, in May this year, a single component that has probably had the greatest impact on optical telecommunications transmission and the growth of the internet joins the “Quarter Century Club.” The Erbium Doped Fibre Amplifier (EDFA) was first demonstrated by Professor David N. Payne and his team at Southampton University (UK) in May 1986.

In simple terms, the EDFA consists of a length of optical fibre, doped with ions of the rare earth Erbium. Within this fibre the optical transmission signal wavelengths are mixed with a high powered signal from a pump laser, which excites the ions in the erbium, causing them to give up this energy in the form of additional photons in phase with the transmission signal, thus amplifying the incoming transmission signal.

So why is the EDFA so important?

Prior to the invention of the EDFA, optical transmission systems had operated over long distances by the use of electro-optic regeneration. As an optical pulse travels along a fibre it is attenuated and loses its shape; eventually the information contained in the pulse will be lost unless, before this occurs, the signal can be boosted. Initially, the only viable method of doing this was to detect the incoming signal with a photo diode, convert it to an electronic signal, and then use that signal to switch a laser, thus sending out a new optical pulse along the next length of fibre. This type of system had the limitation of only being able to work with one signal (wavelength) and the system had to be designed to operate at a specific bit rate.

In contrast, the EDFA offered direct amplification that was independent of the signal bit rate and the ability to have greater spacing between repeaters. The EDFA is also a much simpler device than the regenerative circuitry of a repeater, and so it is far more reliable, which is of particular importance for submerged repeaters.

From its initial invention, it took several years for Payne’s group in Southampton and a parallel development team at Bell Labs, under Emmanuel Desurvire, to produce a reliable EDFA that could be manufactured in volume. During their experiments they found that the EDFA could simultaneously amplify signals at two or more different wavelengths (Wave Division Multiplexing or WDM). Something that was not possible with regenerative systems. So EDFA’s appeared to offer the opportunity for the
The design of much higher traffic carrying capacity systems than could be achieved with regenerators.

The first Trans-Atlantic fibre optic system was TAT 8 (1987). This was a regenerative system operating at 1,310nm and a line rate of 240Mbits/s. In 1991, TAT 9 went into operation. This was still a regenerative system but it operated at 1,550nm and a line rate of 560Mbit/s. The first Trans-Atlantic optically amplified systems were TAT 12 and TAT 13, creating a ring network. These systems utilised a single wavelength of 1,550nm with a line rate of 5Gbits/s; they did not go into operation until 1996.

The invention of the EDFA coincided with the start of the dot com doom and the deregulation/liberalization of the telecommunications industry in the USA and the UK. Competition between telecoms companies, the increasing demand for capacity from the internet, and the willingness of banks to fund submarine cable project, created an environment that sent the industry into a boom period. With so many traditional carriers and start-up companies wishing to build new cable systems, system suppliers looked to find ways of differentiating themselves. The EDFA gave them the opportunity to develop and offer systems with more and more capacity on a single fibre pair. Because of the EDFA, the concept of the “transparent pipe” became popular. This is the idea that the capacity of a fibre system is only limited by the equipment connected to each end. This is, of course, an over simplification; the number of wavelengths that can be transmitted and amplified over long distances, is dependent on the ability to separate wavelengths and the bandwidth of the EDFA. The bandwidth of the EDFA is a function of the properties of the erbium doping ions, the structure of the fibre and the power and wavelength of the pump laser. All submarine systems were and still are designed to have an ultimate or “Design Capacity” based on the technology available at the time, and generally they are initially equipped at a much lower capacity capability, allowing for growth over their theoretical 25-year lives.

WDM was quickly developed to offer 16 wavelengths per fibre pair. Once the ability to space wavelengths even closer together, Dense Wave Division Multiplexing (DWDM), was developed for the terrestrial systems, and then quickly taken up by the submarine cable industry. In a relatively short timescale, when one takes into account the rigorous reliability requirements of submarine system, the available capacity on a fibre pair for an optically amplified system had moved from one wavelength (λ) @ 5Gbit/s to an industry standard offering of 64λ x 10Gbit/s = 640Gbit/s, by the year 2000. Of course, the total capacity of a submarine cable is a function of line rate, wave length, and the number of fibre pairs in the cable. For repeatered systems, the number of fibre pairs is constrained by the number of amplifiers that can be accommodated in the repeater housings and that can powered through the cable. From its inception, the fibre optic system model had been built around a maximum of four fibre pairs per system, but during the boom, design and development was undertaken for six and eight fibre pair repeatered systems. For
repeaterless systems, there was no such constraint and one system was installed between the UK and Belgium which contained 96 fibre pairs. The EDFA also played a major role in the development of repeaterless systems extending the distance that could be spanned through the use of transmit and receive amplifiers plus Remote Pumped Optical Amplifiers (ROPA). This made fibre connectivity possible to islands and remote locations where the cost of repeatered systems could not be commercially justified.

In the year 2000, the submarine cable industry was on the crest of a wave, buoyed by what, in retrospect, was an insane optimism that the exponential growth in capacity demand, then being enjoyed, would go on forever. For many reasons, the boom had created a market where, in reality, it was the provision of new capacity rather the demand for capacity that was spiralling. It had been expected that bandwidth hungry applications such as video streaming, 3G mobile services, internet data, etc. would create the demand for huge capacities to be available on the major backbone and internet routes. Although demand did continue to rise at a steady rate, history has shown that the forecasts for growth were excessively optimistic. The bubble burst, and for the next 5 years very few new systems were required. The continuing growth of demand was taken up by the commissioning of previously unlit capacity on existing systems. The transparency of the EDFAs also allowed, through advances in technology, systems to be upgraded far beyond their original design capacity.

As the existing systems filled up and new technology allowed them to carry more than their original design capacity, the international networks became vulnerable to single point failures due to the lack of route diversity, and the industry recovery began due to the need to make existing networks more robust.

Today submarine cable systems can support > 100λ @ 10Gbit/s and multi-wavelength 40Gbit/s transmission on a single fibre pair. Repeaterless systems of up to 400km in length can be accommodated with ease and more ‘heroic’ systems of 400 – 500km in length, are possible. This is all because of the EDFA.

When you downloaded this edition of SubTel Forum, it is a sobering thought that, the data stream probably passed through several hundred of these devices on its journey from our server to your computer.
Verizon’s Asia-Pacific Mesh Network Performs as Designed
During Multiple Submarine Cable Disruptions after Devastating Japan Earthquake

Steve Misencik & Yali Z. Liu
In today’s online environment, communications networks are the lifeblood of large enterprise companies. Even five minutes of interrupted communication services for large enterprise businesses can create difficult and sometimes frustrating situations. So when catastrophic earthquakes, undersea landslides or typhoons strike and damage critical communications network infrastructure, global network service providers like Verizon must be in a position to minimize the impact of the service disruptions.

Within seconds after an earthquake measuring 9.0 on the Richter scale hit off the northeast coast of Honshu, Japan on March 11, Verizon turned to its trusted optical mesh network architecture to reroute communications traffic on its Asia-Pacific mesh network. Since meshing creates additional paths and seamlessly reroutes traffic, the company was able to reroute traffic that originally was on damaged submarine cables to alternate network paths. Within milliseconds, all protected and restorable Verizon traffic was moved to the new routes. The company also was able to use its mesh network to support restoration efforts for services not originally provisioned on the mesh network and provide additional capacity to other service providers.

As an owner, operator and participant in more than 80 submarine cable networks around the world, Verizon is a leader in global optical mesh deployment. The company made the decision to invest in a global mesh network after undersea cables were cut between North America and Europe during 2003. The cable disruption isolated communications traffic for several weeks as cable repair ships were deployed to the impacted locations to repair the cables. A few weeks after the trans-Atlantic submarine cable incident, Verizon began discussing how to design and build a global mesh network architecture that seamlessly would reroute traffic in the event of almost any type of undersea cable break, fault or network disruption.

In 2006, Verizon deployed its first major submarine cable mesh network with six-way mesh diversity across the Atlantic. This region now has eight-way diversity on the Verizon mesh network. In 2008, Verizon deployed five-way mesh diversity in the Asia-Pacific region, which later was increased to eight-way diversity. The company continued to deploy its mesh network and circled the globe with its
undersea mesh technology in 2009. Verizon has one of the largest facilities-based communications networks in the world.

The Asia-Pacific region is Verizon’s most tested location for responding to catastrophic natural events on its global mesh network. After the initial Japan earthquake and massive tsunami devastated parts of northern Honshu, Japan on March 11, strong aftershocks continued to play havoc on the northern submarine cables in the region. Then on March 20, another earthquake measuring 5.9 in the Richter scale shook central and southern Taiwan damaging additional undersea cables.

For Verizon, these earthquakes meant five submarine cable systems damaged in 14 separate locations. The submarine networks were affected on three of eight trans-Pacific mesh routes between the United States and Japan, and three of the nine intra-Asia mesh routes. The Japan earthquake caused cable damage on Verizon’s primary trans-Pacific mesh route which is Japan-US North and Japan-US South. Manual restoration on the damaged submarine cables is taking months to fully restore, but with Verizon’s mesh network, all services on the mesh network were restored within milliseconds each time a cable route went down.

The Trans-Pacific Express (TPE) cable system, the first cable system with direct 10Gbps wavelength access from the U.S. to China, was not physically impacted by the earthquakes and served as a key Verizon mesh restoration option for South Korea, Taiwan, Hong Kong and Singapore. The TPE cable route specifically was selected to avoid major earthquake fault areas and to be geographically separate of the other major trans-Pacific cable routes. TPE was designed to withstand this exact scenario that occurred in the region during March. TPE also provided additional capacity for the region in case other cables were damaged before all cable repairs are completed. Verizon is a charter member of the TPE Consortium.

Almost two years ago on August 10, 2009 Typhoon Morakot, one of the deadliest typhoons in Taiwan’s recorded history, wreaked havoc not only on Taiwan but also the submarine cables in the region. Action from Typhoon Morakot, the undersea landslides and a 6.7 earthquake one week later off the southern coast of Japan damaged 10 Asia-Pacific submarine cable systems in more than 20 locations. Verizon’s mesh network operated as designed and within milliseconds of the cable breaks, all protected services were automatically rerouted to alternate paths.

Prior to deploying the mesh network, it took a much longer time for traffic to be restored. For example, on December 26, 2006, the Hengchun earthquake measuring 7.1 on the Richter scale hit off the southwestern coast of Taiwan. The earthquake and subsequent landslides damaged at least eight cables in 22 locations. Since Verizon did not have its Asia-Pacific global mesh deployed at the time, repairs and full physical restoration took almost two months. This is a sharp contrast to the automatic restoration done today on the mesh network.

As a critical component of the Verizon’s global communications network infrastructure, the global mesh network operates 365 days a year. The mesh network is always looking for the shortest path to move traffic around the world per design and ready for handle any catastrophic event.
The Verizon global mesh network offers automatic restoration of service at 10G level and has industry-leading rates of network availability exceeding 99.9999 percent in the Asia-Pacific, trans-Pacific, trans-Atlantic and European regions.

Three important Verizon mesh network benefits include node diversity (geographically separate building locations), route diversity and capacity built into the system. Verizon’s global mesh is also evolving to support 40G and 100G submarine cable and terrestrial transport systems. The combination of all these benefits provides high-quality network performance, reliability and scalable and predictable latency – exactly what multinational enterprise customers expect today. Financial customers are specifically interested in predictable low latency options on the mesh network.

Currently, the Verizon Asia-Pacific mesh network extends from India to Singapore, Hong Kong, Taiwan, South Korea, Japan and the U.S. Later this year, Verizon is scheduled to extend the Asia-Pacific global mesh network to Australia and Hawaii.

Verizon also will begin to integrate the newly activated Europe India Gateway cable system into the global mesh network. The benefits of the Europe India Gateway cable – additional capacity, cable route diversity, network redundancy, direct connectivity to the Verizon European and India networks, global mesh around the world, and seamless connectivity to major submarine cables in Europe, the Middle East, Africa, India, Asia and North America – combined with the Verizon global network benefits truly demonstrate why Verizon has one of the most robust and diverse communications network infrastructures in the world.

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Conferences

International Telecoms Week 2011
23-25 May 2011
Washington, DC USA
Website

ENTELEC
24-26 May 2011
Houston, Texas USA
Website

Submarine Networks World Africa 2011
25-28 July 2011
Singapore
Website

Submarine Networks World 2011
27-29 September 2011
Singapore
Website

Offshore Communication Conference
8-10 November 2011
Houston, Texas USA
Website

Pacific Telecommunications Council
15-18 January 2012
Honolulu, Hawaii
Website
A Funny Thing Happened...

MY
INTERNET
IS SO
SLOW!

ELSEWHERE...

CHECK IT OUT, GUYS... THE ROYAL WEDDING!
Dear Friend,

Syria is now on the first page of the news magazines, but it is a different story than Tunisia, Algeria, Libya and Egypt. I have entertained relationships, done business, cut deals, and negotiated contracts in each of these countries, and my “road to Damascus” has been by far the most difficult!

Everywhere I have met very good people--knowledgeable, dedicated, friendly and very often highly educated, sophisticated, and showing a high level of culture. Unfortunately, many have been limited, constrained, completely impeached, or blocked by the system in which they were living.

When I joined Submarcom in 1977, the company was trying to recover the last payments (30%) of a recently completed project (Alexandria-Beyrouth-Damascus). The land segment (Beyrouth-Damascus) was a microwave system. A few days after the system acceptance, one of the microwave poles had been blown up. Visiting the Lebanese PTT, it was decided to pay a joint visit to Damascus. This short trip by car (80 km) ended up into a very long journey. Our car had to go through several barrages of various types of fighters! What struck me the most in Syria was the large regional map on the wall behind the desk of the PTT minister.

Neither Lebanon nor Israel was represented, but only Syria. Syria refused to accept the existence of these two countries. I should also note that we have still never been paid!

This did not discourage us from bidding for and winning a 1978 contract for the implementation of the Syria (Tartous) - Greece (Crete) cable. The leader of the team with whom we negotiated the T’s and C’s was a very capable fellow from the transmission department, but we slowly found out that he was closely monitored by a couple of representatives from the “political level” (ala the Soviet Union). After several weeks, we finally managed to initial the various pages of the document. What I saw as the end of a long process was, in fact, the beginning of another long and underground battle. I came back to Damascus every month of a full year in hopes of speeding up the process. This, at least, gave me the opportunity to visit some interesting spots such as Palmyra in the desert.

The formal execution of the contract was pending the signature of the State President Assad. Our local agent explained to us that each time our file was close to be signed by Assad, “somebody” working in favor of our competitor, was moving the file down the slush pile! One evening, he brought me to a private house at midnight for an informal meeting. I spent an hour, listening to Arabic music. I learned later on that it was the prime minister’s house!

The green light was finally obtained, and the contract signature was planned in Athens at

(continued on next page)
the minister’s level. It was supposed to be a 12 O’clock formal ceremony, followed by a 1 pm lunch in an old Greek club.

That day, the Syrian delegation showed up late, around 1:30. My counterpart requested a short review meeting while the ministers were waiting next door. In reality, the Syrians were there with a list of 35 “small changes” requested by the “political commission!” I was quite embarrassed, but so was the Syrian team.

The lunch finally took place from 3 to 5 pm!

A year later, I was invited to join the Syrian PTT team, travelling in convoy from Damascus to Tartous through Homs for the system opening ceremony. I remember our entry in Tartous, surrounded by local guards running and shouting alongside our cars, their Kalashnikov hanging dangerously in their hands! At the end of the formal banquet all of the guests were smoking big Cuban cigars that came from Moscow.

The Damascene conversion led Paul of Tarsus to cease persecuting people. Let’s dream that the young president Assad got suddenly a similar illumination “on the road to Damascus.”

Jean Devos
Better is the end of a thing than its beginning. After running all-out for the past few months, I can certainly see where old King Solomon was coming from when he wrote those words in the Book of Ecclesiastes. After, literally, a year of compilation, fact checking, GIS mapping, layout, graphic design and marketing, it is with tremendous relief that our first annual Submarine Cable Almanac is finally complete.

In the next few weeks, SubTel Forum subscribers all over the world will begin receiving our latest product in the mail. We hope you will find this volume to be a valuable resource, especially in conjunction with our Submarine Cable Map.

While I have a minute, I want to publicly thank some individuals without whose tireless effort the Almanac would not have been possible.

Meredith Cleveland has been the shepherd of this project from the very beginning. The countless hours of research that she spent in the development of the Almanac are truly the backbone of the product.

Kristian Nielsen, our Sales Manager, rolled up his sleeves and pitched in when deadlines began to close in on the Almanac. He spent an entire weekend staring at our database.

James Case was an enormous help to me as well. His expertise with databasing and GIS mapping created not only the skeleton upon which the Almanac was built, but also the system maps which appeared on every page.

Finally, I want to thank the many system owners who responded to my inquiries about their cables and fact-checked our work.

I hope you enjoy the Almanac, and don’t forget that in just a few short months, it will be time for the SubTel Forum Calendar once again. Thanks!

What do you think? Click on the Letter To The Editor icon and drop me a line. I’d love to hear from you.