SubOptic 2007 | *Enabling Global Communications*

Conference *Program*

May 14-17, 2007

BALTIMORE MARRIOTT WATERFRONT HOTEL
INNER HARBOR
BALTIMORE, MARYLAND, USA

www.suboptic.org

Host Organization:
tyco / Telecommunications
60 Columbia Road, Morristown, NJ 07960

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SubOptic 2007 *Conference Schedule*

	MONDAY MAY 14, 2007		TUESDAY MAY 15, 2007		
REGISTRATION	8:30 AM – 5:30 PM		8:30 AM – 5:30 PM		
EXHIBITION	6 – 8 PM		9 AM – 5:30 PM		
8:30 AM					
9 AM			**TUESDAY OPENING SESSION** *Welcome Addresses* *Keynote Address by Jaron Lanier* GRAND BALLROOM V-VI		
9:30 AM					
10 AM					
10:30 AM			**BREAK**		
11 AM			**ROUNDTABLE #1** *Demand Drivers and the Global Bandwidth Supply Chain* GRAND BALLROOM V-VI		
11:30 AM					
12 PM					
12:30 PM			**LUNCH** WATERVIEW BALLROOM		
1 PM					
1:30 PM					
2 PM			**ORAL SESSION TuA1** *Going Deep: Marine Services & Operations* GRAND BALLROOM V	**ORAL SESSION TuB1** *Charting the Course: The System Supply Market* GRAND BALLROOM VI	**TUTORIAL TuC1** *Surveillance & Security Applications of Subsea Cable Technology* LAUREL A&B
2:30 PM					
3 PM					**TUTORIAL TuC2** *Alternative Transmission Technologies* LAUREL C&D
3:30 PM					
4 PM	**TUTORIAL MoA1** *Offshore Oil and Gas Applications of Undersea Cable Systems* LAUREL A&B	**TUTORIAL MoB1** *Fundamentals of Project Finance* LAUREL C&D	**BREAK**		
4:30 PM			**ORAL SESSION TuA2** *Non-Telecom Applications* GRAND BALLROOM V	**ORAL SESSION TuB2** *Carrier Essentials: The Undersea Bandwidth Market* GRAND BALLROOM VI	**TUTORIAL TuC3** *High Performance Hybrid Optical-Packet Networks: Developments and Potential Impacts* LAUREL A&B
5 PM					
5:30 PM					**TUTORIAL TuC4** *Data Coding for Submarine Systems* LAUREL C&D
6 PM	**WELCOME RECEPTION** HARBORSIDE BALLROM EXHIBITION HALL				
6:30 PM					
7 PM					
7:30 PM					

SubOptic 2007 *Conference Schedule*

	WEDNESDAY MAY 16, 2007			THURSDAY MAY 17, 2007		
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EXHIBITION	9 AM – 4:30 PM			9 AM – 12 PM		
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10 AM	**BREAK**			**BREAK**		
10:30 AM	**ROUNDTABLE #2** *Finding Economic Equilibrium: Impossible Dream or Worthwhile Pursuit?* GRAND BALLROOM V-VI			**ROUNDTABLE #3** *The Future of Marine Maintenance* GRAND BALLROOM V-VI		
11 AM						
11:30 AM						
12 PM	**LUNCH** WATERVIEW BALLROOM			**LUNCH** WATERVIEW BALLROOM		
12:30 PM						
1 PM						
1:30 PM	**ORAL SESSION WeA1** *Spotlight Session* GRAND BALLROOM V	**ORAL SESSION WeB1** *Evolution & Revolution: Equipment & Component Technologies* GRAND BALLROOM VI	**TUTORIAL WeC1** *Legal Aspects of Bandwidth Sales for New and Existing Systems* LAUREL A&B	**ORAL SESSION ThA1** *Before You Dive In: Project Development & Implementation* GRAND BALLROOM V	**ORAL SESSION ThB1** *Weaving the Worldwide Web: System Design & Applications* GRAND BALLROOM VI	**TUTORIAL ThC1** *The Evolution of Marine Tools and Technology* LAUREL A&B
2 PM						
2:30 PM			**TUTORIAL WeC2** *International Law and Submarine Cables* LAUREL C&D			**TUTORIAL ThC2** *Cable Maintenance and Sparing Strategies* LAUREL C&D
3 PM						
3:30 PM	**POSTER SESSION & NETWORKING EVENT** HARBORSIDE FOYER			**BREAK**		
4 PM				**CLOSING SESSION** GRAND BALLROOM V-VI		
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5 PM						
5:30 PM						
6 PM						
6:30 PM						
7 PM				**CLOSING GALA** 7 – 11 PM B&O RAILROAD MUSEUM		
7:30 PM						

Welcome to SubOptic 2007

Greetings from Alan Robinson

President of the Executive Committee

Welcome to the 6th SubOptic and a stimulating program of papers, tutorials, posters and debate. Our conference in Baltimore, Maryland, USA continues the tradition and philosophy of SubOptic at which any member of the subsea community can offer a paper on a wide range of commercial and technical topics, and have that paper accepted against a set of criteria established and implemented by the Program Committee. These papers, together with tutorials, roundtables and invited speaker sessions, form the core of this and every SubOptic.

SubOptic has used this successful format since its inception in 1986 and the continued quality of content at each successive conference is a credit to the many speakers who have delivered SubOptic papers over the years. I can assure you that, in this regard, the 2007 event in Baltimore will be no different.

There will be differences, of course, in the content: the views, reflections, forecasts, and predictions that are presented under the different categories. SubOptic is not designed to promote the particular interests or ambitions of companies or industry sectors. It was established to educate and foster debate within the subsea community. And these principles will be maintained in Baltimore.

In a time of unparalleled change to the telecommunications industry in general, it is not unnatural to see a changing pattern reflected at the subsea infrastructure level. The continued deployment of submarine cables as part of a communications network is not in doubt. However, the investment and ownership strategies, the use of a wide range of technology in an inherently hostile environment, and the means of operating and maintaining these assets are all subject to competitive pressures and relentless change. SubOptic 2007 is an opportunity to reflect and review this change, and look forward to an unpredictable future in the best company possible, that of the subsea community itself.

Greetings from David Coughlan

President of Tyco Telecommunications
Host of SubOptic 2007

On behalf of Tyco Telecommunications, it gives me great pleasure to welcome SubOptic back to the American shores for the first time in ten years.

Our industry has changed a great deal since SubOptic 1997 in San Francisco. In the intervening years we have felt the exuberance of the dot-com boom, the disappointments of the dot-com bust, and the near-collapse of the entire cable industry. And now, on the occasion of the sixth event in the SubOptic conference series, we find ourselves on the rising slope of another market expansion.

Fortunately, through all the industry's ups and downs, SubOptic has brought us together on a regular basis to take stock of the business and exchange views on this dynamic industry. The cycle of SubOptic events, held every three to four years, has matched the cycle of market fluctuations in the cable business. So, with history on our side, we approach SubOptic this year full of optimism and excitement about the prospects for the next several years.

So welcome to SubOptic 2007 and welcome to Baltimore, one of America's historic maritime cities. I hope that in addition to the networking, education and business benefits of the conference this week, you also have a chance to sample the culinary, cultural and historic treasures this city has to offer.

I wish you a productive and enjoyable conference.

Greetings from David Robles

Chairman of the Program Committee

The submarine systems business – as "small" as it sometimes seems to us – is of gigantic importance to global communications. And communications has become one of the pillars of human interaction in the twenty-first century. Commerce, education, health, defense and entertainment all rely, to an increasing degree, on the construction and maintenance services that our industry provides.

With this global perspective in mind, the SubOptic 2007 Program Committee (PC) has spent the past eighteen months developing the content for this year's conference. Building on the positive feedback gathered from SubOptic 2004, one of the PC's first decisions was to continue the emphasis on business and commercial topics in the program. Indeed, one look at this year's Tutorial list should dispel any thoughts that SubOptic 2007 is purely a "technical conference." With sessions on project finance, capacity sales and international law, SubOptic 2007 will be an educational forum for the industry's business leaders as well as its scientists and engineers.

But don't think that we have forgotten our roots. Technology has been the foundation of our industry's growth for the past twenty years and new innovations will continue to drive competition in the years ahead. That innovative spirit is abundant in this year's program, and it has spread to new applications and new markets. See, for example, the numerous presentations on the offshore oil and gas market, underwater observatory projects, as well as surveillance and security applications of subsea cable technology.

Undoubtedly the most original feature of this year's program is the selection of keynote speakers and invited talks planned throughout the week. These speakers – several of whom come from outside our traditional industry – will lend a broader perspective to the conference, coming as they do from diverse technological, political and business backgrounds.

Finally, I will take this opportunity to thank the contributing authors, presenters, and the other members of the Program Committee who have given their valuable time and energy to making an original program. They managed to do this, I should add, during one of the most intense periods of business activity that our industry has ever experienced. Thank you all, and congratulations on this memorable achievement!

SubOptic 2007 Program Committee

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Tyco Telecommunications

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Vice Chairman, Marine Services & Operations
Telefonica

Jackie Fitzgerald
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Vice Chairman, Carrier Essentials
REACH

Motoyoshi Tokioka
Vice Chairman, System Supply Market
NEC Corporation

Opening *Sessions*

Tuesday, May 15 • 9 AM
Grand Ballroom V-VI

Welcome from

Alan Robinson
President of the SubOptic Executive Committee

David Coughlan
President of Tyco Telecommunications,
Host of SubOptic 2007

Mayor Sheila Dixon
Mayor of the City of Baltimore

Keynote Address

Jaron Lanier
Computer scientist, artist, musician and technology visionary

Named one of the world's top 100 public intellectuals by *Prospect Magazine*, Jaron Lanier's talents span multiple fields of endeavor. A computer scientist, visual artist, musician, composer, and technology visionary, Lanier defies categorization and blends his talents in surprising ways. As one of the original developers of "virtual reality" – a phrase he coined, by the way – Lanier is often identified with that nascent technology and its intriguing possibilities.

Since the late 1990s, Lanier has served as Lead Scientist of the National Tele-Immersion Initiative, a coalition of research universities studying advanced applications for Internet 2. For his work in VR and tele-immersion, Lanier has received an Honorary Doctorate from the New Jersey Institute of Technology. He continues to serve on multiple advisory committees for science and communications, and has occasionally served as a consultant for documentary and feature films.

Lanier's writing has appeared in *The New York Times, Discover, The Wall Street Journal, Forbes, Harper's Magazine, The Sciences, Scientific American* and *Wired Magazine* (where he is a founding editor). He has appeared on television shows such as "The News Hour", "Nightline", and "Charlie Rose", and has been profiled on the front pages of *The Wall Street Journal* and *The New York Times.*

Wednesday, May 16 • 9 AM
Grand Ballroom V-VI

Keynote Address

Ambassador David A. Gross
U.S. Coordinator for Communications and Information Policy, U.S. Department of State

Ambassador Gross began his career in communications more than twenty-five years ago, specializing in communications and telecommunications law. Since joining the State Department in 2001, Ambassador Gross has, among other things, led the US delegation to both phases of the U.N.'s "heads of state" World Summit on the Information Society (WSIS) (Geneva 2003 and Tunis 2005), two Asia-Pacific Economic Cooperation (APEC) Telecommunications Ministerial conferences, and to more major International Telecommunication Union (ITU) conferences than anyone in modern U.S. history. He has also served as a member of the United Nations' Information and Communications Technologies Task Force.

During his tenure, Amb. Gross has conducted bilateral discussions at senior levels with representatives from more than 70 countries and has advocated for the creation of enabling legal and regulatory environments around the world. The goals of these efforts are not only to promote American business interests abroad, but also to promote access to and expansion of information and communications technologies (ICTs) to improve the education, health and welfare of all the world's people. Amb. Gross has been outspoken on the positive impact that new technologies are having on political liberties around the world. It is in this context that Amb. Gross often speaks not of a "digital divide" but rather of the "digital opportunity" that information and communications technology represents for the entire world.

Thursday, May 17 • 9 AM
Grand Ballroom V-VI

Keynote Address

Richard Karlgaard
Columnist and publisher of *Forbes Magazine*

Rich Karlgaard is the publisher of *Forbes* – the world's most popular business and financial magazine, read by 4.5 million people per issue. He also is the author of the book, *Life 2.0 How People Across America Are Transforming Their Lives by Finding the Where of Their Happiness*, which was an Amazon and *Wall Street Journal* business best-seller.

In every issue of Forbes, Rich writes a column called *Digital Rules*. In his *Digital Rules* column, Rich writes about technology, entrepreneurship, regional and economical development, and the future of business and work. He frequently lectures on these subjects and is a regular guest on the Fox News Channel's "Forbes on Fox." In 2005, Rich began writing a daily blog, which appears on the homepage of Forbes.com.

Rich joined Forbes in 1992 to start *Forbes ASAP*, a technology magazine, along with Forbes CEO and editor-in-chief Steve Forbes, and the futurist and writer George Gilder. At *Forbes ASAP* Rich commissioned original works by Tom Wolfe, John Updike and other notable American writers.

Rich is an accomplished entrepreneur. He has co-founded two companies (Garage Technology Ventures, in 1997; and *Upside Magazine* in 1988) and one civic organization (the 5,500-member Churchill Club in 1985). For the latter, Rich was a co-winner of the Ernst & Young Northern California "Entrepreneur of the Year" award.

Roundtable *Sessions*

Roundtable 1

Tuesday, May 15 • 11 AM
Grand Ballroom V-VI

Demand Drivers and the Global Bandwidth Supply Chain

Moderated by Stephen McClelland of *Telecommunications Magazine*

With an introductory presentation on supply, demand and pricing trends by Alan Mauldin, Research Director at Telegeography

Where will the (profitable) demand come from?

Internet traffic continues to surge year-after-year. Already, new major infrastructures are planned, particularly in Asia-Pacific. But is this good or bad news for the wider telecom community? Given broadband takeup worldwide and a continued explosion in social media such as P2P, VoIP and videosharing, what are the factors that will ensure realistic accommodation of the traffic demand through the telecom value chain from retail to global backbone? Are we destined to see capacity shortfalls at the metro level simultaneously with possible overbuild in the global backbone? Will a comfortable equilibrium between supply and demand ever be possible – or even desirable? In short, what are the new business models that we can use to point the way to a more prosperous future, and can we learn from the exponents of new applications to get there?

Invited panelists will include senior carrier executives.

Roundtable 2

Wednesday, May 16 • 10:30 AM
Grand Ballroom V-VI

Finding Economic Equilibrium: Impossible Dream or Worthwhile Pursuit?

Moderated by Howard Kidorf of Pioneer Consulting

With the introductory presentation "Towards a Profitable Supply Industry" by Geoffrey Thornton of Don Quixote

(See Abstract on page 25.)

"Economics is a subject that does not greatly respect one's wishes" … and so goes the business of submarine cables. The desire to find sustainable models for businesses all along the submarine system supply chain has spurred a reexamination of all of the assumptions underpinning the market. Leading representatives from this supply chain will examine these assumptions along with: the desire for "rational behavior", the impact of capacity prices on infrastructure spending, and the current state of the marketplace.

Invited panelists will include senior executives from the supplier, operator and bandwidth purchaser communities.

Roundtable 3

Thursday, May 17 • 10:30 AM
Grand Ballroom V-VI

The Future of Marine Maintenance

Moderated by Frank Cuccio of Tyco Telecommunications

Most industry experts would agree: this is a pivotal time for the marine maintenance business. On the one hand, the number of new cable systems being deployed each year is far greater than the number being retired. On the other hand, the number of vessels available to maintain the world's cable infrastructure decreased dramatically over the last several years. Consider, also, that carriers now sustain fewer in-house resources for submarine activity, so a greater range of support services are demanded of the maintenance providers. From the customer's perspective, marine maintenance represents a significant financial burden at a time when capacity prices are at historic lows and the competition shows no signs of letting up. What's the net result for the industry? More cables, fewer ships, more services, and a demand for lower prices. Any industry observer would rightly wonder what the future holds…

This special Roundtable Session will feature five excellent papers submitted in response to the SubOptic 2007 Call for Papers, all dealing with issues surrounding today's marine maintenance sector. Following the presentations, there will be a moderated a panel discussion with invited members of the marine maintenance community.

Presentations will be made by:

Charles L. Collins, Jr. (3U Technologies, LLC)
RT3.1 **A New Paradigm for Responsive Submarine Cable Repair**

Stephen J. Dawe (Cable & Wireless)
RT3.2 **Standardisation in Operations Administration and Maintenance for Submarine Cable Systems**

James K. Herron (Tyco Telecommunications)
RT3.3 **The Metamorphosis of Marine Maintenance Providers: Meeting the Expanding Needs of Cable System Owners**

Michael G. Kelly (VSNL International)
RT3.4 **Wet Maintenance, What's the Right Model?**

Ove Smidt (ASN Marine)
RT3.5 **The Market for Marine Maintenance and Installation – How to Optimise the Resources in a Changing Market**

(See Abstracts on pages 25-26.)

Tutorial *Sessions*

MoA1 Offshore Oil and Gas Applications of Undersea Cable Systems

Monday, May 14 • 4 PM
Laurel A&B

Greg Otto, BP America
with Rob Munier, Tyco Telecommunications
Chaired by Alberto Delgado (Telefonica)

This tutorial will survey the need for high bandwidth, low latency and reliable digital communication in offshore fields. It will provide insight into critical technical criteria and considerations when designing, constructing and maintaining undersea cable system solutions from the end user and oil & gas perspective. System ownership models, especially in emerging markets, and options for ongoing operation and maintenance will be discussed. The tutorial will conclude with a forecast of the anticipated undersea communication requirements for the oilfields of the future.

Mr. Otto manages the Field Digital Infrastructure for BP's Exploration and Production segment worldwide. He currently has responsibility for undersea systems in operation or being developed in the North Sea, Gulf of Mexico, Azerbaijan and Angola offshore fields. Mr. Otto holds an Electrical Engineering degree from the University of Iowa. He has worked supporting telecommunications for oil & gas for over 15 years.

MoB1 Fundamentals of Project Finance

Monday, May 14 • 4 PM
Laurel C&D

Jackie Fitzgerald, Apollo SCS
Chaired by Motoyoshi Tokioka (NEC Corporation)

The tutorial will be aimed at non-experts and will offer a primer on how a submarine cable build can be financially engineered. It is intended that by the end of the tutorial someone without a finance background should be comfortable with the basics of project finance and have the confidence to begin to deal with the more advanced finance issues that may arise at any stage of a project.

The tutorial will introduce the basic financial statements (P&L or Income Statement, Balance Sheet and Cashflow) and their purpose, together with the key differences between them.

The advantages and disadvantages of different project structures and financing alternatives will then be considered, along with the tax issues that may influence the success or failure of a given project. In this section we'll look at:

- debt versus equity,
- borrowing versus self financing,
- the factors that influence the interest rate(s) at which a lender will advance funds and other issues of concern to lenders
- multinational financing and consortia

The tutorial will also discuss the factors a finance professional would consider when evaluating a project, or choosing between different projects, and preparing an initial business case, introducing and explaining evaluation criteria such as payback, breakeven, discounted cashflow analysis and the internal rate of return.

Jackie Fitzgerald was appointed Apollo's Managing Director in March 2007, having joined Apollo as Finance Director in July 2004. Jackie has many years' experience in telecommunications and has been involved in major projects, including consortium systems and private cable ventures, IPOs, mergers and acquisitions and divestments. Jackie is a Chartered Management Accountant (UK) and holds a Combined Honours degree in French and Spanish from King's College, University of London.

TuC1 Surveillance & Security Applications of Subsea Cable Technology

Tuesday, May 15 • 2 PM
Laurel A&B

Dr. Seymour Shapiro, Tyco Telecommunications
Chaired by John Tibbles (REACH)

This tutorial will briefly trace the history of undersea cable communications, from the initial telegraph cable of the mid-19th century to the present multi-Tera-bit trans-oceanic fiber optic cables. It will also discuss the evolution of the surveillance initiatives, which began over a half-century ago and continue apace. We will describe how this combination of disciplines has led to the more recent initiatives in the area of research and surveillance/security applications.

Specific focus will be devoted to cabled ocean observatories currently under construction or in the planning stages (MARS, VENUS, NEPTUNE, etc.), the basic elements that go into such systems, and the manner in which they relate to classical telecom systems. Similarly the elements of a marine security system will be discussed, both in general terms and specific applications to harbor or port security. Emphasis will be placed on the connectivity, flexibility and robustness that can be provided by undersea cable systems, rather than on specific sensor or research tool technology. Powering objectives and options will also be discussed.

Finally, proposals will be offered as to how mixed-use systems can be configured to combine different applications and achieve overall cost effectiveness.

This tutorial is intended for telecommunications engineers and managers who seek greater understanding as to how basic undersea transmission principles are being applied to new non-telecom markets.

Seymour Shapiro is Vice President, Research & Development, and Chief Technical Officer of Tyco Telecommunications Laboratories. He joined AT&T Bell Laboratories in 1969 after obtaining a Bachelor's degree from the City College of New York. His graduate degrees are from Columbia University; all in mechanical engineering. For the last 20 years, Dr. Shapiro has been the chief engineer responsible for the mechanical design, development, qualification and introduction to manufacture of submerged undersea cable, hardware and electronics. Dr. Shapiro holds several patents in these areas. As VP of R&D, he now heads Tyco Telecommunications Laboratories and leads all technological aspects for Tyco Telecommunications, including forward looking research work and undersea transmission design, as well as submerged plant and terminal equipment design and engineering.

TuC2 Alternative Transmission Technologies

Tuesday, May 15 • 3 PM
Laurel C&D

Isabel Alcober, Telefonica
Chaired by Daniel Welt (VSNL International)

In today's telecommunications environment, ever-faster data streams are able to connect the most distant reaches of the world by traversing complex fiber networks and then, at times, "jumping" through the air via satellite and microwave links. This communications flow continues, rarely interrupted, even as the infrastructure that supports it constantly changes and evolves.

This tutorial will begin by acknowledging the various ways in which communication has become the daily currency of our society, and the extent to which individuals and groups have come to depend on access to information. Given this all-pervasive demand, the general aim of transmission technologies is, in simplest terms, to reach as many people as possible with fastest connections possible.

The tremendous increases in transmission capacity, made possible by technological advances of the past few decades, have made communications almost universally accessible – not only because of their physical reach, but because of the rapidly decreasing costs of providing access. In addition to voice services, broadband is now becoming available in remote areas, largely thanks to the amalgamation of alternative transmission technologies.

Following this general introduction, the tutorial will show how global telecommunications are based on optical fibre cable networks, satellites and microwave links transmission.

The aim of the tutorial is to compare, in some detail, the characteristics of submarine cables, satellite and microwave transmission links: their technological evolution over time, the state of the art, user demand, some markets aspects, and some perspectives on the future of each technology.

The presentation will conclude with an evaluation of all the significant parameters in determining whether one transmission system is more feasible or more convenient for one geographical environment, one market niche or operational situation.

In the global network, these technologies complement each other, offering multiple solutions in response to the same universal need: getting connected.

Isabel Alcober joined Telefónica Satellite Engineering Department in 1989 after graduating in Solid State Physics in Zaragoza University (Spain). Since 1989 she has been dedicated to satellite engineering, has taken part in installation projects, factory, acceptance and commissioning testing, together with equipment market research and contacts with suppliers. In 2001, she started work in the O&M of marine systems as New Submarine Cables Maintenance Adviser. Since then, she has been involved in various aspects of submarine systems maintenance, giving support to Terminal Stations on the analysis and diagnosis in the supervision of the submarine cables; projects such as setting up a submarine cables remote surveillance network, as well as representing Telefónica in different forums, or coordinating and participating in training plans for O&M submarine staff.

TuC3 High Performance Hybrid Optical-Packet Networks: Developments and Potential Impacts

Tuesday, May 15 • 4:30 PM
Laurel A&B

Dr. Donald R. Riley, Professor, University of Maryland
Jerry Sobieski, Mid-Atlantic Crossroads
Chaired by David Robles (Tyco Telecommunications)

The international research and education community has mounted significant efforts to develop a new generation of networking capabilities that have at the core infrastructure owned/controlled, provisioned and managed by the R&E community. These networks are all-optical with multiple point-to-point wavelengths, currently at the 10Ge level. Services provisioned across these backbones are multi-layer, multi-service in nature, including Layer 1, 2 and 3 services. A number of efforts are focused on the "control plane" issues of how you manage and monitor provision of "hybrid" services across multiple service layers, across multiple network domains, often on an international basis.

The need for such new services is driven by the applications community – the research community that is typically a globally-distributed collaboration. "Cyber-Infrastructure" one term used in the U.S. to describe such developments, and is now a new program office of the National Science Foundation. Such collaborations include the need to move massive amounts of data in real time, control expensive and unique equipment, etc. Example projects include the high energy physics community's Large Halon Collider (LHC) project coming on line next year at CERN in Geneva, the extended very long baseline interferometry (eVLBI) radio astronomy project with antenna arrays located around the world.

The GLIF (Global Lambda Integrated Facility) international consortium was formed in 2004 to focus on the need for sharing and managing multiple "light paths" on demand on a global basis. Various initiatives at the national and regional level focus on some of the core issues in technology development as well as applications development. One of the US-funded projects is the DRAGON project: Dynamic Resource Allocation on GPLS-enabled Optical Networks, an NSF funded testbed exploring GMPLS provisioning of LightPath services across multiple network layers, and across multiple network domains.

This tutorial will provide some insight into these developments and the driving motivations – and potential future developments and possible implications for the submarine cable industry. The presentation will include overviews of GLIF and DRAGON objectives and technology developments, and other similar, related projects and initiatives.

Dr. Riley is Professor of Information Systems, Robert H. Smith School of Business, and Affiliate Professor of Mechanical Engineering at the University of Maryland, College Park. He currently serves as IT Fellow at the Southeastern Universities Research Association (SURA) in Washington, DC, chairs the Board of Directors of the Internet Educational Equal Access Foundation and serves on the board of National LambdaRail. Dr. Riley is founder and co-chair of the annual Chinese American Network Symposium and was recognized in 2000 by the Chinese Academy of Sciences as "Senior Technical Adviser to China Science and Technology Network." He also serves on the external advisory board of Capital Technology Information Services, Inc. (CTIS). He is co-PI on the NSF-funded DRAGON project (Dynamic Resource Allocation on GPLS-enabled Optical Networks). Dr. Riley was one of the founding members of the national Internet2 initiative, served on the Network Planning and Policy Advisory Council (NPPAC); founded the Mid-Atlantic Crossroads (MAX) regional networking consortium, one of the largest Internet2 regional gigapops, hosting the NGIX-DC (Next Generation Internet Exchange) for the federal agency NGI R&D networks. Dr. Riley has held the position of CIO at the University of Maryland, and also at the University of Minnesota, where he also was a Professor of Mechanical Engineering from 1976 to 1998.

Jerry Sobieski is the Director for Research Initiatives at the Mid-Atlantic Crossroads (MAX) in the Washington DC region. He is the PI on the DRAGON project ((Dynamic Resource Allocation on GPLS-enabled Optical Networks), an NSF funded testbed exploring GMPLS provisioning of LightPath services, and program manager for the Internet2 HOPI (Hybrid Optical and Packet Infrastructure) Testbed Support Center. Mr Sobieski has a background in high performance parallel and distributed computing, advanced networking, and application of these technologies to e-science. He serves on the Internet2 Abilene Technical Advisory Committee and the HOPI Design Team and is an active contributor to the GLIF (Global Lambda Integrated Facility international consortium) Control Plane working group. An ex-skydiver, Jerry has been known to engage in equally risky activities - such as navigating the DC Beltway, and giving keynote talks to various international networking organizations.

TuC4 Data Coding for Submarine Systems

Tuesday, May 15 • 5:30 PM
Laurel C&D

Kiyoshi Fukuchi, NEC Corporation
Chaired by Vincent Letellier (Alcatel-Lucent)

Data coding technology for submarine cable optical fiber communication systems plays an important role for extending application areas, such as longer distance transmission, 40Gb/s upgrades in installed fiber, and multi-terabit class higher density WDM systems. Various data coding technology, such as optical signal modulation formats and forward error correction codes, are already proposed and enabled for different applications to fully utilize the technology's advantages. The advancement of data coding technologies is ongoing in optical R&D fields for extending system performances.

This tutorial reviews state-of-the-art and future data coding technology for submarine cable systems. The main topic of this tutorial is a summary and comparison of modulation formats. Standard modulation formats, such as NRZ or RZ, along with the future advanced formats like DPSK, FSK, or QAM are discussed with a viewpoint of basic operation principles, the role of the technology in fiberoptic systems, their advantages and disadvantages, and transmission experiments. The tutorial will also cover forward error correction code technologies with regard to system improvements and other impacts. Finally, we will discuss signal compensation technology, which will soon be recognized as important and closely related to data coding in future fiberoptic cable systems. Electrical compensation technology, along with state-of-the-art optical compensation techniques, will enable higher performance and more cost effective systems.

Kiyoshi Fukuchi received B.S. and M.S. degrees in Electronics Engineering from University of Tokyo in 1989 and 1991, respectively. He joined Opto-Electronics research laboratories, NEC Corporation in 1991, where he has been researching high speed optical fiber transmission systems. He is now a principal researcher of System Platforms research laboratory, where his main theme is high capacity WDM system and related technologies. His research carrier includes:

- *10G/20G/40G electronic circuit for optical fiber communication*
- *modulation format*
- *transmission system design including system simulation technologies*
- *high capacity WDM transmission experiments.*

WeC1 Legal Aspects of Bandwidth Sales for New and Existing Systems

Wednesday, May 16 • 1:30 PM
Laurel A&B

Mike Conradi, Kemp Little LLP
Chaired by Jackie Fitzgerald (Apollo-SCS)

This tutorial will focus on the legal issues surrounding buying and selling submarine fibre capacity. It will discuss the following items:

- The true legal meaning of an "IRU" – by looking at the early history of consortium-built submarine cables, the tutorial will explain the original meaning of an "IRU" and explain why the term continued to be used in the days of privately-built cables even though its meaning, in the modern context, is quite different. This will also cover the significance of the accounting treatment of IRUs in the company's books.
- The contents of a submarine capacity contract.
- Ensuring Continuous Quality – This would discuss the importance of recognising that, because the service is delivered over many years, the contract needs mechanisms to ensure continuous quality. It would cover how to build flexibility into the agreement, choosing the right pricing model, benchmarking and market testing, upgrade rights and continuous improvement obligations, the value of "most favoured customer" clauses, maintenance obligations and, of course, service levels.
- Protecting against insolvency – can a customer take security over capacity on a fibre?
- Terminating a submarine capacity contract – anticipating early termination in the contract, typical termination rights, limiting the supplier's termination rights and avoiding accidental waiver of rights.

Mike Conradi is a senior lawyer at city of London technology specialist firm Kemp Little LLP (described in the most recent edition of the Legal 500, the main guide to UK lawyers, as "The City's outstanding technology focused law firm"). Mike has extensive experience in the submarine fibre world. This includes:

- *Acting for Pangea Networks in the UK, where he advised on the principal equipment supply agreement (with Nortel) and on many of the contracts needed to buy capacity (both lit fibre and dark fibre). The deal raised some knotty legal issues – most notably on whether or not is was possible to take security over individual optical fibres.*
- *Acting for Nava Networks in Australia. This was a proposed fibreoptic cable system connecting Singapore to Sydney. Mike advised mainly on the pre-sales negotiations and in coordinating regulatory advice from overseas jurisdictions. He negotiated landing party agreements in Indonesia and in Singapore and distribution agreements appointing resellers of capacity in various jurisdictions.*

Mike has written and spoken extensively on various submarine fibre topics including at SubOptic 2004 and at several Submarine Networks World conferences in Asia-Pacific. His article How to Get High in Fibre *was published by the* Carriersworld Journal.

WeC2 International Law and Submarine Cables

Wednesday, May 16 • 2:30 PM
Laurel C&D

Douglas Burnett, Holland & Knight LLP
Chaired by Jackie Fitzgerald (Apollo-SCS)

This tutorial will provide a thorough understanding of the United Nations Law of the Sea Convention (1982), as well as international law. Focus will be: maritime zones; the rights and obligations of cable owners in each of these zones with respect to maintenance, repairs, and laying of international cables; the requirement to indemnify vessels that sacrifice their fishing gear or anchors to avoid injury to a cable; the requirements and responsibilities when crossing other cables and pipelines; recovery of damages to cables by third parties; trends in international laws regarding permitting of cables and repair; and a precautionary look at environmental issues.

Douglas Burnett practices primarily in the areas of telecommunications (submarine cables) and international and maritime law litigation and arbitration in the New York office of Holland & Knight LLP. Mr. Burnett is the International Law Advisor to the International Cable Protection Committee (ICPC). In this capacity, he advises members of their rights and responsibilities under international law and associated treaties and national legislation regarding undersea telecommunication cables. His unique experience includes litigation in numerous cases in U.S. and foreign courts concerning internationally protected submarine cables. Mr. Burnett has had a distinguished naval career, qualifying as a surface warfare officer, serving in the Brazilian Navy for 2 years as an exchange officer, and as an operations officer with the Military Sealift Command. He holds the rank of Captain and his last assignment until retirement was as Commanding Officer of the Naval Coordination and Protection of Shipping (NCAPS) unit assigned to the Commander of the U.S. Fifth Fleet based in Bahrain. His duties have included special assignments where Portuguese and Spanish language fluency is required in Latin America.

Mr. Burnett is a member of the Maritime Law Association of the United States, where he has been Chairman of the Committee on International Law of the Sea from 1994-2000, the New York County Lawyers Association (NYCLA), where he is the Chairman of the Admiralty and Maritime Committee (2003-present), and the Intituto Iberoamericano de Derecho Maritimo. He was a guest lecturer at the Rhodes Academy of Ocean Law and Policy, July 2006. He holds the highest rating assigned by Martindale-Hubbell Law Directory.

ThC1 The Evolution of Marine Tools and Technology

Thursday, May 17 • 1:30 PM
Laurel A&B

Gordon Lucas, Alcatel-Lucent
Chaired by John Horne (Secretary, SubOptic EC)

Over the past decade with the advent of Dense Wavelength Division Multiplexing (DWDM) technology, the industry has seen an increase in capacity of submarine cables of several orders of magnitude. In the event of a serious fault in the submerged plant (cable break; repeater failure), this huge increase in capacity has significant problems for traffic restoration and service reliability, unless of course, the operator can afford the luxury of a redundant ring system (two cables).

The most cost effective solution to this dilemma is to increase the reliability of the system; improving component reliability, process control and, more significantly, the quality of marine installation to protect the cable from external aggression and avoid failures due to sea bed abrasion.

We know from fault statistics that component and process reliability has increased over the last decade as the percentage of faults due to 'external aggression' (including that from the sea bed) has risen from 70% to 80% although the number of faults per system kilometre has declined (and continues to do so).

Therefore the key to improving system reliability is to improve marine installation techniques and reduce the incidence of faults from 'external aggression'.

This tutorial presentation looks at the evolution of marine tools and technologies over the past decade to see how the industry has risen to the challenge of providing greater reliability in the marine environment. It will look at developments in Geographical Information systems (GIS), in Geophysical Survey (to better define the cable route), in burial assessment (to better define cable protection), ploughs and ROVs (to achieve better burial) and cable ships (to achieve better installation). It will also ask questions as to whether some of these developments represent value for money.

Finally, the tutorial will consider what might be the evolutions for the future.

Gordon Lucas is currently Marine Technical Services Manager within the Marine Operations group of Alcatel Submarine Networks based in Greenwich, London. He joined Standard Telephones and Cables (STC) in 1977 after graduating in Electrical and Electronic Engineering at Kingston University, London.

After various posts in hardware design, software engineering and manufacturing of digital transmission systems, Gordon Lucas moved into the marine and project management environment with high definition seismic acquisition systems for the oil and gas exploration market. For the past 15 years, he has been working in the submarine cables industry, initially, with the project management of all marine operations associated with the engineering and installation of submerged plant. As Marine Technical Services Manager, Gordon Lucas heads a team of specialist engineers responsible for all technological aspects for the marine engineering and installation of submarine cables from initial route feasibility study, through survey, installation and into maintenance. His responsibilities include the specification of tools and techniques for survey, installation and burial of submerged systems.

ThC2 Cable Maintenance and Sparing Strategies

Thursday, May 17 • 2:30 PM
Laurel C&D

James Coble, AT&T
Frédéric Exertier, France Telecom Marine
Chaired by Alberto Delgado (Telefonica)

Maintenance of undersea cable networks actually begins during the planning stage for construction. Many factors need to be considered when determining how an undersea network will be maintained. Initially, consideration should be given toward the reliability of the components (mean time between failure), the route planned for the cable (as this will affect the type of cable installed in certain areas as well as highlight the potential for failure due to undersea phenomena such as landslides), burial, armoring and landings. Planning for the frequency of failures that are not related to the above, such as fishing or anchoring, needs to be taken into account when planning the amount of spare cable to be ordered. Further, the complexity of the systems being installed has increased, leading to increased component failures such as laser diode failure within the repeaters and premature fiber degradation. After installation, consideration must be given to the type of repair maintenance that will be obtained, whether through private arrangements with cable ships or through consortia maintenance through zone maintenance arrangements. Upon retirement, consideration should be given as to whether there are alternative uses for the remaining spares or whether they should be disposed of, sometimes at great expense given the components (previous generations of spare repeaters contained both heavy metals and radioactive cesium).

James Coble joined AT&T in 1984, working in the undersea cable portion of the business. During that time, he has held various positions in both network operations and finance. He has served in various undersea cable roles including the role of Chairman of several maintenance agreements (ACMA, PIOCMA, North America Zone and Hawaii Zone). His current job responsibilities include maintenance of AT&T's undersea cable network, representation on the management committees and O&M subcommittees of various systems, procurement representation on new systems AT&T is participating in, and various miscellaneous responsibilities. His experience in the industry spans more than 20 years and his education includes certificates in accounting, an executive MBA degree and a normal MBA degree.

Frédéric Exertier joined France Telecom Marine 4 years ago as EVP in charge of the Mediterranean depot and as MECMA Project Manager. Since 1992, he was in charge of sales and technical support to the wholesales teams of France Telecom Long Distance. He is a graduate of the technical high school "Ecole des Mines".

Oral Presentation *Sessions*

See Abstracts on pages 27-38.

Tuesday, May 15 • 2-4 PM
Grand Ballroom V

TuA1 Going Deep: Marine Services & Operations

Chaired by Mick Green (BT)

TuA1.1 Aspects of Submarine Cable Retirement
Jürgen Ridder (T-Com)

TuA1.2 Cable Route Planning and Installation Control: Recent Advances
Jose M. Andres, Tie Fang , Michael A. Nedbal (Makai Ocean Engineering, Inc.)

TuA1.3 The Future of the Universal Joint Consortium
Joel Whitman (Global Marine Systems Limited)

TuA1.4 Advances in Deepwater Cable Maintenance Through New Grapnel Technology
Jeremy Featherstone (Blue Ocean Projects Ltd.) and Andrew Thomas (Ocean Cable Technologies Ltd.)

TuA1.5 Is BAS Still Necessary, and If So, Where and How?
Mark Jonkergouw (Alcatel-Lucent)

TuA1.6 Re-Installation of Recovered Submarine Cables: Case Histories of Success
Chris Willey, Philip J. Footman Williams, Paco Rego, Javier de la Cruz (Tyco Telecommunications)

Tuesday, May 15 • 2-4 PM
Grand Ballroom VI

TuB1 Charting the Course: The System Supply Market

Chaired by Mike Rieger (Tyco Telecommunications)

TuB1.1 Blips on the Radar Screen: The Case for Sustained Stability in New Subsea Systems Development Market
Thomas A. Soja, John Manock, S. Hansen Long (T Soja & Associates, Inc.)

TuB1.2 Cost Ahead of Technology? Are Purchasers Buying Criteria Equivalent in the Current Market Segmentation?
Marc Fullenbaum, Stéphane Delorme, Jean-Marie Beaufils (Alcatel-Lucent)

TuB1.3 The Emergence of Affordable Broadband Services for Remote Locations Using SFOC Technology
William J. Barattino and Nicholas Koopalethes (Global Broadband Solutions, LLC)

TuB1.4 Drivers for Building New Systems
Benoit Duguet (Tyco Telecommunications)

TuB1.5 The Impact of Convergence on Submarine Cable System Deployment
Edward West and Stephen J. Dawe (Cable & Wireless)

TuB1.6 Undersea Market Trends: What's New and What's Next?
Elaine Stafford, John Mariano, David Ross (The David Ross Group, Inc.)

Tuesday, May 15 • 4:30-6:30 PM
Grand Ballroom V

TuA2 Non-Telecom Applications

Chaired by Steve Scott (Global Marine Systems Limited)

TuA2.1 Unique Marine Operations: Oil and Gas and Scientific Applications
Frank Cuccio and Ronald J. Rapp (Tyco Telecommunications)

TuA2.2 Drivers and Technologies for Next Generation Digital Connectivity in Offshore Oil and Gas Production Facilities
Greg Otto (BP America Inc.) and Wayne Nielsen (WFN Strategies)

TuA2.3 Repeaterless Fiber Optic Telecommunication Solutions as a Powerful Tool to Overcome the Challenges in the Offshore Oil and Gas Business
Winfried Rutzen, Rudolf Stahl, Clemens Unger, Heiko Dirks (Norddeutsche Seekabelwerke GmbH & Co. KG)

TuA2.4 Cabled Science Observatories Solutions: Bringing Power and Broadband Communication to the Ocean Depths
Antoine Lecroart (Alcatel-Lucent), Nazeeh Shaheen (L-3 Communications MariPro), Peter Shawyer (Texcel Technology)

TuA2.5 Seismic Observation Systems Utilizing Significant Telecommunication Technology in Japan
Kenji Hishiki and Wakana Kobayashi (NEC Telenetworx, Ltd.)

TuA2.6 NEPTUNE Canada (NEPTUNE Stage I) and the Opportunities Presented
Peter Phibbs (University of Victoria) and Stephen Lentz

TuA2.7 Design of the Scientific Cabled Network Between Ireland and Porcupine Seabight and Abyssal Plain, Study Site of the European Seafloor Observatory Network Implementation Model (ESONIM)
Jean-François Rolin (IFREMER), Gary Waterworth (Alcatel-Lucent), Mick Gillooly (Marine Institute Galway), Imants G. Priede (University of Aberdeen), Olaf Pfannkuche (IFM-Geomar), Glen Nolan (Marine Institute Galway)

Tuesday, May 15 • 4:30-6:30 PM
Grand Ballroom VI

TuB2 Carrier Essentials: The Undersea Bandwidth Market

Chaired by Yves Ruggeri (France Telecom)

TuB2.1 Future Broadband Applications: What Would the Impact Be, If Any, on the International Bandwidth Industry?
Zvika Caspy (Mediterranean Nautilus Ltd.)

TuB2.2 Demand Drivers for Carriers – Evolution of Ethernet
Momtchil Petrov, Robert Thomas and Jeffrey Stark (Tyco Telecommunications)

TuB2.3 Trend in Submarine Maintenance as IP and DWDM Converge
Ken Herrmann (VSNL International)

TuB2.4 Enhanced Resilience for Terrestrial Restoration Capacity
Dave Pinion (BT Global Services)

TuB2.5 Refresh Operation and Maintenance Training
Voahangy Rakotomanana, Pierre Fidry, Christian Ausanneau, Stéphanie Rousseau (Alcatel-Lucent)

TuB2.6 Undersea Cable Markets and the Developing World
Michael Ruddy (Terabit Consulting)

Wednesday, May 16 • 1:30-3:30 PM
Grand Ballroom V

WeA1 Spotlight Session

Chaired by David Robles (Tyco Telecommunications)

WeA1.1 Observations on the 2006 Taiwan Earthquake
William Barney (CEO, Asia Netcom)

WeA1.2 Trends in Submarine Cable System Faults
Submarine Cable Improvement Group (SCIG): Maurice E. Kordahi and Seymour Shapiro (Tyco Telecommunications), Gordon Lucas (Alcatel-Lucent)

WeA1.3 Activities of the ICPC
Bob Wargo (AT&T Services Inc.)

WeA1.4 National Security Regulation of International Telecommunications Infrastructure and the Law of Unintended Consequences
Kent Bressie (Harris Wiltshire & Grannis LLP)

Wednesday, May 16 • 1:30-3:30 PM
Grand Ballroom VI

WeB1 Evolution & Revolution: Equipment & Component Technologies

Chaired by Colin Anderson (NEC Corporation)

WeB1.1 Multi-Service Integrated Platform (MSIP) Solution and Its Impact on Submarine Cable System
Daiki Miwa, Taka-aki Ogata, Yoshitaka Kanno, Yoshinori Chiba, Satoru Hadano, Masataka Goto and Yu Aoki (NEC Corporation)

WeB1.2 The 10Gigabit Ethernet Impact on Submarine Networks
Ken Reynolds, Andy Aitken, Joerg Schwartz, Stuart Barnes (Azea Networks Ltd.)

WeB1.3 DQPSK Modulated Turbo Code FEC for Cable Capacity Upgrades
Takashi Mizuochi, Yoshiaki Konishi, Kazuhide Ouchi, Kiyoshi Onohara, Kazuyuki Ishida, Katsuhiro Shimizu, Kazuo Kubo, Shunsuke Mitani, Hitoyuki Tagami (Mitsubishi Electric Corp.)

WeB1.4 Novel Undersea Line Monitoring Technology Enables Improved Performance and OTDR Capability
Brian Jander, Hongbin Zhang, Ram Engira, Bill Ruthrauff, Yan Jiang, Angelo Giordano, Boris Bark, Richard Kram, Sam Sabet, Brian Li, Jonathan Liss, Charles Breverman (Tyco Telecommunications)

WeB1.5 A Long-span Repeater for Regional Submarine Systems
Patrice Le Roux, Mélanie Jaouen, Ghislaine Vareille (Alcatel-Lucent)

WeB1.6 Advanced Fibers for Submarine Networks
Sergey Ten (Corning Optical Fiber)

WeB1.7 Rating Subsea Cables for Resistance to External Aggression
Trevor Taylor (BT Global Services)

Thursday, May 17 • 1:30-3:30 PM
Grand Ballroom V

ThA1 Before You Dive In: Project Development & Implementation

Chaired by Fiona Beck (Southern Cross Cable Network)

ThA1.1 How Fast Can an Undersea Telecommunication System Upgrade Be Implemented?
Debra Brask (Tyco Telecommunications)

ThA1.2 Advanced Enhancements of the SAm-1 Submarine Cable System
Eduardo Saravia, Guillermo Canete, Miguel Angel Martinez (Telefonica International Wholesale Services)

ThA1.3 A Standard Set of Terms of Contract for the Submarine Telecommunications Industry
Michael S. Carter (Alcatel-Lucent)

ThA1.4 Enabling Global Communications – From Risk to Reward: Why must we learn our own lessons before we change risk management behaviour?
Keith Schofield (Dotdash Consulting)

ThA1.5 Structuring for Successful Financings of Submarine Fiber Optic Networks
Glenn S. Gerstell (Milbank, Tweed, Hadley & McCloy LLP)

ThA1.6 The Yellow Cable System – Development, Implementation and Post Project Experience
Bob Kelly and Mike Saunders (Level 3 Communications)

Thursday, May 17 • 1:30-3:30 PM
Grand Ballroom VI

ThB1 Weaving the Worldwide Web: System Design & Applications

Chaired by Olivier Gautheron (Alcatel-Lucent)

ThB1.1 Overview of Submarine System Upgrades
M. André and N. Brochier (France Telecom R&D)

ThB1.2 Predicting the Unpredictable
Tony Frisch and Joerg Schwartz (Azea Networks)

ThB1.3 All-Raman Technology Roadmap for High-Performance Unrepeatered DWDM Systems
Herve Fevrier, A. Puc, P. Perrier, D. Chaires (Xtera Communications)

ThB1.4 40 Gb/S DWDM Transmission Technologies for Future Repeatered and Non-Repeatered Submarine Cable Systems
Yoshihisa Inada, Toshiharu Ito, Kiyoshi Fukuchi, Tadashi Koga, Takaaki Ogata (NEC Corporation)

ThB1.5 A Study of Upgradeability Using the RZ-DPSK Format on Existing WDM Transmission System
Hiroshi Nakamoto, Kenji Ohta, Akira Sugiyama, Takeo Osaka, Izumi Yokota (Fujitsu Limited)

ThB1.6 The RZ-DPSK Modulation Format in Long-Haul Transmission Systems
Alexei Pilipetskii, Morten Nissov, Neal S. Bergano (Tyco Telecommunications)

ThB1.7 DPSK Transmission Experiments Over DSMF and NZDSF
Philippe Plantady, Laurent du Mouza, Sébastien Dupont, Pierre Marmier, Clement Lange, Patrick Bollaert, Mélanie Jaouen, Ghislaine Vareille, Vincent Letellier (Alcatel-Lucent)

Poster *Session &* Networking *Event*

Wednesday, May 16 • 3:30 – 6 PM
Harborside Foyer

See Abstracts on pages 38-53.

We1 Group 1: Marine Services & Operations

We1.01 **What Next for the Universal Joint?**
Craig Beech (Global Marine Systems Limited)

We1.02 **High Reliability – Low Cost Submarine Cable Deployment**
Gunnar Berthelsen (Nexans Norway)

We1.03 **Marine Challenges and Opportunities in Newly Emerging Markets and Sectors**
Philip Footman Williams (Tyco Telecommunications)

We1.04 **Low Price Method to Repair Cables at Shore End**
Jorge Orlando Garcia Lozano (Telemediciones SA)

We1.05 **JADE: A Universal Tool for Consistent Jointing Performance and Data Recording Throughout the Submarine Cable Industry?**
Phil Hart (Global Marine Systems Limited)

We1.06 **Fault Location on Subsea Cable Systems**
Adrian Hilton (BT Global Services)

We1.07 **Evolving Cable Awareness Programs in Response to Developing and Experimental Fisheries**
Glenn Hovermale (Tyco Telecommunications)

We1.08 **Innovative Jointing & Stable Technology – Closer Than We Think**
Maurice Kordahi, Jeremiah Mendez, Marsha A. Spalding, Robert K. Stix (Tyco Telecommunications)

We1.09 **Re-Use And Re-Routing Of Retiring Systems**
Jamie Merrett (Alcatel-Lucent)

We1.10 **Experimental Results of the Real Time Simulation System (RTSS) for Cable Installation Employing a Kalman Filter Algorithm**
Yukitoshi Ogasawara (Kokusai Cable Ship Co. Ltd.) and Junichi Kojima (KDDI R&D Laboratories Inc.)

We1.11 **Marine Crew Training and Competence – Raising the Standard**
Steve Searle (Global Marine Systems Limited)

We1.12 **Extending the Use of In Service Repair Technology to Mobile and Land Jointing Cable Operations**
Andrew Thomas (Ocean Cable Technologies Ltd.) and Franck Tortey (Alcatel-Lucent)

We1.13 **Power Safety – A Global Standard**
Tim Thornett and Ephraim Tozowonah (Global Marine Systems Limited)

We1.14 **High Pressure Moulding Technology**
Romuald Lemaitre, Pierre Gaillard, Franck Tortey, Paul Woodward (Alcatel-Lucent)

We1.15 **New U.S. Coral Reef Protection Regional Permit Condition and its Effect on Cable Repairs**
Bob Wargo and Paul Shorb (AT&T Services, Inc.)

We2 Group 2: System Design & Applications

We2.01 All-Raman Amplification Extends the Life of Previous Generation Unrepeatered Systems
Jol Paling , Gregg Palinski (Global Crossing), Philippe Perrier, Andrej Puc, Daryl Chaires (Xtera Communications)

We2.02 Phase Modulation for the Transmission of Nx40Gbit/S Data Over Transoceanic Distances
Gabriel Charlet, Sébastien Bigo, Jérémie Renaudier, Mathieu Lefrançois (Alcatel-Lucent)

We2.03 How Accurate Is Mean Q – 5 Sigma During Segment Commissioning?
Michael Cuddington (BT Global Services)

We2.04 Wet Plant Considerations for High Capacity/ Long Haul System Applications with Passive Amplification Methods
Heiko Dirks, Winfried Rutzen, Rudolf Stahl, Clemens Unger (Norddeutsche Seekabelwerke GmbH & Co. KG)

We2.05 The Future of Submarine Solutions
Marc Fullenbaum, Vincent Letellier, Eric Brandon, Stéphane Delorme, Laurie Doyle (Alcatel-Lucent)

We2.06 Maximizing the Capacity and Changing the Network Topology of Existing Systems
E. A. Golovchenko, G. Mohs, L. Rahman, B. Bakhshi and S. M. Abbott (Tyco Telecommunications)

We2.07 Pushing the Reach of Repeaterless Transmission Systems
E. A. Golovchenko, L.J. Richardson, B. Bakhshi, S. M. Abbott (Tyco Telecommunications)

We2.08 Next Generation Operations Support System for the Southern Cross Cables Network
Dean Veverka and Brian Hart (Southern Cross Cable Networks), Mike Schwarz (Telecom New Zealand Ltd), Mitchell Forbes (Agilent Technologies Ltd), Tim Packer (Boss Portal Ltd)

We2.09 Alternative Approaches to the Supply of High-Reliability Components
Patrick Laverty and Barbara Dean (Tyco Telecommunications)

We2.10 Today's Thin Routes
Mark McGilvray (Tyco Telecommunications)

We2.11 Submarine Cable System Applications toward Next Generation Networks (NGN)
Daiki Miwa and Kazushige Mori (NEC Corporation)

We2.12 Planning for Out of Plan Requirements
Philip Murphy (Australia-Japan Cable Ltd)

We2.13 Development of Commercial, Remotely-Pumped EDFA System
Akira Naka, Hideki Maeda, Tomoyoshi Kataoka and Shinji Matsuoka (NTT Corporation)

We2.14 Spectral Hole Burning Effects and System Engineering Rules for System Upgrades
Richard Oberland, Steve Desbruslais, Joerg Schwartz, Steve Webb, Stuart Barnes (Azea Networks Ltd.)

We2.15 Optimization of the Unrepeatered Links with Remote Amplifiers
S.B.Papernyi (MPB Communications Inc)

We2.16 New Branch Construction of Third Party Existing Submarine Cable System in EAC1 Qingdao Landing Extension
Hiroshi Sakuyama, Makoto Saitoh, Yutaka Kiuchi, Tomohisa Nishiyama, Mikinori Niino (NEC Corporation)

We2.17 Higher Bitrates and Advanced Modulation Formats Facilitate Overlay Upgrades of Installed Submarine Systems
Jörg Schwartz, Steve Webb, Stuart Barnes (Azea Networks Ltd.) and Ronald Freund, Lutz Molle, Christoph Caspar (Fraunhofer-Institute for Telecommunications)

We2.18 Raman Opens Up Bandwidth on Non-Ideal Fibres for Un-Repeatered Systems
Lynsey Thomas (Cable & Wireless) and Philippe A. Perrier (Xtera Communications, Inc)

We2.19 Unrepeatered Systems: State of the Art Capability
Nicolas Tranvouez, Eric Brandon, Marc Fullenbaum, Philippe Bousselet, Isabelle Brylski (Alcatel-Lucent)

We2.20 Efficient and Expedited Upgrading of Existing Submarine Cable Systems
Kenichi Yoneyama, Kenichi Nomura, Isao Matsuoka, Yoshihisa Inada and Takaaki Ogata (NEC Corporation)

We3 Group 3: Equipment & Component Technologies

We3.01 Cost Effective Next Generation Submarine Application Management
Richard Cruau (Alcatel-Lucent)

We3.02 A Next Generation Distributed Network Management System
Jonathan Liss, Renata Bodner, Sameh Sabet, Ricardo Alves (Tyco Telecommunications)

We3.03 A New Generation of Submarine Line Terminal Equipment
Charles Breverman, Greg Valvo, Brian Jander (Tyco Telecommunications)

We3.04 Reliability Considerations for Terminal Amplifiers
Jeff Gardner, Barbara Dean, Brian Jander (Tyco Telecommunications)

We3.05 Transport of 10GE over Submarine Networks
L. Doyle, O. Ait Sab (Alcatel-Lucent)

We3.06 Capabilities of Electrical Supervision Systems for Submerged Equipment
Neville Hazell, Derek Willetts (Alcatel-Lucent)

We3.07 RZ-DPSK 10Gb/s SLTE and Its Transmission Performance Assessment for Application to Trans-Pacific Submarine Cable Systems
Yoshihisa Inada, Keisuke Watanabe, Katsuya Satoh, Ken-ichi Nomura, Takaaki Ogata (NEC Corporation)

We3.08 RZ-DQPSK Transponder for 40 Gbps Submarine Cable Systems
Kazuyuki Ishida, Katsuhiro Shimizu, Shunsuke Mitani, Junichi Abe, Toshiyuki Tokura, Takashi Mizuochi (Mitsubishi Electric Corp.)

We3.09 Novel Wavelength-Format Converter for Future Lambda-NNI
Katsuhiro Shimizu, Shunsuke Mitani, Ken Mishina, Suresh M. Nissanka, Kazuyuki Ishida, Tatsuo Hatta, Toshiharu Miyahara, Yasunori Miyazaki, Akihiro Maruta, Ken-ichi Kitayama (Mitsubishi Electric Corp.)

We3.10 40 Gb/s Transmission in Long-Haul Undersea Networks
Morten Nissov, Alexei Pilipetskii, Jin-Xing Cai, Yi Cai, Neal S. Bergano (Tyco Telecommunications)

We3.11 How to Stay Fit – Improving Performance and Flexibility in Terminal Equipment
Alice Shelton, Michele Barezzani, Georges Grandpierre and Philippe Bonno (Alcatel-Lucent)

We3.12 Flexible Regional Networks Using Broadband Optical Add/Drop Branching Units
Mark Enright (Tyco Telecommunications)

We3.13 Reliability Culture of Cost Effective 980 nm Submarine Pumps
Stefan Mohrdiek, Mark Ives, Hans-Ulrich Pfeiffer, Rainer Bättig, Nadhum Zayer, Shaun Quinlan, Tomas Pliska, Robert Cann, Nicolai Matuschek, Jeffrey Greatrex, Norbert Lichtenstein (Bookham)

We3.14 Equalizer in a Jointing Box: Improved Flexibility, More Cost Effective Solution
Florence Palacios, Romuald Lemaitre (Alcatel-Lucent)

We3.15 OALC-5, An Optimised Solution for Regional Systems
Patricia Boulanger and Florence Palacios (Alcatel-Lucent)

We3.16 A Low-Attenuation, High SBS-Threshold Fiber Link Optimized for Unrepeatered System Transmission at 10.7 Gbit/s
John Downie, Andrey Kobyakov, Jason Hurley, Michael Sauer, Scott Bickham, Sergey Ten, Claudio Mazzali (Corning Incorporated)

We3.17 Optical Properties Improvements of N-MDFs by Combining Two Novel Negative Dispersion Fibers
Katsunori Imamura, Kazunori Mukasa, Masateru Tadakuma, Ryuichi Sugizaki, Takeshi Yagi (Furukawa Electric Co.)

We3.18 DSMF Fibers, a Comparison of Various Solutions
Jean-Luc Lang, Florence Palacios, Nathalie Robin, Romuald Lemaitre (Alcatel-Lucent)

We3.19 Reliability Evaluation of Fiber Coating Anomalies
Haiyang Wang and Johnny Issa (Tyco Telecommunications)

We3.20 Splicing Technologies for Dispersion Slope-Matched Fibers
Rong Zhu, Johnny Issa, Michael Sanders, Marsha Spalding, Qian Zhong (Tyco Telecommunications)

We4 Group 4: Project Development & Implementation

We4.01 Global Strategy for Uniform Tariff Classification
Charles A. Barber and Michael S. Carter (Alcatel-Lucent)

We4.02 Turning Back the Bureaucratic Tide – Can We Recover Sanity in Environmental Permitting?
Roy Carryer (Alcatel-Lucent)

We4.03 Provisional Measures: A Way To Improve Cables Protection?
Alexandre Martins Boto Leite (São Paulo University – Faculty of Law)

We4.04 Completing Our Mission to Connect the World: Emerging Market Success Models
Thomas A. Soja, John Manock, S. Hansen Long (T Soja & Associates)

We4.05 The Procurement Process
Dec Wallace (BT Global Services)

We4.06 Commercial Structures and Project Methodology – Development, Planning & Implementation
G. Scott Weese (IT International Telecom Inc.)

We4.07 Incorporation Risk Analysis as an Essential Decision Making Component of Subsea Cable Projects
Donald W. Welch, Wayne Hughes, Chuck Collins, George Seltzer, Larry Mackey, Tim Axelsson (3U Technologies, LLC)

We5 Group 5: Carrier Essentials

We5.01 On-Line Expert Support Through VPN Access
Pierre Fidry, V. Rakotomanana, C. Ausanneau (Alcatel-Lucent)

We5.02 What Telecom Service Providers Want From Their Suppliers
Jacques Gros (VSNL International)

We6 Group 6: System Supply Market

We6.01 The Re-Deployment Route to Cost-Effective Cable Systems
Maja Summers and John Kincey (Cable & Wireless)

We7 Group 7: Non-Telecom Applications

We7.01 Design Challenges for Undersea Systems Serving Offshore Production Platforms
Guy W. Arnos (WFN Strategies)

We7.02 One Size Fits None: Identifying standards to facilitate future connections of undersea fiber optic networks to offshore oil and gas platforms
Christopher Carobene and Robert Munier (Tyco Telecommunications)

We7.03 Telecom/Offshore Oil and Gas: Convergence, Cooperation or Competition?
Philip Footman Williams (Tyco Telecommunications)

We7.04 Which Technology for Your Offshore Network: Unrepeatered Or Unrelentingly Repeatered?
Marc Fullenbaum, Antoine Lécroart, Jean-Pierre Odier, Ronan Michel, Vincent Letellier, Neville Hazell, Gary Waterworth, Eric Brandon (Alcatel-Lucent)

We7.05 Underwater Hardware Design Challenges for the Offshore Platform Market
Maurice E. Kordahi, Marsha Spalding, Michael Sanders, Chung-shin Ma, Johnny Issa, Jeremiah Mendez, Robert Stix (Tyco Telecommunications)

We7.06 To Boldly Go Where No System Has Gone Before
Sasha O'Bow-Hove (Alcatel-Lucent) and Cheryl Katnick (The University of Victoria)

We7.07 Scientific Applications for Telecommunications Technology
Jim Olson (Tyco Telecommunications)

We7.08 A Fibre Optic Cable End Module
Inge Vintermyr, Jørn Wardeberg, Einar Magnus Bjelland (Nexans Norway AS)

Closing *Session*

Thursday, May 17 • 4 – 5 PM
Grand Ballroom V-VI

Alan Robinson

President of the SubOptic Executive Committee

Alan Robinson will make closing remarks for SubOptic 2007, marking the end of his tenure as President of the SubOptic EC. He will close by introducing the next President of the EC.

Incoming President of the SubOptic Executive Committee

The newly announced President of the SubOptic Executive Committee will offer a vision and plans for the future of the SubOptic conference series.

Social *Program*

Welcome Reception

Monday, May 14 • 6 – 8 PM
Harborside Ballroom Exhibition Hall

The week's social program will begin with the official opening of the conference Exhibition. Cocktails and hors-d'œuvres will be served in the Exhibition Hall, giving attendees their first opportunity to meet the Exhibitors while getting reacquainted with old friends and colleagues.

Poster Session & Networking Event

Wednesday, May 16 • 3:30 – 6 PM
Harborside Foyer

The "centerpiece" event of the Conference, the Poster Session & Network Event will bring all SubOptic attendees together for an interactive presentation of the Poster papers. Cocktails and refreshments will be served as attendees are free to browse the displays, meet the authors, and discuss the papers in detail.

Closing Gala

Thursday, May 17 • 7 – 11 PM
B&O Railroad Museum

SubOptic's traditional finale will take place in the unique setting of the Baltimore & Ohio (B&O) Railroad Museum. The museum is located just 2.5 miles (4 km) from the Marriott, and private coaches will be provided for transportation to and from the Gala.

Lunch

Waterview Ballroom

Tuesday, May 15	12:30 – 2 PM
Wednesday, May 16	12 – 1:30 PM
Thursday, May 17	12 – 1:30 PM

Coffee Breaks

Harborside Ballroom Exhibition Hall

Tuesday, May 15	10:30 – 11 AM	4 – 4:30 PM
Wednesday, May 16	10 – 10:30 AM	
Thursday, May 17	10 – 10:30 AM	

Grand Ballroom Foyer

Thursday, May 17	3:30 – 4 PM

Abstracts

Part I: Roundtable Presentations

Session RT1: Demand Drivers and the Global Bandwidth Supply Chain

Introductory presentation by Alan Mauldin (Telegeography)

Session RT2: Finding Economic Equilibrium: Impossible Dream or Worthwhile Pursuit?

Towards a Profitable Supply Industry

Geoffrey Thornton (Don Quixote)

Although the market for submarine systems has recovered to a level that, at best, is the likely average size for the foreseeable future, the supply industry is not profitable.

The paper examines the consequences of this that are already evident and goes on to then predict the further consequences while this situation continues.

The paper then examines the possible ways forward. Ultimately prices will have to rise and we describe the possible scenarios which could lead to this outcome. Whichever one develops the ultimate outcome will be more restructuring and higher system prices.

Session RT3: The Future of Marine Maintenance

RT3.1 A New Paradigm for Responsive Submarine Cable Repair

Charles L. Collins, Jr., E. Wayne Hughes, George H. Seltzer, Donald W. Welch (3U Technologies)

With the increased dependence upon Submarine Telecommunications Systems for world wide connectivity, the pressure to rapidly restore damaged systems to service is greater than ever. Since SubOptic 2001, the maintenance assets worldwide have been dramatically reduced in number due to removal from service and redeployment to other markets. In the midst of this turmoil, the operational models for maintenance and repair of submarine cables have remained unchanged. This paper reviews the current state of the marine industry This paper will also present potential contracting methodologies to enable a return to service of damaged cables in the earliest timeframe when conventional assets are unavailable due to geographic or alternative use considerations.

RT3.2 Standardisation in Operations Administration and Maintenance for Submarine Cable Systems

Stephen J. Dawe (Cable & Wireless)

A review of current trends for Operation, Administration & Maintenance (OAM) of Submarine Cable Systems aiming to present an overview of current OAM structures; contrasting different OAM propositions. With the objective of highlighting questions that potential Capacity Owners should consider as part of investment appraisal.

The paper spans Marine Maintenance options, Depots, Maintenance Authorities (MA), Maintenance Organisation, Network Administration (NA), Landing Parties, Operation & Maintenance committees (O&MSC), Assignment Restoration and Administration Committees (AR&RSC), Submarine Network Operations Centres (SNOC) and Supplier Support Services.

This paper describes Operations and Maintenance (O&M) systems that have evolved and are widely deployed within the industry. The key features of these systems will be compared and contrasted in terms of their economics, strengths and weaknesses. System features will be compared against a control model of OAM, allowing the author to postulate whether there is a set of universally applicable OAM requirements that can be applied to all Submarine Systems.

Drawing from the themes developed a set of broad standards of OAM will be outlined and proposals for benchmarking OAM Services and suggestions for a Service Level Agreement (SLA) for Submarine System OAM.

RT3.3 The Metamorphosis of Marine Maintenance Providers: Meeting the Expanding Needs of Cable System Owners

James K. Herron, Jorge Porto, Javier De la Cruz, Steve Drew, John Grant (Tyco Telecommunications)

In years past, it was common for Cable System Owners to handle management of their undersea cable maintenance programs in-house.

In recent years, the trend has been for Cable System Owners to reduce or eliminate their in-house organizations and out-source the responsibility to Marine Maintenance Providers.

Marine Maintenance Providers perform the maintenance work under more stringent requirements and carry significant financial penalties for failure to achieve certain measures of quality. To accommodate Cable System Owners' expanding needs, Marine Maintenance Providers also make available enhanced services.

The programs offered by today's Marine Maintenance Provider are a better (due to the establishment of DMOQs) more cost efficient business proposition for Cable System Owners than the in-house programs of the past.

RT3.4 Wet Maintenance, What's the Right Model?

Michael G. Kelly (VSNL International)

Today's undersea cable system owners have a number of wet maintenance options available to choose from. What is the right solution, and how do we arrive at the correct choice?

The market currently is offering many variants of both the consortium and private agreement models. Consortium models are typically characterized by cable owner leadership and control, where private models are lead by ship operators willing to assume the financial risks and rewards of the marketplace. How do these models fit into decisions about the cost and operational efficiencies of your global or regional wet maintenance solution?

What about an option of no wet maintenance coverage? Have our networks become robust enough that wet repairs can wait for a ship of opportunity? What is the state of the cableship market? Will a robust oil industry, ship operator consolidation and resurgence of new cable construction impact the availability of cableships on the spot market? Should a network owner purchase their own cable ship to provide global maintenance coverage?

No one solution may be the answer! Cable owners must assess their risk tolerance in relation to the specific characteristics of their network such as protection schemes, available capacity inventory, equipment/cable reliability and product portfolio and most importantly customer expectations.

This paper will address the pros and cons of conventional and unconventional wet maintenance solutions.

RT3.5 The Market for Marine Maintenance and Installation – How to Optimise the Resources in a Changing Market

Ove Smidt (ASN Marine)

This paper will look at how the market for installation and maintenance have developed over the last couple of years until now and give a view on how the market may develop.

In particular this paper will look at:

The potential to undertake alternative work for the marine contractors in parallel with the normal cable operations so that a reasonable revenue stream can be obtained for the contractor and a cost-effective price structure can be maintained for the customers.

There is potential for a cross utilisation between the maintenance and installation vessels based on the use of a universal spare cable concept, so peaks and troughs can be managed without leading to extended implementation time, increased cost and quality issues.

Abstracts

Part II: Oral Presentation Sessions

Session TuA1: Marine Services & Operations

TuA1.1 Aspects of Submarine Cable Retirement

Jürgen Ridder (T-Com)

Since the development of optical transmission via optical fibres has been improved enormously, the capacity, transported on submarine cables has increased rapidly. But because the Operation & Maintenance costs of older submarine cable systems, carrying lower capacity compared to modern systems are almost the same, all international carriers, involved in submarine cables are showing a high interest in retiring of older submarine cable systems in order to be released from the costs and the duties of the Consortium contract. Scope of this presentation is to provide a guideline for considering the key aspects of submarine cable retirement.

TuA1.2 Cable Route Planning and Installation Control: Recent Advances

Jose M Andres, Tore K. Leraand, Tie Fang , Michael A. Nedbal (Makai Ocean Engineering, Inc.)

Recent software advances have improved the efficiency and accuracy of cable route planning and have provided better quality assurance and control during installation – important improvements for both the owner and installer. Geographic information system (GIS) technology has proven to be a reliable means of integrating various data forms into a single platform. Recent developments in 3D GIS provide the capability to deal with very large data sets and convey information more effectively than traditional, 2D static maps. In cable installations, real-time slack management systems have been expanded for tension control of lay operations, typical of power cables and plow operations.

TuA1.3 The Future of the Universal Joint Consortium

Joel Whitman (Global Marine Systems Limited)

The Universal Joint Consortium (UJC) is a longstanding cross industry body which exists specifically to ensure that proper and consistent joints can be created by all industry members for any cable types which have gone through the certification process. This UJC currently consisting of the major cable installation and maintenance providers has done a great deal of good over the years, ensuring a certain amount of fairness and quality in this core part of our industry. In recent years both the reporting and the UJC group of companies have not kept up with the rapid changes in the telecommunications industry. The envisioned presentation will give a non-partisan status of the UJC, will propose some concrete suggestions for change and will provide examples of how an improved UJC might restore some significant cooperation and accountability to our industry.

TuA1.4 Advances in Deepwater Cable Maintenance Through New Grapnel Technology

Jeremy Featherstone (Blue Ocean Projects Ltd.) and Andrew Thomas (Ocean Cable Technologies Ltd.)

The recovery for repair of deepwater lightweight cables remains a time consuming and hence costly activity. Potential solutions to this problem have been developed over the last one hundred and thirty years; however there is no solution in widespread use today other than the conventional, time consuming, use of three separate grapnels drives. This paper reviews the previous solutions, and examines why none has proven sufficiently successful to achieve widespread use today. Recent work undertaken by the authors on cable gripping is described leading to a novel solution for a new generation of deepwater cut and hold grapnels.

TuA1.5 Is BAS Still Necessary, and If So, Where and How?

Mark Jonkergouw (Alcatel-Lucent)

Since their introduction to the submarine cable industry in the mid-1990s, Electronic-Burial Assessment Surveys (E-BAS) have become an accepted survey technique for providing burial predictions, and determining the cable armouring necessary to ensure safety from external threats to cables. Since the year 2000, the arrival of a modern fleet of powerful installation ships and high penetration ploughs has led to a quantum improvement in installation performance, raising the question “Is BAS Still Necessary”? This paper looks at a risk-assessment approach to determine E-BAS data validity in the route engineering process. It concludes that, as a result of the improved installation tools, the value added by E-BAS surveys in their current form is severely limited. A need to re-focus the method of performing E-BAS is necessary if it is to remain useful in future submarine cable installation projects.

TuA1.6 Re-Installation of Recovered Submarine Cables: Case Histories of Success

Chris Willey, Philip J. Footman Williams, Paco Rego, Javier de la Cruz (Tyco Telecommunications)

There have been several recent projects where recovered out-of-service cables have been redeployed for commercial or scientific use. This paper looks at several of these recent cases, including a case in which telecommunication cable systems have been constructed out of unused spares inventory. This paper will discuss both the feasibility analysis stage as well as the operational phase of chosen projects. The parameters and factors that influence the decision whether to recover and re-use an out-of-service cable, to construct a cable system from existing unused spares inventory or to build a new cable system will be discussed. A number of trade-off parameters must be considered when determining feasibility to build new or reuse, such as: decommissioned cables availability, cable recovery and installation relative locations, optical architecture, cable condition, permits and regulations, willingness of owners to donate or sell the decommissioned cable, available recovery vessels, willingness of installers to provide warranties, comparative cost of new cable, life expectancy of the new system, maintenance etc. These parameters change frequently i.e. considering current vessel dayrates from a year ago. Operational details will be discussed such as: cable recovery planning including implications of cable crossings, recovery in areas of cable congestion and traffic congestion, jointing and tanking planning of recovered cable for optimum deployment, testing and criteria for re-use, re-assembly of the "new" system and finally the re-installation. As a final analysis the use of decommissioned submarine telecommunications cables for scientific use will also be analyzed as this practice is now well established. There is no correct single recommendation for new build versus re-use since each application has unique requirements that will affect the trade-off. This paper will assess the parameters involved in the decision making process and the advantages and disadvantages in each unique application to assist decision makers.

Session TuB1: The System Supply Market

TuB1.1 Blips on the Radar Screen: The Case for Sustained Stability in New Subsea Systems Development Market

Thomas A. Soja, John Manock, S. Hansen Long (T Soja & Associates, Inc.)

The resurgence of substantial growth in the telecom services sector has fueled a sharp increase in activity in the submarine fiber cable industry. While many industry observers interpret these developments as the beginnings of another boom-bust cycle, many of the underlying key ingredients that lead to past cycles are absent from today's market and unlikely to return. This paper presents evidence that despite the many announcements to complete major new cable builds by 2008, a variety of mitigating factors will more likely cause schedules for many of those cables to be pushed farther out in time, while the supply industry sees a return to near full-capacity operating conditions that will endure for several years without major expansions over current levels.

TuB1.2 Cost Ahead of Technology? Are Purchasers Buying Criteria Equivalent in the Current Market Segmentation?

Marc Fullenbaum, Stéphane Delorme, Jean-Marie Beaufils (Alcatel-Lucent)

The submarine solution purchasers still want to seize benefits of the fierce competitive environment in spite of the tremendous cost reductions achieved by the industry over the past three years. In parallel, the submarine market has been segmented amongst the unrepeatered, regional, transoceanic and offshore markets.

There are now signs of a burgeoning market ahead, which may affect the entire supply industry and its current balance. Will it influence some of the customer's choices, their buying criteria and overall strategy?

The paper will discuss the environmental changes affecting the industry and review how this could impact each of the aforementioned market segments. Finally, the paper will attempt to figure out what might be the future expectations of the customers over the next 2-3 years.

TuB1.3 The Emergence of Affordable Broadband Services for Remote Locations Using SFOC Technology

William J. Barattino and Nicholas Koopalethes (Global Broadband Solutions, LLC)

A case study was conducted to compare expanding current Satellite Communications (SATCOM) services or installing a regional Submarine Fiber Optic Cable (SFOC) system for meeting broadband requirements of a remote user currently using SATCOM services for off-island traffic. Based on life cycle costs, a scaled-down, regional SFOC system financed over a 15 year capitalization phase, was shown to be the more cost effective solution at an OC-3 transmission rate. Furthermore, as the remote user's transmission requirements are projected to increase at a moderate growth rate over the 25 year lifetime, the case becomes quite compelling for the installation of a regional SFOC system, with the existing SATCOM service used for restoration until demand increases sufficiently to justify a second cable system.

TuB1.4 Drivers for Building New Systems: Speed and Versatility. Oceans, like the world, are flat but very deep.

Benoit Duguet (Tyco Telecommunications)

Politics, finance and market demand have always been the three drivers for developing major infrastructures such as submarine systems, with the strong boosting influence brought by technology. And we can see that in the past 20 years that each one has morphed towards some new balance.

It is also obvious that the imbalance between prosperous and less rich areas, as well as interconnection or remoteness to the submarine web, and the mix of the two, had a major impact in flattening the oceans.

Therefore this paper examines the evolution of the political environment and its impact on development of the submarine networks. The term "political" is here used in the sense of the management of the public interest by the public authorities.

Financing of projects has moved towards a more active and reactive filling of the gap left by monopolies and governments for this competitive, open market that is now telecommunications.

Traffic demand is stormed by the versatility with which networks can be used, the new technologies influencing the routes as well as the required bandwidth, and also the change of development model of the carriers.

In conclusion, the market has changed with the evolution of technology and the change of structure of the participants, to a solid and active sector, which enables development of new systems from very competitive areas to very under developed zones, and that finally enables the connection of everyone, everywhere with the worldwide spread of homogeneous levels of services.

TuB1.5 The Impact of Convergence on Submarine Cable System Deployment

Edward West and Stephen J. Dawe (Cable & Wireless)

A review of recent submarine system deployments and upgrades has revealed a significant influence on design from equipment convergence and new transmission protocols. This influence has been particularly significant in the unrepeatered market but such concepts lend themselves to repeatered systems. Until the advent of this trend, submarine cable system technology was based on specialist or even bespoke system design; however, the submarine industry does not exist in isolation and is influenced by wider change in the telecommunications industry. The broadband revolution is rapidly using up surplus capacity and driving future traffic growth. New ownership models for common carrier submarine systems will be needed to reflect the change in aggregate layer technology away from the Synchronous Digital Hierarchy (SDH) towards Internet Protocol (IP) based technologies. The distinction between terrestrial and submarine equipment is becoming less marked. Submarine systems will increasingly be seen as extensions of the terrestrial network, rather than special networks in their own right. Terrestrial-based technology is increasingly being used on submarine systems, removing Owners' dependence on the traditional specialist submarine suppliers.

TuB1.6 Undersea Market Trends: What's New and What's Next?

Elaine Stafford, John Mariano, David Ross (The David Ross Group, Inc.)

Today's market demand is increasingly driven by non-traditional players and applications rather than new technology. Many developing areas have, or will soon have, their first undersea fiber cables. Non-traditional markets (e.g. oil platforms and sensor systems) are on the rise. Growth in these sectors is driven by the increased dependency of national economies and global businesses on reliable, economical communication, enabled by recent undersea network cost improvements.

These new and growing market sectors involve parties who may do business in a different way from traditional owners – stimulating increased interest in alternative ownership models and solutions.

This paper provides a synopsis of new trends in the market from a variety of perspectives and suggests what might be next.

Session TuA2: Non-Telecom Applications

TuA2.1 Unique Marine Operations: Oil and Gas and Scientific Applications

Frank Cuccio and Ronald J. Rapp (Tyco Telecommunications)

The traditional, time tested, installation techniques for deploying commercial undersea telecommunications systems apply directly to an emerging new market of oil platform connectively and also to scientific sensor systems and observatories. Traditional cable designs, branching units, repeaters, and cable burial and protection methods apply equally well in these new applications.

The new systems also have unique hardware requiring new installation techniques that are being developed and tested for these applications. Deployment pallets, cable termination modules, fusible links and wet mate connectors are used in the oil and gas sectors at the connection point to offshore platforms. Trawl resistant science nodes, wet mate connectors, sensor instrumentation and cabling are being used in undersea science observatories. This hardware requires special shipboard storage, handling, over boarding and deployment methods and a means to accurately positioning the equipment on the seabed. Also, unique to oil and gas are the safety requirements for working around oil platforms and its adjoining infrastructure. Health, Safety and Environment (HSE) procedures are standard requirements in this industry.

There is significant synergy between the oil and gas applications and the scientific systems both in hardware designs and deployment systems and methods. In this paper, the areas of commonality between commercial systems, oil and gas systems, and scientific systems are compared and reviewed with a view to how this synergy may benefit the purchasers.

TuA2.2 Drivers and Technologies for Next Generation Digital Connectivity in Offshore Oil and Gas Production Facilities

Greg Otto (BP America Inc.) and Wayne Nielsen (WFN Strategies)

This paper explains how increased demand digital systems and subsequent demand for high performance connectivity is leading the oil and gas industry to standardize on fiber optic based connectivity including subsea fiber for offshore platforms. The paper explores various technical considerations in designing a fiberoptic system for these special applications, as well as the commercial, operational and maintenance considerations involved for the enterprise. The paper concludes with a summary of how the subsea cable industry can address the unique requirements of the offshore market, wherein communication services are an ancillary function rather than a primary objective of the customer's business.

TuA2.3 Repeaterless Fiber Optic Telecommunication Solutions as a Powerful Tool to Overcome the Challenges in the Offshore Oil and Gas Business

Winfried Rutzen, Rudolf Stahl, Clemens Unger, Heiko Dirks (Norddeutsche Seekabelwerke GmbH & Co. KG)

New oil patches are more remote with simultaneously escalating external hazards. Challenging technologies such as subsea exploration are being pursued. Concurrently, pressure continues to keep a tight rein on costs. Remote control, automation and other bandwidth demanding applications are obvious trends in the industries. Therefore, highly reliable and flexible telecommunication systems are becoming a key function for ongoing success. Repeaterless fiber-optic submarine networks can easily be adjusted to continuous changing business environments and can be incorporated into future engineering concepts.

TuA2.4 Cabled Science Observatories Solutions: Bringing Power and Broadband Communication to the Ocean Depths

Antoine Lecroart (Alcatel-Lucent), Nazeeh Shaheen (L-3 Communications MariPro), Peter Shawyer (Texcel Technology)

To deliver high power and broadband communication to the ocean floor requires a number of changes to existing technology developed to bridge oceans from shore to shore. Adapting this well mastered dry-dry solution to become dry-wet represents a major technical challenge. The cabled observatory system developed for the Canadian part of the North-East Pacific Time-series Undersea Networked Experiment (NEPTUNE) encompasses major breakthroughs in several areas, including optical transmission, ocean engineering and powering.

This paper discusses how an industrial team led by Alcatel-Lucent along with partners L-3 Communications MariPro and Texcel Technology have managed the design and development effort in all these fields.

The capabilities of this design to be extended to cover the needs of the full NEPTUNE Regional Cabled Observatory (RCO) or to be deployed for other applications such as undersea neutrino telescopes or tsunami detection systems is also assessed.

TuA2.5 Seismic Observation Systems Utilizing Significant Telecommunication Technology in Japan

Kenji Hishiki and Wakana Kobayashi (NEC Telenetworx, Ltd.)

The Japanese Islands have suffered from disastrous earthquakes over their entire history. In order to deal with this phenomenon, we have developed the Seismic Observation System. Presently there are 7 Seismic Observation Cable systems in the ocean around the Japanese Islands. This sensing system, based on the Ocean Bottom Seismometer, improves earthquake observation accuracy, provides early warning to prevent expected damage, and enables the continuous study of earthquake mechanisms. The first stage of this system used Analog data transmission to transfer the observed seismic data, but was later followed by Digital data transmission. All systems developed by us are in use today and have been fully functional with no failures over their lifetimes. Enhancement of the observation network and real-time data exchange has made a great contribution to disaster mitigation in Japan. We presently have a new, large ongoing project called "TONANNKAI" using the latest and most advanced technology.

TuA2.6 NEPTUNE Canada (NEPTUNE Stage I) and the Opportunities Presented

Peter Phibbs (University of Victoria) and Stephen Lentz

Developed over the course of over six years, the NEPTUNE Canada network will be the first ocean observatory to support a wide variety of deepwater undersea science instruments and link them with the Internet. Provision of this utility to ocean scientists requires the design and deployment of a power and communications network including terminal equipment, the backbone cable and nodes. This paper discusses the extent of this effort and the significance of the goals. The paper acknowledges the importance of the involvement of the submarine cable systems providers to the success of these observatories, and argues that the opportunities presented by their involvement will justify the research and development.

TuA2.7 Design of the Scientific Cabled Network Between Ireland and Porcupine Seabight and Abyssal Plain, Study Site of the European Seafloor Observatory Network Implementation Model (ESONIM)

Jean-François Rolin (IFREMER), Gary Waterworth (Alcatel-Lucent), Mick Gillooly (Marine Institute Galway), Imants G. Priede (University of Aberdeen), Olaf Pfannkuche (IFM-Geomar), Glen Nolan (Marine Institute Galway)

In the North Atlantic margin, the Porcupine Seabight and Abyssal plain are important areas for bio-geochemical flux studies. It has revealed a rich fauna associated to carbonate mounds and corals and has been chosen for the first complete study of scientific cabled observatory network in European waters. It is the case study of the European Seafloor Observatory Network Implementation Model (ESONIM) project, funded by the European Union. The multidisciplinary scientific objectives lead to specify a cable route from South West Ireland and associated scientific instrumentation packages.

The engineering study was conducted in order to minimise infrastructure and running costs while allowing future extensions.

Session TuB2: Carrier Essentials

TuB2.1 Future Broadband Applications: What Would the Impact Be, If Any, on the International Bandwidth Industry?

Zvika Caspy (Mediterranean Nautilus Ltd.)

The following paper will try to evaluate what the impact of the future broadband applications on the international capacity consumption would be. The new broadband arena will consume a greater capacity, however the proportions of the usage in the domestic networks rather than international capacity will be higher than today's ratio. This will occur due to various factors such as most of the demand is for local content; illegal content will become more and more legal and will allow proxy applications which will be stored on the domestic rings. Therefore any capacity forecast should analyze the differentiation in demand between domestic and international factors better.

TuB2.2 Demand Drivers for Carriers – Evolution of Ethernet

Momtchil Petrov, Robert Thomas and Jeffrey Stark (Tyco Telecommunications)

In the past, the transmission world evolved around the demand for voice. As the world discovered the Internet, the transmission market grew to understand SDH, Sonet, DWDM and 10G waves. A simple 64Kb voice line was no longer acceptable. The key to the future was speed, enhanced services and now the term triple play to represent the latest in carrier services. What is the next step which drives the bandwidth demand – the convergence of Ethernet and the ability to plug and play applications?

1. Initially (less than 20 years ago) the Ethernet connection drove LAN services for the office applications
2. Via private leased lines, the service expanded to WAN
3. The internet opened doors which promoted the development of options for metropolitan and now long haul network applications
4. New applications and services accessible via Ethernet connectivity which will drive international submarine cable development.

TuB2.3 Trend in Submarine Maintenance as IP and DWDM Converge

Ken Herrmann (VSNL International)

Trans-oceanic cables installed in the past 5 years have vast transmission capacities. Some systems were installed with only a relatively small portion of the design capacity; these systems have required upgrades early in their design life. Some systems were installed to a larger portion of their design capacity; these systems are severely under utilized, but have not required upgrades in their early design life. Cable owners and carriers are currently deploying IP networks across Dense Wave Division Multiplexing ("DWDM") based submarine systems, providing user restorable capacity over a selectable path or paths. The cost of maintaining these cable systems is a large yearly expense for all cable owners. Is it better for the submarine owner's community to spend the money to more fully complete the build out of trans-oceanic systems, , ensuring multiple paths for restoration, while concurrently reducing repair response time, instead of paying a large maintenance contract? Could there be a trend towards a spot market for cable repair?

TuB2.4 Enhanced Resilience for Terrestrial Restoration Capacity

Dave Pinion (BT Global Services)

When a subsea cable fails some or all of the capacity carried via the cable is usually diverted onto pre-planned alternative "restoration" routes. Historically, the restoration routes would be implemented at the VC4 (155Mbit/s) level using a number of different network routings between any two nodes. Hence a secondary failure within the restoration path would only affect a small proportion of the total restored capacity. The paper follows the evolution of the restoration network, examines how this has resulted in a reduction in resilience, and proposes enhancements to ensure an appropriate level of route availability in future.

TuB2.5 Refresh Operation and Maintenance Training

Voahangy Rakotomanana, Pierre Fidry, Christian Ausanneau, Stéphanie Rousseau (Alcatel-Lucent)

To realize the maximum benefit from their investment on networks, system operators recognize that preventing any down time of their system repeated or not, in order to avoid consequent penalties is a key factor. To achieve this responsibility, station staff should be comfortable and autonomous in performing any regular operations.

The Customer Support mission aim is to deliver Customer satisfaction for commercial and technical support and the provision of additional services to assist our customers to efficiently operate and maintain their systems.

Refresh Operation and Maintenance Training, one of the new services, has been developed to support system operators to realize their daily activity: performing efficient operations and maintenance of their equipment and management systems.

TuB2.6 Undersea Cable Markets and the Developing World

Michael Ruddy (Terabit Consulting)

Large swaths of the developing world, particularly in Africa, are still without fiber optic connectivity. Past efforts to link these regions have had only limited success. How have macroeconomic trends, the growth of the telecommunications industry, and the development of the submarine communications industry progressed in the last decade to make ubiquitous fiber optic connectivity to less-developed countries (LDCs) suddenly more viable?

This paper will examine the state of submarine cable and terrestrial backhaul markets in developing regions, focusing on the struggle of poorer nations to advance their information and communications technology (ICT) infrastructure. Conclusions will be drawn as to the overall developmental trend: is the world moving gradually toward ICT (and international network) equality, or are the disparities today greater than they were in the monopoly era? The article will distill Terabit Consulting's analysis of global undersea markets to predict whether the most beneficial capacity cost reductions will continue to be confined to the wealthiest markets, or whether future patterns in fiber optic deployment will be spread more equitably among the world's community of nations.

Session WeA1: Spotlight Session

WeA1.1 (Invited Talk) Observations on the 2006 Taiwan Earthquake

William Barney (Asia Netcom)

As optimism at last finds its way back into the telecommunications industry, so has vulnerabilities been brought to the forefront in the form of multiple cable cuts that brought the Internet to a standstill. Bill Barney, Chief Executive Officer of Asia Netcom will take the opportunity at SubOptic 2007 to explore the opportunities and challenges facing an industry on the verge of a major breakthrough.

Not since the emergence of the Internet has the telecommunications industry experienced so much buzz and excitement. From the accelerated demand in bandwidth across all regions, to the emergence of new technologies and applications, the industry is again approaching a critical turning point.

Is demand finally catching up with supply? How much bandwidth is enough bandwidth?

In light of the recent network impacts off the southern coast of Taiwan, further questions must be brought to the table. What can make it better? What responsibility do we have as an industry to work together to prevent future crisis?

At the same time, the recent announcement of new projects to add connectivity in the region and across the Pacific throws another dimension into the equation. Is it really time to build again? Where should we invest? What are the technologies that will impact the industry in the next ten years?

In addition, Asia Netcom has also announced a new cable extension that seeks to alleviate some of the issues the industry encountered last December.

These questions and a look at the current state of the industry will form the foundations of this address at SubOptic 2007.

WeA1.2 Trends in Submarine Cable System Faults

Submarine Cable Improvement Group (SCIG): Maurice E. Kordahi and Seymour Shapiro (Tyco Telecommunications), Gordon Lucas (Alcatel-Lucent)

This paper is written on behalf of the Submarine Cable Improvement Group (www.scig.net). Data from undersea system faults continues to be collected by several organizations. The analysis herein highlights recent system faults and provides a continuation of previous studies which were presented in 2004, 2001, and 1997. Global trends are reported, with focus on data from the last six years.

WeA1.3 (Invited Talk)
Activities of the ICPC
Bob Wargo (AT&T Services Inc.)

Next year (2008) the International Cable Protection Committee (ICPC) will turn 50 years old. During that time period it has grown from a very few members at its inception as the Cable Damage Committee to over 80 members from over 45 nations today. In that time it has led the way in providing advice to submarine cable owners on protecting their most valuable assets and serving as a forum for the benefit of all cable owners. This paper will provide an overview of the history of the ICPC and detail recent developments in its continuing evolution.

WeA1.4 (Invited Talk)
National Security Regulation of International Telecommunications Infrastructure and the Law of Unintended Consequences
Kent Bressie (Harris Wiltshire & Grannis LLP)

In recent years, governments have defined their efforts to protect international telecommunications infrastructure largely in terms of national security – guarding against terrorism and against compromise of government communications. The United States in particular has scrutinized foreign ownership as a proxy for threats to national security. But have governments defined infrastructure protection too narrowly by ignoring threats posed by natural disasters? And have such protections come at the expense of hard-fought gains in market liberalization? What role might government regulation play in broadly-defined infrastructure protection efforts?

Session WeB1: Equipment & Component Technologies

WeB1.1 Multi-Service Integrated Platform (MSIP) Solution and Its Impact on Submarine Cable System
Daiki Miwa, Taka-aki Ogata, Yoshitaka Kanno, Yoshinori Chiba, Satoru Hadano, Masataka Goto, Yu Aoki (NEC Corporation)

Multi-Service Integrated Platform (MSIP) provides an integrated transmission platform supporting both Submarine Line Terminal Equipment (SLTE) and Next Generation Synchronous Optical Network/ Synchronous Digital Hierarchy (NG SONET/SDH) functionalities. This paper presents characteristics and applications of the MSIP, and discusses its impact on submarine cable systems in terms of improvements in Capital Expenditure (CAPEX) and Operational Expenditure (OPEX). The MSIP is capable of being the optimum solution to evolve submarine cable systems towards Next Generation Networks (NGN).

WeB1.2 The 10Gigabit Ethernet Impact on Submarine Networks
Ken Reynolds, Andy Aitken, Joerg Schwartz, Stuart Barnes (Azea Networks Ltd.)

Over the last decade there has been an inexorable shift from voice to data in transport networks. Despite this SDH/SONET transport has remained the standard of choice for Submarine Systems despite the fact that well over 50% of all traffic is data by nature. This is typically attributed to a combination of Quality of Service (QoS) concerns, strong performance monitoring (PM) requirements and inertia. In this paper we describe the 10Gigabit Ethernet (GE) impacts and subsequent development and first application results of a 'configurable' SDH/SONET/10GE Transponder.

WeB1.3 DQPSK Modulated Turbo Code FEC for Cable Capacity Upgrades
Takashi Mizuochi, Yoshiaki Konishi, Kazuhide Ouchi, Kiyoshi Onohara, Kazuyuki Ishida, Katsuhiro Shimizu, Kazuo Kubo, Shunsuke Mitani, Hitoyuki Tagami (Mitsubishi Electric Corp.)

Economical expansion of existing cables requires upgraded line terminal equipment with advanced modulation and strong FEC. However, no experimental demonstration has yet been reported of a genuine combination of these advances. We demonstrate true FEC-encoded PRBS transmission at 20 Gbps using a live precoder for return-to-zero differential quadrature phase-shift keying (RZ-DQPSK), together with a block turbo code (BTC) FEC LSI. These two technologies will open new possibilities for robust capacity upgrades in the coming generation of submarine transmission.

WeB1.4 Novel Undersea Line Monitoring Technology Enables Improved Performance and OTDR Capability

Brian Jander, Hongbin Zhang, Ram Engira, Bill Ruthrauff, Yan Jiang, Angelo Giordano, Boris Bark, Richard Kram, Sam Sabet, Brian Li, Jonathan Liss, Charles Breverman (Tyco Telecommunications)

Line monitoring systems are employed to measure the condition of optically amplified undersea systems; enabling wet-plant fault detection. These systems are usually augmented with expensive C-OTDR test equipment which provides optical fault localization capability to within 500 meters. A distinct advantage of loop-back monitoring systems is the simplicity of the undersea repeater since few passive optical components are needed to create the loop-back paths. In this work we describe a cost-effective system monitoring solution combining both loop-back monitoring and OTDR capabilities in the same station equipment. Using new signaling and correlation methods we demonstrated significant improvements for in-service loop-back measurements as well as out-of-service correlation-OTDR monitoring over a transatlantic undersea fiber pair.

WeB1.5 A Long-Span Repeater for Regional Submarine Systems

Patrice Le Roux, Mélanie Jaouen, Ghislaine Vareille (Alcatel-Lucent)

A new long-span submarine repeater dedicated to regional telecommunication cable systems is described in this paper. Its design, based on a double-stage erbium-doped fibre optical amplifier, is optimised to reach span of 150 km. This repeater topology provides very stable optical amplification for gains exceeding 40 dB. It is fully qualified for use on undersea operation over a lifetime of twenty five years.

WeB1.6 Advanced Fibers for Submarine Networks

Sergey Ten (Corning Optical Fiber)

We discuss the development of advanced fibers for repeatered and unrepeatered submarine networks that provide a wide choice of optical attributes such as dispersion, dispersion slope, attenuation and effective area. Advances in electronics and electro optics, combined with a wide variety of available submarine fibers bring more flexibility to submarine network designers and ultimately enable them to meet very challenging technical and cost targets.

WeB1.7 Rating Subsea Cables for Resistance to External Aggression

Trevor Taylor (BT Global Services)

Apparatus to extend the existing ITU G976 impact test for subsea cables to failure is described and test results for several cable types are presented. The tests relevance as a method to measure a cables resistance to external aggression is discussed and compared with existing fault data.

Session ThA1: Project Development & Implementation

ThA1.1 How Fast Can An Undersea Telecommunication System Upgrade Be Implemented?

Debra Brask (Tyco Telecommunications)

Network owners require high quality systems that meet their immediate needs, but many forward-looking purchasers of communications networks are also aware that in areas of burgeoning communications demands, their systems may require future capacity upgrades. As a result, they are seeking network upgrades in the shortest possible timeframe. Some are even searching for the same model of quick, plug-and-play upgrades available to personal computer users requiring a software upgrade. Given the complexity of undersea telecommunication systems, will these autonomous upgrades ever be possible? And if not, what can purchasers look for from their suppliers to shorten the time required for network upgrades?

ThA1.2 Advanced Enhancements of the SAm-1 Submarine Cable System

Eduardo Saravia, Guillermo Canete, Miguel Angel Martinez (Telefonica International Wholesale Services)

Telefonica's South America I (SAm-1) is a 1.92 Tb/s submarine cable that connects all major cities in Latin America with the United States. This paper describes the evolution of SAm-1 from a pure SDH/SONET network to an IP over the WDM layer. Other optimizations on the ring included the modification of the original design to build direct express ultra long-haul all optical links to major cities in the region and the introduction of new generation of optical cross-connect equipment to add flexibility to traditional SDH/SONET circuits. In the last part, the paper reviews the extensions of the SAm-1 cable to Colombia and Ecuador to be operational by the end of 2007.

ThA1.3 A Standard Set of Terms of Contract for the Submarine Telecommunications Industry

Michael S. Carter (Alcatel-Lucent)

Unlike certain other industries, the submarine telecommunications industry lacks a recognized set of standard contractual terms. This paper looks at the approach taken in the submarine industry and that taken in other similarly structured industries and compares the advantages/disadvantages of the respective approaches. The paper argues that the industry could benefit enormously from the acceptance of a recognized standard set of terms for the small number of recurring types of contract, including those for turnkey system supply, system upgrades, marine maintenance and dry maintenance. Many purchasers have their own preferred model contract, which they include in a request for quotations (RFQ) and against which prospective suppliers are expected to bid, including a "statement of compliance," indicating acceptance or non-acceptance of each term and any requested changes. The issuer of the RFQ then evaluates the offers received, including the statements of compliance as to the contractual terms. While direct comparisons between the merits of the technical solution proposed, or the pricing of equipment or services deemed equivalent, in the bids received may seem relatively straightforward, the risk associated with acceptance or non-acceptance of a particular contractual provision in either the original or some modified form may not be obvious to suppliers or purchasers, who may have difficulty quantifying the risk. So-called "non-compliances" invariably give rise to protracted discussions in bid-clarification meetings or best-and-final-offer negotiating rounds. The paper considers the significant benefits, including time to market for the customer, that would accrue to all involved parties if the industry were to adopt a recognized set of fair and balanced standard contractual terms for recurring types of contracts, and looks at some of the models for such an approach.

ThA1.4 Enabling Global Communications – From Risk to Reward: Why must we learn our own lessons before we change risk management behaviour?

Keith Schofield (Dotdash Consulting)

Keith Schofield unpacks the decision processes leading to challenged decision-making, exploring how engineers, managers and investors can improve it. He proposes that risk management goes beyond pre-investment activity. Using specific examples after Hurricane Ivan and the Asian Tsunami, he demonstrates that team qualities define the quality of the outcome. From experiences in cable manufacturing, implementation, Cable & Wireless Operations and latterly at Dotdash Consulting, he lays down some principles for project risk management and proposes some persuasive strategies to make this attractive to those who really decide about cable investments. After all, why learn from our own mistakes when we can learn from someone else's?

ThA1.5 Structuring for Successful Financings of Submarine Fiber Optic Networks

Glenn S. Gerstell (Milbank, Tweed, Hadley & McCloy LLP)

The revival of the submarine cable industry has seemingly commenced, but new cable systems and expansions and upgrades of existing ones will not come to fruition unless adequate funding is available. This paper reviews the principal financing options available in the markets following the collapse of several years ago, with a focus on project financings. The requirements of lenders for fully funded business plans, with adequate assurance of customer revenues are explored, along with an assessment of the pros and cons of various forms of financing. The paper concludes with the view that by tailoring financing precisely to particular risks and problems, the industry will be able to meet its financing needs – but the increased complexity will pose unique challenges for all project participants.

ThA1.6 The Yellow Cable System – Development, Implementation and Post Project Experience

Bob Kelly and Mike Saunders (Level 3 Communications)

Level 3 decided to lay the Yellow transatlantic cable system in May 1999, at a time when demand was heavily outstripping supply. The initial cost was relatively high for a single company, therefore the decision was taken to defray the large upfront project cost by entering into a strategic partnership. While reducing the upfront exposure, there was still a large cost to recover and in the years that followed, Level 3 was confronted with a rapidly deteriorating market. Level 3 had to adapt to the changing market conditions and the corresponding challenges, implementing a revised view of capital cost and approach to the market. This paper aims to discuss what value the transatlantic cable has really given to Level 3's network offering, in what is perhaps the most competitive transoceanic market in the world.

Session ThB1: System Design & Applications

ThB1.1 Overview of submarine system upgrades

M. André and N. Brochier (France Telecom R&D)

Since the late 1990s, submarine optical cable systems make use of advanced technologies such as 10 Gbit/s high speed modulation, Dense Wavelength Division Multiplexing (DWDM) and Forward Error Correction (FEC). Most of the systems initially operate below the capacity they are designed for, allowing carriers to apply the well-known "pay-as-you-grow" concept. The original Supply Contract covers their progressive equipage commercially and technically (standard upgrades). When alternative technologies are used in the terminal equipment, they allow going beyond the designed capacity. Upgrades become challenging and depend on system design as well as actual margins.

ThB1.2 Predicting the Unpredictable

Tony Frisch and Joerg Schwartz (Azea Networks)

Today's upgrades usually aim to expand the capacity of existing systems as much as possible. This in turn means that the power budget for an upgrade needs to be as precise as possible, since including large margins will reduce capacity. Accordingly, minimising the uncertainties regarding the actual parameters of an existing system is a prime focus.

Non-intrusive measurements of optical spectra can give information about noise performance and system bandwidth and long-term performance, as logged by FEC and wet-plant monitoring provide insight into ageing and repairs. However, there are usually uncertainties in some of the data and there are a number of practical constraints which must be considered.

This paper discusses some of the issues and some of the techniques which can be used to reduce uncertainty.

ThB1.3 All-Raman Technology Roadmap for High-Performance Unrepeatered DWDM Systems

Herve Fevrier, A. Puc, P. Perrier, D. Chaires (Xtera Communications)

The transmission of multiple 10 Gb/s signals over a 500 km optical submarine network once required the use of submerged repeaters. Technological advancements, however, now make it possible to span what were once considered repeatered distances with new high-performance unrepeatered DWDM systems. This is accomplished by coupling technologies like Raman amplification with "in-line" technologies like ultra-low loss fibers, remote optically pumped amplifiers and new modulation techniques to obtain significant performance gains for capacity, distance and the transmission of emerging high bit rate channels (OC-768/40 Gb/s). This paper will discuss recent demonstrations that show how these technologies have been combined to maximize capacity over long distances.

ThB1.4 **40 Gb/S DWDM Transmission Technologies for Future Repeatered and Non-Repeatered Submarine Cable Systems**

Yoshihisa Inada, Toshiharu Ito, Kiyoshi Fukuchi, Tadashi Koga, Takaaki Ogata (NEC Corporation)

This paper describes our extensive study results toward deployment of 40Gb/s DWDM technologies in repeatered and non-repeatered submarine cable systems. For trans-Oceanic transmission of 40Gb/s WDM signal, we have optimized the system design of EDFA and medial-dispersion DMF transmission system, which supports the 40Gb/s CS-RZ WDM signal transmission over distances exceeding 6,000km. We have also confirmed by experiments that, with remote pumping scheme, over 300 km transmission of 40Gb/s WDM signal is feasible under 100GHz channel spacing.

ThB1.5 **A Study of Upgradeability Using the RZ-DPSK Format on Existing WDM Transmission System**

Hiroshi Nakamoto, Kenji Ohta, Akira Sugiyama, Takeo Osaka, Izumi Yokota (Fujitsu Limited)

We examined a technique for upgrading a system by using RZ-DPSK and confirmed its feasibility. Optimizing the channel interval reduces the interference between signals in a system with a mixture of RZ-OOK and RZ-DPSK. Optimization of waveform improves the transmission performance.

ThB1.6 **The RZ-DPSK Modulation Format in Long-Haul Transmission Systems**

Alexei Pilipetskii, Morten Nissov, Neal S. Bergano (Tyco Telecommunications)

An effective way to enhance the transmission capabilities and reduce the first cost of long-haul WDM systems is to improve the terminal's performance. One promising modulation format for long-haul operation is the Return-to-Zero, Differential Phase Shift Keyed (RZ-DPSK) modulation format. The allure of RZ-DPSK is that it provides a combination of 3 dB improvement in OSNR sensitivity due to balanced detection and benefits of RZ pulse shapes. An important issue with 10 Gb/s DPSK transmission is whether the 3-dB benefit over On-Off Keyed (OOK) exist for long-haul transmission over transoceanic distances that are limited by fiber nonlinearities.

ThB1.7 **DPSK Transmission Experiments over DSMF and NZDSF**

Philippe Plantady, Laurent du Mouza, Sébastien Dupont, Pierre Marmier, Clement Lange, Patrick Bollaert, Mélanie Jaouen, Ghislaine Vareille, Vincent Letellier (Alcatel-Lucent)

This paper reports on trans-oceanic transmission experiments : 125 x 10 Gbps RZ-DPSK over 12380 km of DSMF and 100 x 10 Gbps RZ-DPSK over 9128 km of NZDSF as well as transmission experiments with a mix of RZ-OOK & RZ-DPSK modulation formats over 4300 km of NZDSF. Finally technical solutions allowing to offer cost-optimized design system are discussed.

Abstracts

Part III: Poster Presentations

Group 1: Marine Services & Operations

We1.01 **What Next for the Universal Joint?**

Craig Beech (Global Marine Systems Limited)

The Universal Joint (UJ) is well established as a core industry technology for submarine telecommunications cables having its roots in the first optical cables systems which has evolved as optical cable technology has developed and grown. The emphasis placed on it by system owners, service providers and industry monitoring bodies demonstrates the significance and value it still provides to the industry. This stems from the availability of a common joint platform which permits freedom of choice for the system owner in its maintenance provider. The technology utilises a common set of parts, equipment and assembly methods facilitating efficient technology transfer and knowledge sharing within the industry wide pool of qualified jointing personnel.

This was established early in the 20 years of the subsea optical fibre telecommunications industry and continues to incorporate the changes to cable technology to an ever changing customer base of system owners, maintenance providers and system suppliers. While that is all very well, are we approaching the position where it is appropriate to ask, what next? How should jointing move forward? What is the next technology leap? Closely aligned to this question, in our industry cycle of limited free cash, is the question of where should we target the investment of resource for maximum benefit and how shall it be funded?

This paper sets out the drivers that Global Marine Systems Limited (Global Marine) sees from our customers as a maintenance provider and end user of jointing technology; the innovations that have been and will be introduced by us to meet them and engage in discussion to determine what we as an industry should be doing next?

We1.02 **High Reliability – Low Cost Submarine Cable Deployment**

Gunnar Berthelsen (Nexans Norway)

A method is developed to utilize the topology of the seabed and a detailed discussion with the permitting parties to protect the submarine cables, so that burying has become unnecessary.

We1.03 Marine Challenges and Opportunities in Newly Emerging Markets and Sectors

Philip Footman Williams (Tyco Telecommunications)

Submarine cable systems are being deployed in new geographic regions and in new technology sectors, away from what may be considered "traditional" telecom systems areas. These new opportunities are allowing the industry to expand and grow; but there are new challenges that must be understood, addressed and managed. This paper will review the differences and challenges associated with the newly emerging markets and sectors from technical, commercial, geographical, and demographic points of view, and will review how the risks associated with these differences are assessed and managed so that projects are planned and delivered safely and successfully.

We1.04 Low Price Method to Repair Cables at Shore End

Jorge Orlando Garcia Lozano (Telemediciones SA)

This document is a proposal to the cable brotherhood to consider a simple but proved and economic method to fix damaged cables at shore end. Attached graphic details showing how the repair work was conducted by a small team without previous experience. Nine fibers from 24, survived the action of a trencher contracted to protect a main street from high tide. The plan included the installation of a construction platform to safely repair the cable on it. It was also necessary to recover around 100 meters of buried Single Armoured cable. Total repair cost including Single Armoured cable was around US $20,000, against the US $300,000 of the cheapest quotation.

We1.05 JADE: A Universal Tool for Consistent Jointing Performance and Data Recording Throughout the Submarine Cable Industry?

Phil Hart (Global Marine Systems Limited)

Global Marine has introduced JADE (Jointing Automated Documentation Environment) internally, to record the progress of each joint through its various sub-operations, thus capturing more accurate and consistent information than it is generally possible to do on a manual basis. The use of JADE drives jointing consistency across all jointing teams. In a world of more reliable systems and less frequent need for jointing repair, JADE keeps skills sharp, and times fast without sacrificing quality. The envisioned presentation will provide a description of how JADE works, the impact it has had on improving internal controls and the possible benefits to cable owners were it (or something similar) to be adopted across our industry.

We1.06 Fault Location on Subsea Cable Systems

Adrian Hilton (BT Global Services)

Cable system fault location techniques for coaxial cables were well established and accurate with several tools available. Fibre Optic systems are not constructed in the same manner and therefore require different fault location tools, practices and procedures.

The accuracy of fault locations on the current generation of optical Subsea cable systems needs review. Inaccurate fault locations can result in extended repair times and increased cost to the owners. To avoid this it is essential that the tools and techniques that are currently available are understood and used to their best advantage.

As new systems are being installed it is important that the requirement to be able to locate faults on these systems is understood and that the appropriate equipment procurement takes place to facilitate this. There is a serious risk associated with the ongoing manufacture and supply of this specialised test equipment (i.e. cessation of the Advantest COTDR and of some dc test equipment manufacture).

It is hoped that the paper will act as a catalyst to stimulate industry debate on fault location equipment, techniques and accuracy.

We1.07 Evolving Cable Awareness Programs in Response to Developing and Experimental Fisheries

Glenn Hovermale (Tyco Telecommunications)

According to the Tyco Telecommunications fault database, approximately 50% of known cable faults since 1960 have been attributed to commercial fishing practices. With the high cost of cable repair and potential lost revenue it is not a surprise that cable owners and maintenance companies are willing to invest in cable awareness services broadcasting information to the fishing industry. Efforts typically involve providing the routes of cables and an explanation of why it may be dangerous to fish near cables. Unfortunately, the concerns for submarine cables are not always reciprocated by all fishing fleets. Limited access to fisheries resources due to stock depletions, ecosystem based management, closures, and other industry regulations instill the concern that the livelihood of fishermen and their available fishing grounds are ever decreasing. To counter such situations, the fishing industry is constantly investing in new capture technologies. Therefore, it is in the best interest of the submarine cable industry to closely monitor developing fisheries and consider their prospective impacts on active cable systems. This investigation focuses on three fisheries sectors; exploratory deepwater fisheries, coastal aquaculture and open-ocean mariculture, and the use of area closures as a regulatory tool. Deep sea fisheries utilize extremely robust gear that can have damaging effects on cables. Aquaculture is growing at a rate of 13% per year and may soon

compete with cables for seabed rights. The use of area closures for management is touted as being successful, but being a relatively new procedure, there is little evidence to support such claims. Cables routed through such areas are sometimes subject to additional fees and monetary penalties that lack precedent and so can vary between locations. Similarly to the modern approach to fishery management, the cable awareness community needs to implement proactive approaches for dealing with cable/fishing gear interactions. Understanding the long and short-term impacts of developing fisheries could lead to a reduction in faults as well as provide a lead into changing permitting regulations.

We1.08 Innovative Jointing & Stable Technology – Closer Than We Think

Maurice Kordahi, Jeremiah Mendez, Marsha A. Spalding, Robert K. Stix (Tyco Telecommunications)

The goal of offering innovative jointing techniques, compatible with the existing, globally-deployed shipboard jointing infrastructure, presents a challenge not only to system suppliers but also to ship operators and system owners. Over the past two decades, the undersea telecommunications community has equipped its undersea cable installation and maintenance fleet with purpose-built jointing equipment that most marine providers use to assemble at-sea joints. Although it is possible to take a forward leap in innovative jointing methods which would likely require new investment in shipboard infrastructure, would the resulting improvements in assembly time or performance justify the re-investment?

Today's shipboard jointing methods focus on achieving standardized connections among a variety of cable types from different suppliers, using a minimal set of designs, tools and procedures. This principle, by its very nature, limits the breadth of possible technologies, and does not readily lend itself to novel innovations. Recently, however, newer cable designs have afforded opportunities for jointing method improvements, which could become the impetus for introducing changes over time that may fundamentally alter the concept of having a single, stable approach to "jointing". This paper presents a study of some of the challenges that face the industry, and suggests ways forward.

We1.09 Re-Use And Re-Routing Of Retiring Systems

Jamie Merrett (Alcatel-Lucent)

Over the last few years there has been an increasing interest in recycling the components of retiring systems, to provide telecom traffic over a new route. As these new routes may not warrant the cost of purchasing a completely new system, the recovery and re-installation of a retiring system may provide a more cost effective solution. The challenges of recovery and relaying a retiring system along a new route are discussed. The associated testing and commissioning requirements are also examined. Whilst the standard system life design is for 25 years, other equipment and software has a shorter life, as such, re-engineering maybe required to replace obsolete equipment. The consequences of dismantling and the reassembly of equipment are considered. Operation and Maintenance of re-furbished systems is an important consideration as skilled people are required for installation, testing and training. Finally, the parameters and conditions required from both the donor system and new route are discussed so that any future system-recycling program can be evaluated objectively.

We1.10 Experimental Results of the Real Time Simulation System (RTSS) for Cable Installation Employing a Kalman Filter Algorithm

Yukitoshi Ogasawara (Kokusai Cable Ship Co. Ltd.) and Junichi Kojima (KDDI R&D Laboratories Inc.)

The most important factor in optimal laying of the submarine cable is a sense of the appropriate cable tensions and slack along the planned route. To establish of laying technology of the submarine cable without formation of kink or suspension on the seabed, several numerical simulation systems using three dimension dynamic models were developed in a software companies or ship's operators. However, the simulated results have not been evaluated to compare with the actual laid position of repeaters and the cable slack on the seabed. This paper describes the newly developed RTSS for cable installation employing "Kalman filter" to improve accuracy, stability and actual results obtained offshore.

We1.11 Marine Crew Training and Competence – Raising the Standard

Steve Searle (Global Marine Systems Limited)

It is indisputable that a competent work force is more productive, operates with reduced risks, shorter down times and fewer injuries. In accepting this fact, Global Marine Systems Limited (Global Marine) recognises that there needs to be specific competencies for each specialist area of submarine cable operations. This has led to the development of a unique and specific set of competencies associated with each specialist role.

These competencies were targeted at 4 main areas that were considered critical and significant in offshore cable maintenance or installation operations, Deck, Cable Engineering, Jointing and Subsea. Each discipline had assigned a number of key competency areas with a subset of competency components. The system was implemented for existing ranks and set the guidelines for new entrants to the business on what they needed to achieve over and above any statutory or academic criteria that they may have already met.

This paper describes the foundations of the Global Marine competencies scheme, associated and bespoke training courses either in use or developed to support the process and the administration and monitoring of the competencies.

We1.12 Extending the Use of In Service Repair Technology to Mobile and Land Jointing Cable Operations

Andrew Thomas (Ocean Cable Technologies Ltd.) and Franck Tortey (Alcatel-Lucent)

For well over a decade the industry has benefited greatly from the introduction of various in- service repair technologies, installed on the global fleet of maintenance and installation vessels. However, as system architecture has evolved and the resulting installation programs have become ultimately more complex, the commercial advantages of utilising this technology in terrestrial locations, will by far out-weigh those offered by its predecessor.

Over the last year Ocean Cable Technologies Ltd and Alcatel-Lucent have worked jointly to overcome some unique engineering barriers, to introduce the industries first mobile in-service repair system (ISRSystem Mobile). The system has been engineered specifically for use in terrestrial and mobile locations.

Together with a discussion on the technical issues that have been resolved, this paper will look into the work undertaken by both organisations to implement the first system, the role that this new technology will provide and also the benefits offered to the system owner, system installer and maintenance provider alike.

We1.13 Power Safety – A Global Standard

Tim Thornett and Ephraim Tozowonah (Global Marine Systems Limited)

This paper focuses on Global Marine Systems Limited's (Global Marine) commitment to power safety and highlights the importance of a global understanding and agreement on power safety procedures. Initially Global Marine's fully revised and updated procedures are discussed in the context of ensuring powering operations are carried out as efficiently as possible, with safety to personnel of prime importance. Global Marine has recognised that safety requires the cooperation of all parties, so our power safety procedures have been written around not only our safety needs but equal consideration has been given to the needs of our customers. When, for example, testing between a terminal station and cable ship during a repair operation it is vital for global standards. They may be many hundreds of kilometres apart and working for different organisations, but in this situation they need to work efficiently and safely as a team. Global Marine has discussed the issue with many companies to ensure that the procedures meet a global requirement. Here an argument is put forward for a global standard and not just a Global Marine standard. The paper finally discusses how Global Marine is being proactive in its approach, we insist all of our engineers are fully trained in power safety procedures and offer training to our customers. It concludes with identification that procedures put in place to ensure safety to all personnel can only be achieved if there is the adoption of a Global Standard.

We1.14 High Pressure Moulding Technology

Romuald Lemaitre, Pierre Gaillard, Franck Tortey, Paul Woodward (Alcatel-Lucent)

The Optical submarine cables are insulated with a polyethylene (PE) layer. When a cable joint is required, the electrical insulation and water tightness functions are usually provided by a polyethylene over moulding, especially when high dielectric insulation performance is required.

The main technical constraints of this operation are to maintain the minimum wall thickness of the PE sheath to guarantee the electrical performances and to avoid or minimize the defaults that can appear during the process, such as pollution (metallic or not), voids or bubbles which may lower its electrical performances. The moulding operation shall be as well designed to minimise the overall jointing time in order to be the most appropriate tool whatever the situation or configuration is in operation. Several technologies exist in the field depending on the application (on or off shore) and depending on the targeted performances (repeatered or un-repeatered system).

The paper therefore concentrates on the various PE reinstatement technologies and compares them to an alternative moulding technology based on a "high pressure" moulding technology.

We1.15 New U.S. Coral Reef Protection Regional Permit Condition and its Effect on Cable Repairs

Bob Wargo and Paul Shorb (AT&T Services, Inc.)

The U.S. Army Corps of Engineers (ACOE) Jacksonville District, which encompasses cable landings in Florida, the U.S. Virgin Islands and Puerto Rico, in 2004 adopted a Regional Condition that excludes work in areas of submerged aquatic vegetation, tidal wetlands and coral reefs from Nationwide Permit 3 (NWP-3). In 2005, the ACOE applied this Regional Condition to a submarine cable repair for the first time, which required a permitting effort similar to that required for a cable installation, and which took 169 days to complete. This paper will discuss NWP-3 and the Regional Condition; the permitting effort and its ongoing requirements; the repair; implications for other cable owners; and comments filed with the ACOE requesting modification of this Regional Condition.

Group 2: System Design & Applications

We2.01 All-Raman Amplification Extends the Life of Previous Generation Unrepeatered Systems

Jol Paling, Gregg Palinski (Global Crossing), Philippe Perrier, Andrej Puc, Daryl Chaires (Xtera Communications)

The recent upturn in demand for bandwidth-intensive service has operators of unrepeatered submarine networks reviewing their options for cost-effectively increasing the capacity on existing unrepeatered submarine networks. They are finding that the application of all-Raman amplification enables a simple and cost-effective upgrade for systems, including those with older generation remote optically pumped amplifiers.

We2.02 Phase Modulation for the Transmission of Nx40Gbit/S Data Over Transoceanic Distances

Gabriel Charlet, Sébastien Bigo, Jérémie Renaudier, Mathieu Lefrançois (Alcatel-Lucent)

The implementation of 40Gb/s rate in submarine system is very challenging from a technical point of view. Nevertheless, advanced technologies have been proposed and demonstrated in the past 5 years in order to turn it into a reality. Phase modulation of the light is one of the key enabling technologies. We will give an overview of different ways to exploit all the potentialities of phase modulation for improving the system performance and for increasing the system capacity.

We2.03 How Accurate Is Mean Q – 5 Sigma During Segment Commissioning?

Michael Cuddington (BT Global Services)

This paper looks at the $\overline{Q} - 5\sigma$ figures derived from real data over a couple of years and compares them to minimum figures obtained subsequently, to try and determine whether the use of $\overline{Q} - 5\sigma$ is accurate or otherwise.

The paper considers the variation of Confidence Trial length as a function of accuracy.

It is concluded that the accuracy of the $\overline{Q} - 5\sigma$ Confidence Trial is not particularly good, for a number of examples, and that is likely to be due to their non-normal distribution.

We2.04 Wet Plant Considerations for High Capacity/ Long Haul System Applications with Passive Amplification Methods

Heiko Dirks, Winfried Rutzen, Rudolf Stahl, Clemens Unger (Norddeutsche Seekabelwerke GmbH & Co. KG)

Submarine Fiber Optic Systems are highly dependent on reliable technological advances. They still continue to push the limits of fiber-optic transmission, both in terms of system length as well as bit rate.

Improved TR equipment, e.g. with forward error correction, newly developed fiber types and/or additional optical amplification (EDFA and Raman) can be used as modern instruments to provide solutions for high bandwidth telecommunication approaches as well as special systems such as ultra long haul systems with low data rates for the oil and gas industry in deep water and/or far away from shore.

By means of two actual projects, the JANNA and the SHEFA-2 project, the possibilities/limitations of repeaterless systems will be described.

Newly gained experience, increased performance, sophisticated manufacturing technology, significant quality measures, alternative approaches and future trends in the design of typical systems for repeaterless fiber optic systems will be discussed.

We2.05 The Future of Submarine Solutions

Marc Fullenbaum, Vincent Letellier, Eric Brandon, Stéphane Delorme, Laurie Doyle (Alcatel-Lucent)

The paper will provide a review of the current submarine market and of its segmentation. Over the past three years, the submarine suppliers have segmented the market in between unrepeatered, regional, transoceanic and offshore. Thus the paper will go over each segment while discussing the technology and product suite used for each.

Where is the submarine technology now going and when will the next technology breakthrough happen? The paper will detail and explain how the submarine market is likely to evolve from 2007 to 2010. The technology and trade offs will be discussed in light of the market driving forces. Thoughts will be shared as to the nature of the submarine solutions past 2010.

We2.06 Maximizing the Capacity and Changing the Network Topology of Existing Systems

E. A. Golovchenko, G. Mohs, L. Rahman, B. Bakhshi, S. M. Abbott (Tyco Telecommunications)

New technologies and sophisticated design tools allow the industry to extract new life from older undersea systems. The continued pressure to reduce the cost of adding capacity and the availability of newer terminal technology have combined to change the approach to upgrades and the way they are implemented. In many cases, this yields dramatic changes in system capacity and topology. Links originally designed for as little as 20 Gb/s per fiber pair are being upgraded to several times that capacity. In some networks implemented with several terminated links, it is now possible to bypass some of the intermediate termination points for some or all traffic on a fiber pair.

We2.07 Pushing the Reach of Repeaterless Transmission Systems

E. A. Golovchenko, L.J. Richardson, B. Bakhshi, S. M. Abbott (Tyco Telecommunications)

Technologies that enhance the maximum obtainable capacity and reach of repeaterless systems are reviewed. It is shown that 64x10 Gbit/s can be transmitted over a segment loss > 70 dB using simple, commercially available technology. After considering the trade off between wet plant and terminal complexity, it is concluded that increasing wet plant complexity is the preferred option for the design of new undersea repeaterless systems.

We2.08 Next Generation Operations Support System for the Southern Cross Cables Network

Dean Veverka and Brian Hart (Southern Cross Cable Networks), Mike Schwarz (Telecom New Zealand Ltd), Mitchell Forbes (Agilent Technologies Ltd), Tim Packer (Boss Portal Ltd)

This paper explains some of the key considerations in building a next generation operations support system (OSS), and describes how Southern Cross Cables Ltd (SCCL), in collaboration with Telecom New Zealand International Ltd, Agilent Technologies Ltd and Boss Portal Ltd, have implemented it with the use of a meta-data driven unified solution framework. Also discussed are the Business benefits to SCCL and its customers, and the profound ramifications to the submarine cables industry from this new platform.

We2.09 Alternative Approaches to the Supply of High-Reliability Components

Patrick Laverty and Barbara Dean (Tyco Telecommunications)

Reliability management of undersea systems has traditionally involved qualification of components with custom designs, specifications, and manufacturing processes. This approach yields high quality components with low failure rates and high cost. Recent downward price pressure on the industry has created a conflict between the continued need for high reliability and the costs associated with managing reliability according to the historical paradigm. Given the fiscal constraints, coupled with reliability requirements, innovative approaches have been developed to make use of redundant architectures, in concert with commercially available high reliability components, to provide the required reliability with lower-priced components.

We2.10 Today's Thin Routes

Mark McGilvray (Tyco Telecommunications)

The majority of undersea telecommunications systems implemented during the past few years have been Thin Route projects addressing niche markets. Initially, the equipment used on many of these projects was an amalgamation of excess inventory held by the system suppliers after the downturn that was re-engineered to fit a specific application. Although these projects were all successful, the engineering and implementation of some proved interesting given the design and configuration of the available inventory. Today, the introduction of new technologies and equipment for both the undersea plant and the cable stations allows the design of Thin Route systems to be customized for specific applications. From new transmission and power-feed equipment with very small foot print requirements and very low power consumption, to new network management equipment designs and techniques, to specialized undersea multiplexing devices, this paper will overview some of the latest products and configurations tailored for the Thin Route market. From re-engineering left over inventory to "fit" a specific system application as well as possible, to designing with latest generation products to customize a system for a specific application, Thin Route systems of today offer Purchasers many new features and benefits.

We2.11 Submarine Cable System Applications Toward Next Generation Networks (NGN)

Daiki Miwa and Kazushige Mori (NEC Corporation)

Along with the rapid popularization of broadband applications and world wide mobile services, the structure of the telecommunications industry infrastructure is shifting toward Next Generation Networks (NGN). This paper will discuss various technologies for submarine applications in NGN in view of the latest requirements from the submarine cable system operators. Diversification of the application as shown in the trend of terrestrial products is required for submarine cable system to support the growth of NGN. We present a solution for the next generation submarine cable system as well as several technologies supporting the migration toward NGN.

We2.12 Planning for Out of Plan Requirements

Philip Murphy (Australia-Japan Cable Ltd)

This paper reviews some of the considerations associated with implementing a submarine cable system upgrade comprising installing additional wavelength equipment and lower order interface requirements.

The strong take-up of broadband since about year 2004, in terms of subscribers and bit rate per subscriber, has resulted in a number of upgrades being planned and/or announced. Complementing the demand aspects, the capacity available for upgrading systems has been enhanced in terms of both transmission capabilities and Design Capacity. For example, the Design Capacity of the Australia-Japan Cable Network (AJC) Australian connectivity has gone from an initial 640Gbit/s to a potential of some 1,280Gbit/s.

If users are largely requiring capacity on a Just-In-Time or Out-Of-Plan basis, that is, not necessarily being able to provide longer term capacity requirements, then these limited longer term user forecasts can provide a dilemma for the Cable Operator planning an upgrade to meet requirements for several years.

This paper describes some of the challenges experienced by AJC when navigating the Upgrade route.

We2.13 Development of Commercial, Remotely-Pumped EDFA System

Akira Naka, Hideki Maeda, Tomoyoshi Kataoka, Shinji Matsuoka (NTT Corporation)

We have developed a new submarine optical cable WDM system that employs remotely-pumped EDFAs. The system was deployed between Okinawa-Island and Miyako-Island by Nippon Telegraph and Telephone West Corporation in March, 2005. The installed system length is about 340km, which is one of the longest unrepeatered systems without power feeding. This paper shows the transmission design, evaluated using a test bed in our laboratory, and the performance of the installed system.

We2.14 Spectral Hole Burning Effects and System Engineering Rules for System Upgrades

Richard Oberland, Steve Desbruslais, Joerg Schwartz, Steve Webb, Stuart Barnes (Azea Networks Ltd.)

The massive capacity potential of submarine systems is rarely exploited on installation. Loading channels are typically applied to maintain the traffic channels within their desired operating limits until the system is equipped to full capacity. Initially, the power density across the spectrum may differ from the End Of Life design, and this gives rise to Spectral Hole Burning. We discuss how these effects can be minimised and engineering rules are proposed that may be applied if a system is to be upgraded towards its ultimate capacity. Examples are presented based on real systems, simulation tools, and test bed measurements.

We2.15 Optimization of the Unrepeatered Links With Remote Amplifiers

S.B.Papernyi (MPB Communications Inc)

A new transmission link configuration with remote Er post- and pre-amplifiers where pump power is shared between a pair of fibers carrying traffic in opposite directions is proposed. Experimental verification of the principle was successfully carried out for single-channel 2.5GHz transmission. More than 4 dB budget improvement was achieved for a total link loss >90dB using only one third-order cascaded Raman pump source per transmission fiber.

We2.16 New Branch Construction of Third Party Existing Submarine Cable System in EAC1 Qingdao Landing Extension

Hiroshi Sakuyama, Makoto Saitoh, Yutaka Kiuchi, Tomohisa Nishiyama, Mikinori Niino (NEC Corporation)

EAC1 Qingdao Landing Extension has been successfully installed, commissioned and entered into commercial service in July 2006 as part of East Asia Crossing Network. This extension provides the additional connectivity to Mainland China for EAC to support the IT and Video traffic growth in the period up to the Beijing Olympic Games in 2008. This paper describes the design approach and implementation of a hybrid submarine system, which comprises an existing cable segment and a newly extended submarine part from multiple suppliers, to enable inter-working without compromise of the original design performance. The system has operated well, and a further capacity upgrade has been implemented in September 2006 which shows the viability and success of the hybrid system design.

We2.17 Higher Bitrates and Advanced Modulation Formats Facilitate Overlay Upgrades of Installed Submarine Systems

Jörg Schwartz, Steve Webb, Stuart Barnes (Azea Networks Ltd.) and Ronald Freund, Lutz Molle, Christoph Caspar (Fraunhofer-Institute for Telecommunications)

Upgrades of undersea communication systems beyond their design capacity is an attractive alternative to deploying new cables. Increasing the per wavelength channel bitrate is an obvious way to facilitate this. Nevertheless, this comes with tightened performance requirements, such as improved noise and dispersion tolerance, which will reduce any available margins. Applying new modulation formats is a route to mitigate these effects. This paper discusses the technical challenges for carrying out upgrades, either as overlays or on dark fibres, and also presents recent research results on how to add capacity to systems currently operating with N¥10.7 Gbit/s RZ-ASK signals over transoceanic distances. Experiments and simulations are used to analyse performance and limitations, with 20 Gbit/s RZ-DPSK being a strong candidate for upgrades.

We2.18 Raman Opens Up Bandwidth on Non-Ideal Fibres for Un-Repeatered Systems

Lynsey Thomas (Cable & Wireless) and Philippe A. Perrier (Xtera Communications, Inc)

In recent years the telecommunications industry has had to step away from bespoke designs for new cable systems. There have been a number of reasons why non-optimal fibre types have been considered for deployment, the usual driver being economics, but hand in hand come new development and scientific progress. The use of submarine cable for non-telecom applications is becoming more commonplace, groundbreaking redeployment of systems is being carried out, and the use of cable that has been pre-manufactured for alternative systems continues.

We2.19 Unrepeatered Systems: State of the Art Capability

Nicolas Tranvouez, Eric Brandon, Marc Fullenbaum, Philippe Bousselet, Isabelle Brylski (Alcatel-Lucent)

The unrepeatered systems technology has matured over the last three years while still providing significant improvements. The Raman amplification techniques have moved to 3rd order, more powerful amplifiers have come to the fore, new system schemes such as co- and counter-propagation have been conceived, the fiber characteristics have been improved while the terminal coding gain and modulation formats have also switched to a new generation.

This paper will review and describe the latest technology status and system schemes technologies. It will also discuss the state of the art solutions which are industrially available today or have been recently implemented. As an illustration a 380 km single-span system operating in WDM 10 Gb/s configuration, without remote optically pumped amplifiers, is detailed. Their main features will be described, focusing mainly on capacity, distance and costs.

This paper will also go over the next potential improvements in the unrepeatered arena along with a report of some world record experiments carried out. Among these records, a transmission experiment over 525 km is detailed, corresponding to the longest unrepeatered distance ever reported to our knowledge at 10 Gb/s, using commercial WDM equipment and Raman pumps ready for field deployment. A tentative roadmap will then be discussed in order to present the time frame for industrially available solutions through to 2010.

We2.20 Efficient and Expedited Upgrading of Existing Submarine Cable Systems

Kenichi Yoneyama, Kenichi Nomura, Isao Matsuoka, Yoshihisa Inada, Takaaki Ogata (NEC Corporation)

Submarine cable systems with optically amplified repeaters were first deployed with a design capacity of 2.5Gb/s and/or 5Gb/s per fiber pair. If we compare these older systems with the latest 10Gb/s Dense Wavelength Division Multiplexed (DWDM) systems, there will not be a striking difference observed in terms of their traffic carrying capacity despite having a rested lifetime of more than 10 to 15 years. Due to the recent advancements in transmission and terminal equipment technologies, it is now possible for these older systems to be upgraded by utilizing the 10Gb/s DWDM scheme.

In this paper we shall describe our process for determining upgrade feasibility as well as the potential maximum capacities achievable by upgrading existing systems. In addition, technologies and terminal equipment to be newly developed for upgrading applications will be presented with upgrade implementation examples from actual projects.

Group 3: Equipment & Component Technologies

We3.01 Cost Effective Next Generation Submarine Application Management

Richard Cruau (Alcatel-Lucent)

There's an industry demand for thin submarine application management able to leverage technology to manage complexity across the network, to minimize overall IT operating cost, to keep network up and running efficiently and to facilitate remote management through internet.

This paper presents and discusses multiple innovative solutions to answer to those challenges, giving to the operator ease of use, which reduces training time and IT operations, ease of deployment and upgrade by plug and play mechanisms ensuring a smooth migration path and keeping operational expenditures at a minimum, intuitive graphical interface, advanced features to reduce downtime network and quick customer feedback facing network or equipment problems.

Some others topics like reliability, security wherever operator is based (locally in the station or externally via internet connection offered by combining hardware platform enhancements and new software services), and scalability when it's required based on user adoption are presented.

We3.02 A Next Generation Distributed Network Management System

Jonathan Liss, Renata Bodner, Sameh Sabet and Ricardo Alves (Tyco Telecommunications)

Network management of geographically diverse telecommunication systems, such as undersea cable networks, poses special operational challenges above and beyond customer expectations of high quality data transmission. These include ease of use and low costs of deployment, operation and maintenance. This paper presents the architecture and functional capabilities of Tyco Telecommunications' next generation Network Management System (TEMS-NMS) specifically designed to meet the challenges of these types of cable networks. TEMS-NMS supports geographically diverse undersea networks providing NMS high reliability and with significant new capabilities that effectively mitigate customer issues which often arise with more traditional NMS systems.

We3.03 A New Generation of Submarine Line Terminal Equipment

Charles Breverman, Greg Valvo, Brian Jander (Tyco Telecommunications)

A new generation of Submarine Line Terminal Equipment has been developed and deployed into revenue-generating service. Within this product line are Transponders, Muxponders, Terminal Line Amplifiers, Initial Loading Equipment and Line Monitoring Equipment. All SLTE products operate in an extended range NEBS or ETSI environment. The Transponders and Muxponders use strong FEC and the RZ-DPSK modulation format, have tunable laser sources, and support multiple client-port protocols. The Terminal Line Amplifiers have redundant, hot-swappable pump laser modules and are field-configurable to constant power or constant gain operation. The Initial Loading Equipment is field-configurable to support flexible in service addition of new wavelengths while maintaining near-constant power spectral densities in the wet plant. The Line Monitoring Equipment supports in service, terminal-based detection and classification of wet plant impairments. The Line Monitoring Equipment also performs OTDR evaluation of fiber-segments with performance superior to commercial C OTDR products.

We3.04 Reliability Considerations for Terminal Amplifiers

Jeff Gardner, Barbara Dean, Brian Jander (Tyco Telecommunications)

Terminal Line Amplifiers (TLAs) are a critical subsystem from a reliability perspective in an undersea communications network. The reliability of the TLA must be commensurate with the reliability of the undersea plant since a TLA failure affects service. Pump lasers have historically been weak links in the TLA reliability chain. Field experience shows the next most prevalent failure mode is pump connector failure. Analysis of the optical and mechanical physics at the connector interface, together with amplifier field experience, allows us to determine the conditions under which the connector itself becomes a greater risk factor than the pump laser.

We3.05 Transport of 10GE over Submarine Networks

L. Doyle, O. Ait Sab (Alcatel-Lucent)

This paper deals with the transport of 10GE over submarine networks. It summarizes 10GE standardization status, describes different mapping options and discusses their impact on the submarine line design and terminal station equipment. Finally, we touch on network protection options for 10GE signals, in comparison with protection options currently used in submarine networks.

The aim is to provide a simple guide to system owners on the key issues in the transition from SDH/SONET to 10GE client traffic.

We3.06 Capabilities of Electrical Supervision Systems for Submerged Equipment

Neville Hazell, Derek Willetts (Alcatel-Lucent)

An electrical repeater supervisory has been a key feature of many optically amplified repeater systems installed over the last ten years. The operation of this system is described and a number of fault location case histories discussed. The historical data is compared with the budgeted allowances for 25 year ageing performance. Other uses of the electrical supervisory system will be considered, e.g. control of Branching Units, and finally further applications are considered.

We3.07 RZ-DPSK 10Gb/s SLTE and Its Transmission Performance Assessment for Application to Trans-Pacific Submarine Cable Systems

Yoshihisa Inada, Keisuke Watanabe, Katsuya Satoh, Ken-ichi Nomura, Takaaki Ogata (NEC Corporation)

This paper describes RZ-DPSK 10Gb/s SLTE for commercial use, which can detects 10Gb/s signal with 2.5dB improved performance in terms of optical noise loading under back-to-back measurement. The effectiveness of the equipment has been assessed through very long distance transmission experiment over trans-Pacific reaches. The improvement factor of 2.5dB with RZ-DPSK transponder is kept even under very long distance transmission up to 11,300km.

We3.08 RZ-DQPSK Transponder for 40 Gbps Submarine Cable Systems

Kazuyuki Ishida, Katsuhiro Shimizu, Shunsuke Mitani, Junichi Abe, Toshiyuki Tokura, Takashi Mizuochi (Mitsubishi Electric Corp.)

40 Gbit/s per wavelength operation is approaching commercialization for upcoming submarine systems. However one major concern in 40 Gbps transmission has not been resolved yet: the effects of cumulative polarization mode dispersion (PMD) in a long fiber cable. For reducing the performance degradation due to PMD, return-to-zero differential quadrature phase-shift keying (RZ-DQPSK) holds promise because of its broad pulse width. We have developed an RZ-DQPSK transponder and confirmed experimentally its large DGD tolerance and highly stable performance. We believe that this RZ-DQPSK transponder opens up the possibility of building next generation 40Gbps submarine cable systems.

We3.09 Novel Wavelength-Format Converter for Future Lambda-NNI

Katsuhiro Shimizu, Shunsuke Mitani, Ken Mishina, Suresh M. Nissanka, Kazuyuki Ishida, Tatsuo Hatta, Toshiharu Miyahara, Yasunori Miyazaki, Akihiro Maruta, Ken-ichi Kitayama (Mitsubishi Electric Corp.)

Submarine cable networks may be required to connect to terrestrial networks without costly OE/EO conversions. Due to the differences in fibers and repeaters, it is likely that at a gateway node signals with different wavelengths and different modulation formats will need to be connected transparently using all-optical wavelength and modulation conversions. We have developed a semiconductor optical amplifier Mach-Zehnder interferometer (SOA-MZI) and confirmed experimentally successful wavelength conversion over a 30 nm range. We have also demonstrated error-free all-optical conversion from OOK to BPSK/QPSK modulations. The proposed transparent conversion techniques can play a key role for future all-optical networks.

We3.10 40 Gb/s Transmission in Long-Haul Undersea Networks

Morten Nissov, Alexei Pilipetskii, Jin-Xing Cai, Yi Cai, Neal S. Bergano (Tyco Telecommunications)

Enabling technologies for future 40G systems are described: dispersion slope compensation, polarization mode dispersion compensation, choice of modulation formats, and forward error correction. These technologies will be needed for future applications of 40G in long haul undersea networks. The upgradeability of previous and present generations of systems is then discussed.

We3.11 How to Stay Fit – Improving Performance and Flexibility in Terminal Equipment

Alice Shelton, Michele Barezzani, Georges Grandpierre, Philippe Bonno (Alcatel-Lucent)

In 2004 we described a new generation of Alcatel submarine line terminal equipment adapted to the prevailing market conditions. Whilst there has been no particular market requirement to revise the terminal core, technology advancement and functional evolution have led to many changes, resulting in a notably different terminal, a closer fit to today's wider-ranging market needs. We focus on two specific topics; the improvement in performance realized through the use of DPSK transponders in place of the traditional CRZ modulation format and secondly the functional evolutions that have been considered as a result of a number of diverse requests.

We3.12 Flexible Regional Networks Using Broadband Optical Add/Drop Branching Units

Mark Enright (Tyco Telecommunications)

The broadband Optical Add/Drop Multiplexing Power Switched Branching Unit supports effective solutions for regional and offshore petroleum networks with complex connectivity requirements. Some key equipment features for the broadband OADM network are passive optics in the undersea plant and optical control of the powering configuration of the Branching Unit. The broadband feature of the optical couplers in the Branching Units enables high reliability and a very high degree of network flexibility. This paper reviews the equipment developed to implement such a system as well as enhancements for the future.

We3.13 Reliability Culture of Cost Effective 980 nm Submarine Pumps

Stefan Mohrdiek, Mark Ives, Hans-Ulrich Pfeiffer, Rainer Bättig, Nadhum Zayer, Shaun Quinlan, Tomas Pliska, Robert Cann, Nicolai Matuschek, Jeffrey Greatrex, Norbert Lichtenstein (Bookham)

We describe a methodology to maintain performance, quality, and reliability of undersea components and reveal a design for cost effective pump laser modules at 980 nm. Further we present our advanced submarine 980 nm pump module, consisting of an eight pin, hermetically sealed, ceramic Mini-DIL package housing without thermo-electric cooler.

We3.14 Equalizer in a Jointing Box: Improved Flexibility, More Cost Effective Solution

Florence Palacios, Romuald Lemaitre (Alcatel-Lucent)

In high-speed, high-capacity transmission systems, gain equalization and channel pre-emphasis ensure that all the transmitted wavelengths are received with adequate margins. Gain equalization is a combination of gain flattening filters in repeaters, tilt equalization filters used at regular intervals along the system to correct the residual tilt, and shape equalization filters to better flatten the gain spectrum. This paper presents an improved flexibility, more cost-effective solution to implement the tilt correction on high bit rate, long range transmission systems: Tilt equalization filters housing in a joint which design is based on the ASN joint box.

We3.15 OALC-5, an Optimised Solution for Regional Systems

Patricia Boulanger and Florence Palacios (Alcatel-Lucent)

Concurrently to long haul and ultra-long haul systems such as trans-Atlantic or trans-Pacific crossings, short/medium haul regional repeated systems represent a non negligible share of the submarine transmissions systems applications. These systems require only low powering voltage, thus providing an opportunity for the use of a further cost-effective, optimised cable design compared to what is required for the long haul systems.

We3.16 A Low-Attenuation, High SBS-Threshold Fiber Link Optimized for Unrepeatered System Transmission at 10.7 Gbit/s

John Downie, Andrey Kobyakov, Jason Hurley, Michael Sauer, Scott Bickham, Sergey Ten, Claudio Mazzali (Corning Incorporated)

We combine two fiber types to optimize the SBS-limited performance of a long unrepeatered system with 1550 nm transmission at 10.7 Gbit/s. One fiber is a low-attenuation ITU-T G.654-compliant silica core fiber with typical 1550 nm attenuation about 0.165 dB/km and SBS threshold comparable to standard single-mode fiber. The second fiber type is ITU-T G.652.D-compliant fiber with a high SBS threshold typically at least 3 dB higher than conventional G.652-compliant fiber. We investigate theoretically and experimentally a single long heterogeneous span and demonstrate transmission ≥300 km with NRZ signals and without Raman amplifiers. The ratio of the constituent fiber lengths is optimized to balance the SBS threshold and thus maximum channel launch power with total span loss.

We3.17 Optical Properties Improvements of N-MDFs by Combining Two Novel Negative Dispersion Fibers

Katsunori Imamura, Kazunori Mukasa, Masateru Tadakuma, Ryuichi Sugizaki, Takeshi Yagi (Furukawa Electric Co.)

By dividing N-MDF into two parts and applying a restrict mode excitation method, we successfully enlarged the Aeff of N-MDF. The equivalent Aeff of MDF which consists of P-MDF and N-MDF could be successfully enlarged and the optical characteristics of the transmission line were drastically improved.

We3.18 DSMF Fibers, a Comparison of Various Solutions

Jean-Luc Lang, Florence Palacios, Nathalie Robin, Romuald Lemaitre (Alcatel-Lucent)

Ultra long haul, high bit rate WDM transmission systems now require the use of a transmission media that precisely manages not only the chromatic dispersion in itself, but as well its variation across the window of operation i.e. its slope. To address this need a specific type of fiber or couple of fibers has been developed, called Dispersion Slope Matched Fibres (DSMF).

DSMF products from different suppliers have been investigated and compared in their transmission parameters and capability, cabling and splicing performances.

This presentation concludes on the possible applications, performances and advantages of these fibers for ultra long haul, high bit rate systems.

We3.19 Reliability Evaluation of Fiber Coating Anomalies

Haiyang Wang and Johnny Issa (Tyco Telecommunications)

Dual-coated optical fibers provide easier stripping and less sensitivity to micro-bending. Despite a record of success in the field, dual-coated fibers can still pose a challenge within the manufacturing environment since they are susceptible to developing physical anomalies during processing and fiber-handling. Although these anomalies are believed to be benign, there are very few published reports on reliability assessments.

We have investigated the effect that the presence of two types of anomalies has on the long-term reliability of fiber under a variety of conditions. The results are consistent with the favorable field experience to date, but also highlight the need for meticulous fiber-handling and diligent inspection techniques.

We3.20 Splicing Technologies for Dispersion Slope-Matched Fibers

Rong Zhu, Johnny Issa, Michael Sanders, Marsha Spalding, Qian Zhong (Tyco Telecommunications)

Due to significant differences in fiber core geometry and refractive index profiles between the positive and negative dispersion fibers in dispersion slope-matched systems, it is a challenge to splice both fibers together to achieve the low loss and high strength required for submarine applications. Two splicing technologies considered for joining these dissimilar fibers include bridge fiber splicing and direct splicing. The success of bridge fiber splicing has been field validated through the successful implementation of the VSNL TGN Pacific Cable System Segment G6, the first deployed system with slope-matched fibers. In this paper we discuss the development of these two splicing techniques and compare their benefits in terms of performance, implementation complexity, yield and applications.

Group 4: Project Development & Implementation

We4.01 Global Strategy for Uniform Tariff Classification

Charles A. Barber and Michael S. Carter (Alcatel-Lucent)

It is in the nature of an international business that the industry spends vast sums on duties and other charges on imported equipment. Lack of clarity on tariff classification is also responsible for significant delays in customs clearance to the detriment of the project timescales. Both these factors have a marked impact on customer's budgets and time to market. This paper argues for an industry process that will benefit suppliers and customers alike, saving time and money and reducing risk. A global strategy for uniform tariff classification is one that seeks consistent classification of a company's products in its home market and in every export market. The WCO's Harmonised System (HS) facilitates uniformity in customs classification and provides a good basis for a global approach to uniform classification. All countries, territories and customs or economic unions applying the HS should classify any given commodity the same way even if, in practice, the classification numbers and nomenclature and the wording of the rules of interpretation vary from country to country. The authors posit that the best way to achieve uniform tariff classification is to obtain a binding tariff ruling in each target market and recommend that a company first obtain a binding tariff ruling for each product in its home market, on the basis of a simplified technical specification specially designed for use with customs authorities, and then apply for a ruling confirming the same classification on the basis of the same technical specification in each export market. The paper discusses the practicalities and potential difficulties of the suggested approach. This topic is particularly timely since the HS nomenclature has been completely revised, effective January 1, 2007, and many jurisdictions have implemented the changes as of the same date.

We4.02 Turning Back the Bureaucratic Tide – Can we Recover Sanity in Environmental Permitting?

Roy Carryer (Alcatel-Lucent)

Environmental permitting has become the most common source of delay in the implementation of submarine telecommunications projects, with potentially serious commercial effects. This Paper challenges the assumption that the trend towards longer and more complex environmental procedures results in higher environmental standards. It also asserts that the culture of public agencies tends to prevent delay being viewed as a serious problem. Although the bureaucratic tide probably cannot be turned back, there are strategies that the industry can adopt to encourage regulators to develop a more sensitive, proportional and efficient environmental permitting regime.

We4.03 Provisional Measures: A Way To Improve Cables Protection?

Alexandre Martins Boto Leite
(São Paulo University – Faculty of Law)

This article is meant to show elements that can help reflecting upon the application and enforcement of provisional measures prescribed by the International Tribunal for the Law of the Sea in submarine cables protection cases and other disputes arising under its activities. However, the analysis of proceedings shall have ratione materiae and ratione personae jurisdiction rules as a background. From this point of view, the present paper will target at exhibiting the rules that favor the improvement of submarine cables protection and also the action of players of cables activities in the international scenario.

We4.04 Completing Our Mission to Connect the World: Emerging Market Success Models

Thomas A. Soja, John Manock, S. Hansen Long
(T Soja & Associates)

Subsea fiber cable networks provide vital links to information resources necessary for sustainable economic development. Beyond microeconomic benefits for developing private local, regional and global networks, there are broader macroeconomic and social benefits that can provide justification for government, NGOs and the philanthropic community to consider co-investing in networks to connect the yet un-connected and under-connected regions of the world. Governments have long recognized the benefits of good communications and several have re-asserted themselves in recent years but here is additional potential for resource expansion toward additional initiatives.

We4.05 The Procurement Process

Dec Wallace (BT Global Services)

In the current economic climate many companies, including telecommunication companies, face increased financial constraints. There is a desire to drive down capital and operational expenditure through improved investment and operational and financial efficiency. Companies are more careful how they invest their capital and aim to receive the best value possible for that investment. Prospective subsea cable system purchasers are no different, the investment required for a new build system or to upgrade an existing system is significant. Purchasers proactively set out ground rules to achieve their objective, to gain their desired system within a designated budget. We achieve this through the procurement process; this paper aims to describe this procurement process.

We4.06 Commercial Structures and Project Methodology – Development, Planning & Implementation

G. Scott Weese (IT International Telecom Inc.)

In today's submarine telecommunications' market, small-scale projects are ever-present as we strive to connect the world through our existing transoceanic systems.

The early development and planning of each aspect of a small-scale project proves invaluable in its effort to increase efficiency and improve relationships between the customer, contractor and end user. One must consider a straight forward, adaptive approach, while encountering the same constraints of a large system undertaking.

A key factor is to establish and ensure consistency in Project Management and Cost Control standards throughout a Company and to avoid the need to re-establish such procedures and controls at the beginning of each project.

We4.07 Incorporation Risk Analysis as an Essential Decision Making Component of Subsea Cable Projects

Donald W. Welch, Wayne Hughes, Chuck Collins, George Seltzer, Larry Mackey, Tim Axelsson (3U Technologies, LLC)

Effective system life cycle risk management is critical to the sustained success of an underwater telecommunication system. Three propositions are presented. First, effective system level risk management practices focused on Return on Investment (ROI) should be the over-arching project decision making tool. Second, effective maximization of ROI requires risk management to begin in the Feasibility Study and third, this risk analysis must include all of the phases of the system life. The use of a modular Monte Carlo Simulation is presented to equip decision makers with critical data beginning in the Feasibility phase and extending through the life of the system.

Group 5: Carrier Essentials

We5.01 On-Line Expert Support Through VPN Access

Pierre Fidry, V. Rakotomanana, C. Ausanneau (Alcatel-Lucent)

As a consequence of the operation and maintenance cost reduction and quality of service improvement, and since the arrival on the market of broadband internet access using DSL (Digital Subscriber Line), a new On-line remote access service based on VPN (Virtual Private Network) has been developed.

This solution allows On-Line Expert to connect to supplier remote access platform from nearly anywhere through internet broadband access such as home, hotel or airport and then bounce to authorized customer networks.

This particular architecture could also be adapted to provide the customer with a secure remote access directly to his own system through internet access. This could reduce significantly the need to have staff on site for first level investigation or for periodic operation on the system.

We5.02 What Telecom Service Providers Want From Their Suppliers

Jacques Gros (VSNL International)

What do Service Providers want from our suppliers? We want RELIABILITY, PREDICTABILITY, RESPONSIVENESS, OBSERVABILITY, and QUALITY in all its dimensions. Nothing new here. What is different is how much more vigorously and statistically we manage the supplier relationship, uncovering hidden costs, and the suite of tools that back up the analysis and discussions. We keep many statistics on supplier and equipment performance in key areas that impact network performance, and share these findings with suppliers in regularly scheduled meetings. Techniques used are described which resulted in substantial savings in operations cost and investment, and created environments that led to substantial improvements in our supply chains. (Techniques which we know other service providers use, such as project management of new installations, are not covered.)

Group 6: System Supply Market

We6.01 The Re-Deployment Route to Cost Effective Cable Systems

Maja Summers and John Kincey (Cable & Wireless)

The high demand for submarine cable systems in the late 1990s and the subsequent downturn has forced Owners to retire some of their cables early in order to consolidate operation and maintenance costs into fewer higher capacity cables. As a result there are a number of retired cables that have much of their 25 year design life remaining and could beneficially be re-used for new applications. Cable re-deployment can bring a significant cost saving when compared with new build systems. This makes the submarine cable links financially viable for low capacity routes that could otherwise not be economically served.

Group 7: Non-Telecom Applications

We7.01 Design Challenges for Undersea Systems Serving Offshore Production Platforms

Guy W. Arnos (WFN Strategies)

Different design priorities and requirements have evolved for undersea cable systems serving offshore production platforms which vary significantly from the requirements of traditional telecommunication cable systems. High survivability and platform independence, particularly in geographic areas subject to severe weather events, are critical and may outweigh pure cost considerations. Sharing a single cable system among the platforms of multiple operators requires additional technical, operational and political considerations.

This paper identifies key operational parameters, presents a set of design criteria specific to the offshore oil and gas industry then considers the tradeoffs of various system architectures.

We7.02 One Size Fits None: Identifying Standards to Facilitate Future Connections of Undersea Fiber Optic Networks to Offshore Oil and Gas Platforms

Christopher Carobene and Robert Munier (Tyco Telecommunications)

Commercial transoceanic cable systems rely on product and infrastructure standards which serve to streamline the deployment and installation of complex undersea systems. Now that submarine fiber networks are being installed to offshore oil and gas platforms, these familiar infrastructure standards no longer exist. As a result, network deployment to offshore platforms often requires product customization, the creation of one-off designs or modifications made in the field during installation. Each of these carries schedule and cost penalties which impacts the entire project.

The establishment of a common telecom infrastructure standard by the offshore community may streamline future networks much in the same way standardization has contributed to the efficient delivery of complex transoceanic networks. This paper examines the impacts of multiple infrastructure requirements to the delivery of an offshore submarine system, demonstrates how existing standards have benefited commercial networks, and offers suggestions to standardize and streamline future submarine fiber optic installations to offshore oil and gas platforms.

We7.03 Telecom/Offshore Oil and Gas: Convergence, Cooperation or Competition?

Philip Footman Williams (Tyco Telecommunications)

In the 1980s the submarine telecommunications supply industry failed to enter the offshore oilfield market. In the 1990s the oil industry failed to enter the telecommunications market.

In the 2000s, is the time now right for the telecommunications industry to converge with the oilfield industry?

Will this convergence succeed whereas previous attempts failed? If so, why?

Will there be a resource drain from the telecom industry into the offshore industry? If so, what?

The issues specifically associated with installation will be discussed in this paper.

We7.04 Which Technology for Your Offshore Network: Unrepeatered Or Unrelentingly Repeatered ?

Marc Fullenbaum, Antoine Lécroart, Jean-Pierre Odier, Ronan Michel, Vincent Letellier, Neville Hazell, Gary Waterworth, Eric Brandon (Alcatel-Lucent)

Communications networks may be the one challenge facing the Oil and Gas industry in exploiting deepwater and remote fields. What is lacking are long distance communication solutions based around high reliability, real time and undersea connectivity. Now the industry is pondering about the respective merits of the unrepeatered and repeatered technologies to build up their offshore network solutions.

This paper will provide all the necessary pieces of information in order for one to run their tradeoffs and decide on the best technology for their application. It will thoroughly go over the performance versus costs tradeoffs for each solution. Finally a decision grid guideline will be offered so as to match the solution to the customer criteria.

We7.05 Underwater Hardware Design Challenges for the Offshore Platform Market

Maurice E. Kordahi, Marsha Spalding, Michael Sanders, Chung-shin Ma, Johnny Issa, Jeremiah Mendez, Robert Stix (Tyco Telecommunications)

This paper presents a trunk & branch suite of undersea hardware developed for optical fiber communications between terrestrial landings and offshore oil & gas floating platforms. The trunk connects the two ends of the system, while the branches connect the platforms to the trunk. The branches consist of dynamic risers that terminate on one end at the platforms, and on the other end at an SL Wet Mate Fiber Distribution Canister (SL FDC), before reaching an SL Optical Add/Drop Multiplexing Branching Unit (SL OADM BU) that ties it to the trunk. This riser cable system uses the latest technology of undersea optical fiber cable, along with the FDC's which allow the network to be expanded to tie in additional platforms, without cutting into the cable system, but through the use of an undersea wet mate. It also uses the latest OADM Branching Units to provide the ability to optically control the powering configuration of the undersea network. The termination and joint for the riser cable are designed to maintain strength, optical, and electrical continuity.

We7.06 To Boldly Go Where No System Has Gone Before

Sasha O'Bow-Hove (Alcatel-Lucent) and Cheryl Katnick (The University of Victoria)

Cabled Ocean Observatories are being developed around the world by science and engineering teams. These observatories will transform the way traditional ocean science is conducted with data now being available in continuous streams and in real time. Ocean science will no longer be solely dependant on ship availability and weather windows.

Projects such as the NEPTUNE Canada Cabled Ocean Observatory required an innovative approach to the marine engineering and planning of the network infrastructure.

As the network layout was driven by the research themes selected by ocean scientists, the challenge was to deliver a network that provided reliable power and data transmission to some of the harshest environments on the northern Juan de Fuca plate.

This paper outlines how the marine teams from the University of Victoria and Alcatel-Lucent approached the challenge of the NEPTUNE Canada route and developed new tools to manage the data and engineering process.

We7.07 Scientific Applications for Telecommunications Technology

Jim Olson (Tyco Telecommunications)

For decades companies have been constructing undersea communications networks to support the telecommunications industry. New markets, specifically the scientific community, have emerged recently that are leveraging this technology to build new, large telecom infrastructures. This paper will identify these markets and discuss how the hardware and techniques are being implemented in these markets to support these endeavors.

We7.08 A Fibre Optic Cable End Module

Inge Vintermyr, Jørn Wardeberg, Einar Magnus Bjelland (Nexans Norway AS)

This paper describes the concept of a Cable End Module (CEM), enabling quick and reliable connection between a Fibre Optic (FO) cable and auxiliary sub-sea equipment. The CEM comprises a FO cable mechanical termination, a cable joint, up to three FO ROV operable wet mateable connectors and ROV operable FO jumper cables.

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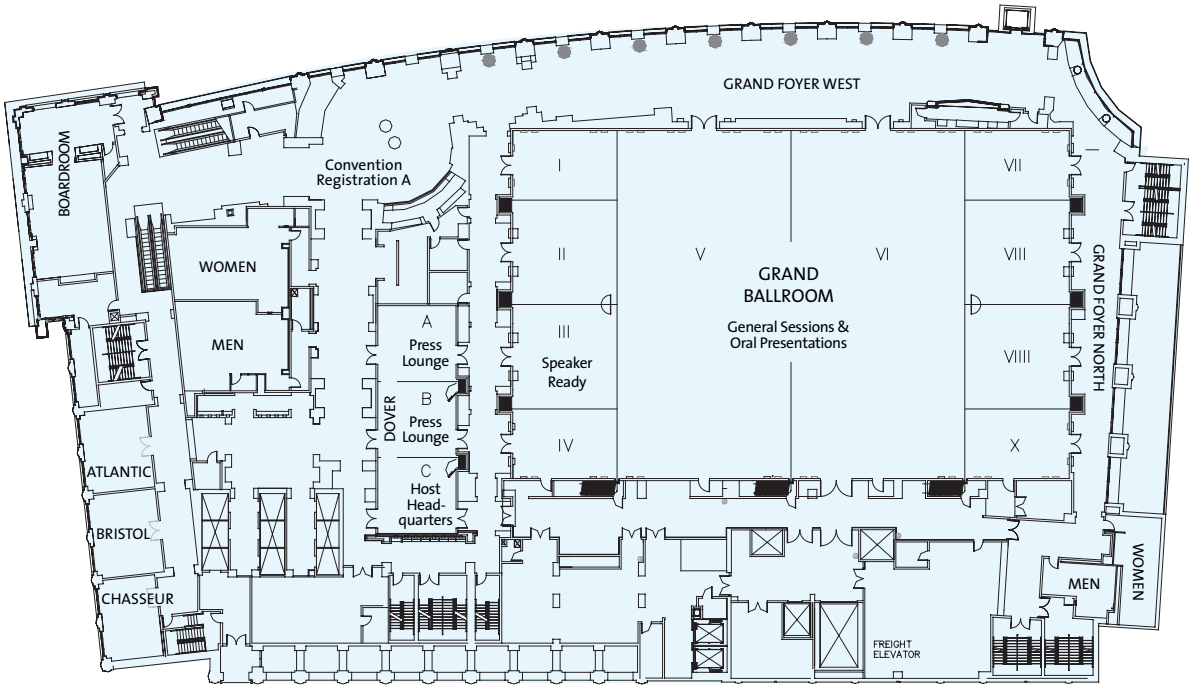

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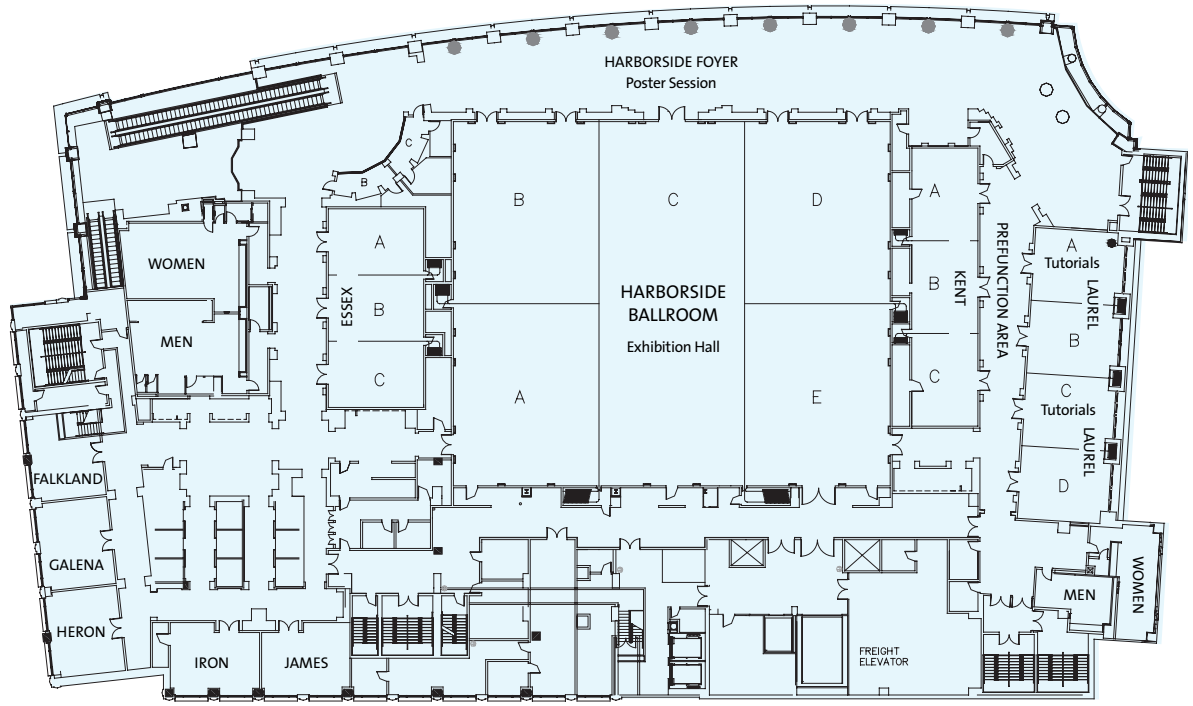

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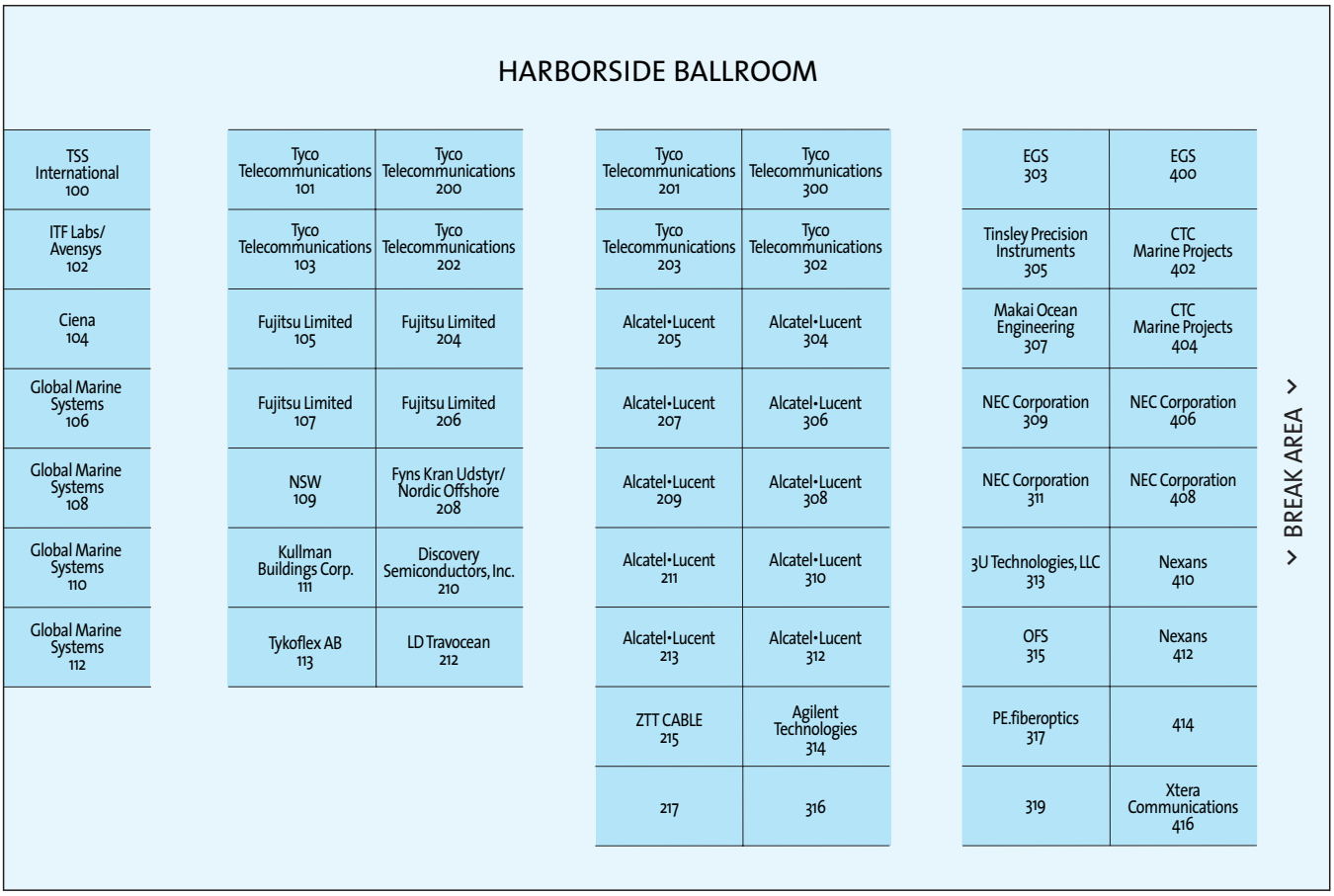

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