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SHORT COMMUNICATION

THE IMPLEMENTATION OF AN OPTICAL INTERNET SUBMARINE NETWORK IN BALKAN REGION

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There are shown the architectural and engineering issues of building a submarine optical Internet network between Romania, Bulgaria, Turkey and Greece which use the recent developments in high density Wave Division Multiplexing fibre systems allows for the deployment of a dedicated optical Internet network for large volume backbones pipes that does not require an underlying multi-service SONET/SDH and ATM protocol.

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The rapidly growing popularity of the Internet is the key driver in communication today. Even conservative observers estimate that Internet traffic will double every six months for the next few years. The response to this problem is the Optical Internet networks.

An optical Internet is defined as any Internet network where the network link layer connections are “dedicated” wavelengths on an Wave Division Multiplexed (WDM) optical fibre directly connected to a high performance network router. The high performance network router replaces traditional ATM and SONET/SDH switching and multiplexing equipment.

Based on the development of the Balkan region in terms of telecommunication and other services I will try to design an optical Internet submarine network which will link the following countries: Romania, Bulgaria, Turkey and Greece.

This network will open up a new and boundless frontier – in much the same way as the railway opened up in 1800. It will be the first network in Balkan built from the bottom up to carry Internet Protocol (IP) traffic.

The first characteristic of this network is its “link layer” connections of dedicated wavelengths, or lambdas, on a Dense Wavelength Division Multiplexed (DWDM) optical fibre that multiplies the bandwidth of a fibre by driving it simultaneously with 80 different colours of laser light.

The multilayer communications network now in use was designed primarily for circuit switching, when voice was dominant, bandwidth was expensive, and capacity was portioned out in 64 kb/s pieces [1]. Although this multilayer architecture works well for voice, it is less than ideal for data, especially with respect to efficiency and cost effectiveness.

The Fig. 1 [2] illustrates a possible future network Internet architecture that integrates IP over WDM with ATM and SONET services. The IP over WDM might be used for high volume, best efforts computer traffic, while IP over ATM might be used to support VPNs and mission critical IP networks while IP over SDH would be used to aggregate and deliver traditional IP network services that are delivered via E1.

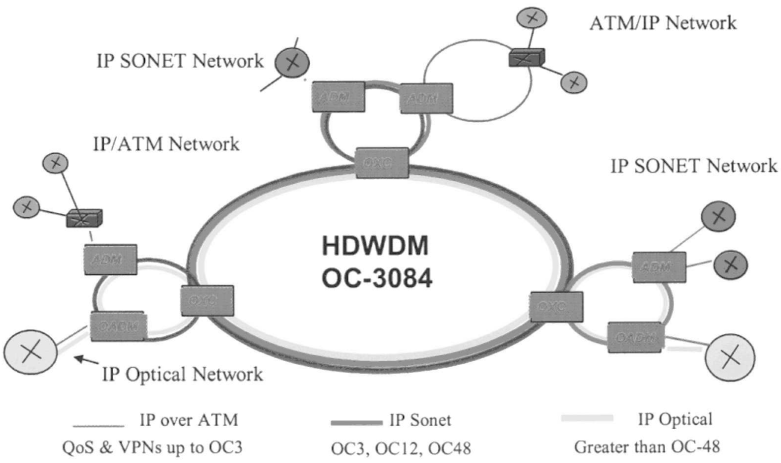

Fig. 1. Integrated optical Internet.

Applications on the Internet can be divided into three broad categories based on their unique traffic profiles and network requirements: human to human, human to computer and computer to computer applications. Human to human communications are considered to be those services where a live human being is required at both ends to complete the communication connection. Such applications include voice telephony and video conferencing.

Human to computer communications include the obvious things like Web, but it also includes such things as voice and video play-back services that are just starting to come on line.

Computer to computer communications occurs when no human is required to initiate or terminate the communication. Such things as distributed web caching, multicast feeds, new feeds, batch processing, and database synchronisation are typical of computer to computer communication.

The understanding of Internet traffic characterisations is crucial to the design of future networks. There are some studies [3] indicating that Internet traffic is fractal or self-similar in nature. Self similar means that traffic on Internet networks exhibits the same characteristics regardless of the number of simultaneous sessions on a given physical link.

The consequences [2] of the fractal nature of the Internet is that in order to minimize congestion IP networks must operate at a higher average peak to average load than in a traditional telecommunication network.

Another unusual characteristic of Internet data is the extreme imbalances that exist between the transmit and receive paths on most Internet links. The asymmetric data flows are attributed to larger servers farms sending out large amounts of data in response to small requests and to the preponderance of users who download web pages. An example of asymmetric data flows on the Internet is presented in Fig. 2 [2].

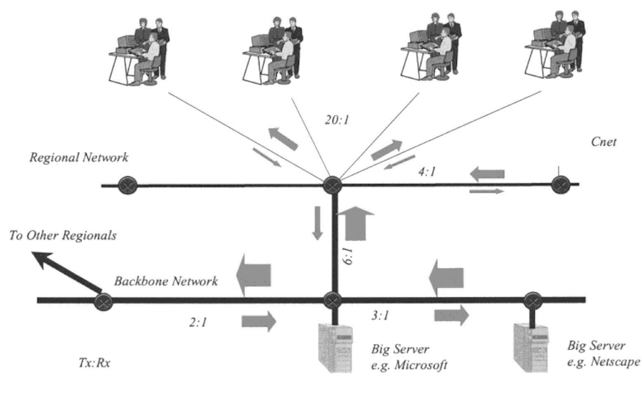

Fig. 2. Examples of asymmetric data flows on the Internet.

Fig. 3 [2] illustrates some of the basic architectural concepts of an optical Internet network.

The principal characteristic is the use of high density Wave Division Multiplexing fibre to deliver individual wavelengths directly to high performance IP routers.

The wavelengths are coupled and de-coupled from the fibre using a WDM Coupler or sometimes referred to as optical multiplexer and/or an optical add drop multiplexer. The WDM coupler is a passive device that using the same principle of a prism splits or combines the light beam into its constituent wavelengths.

The output and input of the WDM coupler are simple fibre connectors which then direct the data on the original wavelength to either the traditional SONET/SDH gear or the high performance IP router.

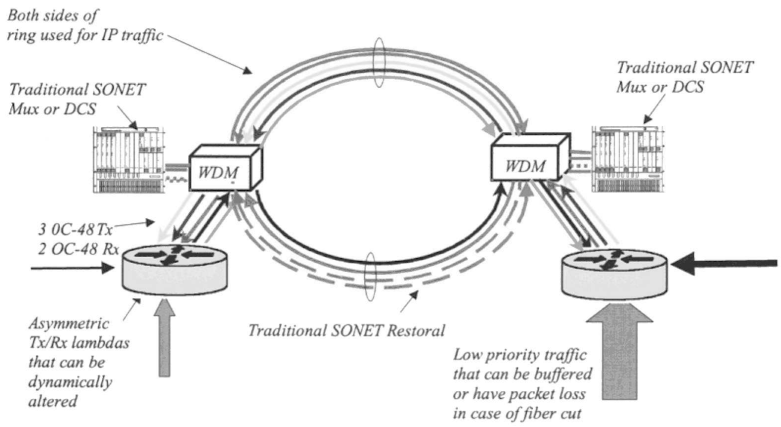

Fig. 3. Architectural features of an optical Internet.

This type of configuration would support a 3:2 Tx/Rx data asymmetry which is relatively common on the Internet today. There are a total of 9 wavelengths, 5 on the working fibre and 4 on the protection fibre.

The other major distinguishing feature of an optical Internet is the use of both sides of a fibre ring. By doing restoral at the IP layer rather than at the physical layer at lot more sophisticated restoral techniques can be used as compared to the traditional SONET/SDH restoral.

On the other hand in an optical Internet there is no lower layer transport protocol, and as such traffic engineering must be done at the IP layer. One solution is to use MPLS – Multi Protocol Label Switching.

MPLS integrates a simple fixed label switched networks with a more complex network routing protocol.

Oceans represent some of the most challenging environments on earth, separating people and business around the world. Through the launch of its Submarine Solution, Nortel Networks continues to be on the edge of disruptive technological innovation, with the extension of a truly global Optical Internet.

Nortel Networks introduces the OPTera Long Haul 5000 Optical Line System, as part of its industry-leading portofolio of next – generation open optical systems for backbone networks. The network proposed will be build based on the OPTera 5000 equipments.

The network will interconnect 5 GigaPOPs where regional high speed research networks will interconnect to the optical Internet backbone. The GigaPOPs wil be installed at Constanta, Varna, Burgas, Instanbul and Athens.

Two groups of signals are used, one occupying the C band and one the L band and the channel spacing is 100 GHz on the ITU grid.

The network will operate at 3,2 Tbit/s (80 channels $\times$ 40 Gbit/s). The transmission comprises two 90 km spans and one 120 km span, with combined Raman / Erbium amplifiers after each span.

The amplifiers give a gain around 26.5 dB. The span loss is 28.665 db. The transmitted power per channel is 0 dBm.

The fibre spans use NZDSF – **n**on **- z**ero **D**ispersion **S**hifted **F**ibre – with a dispersion of 5.7 ps/(nm.km), and a slope of 0.037 ps/(nm^2.km), but is mostly compensated by high-slope DCF within the amplifier.

The transmitter [4] is composed of a 40 GHz pulse source and a 40 Gbit/s data transmitter. The 40 GHz optical pulses were generated using a LiNbO3 intensity modulator driven close to $2V\pi$ at 20 GHz and biased at the null point. The width (FWHM) of the pulses was estimated to be close to 17 ps, corresponding to a duty cycle in excess of 60 %.

The network will be available to researchers at universities, and government laboratories engaged in research and applications development relating to high-performance networks.

Why is an optical Internet better? It is simpler, more flexible and faster. Essentially, an optical Internet de-layers the complexity of traditional telecommunication networks, allowing optimum Internet Protocol traffic.

The network will be fast enough to download the entire two and half-hour movie Titanic in one-fifth of a second and also could carry all the telephone calls at any given time from the countries mentioned before and simultaneously carry video from every household with a home computer in any major city if they were all equipped with video cameras.

With this network scientists could exchange mammoth databases in a matter of hours, if not minutes, doctors could consult on operations performed thousands of miles away, or engineers and researchers could build and correlate databases and models for weather patterns, exploding stars or space shuttles re-entering the earth’s atmosphere.

In effect, this capacity will virtually lift research and technological development into another dimension.

Recent developments in optical network technology, plus the extension of well-known LAN architectures from the desktop to the neighbourhood and beyond, are allowing the deployment of very low cost, very high bandwidth optical networks for the carriage of Internet traffic.

These developments will also allow schools, universities, banks, ISPs and other organizations to deploy and manage their own, very high speed optical networks, rather than relying on the service-based offering from traditional carriers. Over the next few years, this new generation of Internet network could have the same radical effect on the telecommunications sector as the personal computer did on the computing industry twenty years ago.

In my view, the technological opportunities discussed in this paper are poised to fundamentally alter the telecommunications market and the telecommunication environment as we know it today.

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