A Technique To Improve Transport Network Architecture Using Super-Channel Based On High Performance Photonic IC

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***Abstract*-Coherent super-channels are now the most important way for service providers to deploy long haul DWDM capacity at the transit scale. This paper shows idea that how coherent technology has delivered a factor of ten improvement in spectral efficiency, While super-channels based on high performance Photonic Integrated Circuits (PIC) allow the resulting capacity to be operationally scalable.Transport Network Architectures are evolving to take advantage of modern, high performance switching platforms. Service providers need to understand the benefits of each type of platform as they strive to drive down costs, while keeping pace with demand.Control Plane technology has tended to be distributed over the network elements, as in the case of GMPLS. But by centralizing the control plane, in a Carrier SDN architecture it's possible to solve important challenges for end to end, multi-vendor, or multi-domain service management.**

Keyword- DWDM, photonic Integrated circuits (PIC), Generalized multiprotocol Label Switching (GMPLS), Software defined Network (SDN).

I.INTRODUCTION

Transport Networks are the foundation of the modern internet. This paper describes at three specific areas of Transport Network technology: Coherent Super-Channels; Transport Network Architectures; and Carrier Grade Control Planes.

The overall global IP network and the various trends within the network that arebehind the on-going bandwidth explosion being seen throughout the network [1].
While simplistic, this equation provides a meaningful way to understand the underlying forces driving the never-ending bandwidth explosion networking has been experiencing

Increased no of usersx Increased accessrates and methodsx Increased services=Bandwidth Explosion.

TheTraffic forecast of 1.demand 2. access technology 3.storage. are shown below

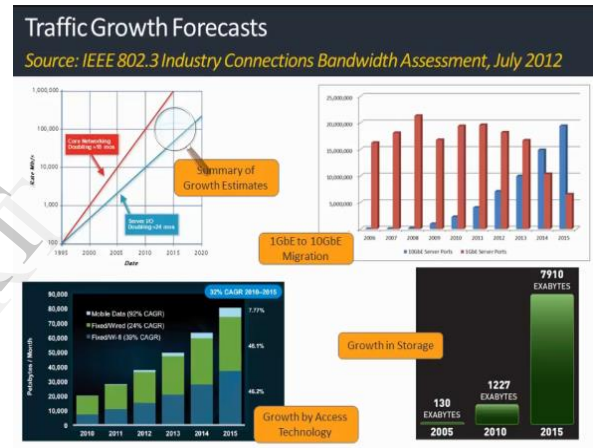

Fig1: Traffic growth forecast

You could notice that there is exponential growth in demand evolving to the terabit era. Ultimately leading to An infinite pool of intelligent Bandwidth .

Initially it got started with photonic integrated circuits and then came digital optical network (10G -100 G)was implemented using converged OTN switching and WDM without compromise.

The main key element is convergence ofdata, media into OTN .The data media into OTN in digital optical network via convergence multi- layer switching viz., MPLS, OTN,WDM, and ROADM. It implies that we can implement high levels network automation because digital architecture is truly deterministic.

The automation in transport network is an open software control programmability and has recovery architecture.PIC is small in size and uses less power. Super channel transmission supports coherent transmission, ready for 1Tbps. Wherein the transition between

(100G -500G) to Terabit is accomplished using as intelligent transport network.

The Three classification of Transport network Architecture are

a) Scalability :The technological and commercial success of DWDM super channels
b) Convergence :The evolution of transport network architecture and platforms
c) Automate : the role and evolution of carrier grade control plane technologies

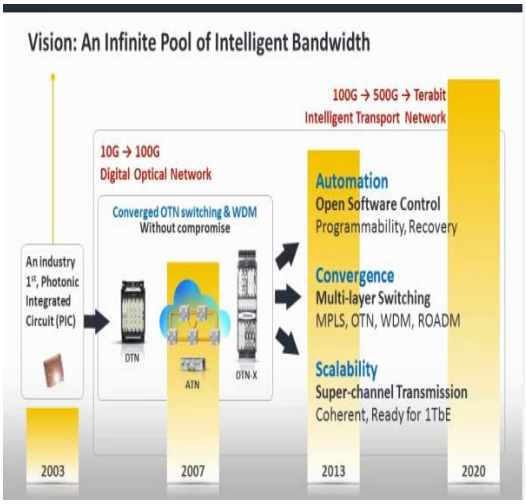

Fig:2 An infinite pool of intelligent Bandwidth

II.SCALABILITY

Scalability term signifies the performance of fiber optic by means of speed capacity error correction technique with ease and less complexity.

Capacity:

Total fiber capacity is a function of :

a) Data rate per wavelength.
b) Number of wavelengths in fiber

Also,capacity and distance are antagonistic .One of the general trend of DWDM is to increase the product of capacity and distance. Some of the early innovations are based on laser technology evolves to fiber “sweet spot” transmission data with minimum attenuation. Followed by EDFA (high amplifying technology) enables WDM –multiple waves in a fiber to Terabyte technology. It does amplifies all WDM using Single fiber amplifier without any need of demultiplexer at amplifying site .On inclusion of FEC (forward error correction)directly increases cap* distance product.Since, it detects error and rectify it[7Then C+L band innovation came into existence to support multiple application demands.Finally Raman amplification gives excellent distance boost power amplification combination of all these increases the capacity of factor10

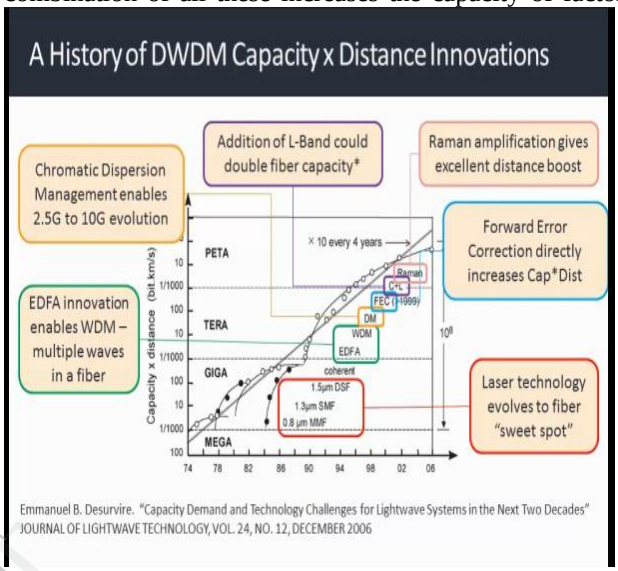

Fig 3: DWDM capacity * distance innovation

The PIC makes following polarizing muxing :

Factor 2 capcity*reach* increase with complex modulation.

Modulation technique used are:

PM-QPSK at 4 bits per symbols has better optical reach but less capacity. While for higher modulation technique - PM-16QAM at 8bit per symbol has better capacity but less optical reach.[6].

Thus the arrival of coherent detection wherein it supports 100Gbps and boost capacity by 10 times. If 10Gbps is used per channel then for 80 channels it is up to 800Gbps and signals are transmitted in binary. Thus, no need of modulation at receiver ends.Likewise,for 100GBPS leads to 8TBps. Implementing for such coherent super channel becomes more complex especially at receiver section. But the key is to increase the unit of capacity scaling. And hence, comes the coherent super channel.On integration of multiple cores on a single chip also combining multiple DWDM on a single line card called PIC.When brought into single channel called super channel as the number of carrier increases ban ,number modulators also increases but

provide spectral efficiency.

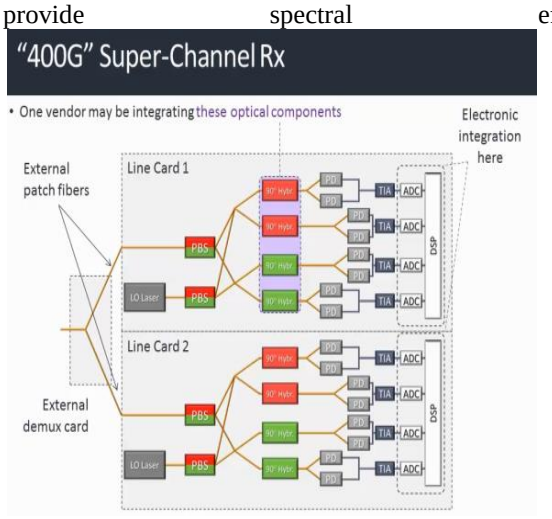

Fig 4: Super channel receiver

Thus, by collapsing entire set optical components for a single super channel for a pair of chip we can integrate more than 600 optical functions such integration eliminate over 250 fiber connections Thus becomes simpler scalable uses less power.

Dotted lines shown in above diagram depicts the electronic integration where actual coherent detection takes place.

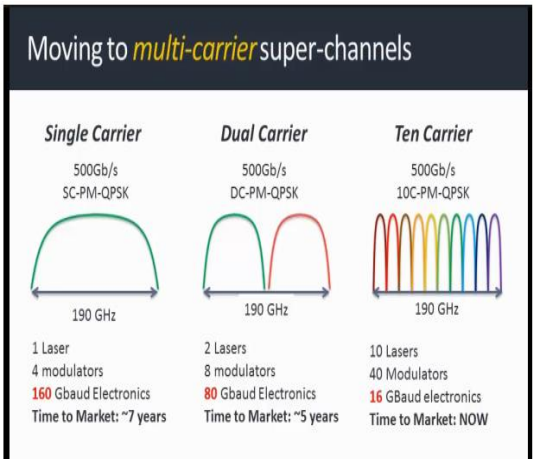

Fig 5: multi-carrier super channels

Basically, for better optical reach PM-OPSK or BPSK can be used.

Also, 16 QAM does not have enough amount of power for each symbol,thus the reach is low. Thus, Flex coherent is used which equals "Dial –a Reach" technique.It is an ability to reach maximum capacity on the per channel modulation format.as per need of reach different modulation technique is used.

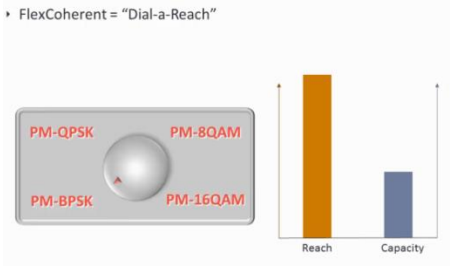

Fig 6:An Infinite pool of intelligent Bandwidth

It is been paid forslice matching customer revenue.Entire bandwidth is available for services out of which100G is enough in superchannel for usual transmission. On higher traffic demand another slice get activated this is called *instant bandwidth* .unlike, Static Circuit of Bandwidth where transponders store the 100G module (wave) . In case of, further capacity there is a need to have wavelength engineering whenever required each time it has to be activated as shown in diagram below.

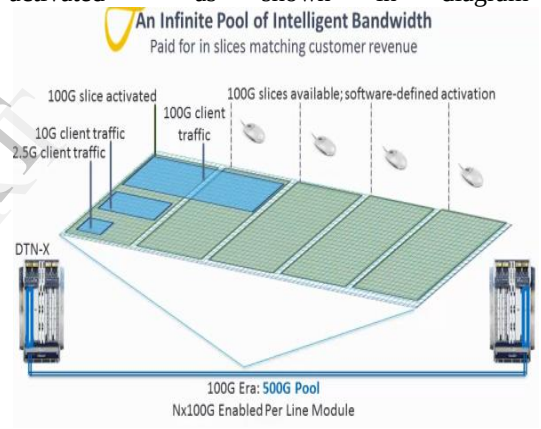

Fig:7 Instant Bandwidth

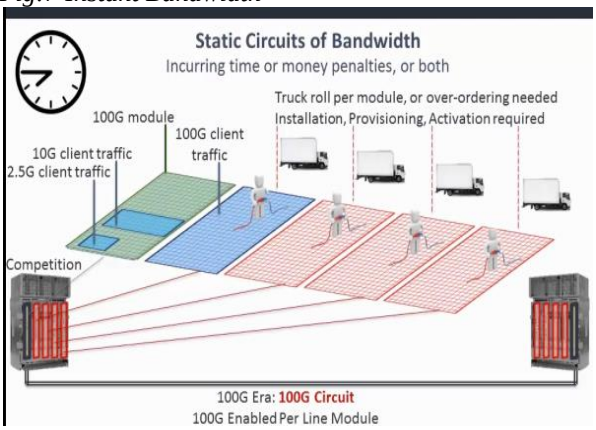

Fig:8 static circuits of Bandwidth.

Service provider has 160 transponders connect 160 fibers into the line system to achieve 8 bits of 8Tbps capacity. Through super channel approach 32 line module, 32 fibers is enough for 8Tbps. Thus, becomes scalable.

III.CONVERGENCE

An efficient transport platform is formed by converging heterogeneous networks to provide efficient platform. In this architecture, Both OTN and DWDM is been combinedtogether in a single platform transport network forms convergence while IP Networking is moves apart.

A Specialized line cards with special switching idea and less expensive switching transform package super core is implemented.

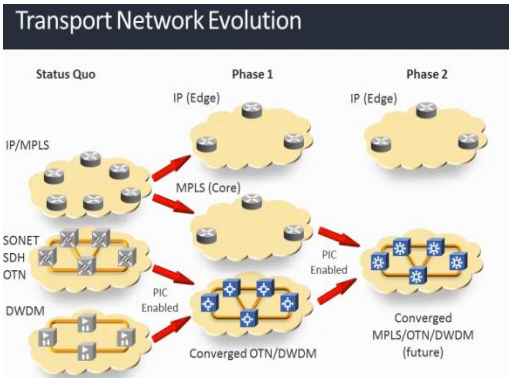

Fig 9:Transport network evolution

SONET,SDH,OTN,DWDM are PIC Enabled to Converged OTN/DWDM Network. MPLS (core) Networks and Converged OTN/DWDM network are converged to MPLS/OTN/DWDM Network on PIC Enabled in future.

cost of IP Routing, and least cost for optical switching IPoWDM uses costly IP router muxed to 100 gateway. It employs complex design . Since, it requires coherent and non coherent optics on the same fiber. Thus, fiber capacity has to be increased. whileIP over OTN is less cost. Since, it uses gray optics.Therefore, IP over OTN enables Practical and cost effective IP networking.

Also, MESH topology is easy to debug due to digital switching and does not waste bandwidth.To operate at higher speed requires higher data rate of 1Tbps need intelligent multiplexing to feed large numbers of lower rate data services in mesh topology. Thus, the solution is to use without OTN switching.

Therefore, an idea is to merge the traffic together produced in right direction called *trafficroaming*.

To perform traffic roaming efficiently there is a need of external switch each for 10G services to brought out of the lines transmission platform using muxponder card and patched into switch. The switch that need bunch of fibers connected to muxponder card goes to fiber direction .But all these implementation are very difficult consumes more power and space .It eventually gives rise to integrated switch +WDM.

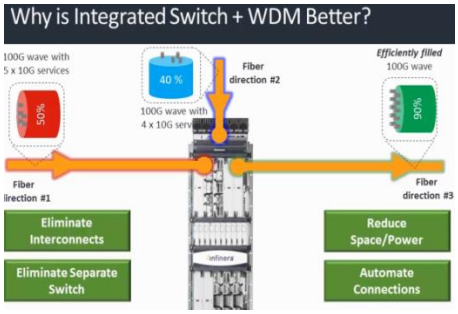

Fig 10: Integrated switch

The advantages of photonic integration line cards for switching platform functional integration.

WDM is least expensive while, OTN improves efficiency ,Faster recovery by SONNET/SDN provides protection in less than 50ms.Thus, backup due to failure link may lead to more bandwidth and more expensive .Well designed factory can reduce the multi-failure backups butit is costly and protection bandwidth is gets shared. WDM with OTN provides *wavelength efficiency*. Integration of which provides platform efficiency.

First backup entries uses1+1 protection sharing saving protection path bandwidth technology.Dynamically infinite bandwidth pool activate new bandwidth in real time.On the superchannel it is possible to trigger instant bandwidth based on protection policy .

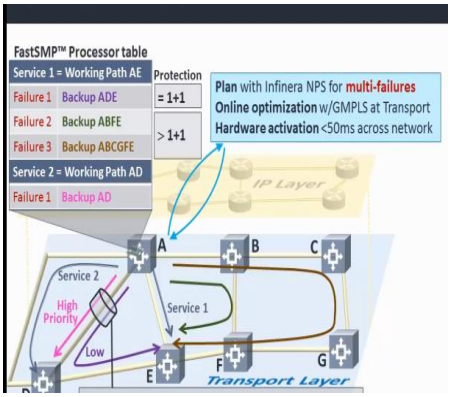

Fig 11: Transport Network

supposing if node A wants to transmit to node E then there are around 3 backup possible. Thus online optimization can be done .Both service 1 and 2 uses sharing, saving protection bandwidth technology . There by it reduces cost, Access to channel is based on priority.If a path link failure occurs it suitably chooses the other link CG link shown in brown line and it is also possible to trigger instant bandwidthbased on protection policy.

IV. CONTROL PLANES

Carrier grade control planes allows the network automation.Initially Centralized technique involves human driven, hop by hop communication and highly proprietary then in next evolution GMPLStechnique arrived wherein network is distributed to one which is protocol-driven,end to end communication and it is standard based. Finally,evolved with Hybrid architecture of Distributed and Centralized called carrier SDN which is protocol-driven, end to end communication it is standard based and open source.The ability to Control network resources for and properties at a distance for service ready capacity and for digital network operation. Thus capacity is designed and planned and kept for additional serviceon demandsuch that it should not be slow.

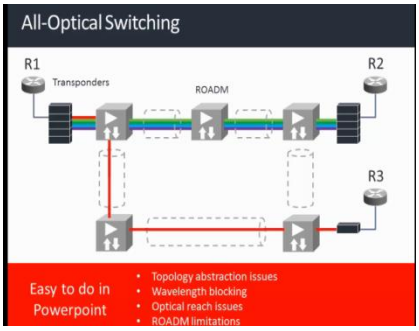

Fig 12: Optical switching

Moving switches to lower possible layer saves money needs less intelligence and less controllable. ROADM redirects red wavelength to R3 via lower layer with end to end parameters includes attenuation, chromatic dispersion cross modulation and mixing system margin . Also, traffic engineer is required eventually becomes Very difficult to maintain metrics for all optical networks.

Wavelength is a scares resources in fiber and

there is a probability that same colour wavelength can be used in another hop in the path where individual transponders are tunable there is no optical mechanism.

ROADM uses CDC (Colorless Directionless Contention less) which is very costly and optical switches resist automation. Thus digital plane network arrived with DWDM digital capacity.

Initially capacity is setup between r1 and r2 redirected to r3 , Actually, the network capacity is virtualized and becomes extremely easy to redirect capacity in highly deterministic way with digital link such that it can connect to any parameter and best path gets connected . We can add traffic parameters to give network the complete control thus there is no wavelength blocking. Therefore, digital network enables automation.

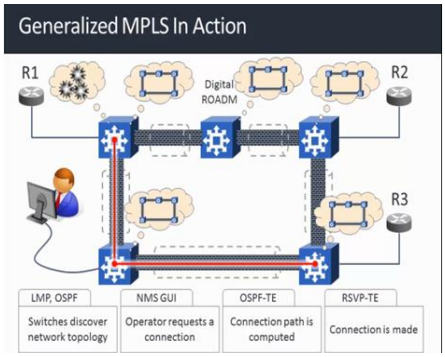

Fig 13: GMPLS

In case of Generalized MPLS in Action, digital ROADM is used , it switches to discover new network topology sequentially maintains shortest and best path among switches on the demand operator request for connection. Connection path is computed based on (OSPF-TE).

This technique is more feasible and meets bandwidth on demand .Carrier SDN control plane Models combines both explicit and implicit models in which SDN controller (centralized of all network control) controls each. Likewise, every node individually get controlled by SDN controller (hop by hop provisioning) and in case of implicit SDN controller contacts only OTS of different networks of MPLS , Ethernet, GMPLS etc respectively. In indirect model OTS converts into local addressing this thus this implicit model allows any type of hybrid network control model.

V. CONCLUSION

This paper concludes that an implementation of coherent technology using super channel based on high performance photonic integrated circuits improves the spectral efficiency. On hybrid combination of multiplexing technique and digital network made transport network architecture operationally scalable, convergence, and automated

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