Name of Course : E1-E2 CFA

Chapter 14

Topic : NG SDH & MSPP

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NGN SDH and MSPP

1. Introduction:

Innovation, the lifeline to survival in the telecommunication market, has spurred the telecommunication industry to adopt NGSDH as the most economic and technologically feasible solution for transmitting voice & data over carrier network. The new applications, mostly relying on data packet technology, offer easy implementation and access to applications based on the Internet, Mobile, Multimedia, DVB, SAN, Ethernet or VPN. The architectures are increasingly demanding long haul transport that today can only be provided by SDH/SONET. These technologies have a massive installed base, developed over recent decades. SDH/SONET has now evolved, and is ready to adapt to the new traffic requirements.

Next Generation SDH enables operators to provide more data transport services while increasing the efficiency of installed SDH/SONET base, by adding just the new edge nodes, sometime known as Multi Service Provisioning Platforms (MSPP) / Multi Service Switching Platforms (MSSP), can offer a Combination of data interfaces such as Ethernet, 8B/10B, MPLS(Multi Protocol Label Switching) or RPR(Resilient Packet Ring), without removing those for SDH/PDH. This means that it will not be necessary to install an overlap network or migrating all the nodes or fiber optics. This reduces the cost per bit delivered, and will attract new customers while keeping legacy services. In addition, in order to make data transport more efficient, SDH/SONET has adopted a new set of protocols that are being installed on the MSPP/MSPP nodes. These nodes can be interconnected with the old equipment that is still running

.

2. What is Next Generation SDH?

Following major issues that exist in the legacy SDH:

- Difficulty of mapping newer (Ethernet, ESCON, FICON, Fiber Channel etc) services to the existing SDH transport network.
- Inefficient use of the transport network in delivering data services.
- Inability to increase or decrease available bandwidth to meet the needs of data services without impacting traffic.

Three mature technologies—

- Generic Framing Procedure (GFP), ITU-T G.7041
- Link Capacity Adjustment Scheme (LCAS), ITU-T G.7042
- Virtual Concatenation (VCAT), ITU-T G.707

-Together in <u>Next generation SDH</u> solved the above issues and adding three main features to traditional SDH:

1. Integrated Data Transport i.e. Ethernet tributaries in addition to 2Mb, 140 Mb, STM-1, 4,16 ----**GFP**

2. Integrated non blocking, wide-band cross connect (2Mb granularity) making the efficient use of the transport network in delivering data services ---**VCAT**

3. Dynamic Bandwidth allocation, Intelligence for topology discovery, route computation and mesh based restoration------**LCAS**

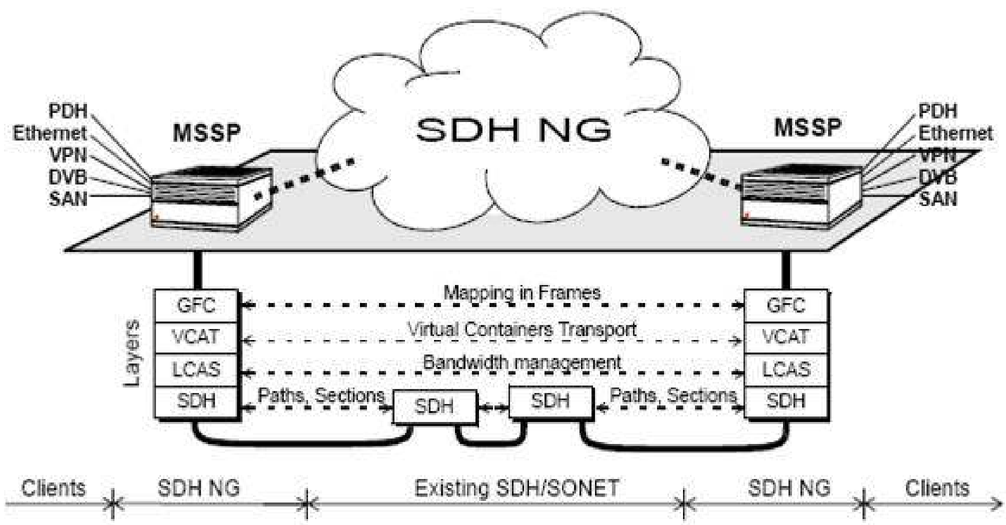

Fig. 1 Block Diagram of NGSDH

Next Generation SDH is Packet Friendly and has IP router like capabilities. It does not matter if the client stream has constant or variable bit rates.

"VCAT provides more granularity, LCAS provides more flexibility and GFP efficiently transports asynchronous or variable bit rate data signals over a synchronous or constant bit rate".

Hence,

Next Generation SDH = Classic SDH + [GFP+VCAT+LCAS]

3.0 Components of Next Generation SDH: -

3.1 Generic Framing Procedure (GFP):

Generic Framing Procedure (GFP), an all-purpose protocol for encapsulating packet over SONET (POS), ATM, and other Layer 2 traffic on to SONET/SDH networks. GFP is defined in ITU-T G.7041 along with virtual concatenation and link capacity adjustment scheme (LCAS) transforms legacy SDH networks to Next generation SDH networks.

GFP adds dynamism to legacy SDH. GFP is most economical way of adopting high-speed services, constant bit rate and variable bit rate, in SDH networks and can provide basis for evolving RPR. It provides a flexible encapsulation for both block-coded and packet oriented data units (PDU) as shown in fig.

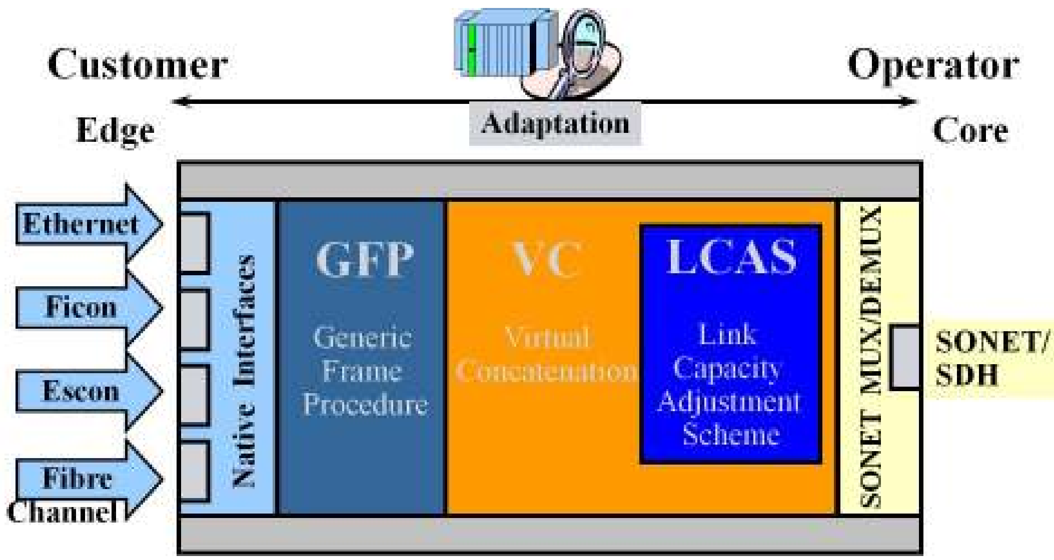

Fig. 2 Functional Model of GFP

There are actually two types of GFP mechanisms: -

1. PDU-oriented known as Frame mapped GFP (GFP-F)
2. Block-code-oriented known as Transparent GFP (GFP-T)

1. GFP-F: -

GFP-F (Framed) is a layer-2 encapsulation in variable sized frames. Optimised for data packet protocols such as DVD, PPP and Ethernet, MPLS etc Frame mode supports rate adaptation and multiplexing at the packet/frame level for traffic engineering. This mode maps entire client frame into one GFP frames of constant length but gaps are discarded. The frame is stored first in buffer prior to encapsulation to determine its length. This introduces delay and latency.

2. GFP-T:

GFP-T is useful for delay sensitive services. GFP-T (Transparent) is a layer 1 encapsulation in constant sized frames. Optimised for traffic based on 8B/10B codification such as VoIP, DVB-ASI, 1000BASE-T, SAN, Fibre Channel, and ESCON.

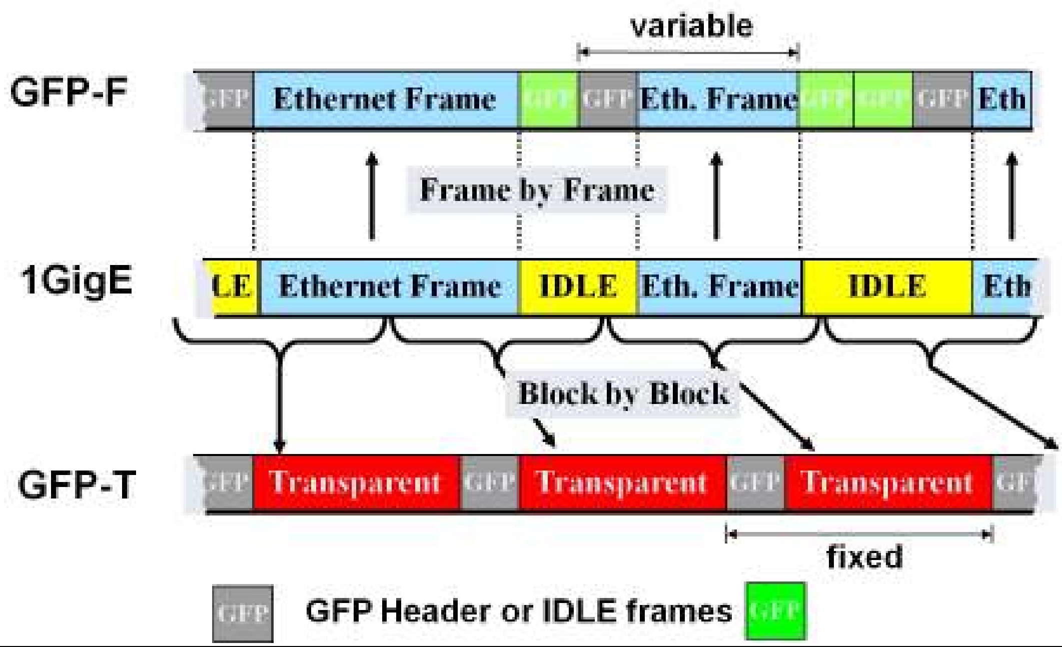

Fig. 3 GFP-F & GFP-T

Transparent mode accepts native block mode data signals and uses SDH frame merely as a lightweight digital wrapper. GFP-T is very good for isocronic or delay sensitive protocols &SAN (ESCON). GFP-T is used for FC, Gigabit Ethernet etc.

3.2 CONCATENATION (V-CAT & C-CAT):

SDH concatenation consists of linking more than one VCs to each other to obtain a rate that does not form part of standard rates. Concatenation is used to transport payloads that do not fit efficiently into standard set of VCs.

Two concatenation schemes are:

1. Contiguous concatenation
2. Virtual concatenation

Data Rates	Efficiency w/o VC	using VC
Ethernet (10M)	VC3 ⇨ 20%	VC-12-5v ⇨ 92%
Fast Ethernet (100M)	VC-4 ⇨ 67%	VC-12-46v ⇨ 100%
ESCON (200M)	VC-4-4c ⇨ 33%	VC-3-4v ⇨ 100%
Fibre Channel (800M)	VC-4-16c ⇨ 33%	VC-4-6v ⇨ 89%
Gigabit Ethernet (1G)	VC-4-16c ⇨ 42%	VC-4-7v ⇨ 85%

Fig. 4 - VCAT Efficiency

i. Contiguous concatenation:

The traditional method of concatenation is termed as contiguous. This means that adjacent containers are combined and transported across the SDH network as one container. Contiguous concatenation is a pointer-based concatenation. It consists of linking N number of VCs to each other in a logical manner within the higher order entity i.e. VC4 and above. The concatenated VCs remain in phase at any point of network. The disadvantage is that it requires functionality at every N/E adding cost and complexity. Lower order VCs (VC-12, VC3) concatenation is not possible in contiguous concatenation as shown in Fig.

ii. Virtual Concatenation:

Virtual concatenation maps individual containers in to a virtually concatenated link. Any number of containers can be grouped together, which provides better bandwidth granularity than using a contiguous method. It combines a number of lower/higher order VCs (VC-12, VC3 & VC4 payload) that form a larger concatenation Group, and each VC is treated as a member. 10 Mb Ethernet would be made up of five VC-12s, creating these finely tuned SDH pipes of variable capacities improve both, scalability and data handling/controlling ability as per SLA (service level agreement).

The transport capacity with or without VC is shown in Fig. 4

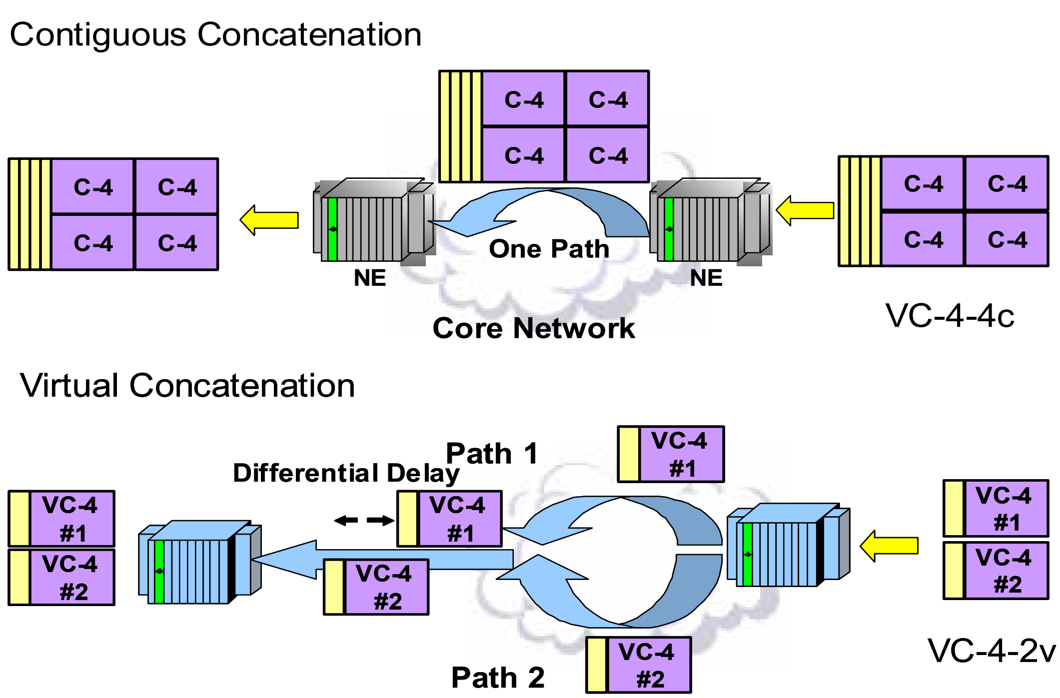

Fig. 5 - *Virtual* & Contiguous Concatenation

VCs are routed individually and may follow different paths, within the network, only the path originating and path terminating equipment need to recognize and process the virtually concatenated signal structure as shown in Fig. 5

Virtual concatenation Benefits:

1. Use the same core NEs, modify only edge NEs.
2. Low investment and fast ROI (return on investment).
3. Efficient & scalable i.e. fine granularity and multi-path capability.
4. SDH gives best QoS, well engineered and reliable.

3.3 Link Capacity Adjustment Scheme (LCAS):

Link Capacity Adjustment Scheme (LCAS) is an emerging SONET/SDH standard and is defined in ITU-T G.7042 having capability to dynamically change the amount of bandwidth used in a virtually concatenated channel i.e. bandwidth management flexibility. LCAS is bi-directional signaling protocol exchanged over the overhead bytes, between Network Elements that continually monitors the link. LCAS can dynamically change VCAT path sizes, as well as automatically recover from path failures. LCAS is the key to provide “bandwidth on demand”.

LCAS enables the payload size of VCG (group of VCs) to be adjusted in real time by adding or subtracting individual VCs, from VCG dynamically, without incurring hits to active traffic. In LCAS, signalling messages are exchanged between the two VCs end points to determine the number of concatenated payloads and synchronize the addition/removal of SDH channels using LCAS control packets.

Benefits of LCAS: -

A. Call by call bandwidth (Bandwidth on demand)

Customer

⇨ rents a 6Mb Internet connection (VC-12-3v)
⇨ calls to get additional 2Mb

Operator

⇨ will provision additional VC-12 path
⇨.and will <u>hitless</u> add it to existing connection via <u>LCAS</u>!

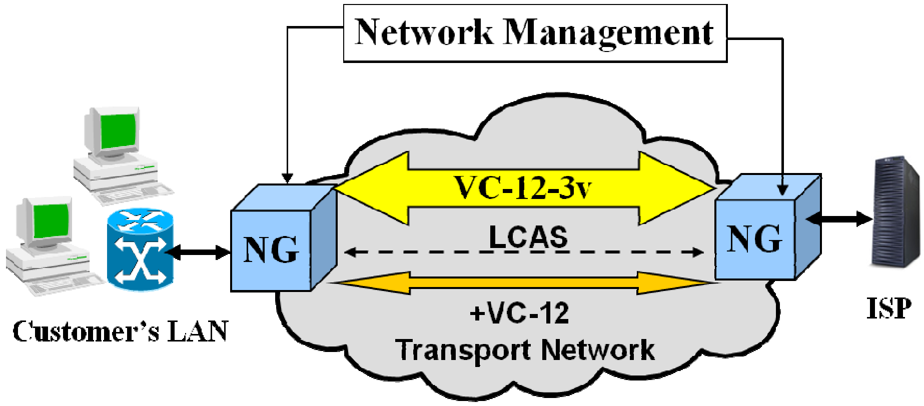

Fig. 6 Bandwidth call by call

B. Bandwidth on Schedule

A customer is offered a fixed bandwidth of 100 Mb (VLAN) Ethernet, allotting 46 VC-12 (0ne VC12 = 2.176 Mb x 46 = 100.1 Mb). Every night for one-hour additional 900 M ESCON service is provisioned by LCAS. New revenue opportunity at low traffic hours

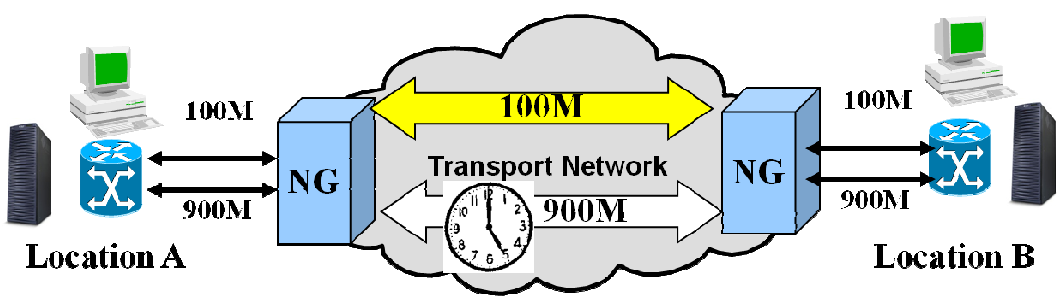

Fig. 7 Bandwidth on scheduled Time

LCAS is not only used for dynamic bandwidth adjustment but also for survivability options for next generation SDH. LCAS is a tool to provide operators with greater flexibility in provisioning of VCAT groups, adjusting their bandwidth in service and provide flexible end-to-end protection options. LCAS is defined for all high and low order payloads of SDH.

4. CONCLUSION

The biggest advantage of Next Generation SDH is that it allows network operators to introduce new technology into their existing SDH networks by replacing only the edge NEs. New technologies now allow service providers to bring greater efficiency and flexibility to these existing networks for data transport. With this capability, both TDM and packet oriented services are handled efficiently on the same wavelength. Using GFP to map data services to the SONET/SDH infrastructure is the first step in using this investment by making it data friendly. The injection of VCAT further increases the value of the network by right-sizing network capacity to match native data rates and using what otherwise would be stranded bandwidth. VCAT's capability to provide very granular bandwidth. The addition of LCAS further enhances the value of VCAT by allowing service providers to make bandwidth adjustments to meet customers' changing needs in a manner transparent to customers.

Multi-service Provisioning Platform (M S P P)

MSPP is deployed in the boundary of Access and Metro core backbone. TEC has prepared two different platforms for catering to the needs of the inter city and intra equipment. The first platform is the STM-16 with the GFP-F, GFP-T protocols and layer-2 switching functionality and caters to the need of inter-city traffic. This platform also includes higher cross connect capability, and supports EoS as per IEEE standards. The second platform is using Multi service Provisioning Platform (MSPP), and caters to the need for the intra-city traffic requirements.

The main application of this system shall be for multi-service traffic switching and aggregation at MAC layer, traffic grooming and traffic consolidation of TDM traffic at SDH layer from access network towards core network. Another prominent application of MSPP shall be, multiple SDH ring inter connection at STM1 tributary interfaces as well as at STM4 & 16 aggregate interfaces. The equipment shall provide an integrated cross connect matrix to switch digital signals at SDH layer.

The MSPP equipment shall be capable of simultaneously interfacing the PDH streams and mapping / de-mapping into SDH payloads and vice-versa, thus enabling the co-existence of SDH & PDH on the same equipment. This is the greatest advantage for the network as SDH and PDH existing in the present network can integrate easily which in turn enables quick bandwidth provisioning to the customer.

MSPP is implemented with two different back haul transmission rates, viz. STM-16 and STM-64. TEC has also been working on the STM-64 in BSNL Metro networks. Apart from the standard interfaces on the tributary side, the revised STM-16 provides POS (packet over SDH) capability on Ethernet interface at 10Mb,100 Mb, and 1000Mb. The equipment is also envisaged to support DS-3 of SONET. The encapsulation of Ethernet on SDH capability shall be in accordance with ITU-T G.7041. the system should support Tandem Connection Monitoring (TCM) on N1 byte and N2 byte for HO path & LO path respectively.

ADMs supporting GFP and VCAT are known as Multi Service Provisioning Platform (MSPP). Service providers can now deliver packet based transport services using existing SDH infrastructure. GFP and VCAT is located at the endpoint s of the network, therefore MSPP need only be deployed at the edge of the transport network. MSPP targets all application connecting ultra-high capacity backbones to end customers at their premises. The advent of GFP has created a spur of customer located equipment and MSPP cards that function as aggregating Ethernet traffic onto SDH rings. The generic structure of a next generation MSPP is shown in (fig 8). This platform consists of the integration of metro WDM with Ethernet /RPR and SDH VC-4 switching fabrics. Integration means both direct inter working, in terms of WDM wavelengths, and full NMS/control plane integration for management and path provisioning.

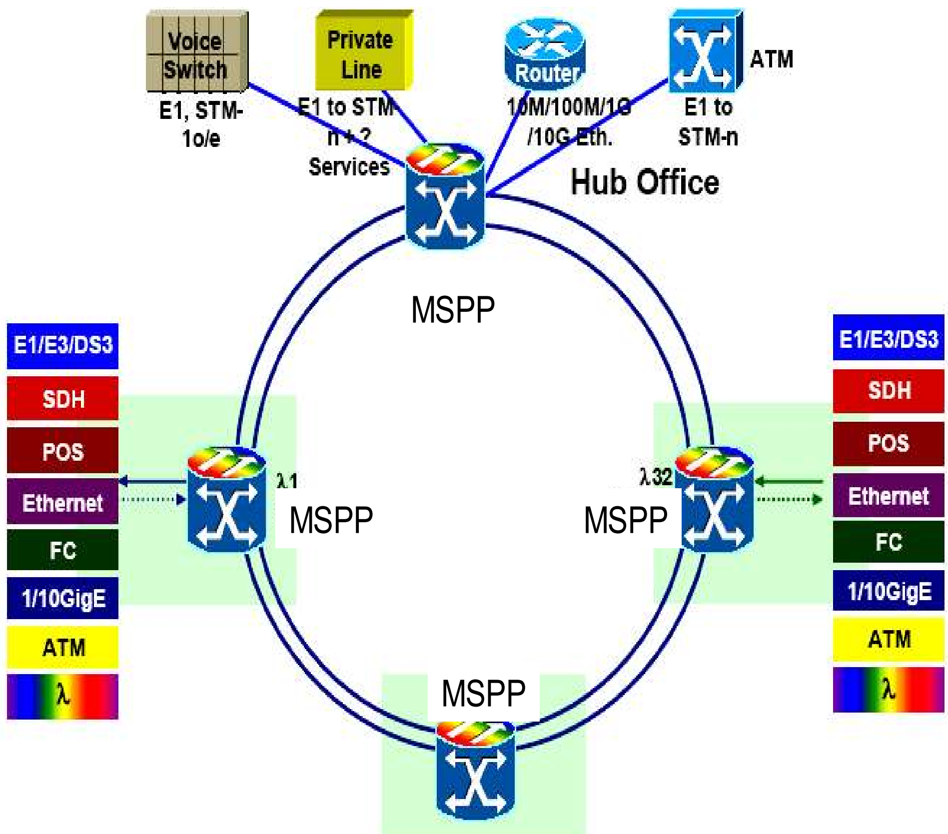

Fig 8 MSPP Applications

Features of MSPP:

The major features of MSPP are as listed below:

1. Generic Framing Protocol-Frame (GFP-F)
2. Generic Framing Protocol-Transparent (GFP-T)
3. Link Capacity Adjustment Scheme (LCAS).
4. Virtual concatenation (V-CAT)

5. Layer 2 switching.
6. Integrated higher cross connect capability
7. Ethernet on SDH (EoS)
8. PoS capability on Ethernet interface
9. DS-3 tributary interface
10. Support block code oriented payload (FICON)
11. ESCON (Enterprise system connection)
12. FC (Fiber Channel) at gigabit Ethernet interface
13. Tandem Connection Monitoring (TCM) on N1 & N2 bytes
14. Multi service traffic switching
15. Traffic aggregation at MAC layer
16. Traffic grooming
17. Traffic consolidation of TDM traffic at SDH layer from access towards core network.
18. Multiple SDH rings interconnection at STM-1tributary interfaces as well as at STM-4/16 aggregate interfaces.
19. Interfacing the PDH streams (2Mb, 34Mb, 140Mb) and mapping / De-mapping into SDH payloads and vice-versa.

Key Technologies

Key sets of technologies for delivering client services efficiently via MSPP are:

- Generic Framing Procedure (GFP), ITU-T G.7041
- Link Capacity Adjustment Scheme (LCAS), ITU-T G.7042
- Virtual Concatenation (VCAT), ITU-T G.707

VCAT is used to provide better data granularity, GFP is used to wrap the data in a converged TDM network, & LCAS is used to dynamically allocate& manage B/W.

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