TransPacket
white paper

Fusion networking explained

11.06.2012

Bringing true circuit and packet properties to the packet network

Executive summary

Ever increasing IP traffic with the resulting demand for greater capacity of the underlying Ethernet network has compelled most telecom operators to install IP/MPLS in their network core. This transfer to packet based networks brings higher throughput efficiency and lower costs, and has inevitably led to the replacement of legacy SDH/SONET circuit switched equipment. Whilst this fundamental shift has been necessary, the established operational advantages of SDH/SONET transmission – guaranteed Quality of Service (QoS), fast protection switching and minimal delay – are still essential and are becoming more vital as the range and demands of applications increase. In response for the real need of these features, packet network designers have introduced a variety of advanced networking protocols and QoS mechanisms which have inevitably increased both hardware and software complexity and correspondingly increased cost. Furthermore these techniques often result in proprietary solutions which dilute the benefits of competition. As a result MPLS networks have high CAPEX and OPEX and demand advanced levels of expertise to implement and manage, and often require sophisticated and expensive management and provisioning software.

The TransPacket Fusion approach (or “integrated hybrid network”) is a disruptive technology solving the problem of providing packet networks with the advantages of circuit switched networks. The Fusion approach combines the best of packet and circuit switching.

Meeting the network challenge with fusion networking

SUPPORTING ALL APPLICATIONS IN A SINGLE NETWORK

Traffic volumes in both fixed and mobile networks are expected to continue to increase exponentially over the next few years. It is already established that video services will form a large part of this increased traffic demand and that these services cannot tolerate data loss or significant delay variations and so demand a higher QoS than many other forms of data transfer. Mobile back-haul networks like e.g. LTE, have strict demands to synchronization and timing, while networks for high-frequency trading require ultra-low latency, all challenges which can be solved with a true circuit type of QoS. The high throughput efficiency known from packet switched networks is however also required for ensuring cost-efficiency of the network. To satisfy all these demands in a multi-service network, networks must have high throughput efficiency as well as an effective QoS capability which includes a no data-loss and strict timing-requirements option.

The Fusion network technology provides all of these requirements by a combination of circuit and packet techniques in an integrated way. Figure 1 illustrates how the best properties of packet and circuit switching are integrated in Fusion equipped network.

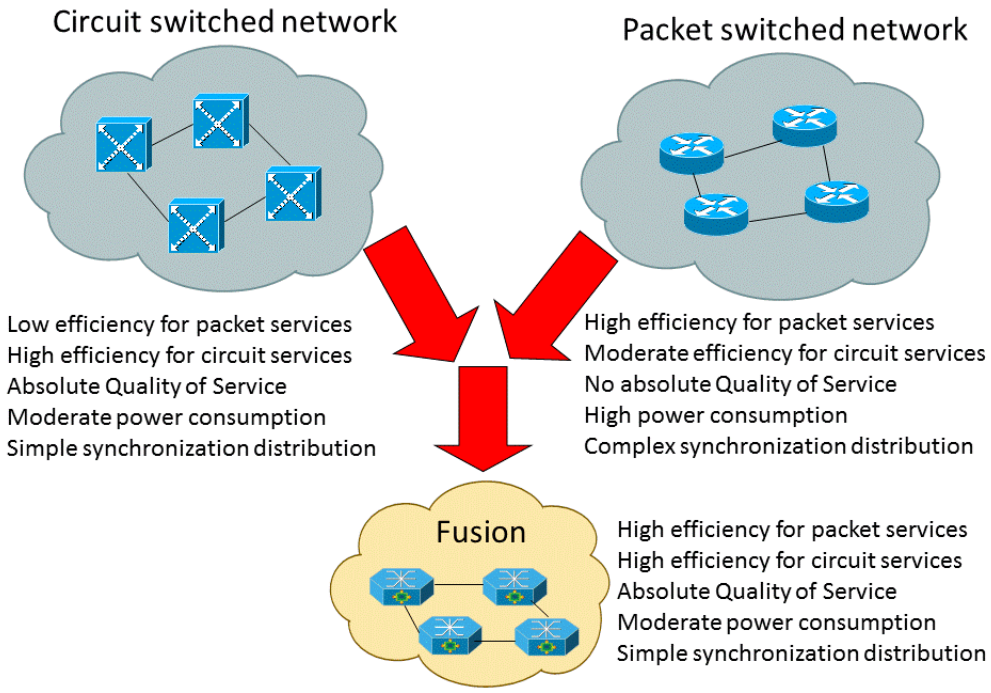


Figure 1, Combining the best properties of circuit and packet switching in the Fusion network.

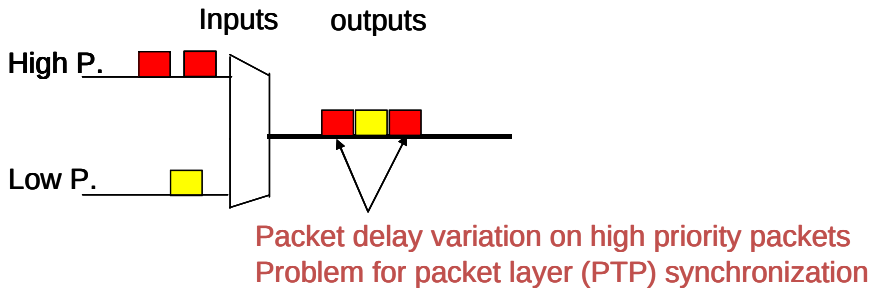
Fusion network principle

Imagine a train service between two cities which does not stop at any of the intermediate stations along the route. This direct express train service represents the properties of circuit switching: minimum latency, no delay variation and no packet (passenger) loss. Once on the train and in their seat, passengers are guaranteed a ride, with no stopping delays, all the way to the city where the train terminates. However, if this express train is not full and there are too few inter-city passengers, train capacity will not be efficiently utilised and, of course, passengers wanting to travel to and from intermediate stations are ignored.

Now imagine a train stopping at every station where passengers are obliged to leave the train at every station and wait in line with passengers waiting to board the train. Only when all the passengers are in a neat line on the platform and have been checked in are they allowed to enter the train for its next part of the journey - and only if there are sufficient seats: this is an analogy of a packet switched network.

Train capacity is more efficiently used, passenger flows from all stations are aggregated and seats vacated by passenger leaving the train are likely to be used by new passengers joining at intermediate stations. But the travelling experience has suffered especially for the inter-city passengers as the journey takes longer with delay variations resulting from the queuing and checking at station stops and at busy times some passengers may not be able to get on the train at all and so are "lost".

Strict Priority QoS scheduling applied in routers and packet switches



Fusion scheduling

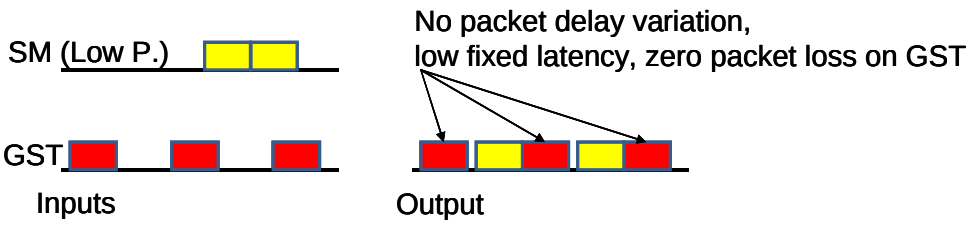


Figure 2, Upper figure shows strict priority QoS scheduling in packet switches and routers. If two packets of low and high priority arrive simultaneously, the low priority packet will be scheduled as soon as the high priority queue is empty. If a high priority packet is arriving during scheduling of a low priority packet, it will be delayed until the low priority packet has been scheduled. Hence packet delay variation (PDV) occurs on high-priority packets. Lower figure illustrates the fusion scheduling where low priority SM packets are inserted only if there is a vacant gap between the high-priority GST packets. Hence, PDV and packet loss is avoided on GST packets.

The train analogy for a Fusion network is simple to state, but more difficult to imagine for real passengers. We now have the express inter-city train which does not stop at any intermediate stations, but somehow at the right time passengers waiting at intermediate stations are accelerated to the speed of the train and placed on their seats and those wanting to get off are extracted and decelerated and left safely on the platform. Performing this with packets is much more feasible than with real passengers and represents the Fusion approach with the best features of both packet and circuit networks. The network (train) capacity is efficiently utilised and no packets are lost and there is a minimum and fixed latency (i.e. no packet delay variation). If the network is busy, some packets (passengers) at intermediate nodes may not be transmitted and this represents the situation for lower priority statistical multiplexed services.

The Fusion network accommodates Guaranteed Service Transport (GST) paths which are transparent Ethernet lines with wavelength grade (high) QoS. This line connection has the same properties and advantages as a circuit switched network with only light processing of the packets and low cost overhead. The Fusion network also allows statistically multiplexed (SM) traffic to be aggregated onto the network using the spare capacity not used by the transparent Ethernet lines and these are called SM paths. Figure 2 shows how the GST packets on the transparent Ethernet lines are left untouched whilst the SM packets are inserted in spare slots between the GST packets, avoiding Packet Delay Variation (PDV) and packet loss on the GST packets.

Comparing transport solutions

The conventional MPLS network approach is to deploy routers or switches at the edge of the network and to interconnect these with an optical transmission network to MPLS core routers as shown on Figure 3. This enables statistically multiplexed aggregation and transport of services to be distributed throughout the network. However, this has the disadvantage of needing a large number of routers and/or switches with advanced functionality as well as additional transmission equipment to provide direct wavelength services. Also each of these switches/routers need configuration, potentially resulting in a large number of nodes to configure with an even larger number of parameters.

A better approach - more flexible and cost effective - removes switches/routers from the network edge and uses fewer and larger routers at the centre of the network core. There are fewer routers to configure and it becomes economic to invest in more expensive routers able to provide advanced service features. Ideally, the centralised router or switch should be connected to the access points by links capable of transmitting any data format enabling L1, L2 or L3 services. The various access points may span a large variety of applications and services such as mobile base stations, enterprise customers, DSLAMs, service –provider transport, etc. A transparent Ethernet link can be provided either directly on a wavelength via the WDM optical equipment or, alternatively, on the Fusion network by provisioning a virtual wavelength and a transparent Ethernet line. Both means represent a valid method of providing transparent and secure connections and enabling L1, L2 or L3 transport services. However, the Fusion network approach is more bandwidth efficient and cost effective than dedicated fibres or wavelengths in a WDM system as any spare capacity can be used to transport statistically multiplexed (SM) services. Still, the QoS characteristic of the wavelength is maintained in the GST transport.

Both the GST transparent and SM paths are provisioned through the management system and hence are dynamically provisioned. This centralised approach using Fusion nodes is shown in Figure 4. For legacy TDM services wavelength transport may be preferable and this is also handled by the fusion optical network node, avoiding the need for additional optical nodes.

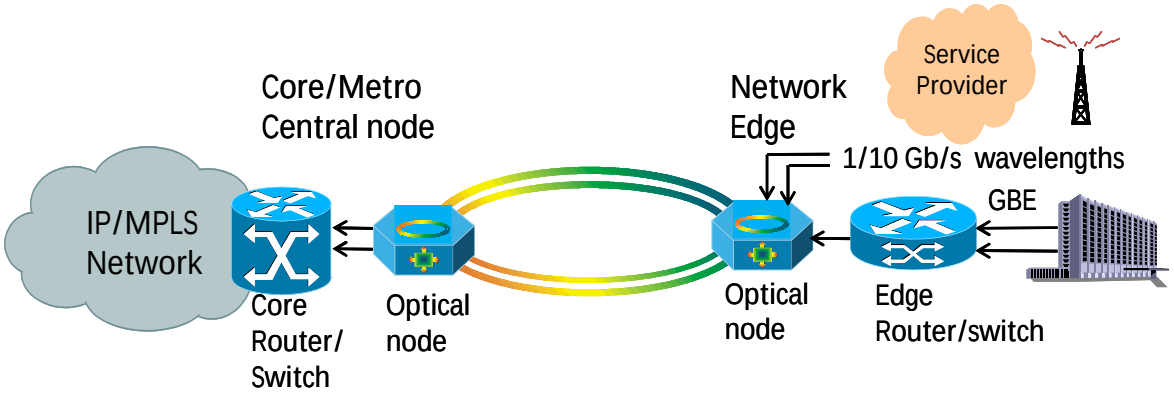


Figure 3, Network with access edge routers or switches and optical nodes for wavelength transport of critical services.

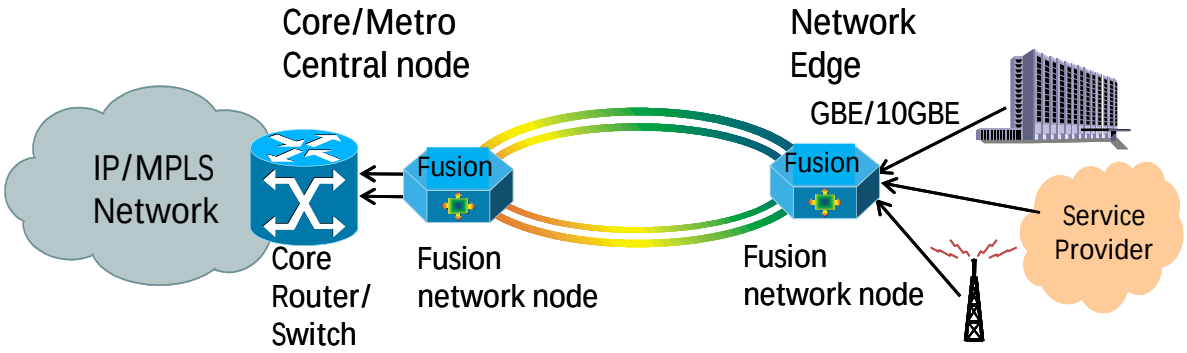


Figure 4, Cost efficient and flexible Fusion network using centralized router/switches in a central node and Fusion network nodes at the edge of the network for both multiservice transport and aggregation. Aggregated traffic from e.g. business users is transported in SM paths. Critical services are utilizing the virtual wavelength function available on transparent Ethernet lines. Legacy or 10GE services may benefit using separate wavelengths. All demands are handled by the transparent Ethernet node and additional nodes for optical transport are not required.

H1 Fusion network muxponder properties

The H1 Fusion network muxponder from TransPacket is an Ethernet based product with 10 X 1GE (Gigabit Ethernet) client interfaces and 2 X 10GE (10 Gigabit Ethernet) line interfaces. The 10GE line-interfaces can be applied for resilience services to give 1+1 or 1:1 protection or they can be used for East-West interfaces enabling add/drop functionality of transparent Ethernet lines and SM paths in a ring topology. Each of the GE client interfaces is dynamically configurable as either transparent Ethernet lines or SM paths respectively.

Figure 5 illustrates the combined GE aggregation (SM) and GE transparent Ethernet line transport (GST). The network can be configured with up to 8 X transparent Ethernet lines and 10 X SM paths for each wavelength. The transparent Ethernet lines are guaranteed to be 1Gbps for each interface whilst for the SM paths capacity is shared and the total capacity depends on the number of assigned transparent Ethernet lines as well as the traffic load on these lines. This gives a maximum capacity of 10Gbps for the SM paths and a minimum capacity of 10Gbps – number of assigned transparent Ethernet lines.

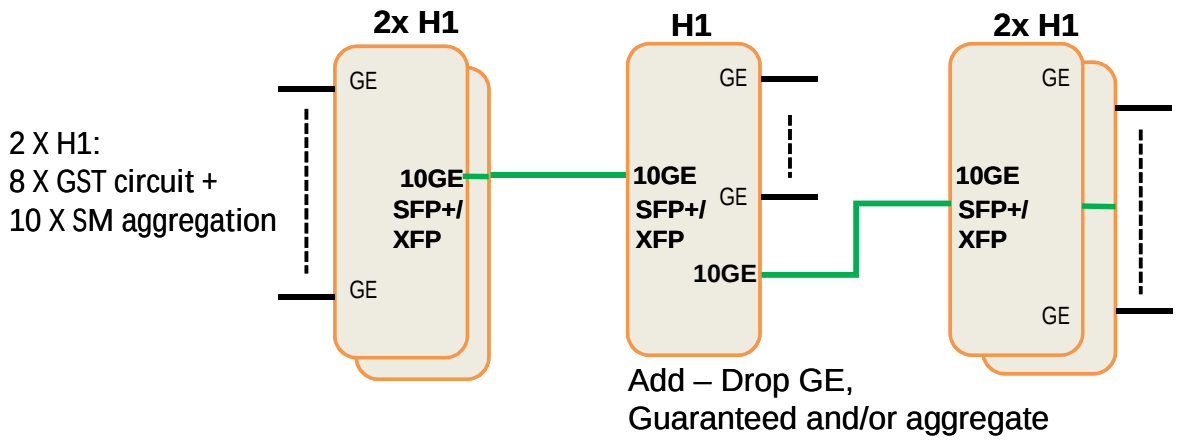


Figure 5, Combining bandwidth-efficient aggregation (SM) and transparent Ethernet line transport (GST) in a transparent Ethernet network. The transparent Ethernet lines can e.g. enable virtual wavelengths, replacing GE transport over wavelengths in an existing WDM network.

Aggregation requires the handling of bursty traffic patterns with short traffic peaks and while large core routers have adequate buffering capacity smaller enterprise switches and routers have shorter buffers to reduce costs. If these smaller routers are used in a multiservice network packet loss on services with an assigned high quality of service may occur. The H1 SM aggregation interfaces have high buffering capability similar to high end routers and so avoiding packet loss caused by shallow routers.

A future proof solution

The ability of an H1 Fusion network to offer virtual wavelength links provides a future proof solution for modern day networks. Only a few years ago, transport of synchronisation signals across packet networks was not even considered a requirement by network operators. With the migration from SDH networks to all packet-based Ethernet networks together with the growth of new mobile applications, synchronisation, low latency and packet delay variation have now become vital requirements. These characteristics were inherent in SDH/SONET circuit networks and now the H1 Fusion provides these essential features and so meets the requirements of the IEEE 1588 network synchronization as well as synchronous Ethernet (G.8262).

Summary and product comparison

Table 1 compares the properties of the H1 transparent Ethernet muxponder with other available product categories. Transparent Ethernet lines are fully compatible with IEEE 802.3 Ethernet standards and these are realised on virtual wavelengths and so can support transport across service layers: L1, L2 and L3. Statistically multiplexed aggregation is added on top of provisioned transparent Ethernet lines to give high bandwidth utilisation and cost efficiency.

Support of demanding services such as broadcast quality video, video-conferencing and mobile backhaul is performed through the high performance transparent Ethernet line transport and synchronous Ethernet. Less demanding, lower bandwidth applications are supported at high bandwidth efficiency by using

statistical multiplexing aggregation. As can be seen, H1 provides a unique combination of properties not usually found with a single network technique.

	Hybrid Muxponder	L1, Circuit Muxponder	Ethernet muxponder	L2, Layer 2 switch	L3, Layer 3 router
Transparency	Yes	Yes	No	No	No
Latency	Low	Low	Moderate	Moderate	High
Packet Delay Variation	Zero or Negligible	Low	High	High	High
Packet loss	No (On hybrid lines) Yes (when congested on SM aggregation interfaces)	No	Yes, when congested	Yes, when congested	Yes, when congested
Aggregation	Yes	No	Yes	Yes	Yes
Dynamic Bandwidth utilization on circuit paths	Yes	No	N.A.	N.A.	N.A.
Absolute QoS	Yes	Yes	No	No	No
Power	Low	Moderate	Moderate	Moderate	High
1U size	Yes	Yes	Yes	Yes	Yes

Table 1, Overview of properties of L1, L2 and L3 product categories.

Conclusion

The Fusion network technology is a disruptive approach that enables a new era of cost-effective and flexible networking through its unique combination of virtual wavelength provision, high bandwidth utilisation and unbeatable QoS properties. It provides a future proof solution with backwards compatibility achieved by preserving the performance characteristics of legacy SDH/SONET networks whilst combining the efficiency of packet networks and conformance of Ethernet standards.

Increasingly network operators are being required to provide new services such as broadband mobile, video and transmission for cloud services without significant additional expenditure on their network CAPEX or OPEX. The Fusion network approach meets these exacting requirements by combining the best properties of circuit and packet networks and results in a more flexible and cost effective solution than conventional approaches relying on existing L1, L2 or L3 equipment.

Fusion networking: A future proof solution combining the best properties from the worlds of circuit and packet switching.