FS0 in the cellular backhaul – “banishing the bandwidth blues”

Free Space Optics (FSO) already plays a key role in cellular networks, providing cost-effective and quickly deployable connections between base stations and the nearest network switching node. Indeed, the reliability and low cost of the technology has made it a popular option, with GSM operators worldwide.

With the growth of GPRS and the debut of 3G data services, a new wave of backhaul deployment is under way. As base-station densities increase, more cost-effective and flexible systems are required to serve shorter site-to-site distances. As well as supporting the evolution to 3G mobile technology, backhaul networks must also provide additional capacity to meet the increased traffic demands resulting from new content-rich mobile data services. Also, operators need equipment that can be installed rapidly to meet market demand.

Efficient backhauling

In this new environment, the flexibility and ease of implementation of FSO systems offer an efficient and future-proof way of backhauling voice and data traffic. It is vital that FSO systems evolve to handle more dynamic traffic patterns and provide increased capacity. The systems can be optimised where a crowded radio spectrum limits the deployment of microwave technologies. Furthermore, they must enable operators to respond quickly to changing market conditions, while maximizing network availability, quality of service (QoS) and security to boost and protect revenue.

These goals are difficult to achieve using the current backhaul architectures alone. A number of new transmission technologies are needed, and some new network design and management techniques. Operators must also adopt an end-to-end view of the network to achieve maximum efficiency and return on investment.

With PAV FSO systems, the ability to deploy quickly and scale across the backhaul infrastructure has enabled PAV, over the years, to build an impressive client list of GSM operators utilising their technology. With a product range scaleable from E1, through multiple 4E1-63E1 and onto STM1 and STM4, PAV have the complete product suite to meet the ever increasing demands of the GSM operators. A skilled and experienced Research and Development team of engineers are constantly and consistently ensuring PAV technology is at the forefront of FSO. Providing greater reliability and availability ensures PAV’s FSO technology is delivering flexible bandwidth where the users demand.

Traditionally, PTP systems have been complemented with additional equipment to build a complete network. However, the relentless drive to reduce cost and improve quality and control has led to the creation of smart traffic nodes by introducing more traffic-handling features into the access network.

As the traffic generated by voice and data services increases, a combination of FSO and microwave solutions can provide a highly cost-optimized and spectrum-efficient solution for backhauling 2G and 3G networks. The combination - when deployed with synchronous digital hierarchy (SDH) equipment and an integrated management system - creates a unified, fully integrated and cost-effective system. Key benefits of this architecture are a high degree of network control and efficient operation. These features enable mobile operators to match their investment in transport facilities to the volume and nature of the traffic being handled at any point in the network.

PW Comms (UK) Ltd
Summit House
35 Church Road
Lymm
Cheshire. WA13 0QS
Tel: +44 (0) 1925 751638 - Fax +44 (0) 7092 808191

www.pavdata.com
pav@pwcomms.co.uk

Reducing the cost for operators

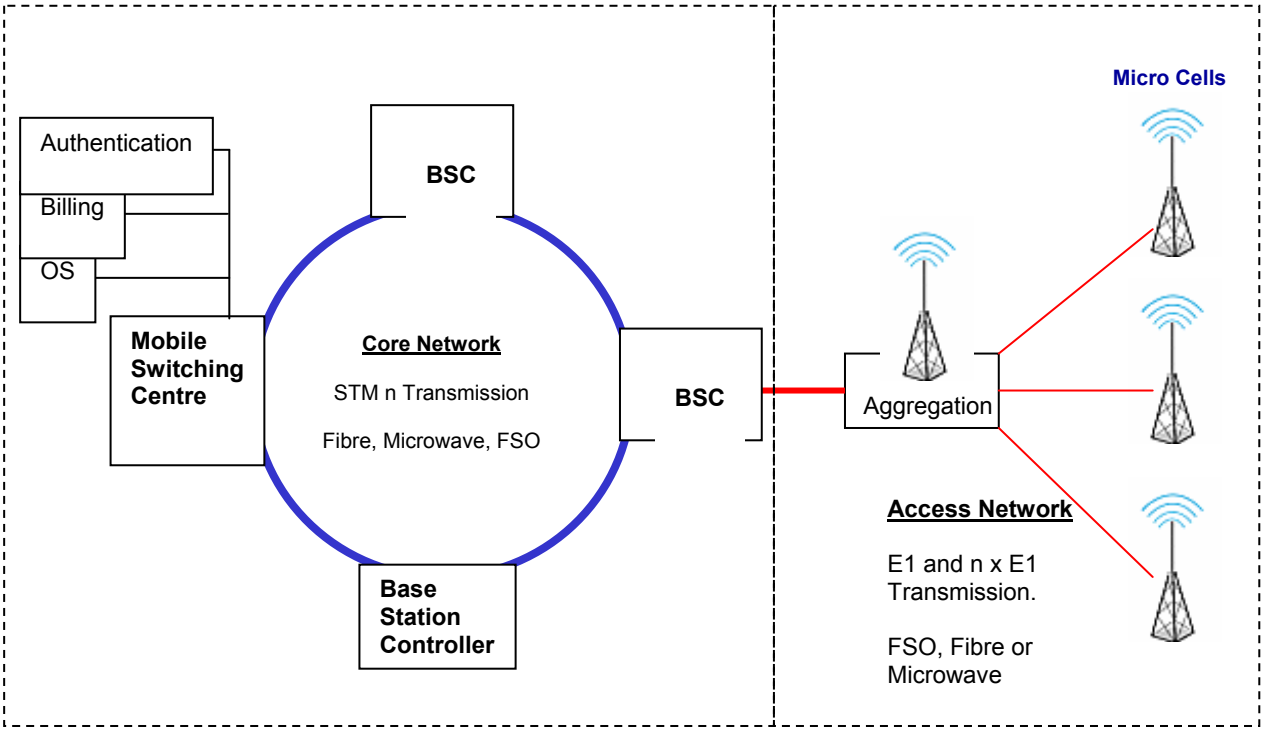
Traffic aggregation is an important factor in any end-to-end network design. How and where it is performed in the mobile transport network has an impact on the overall flexibility and efficiency of the network, which in turn affects long-term operating expenditure and profitability.

In combined FSO/microwave transport networks, the choice is between traditional E1 aggregation and ATM aggregation. Any decision will depend on a number of factors, including network density, nature of the traffic being handled, licensed spectrum availability and fixed line plant availability.

E1 aggregation using PTP links is suitable for hubs where the number of connected base stations is low and bandwidth requirement is relatively low, typically up to 34Mbps (16 x E1). ATM aggregation is suitable for hubs with a greater number of connected base stations and the bandwidth requirement is much higher, typically 155Mbps. PTP systems are used to connect aggregation nodes to one another and to switch sites. Access networks tend to have star and hierarchical star configurations with the backbone/core networks having ring configurations.

E1 aggregation is widely used in 2G mobile networks. A network based on E1 multiplexing nodes requires low initial investment and offers a clear upgrade path with minimal disturbance to existing traffic. It is likely to remain the most efficient solution for 3G operators with networks that continue to be dominated by 2G-like traffic. It is a suitable option for operators that wish to reuse as much of their existing networks as possible by using spare capacity - either on the FSO/Microwave access network or on STM-1 backbone rings. This helps operators who use many leased lines to reduce operating costs.

Back-haul in 2G/3G Networks



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Low and medium capacity aggregation nodes can handle between two and four base stations. These nodes are usually employed where base-station density is low and the distances between base stations are great. FSO can be used for the node – base station connection depending on the distance. High-capacity aggregation nodes are suited to urban or suburban areas where base-station density is high and distances short where FSO connection systems can be used without using up valuable licensed microwave spectrum. The high availability of FSO links makes them highly suitable for ATM and Internet protocol (IP) transport.

The main shortcomings of early E1 aggregation schemes are the limited potential for expansion, which can increase operating cost in the longer term as networks increase in capacity and complexity. Fortunately, systems for more efficient E1 aggregation are now available for FSO/microwave networks. These merge digital cross-connect equipment with FSO/microwave link traffic in smart traffic nodes. They are able to aggregate traffic from multiple links into one common platform, and also offer better opportunities for expansion due to their modular architecture.

Smart traffic nodes such as the “PAVMux Broadband Modular (PMBM)” provide traditional plesiochronous digital hierarchy (PDH) features as well as SDH multiplexing and Packet Switch support. This facilitates integration with either high-capacity FSO/microwave links or an optical network. A key requirement is that smart traffic nodes can be introduced into existing networks in a way that is compatible with the equipment installed at both ends of the link. In this way, existing transmission networks can easily be adapted to new requirements. At the same time, networks with proprietary network management and data-communication architecture can be merged into one system that supports open interfaces and multi-vendor environments based on IP.

In areas where 2.5G and 3G data traffic exceeds 2G-voice traffic, ATM aggregation nodes provide the most cost-effective solution. ATM aggregation is likely to be deployed by new 3G-only operators and existing operators that wish to overlay their current network or replace existing leased-line connections.

In 3G networks systems based on ATM offer distinct advantages. ATM is a packet-based transport technology optimized for telecoms. It provides QoS guarantees and has the ability to carry real-time and non real-time traffic. ATM is very good at accommodating fluctuations in capacity needs; the network can be oversubscribed in terms of registered users, but still maintain a high QoS. ATM can allocate capacity on demand, which allows statistical multiplexing to be implemented over the wireless carrier.

PAVMux Broadband can be utilised to aggregate traffic from PDH, SDH and IP links, as well as from leased lines and digital-subscriber-line links. This equipment can offer ATM-over-STM-1 VC-4 interfaces to higher-level network nodes - which is a very "clean" and cost-effective way to optimize backbone capacity and minimize switch-site complexity.

When evaluating how best to serve the growing and changing traffic needs of next-generation mobile networks, operators must consider the benefits of an end-to-end transport network approach that uses a combination of Free Space Optics (FSO), microwave and fixed link technologies to achieve maximum flexibility, efficiency and control at the lowest possible cost.

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