Fibre: faster, greener and connecting more people

Many countries around the world have launched state-led strategies to expand their broadband access. To maintain advances in economic development, IAN DAVIS says Africa must invest similarly in its telecoms infrastructure.

Recognition of the part played by improved communications in delivering economic growth during a time of global recession has led to several governments taking action by launching initiatives to increase the take-up of high-speed broadband services.

For example, amongst the industrialised nations, *Connecting America* sets the target of 100 million subscribers at 100Mbps by 2020, whilst the European Union's *Digital Agenda* proposes 100Mbps subscription for 50 per cent of the population and 30Mbps available throughout.

In the most rapidly developing economies, even faster penetration is demanded. For instance in China, the twelfth incarnation of the state's five-year plan requires 100Mbps fibre-to-the-home (FTTH) connections to 100 million subscribers by 2015. And in India, the *National Optical Fibre Network (NOFN)* targets 175 million broadband subscribers by 2015, rising to 500 million by 2020.

To maintain advances in economic development, Africa must invest similarly in its telecoms infrastructure, providing fast, accessible connections to subscribers in a vast and geographically diverse continent that includes some of the least densely populated nations on the planet.

The technology to achieve this will be a mixture of fixed lines to the building and mobile connections to the cellphone. At the heart of all this will be optical fibre – the core infrastructure that makes high-speed broadband possible. And to meet the particular challenges of the final connection to the customer, fibre design has evolved to increase capacity, accelerate installation, and diminish capital outlay.

Challenges to broadband penetration become immediately obvious when comparing Africa, for example, to India. The population of India exceeds that of Africa's one billion by around 20 per cent. However, the Sub-continent's landmass is only about 10 per cent of Africa's. Whereas India can rapidly make inroads into government targets by concentrating on rollouts to densely populated cities, Africa will have to connect many more subscribers in remote, rural towns and villages to achieve world-class penetration rates. This significantly impacts the capital cost per subscriber and the time to recoup investment.

A further consideration is the need for energy efficient solutions. Installing networks to remote regions is not only capex intensive; the large-scale operation of active equipment (terminals, amplifiers and regeneration) requires electrical power, and the cost of power directly adds to the service provider's opex. Due consideration must also be given to the environmental impact of the power provision.

CSPs planning broadband deployment in Africa can draw upon the experience of many other operators around the world. Of course, network requirements differ widely and so there is no universal architecture of choice. However, all require optical fibre to be installed deep into the network; the deeper the fibre penetration, the higher the performance of service available.

Mixed technology for broadband delivery

Competing technologies have several trade-offs such as speed, reach, ease of installation, and power usage.

An advantage of wireless technology is its relative ease of installation. Although the wireless data rate is limited by distance and active user density (unlike fixed-line solutions that can offer a dedicated 100Mbps to 1Gbps per subscriber), customer convenience and the need to reach rural communities means wireless will always be a large part of any broadband strategy in any large, sparsely populated country.

Moreover, there is an increasing acceptance by governments that rural outposts tend to suffer disproportionately from economic under-performance, so policies are often enacted to promote rural telecoms infrastructure.

An example is NBN in Australia. Here, the final seven per cent of the population cannot be covered economically by an FTTP connection, so instead wireless or satellite will be employed to enable universal population connectivity (source: *FTTH Forum 2011, Budapest – Roland Montagne, IDATE*).

As more operators become conscious of network energy costs, power reduction becomes a significant factor behind technology selection. Passive Optical Network (PON) technologies in particular offer outstanding broadband speed at less than 1W per subscriber (source: *Power Consumption in Telecommunication Networks: Overview and Reduction Strategies –Vereecken et al, IEEE Communications, June 2011*). In the US, Verizon has previously issued press statements claiming that power requirements for its FTTH gigabit capable PON (GPON) are only 38 per cent of its copper DSL network.

By installing fibre deep into the wireless network and using fibre to connect between antennas, much of the performance and energy efficiency advantages demonstrated by GPON can also be achieved by wireless.

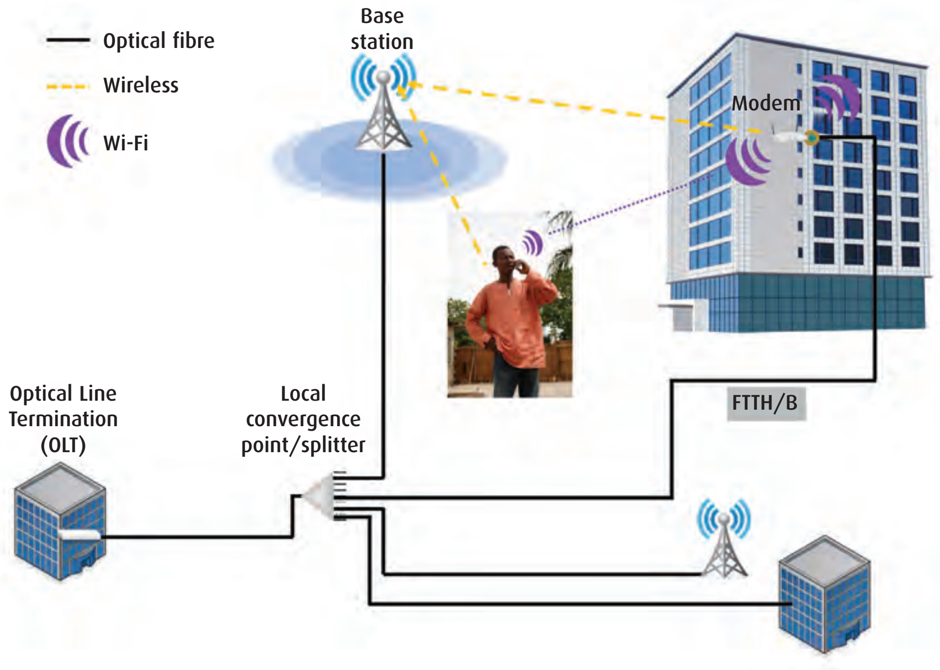

Figure 2. A converged G-PON deployment. Mobile backhaul and FTTP fixed connections can be provided over the same network infrastructure. © 2014 CORNING INC

The key to delivering broadband in remote locations

Copper is not suitable for 3G and 4G backhauling due to its limited bandwidth and reach, and is being rapidly replaced by other transmission media (see *figure 1 below*). Either the signals are hopped from station-to-station by microwave (although the number of hops is likely to be large for long links with low loss budget, rainy areas, for example), or else the stations can be linked by optical fibre and splitters used to direct the traffic. Whilst superficially attractive compared to installing cables in trenches, the microwave solution can be expensive.

Commercially available Ethernet transceivers exist to allow unamplified connectivity up to 80km at data rates of 10Gbps – whereas microwave hops tend to be limited to about 4km (according to Ericsson in its *Microwave Capacity Evolution* paper) depending on carrier frequency, availability, etc, resulting in the need for construction of many intermediate towers.

But remote towers require fuel to maintain operation and, for sites far away from the main power grid, diesel for generators represents an expensive commodity to both buy and transport.

Two Ethernet transceivers (required for bi-directional optical transmission) consume approximately 2W of power, compared to a few tens of Watts for an equivalent outdoor microwave transmit-receive system (see *Wired or Wireless by Dr Sergey Makovejs, South Asian Wireless Communications,*

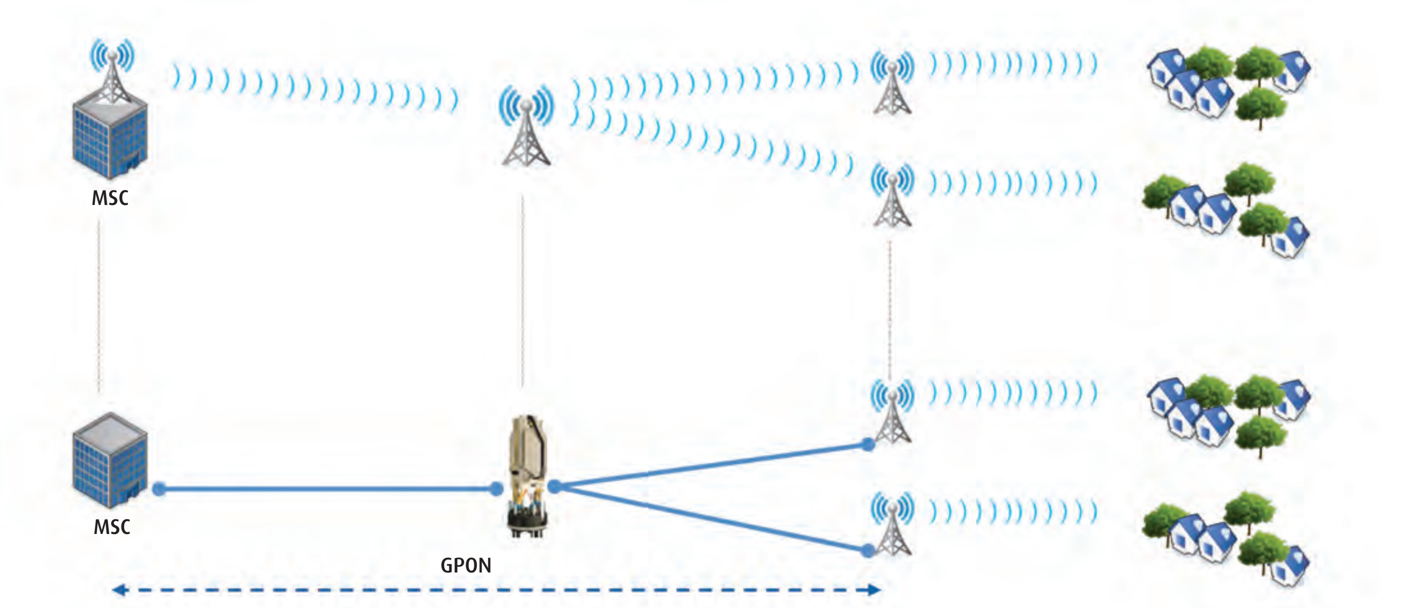

Figure 1. Alternatives for mobile backhaul. Signals may be transmitted between towers through microwave or by optical fibre cable. © 2014 CORNING INC

Q4/2012 issue). Across a large national network, fibre provides the cheaper, greener backhaul alternative. For example, Portugal Telecom says 92 per cent of its cell sites are now fibre-based to take advantage of the improved performance and energy efficiency.

Consideration must also be given to future-proofing the network against the continued increase of data capacity (driven mainly by transport of video content) and higher subscription take-up. The upgrade path for fibre by faster channel WDM (Wave Division Multiplexing) is well established. 100G deployments are now common-place and 400G channel transmission is operational in some live networks (see *France Telecom, AlcaLu Deploy 400G Link, LightReading*).

Migration to higher data rates using microwave is likely to result in a large increase in antenna density because of the increased attenuation at the higher frequency transmission bands assigned by regulators to increase capacity. This leads to even greater power consumption penalties.

As discussed, the GPON network delivers excellent performance whilst maintaining relatively low energy expenditure. Wireless access can be converged into a GPON network (see *figure 2* left) to allow effective delivery of mobile services to a village. Antennas centred directly in the village provide connectivity to all. Businesses may also access the network from the local antenna or, for improved performance, be provided with an exclusive FTTP connection.

Such an approach is planned in the Indian *NOFN* initiative in which thousands of 'panchayats' (outlying villages) will be provisioned with high-speed connections that are accessible to all. A similar methodology in Africa, where communities can be even more remote, seems viable.

Recent advances in optical fibre technology have led to improved products for access networks. Low-loss fibres featuring approximately 10 per cent lower loss at operational wavelengths around 1310nm and 1550nm, allow longer reach and additional power budget margin for repair if the cable is dug-up (a recurrent hazard of installing cable in regions of rapid infrastructure development).

Other fibres have been developed that are more resistant to optical loss by bending, allowing their use in easily-installed, densely-packed mini cables. Combining the properties of low-loss and bend resistance, Corning has recently introduced *SMF-28 Ultra* fibre that is best suited to the demands of the access network. This fibre is also ideal for future upgrading using protocols that utilise a wider operational spectrum to deliver improved capacity.

Conclusion

Increasing the penetration of high-speed connections in Africa is an enabler of economic growth. To deliver these services to a dispersed population in a way that is both environmentally-friendly and economic, optical fibre needs to penetrate as far into the network as possible.

Converged solutions are possible that combine wireless and fixed line connections. The recent development of low-loss, bend-resistant fibres in mini cables allows rapid installation, resilience, and future upgrade to higher capacity protocols. ■

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