Beyond the obvious: discovering new applications for bend-insensitivity

Increasingly, society relies on ’anywhere and anytime’ broadband access, but the required resource – radio spectrum – is generally considered to be scarce. This bandwidth bottleneck can be beaten, by exploiting optical fibre’s spectral abundance.

Fibre today has a huge amount of potential transmission bandwidth, but capacity often remains untapped. *Alain Bertaina,* Singlemode Product Manager Prysmian Group, looks at ways in which the latest generation of optical fibres can secure deployed cable infrastructure for multiple generations of system upgrades. This benefits different topologies and applications and helps unleash their full potential.

MAKING MORE OF BANDWIDTH

“At nearly 400nm, fibre’s potential transmission bandwidth is immense,” explains Alain. “Some 50 terahertz of spectrum is on offer, ranging from the O-band at 1260nm to the U-band up to 1675nm. Many industries are seeing performance improvements, thanks to the enormous bandwidth capacity of current products. However, smart design can enable existing and new users to get even more out of their investments. When we look at bend-immune single-mode fibres, we see a number of obvious applications, but there are also several ‘beyond-the-obvious’ ones. Bend-immunity means extra margins, securing performance levels for an expected infrastructure lifetime of several decades after the fibre has been placed inside a cable, installed, handled and spliced.

“We’ve been analysing individual cases with customers, looking at their challenges in the field and how we can create innovative solutions, based on bend-immunity, with them. Very often they’ll be surprised that they hadn’t thought of using G.657 in these ways before! In any case, it is clear that you can leverage the characteristics of this fibre to deliver a wide variety of designs for different applications. I like to compare bend-immune fibre with a perfect motorway – now, the challenge is to design faster, more efficient vehicles to make the most of it!”

INDOOR

Keeping the power budget under control

In indoor applications, the benefits are clear: greater flexibility when it comes to tricky installations around corners and bends. Light doesn’t escape from the core, meaning better compact connectivity and tidy, attractive cabling solutions. Installation times are reduced, costs optimised and overall optical power loss is significantly lower, securing the optical power budget of the commissioned links.

CENTRAL OFFICE

High power resilience: a useful side-effect of bend-immunity.

One less obvious advantage of the fact that light doesn't escape the core of the fibre under bend, is power leakage prevention. This offers a key advantage when fibre is exposed to very powerful lasers in central offices. With regular fibres, escaping power can heat coating materials, which can induce catastrophic failures above a defined critical temperature (typically 85°C). The distorted coating may even place so much stress on the fibre that it can break. The IEC (International Electrotechnical Commission) issued a technical report on this issue of high power handling under bend (TR 62457) and concluded that bend-immune fibres, especially of the G657A2 type, are much more secure for central office infrastructure. For this reason, many operators have switched to G657A2 fibres for all their central office patching.

MOBILE NETWORKS

Laying the basis for tomorrow's networks

Due to vast and rapid capacity increase requirements, the latest generations of mobile networks increasingly need fibre for backhaul, linking all base stations towards the core network, as well as for fronthaul, linking the base station to the antenna. In fronthaul, fibre is used for capacity and power efficiency reasons. For mobile backhaul, it is introduced to cope with the dramatic increase of bandwidth requirements. CRU estimated the share of fibre consumption used in mobile roll-out to be as high as 20% in 2012.

The rollout of mobile backhaul presents challenges very similar to those involved in rolling out an FTTx access network: going through people's property, sharing infrastructure, controlling deployment costs, right of way and so on. Therefore, many solutions developed for outdoor fixed access, leveraging bend-immune fibres, are also applicable to mobile backhaul. The same applies to the indoor challenges of mobile. Bend-immune fibres are used in distributed antenna topologies for improved indoor coverage, or for femto-cells backhaul, for example, leveraging solutions for indoor FTTx. For the fronthaul, in fibre-to-the-antenna configurations, flexible and compact cables are necessary for deployments on towers, masts, rooftops and façades, to name a few locations. The vast majority of cables connecting the base station to the remote radio head in the antenna with fibre now use bend-immune fibres, for their improved tolerances and resilience. These qualities also make them suitable for hybrid power/fibre cables connecting the active equipment of antenna and providing the data connection and remote power supply in a composite cable.

OUTDOOR ACCESS

Securing deployed infrastructure across all bands

There are two types of bend-insensitivity: millimetre-range macro bend-insensitivity, which accommodates bends and corners, and µm range micro bend-insensitivity, linked to micro local effects that can pressure the fibres. This can happen in a cable when fibres touch, for

example due to material shrinkage, or any other cause of strain. Bend-insensitive fibre was initially developed with macro bend-insensitivity in mind, but also scores very well with regard to micro bend-insensitivity. This results in very low losses and extremely good attenuation in all bands including the highest (L and U) bands. These bands are crucial for next-generation PON systems, which plan to use all wavelength bands from 1260nm to 1610nm and above (for monitoring channels).

Optimised performances and compliance with legacy G652D, coupled to optimised protective coatings, make G657A2 truly ‘bend-immune’ G652D fibres, virtually erasing the problem of micro-bending to secure the deployed infrastructure in all the bands, opening up all possibilities for system evolutions; in addition, the immunity converts into resilience to give birth to cable designs that were not possible before, enabling deployments in very demanding environments (temperature, weather conditions, handle-ability), even in the long distance field, as those fibres are still G652D compliant and compatible. At last, with such extra resilience offered, bend-immune G.652.D fibres also produced 200µm coated fibres (instead of regular 250µm) with same or better performance in cables as the legacy G.652.D fibres, yielding industry-record cable density to deploy extremely high fibre counts in congested right-of-ways.

Alain Bertaina graduated in Optical Engineering at the Institut d'Optique Graduate School, and holds a PhD in Photonics Science from the University of Paris. In 1997 he joined Alcatel as a fibre optics researcher, moving to product management for optical fibre and high bit-rate WDM systems. In 2008 he became responsible for product line management of single-mode fibre at Draka, now Prysmian Group.