TECHNOLOGY BRIEFING

FIBRE SHARING

Motivation

The deployment of a second transmission system over one transmission line can be considered if a capacity upgrade is required, or to improve the isolation of different traffic.

Traffic isolation might be of interest to large networks with both academic and regular traffic. Academic applications can be of different kinds and may potentially interfere with regular data transmission, especially in the case of the advanced modulation formats used for 100G or higher data rates.

While capacity upgrade and isolation issues can be solved by having two independent systems running over two independent fibre pairs, the economic aspects of this solution will usually be unfavourable. In the following situations, running more (typically two) transmission systems simultaneously over the same fibre pair presents a more viable solution:

- **No additional fibre available**
- **Economic constraints**

Installing new fibres is typically extremely expensive due to ground works. The typical annualised cost of a transmission system is lower than the annual cost of leased fibre, so it is economically advantageous to operate two systems over a single fibre pair rather than two systems over two fibre pairs.

The transmission equipment required to run two systems over a single fibre pair differs only slightly from that required for single-fibre bi-directional transmission. In the Porta Optica Study Deliverable 3.2, the typical annualised cost of transmission systems and fibre rental costs are compared. The result shows that the annualised cost of the transmission system is the same for single-fibre and fibre-pair systems due to rounding off.

Furthermore, due to the gradual exhaustion of the available fibre pool, a significant increase in the cost of leased fibre can be observed compared with the situation in 2002 after the .com bubble burst.

Possible approaches

Where it is necessary to operate two or more Dense Wavelength-Division Multiplexing (DWDM) transmission systems over a single fibre pair, a multiplexing scheme must be used. There are several possible approaches.

- **Multiplex in Space**
- **Mulitplex in Specturm**
- **Intra band**

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1) Multiplex in Space

The first possibility is **multiplex in space**. Spatial multiplex utilises two single-fibre bi-directional systems: the first operates over one fibre, the second over the second fibre, as shown in Figure 1. The isolation provided by such a system is perfect. However, a single-fibre bi-directional system is quite limiting.

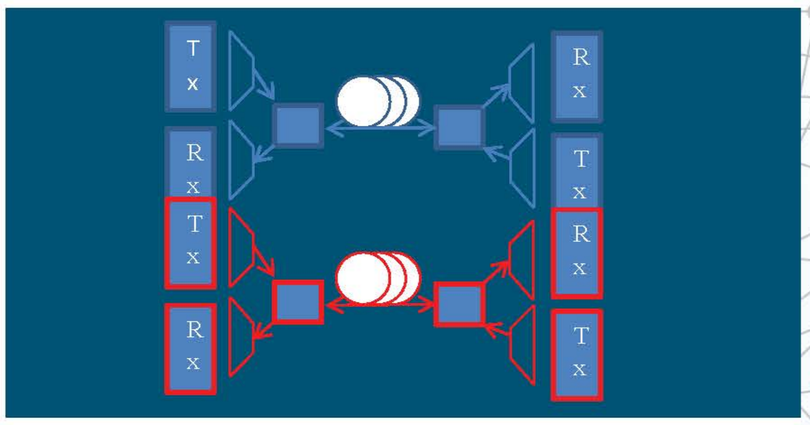

Figure 1: Operation of two single-fibre bi-directional systems over a fibre pair

2) Multiplex in Spectrum

A second approach is **multiplex in spectrum**, which allows the operation of traditional systems. However, it introduces the risk of possible mutual influence between the systems, since the signals travel along the same fibre. The logical way to divide the transmission spectrum is by transmission band: the first transmission system uses one band, the second system uses another band. The mutual influence of the transmission systems is limited, since each system uses its own amplifiers, Reconfigurable Optical Add-Drop Multiplexers (ROADMs), Wavelength Selective Switches (WSSs) and supervisory channels. A good example of this approach would be the coexistence of C and L band systems over a single fibre pair. Such systems are independent, only coupled as they enter and leave the fibre. The mutual influence exists but can be taken into account in design phase. In the event of a lack of available bandwidth in C and L bands, the transmission systems could expand into S band. Given this model, more possibilities of band-based fibre sharing can be expected.

3) Intra band

The third scenario is **intra band**, i.e. division of one transmission band into sub-bands. The mutual influence of systems can be limited via guard bands. However, these cause a waste of bandwidth. The fourth scenario is the interleaving of channels in spectra between transmission systems. Despite the good utilisation of available bandwidth, mutual influence can be an issue.

The last two scenarios represent subsets of the general approach of deploying variable division transmission spectra. It is necessary to harmonise the supervisory channels of these systems, to ensure they do not collide together, as shown in Figure 2.

When comparing the economic outcome, expressed in CAPEX per channel, of inter- versus intra-band solutions, the intra-band solution will probably be less favourable due to the limited bandwidth.

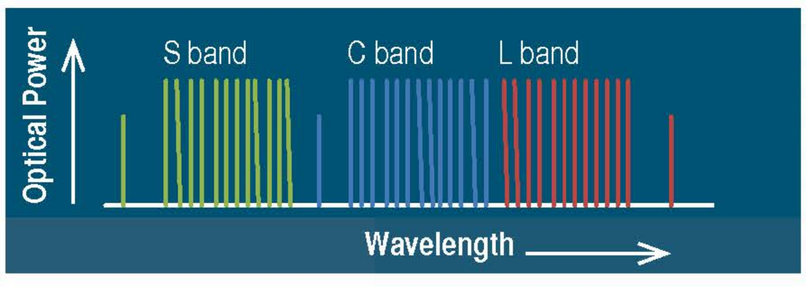

Figure 2: Band-based fibre sharing, S, C and L bands