Impact of New Wavelength Grouping Technique Based on the Subpath Concept

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1. Introduction

Recent advances in photonic cross-connect (XC) systems and their associated switch fabrics are remarkable [1], [2]. Some photonic switches are reported to allow for an abundant switching capability beyond 1000×1000 at the optical path (OP) level. However, the rationale for such large-scale switches has not yet been proven from the viewpoint of network management or operation. Wavelength grouping (WG) is a new feature applicable to the next generation photonic network. Introducing a new layer by the WG technique allows for simpler network management as well as XC switch size reduction [3]. Several authors have reported its impact on XC port/cost quantitatively [4], [5]. This paper introduces a new WG scheme based on the subpath concept, and demonstrates its impact on cost-efficiency. A novel path set-up algorithm enabling this concept is also proposed.

2. Subpath Based Wavelength Grouping

Subpath (SP) based WG is a concept in which multiple OPs that entirely or partly share a certain physical route of interest are collected to form higher-order (HO) OPs (See Figure 1). A lower-order (LO) OP is supported by one or more HO-OPs. As such, it may traverse HO-OP terminations and LO-OP-XCs at intermediate nodes. The benefit of this scheme is a potentially higher level of link utilisation than that of the conventional one which always assigns a HO-OP to the set of LO-OPs on an end-to-end basis [5].

3. Subpath Set-up Algorithm

The essence of this algorithm is as follows. It (1) allocates LO-OP routes; (2) assigns SPs (See Figure 2. At this stage, a LO-OP belongs to one or more SPs. Some of the SPs overlap); (3) determines the most valuable SP (MV-SP) based on a certain criterion that considers the relationship between the maximum number of wavelengths per fibre (denoted as m) and the number of groups per fibre (denoted as n). (4) When the MV-SP is found, it updates the list of SPs by removing parts of the SPs that overlap with the selected MV-SP. (5) It also iterates steps (1) to (4) until the list of SPs is empty.

4. Network Dimensioning

A network design using the same model as given in Ref. [5] was examined, wherein a 4×9 polygrid network is assumed to support 12,000 LO-OPs where m = 64. Figure 3 shows the total cost comparison between a HO-only routing scheme, reported in Ref. [5], and the proposed scheme. The effectiveness of the proposed scheme is apparent when the fibre cost is fairly higher than the port cost. In this example, the threshold of the cost ratio (fibre/port) was around 24. Below this threshold, the benefit of the proposed scheme in terms of link utilisation is cancelled out due to the extra required LO-OP-XC ports. We also found that in the proposed scheme, when n = 8, the most valuable grouping was attained, regardless of the cost ratio. This is of particular interest because such a phenomenon has not yet been reported in HO-only routing. Whether or not this feature is a generic one needs to be investigated since it may have some impact on the WG node configuration.

5. Conclusion

The concept of subpath-based WG and a novel HO-OP set-up algorithm were proposed. Network dimensioning using the proposed algorithm showed that the subpath-based WG scheme allows for cost-effective WG routing when fibre cost is a significant issue.

References

[1] M. Koga, *Proc ECOC '00*, session 9.2.1.
[2] L. Y. Lin et al., *Proc ECOC '00*, session 11.2.1.
[3] N. Nagatsu et al., *Proc. The 1998 IEICE General Conf.*, B-10-100.
[4] L. Noirie et al., *Proc. ECOC '00*, session 9.2.4.
[5] J. Yamayaku et al., *Proc. The 2001 IEICE General Conf.*, B-10-110.

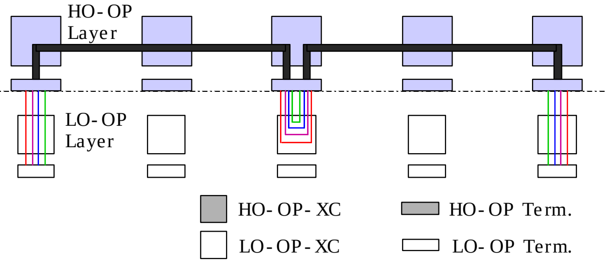

Figure 1. Example of wavelength grouping

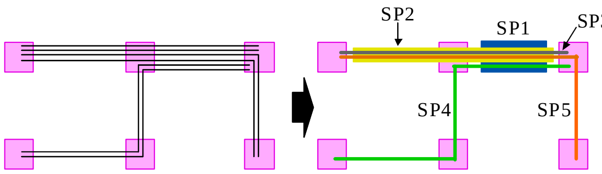

Figure 2. Subpath allocation from LO-OP routing

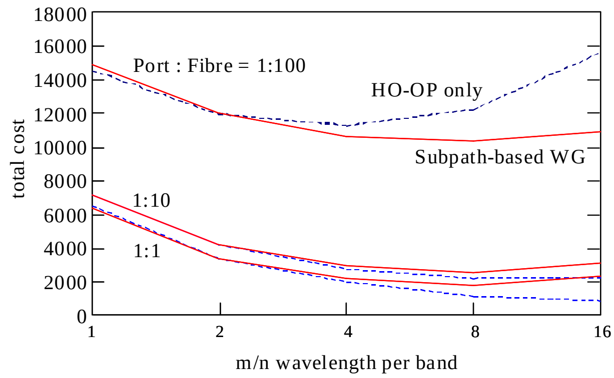

Figure 3. Total cost comparison