Chapter 1
Introduction

The primary purpose of this paper is to study the system performance of reconfigurable metro add/drop nodes using point-to-point optical transmission system simulation. The state of the art of fiber optic communication system has advanced dramatically during the relatively short period of past ten years. Generally, telecommunications networks are usually segmented in a three-tier hierarchy: access, metropolitan, and long haul. Long haul/backbone networks span interregional/global distance and provide large tributary connectivity between regional and metro domains. By 2002, commercially available ultra long haul (>2000km) light-wave systems has exceeded 1.28Tb/s (128×10Gbit/s), and the ultra high capacity light-wave systems (2.56Tb/s, 64×40Gbit/s), which capable of transmitting more than 1000km, are obtainable in the market as well. On the other end of the hierarchy are access networks, providing connectivity to a plethora of customers. Straddled in the middle are metropolitan (metro) networks, averaging regions between 10-100 km [1.1] and interconnect access and ling-haul networks.

With the rapid progress of long haul transport systems in wide area networks (WANs), the bottleneck of light-wave system gradually shifts to metro area networks (MANs). To cater different service requirements and to cope with more diversified traffic patterns, metro networks need to provide more functionalities than long haul transport networks. Reconfigurable add/drop nodes will significantly enhance network flexibility and be able to provide the much needed functionalities.

Therefore, continuing improvement in optical component technologies and declining costs are making metro DWDM increasingly viable. These component technologies include lasers, amplifiers, filters, and switching devices. From Market standpoint, the collective effects of increased production capacities, improved fabrication techniques, and competitive pressures will yield annual price erosions of 8-20%. Multi-channel optical amplification was the primary enabler for long-haul DWDM, as increased amplifier spacing eliminated more costly electronic regenerators. As operators expand their networks and utilize more complex optical gear, optical amplifiers will be needed to compensate for transmission and nodal losses. Therefore, this is important topic to effectively decrease the number of the optical amplifiers in the metro networks [1.2].

Filtering is a key to wavelength channel management. Today, improving technologies are yielding increasingly dense channel spacings and higher channel counts, for example, commercial 100GHz and 50GHz filters give 40 and 80 channels, respectively. Overall, three filter schemes are common in the metro, namely thin film, planar waveguides, and fiber-based grating. In them, planar waveguides, such as bulk arrayed waveguide gratings (AWG), can give 100-GHz spacing and lend well to high integration/channel counts, but its temperature stability and insertion losses need to be concern.

However, due to the high insertion loss of the add/drop engine (typically >10dB), 100% traffic add/drop nodes will severely limit the maximum cascadable add/drop nodes. And because of the high insertion loss, more optical amplifiers will be needed in the transmission systems. This will increase both the capital expenditure and operational expenditure, and that is the last thing service provider wants to know. Nonetheless, it is very unlikely that all the traffic will be dropped into a single node. Therefore, an add/drop node that can offer 50% traffic add/drop capability is considered sufficient. A new network architecture based on a pair of dispersion compensated interleavers is proposed. The new design will guarantee future upgradeability when compared with band add/drop architecture, and it will ensure compatible with next generation 40GB/s systems by carefully compensated the dispersion of the interleaver pair. By using the interleaver, the express channel insertion loss will significantly reduce to less than 2.5dB. The new network architecture will provide adequate 50% traffic add/drop capability (Fig. 1.1), and it can pass through larger add/drop nodes without heavily invest in optical amplifiers.

Optical loop experiments were performed as early as 1977 to study pulse propagation in multi-mode fiber. Circulating loop techniques, applied to an amplifier chain of modest length, are considered the most economic way of conducting transmission experiments. Without heavily invest in duplicated equipments, optical loop can provide an experimental platform to study a broad range of transmission phenomena with much longer transmission distance.

In the future work, the system experiment will be constructed by re-circulating optical loop, the basic building block of an optical ring is the reconfigurable optical add/drop multiplexer (ROADM) node (Fig.1.2). These architectures use various filtering and switching techniques to implement wavelength programmability (selective channel add/drop), as shown in Fig. 1.3.

Before this future work, we were devoted to construct the new reconfigurable add/drop node by using the dispersion-free interleaver pairs on the platform of the VPI transmission Maker. According to this ideal simulation model, we had already caught the more information about module characteristics, impacts on system performance, and the design tradeoff of different network architectures and network modules.

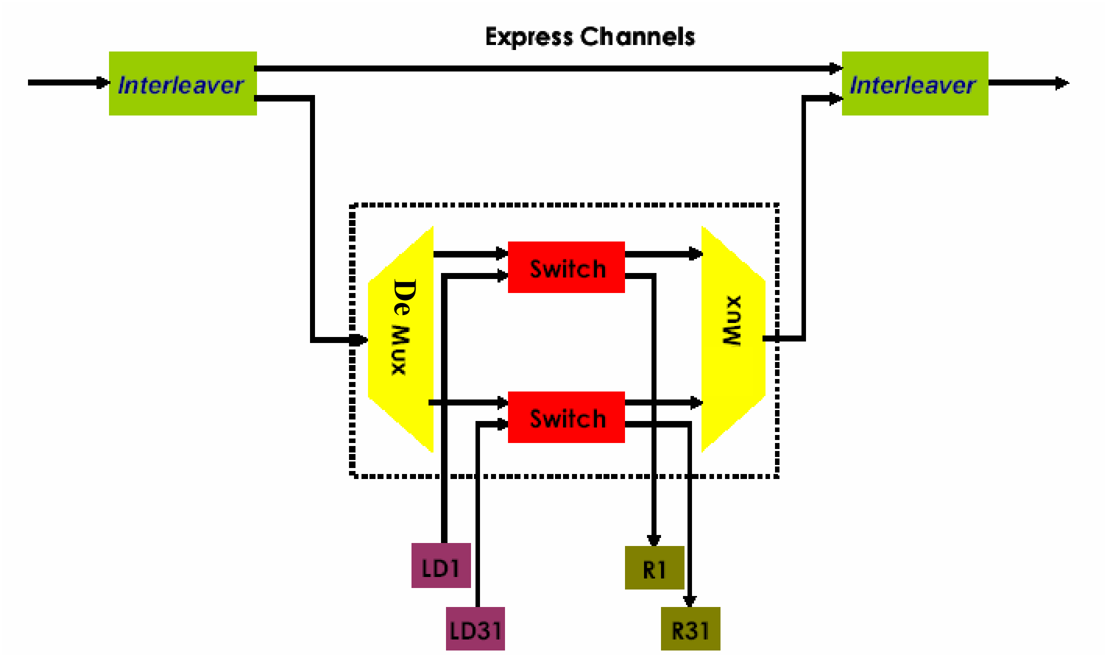

Fig. 1.1 The new network architecture will provide adequate 50% traffic add/drop capability.

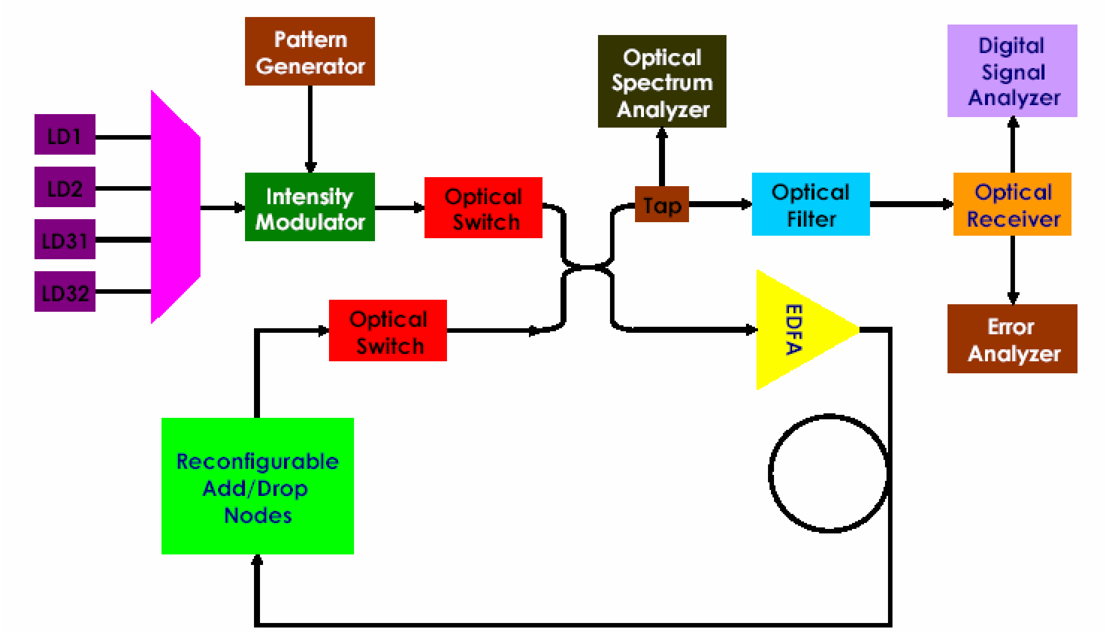

Fig. 1.2 The test platform of re-circulating optical loop for cascaded ROADMs.

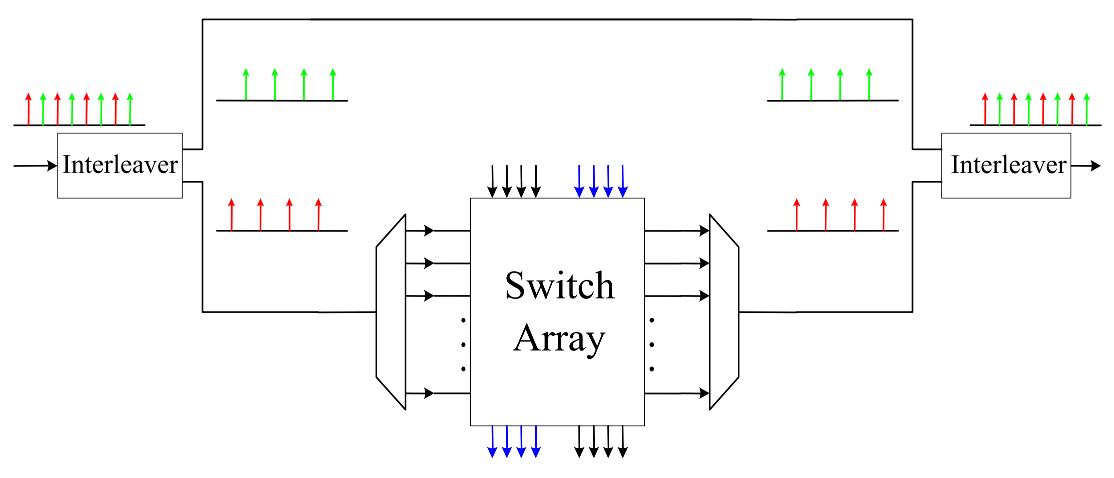

Fig. 1.3 ROADM

References

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[1.2] "Optical Fiber Telecommunications IVB systems and impairments," Ivan Kaminow, Tingye Li, Academic Press, pp. 344-347.

[1.3] Jyehong Chen, 2003 NSC proposal.