ABSTRACT

The sharp increase in data intensive applications, wide Internet usage, and new evolving networking scenarios, such as enterprise networks and grid computing etc., demand a high capacity, reliable, and flexible communication infrastructure, essentially in the form of a broadband photonic network. Such broadband photonic networks will avoid electronic bottlenecks and are expected to provide smoother network migration, easier capacity expansion, efficient bandwidth utilization, higher cost reduction, signal transparency, greater reliability, and better quality-of-service (QoS). They are found to have undergone a rapid transformation from the legacy wavelength-routed networks to the current IP-over-WDM networks that encompass both optical packet switching and optical burst switching technologies. Moreover, the high speed capabilities of optical devices like optical gates, switches, wavelength converters, etc. are expected to provide the basic all-optical components required for future broadband photonic networks with high throughput.

The work reported in the present thesis undertakes the principal issues of three important segments of the broadband photonic networks, namely, optical packet switching (OPS), optical burst switching (OBS), and access networks. The provisioning of broadband services to the end users will continue to prolong with the growth of the Internet traffic. Such a phenomenal growth of the Internet traffic has spurred the need for a rapid advancement in several key technological areas including OPS, OBS, and the broadband WDM-PON access networks. We address the improvement in the performance of a packet switched node that is possible by wavelength scheduling and traffic shaping in the presence of a self-similar Internet traffic. An analytical model for the performance evaluation of a packet switch node with partially shared buffer architecture has been developed. The studies also highlight the adverse effect of traffic self-similarity, adjustment of resources for QoS provisioning, and the survivability issues in both OPS and OBS networks. In the context of current and future all-optical networks, the scope of semiconductor optical amplifier (SOA) based all-optical signal processing has been highlighted. An augmented reflective SOA (RSOA) model has been developed, which is expected to play a vital role in the design and analysis of upcoming WDM-PON access networks.

Keywords: *Wavelength division multiplexing, optical packet switching, contention resolution, Markov chain model, quality-of-service, optical burst switching, semiconductor optical amplifier, optical bit comparator, photonic access network.*