The Analysis of Multiple Buses in a Highly Connected Optical Interconnect

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Interconnection networks for parallel computers require three properties to be optimised for good performance; bandwidth, latency and scalability. The performance of the interconnection is especially important in multicomputers, such as Beowulf clusters, as interprocessor communication is in the form of message passing. Electronic interconnects are limited in bandwidth by their aspect ratio [1,2]

Optical interconnection solutions have been suggested [3,4,5]. The inherently high bandwidth and connectivity of such a system looks attractive and latency may be lowered due to fewer amplification stages [2] and less routing. The limiting factor on the bandwidth of the optical interconnect is the efficiency of the optic used as the bandwidth is proportional to the power which reaches the detector. To compensate for this it has been suggested that extra physical links can be added for non-local communications to equalise the bandwidth with nearest neighbour links. The maximum bandwidth of this scheme is given by:

$$B_{optical} \leq \frac{1}{2} f_o N \left[\frac{\xi^X (1-\xi)}{1-\xi^X} \right] \tag{1}$$

Where ξ is the efficiency of the optics, f_0 is the communicating frequency of an unattenuated transceiver pair, N is the number of transceivers and $X = p/2$ [6,7].

It is proposed that adding extra buses to the optical system will provide extra resources to support extra processors. The provision of extra buses will allow for the number of optical stages to be reduced, so the bandwidth, as well as connectivity, will be increased.

This will be demonstrated by replacing a single optical bus with a two-dimensional system of folded one-dimensional buses. The first will connect nodes a single optical stage away and the second, nodes $\sqrt{p}$ away. It will be shown that the maximum bandwidth is doubled and the number of processors supportable at a given bandwidth is more than doubled. The added latency for this is less than doubled.

This system would require a second SPA and double the optical elements but the SPA will require less dense device integration to obtain equal or greater performance.

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