# A New Architecture and A New Metric for Lightwave Networks

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**Abstract**

The notion of *logically routed network* was developed to overcome the bottlenecks encountered during the design of a large *purely optical network*. In the last few years the researchers have proposed the use of *Torus, Perfect Shuffle, Hypercube, de Bruijn graph, Kautz graph and Cayley graph* as an overlay structure on top of a purely optical network. All these networks have a regular structures. Although the regular structures have many virtues, often times in a realistic setting, it is difficult to meet these stringent structural requirements. In this paper we propose a *semi-regular* structure, *Generalized Multi-Mesh* as an alternate to the proposed architectures. In terms of simplicity of interconnection and routing, this architecture is comparable to the *torus* network. However, the new architecture exhibits significantly superior topological properties than the torus. For example, whereas a two dimensional torus with $N$ nodes has a diameter of $\Theta(N^{0.5})$, a Multi-Mesh network with the same number of nodes and links has a diameter of $\Theta(N^{0.25})$.

In this paper we also introduce a new metric, *Flow Number*, that can be used to evaluate topologies for optical networks. For optical networks, a topology with a small flow number is preferable, as it is an indicator of the number of wavelengths necessary for full connectivity. We show that the flow numbers of a two dimensional torus, a Multi-Mesh and a de Bruijn network are $\Theta(N^{1.5})$, $\Theta(N^{1.25})$ and $\Theta(Nlog\ N)$ respectively, where $N$ is the number of nodes in the network. The advantage of the Generalized Multi-Mesh over the de Bruijn network lies in the fact that unlike the de Bruijn network, this network can be constructed for any number of nodes and is incrementally expandable.