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TITLE: HIGH SPEED ALL-OPTICAL NETWORKS

Principal Investigator: Imrich Chlamtac

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1. PROJECT SUMMARY

1. The Lightnet Architecture

An inherent problem of conventional point-to-point WAN architectures is that they cannot translate optical transmission bandwidth into comparable user available throughput due to the limiting electronic processing speed of the switching nodes. This report presents the first solution to WDM based WAN networks that overcomes this limitation. The proposed Lightnet architecture takes into account the idiosyncrasies of WDM switching/transmission leading to an efficient and pragmatic solution. The Lightnet architecture trades the ample WDM bandwidth for a reduction in the number of processing stages and a simplification of each switching stage, leading to drastically increased effective network throughputs.

The principle of the Lightnet architecture is the construction and use of virtual topology networks, embedded in the original network in the wavelength domain. For this construction Lightnets utilize the new concept of lightpaths which constitute the links of the virtual topology. Lightpaths are all-optical, multihop, paths in the network that allow data to be switched through intermediate nodes using high throughput passive optical switches. The use of the virtual topologies and the associated switching design introduce a number of new ideas:

The use of embedded regular topologies reduces the average number of active processing stages a packet has to traverse in the network. With a smaller number of stages, the number of service instances per packet is reduced, so that the total number of packets that can be processed in the network per unit of time, i.e. the network throughput, is increased. Certain regular topologies, furthermore provide inherent load balancing, leading to reduced buffering requirements. Most regular topologies also entail simplification of network control procedures, such as routing, thus further reducing the complexity of network protocols.

The construction of the regular topologies in a virtual mode provides a feasible approach for establishing and maintaining regular structures in wide area networks, which due to distance and cabling considerations are characterized by arbitrary topologies.

Lightnets introduce a two level switching and distribute the processing/switching requirements between the electronic and optical switching capabilities of the intermediate nodes according to the capability of each. Transmissions within lightpaths use passive optical WDM switches whose switching bandwidth matches the rates of optical links. Transmissions between lightpaths use active electronic switches residing in the nodes of the virtual topology. Thus only a fraction of total data needs to be switched actively at each intermediate node, so that the effective link throughput is no longer limited by the "electronic switching bandwidth". In this way, Lightnets can overcome the electronic switching/processing bandwidth bottleneck of intermediate nodes leading to an effective network throughput that can be higher by an order of magnitude than in current wide area networks.

Quantitative results support the performance expectations of the proposed Lightnet architecture.

No patents were submitted or disclosed during the period of the award.

2 PAGES

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