

**Studies on Placement of Semiconductor
Optical Amplifiers in Wavelength Division
Multiplexed Star and Tree Topology Networks**

by

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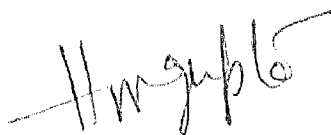
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Certificate

This is to certify that the thesis entitled "*Studies on Placement of Semiconductor Optical Amplifiers in Wavelength Division Multiplexed Star and Tree Topology Networks*" being submitted by Mr. Yatindra Nath Singh to the Department of Electrical Engineering, Indian Institute of Technology, Delhi is the record of the bonafide research work carried out by him. He has worked under our supervision and guidance during the period December 1992 to August 1996. He has fulfilled all the requirements for submission of the thesis which has reached the requisite standard.

The results contained in this thesis have not been submitted either in part or in full to any other university or institute for the award of any degree or diploma.



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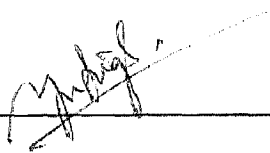
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Abstract

This thesis is mainly concerned with the use of semiconductor optical amplifiers (SOAs) in wavelength division multiplexed (WDM) broadcast topologies viz. star and tree. The aim of investigations is to determine the increase in the number of users when SOAs are placed in the above topologies. Various placement options have been considered in the above investigations.

Error correcting codes can also be used in optical networks to increase the number of users by improving the available power budget. Therefore, an on-off keying (OOK) communication system has been investigated with SOA as preamplifier and an error correcting code. The coding gain in the single channel point-to-point link has been computed. In this study, the baseband filter in the receiver is assumed to be optimum for uncoded system. Hence, the coding gain in the above includes the effect of increased intersymbol interference (ISI). It is compared with the gain obtained due to placement of SOA in the link. The suitability of SOA over coding has been discussed based on the above comparison. It is shown that SOA provides much higher gain than the use of error correcting code.

A detailed study on the use of SOAs in WDM star topology is also carried out. Two schemes have been considered viz. SOAs as postamplifiers and preamplifiers. In the postamplifier scheme, SOAs are placed after the transmitter and in the preamplifier scheme before the receiver. In the postamplifier scheme, three cases have been investigated. First case corresponds to unsaturated SOAs, second to gain saturated SOAs and in third case effect of reflection noise is studied. Similarly, in the preamplifier case unsaturated SOAs, average gain

saturated SOAs with and without gain fluctuations have been considered. Further, reflection noise is considered as in postamplifier scheme. It is observed that for typical values of system parameters, SOAs as preamplifiers perform better than the postamplifiers.

The study on placement of SOAs has been extended to WDM tree topology passive broadcast network i.e. WDM tree-net. The tree-net consists of star as main topology and folded bus as auxiliary topology. Star portion consists of a star coupler. A tree-net with b branches uses $b \times b$ star coupler. The SOAs can be placed in the star portion of the tree-net to increase the supportable number of users. However, the number of SOAs can be smaller than b to support the same number of users as in star. In this study unsaturated SOAs and average gain saturated SOAs with and without gain fluctuations have been considered. On comparison with star, it is observed that a tree-net can support more users than a star for a given number of SOAs.

It is concluded that SOAs as preamplifiers perform better in star topology. When SOAs are used in tree topology, number of users supported can be more than in star. Further, the required number of SOAs would be lesser in tree than in star for a given number of users.

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