PERFORMANCE EVALUATION OF A MULTI-HOP WDM NETWORK WITH OXC ARCHITECTURE

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APPROVAL CERTIFICATE

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I hereby declare that this thesis is my original work and it has been written entirely by myself. I have duly acknowledged all the sources of information which have been used in the thesis. The thesis (fully or partially) has not been submitted for any degree or diploma in any university or institute previously.

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Date: January 2021

ABSTRACT

The combined effect of crosstalk and noise on Bit Error Rate (BER) of a multi-hop Wavelength Division Multiplexing (WDM) transmission system with Limited Wavelength Interchanging Cross Connects (L-WIXC) are investigated in this thesis. In an all-optical WDM network, the route to be followed and the wavelength to be used by the signal along the selected route is designated by an L-WIXC. But, propagation through the switching elements of an L-WIXC results in signal degradation and induces crosstalk both due to device intrinsic losses and their imperfect operation. Moreover, in a long-haul communication system, the cumulative loss of signal strength is restored using optical amplifiers which further degrade the signal due to spontaneous emission that adds noise to the signal during its amplification. In this thesis, the signal to crosstalk plus noise ratio at the receiver output of a multi-hop WDM network is derived for various L-WIXC architectures. An improved mathematical modelling is developed for the analysis of network performance in terms of BER and the mathematical formulations are then used to evaluate Bit Error Rate (BER) performance of the system in terms of parameters like number of hops, number of wavelength channels per fiber and number of fibers. Accordingly, the power penalty for different system parameters due to accumulated crosstalk and noise is determined at a given BER of 10^{-9}. Results show that there is a significant power penalty due to accumulated crosstalk and noise depending on the number of hops. Subsequently, the maximum allowable number of hops that a signal can travel, sustaining a specific level of power penalty for any combination of wavelength channels and input fibers, is evaluated numerically. A Comparative study of the system performance is also depicted for all architectures of L-WIXC which will provide a guideline for system design in choosing the most effective one while designing a WDM network.

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LIST OF SYMBOLS

Symbol	Meaning
T	Temperature
k	Boltzman Constant
h	Plank's Constant
B_e	Receiver Bandwidth
B_o	Optical Filter Bandwidth
f_n	Noise Figure
r_L	Load Resistance
r_D	Photodiode Responsivity
n_{sp}	Spontaneous Emission Factor
f_c	Carrier frequency
i_d	Dark Current
i_b	Background Current
G	Gain of Amplifier
α	Fiber loss
L	Hop Length
P_{in}	Input Power

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LIST OF ABBREVIATIONS

BER	Bit Error Rate
DCS	Delivery And Coupling Switch
DMUX	Demultiplexer
EDFA	Erbium Doped Fiber Amplifier
E/O	Electrical To Optical
IM/DD	Intensity Modulation-Direct Detection
LD	Laser Diode
L-WIXC	Limited Wavelength Interchanging Cross-Connect
MUX	Multiplexer
MWSF	Multi-Wavelength Selective Filter
O/E	Optical to Electrical
OEO	Optical Electrical Optical
O-O	Optical to Optical
OXC	Optical Cross-Connect
PP	Power Penalty
SCNR	Signal to Crosstalk plus Noise Ratio
SDM	Space Division Multiplexing
SOA	Semiconductor Optical Amplifier
SSM	Space Switch Matrix
UHF	Ultra High Frequency
VWP	Virtual Wavelength Path
WC	Wavelength Converter
WDM	Wavelength Division Multiplexing
WSXC	Wavelength Switching-based Cross Connect