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High speed WDM passive optical network using DCF to cover huge length for smart cities at minimum BER

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Abstract

This paper presents analysis and simulation of BER and Quality factor of WDM PON using DCF at different different length. in this paper results compared with simple WDM network with respect to the factor like Q factor and BER simulation is preformed in opti system 13 tool and there for results shows that PON is better perform as compare to ordinary network while using dispersion Compensation fiber.

Keywords : PON,BER,DCF,NRZ,Threshold,OLT

I. INTORDUCTION TO FOUR WAVELENGTH WDM PON WITH DCF

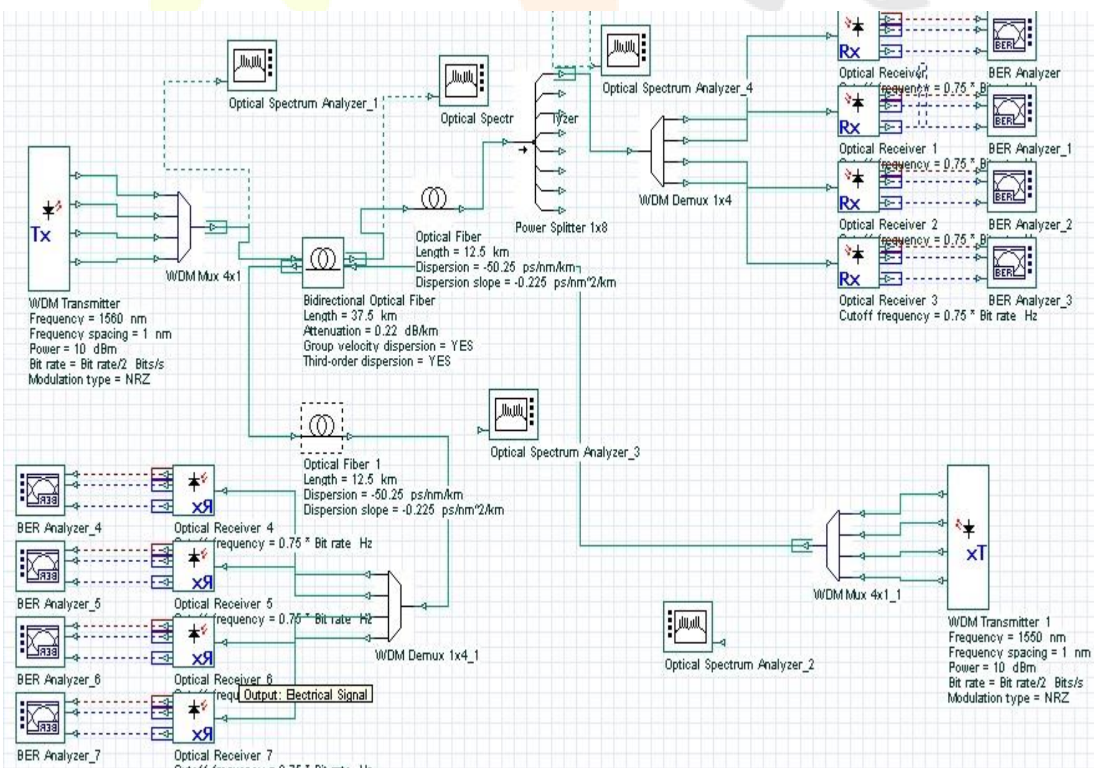

Figure1: four wavelengths WDM PON layout with DCF for proposed system

WDM multiplexed signal at optical line terminal can be observed by spectrum analyzer as depicted in above Fig. where it can be analyzed that different multiplexed signal of wavelength 1560nm to 1563nm with 1 nm spacing with 10 dbm power each. For this layout different spectrum at different stages are given below.

II CALCULATION OF Q FACTOR AND BER

Q factor and BER curve for different fiber length is plotted in figure 2 and 3 respectively which clearly shows that as the fiber length goes beyond 40km then Q factor and BER degrades. In figure 4 and 5, graph is plotted between Q factor versus power and BER versus power respectively, which gives that after a certain input power signal quality, improves rapidly. In addition, this is due the fact of power budget matching. Data used in these plots is given in table 1 and 2.

Table 1: Length (km) vs Q factor and BER for existing C-band WDM-PON

Length (Km)	Q factor	BER
30	4.87	0.8036108
40	4.03	1.2132396
50	2.86	3.0246738

(Q factor and BER value for different fiber length is mention in this table respectively which clearly shows that as the fiber length goes beyond 40km then Q factor and BER degrades)

BER=(1/2)*erfc(Q/√2), erfc= complementary error function. Table 2 shows different different value of Q factor and and BER with respect to time as we increasing the value of power in dB Q factor some how increasing and finally sustained at value 4.4. (Q factor curve for different fiber length is plotted in respectively which clearly shows that as the fiber length goes beyond 40km then Q factor degrades.graph is plotted between Q factor versus power respectively, which gives that after a certain input power signal quality, improves rapidly Simulation is run in two steps, first keeping optical launch power constant at 10 dBm and varying length of the optical fiber from 20Km to 50Km and observed the maximum quality factor (Max. Q-Factor). It can be observed that after 40km length

Table 2: I/P power (dBm) vs Q factor and Log BER for exist C-band WDM-PON

Power (dBm)	Q factor	BER
1	2.56	0.00028
2	3.01	0.0001
4	3.87	0.00004
6	4.43	0.00002
8	4.52	0.00001
10	4.67	0.00001

III

POWER BUDGET CALCULATION FOR PROPOSED SYSTEM

For the network design engineers a power budget analysis is highly recommended before designing and installing any passive optical network system, so that designed system will work within certain limits and gives the desired BER and Q factor. By power budget calculation I can know the input power range for a particular design for which particular signal quality at receiver is guaranteed. During calculation of power budget power margin is also considered for any forthcoming degradation. In any network Losses are of passive and active since prototype is made up of both the passive and active components. Active components are at the OLT and ONU. Passive components are in between the OLT and ONU. Passive loss dwell of fiber loss, connector loss, splice loss and couplers or splitters in the link. Active components losses are wavelength multiplexer, transmitter power and receiver sensitivity. Here in C-band WDM-PON prototype I are using bit rate of 20Gb/s for upstream and downstream hence power budget chart hold good for both upstream and downstream.

$P_{tx} = P_{rx} + C_L + M_s$

Where C_L is expressed as

$C_L = \alpha L + \alpha_{con} + \alpha_{splice} + \alpha_{splitter}$

L_T- Total loss (dB)

α - Fiber attenuation (dB/Km)

L - Length of fiber (Km)

C_L - Channel loss (dB)

Ms –Safety Margin (dB)

Total system losses are depends upon fiber attenuation, length of fiber for which has to transmit different connector and splice losses and splitter losses. For a particular fiber its losses are fixed and one cannot alter these losses. However number of connectors and output port of splitter can be lessened to lessen losses. In our system I have considered fiber losses of 0.22dB/km so for 50 km length accumulated fiber losses are 8.8 dB. In our simulation I have considered the splitter losses of $3.5\mathrm{Log}_2$ (n). Where n is the output port of splitter. So splitter losses are 10.5 dB and 7 dB for 8 ports and 4 ports respectively. Receiver sensitivity is taken at -31 dBm for PIN receiver to detect the signal at receiver within the acceptable range. I have given the input power from 0 dBm to 10dBm.From the above equation

$0= -31 \text{ dBm} +11 \text{ dB}+1.2 \text{ dB}+ \alpha_{splitter} + M_s$

$\alpha_{splitter} + M_s =18.8$ or

$\alpha_{splitter} =18.8- M_s$

by considering Ms = 6dB

$\alpha_{splitter} =18.8- 6 = 12.8$ dB

Similarly for 10 dBm input power

$10= -31 \text{ dBm} +11 \text{ dB}+1.2 \text{ dB}+ \alpha_{splitter} + M_s$

$\alpha_{splitter} =22.8$ dB

From the above calculations I got the range of splitter losses that can be accommodated in the system without performance degradation is 12.8 to 22.8 dB. For this range value of n will be from 16 to 64. Means I can serve up to 64operators. If I keep n=16 than additional 8.8 dB can be used for increasing fiber length further up to 40 km in forthcoming future.

IV COMPARATIVE ANALYSIS OF BER ,POWER AND QUALITY FACTOR

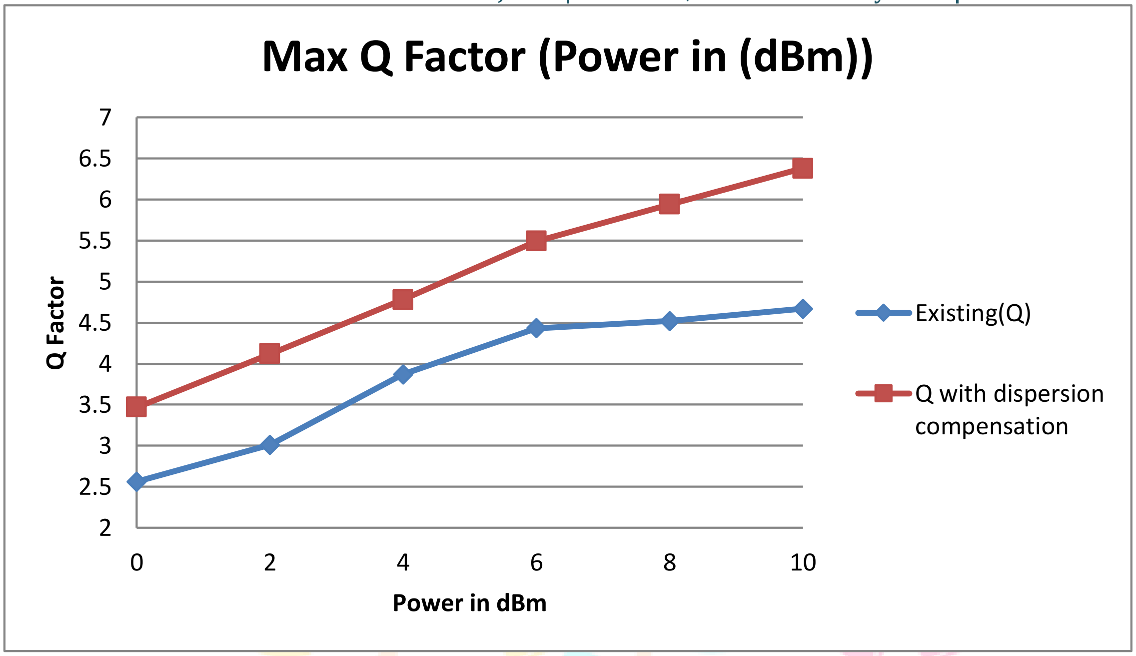

Figure.2: Q-factor Vs Power at 40 km

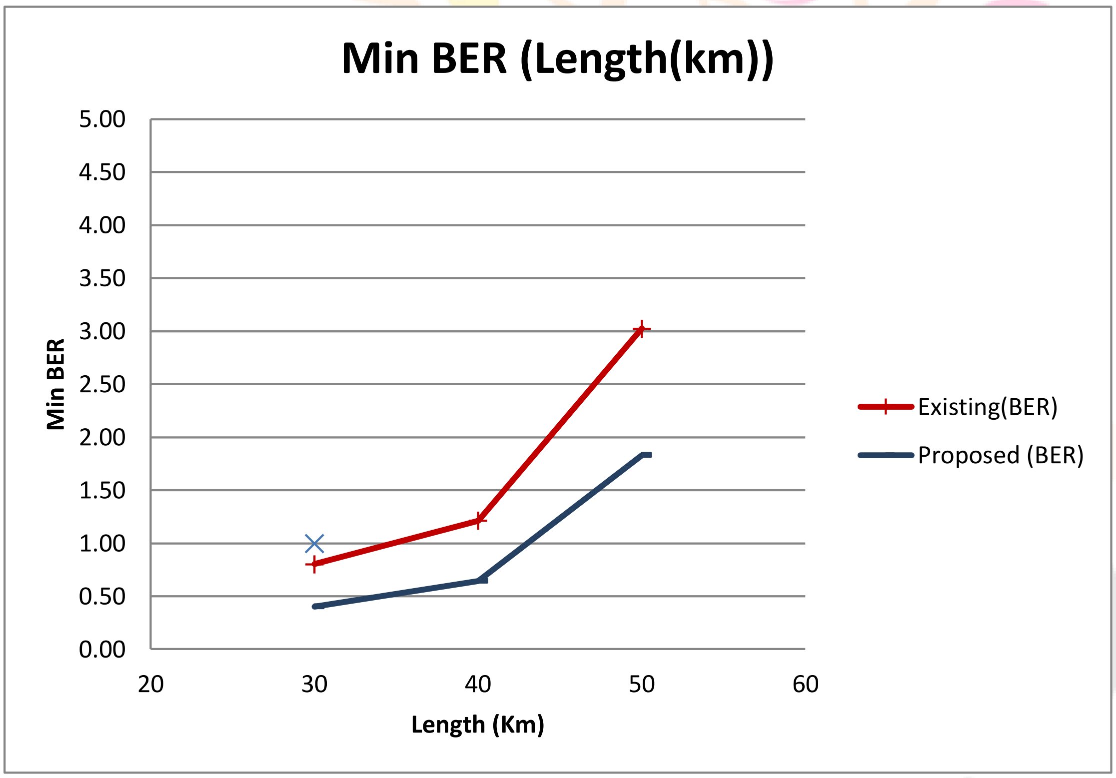

Figure.3 BER Vs Length at 10 dBm

V CONCLUSION

An already developed Band (C-band) Wavelength Division Multiplexed Passive Optical Network (WDM-PON) design has been proposed and analyzed based on simulation results.Comparative study of proposed design with already developed designis also analyzed.Proposed system offers offer 20Gb/s downstream and 20Gb/s upstream bandwidth by using only 4 wavelengths .i.e. each wavelength transmit at 5Gb/s. at higher speed the effect of dispersion becomes significant so dispersion is compensated by using dispersion compensated fiberBy dispersion compensation, dispersion effects are lessened and then I observed that proposed design offers good Q factor and acceptable BER for 50km that is significantly higher than already developed design.As proposed system utilizes only four wavelengths at OLT it necessitated less line cards to hold transmitters and receivers. So this design consumes less power. i.e. proposed design is more energy efficient and cost efficient than already developed design.

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