SNS COLLEGE OF TECHNOLOGY

Coimbatore-35
An Autonomous Institution

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DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

MICROWAVE ENGINEERING

IV YEAR/ VII SEMESTER

UNIT 5 – OPTICAL NETWORKS

TOPIC –POWER BUDGET ANALYSIS

RISE TIME BUDGET

Rise time gives important information for initial system design. Rise-time budget analysis determines the dispersion limitation of an optical fiber link.

 Total rise time of a fiber link is the root-sum-square of rise time of each contributor to the pulse rise time degradation.

$$t_{sys} = \sqrt{t_{r1}^2 + t_{r2}^2 + t_{r3}^2 + \cdots}$$

$$\boxed{t_{sys} = \left(\sum_{i=1}^{N} t_{ri}^2 \right)^{1/2}}$$

Four basic elements that contributes to the rise-time are,

- Transmitter rise-time (ttx)
- Group Velocity Dispersion (GVD) rise time (tGVD)
- Modal dispersion rise time of fiber (tmod)
- Receiver rise time (trx)

$$t_{sys} = \left[t_{tx}^2 + t_{mod}^2 + t_{GVD}^2 + t_{rx}^2\right]^{1/2}$$

Rise time due to modal dispersion is given as

$$t_{mod} = \frac{440}{B_M} = \frac{440\,Lq}{B_0}$$

where,
BM is bandwidth (MHz)
L is length of fiber (km)
q is a parameter ranging between 0.5 and 1.
B0 is bandwidth of 1 km length fiber,

- Rise time due to group velocity dispersion is

$$t_{GVD} = D^2 \sigma_\lambda^2 L^2$$

where,

D is dispersion [ns/(nm.km)]

Σλ is half-power spectral width of source

L is length of fiber

 Receiver front end rise-time in nanoseconds is

$$t_{rx} = \frac{350}{B_{rx}}$$

where,

Brx is 3 dB – bW of receiver (MHz).

 Equation can be written as

$$t_{sys} = \left[t_{tx}^2 + t_{mod}^2 + t_{GVD}^2 + t_{rx}^2\right]^{1/2}$$

$$t_{sys} = \left[t_{tx}^2 + \left(\frac{440\ Lq}{B_0}\right)^2 + D^2\sigma_\lambda^2 L^2 + \left(\frac{350}{B_{rx}}\right)\right]^{1/2}$$

The system bandwidth is given by

$$BW = \frac{0.35}{t_{sys}}$$

Example1 . For a multimode fiber following parameters are recorded.

i) LED with drive circuit has rise time of 15 ns.

ii) LED spectral width = 40 nm

iii) Material dispersion related rise time degradation = 21 ns over 6 km link.

iv) Receiver bandwidth = 235 MHz

v) Modal dispersion rise time = 3.9 nsec

Calculate system rise time.

Solution : $t_{tx} = 15$ nsec

$tT_{mat} = 21$ nsec

$t_{mod} = 3.9$ nsec

Now $$t_{rx} = \frac{350}{B_{rx}}$$

$\therefore$ $$t_{rx} = \frac{350}{25}$$

$\therefore$ $t_{rx} = 14$ nsec

Since $$t_{sys} = \left(\sum_{i=1}^{N} t_{ri}^2 \right)^{1/2}$$

$$t_{sys} = [15^2 + 21^2 + 3.9^2 + 14^2]^{1/2}$$

=29.61nsec

THANK YOU