Single Mode Fibre Skew Variation

Pete Anslow, Nortel Networks

IEEE 802.3 HSSG, Seoul, September 2007

Motivation

The architecture proposed for 100 Gbit/s Ethernet in gustlin_01_0107 includes the use of a gearbox function where the number of lanes in the optical link is not equal to the number of lanes in the electrical interconnect.

In order to aid the scoping of this function, it is useful to understand the maximum amount by which the lane to lane skew of the optical link can change during the life of any one link.

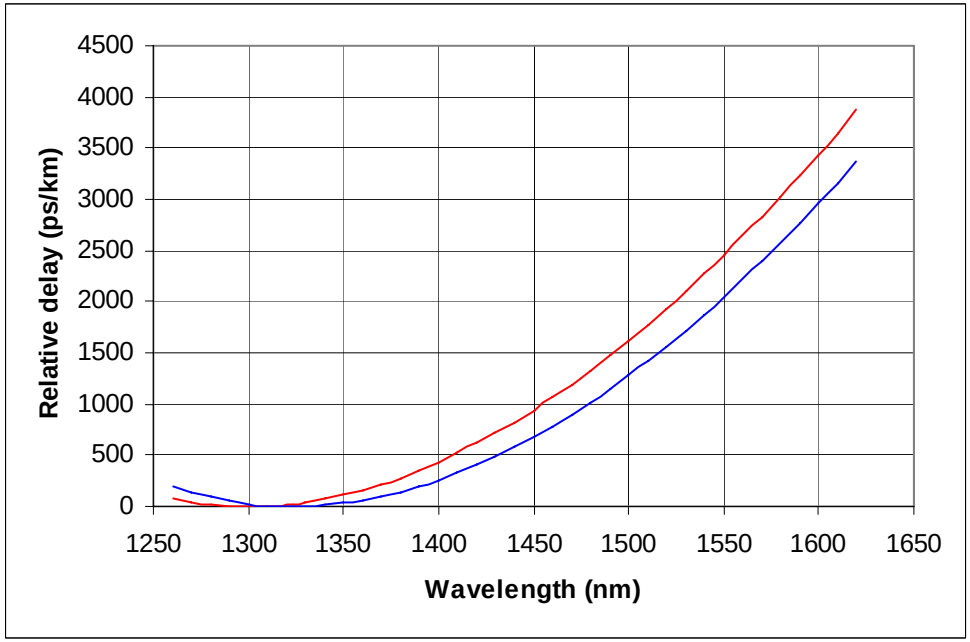
This contribution calculates this skew variation for several possible implementations of the optical link.

Delay equations

Equations for the minimum and maximum relative delay coefficients were given in [anslow_01_0107]

$$\text{Delay}_{max} = A + \frac{0.093\lambda^2}{8}\left[1 + \left(\frac{1300}{\lambda}\right)^4\right]$$

$$\text{Delay}_{min} = A + \frac{0.093\lambda^2}{8}\left[1 + \left(\frac{1324}{\lambda}\right)^4\right]$$



4 lane CWDM solution using 10GBASE-LX4 λs

A 4 lane solution has been proposed using 10GBASE-LX4 λs traverso_02_0407

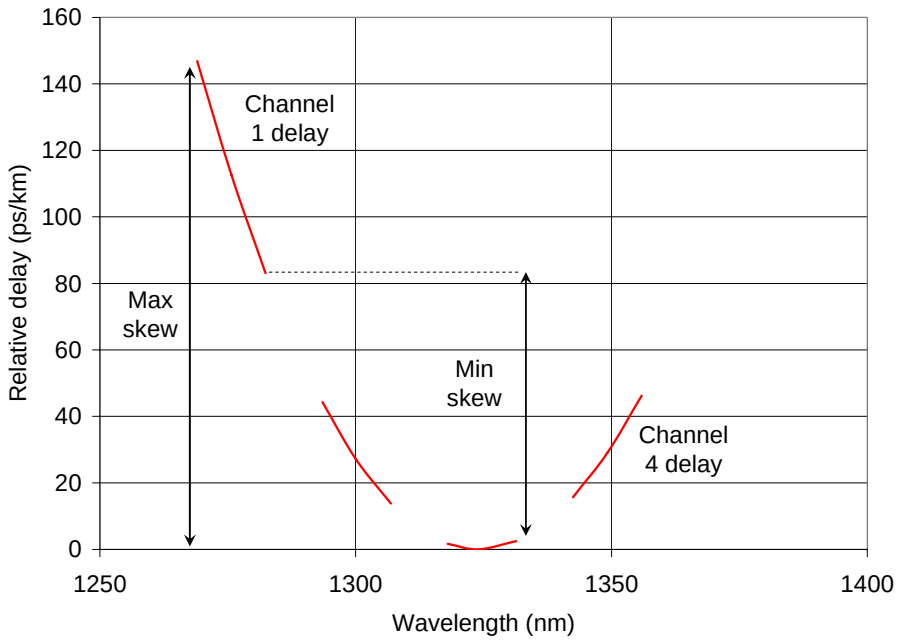
Largest skew change is for λ_0 1324 nm

Chan 1 1269.0 to 1282.4 nm
Chan 2 1293.5 to 1306.9 nm
Chan 3 1318.0 to 1331.4 nm
Chan 4 1342.5 to 1355.9 nm

Max skew = 147 ps / km
Min skew = 80 ps / km

Max skew change = 66 ps / km

For lane rate = 25.78125 Gbit/s
Max skew change 10 km = 17.1 bits
Max skew change 40 km = 68.3 bits



4 lane CWDM solution using ITU CWDM

A 4 lane solution has been proposed using ITU CWDM traverso_02_0407

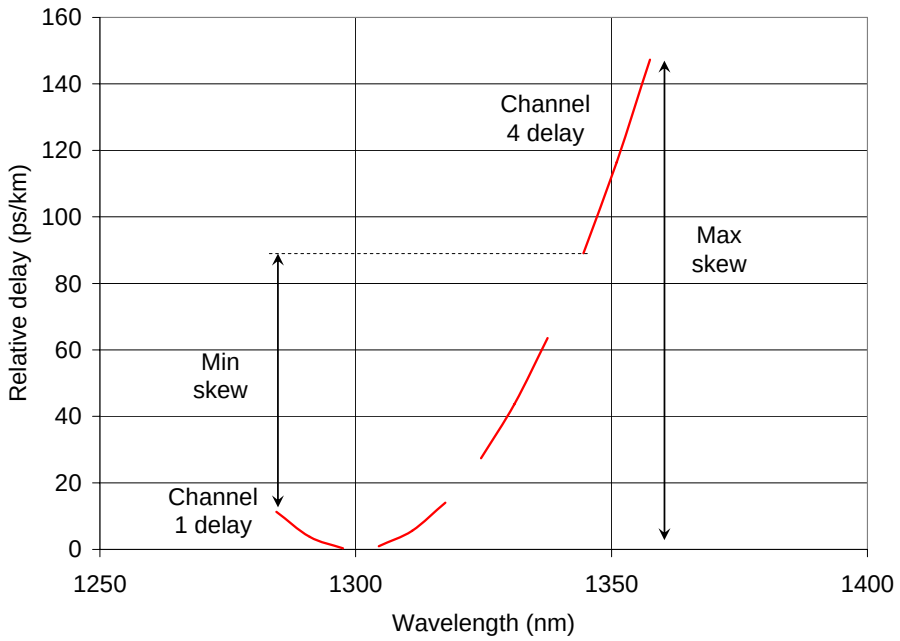
Largest skew change is for λ_0 1300 nm

Chan 1 1284.5 to 1297.5 nm
Chan 2 1304.5 to 1317.5 nm
Chan 3 1324.5 to 1337.5 nm
Chan 4 1344.5 to 1357.5 nm

Max skew = 147 ps / km
Min skew = 78 ps / km

Max skew change = 69 ps / km

For lane rate = 25.78125 Gbit/s
Max skew change 10 km = 17.9 bits
Max skew change 40 km = 71.4 bits



4 lane DWDM solution using ITU 800GHz grid

A 4 lane solution has been proposed using DWDM grid cole_01_0507

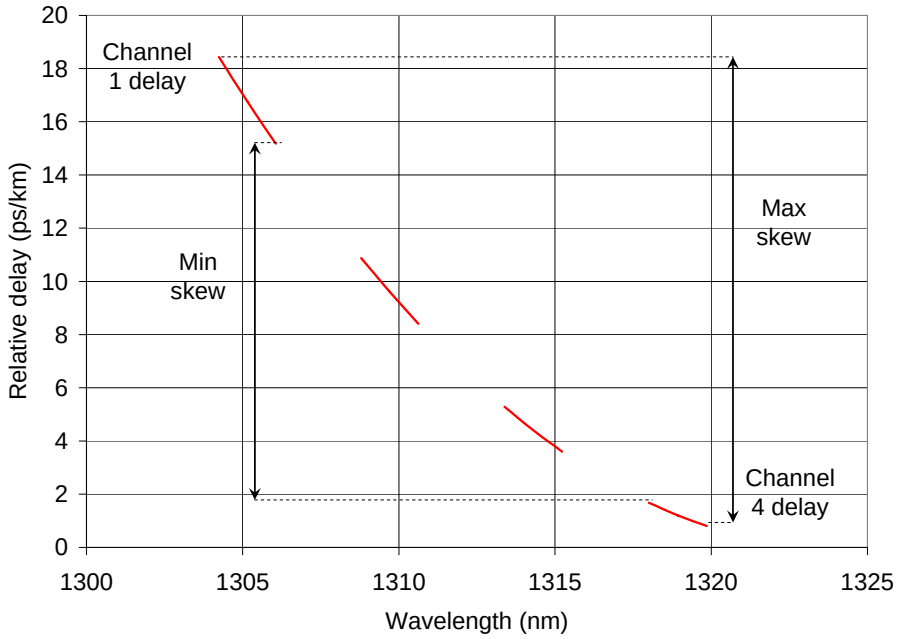
For a 800 GHz channel spacing, largest skew change is for λ_0 1324 nm

Assuming tolerance ±20% spacing
Chan 1 1304.24 to 1306.06 nm
Chan 2 1308.79 to 1310.63 nm
Chan 3 1313.38 to 1315.23 nm
Chan 4 1318.00 to 1319.86 nm

Max skew = 17.6 ps / km
Min skew = 13.5 ps / km

Max skew change = 4.1 ps / km

For lane rate = 25.78125 Gbit/s
Max skew change 10 km = 1.1 bits
Max skew change 40 km = 4.3 bits



4 lane DWDM solution using ITU 400GHz grid

A 4 lane solution has been proposed using DWDM grid traverso_01_0407

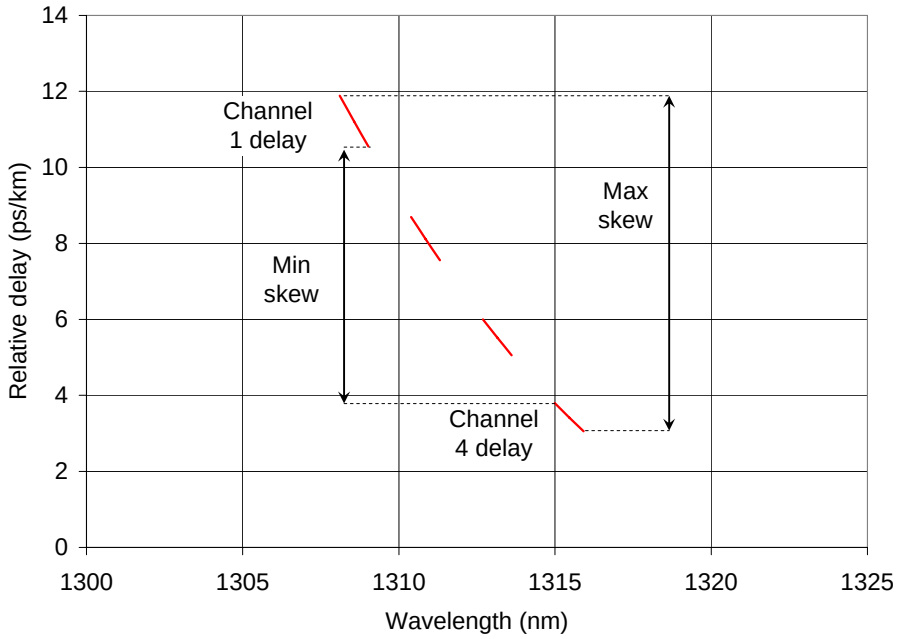
For a 400 GHz channel spacing, largest skew change is for λ_0 1324 nm

Assuming tolerance ±20% spacing
Chan 1 1308.11 to 1309.02 nm
Chan 2 1310.40 to 1311.31 nm
Chan 3 1312.69 to 1313.61 nm
Chan 4 1314.99 to 1315.92 nm

Max skew = 8.8 ps / km
Min skew = 6.7 ps / km

Max skew change = 2.1 ps / km

For lane rate = 25.78125 Gbit/s
Max skew change 10 km = 0.5 bits
Max skew change 40 km = 2.1 bits



Summary

Spacing	25 nm	20 nm	800 GHz	400 GHz
Max skew ps/km	147	147	17.6	8.8
Skew change ps/km	66	69	4.1	2.1
10 km Max skew bits	37.9	37.9	4.5	2.3
10 km Skew change bits	17.1	17.9	1.1	0.5
40 km Max skew bits	151.4	151.6	18.2	9.1
40 km Skew change bits	68.3	71.4	4.3	2.1

Note – these are the wavelength induced skews only, tracking and electronics will add to these values.

Thanks!

Pete Anslow,
Nortel Networks