IEEE802.3aq Channel model ad-hoc
Temperature Variation Impact on Channel Model

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1. Temperature variation

- Transmitter temperature, fiber temperature and receiver temperature can be assumed not correlated.
- Receiver temperature change has minimal impact on received signal, will affect receiver operation and not the received signal.
- Fiber temperature range 60^{o}C, centred at 30^{o}C. The expected speed of change is less than 20^{o}C/hour.
- Connector temperature change may result in small offset change (<1μ).
  - small attenuation change
  - polarisation change depending on the type of laser and launch (kropp_1_0704.pdf and sun_1_0704.pdf)
- Laser operating temperature range is 0^{o}C to 80^{o}C. The expected rate of change is maximum 10^{o}C/hour.

2. Temperature variation impact on fibre

- Fiber temperature range 60^{o}C, centred at 30^{o}C. The expected speed of change is less than 20^{o}C/hour.
- Fiber length change.
  - α_{silica}=3.4x10^{-7}/^{o}C (total expected change 2.04x10^{-5}), will change the modal delays (they scale with the length) by 10 ppm.
  - $\alpha_{plastic}$=10^{-4}/^{o}C (total expected change 6x10^{-3})
- Refractive index change over the working temperature range

3. Temperature variation impact on laser (1)

- Operating temperature range 0°C to 80°C.
- Intensity and extinction ratio are roughly constant, maintained through the feedback loops in the TOSA.
- Laser wavelength change, the amount of change will depend on the type of laser.

  - DFB lasers ~0.1nm/°C, total variation 8nm,
  - FP lasers ~0.25 - 0.5nm/°C, total variation 40nm,
  - VCSEL lasers ~0.08nm/°C, total variation 6.4nm,

- Polarization

  - the random nature of polarization state causes a modal noise process,
  - polarization change depending on the type of laser and launch (sun_1_0704.pdf),
  - DFB and FP lasers are designed to transmit linearly polarized light, the change in polarization is less than a few degrees over working temperature range
  - for high speed 1300nm VCSEL the variation of polarization condition is slow and causes no additional noise.

4. Temperature variation impact on laser (2)

- **Relaxation oscillation and damping**

  - for DFB and FP lasers, the damping and relaxation oscillation frequencies are reduced as the temperature increases,
  - the damping coefficient can typically decrease by a factor of 1.2 to 4, increasing the asymmetry of the rise and fall times, and will result in increased jitter,
  - high speed 1300nm VCSELs have a similar behaviour.

- **RIN**

  - for DFB lasers, RIN is typically -150dB/Hz and will decrease at high operating temperatures
  - for FP lasers, RIN is typically -130dB/Hz and the change over the temperature range is not well defined,
  - for high speed 1300nm VCSELs the RIN is reduced significantly at high operating temperatures,

5. Temperature variation impact on laser (3)

- **Mode-partition noise**

  - mode partition noise is a FM noise due to the power shifting between a laser multiple modes,
  - the mode-partition noise in FP lasers is higher at high temperature,
  - in a DFB laser, the sideband suppression will reduce the mode-partition noise by 40 dB.
  - high speed 1300nm VCSELs are single mode with a high sideband suppression.

- **Spot size**

  - for DFB and FP lasers the spot size changes by less than 1% over the working temperature range,
  - high speed 1300nm VCSELs will show some variation, the absolute size and the degree of variation depends strongly on the design.

6. Next steps

- Review the analysis and make the proposed changes or additions.
- Evaluate the significance of each factor.
- Eliminate the less significant factors.
- Evaluate the impact of each factor for time varying channel.
- Make a proposal for inclusion in the time variation effects.