Revisiting of Alien specifications and Coupling Attenuation for screened links

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Agenda

Current Alien specification

- PSANEXT
- PSAACR-F

Coupling attenuation requirements for

- 10Base-T1L
- 100Base-T1L

Current Alien specification: PSANEXT

We have agreed on the below Power Sum Alien Near End Crosstalk(PSANEXT).

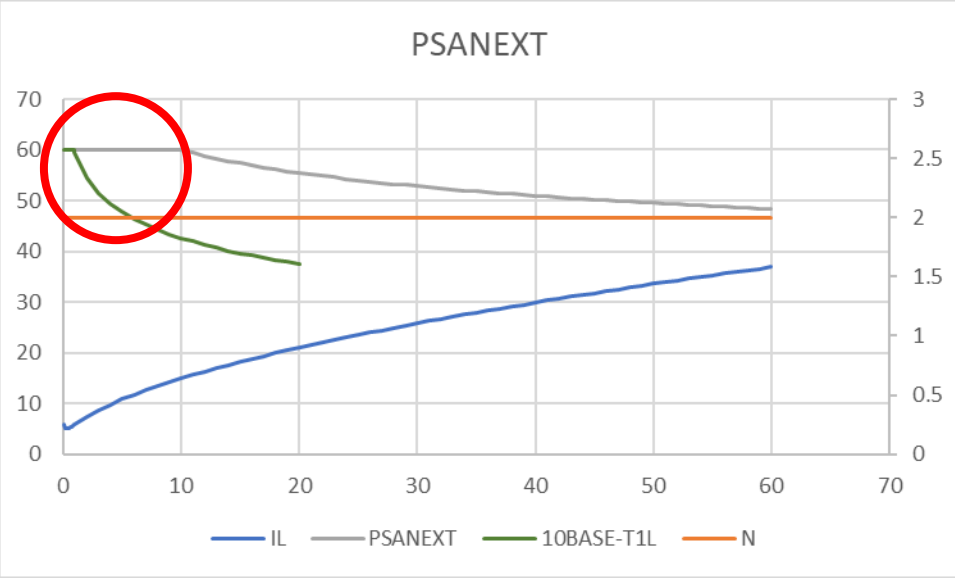
$$PSANEXT\ [dB] = \begin{cases} 50 + 5 \times N & for\ 0.1\ MHz \leq f < 10\ MHz \\ 50 + 5 \times N - 15 \times log_{10}\left(\frac{f}{10}\right) & for\ 10\ MHz \leq f \leq 60\ MHz \end{cases}$$

$$with\ N = \begin{cases} 0 & for\ 16\ dB < IL(20\ MHz) \\ 1 & for\ 16\ dB \leq IL(20\ MHz) < 21\ dB \\ 2 & for\ 21\ dB \leq IL(20\ MHz) \end{cases}$$

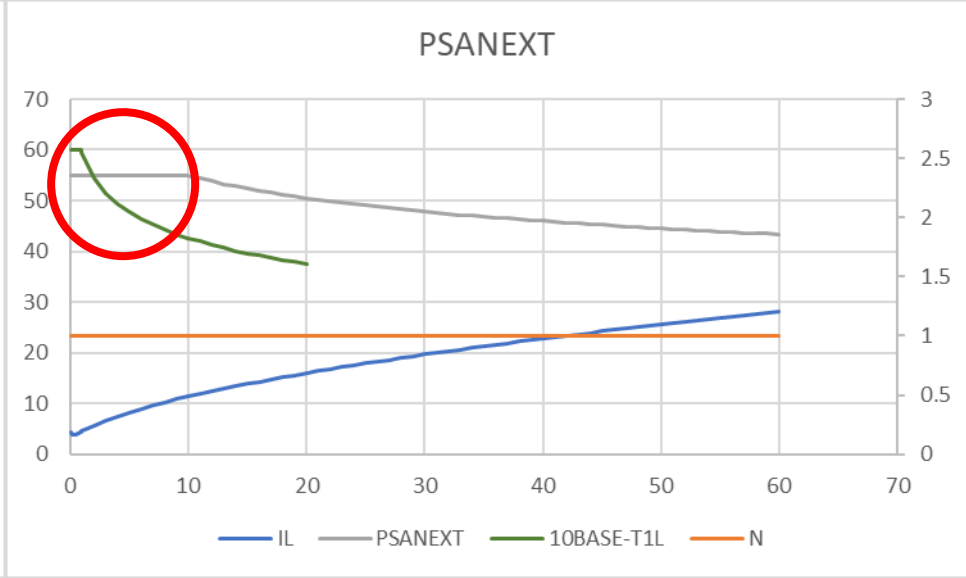
But what does it mean in reality?

Current Alien specification: PSANEXT

Comparison of different link lengths for PSANEXT:



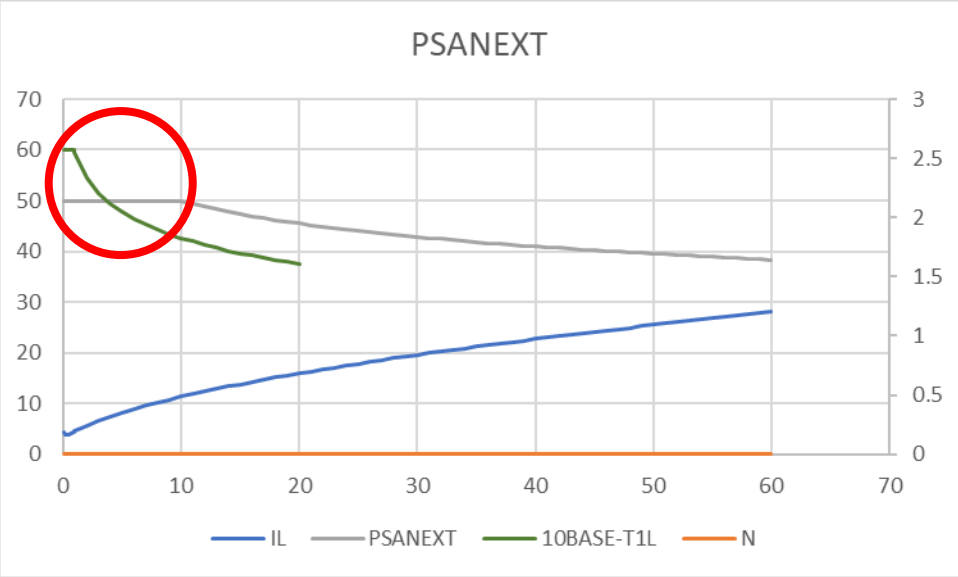
403m and longer



305m to 402m

Current Alien specification: PSANEXT

Comparison of different link lengths for PSANEXT:



304m and shorter

Current Alien specification: PSANEXT

What does it mean?

- IL dependent PSANEXT is changing over the link length→ this behaviour is unusual.
- Changing of components might change IL, like expanding a patchcord from 2m to 3m at the critical IL points (16dB and 21dB) or expand the link by another section (e.g. from 304m to 403m, +10dB), a new PSANEXT evaluation is needed. This is unpractical and generating a lot of extra work as the behaviour is difficult to predict.

Current Alien specification: PSANEXT

What does it mean?

- PSANEXT of a link is physically seen not length dependent, therefore also not depending on IL. Adding additional link segment sections will change IL but not PSANEXT. Therefore, length dependency is an unnecessary complication of the behaviour of a link segment specification.
- The PSANEXT limit gets vulnerable to temperature rise (testing at 20°C, operating above), measurement uncertainty of test equipment or between them.

Current Alien specification: PSANEXT

- We violate indirectly our objective 4 ‘Support for optional single-pair Auto-Negotiation’ as our requirement for PSANEXT for 100BASE-T1L is below the requirement for 10BASE-T1L.

The power sum ANEXT loss between a disturbed 10BASE-T1L link segment and other disturbing 10BASE-T1L link segments shall meet the values determined using Equation (146–14) or 60 dB, whichever is less.

$$\text{PSANEXT}(f) \geq 37.5 - 17\log_{10}\left(\frac{f}{20}\right) \text{ dB} \qquad (146\text{–}14)$$

where

f is the frequency in MHz; $0.1 \leq f \leq 20$

What to do now? Reconsider the link specification, align it with the physical behaviour of a link and the 10BASE-T1L requirements.

Current Alien specification: PSANEXT

New/ old proposal for PSANEXT

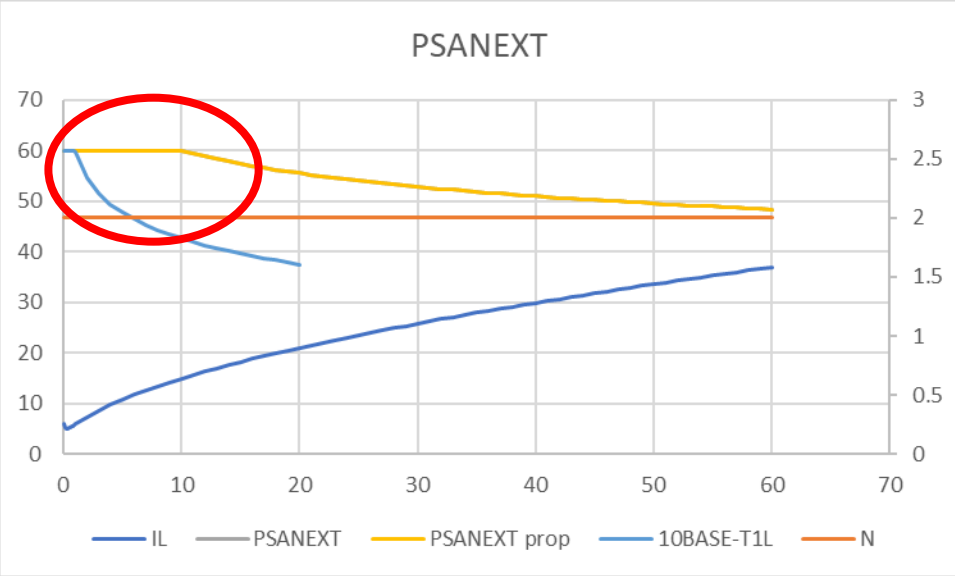
$$PSANEXT\ [dB] = \begin{cases} 60 & for\ f < 10\ MHz \\ 60 - 15 \times log_{10}\left(\frac{f}{10}\right) & for\ 10\ MHz \leq f \leq 60\ MHz \end{cases}$$

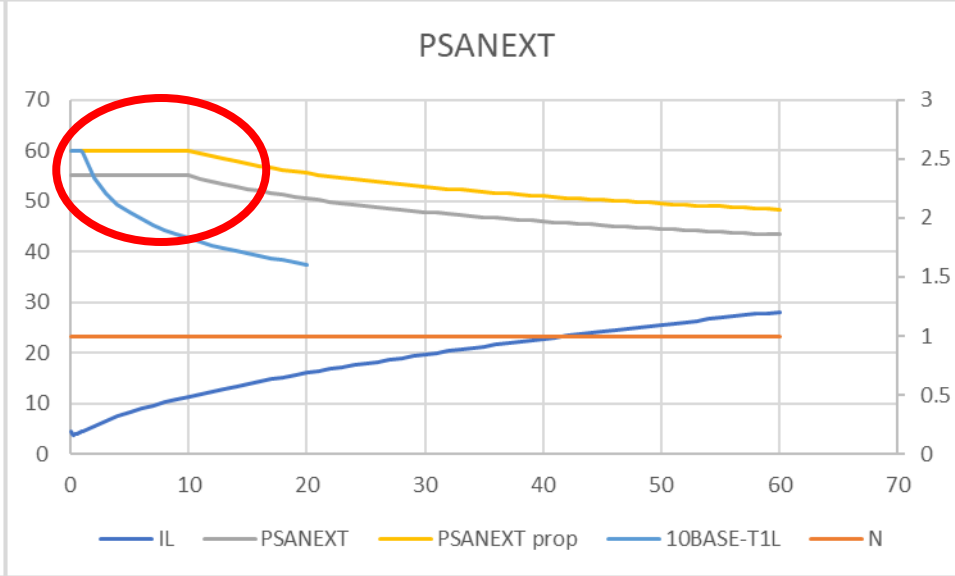
This formula was presented already during the Atlanta plenary in graber_3dg_01_03152023.

What is the impact?

Current Alien specification: PSANEXT

Impact of the new proposal:



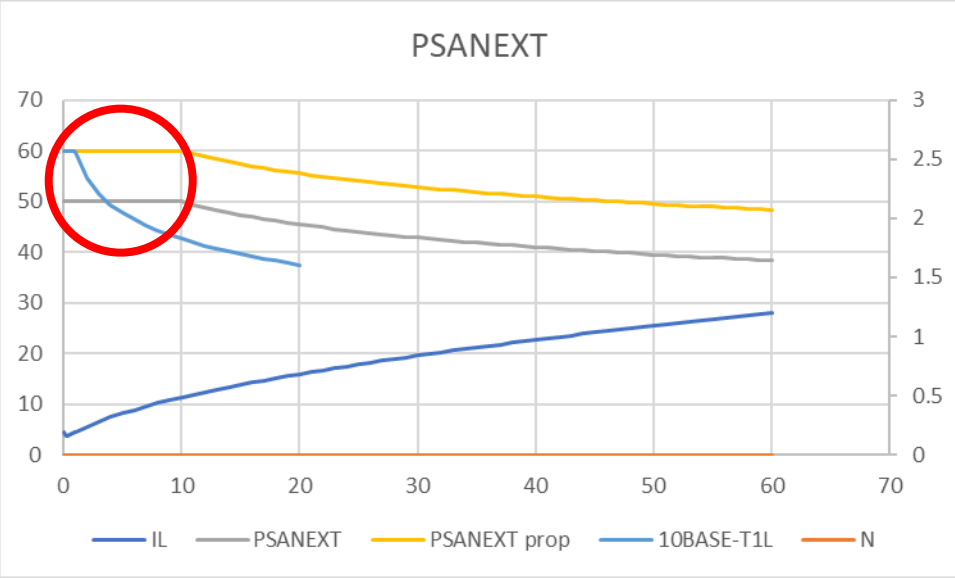


403m and longer

305m to 402m

Current Alien specification: PSANEXT

Impact of the new proposal:



304m and shorter

Current Alien specification: PSANEXT

Conclusion

The new proposal for PSANEXT as shown on slides 9-11 has an impact mainly for links of 402m and shorter. Long links of 403m or longer are not affected as N=2 and requires the highest limit anyway.

With the new limit we remove the IL/length dependency which is physically for a passive link the well known behaviour.

Current Alien specification: PSANEXT

Conclusion

Less complexity makes testing easier and faster as predictions of installation changes are possible.

We can fulfil our goal 4, as we pass the 10BASE-T1L requirements below 4MHz, which is the essential frequency range as the Nyquist frequency is 3.75MHz.

Current Alien specification: PSAACR-F

We have agreed on the below Power Sum Alien Attenuation to Crosstalk Ratio Far end(PSAACR-F) requirement.

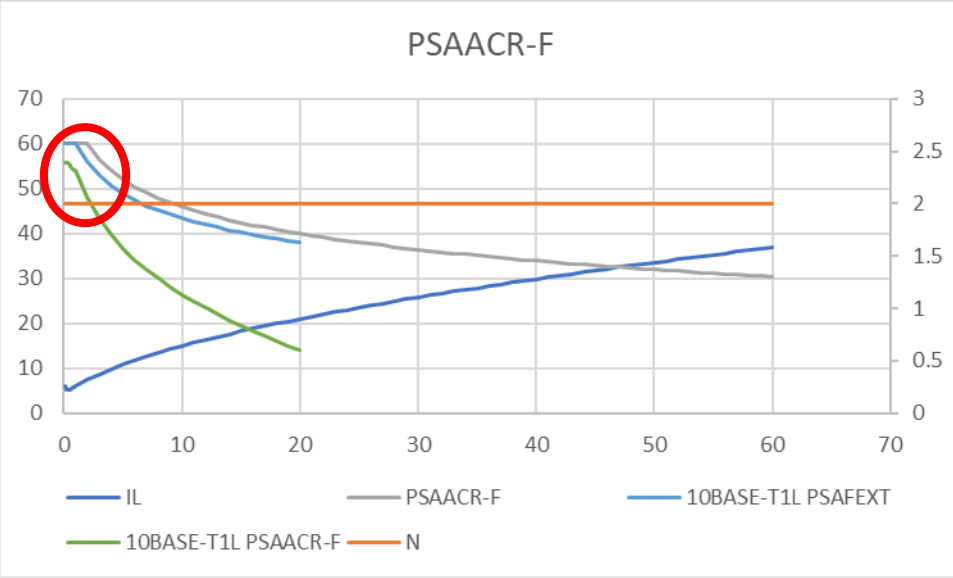
$$PSAACR - F\ [dB] = \begin{cases} 50 + 5 \times N & for\ 0.1\ MHz \leq f < 2\ MHz \\ 36 + 5 \times N - 20 \times log_{10}\left(\frac{f}{10}\right) & for\ 2\ MHz \leq f \leq 60\ MHz \end{cases}$$

$$with\ N = \begin{cases} 0 & for\ 16\ dB < IL(20\ MHz) \\ 1 & for\ 16\ dB \leq IL(20\ MHz) < 21\ dB \\ 2 & for\ 21\ dB \leq IL(20\ MHz) \end{cases}$$

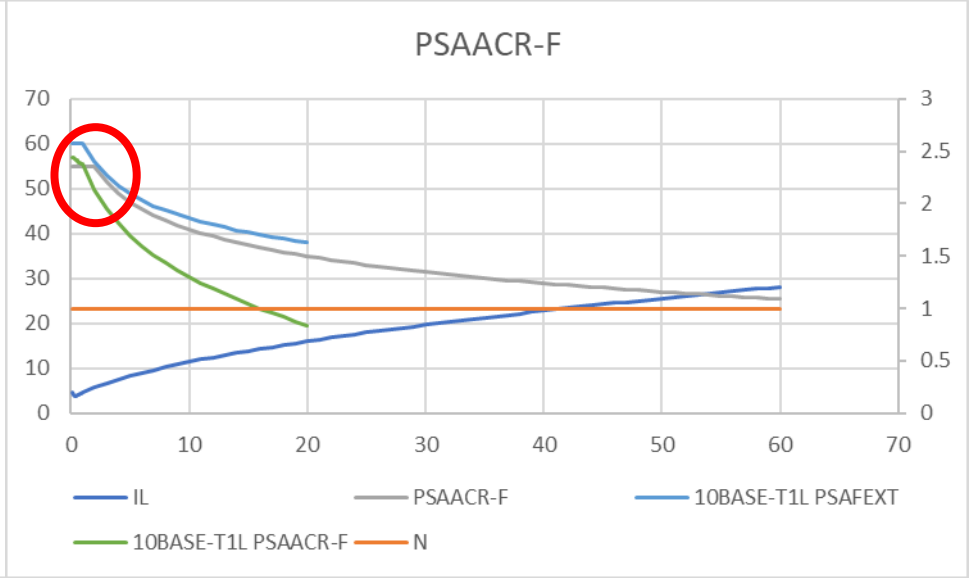
But what does it mean in reality?

Current Alien specification: PSAACR-F

Comparison of different link lengths for PSAACR-F:



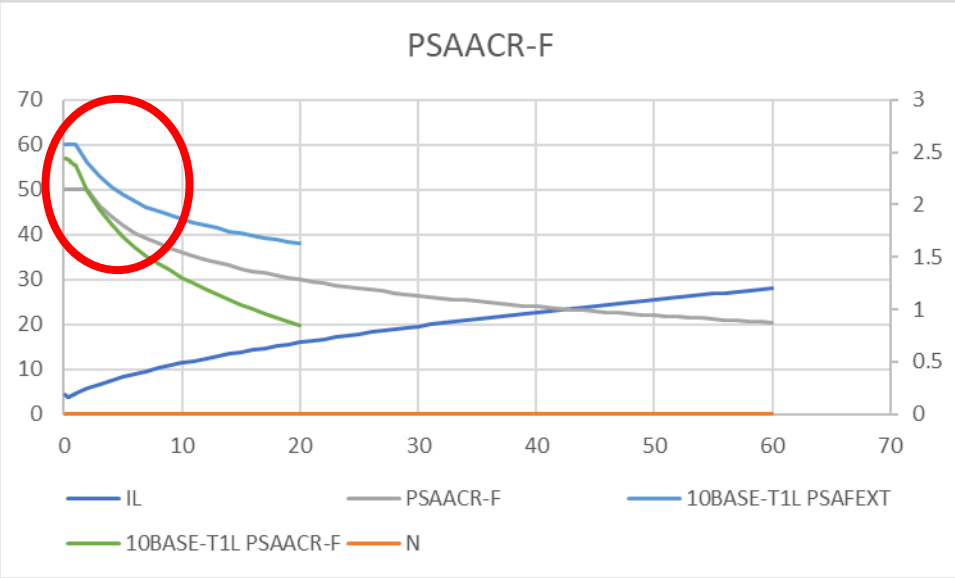
403m and longer



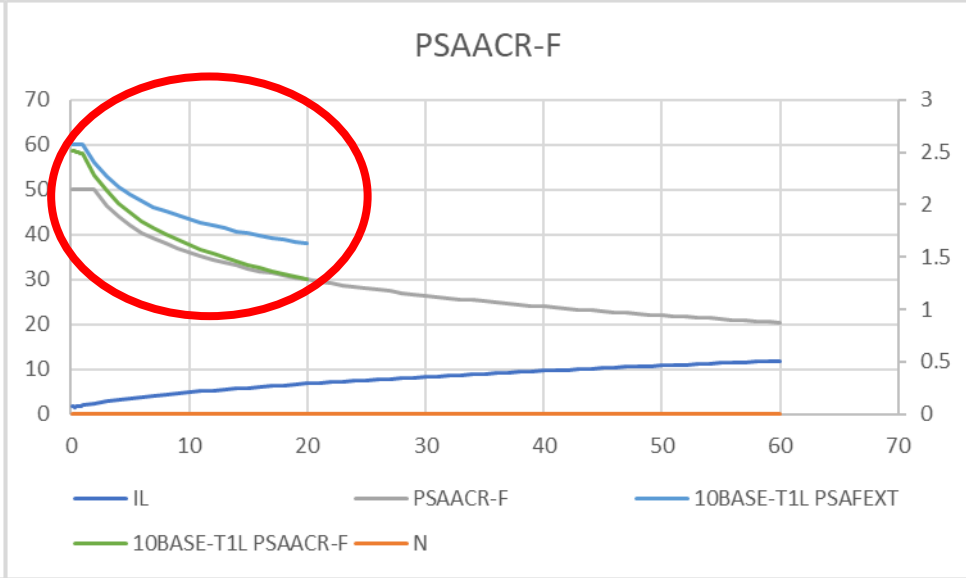
305m to 402m

Current Alien specification: PSAACR-F

Comparison of different link lengths for PSAACR-F:



304m and shorter



124m and shorter

Current Alien specification: PSAACR-F

What does it mean?

- IL dependent PSAACR-F is changing over the link length → this looks unusual.
- Changing of components might change IL, like expanding a patchcord from 2m to 3m at the critical IL points (16dB and 21dB) or expand the link by another section (e.g. from 304m to 403m, +10dB), a new PSAACR-F evaluation is needed. This is unpractical and generating a lot of extra work as the behaviour is difficult to predict.

Current Alien specification: PSAACR-F

What does it mean?

- The PSAAR-F limit gets vulnerable to temperature rise (testing at 20°C, operating above), measurement uncertainty of test equipment or between them.

Current Alien specification: PSAACR-F

- We violate indirectly our objective 4: Support for optional single-pair Auto-Negotiation as our requirement for PSAACR-F for 100BASE-T1L is below the requirement for 10BASE-T1L.

The power sum AFEXT between a disturbed 10BASE-T1L link segment and other disturbing 10BASE-T1L link segments shall meet the values determined using Equation (146–16) or 60 dB, whichever is less.

$$\mathrm{PSAFEXT}(f) \geq 38 - 18\log_{10}\left(\frac{f}{20}\right) \text{ dB} \qquad (146\text{–}16)$$

where

f is the frequency in MHz; $0.1 \leq f \leq 20$

Current Alien specification: PSAACR-F

For links shorter then 124m the complete 10Base-T1L frequency range is not covered by the current 100Base-T1L requirement.

What to do now? Reconsider the link specification, align it with the physical behaviour of a link and the 10BASE-T1L requirements.

Current Alien specification: PSAACR-F

New/ old proposal for PSAACR-F

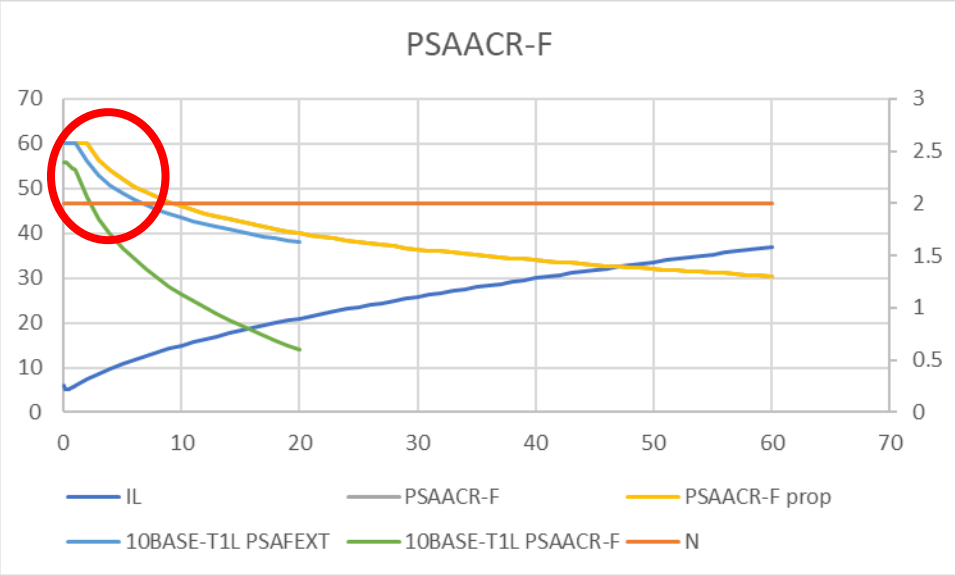
$$PSAACR - F\,[dB] = \begin{cases} 60 & for\ f < 2\ MHz \\ 46 - 20 \times log_{10}\left(\frac{f}{10}\right) & for\ 2\ MHz \leq f \leq 60\ MHz \end{cases}$$

This formula was presented already during the Atlanta plenary in graber_3dg_01_03152023.

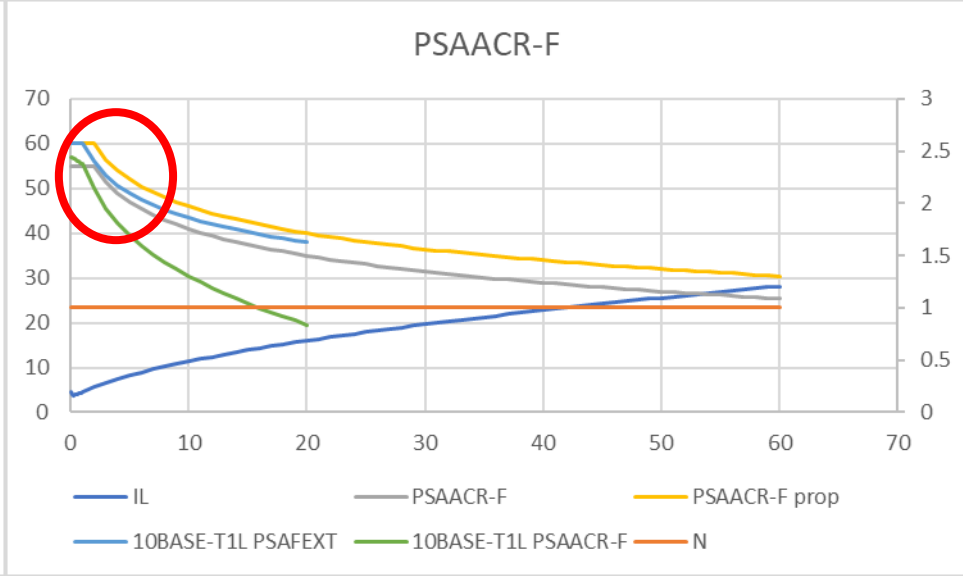
What is the impact?

Current Alien specification: PSAACR-F

Impact of the new proposal:



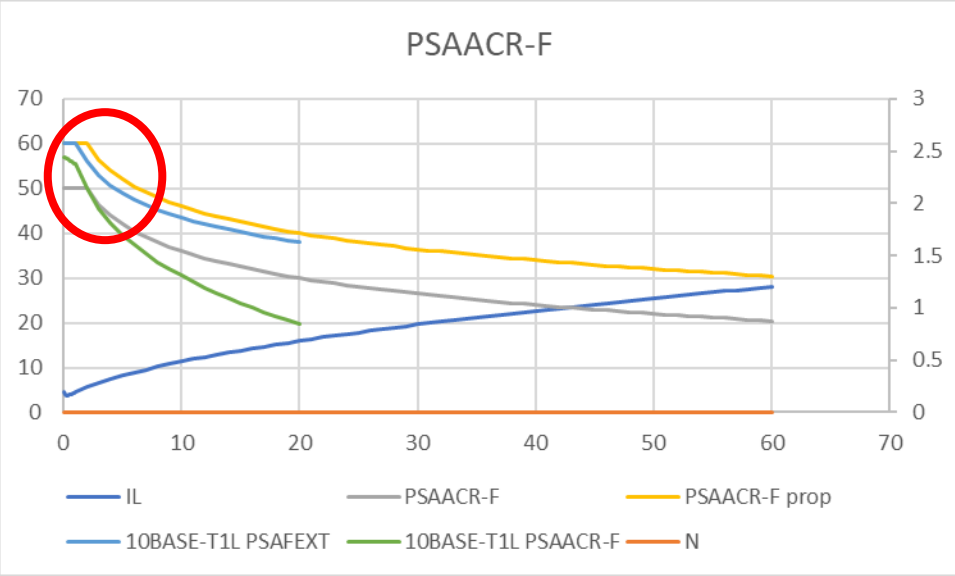
403m and longer



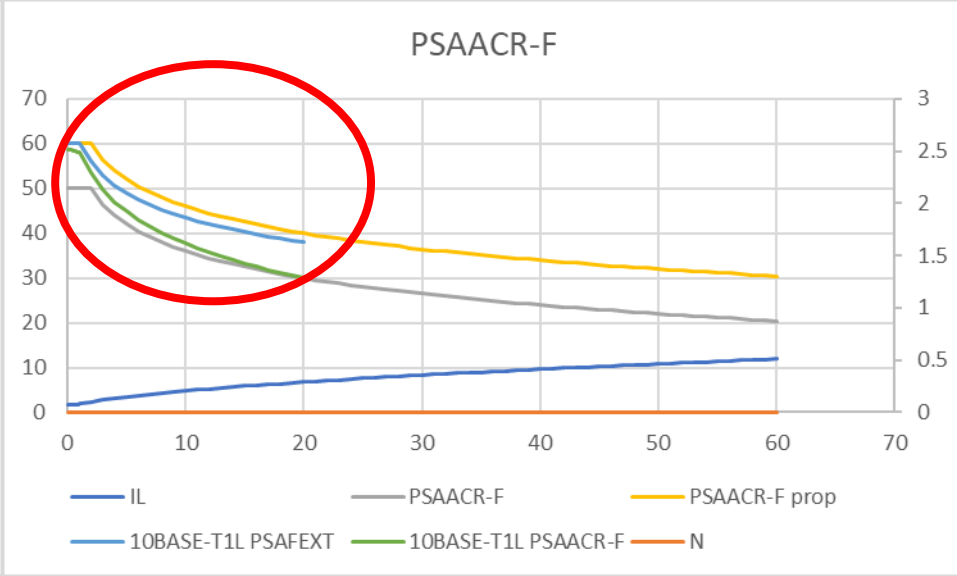
305m to 402m

Current Alien specification: PSAACR-F

Impact of the new proposal:



304m and shorter



124m and shorter

Current Alien specification: PSAACR-F

Conclusion

The new proposal for PSAACR-F as shown on slides 21-23 have an impact mainly on links of 402m and shorter. Long links above 403m are not affected as N=2 and requires the highest limit anyway.

Current Alien specification: PSAACR-F

Conclusion

Less complexity makes testing easier and faster as predictions of installation changes are possible.

We can fulfil our goal 4, as we pass the 10BASE-T1L requirements below 2 MHz (below 403m) to 6MHz (below 305m), which is the essential frequency range as the Nyquist frequency is 3.75MHz.

Coupling attenuation requirements for 10Base-T1L

Coupling attenuation for E1, E2 and E3.

Table 146–6—Coupling attenuation

Frequency (MHz)	(dB)		
	E_1	E_2	E_3
0.1 to 20	≥ 50	≥ 50	≥ 60

Coupling attenuation requirements for 10Base-T1L

In short, according to graber_3dg_01_05172023:

- Ringing is equivalent to 50-to-60-bit times.
- The signal and the ringing frequency will be much closer; therefore, filtering is less effective.
- Many bits are affected during an EFT pulse, FEC coding is limited or leading to high latencies.

What can we do?

Coupling attenuation requirements for 10Base-T1L

What can we do?

Ringing is long, filtering is less effective and FEC limited…

We can improve the mode conversion parameters to reduce the amplitude of the disturbing signal compared to 10Base-T1L.

Coupling attenuation requirements for 10Base-T1L

The fundamental formula for single pair about mode conversion is: TCL + AS = AC

Transvers conversion loss + screening attenuation = coupling attenuation.

The parameters we have to define is TCL for unscreened and coupling attenuation for screened links on the same level. Both parameters have to be improved similarly. Coupling attenuation can be found in several IEEE standards.

Coupling attenuation requirements for 100Base-T1L

For backward compatibility, or the ability to use autonegotiation, as defined as our goal number 4, we need a requirement which is at least as good as defined for 10Base-T1L.

As concluded on slide 27 from graber_3dg_01_ 05172023, we have to improve the mode conversion to reduce the impact of the EFT pulse amplitude.

Coupling attenuation requirements for 100Base-T1L

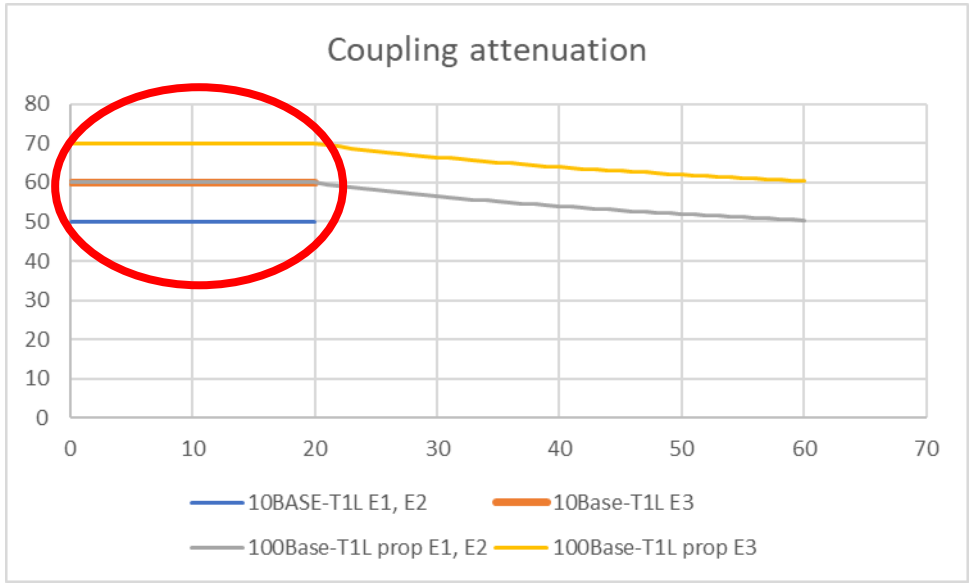
As listed on slide 26, several options we usually can use to suppress the EFT pulse on the signal are not as effective as for other single pair applications by different reasons. Therefore to improve the mode conversion is an additional options to improve the signal quality, which can make here the difference.

The proposal is:

	Frequency (MHz)	E1	E2	E3
Coupling attenuation	0.1 ≤ f ≤ 20	60	60	70
Coupling attenuation	20 < f ≤ 60	66-20*log(f/10)	66-20*log(f/10)	76-20*log(f/10)

Coupling attenuation requirements for 100Base-T1L

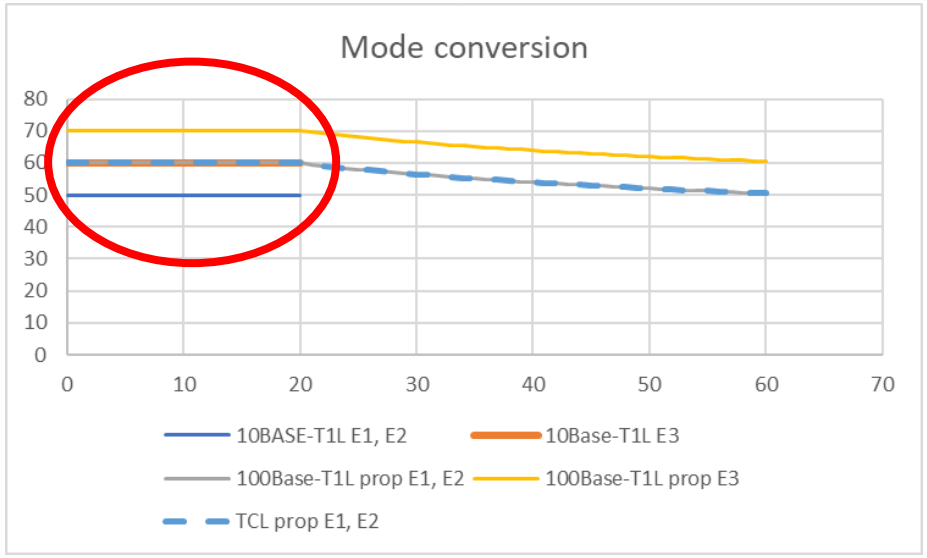
	Frequency (MHz)	E1	E2	E3
Coupling attenuation	0.1 ≤ f ≤ 20	60	60	70
Coupling attenuation	20 < f ≤ 60	66-20*log(f/10)	66-20*log(f/10)	76-20*log(f/10)



Coupling attenuation requirements for 100Base-T1L

By the same reason TCL has to be improved to the same level as coupling attenuation for E1 and E2.

	Frequency (MHz)	E1	E2
TCL	0.1 ≤ f ≤ 20	60	60
TCL	20 < f ≤ 60	66-20*log(f/10)	66-20*log(f/10)



Discussion