Normative Channel Model for IEEE802.3ap

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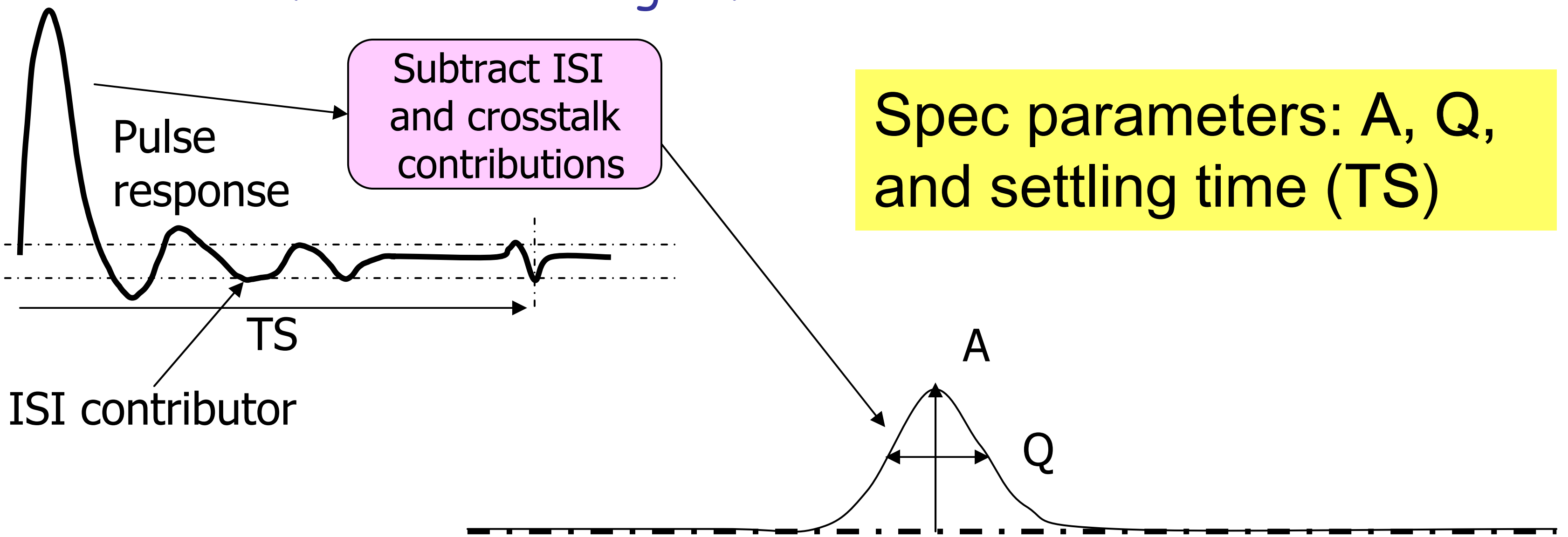
Back Ground for Normative Channel

- The channel only…
  - Lets assume that signaling is tangent to building boards.
  - We qualify the channel on its own merits
  - It is desirable to avoid doing a tx and rx design to evaluate a channel!
- Lets assume equalization does its job
  - Beyond that can we assign a relative "cost" to the channel associated with the degree of difficulty to implement in silicon.
- We can define our "own eye" based on difficultly to implement channel

☛ The normative spec should be relatively easy to understand.

It's not an eye

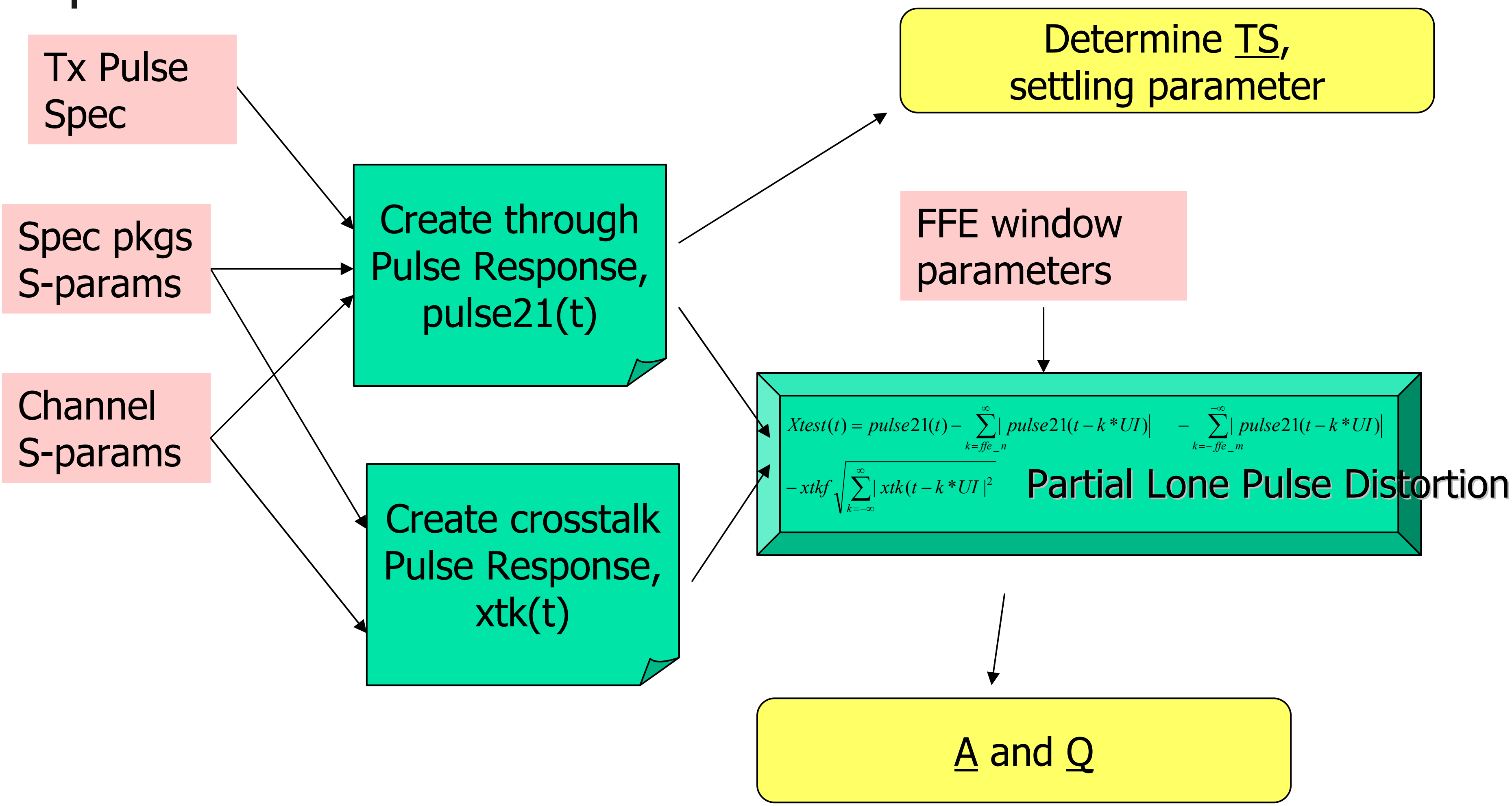
- Basic approach … measure the bump!☺
  - Utilize the sum of ISI distortion to reduce the "pulse in a window" of the system pulse response.
  - Further reduce the "pulse in the window" with the crosstalk pulse response
  - Also measure settling time



Spec parameters: A, Q, and settling time (TS)

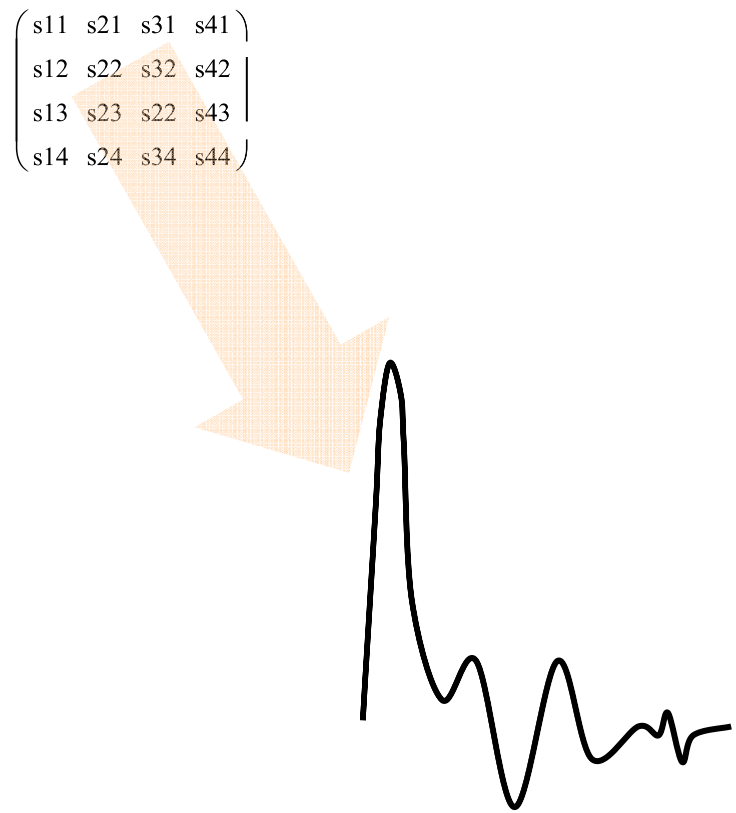
- This is not an eye, but these **3 parameters** should correlate to an eye

Process Overview



Partial Lone Pulse Distortion Response
Pulse response for board

- Can be determine from a variety of sources
- Simulation
- Measurement
- S-parameters convolution
  - Use only 4x4 files (for differential)
    - Through 4x4
    - Crosstalk 4x4's
  - Extract from data base file
  - Stick figure model



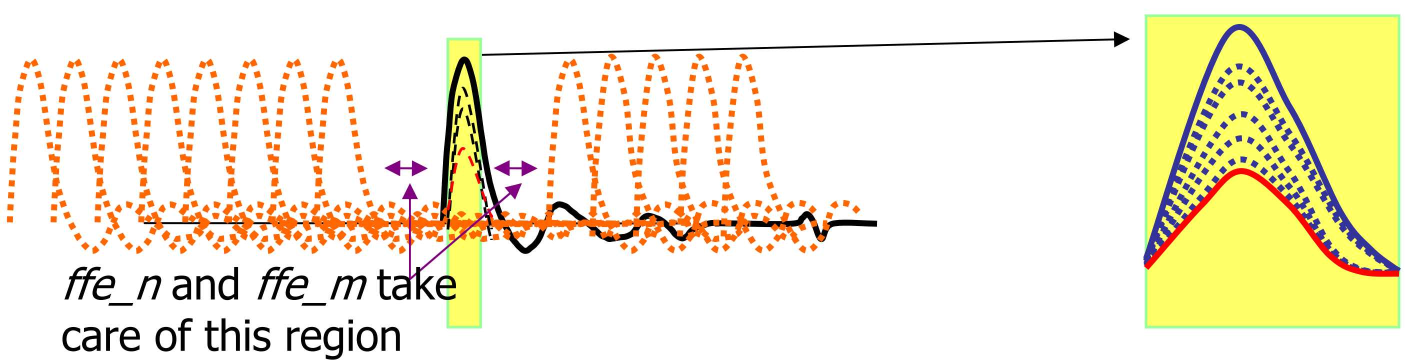
Partial Lone Pulse Distortion Response

Distort pulse with ISI

$$\mathrm{isi\_fct}(t) := \sum_{k = \mathrm{ffe\_n}}^{n} \left(\left|\mathrm{Pulse21p}(t - k \cdot \mathrm{UI})\right|\right) \ldots$$
$$+ \sum_{k = -\mathrm{ffe\_m}}^{-n} \left(\left(\left|\mathrm{Pulse21}(t - k \cdot \mathrm{UI})\right|\right)\right)$$

$$\mathrm{lvl} := .2$$

$$\mathrm{Xtest}(t) := (\mathrm{Pulse21}(t) - \mathrm{isi\_fct}(t) + \mathrm{lvl}) \cdot \Phi(\mathrm{Pulse21}(t) - \mathrm{isi\_fct}(t) + \mathrm{lvl})$$



Add in crosstalk

- Convert the crosstalk to a pulse, xtk(t)
- RSS the contributions of crosstalk
  - Many not want to RSS and just use a strait sum
- We may want to adjust the crosstalk with a factor, *xtkf*, but maybe this is just 1

$$Xtest(t) = pulse21(t) - \sum_{k=ffe\_n}^{\infty} \left| pulse21(t - k*UI) \right| - \sum_{k=-ffe\_m}^{-\infty} \left| pulse21(t - k*UI) \right|$$

$$- \sum_{i=1}^{n} xtkf_i \sqrt{\sum_{k=-\infty}^{\infty} \left| xtk_i(t - k*UI) \right|^2}$$

Example in MathCad

Choose n as convolution limits $n := 35$ Set pulse width $UI := 97ps$

ffe taps

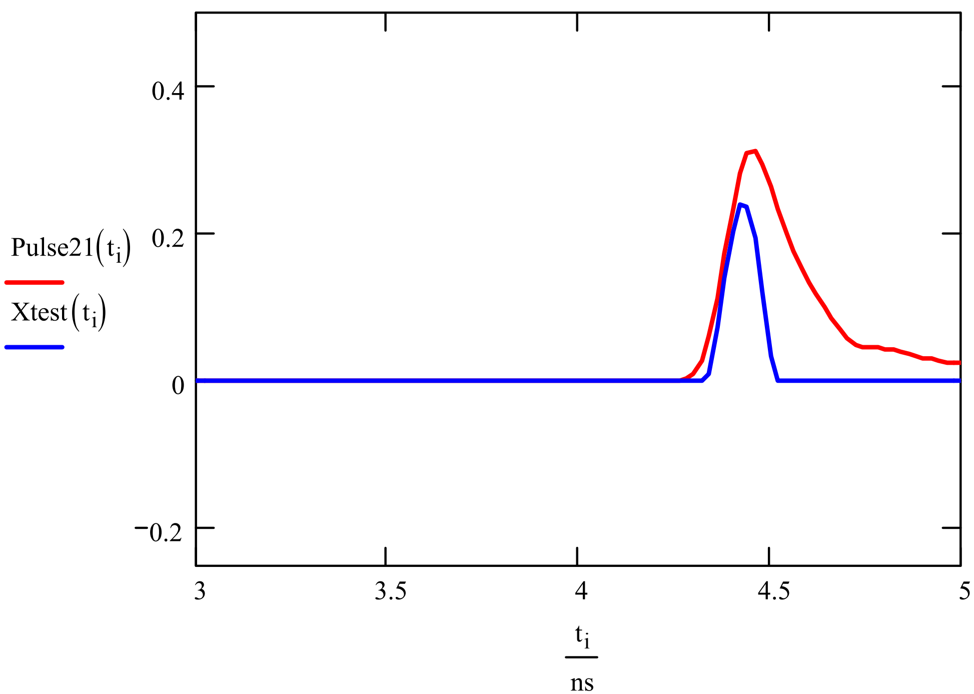
$ffe\_n := 1 \quad ffe\_m := 4$

Create worst case possible history of pulses for ISI.
Assuming FFE fixes some number of UI

$$isi\_fct(t) := \sum_{k = ffe\_n}^{n} \left(\left|Pulse21(t - k\cdot UI)\right|\right) + \sum_{k = -ffe\_m}^{-n} \left(\left|Pulse21(t - k\cdot UI)\right|\right)$$

Define the test function Xtest and set threshold level $lvl := .2$

$$Xtest(t) := (Pulse21(t) - isi\_fct(t) + lvl)\cdot\Phi(Pulse21(t) - isi\_fct(t) + lvl)$$



Find width at 1/2 Xtest

$X_i := Xtest(t_i)$ $\quad max(X) = 0.239$

$$\begin{aligned} T1 := &\ \text{for } k \in ix - 1 .. 0 \\ &\quad \text{return } t_k \text{ if } X_k > 0.5max(X) \\ T2 := &\ \text{for } k \in 0 .. ix - 1 \\ &\quad \text{return } t_k \text{ if } X_k \geq 0.5\cdot max(X) \end{aligned}$$

Width $\quad T1 - T2 = 2 \times 10^5\ ps$

$P_i := Pulse21(t_i)$

Set settling threshold $Sth := .08\%$

$$\begin{aligned} TS := &\ \text{for } k \in ix - 1 .. 0 \\ &\quad \text{return } t_k \text{ if } P_k > Sth\cdot max(P) \\ TS2 := &\ \text{for } k \in 0 .. ix - 1 \\ &\quad \text{return } t_k \text{ if } P_k > 0.5\cdot max(P) \end{aligned}$$

Settling Time: $\quad \frac{TS - TS2}{UI} = 96.086$

Next

- Extract data for A, Q, and Ts
- Compare to order data sets
- Figure out what to do with crosstalk
- Process s-parameters with different lvl, m, and n parameters to optimize correlation.