Error Propagation Effect on FEC Performance

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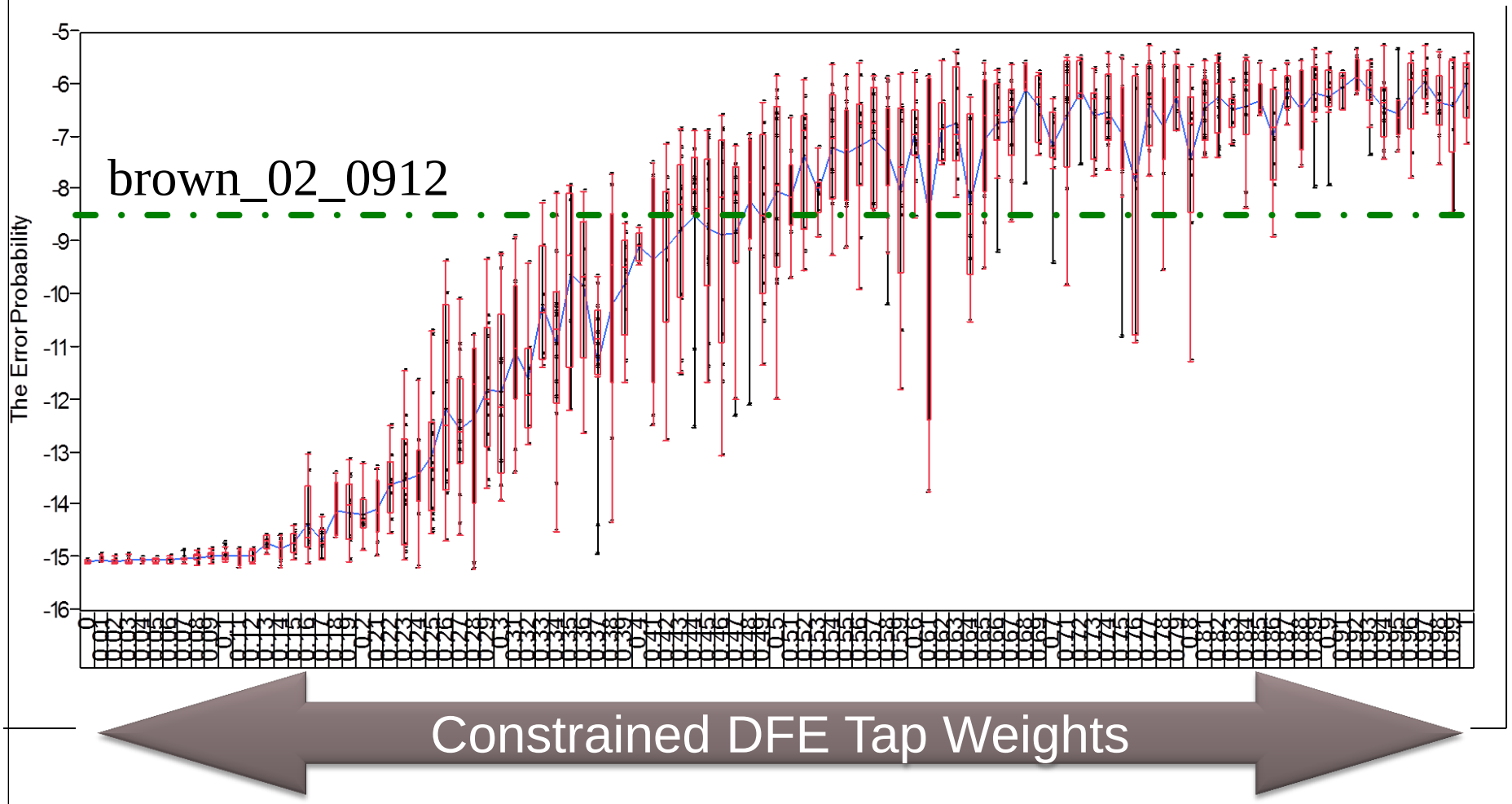
Introduction

- The effects of error propagation in DFE must be taken into consideration when calculating COM.
- Suggestion is to constrain the DFE tap weights to retain an acceptable uncorrectable codeword ratio (UCR).

Methodology Summary

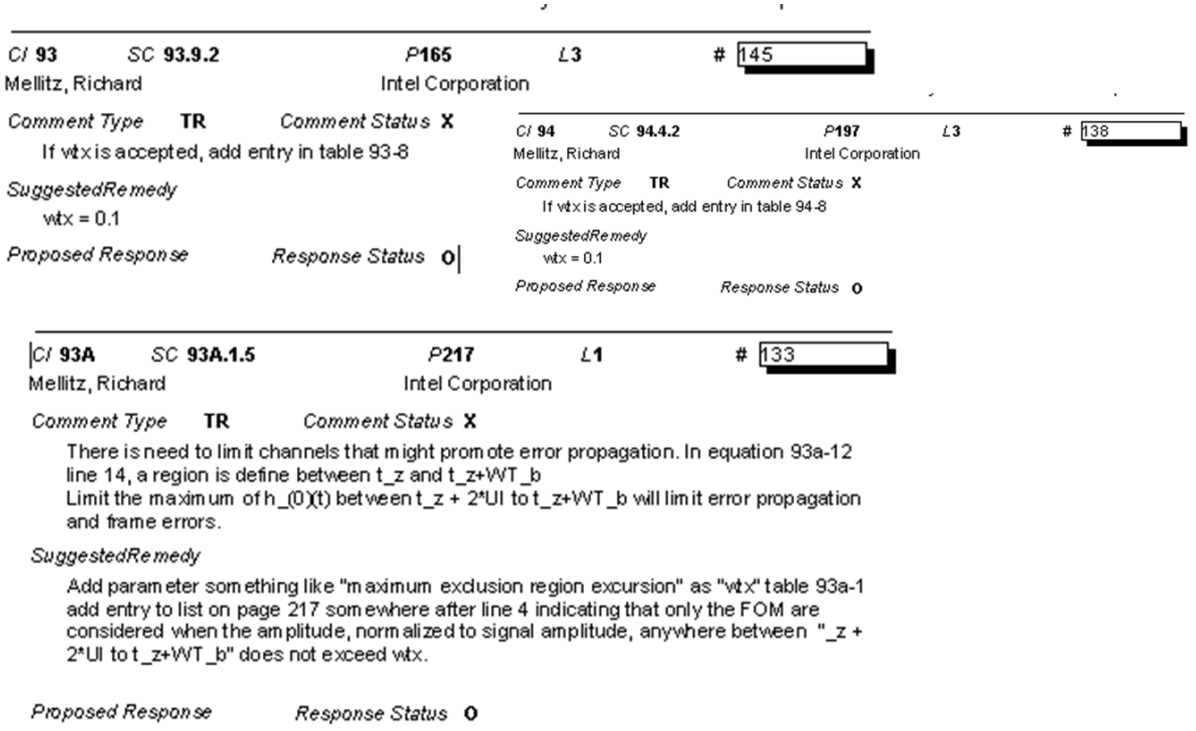
- A DFE is in error state if there exists at least one erroneous decision in the state of the feedback filter.
- An error event occurs when the DFE transitions from the non-error state to the error state.
- The error event manifests as error propagation or an error burst.
- This transition happens only if noise at the slicer input exceeds the minimum distance of the constellation.
- The uncorrectable codeword ratio (UCR) as a function of tap weights can thus be calculated.
  - A more detailed description of the methodology is provided in the backup slides.
- The tap weights must be constrained such that resulting UCR << 2.81E-9 (see brown_02_0912).

The Error Probability vs. Constrained DFE Tap Weights (in the Excluded Window)



Recommendation

- The constrained tap weights are called ‘wtx’ in comments133, 138, and 145
- Setting ‘wtx’ 0.2 is safe



Cl **93** *SC* **93.9.2** *P***165** *L***3** # 145
Mellitz, Richard — Intel Corporation
Comment Type **TR** *Comment Status* **X**
If wtx is accepted, add entry in table 93-8
SuggestedRemedy
wtx = 0.1
Proposed Response *Response Status* **O**

Cl **94** *SC* **94.4.2** *P***197** *L***3** # 138
Mellitz, Richard — Intel Corporation
Comment Type **TR** *Comment Status* **X**
If wtx is accepted, add entry in table 94-8
SuggestedRemedy
wtx = 0.1
Proposed Response *Response Status* **O**

Cl **93A** *SC* **93A.1.5** *P***217** *L***1** # 133
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Comment Type **TR** *Comment Status* **X**
There is need to limit channels that might promote error propagation. In equation 93a-12 line 14, a region is define between t_z and t_z+WT_b
Limit the maximum of h_(0)(t) between t_z + 2*UI to t_z+WT_b will limit error propagation and frame errors.
SuggestedRemedy
Add parameter something like "maximum exclusion region excursion" as "wtx" table 93a-1 add entry to list on page 217 somewhere after line 4 indicating that only the FOM are considered when the amplitude, normalized to signal amplitude, anywhere between "_z + 2*UI to t_z+WT_b" does not exceed wtx.
Proposed Response *Response Status* **O**

Backup

Methodology

- Start the DFE from a non-error state.
- In order to introduce the first error in an error event, artificially fix the amount noise to the first symbol of the error event n_0.
- Sweep the values of $n_0 > \frac{d_{min}}{2}$
- Minimum PAM4 distance is d_{min} and is 2/3
- All other random samples of transmit symbols are created by the Monte Carlo approach. All other sources of noise are random.

Post-Processing

- Adjust the results by conditionally multiplying the collected statistics by $P_{noise}(n_0)$, probability of noise

Post Processing

- Compute the weight distribution of the error events:
- Probability distribution of the number of PAM4 symbol errors per error event.
- Compute the number of PAM4 symbol errors in one frame using the union bound.
- Assume at most one PAM4 symbol in error per RS (Reed-Solomon) symbol.
- Compute PDF of each number of symbols in error in the RS codeword.
- PDF per codeword
- **What is the probability that the number of symbol errors is greater than the capability of the RS codeword?**

Multiple DFE taps, b, set to a maximum value ‘wtx’ for the DFE16 Monte Carlo data presented

b = [2*(0.5-rand()*wtx), 2*(0.5-rand()*wtx), …]

“wtx” is the largest value allowed for a DFE tap