Crosstalk Analysis using Reconvergence Correlation

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Outline

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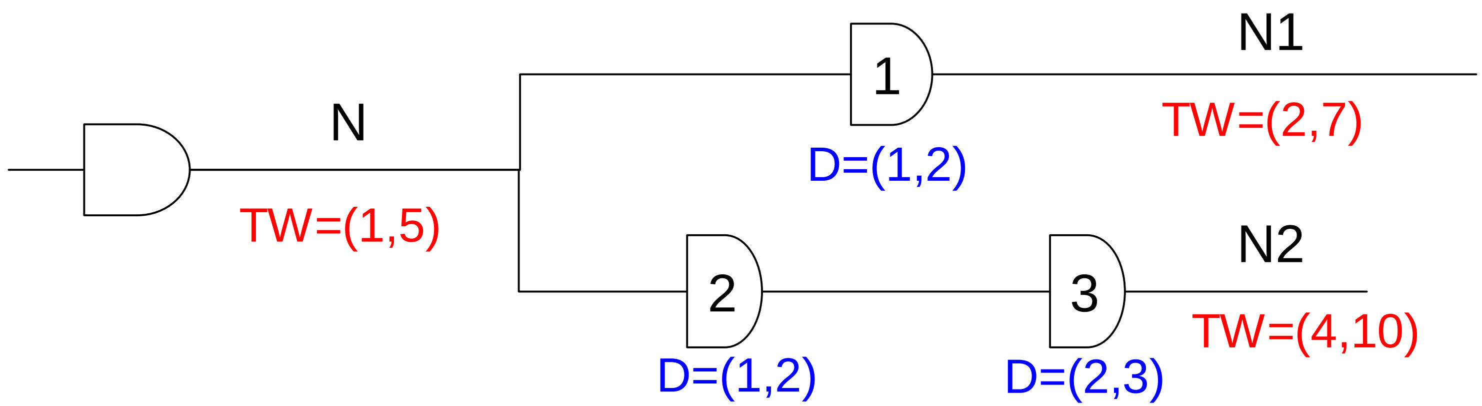
Problem Statement



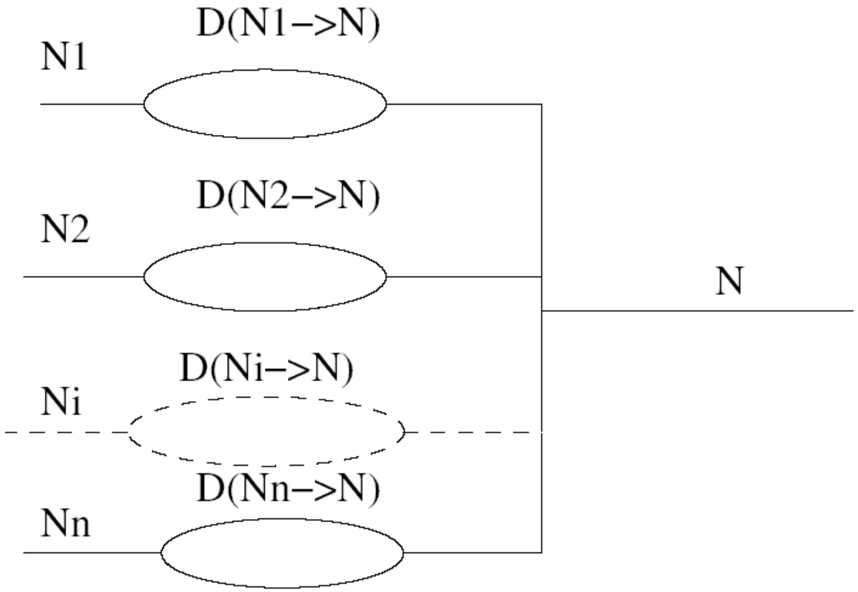
- Timing window at N1 and N2 overlap
  - Hence considered do be switching together
- But, if N switches at time t,
  - N1 and N2 can only witch at [t+1, t+2] and [t+3, t+5] respectively.
  - N1 and N2 can never switch together
- Pessimism in current methodology
- Current methodology ignores the correlation (Reconvergence) between N1 and N2

Timing Windows (Classical)

- Timing windows at Ni

  TW(Ni) = (t^i_{min}, t^i_{max})
- Delay from Ni to N

  $D(Ni \rightarrow N)=(d^i_{min}, d^i_{max})$
- Timing Windows at N



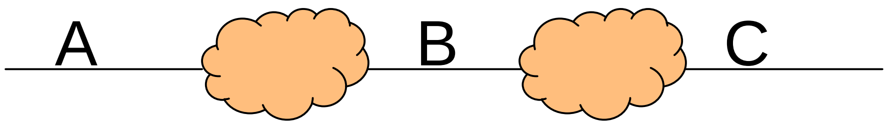
$$TW(N) = \bigcup_{i=1}^{n} \left(t^i_{min} + d^i_{min}, t^i_{max} + d^i_{max}\right)$$

- Due to addition, relative information is lost,
- We need a way to preserve this relative information

Relative Timing Windows

- In relative timing windows based approach, delays and timing windows of previous net are preserved
- TW at N relative to Ni

$$TW(N/Ni) = \{TW(Ni),\ D(Ni \rightarrow N)\}$$



- Given TW(C/B) and TW(B/C),

$$TW(C/B) = \{TW(B), D(B \rightarrow C)\}$$

$$TW(B/A) = \{TW(A), D(A \rightarrow B)\}$$

- TW(C/A) Can be calculated as,

$$TW(C/A) = \{TW(A),\ D(A \rightarrow B) \oplus D(B \rightarrow C)\}$$

Crosstalk Analysis

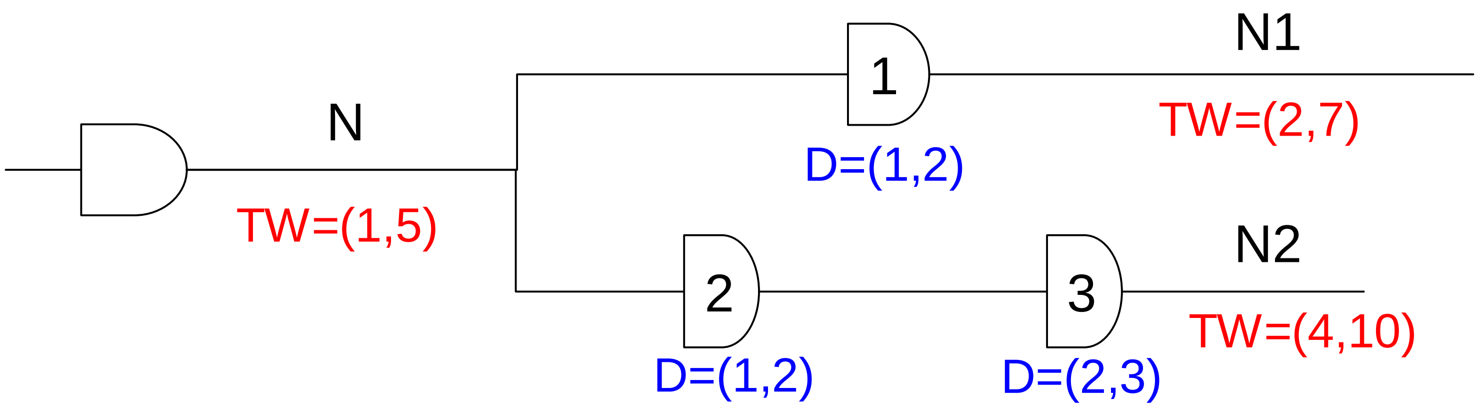
- To find if $A1$ and $A2$ can switch together,
  - Find latest common divergence points in fan-in cone of $A1, A2$. Let these points are set Φ .
  - Find relative TW of $A1, A2$ relative to all points in Φ

$$TW(A1) = \bigcup_{i \in \phi} \{TW(i), D(i \rightarrow A1)\}$$

$$TW(A2) = \bigcup_{i \in \phi} \{TW(i), D(i \rightarrow A2)\}$$

Common part (TW(i)) can be ignored, hence nets $A1$ and $A2$ can switch together if D($i \rightarrow A1$) and D($i \rightarrow A2$) overlap

Crosstalk Analysis (Example)



- To find if N1 and N2 can switch together,
  - Find latest divergence point (N in this case)
  - Find relative TW of N1,N2 relative to N

    TW(N1/N)={TW(N),(1,2)}

    TW(N2/N)={TW(N),(3,5)}
  - Common part (TW(N)) can be ignored hence nets N1 and N2 don't switch together

Probabilistic Analysis

- Let victim has N aggressors
- All switching events are uniformly distributed in time period T.
- If width of timing window of i_{th} aggressor is τ_i.
- Probability that all nets can switch together

$$P_{old} = \left(\prod_{i=1}^{N} \frac{\tau_i}{T} \right) \left(\sum_{j=1}^{N} \frac{T}{\tau_j} \right)$$

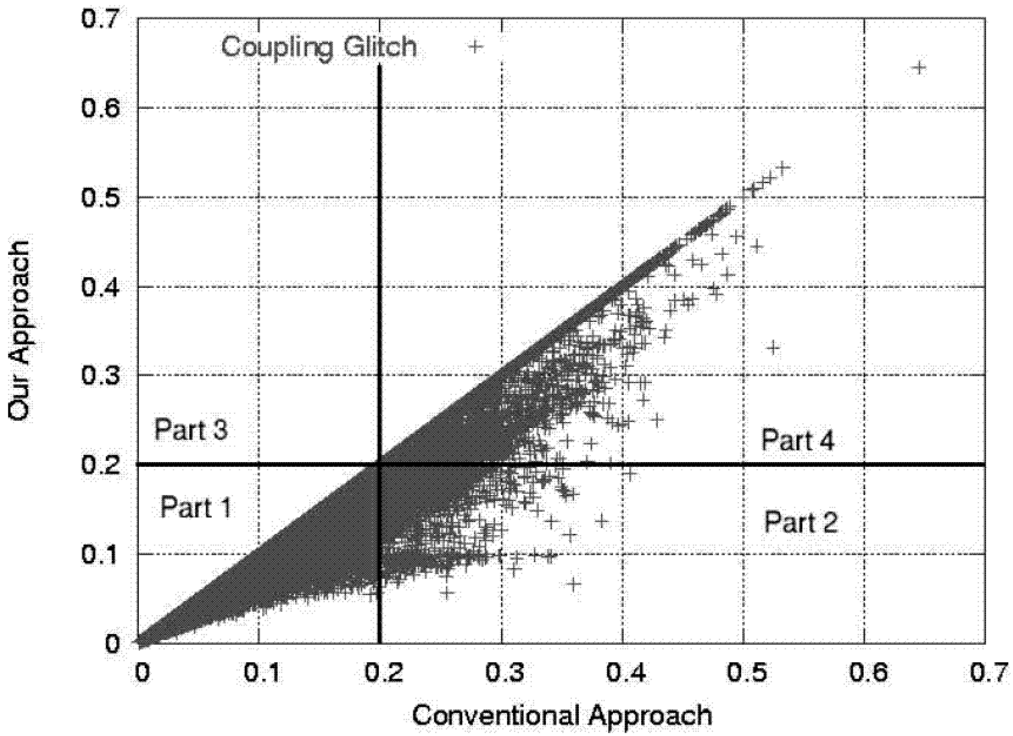
Conventional Approach

- Let width of TW at divergence point is d, Prob. will be

$$P_{new} = \left(\prod_{i=1}^{N} \frac{\tau_i - d}{T} \right) \left(\sum_{j=1}^{N} \frac{T}{\tau_j - d} \right)$$

Our Approach

Results (Crosstalk Glitch)



Part 1 : Nets below threshold (using conventional and proposed approach) = 139634

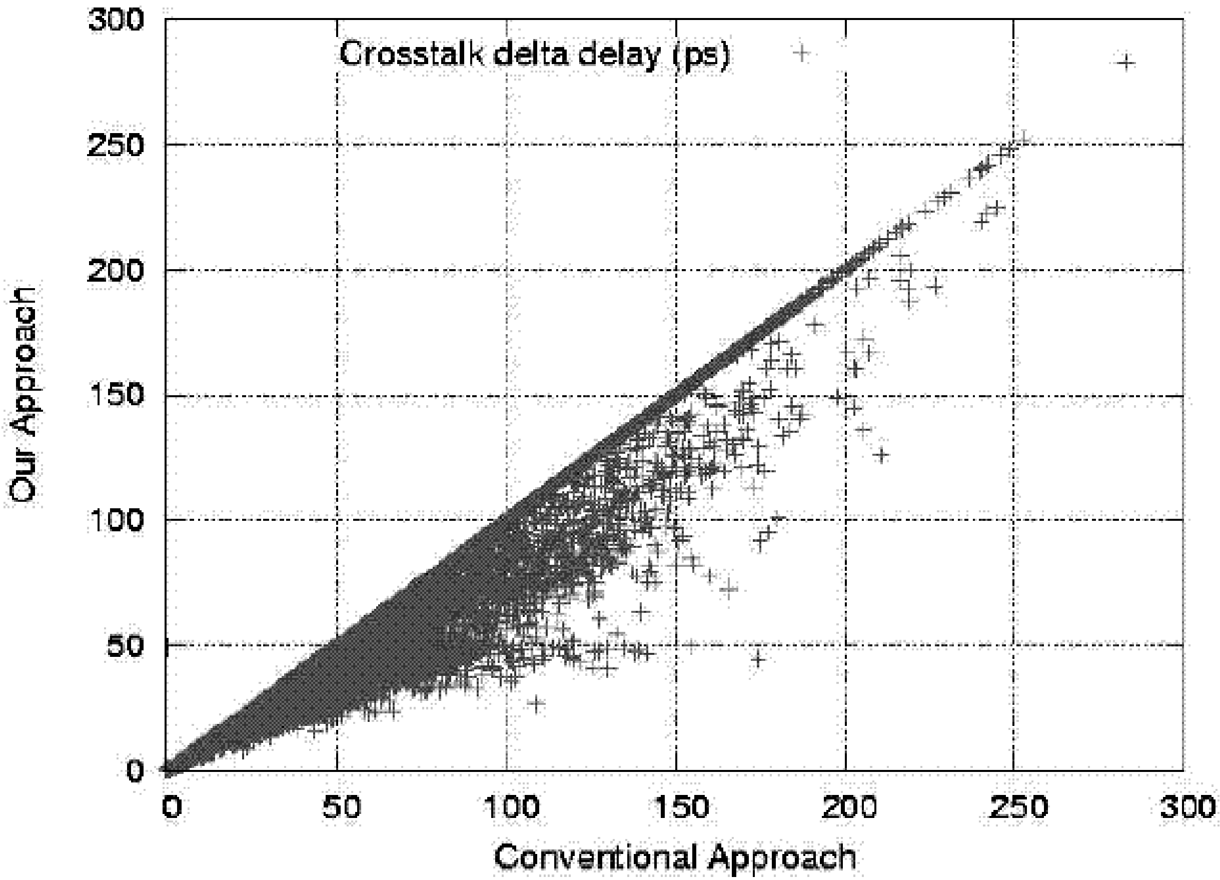
Part 2 : Violation pruned with proposed approach = 2053

Part 3 : New violations due to proposed approach = 0

Part 4 : Nets above threshold (using existing and proposed approach) = 14906

on a 65nm design

Results (Crosstalk Delay)



on a 65nm design

Conclusions

- Current approach does not consider correlation between nets
  - Can lead to pessimistic analysis
- We proposed use of relative timing windows to address this pessimism
- We analytically found the effectiveness of the approach using probabilistic methods
- Our approach pruned many false violation on a real design

Thank You

Q&A