IBM Systems

Hierarchical Coupled Noise Analysis using Timing Windows Derived from Required Arrival Times

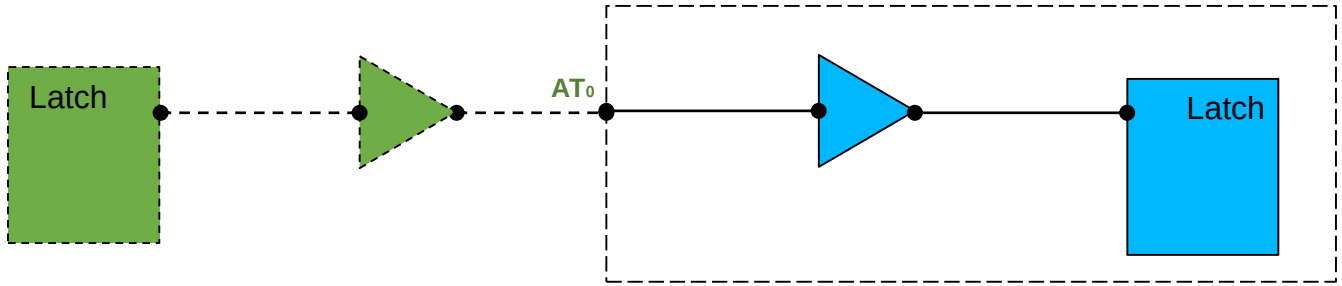
Jason Morsey, Steven Washburn, Patrick Williams
EDA, IBM Systems
Poughkeepsie, NY

June 2019

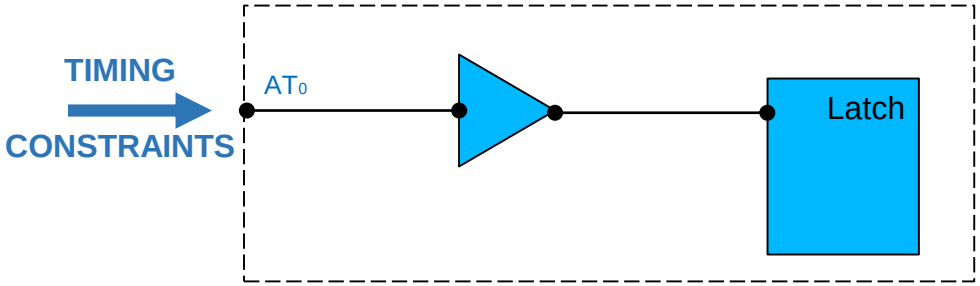
Motivation – Uncertain ATs

- **Goal: Eliminate our exposure in the noise impact on timing analysis due to arrival time constraints.**

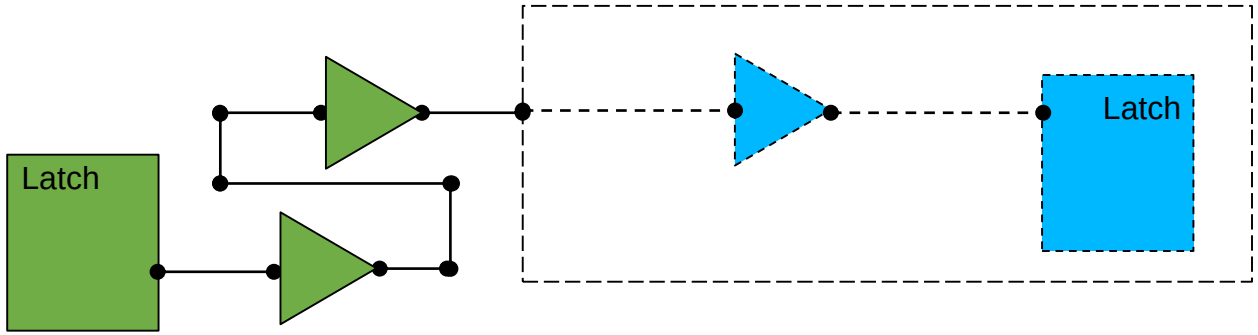
- In a hierarchical design methodology, the Lower Level design (blue) will be closed prior to closure of the Higher Level design (green)



- The timing and noise analysis of the Lower Level design will be done using timing values that are constrained at the hierarchical boundary.

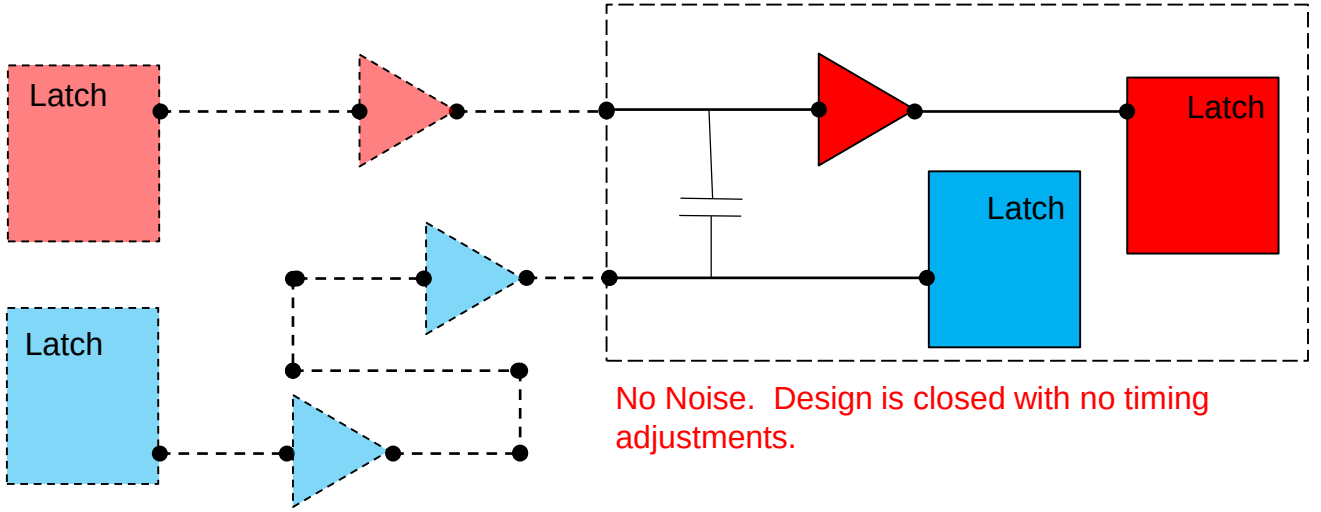


- **The Higher Level design may continue to evolve after the Lower Level design has closed. (Example shows a buffer added)**
- The existing Lower Level noise results may no longer be valid.

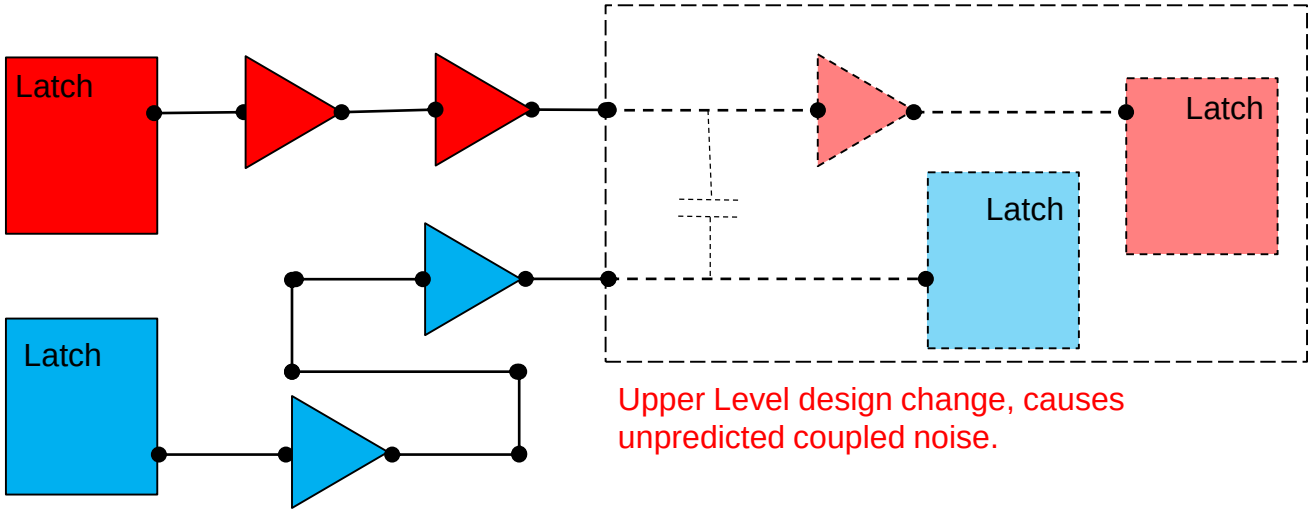


Motivation – Coupled Noise Exposure Example

- Coupled Noise is sensitive to the victim and aggressor path arrival times
  - Aggressors that are not in sync with the victim path are filtered out (windowing)
  - In this example (right), the aggressor path (red) sees less delay and arrives too early.
  - **In this example, the Lower Level design is closed with no coupled noise adjustment to timing.**



No Noise. Design is closed with no timing adjustments.



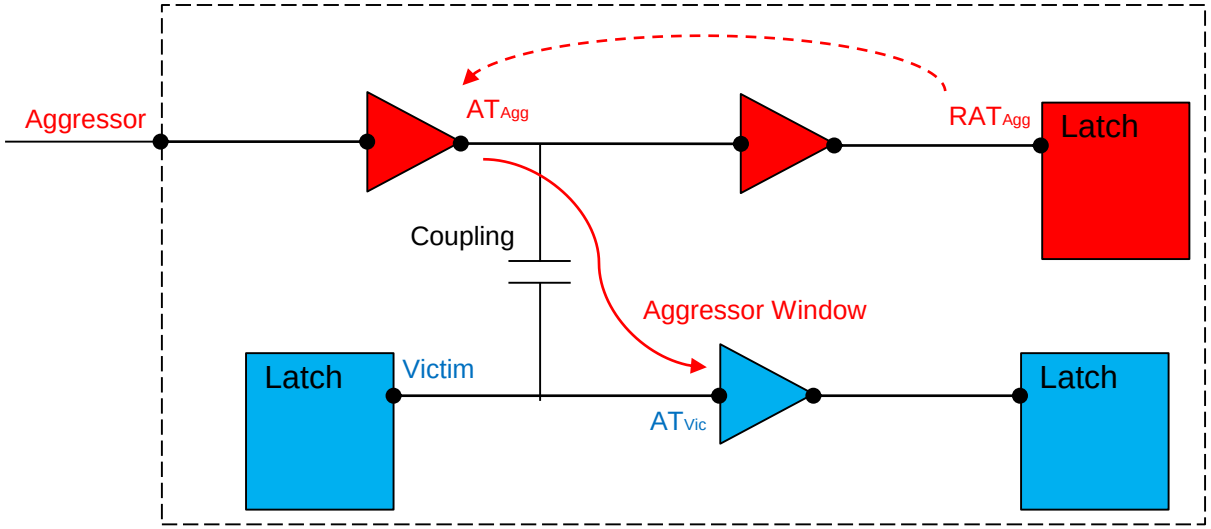
Upper Level design change, causes unpredicted coupled noise.

- **The red path at the Higher Level is now changed (left).**
  - It is now in sync with the blue path, and should have predicted a noise adjustment.
  - **Noise is now missing from the Lower Level analysis, putting hardware at risk of failure.**

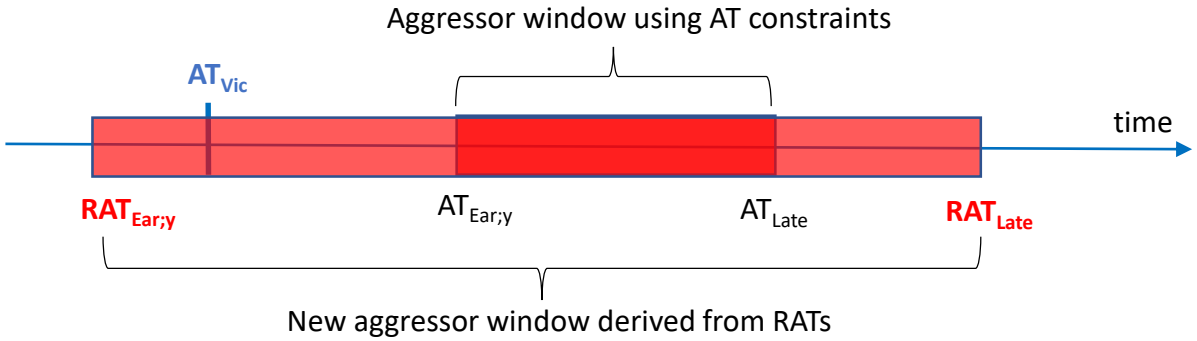
Solution - RAT based Aggressor Timing Windows

- **Main idea**: Remove exposure from arrival times (ATs) constraints in the coupled noise analysis.

- The Aggressor Timing Window is the range of time the aggressor may be injecting noise on the victim pin.
  - It is the range of ATs at the source pin (AT_{Agg}), shifted to the victim sink pin (AT_{Early} ,AT_{Late})
  - **By default, this range of ATs is based on constraint values translated to the victim pin (solid arrow), and may change after the Lower Level design has closed.**



- **Use the Required Arrival Time (dotted arrow)**, translated back to the aggressor driver, then to victim pin (solid arrow).
  - Produces an aggressor window of all realistic arrival times
  - **Independent of the Higher Level design**.

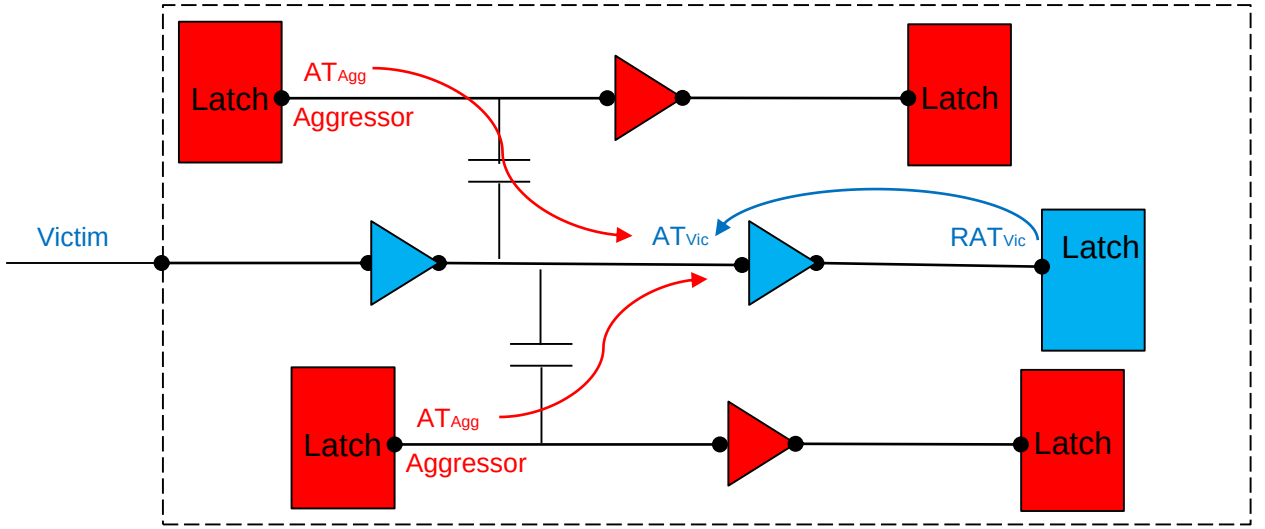


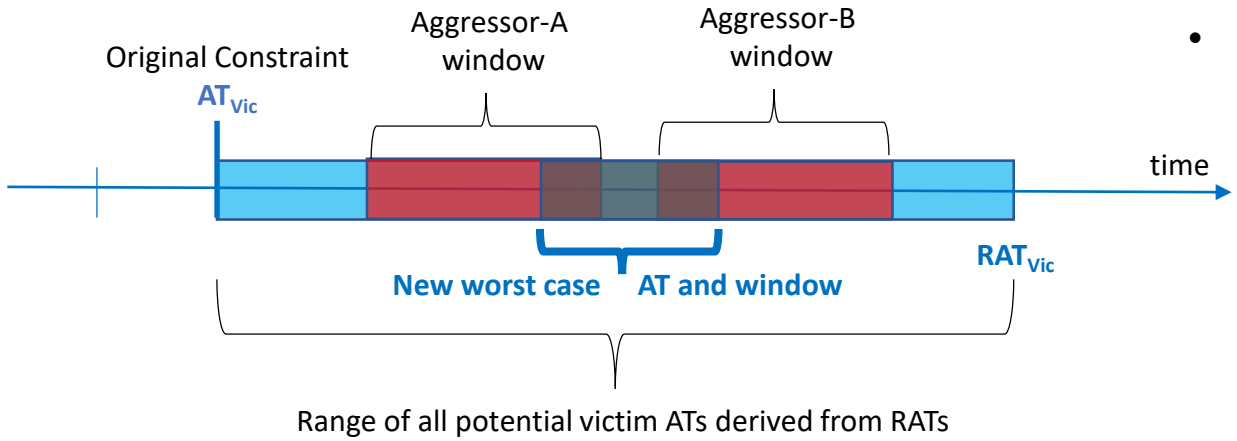
- Picture (left) shows overlay of original and new aggressor windows, and the victim AT.
  - As shown, AT constraints do not show the aggressor in sync with the victim arrival time. By default aggressor would be filtered.
  - **The RAT windowing shows it is possible that the Higher Level design could be changed to sync with victim AT. Therefore, we should include this aggressor.**

Solution - RAT based Victim Timing Windows

- **Main idea**: Remove exposure from arrival times (ATs) constraints in the coupled noise analysis.

- The Victim Timing Window is the range of time around a single arrival time AT_{Vic} on the victim pin.
  - **Victim timing shown is based on an AT constraint, and actual timing may change after the Lower Level design has closed.**
- Instead, the Required Arrival Time at the victim latch is translated back to the victim pin.
  - This **defines a range of potential arrival times** encompassing possible changes to the victim path.
- **The worst case victim arrival time (resulting in largest noise adjust) within this range is used to determine aggressor windowing.**

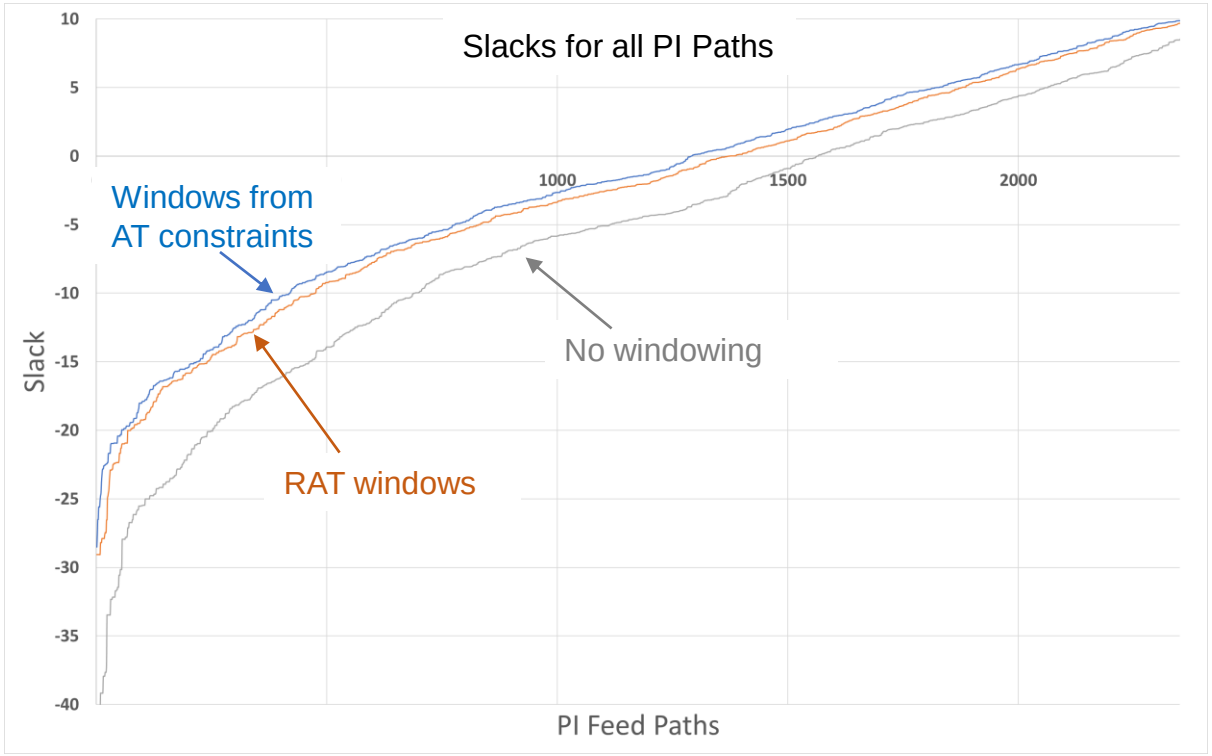


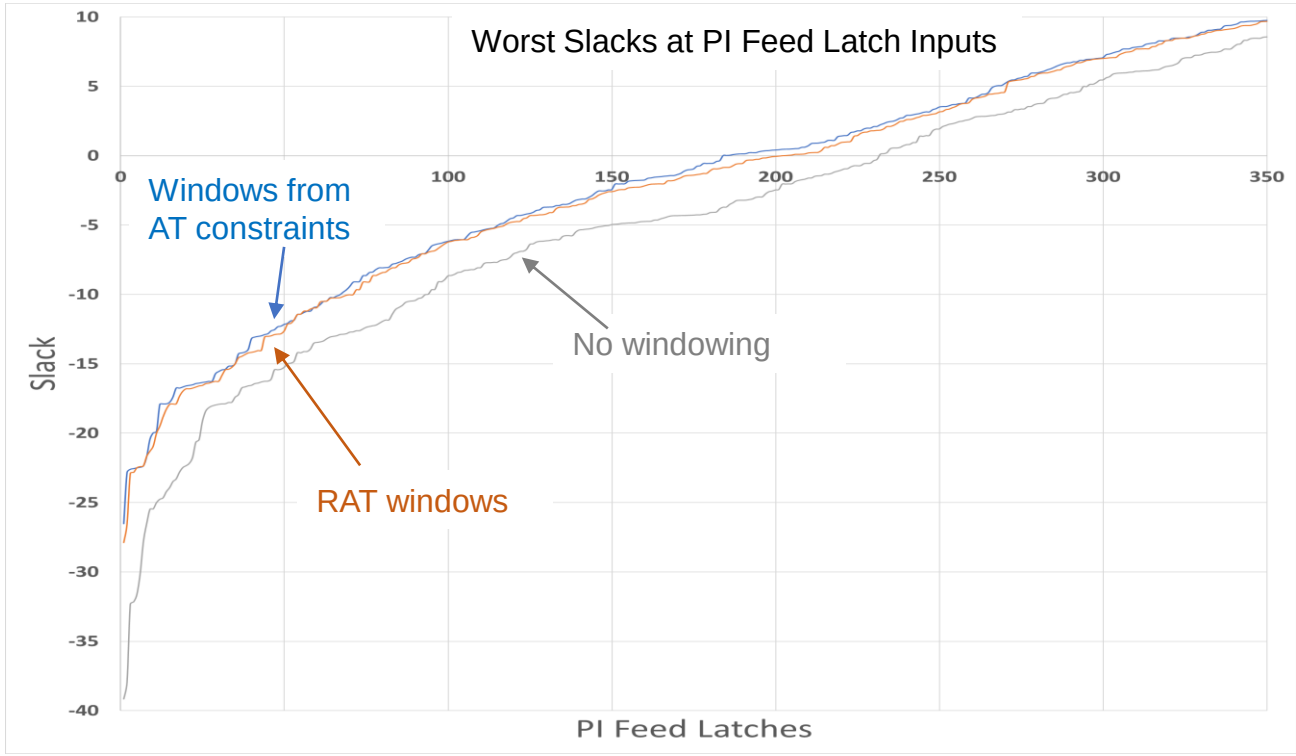


- Picture (left) shows the victim AT constraint, the aggressor AT windows (red), and the full range of possible victim arrival (blue)
  - By default, the victim AT constraint does NOT see any noise.
  - Using new RAT windows, the example would align the victim with both aggressors, worst case.
  - **This represents the noise result that WOULD happen if the Higher Level design were changed to the worst case AT.**

Results - RAT vs AT Constraints vs No Windowing

- The plots below show a comparison of slack values with coupled noise adjustments for all Lower Level paths feed by the Higher Level design (left) and only the subset of those slacks at the latch input pins (right).
- **The slack values including the new coupled noise results (Blue vs Orange curves) protect against all possible Higher Level design changes.**
  - As a metric for comparison, results with windowing disabled (also independent of AT constraints) is also shown
  - **New RAT based windowing gives nearly all the benefits of aggressor windowing, without exposure to Higher Level design changes.**





Summary

- Presented was a method of deriving timing windows for hierarchical coupled noise analysis using Required Arrival Times (RATs) instead of Arrival Time (AT) Constraints.
  - A repeat of the new aggressor method/windows is shown in figure below.

- RAT based windows remove the exposure associated with using the AT constraints, with minimal added pessimism.
  - **Once the Lower Level design has closed, any changes to the Higher Level design can only results in the existing Lower Level noise predications being pessimistic.**
  - **No missing fails!**