SIGMA DYNAMIC VOLTAGE DROP (SDVD): HIGH COVERAGE SOLUTION FOR POWER INTEGRITY SIGNOFF

Anusha Vemuri, Emmanuel Chao, Santosh Santosh (Nvidia)
Chidambaram Rakkappan, Ed Deeters (Ansys, Inc.)

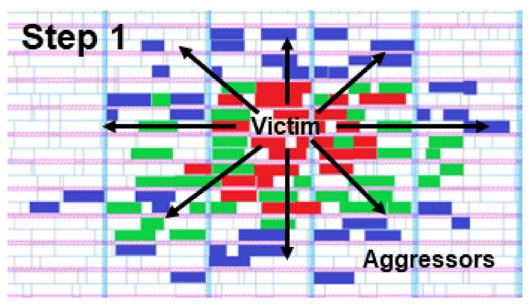
MOTIVATION

For each victim instance:

Step 1: Identify neighbors/aggressors

Step 2: Rank aggressors based on impact and switching probability

Step 3: Compute the total voltage drop on victim instance



SigmaDVD (sDVD) simulation technique examines all physically and timing relevant aggressors to compute a worst case, but statistically relevant, voltage drop for every instance. This method provides orders of magnitude improvement in local aggressor coverage than current IR drop methods (such as Vectorless/Vectorbased/Build Quality Metrics).

sDVD provides detailed root-cause analysis for dynamic voltage drop. Aggressors are identified and sorted, and voltage impacts are known and computed separately for each power rail. Self-drop is isolated and broken out separately.

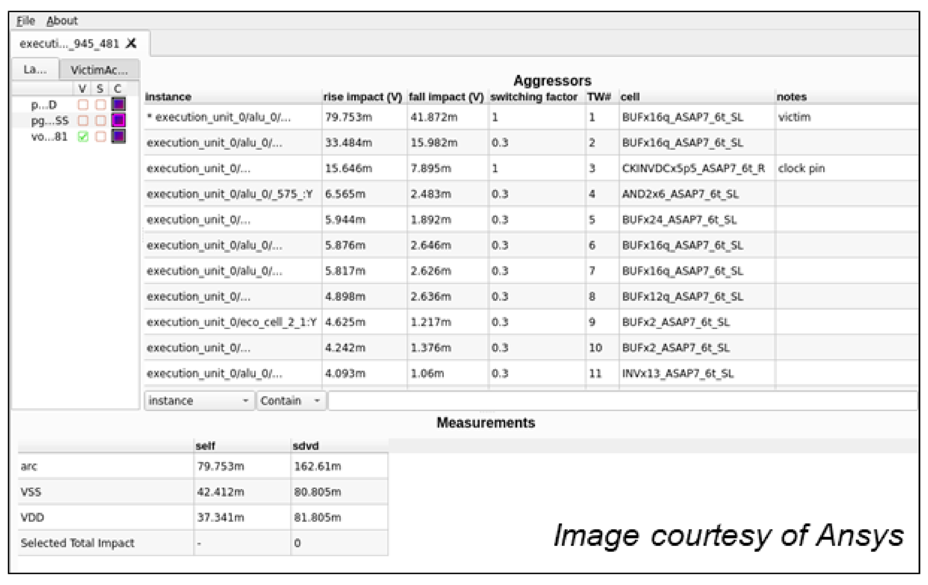


Image courtesy of Ansys

1

MOTIVATION

IR-Drop Methods	Limitations of IR-Drop Methods	How does sDVD address them?
Vectorless	Finite number of cycles in analysis (only **few tens of cases** analyzed) with limited logical coherence	Looks at **tens of thousands of cases**
Vectorbased	**Limited number of use cases** (due to finite number of cycles) with full logical coherence	
Vectorless	Considers **only a subset of top aggressors** [so may be good at estimating self-drop of victim but not the significant impact from aggressors]	There is **a high impact zone of aggressors identified around victim** (sDVD looks at resistive impact on victim & overlapping timing windows)
Build Quality Metrics (BQM) [simultaneous switching plus early grid resistance check]	**Limited halo of aggressors** considered around victim	
Vectorless	Dependent on variables (e.g. simulation time step sizes, small changes in timing windows, random seed/toggle rate) that can **compromise accuracy**	**Has stable results** due to aggressor coverage of every instance in the design, **parallelized trials** (independent of the time-related variables), and **charge-based demand current** analysis

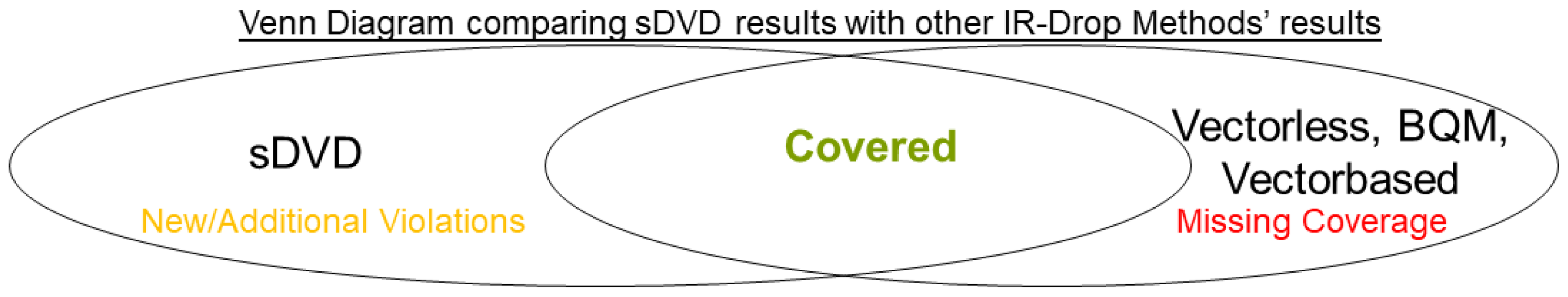
2

MAIN IDEA

<u>NVIDIA</u> studied in detail the tradeoff between coverage *(what % of hotspots from other IR-Drop methods does sDVD cover?)* and the increase in hotspots/violating instances caused by the massive increase in noise coverage. There are noticeable improvements in this tradeoff as new features are added to the sDVD tool.

<u>ANSYS</u> developed the sDVD tool, its enhancement features, and has optimized its runtime/peak memory costs to make it competitive with other IR-Drop methods.

<u>Venn Diagram comparing sDVD results with other IR-Drop Methods' results</u>

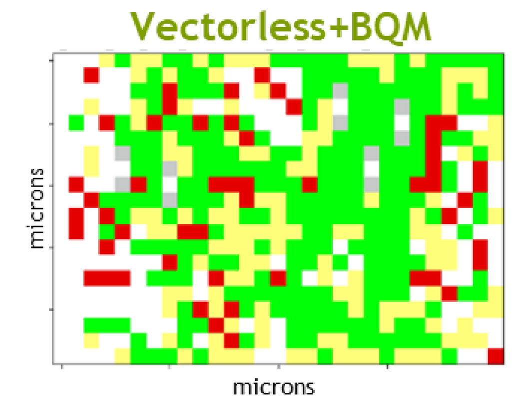


3

EVIDENCE

<u>Takeaway:</u> sDVD metric is providing great coverage over existing IR-Drop methods' hotspots (GREEN) & flagging other potential hotspots (YELLOW). We must be cognizant to flag a reasonable count of additional hotspots to be able to properly fix and close the design.

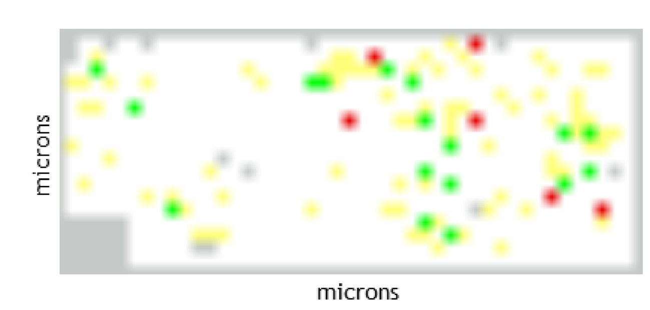
Block A sDVD vs Vectorless+BQM



23.0% *area* of total design is additional coverage

81.7% of baseline hotspots covered

Block B sDVD vs Vectorless



8.8% *area* of total design is additional coverage

71.0% of baseline hotspots covered

<u>Main Features Used in this sDVD Run:</u>
Tool-Detected Logic Correlations

Exclude_clocks – ignores user-specified clocks

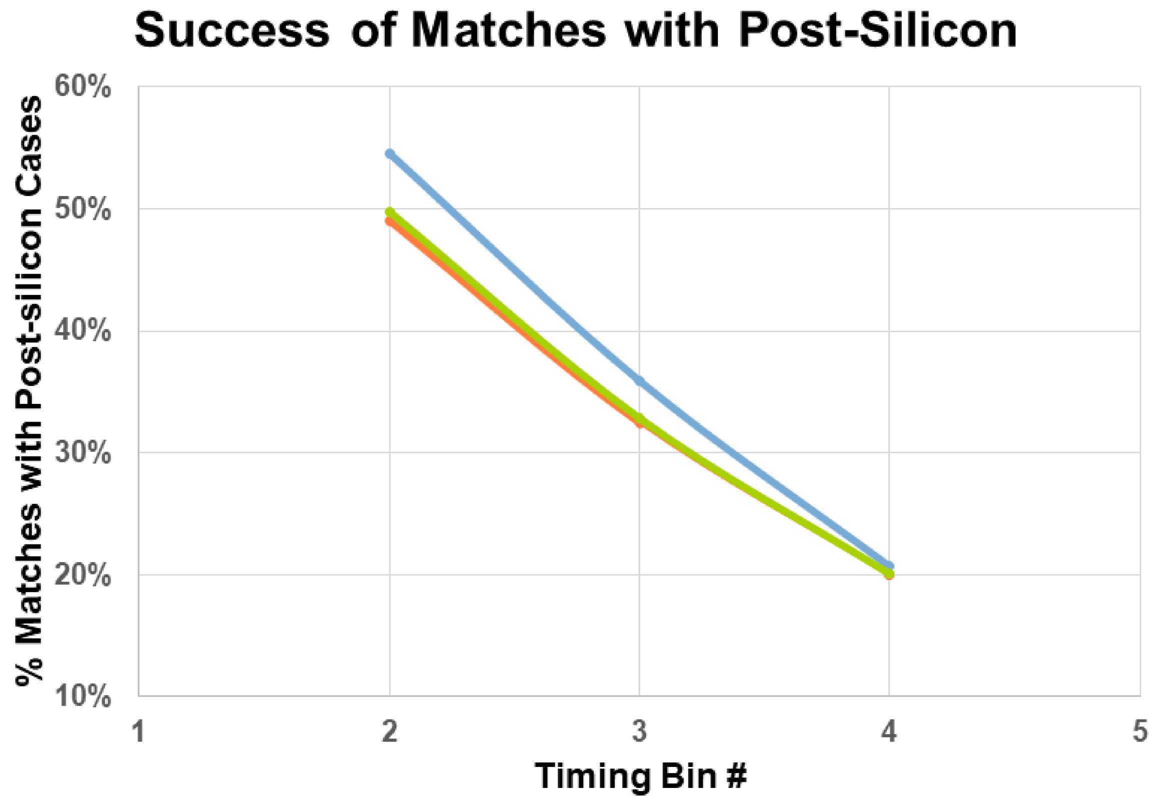
LEGEND
- **GREEN:** *baseline hotspot is covered by sDVD
- **RED:** *baseline hotspot is not covered by sDVD
- **YELLOW:** extra hotspots introduced by sDVD

*baseline = other (existing) IR-Drop methods

4

EVIDENCE

<u>Takeaway:</u> sDVD better captures post-silicon outliers than other IR Drop methods.



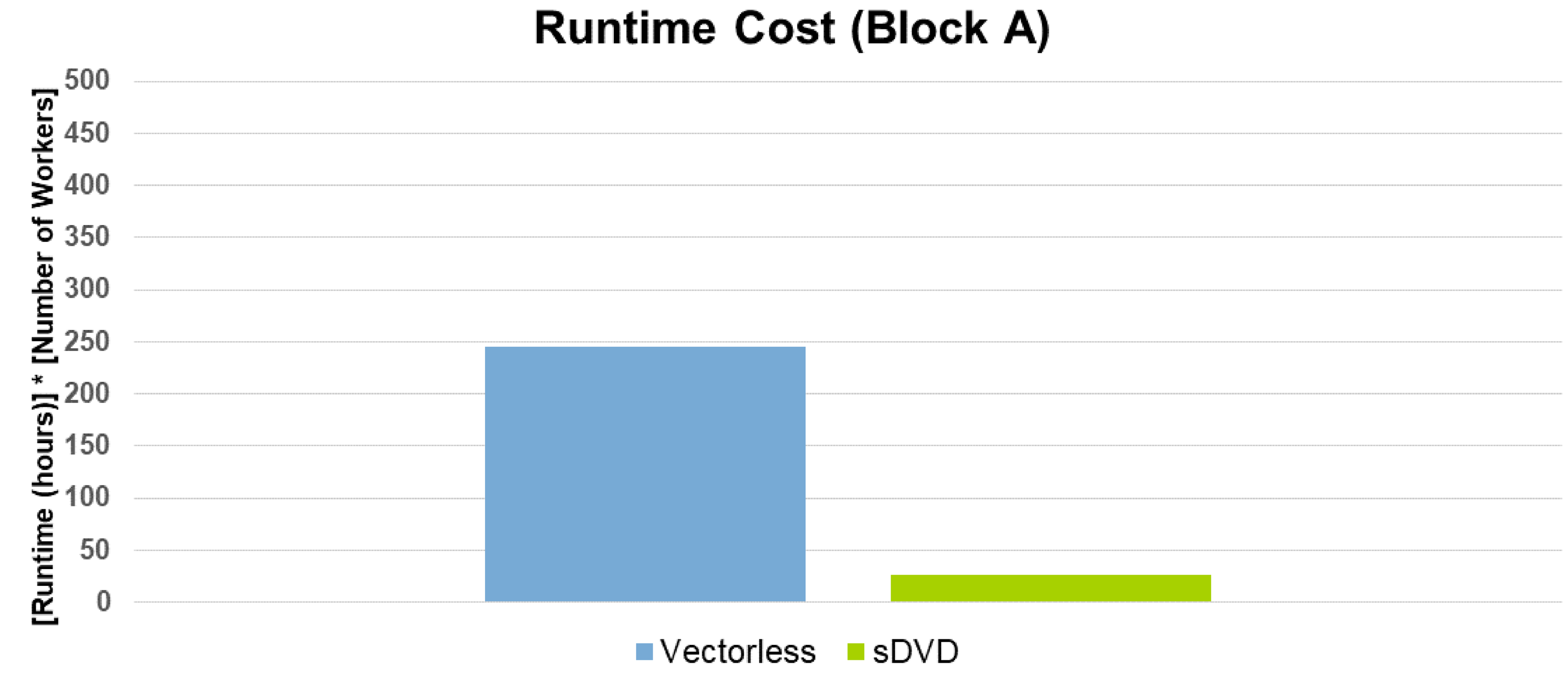
LEGEND
BLUE: sDVD-Annotated Timing
ORANGE: Vectorless-Annotated Timing
GREEN: Non-Annotated Timing

*Note – picked bins where similar counts of Endpoints were considered (for meaningful % match comparisons)

5

EVIDENCE

<u>Takeaway:</u> Overall runtime cost of sDVD is dramatically better than those of other IR-Drop methods.



6

EVIDENCE

<u>Takeaway:</u> sDVD runtime and peak memory considerations across different sized designs are reasonable (i.e. efficient even for larger designs).

Design	Relative Size (reference is Block A)	Worker Count	Runtime (during sDVD-specific views)	Runtime(hrs)* Worker Count	Peak Worker Memory (during sDVD-specific views)
Block A	1x	80	0.33 Hours	26.4	16.937GB
Block B	11x	550	0.55 Hours	302.5	22.844GB

7

SUMMARY

<u>Recent Features</u>

- Aggressor View – identify and fix common aggressors for flagged violating victim instances, reducing fixing overhead for users
- Macro Analysis – include RAMs in sDVD analysis to get more realistic results
- Support for decoupling capacitance

<u>Future Work</u>

- NVIDIA evaluation of recent features (listed above)

sDVD closes a known gap in power grid noise coverage available from other methods, such as Vectorless, Vectorbased, and BQM.

For comprehensive coverage of major hotspots and post-silicon weaknesses, sDVD can be used as an add-on flow.

8