
What is stage-based AOCV?

CLK Design Automation



Advanced On Chip Variation



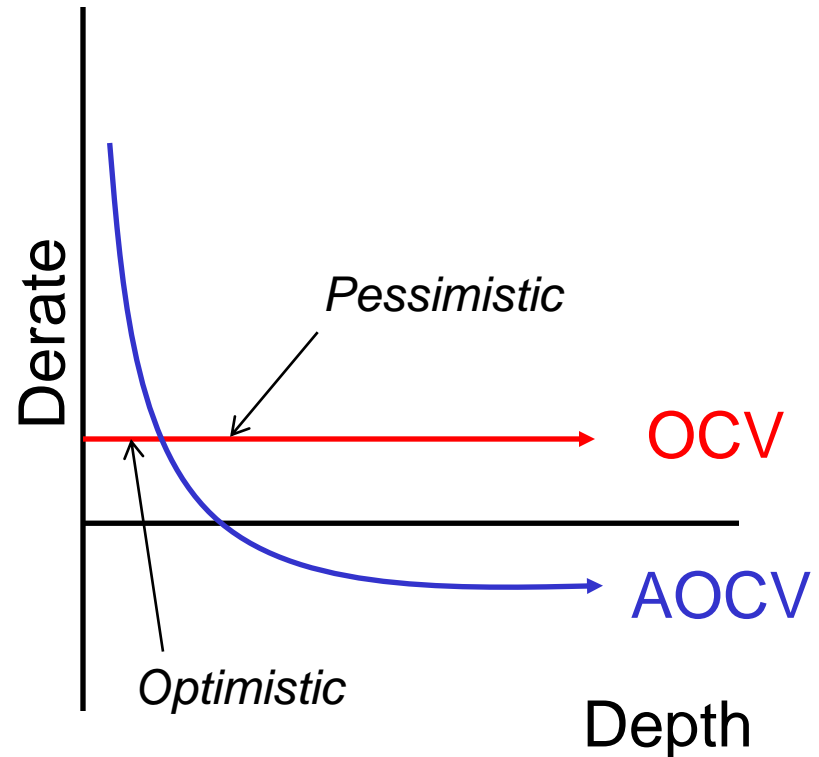
Stage-based AOCV is a systematic correction to liberty timing models for on chip variation based on the logic depth of a path.

- Why use it?
- What is it?
- How do you use it?
- How do you create it?

Why use stage-based AOCV?



- ❑ If properly generated and used, full stage-based AOCV makes it much easier to close timing without sacrificing quality.
- ❑ Stage-based AOCV achieves these results by correcting for pessimism and optimism in timing derates by accurately modeling variance.
- ❑ AOCV tables can be used in existing timing and optimization tool flows without requiring adoption of new methodologies like statistical timing.



Why use stage-based AOCV?



AOCV helps to remove pessimism safely.

- ❑ Good results when applying to data and clock paths
- ❑ Even better results with design specific information.

Derate Method	WNS (ns)	TNS (ns)	Per Path Gain (ps)
Global OCV	-0.361	-2418	
Clock Only AOCV	-0.386	-2380	±10ps
Data & Clock AOCV	-0.328	-1625	79ps
Design Specific AOCV	-0.274	-1074	134ps

Example: Synthesized ARM core at 1Ghz

What is stage-based AOCV?



- ❑ An AOCV table is a companion file to a Liberty library.
- ❑ AOCV derate is applied during timing analysis and optimization.
- ❑ The AOCV tables have derate values for each cell for different depths (path length).
- ❑ AOCV defines 8 derate values for each cell at each depth.

Setup

late data rise

late data fall

early clock rise

early clock fall

Hold

early data rise

early data fall

late clock rise

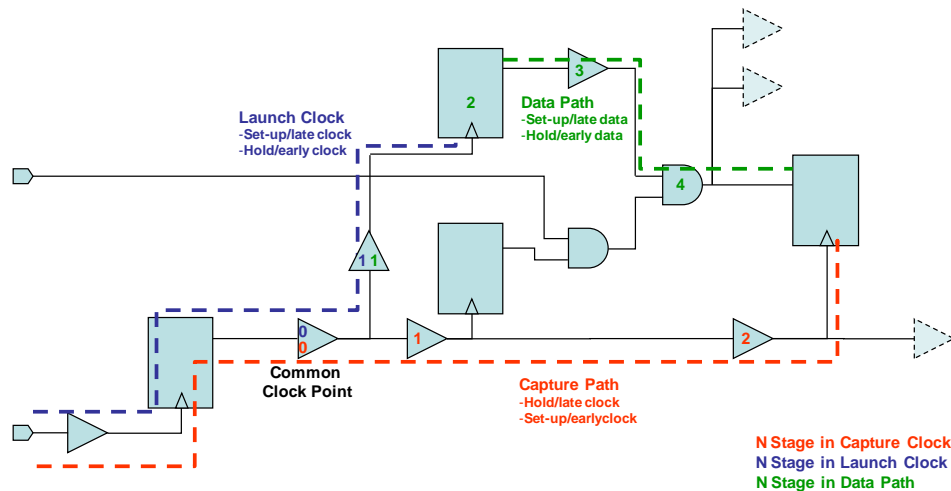
late clock fall

- ❑ The derate values are determined by analyzing the ratio of delay at the global corner with local variance to a fixed corner.

How is stage-based AOCV applied to a timing path?



Your timing analyzer will calculate depth for each segment of the path and then scale each cell's delay independently based on the cell's AOCV table value for that depth.



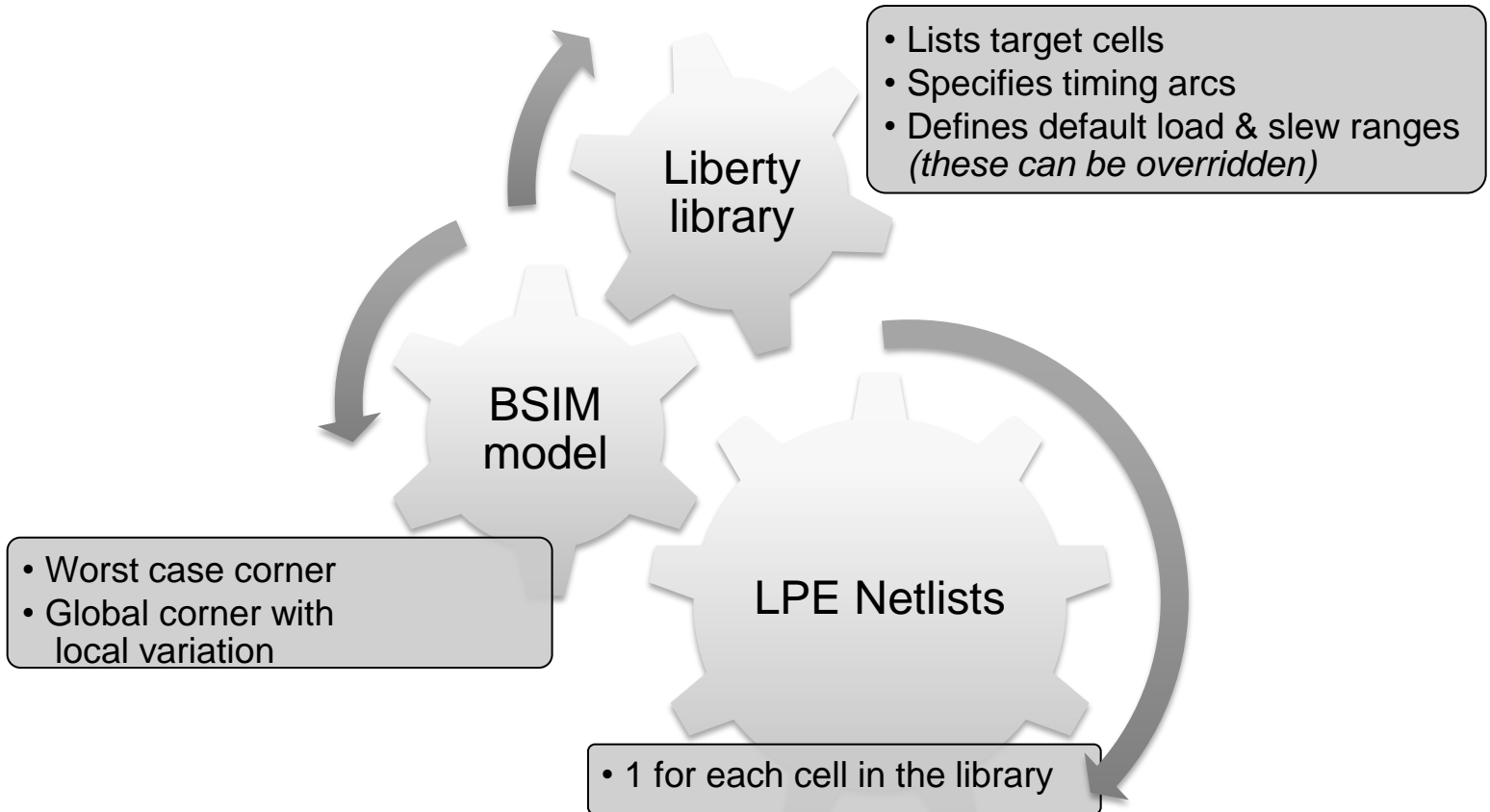
Timing tools may calculate depth based on the common clock point, the start point, or whether the tool is doing path or graph based analysis. **AOCV table generation is independent** of the methodology used by the timing analyzer.

What makes a good AOCV table?



- ❑ Complete
 - Contains unique derate values for every cell in your library or in your design – both combinational and sequential
- ❑ Safe
 - Has accurate values that reflect the correct evaluation of each cell for all possible load and slew combinations at all logic depths.
 - No shortcuts or estimates that could result in respins.
- ❑ Effective
 - Derate values are appropriately adjusted for the actual usage of each cell in the design.

What goes in to AOCV table generation?

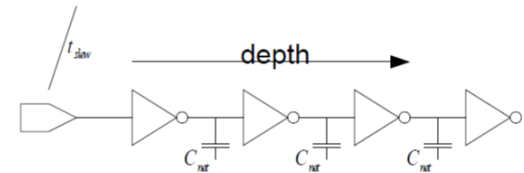


AOCV table generation requires correct models and methodology



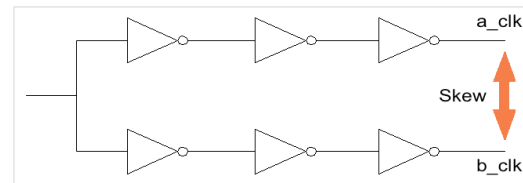
- ❑ Local variation effects cancel out over long distances.
- ❑ For data paths - derate is a ratio of statistical delay to corner delay.

$$\frac{\mu_{\text{statistical delay}} \pm (\sigma_{\text{statistical delay}} * N\text{sigma})}{\text{Corner Delay}}$$



- ❑ For clock paths - derate is a measure of skew.

$$1 \pm \frac{\sigma_{\text{skew}} * N\text{sigma}}{\text{Corner Delay}}$$



How are tables generated?



AOCV table generation requires either a SPICE simulator or a tool built specifically for generating AOCV tables.

	MC SPICE	MC Fast SPICE (reduced samples)	AOCV FX
38 Simple Cells	3 Weeks 120 Licenses	2 Days 120 Licenses	8 Minutes 8 Processors
882 Cell Library	103.5 Years 120 Licenses	9.8 Years 120 Licenses	16 Hours 120 Processors
Compressor cell (288 Arcs)	2.6 Years 120 Licenses	12.8 Weeks 120 Licenses	3 Hours 8 Processors

AOCV tables can be improved with design specific timing data.



Generate AOCV tables

- AOCV FX can generate complete tables – every cell in your library, every arc, clock and data.

Run timing analysis with AOCV enabled

- Collect design specific load and slew values for each instance in your design with a simple TCL script.

Refine AOCV tables using design specific timing data

- AOCV FX can generate incremental updates to AOCV tables using its variation database in seconds.

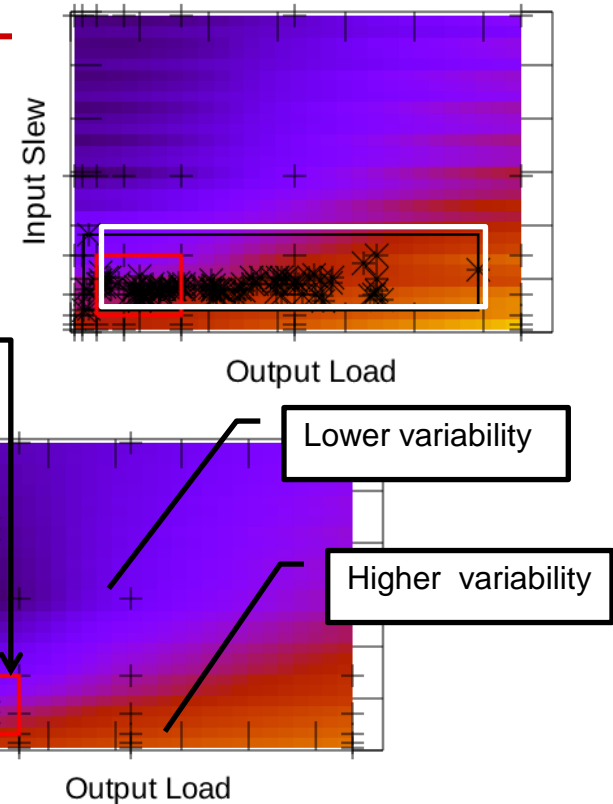
Repeat timing analysis or optimization

- Each ECO can be followed up with a new AOCV table for subsequent timing or optimizations runs.

Maximize Pessimism Reduction without Compromising Quality



- ❑ Default AOCV should use the full load/slew range
 - This is safe but overly pessimistic
- ❑ Shortcuts can be very risky
 - Limiting load slew range to save time is not safe
 - Estimates or even educated guesses can be fatal
- ❑ AOCV FX uses actual load slew to generate improved design specific tables
 - Design specific AOCV tables eliminate much of the unnecessary pessimism



**Sample Derate Data for 2 Cells
Synthesized ARM Core**

Evaluating AOCV table generation alternatives.



Performance

- How fast is it?
- Can it handle the full library?

Accuracy

- How does it compare to SPICE?

Safety

- Are all of the results verifiable?
- Does it require guesses or shortcuts?

Flexibility

- Can I tweak the results to fit my design methodology?

FX Solutions

CLK Design Automation



AOCV FX generates AOCV tables that safely reduce the margin for process variation in your design – tables that work with leading static timing and optimization tools, today.

Path FX analyzes critical paths for delay, SI noise, and variance with the accuracy of SPICE and the speed and ease of use of static analysis. There's no complicated setup – it was designed to complement your current STA and design flows.

Contact sales@clkda.com or visit clkda.com for more information.

