Generating Realistic Stimuli For Power Grid Analysis

P. Marques Morgado, L. Miguel Silveira, Paulo F. Flores

morgado@algos-inesc-id.pt, lms@inesc-id.pt, pff@inesc-id.pt

Problem Description

Power grids

- used to distribute power to feed all electrical devices within an integrated circuit
- may suffer from voltage drop, ground bounce, Ldi/dt noise and elecromigration

Power Grid Analysis

- excessive cell switching activity in a given region may cause voltage droop affecting performance
- worst-case scenario is hard to determine
- size (millions of nodes) complicate its verification

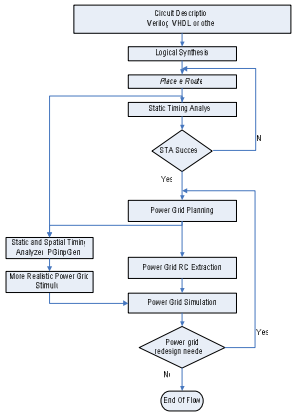
Objectives

- find a realistic set of stimuli that helps predicting worst-case scenario
- search for regions with a high concentration of cell activity that may cause grid integrity problems

Proposed Approach

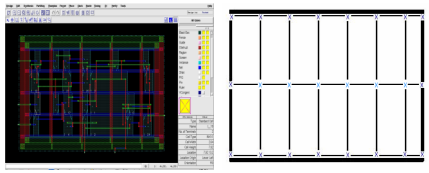
Combines information from

- timing correlations between cells
- circuit placement & routing
- power grid structure



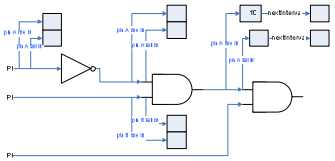
Methodology

1 Power Grid discretization



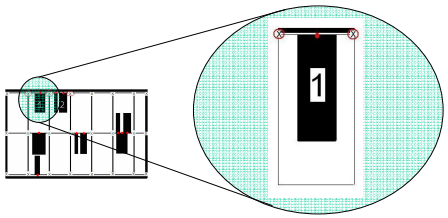
2 Timing correlations

- obtained by traversing the circuit
- uses intervals instead of single instants of time



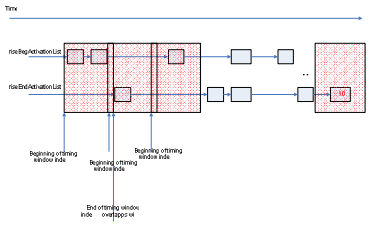
3 Spatial information

- obtained from placement
- connections between each cell and the power grid
- proximity between cells

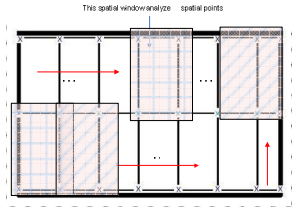


4 Combine all info & search the power grid

1. Determine the time interval where the largest number of switching cells occurs



2. For each time interval determine which region of the power grid is the most affected

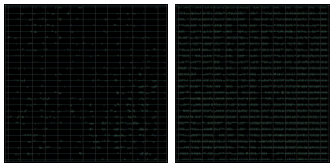


Experimental Results

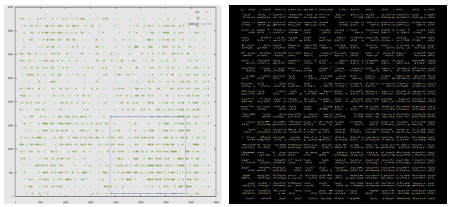
PGinpGen implements the proposed methodology

Circuit Name	s27	s1196	s5378	s13207	s35932	s38417	s38584
# of gates	23	945	2680	6084	24732	20872	27150
Active cells (t.w. 0.1 ns)	43%	7%	8%	10%	18%	22%	15%
STA run-time (s)	0.15	0.70	2.47	14.83	139.59	77.19	68.17
PGinpGen run-time (s)	0.16	0.87	3.08	16.37	142.33	82.02	73.9

Integration of PGinpGen with Voltage Storm



Using PGinpGen to detect hot-spots



Conclusions

- Only a small fraction of blocks can switch in a given time interval
- PGinpGen:
  - runs almost as fast as regular STA
  - less pessimistic than other methodologies
  - can be integrated with power grid analysis tools
  - enables faster power grid analysis by zooming in on the most troublesome regions
- Additional uses of PGinpGen in the design cycle:
  - quickly detect hot-spots

Acknowledgements

This work was partly supported by Project POSI/EEA-ESE/61528/2004- PowerPlan – Planeamento de Potência em Sistemas Electrónicos