Identifying unique power scenarios with data mining techniques at full SoC level with real workloads

Amir Attarha, Pankaj Chauhan, Diwakar Agrawal, Satish-Kumar Agrawal, and Gaurav Saharawat, Siemens

Agenda

- Power Trends

- Power data analysis

  - Traditional method

  - Data mining method

- Experimental results

- Summary

Power Trends

With the failure of Dennard Scaling, entire semiconductor industry is struggling with power

High profile products are commonly not meeting power expectations

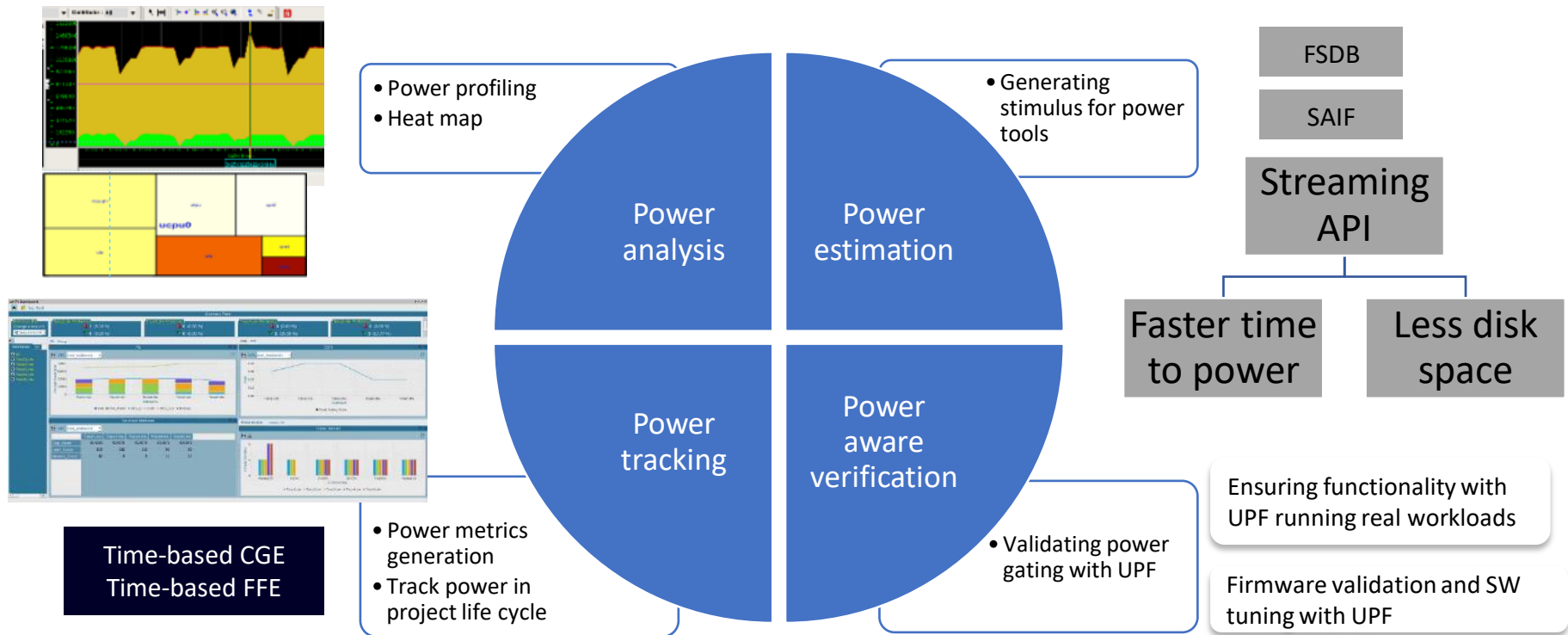Power analysis/estimation needs to be done with end-user software applications

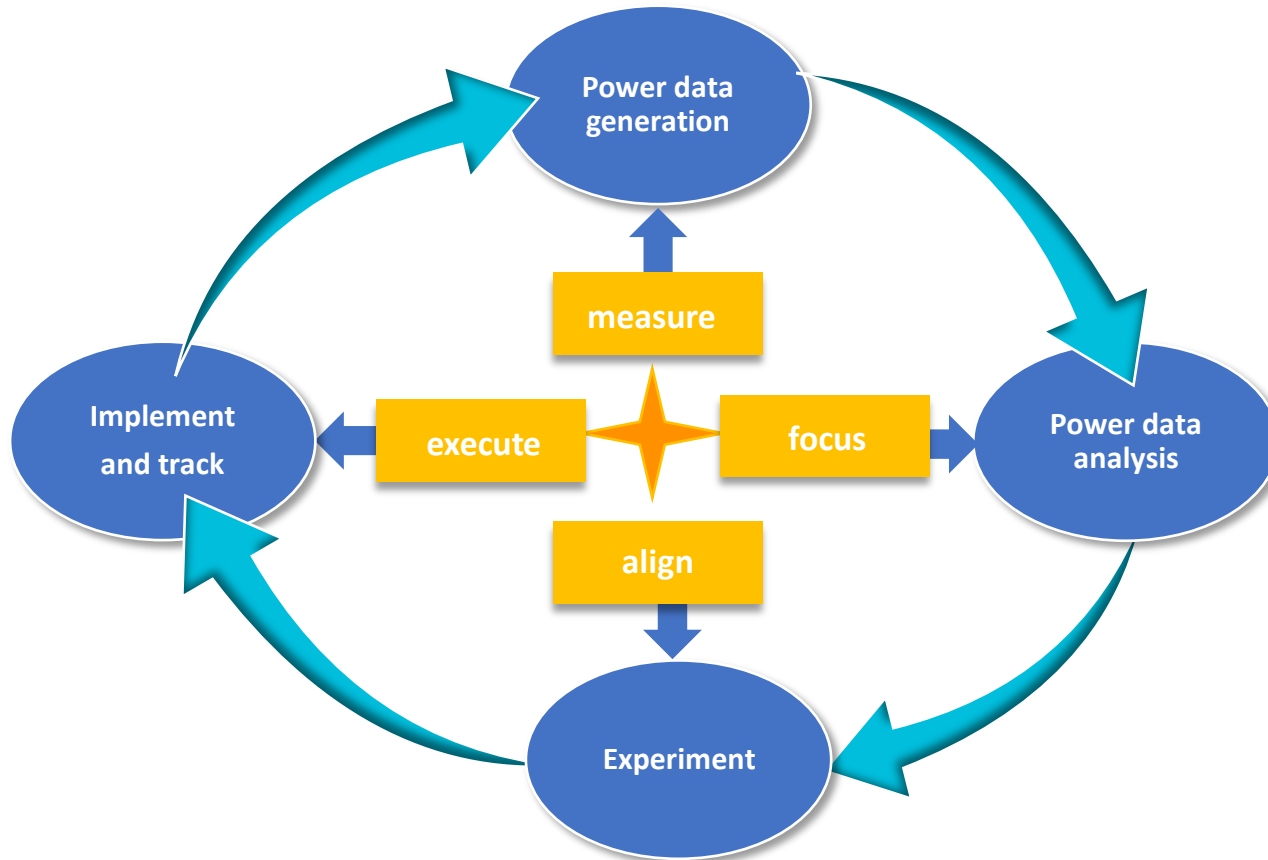Early power analysis is crucial to success of a product

Analyzing power data for each IP over each RTL release is necessary but extremely labor intensive
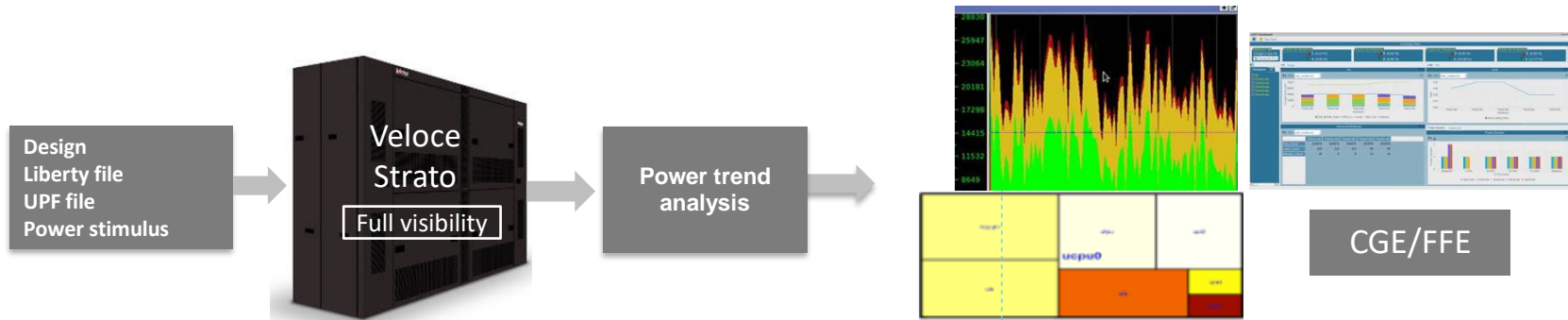
Dimensions of a power solution

Time-based CGE
Time-based FFE

- Power profiling
- Heat map

Power analysis

Power estimation

- Generating stimulus for power tools

FSDB

SAIF

Streaming API

Faster time to power

Less disk space

Power tracking

Power aware verification

- Power metrics generation
- Track power in project life cycle

- Validating power gating with UPF

Ensuring functionality with UPF running real workloads

Firmware validation and SW tuning with UPF

2023 DESIGN AND VERIFICATION™ DVCON CONFERENCE AND EXHIBITION UNITED STATES

SHIFT LEFT vision of power analysis

Compelling solution for design teams

Design
Liberty file
UPF file
Power stimulus

→ Veloce Strato
Full visibility

→ Power trend analysis

→

CGE/FFE

✓ **Capturing power profile for entire workload**

✓ **Capturing key power indicators at cluster or SoC level**

✓ **Finding accurately peaks and IR drop region**

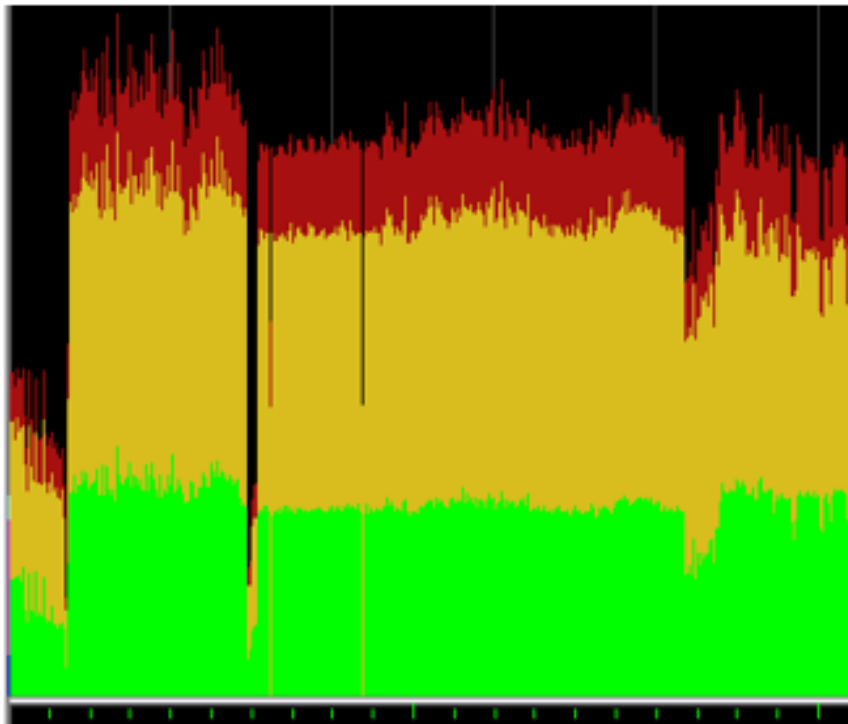**Generating power profile for Billions of cycles**

Making key decisions based on real data

Power Profile/Heat Map for real benchmarks allows focusing on right area

Is this benchmark interesting for power analysis?
For each IP, you will have power profile and metrics
For each RTL release, the data needs to be closely analyzed

Power Data Analysis

KPI Tracking

- To capture power metrics for weekly RTL release power and record in a centralized database

- To track the data over lifetime of the project

- To identify trends and enable comparison of IPs for various end-user software applications

Data Mining

- Define a higher level of abstraction, i.e. Power Behavior State (PBS)

- Extract key data from power profile and define it terms of PBS

- Cluster the data based on PBS and reduce the scope of analysis

- Identify tests which exercise different PBS

Key power indicators with Power Dashboard

- Metrics based tracking for Power optimizations/variations over RTL Revisions
    - Visualize % contribution from different IP (major design) blocks
- Allow designers to compare power attributes and indicators
    - Compare metrics to evaluate different micro-architectures
    - Visualize power trending using activity plot
- Create and maintain power/ energy regressions
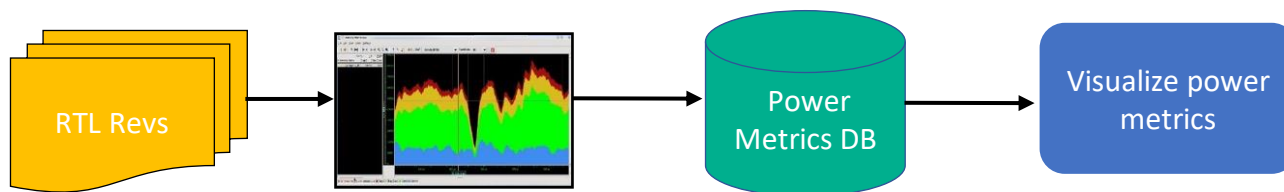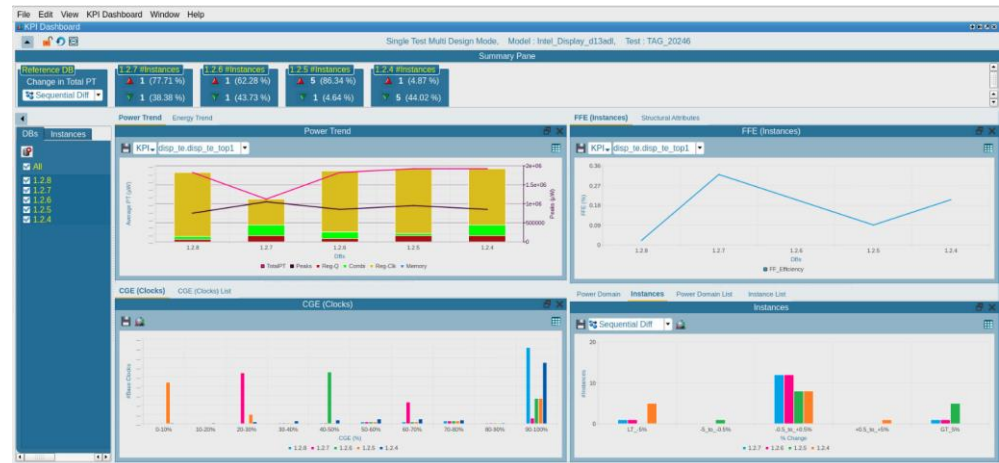
Power KPI – Comprehensive Tracking and Comparison of Important Power Parameters

Several power KPIs are tracked and can be compared across workloads and design versions

Power Trend (Total, Peaks, All 4 components (Memory/Reg-CLK/Reg-Q/Comb))
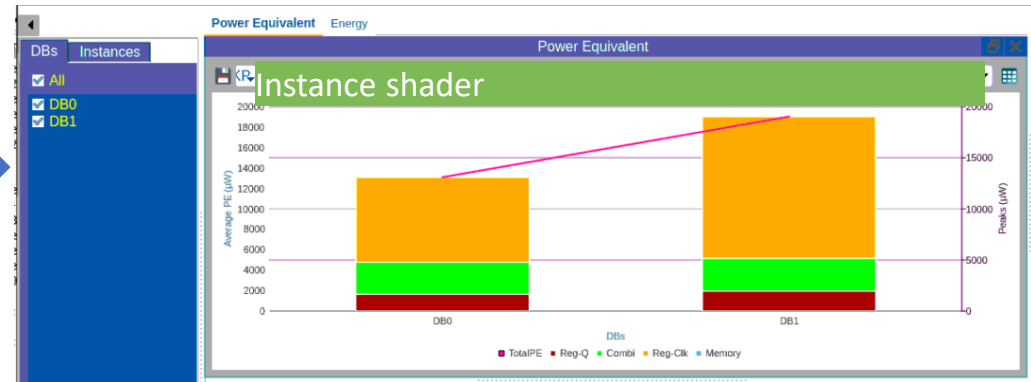
Clocks level CGE and FFE

Blocks Level CGE and FFE
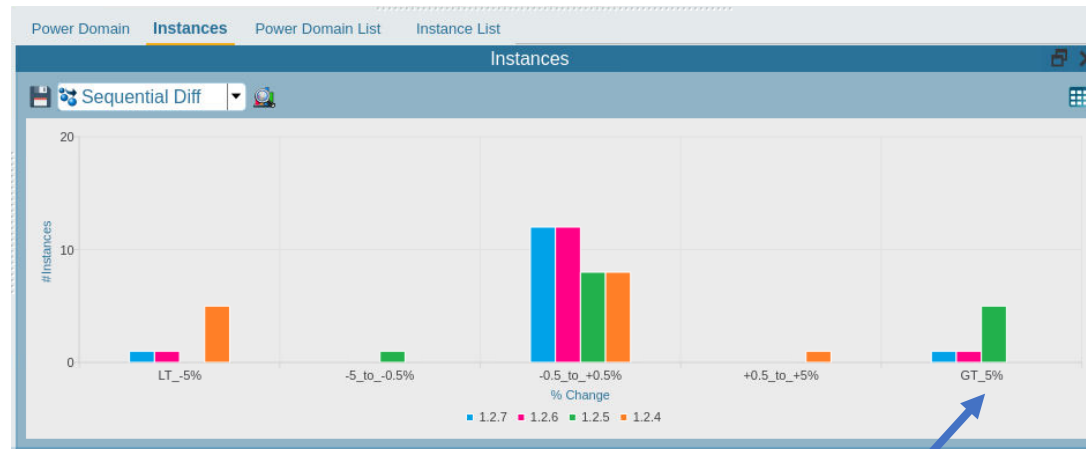
Power Domains

Comparative analysis

Comparing power data of Manhattan and Angry bird tests on "Shader instance"
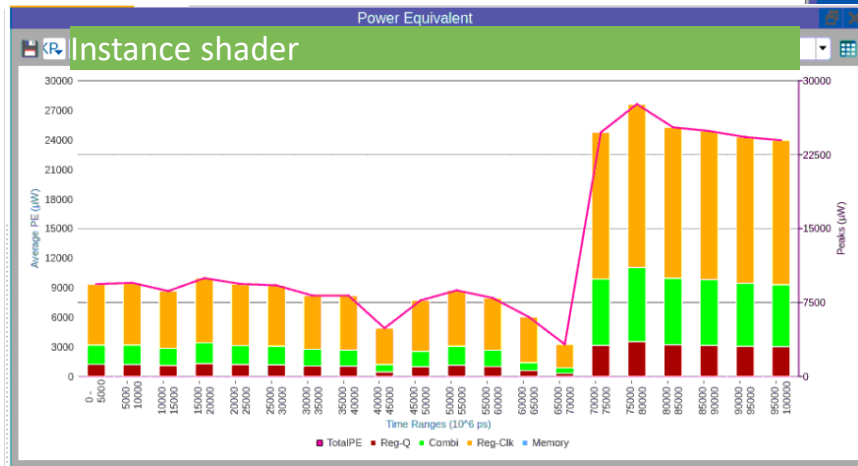
Manhattan test on "Shader instance"

Power data analysis

- Visually Compare Changes in IPs across workloads to identify focus areas

- Number of instances which change across releases/tests based different metrics (such as Average Power)
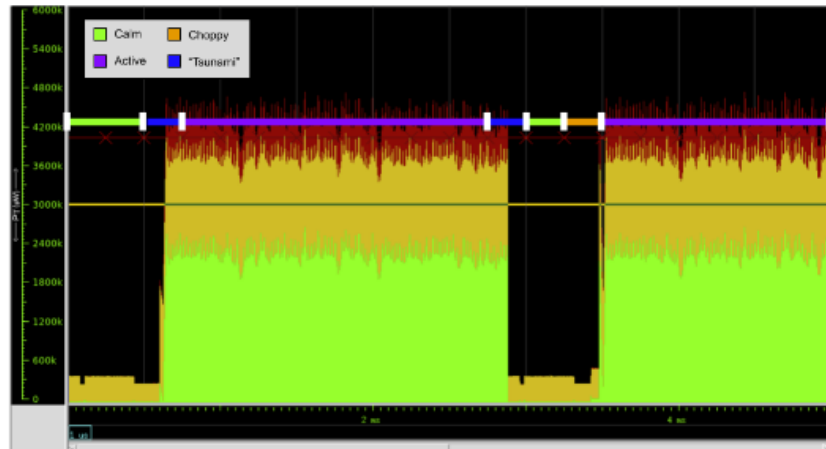

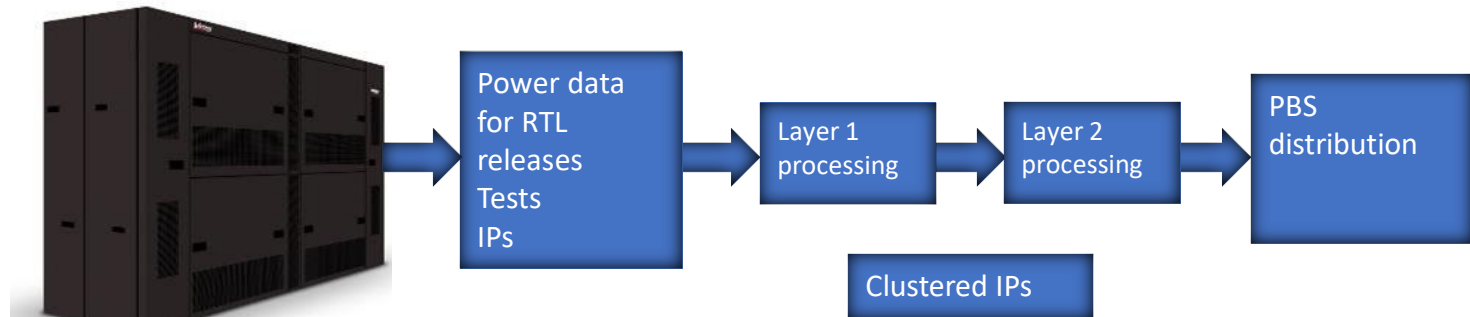Instances which consume 5% more power compared with reference DB

Power Behavior State: higher level of abstraction

- Power Behavior state (PBS) is an overall behavior of an IP in terms of power.

  - Calm

  - Tsunami
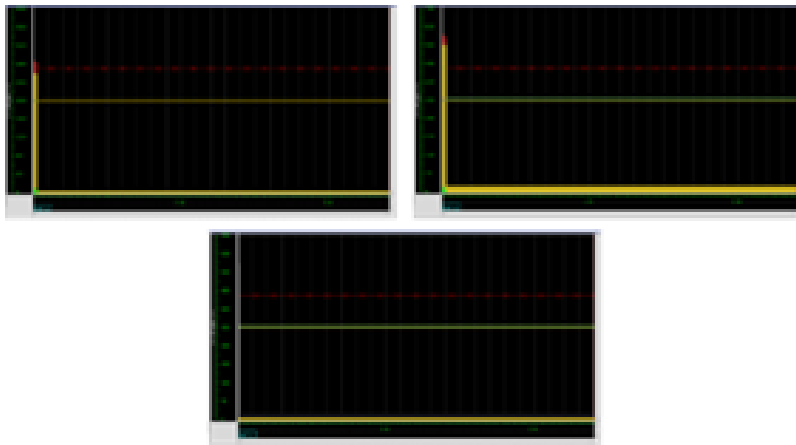
  - Choppy
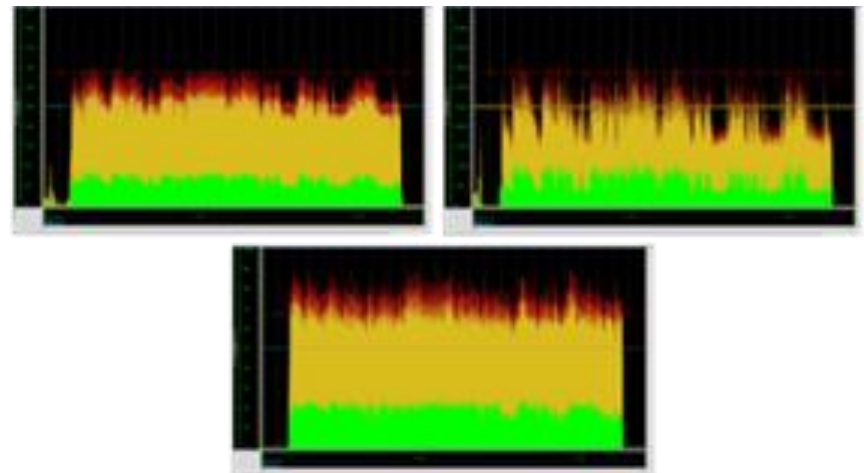
  - Active

Data Mining for power data analysis

Clustering results

Three instances from design 1, cluster 1

Instances from design 1, cluster 2, cluster3 and cluster 4

Experimental results

|	# of IPs after data wrangling	# of clusters	Cluster 1	Cluster 2	Cluster 3	Cluster 4
Design 1	73	4	50	2	18	3
Design 2	48	4	1	37	9	1
Design 3	26	4	8	2	4	12

Each cluster represents the data set of similar characteristics
We have considered four clusters for this experimentation
The analysis becomes much simpler since it is expected per cluster rather than per IP

Experimental results

PBS Distribution across all three tests
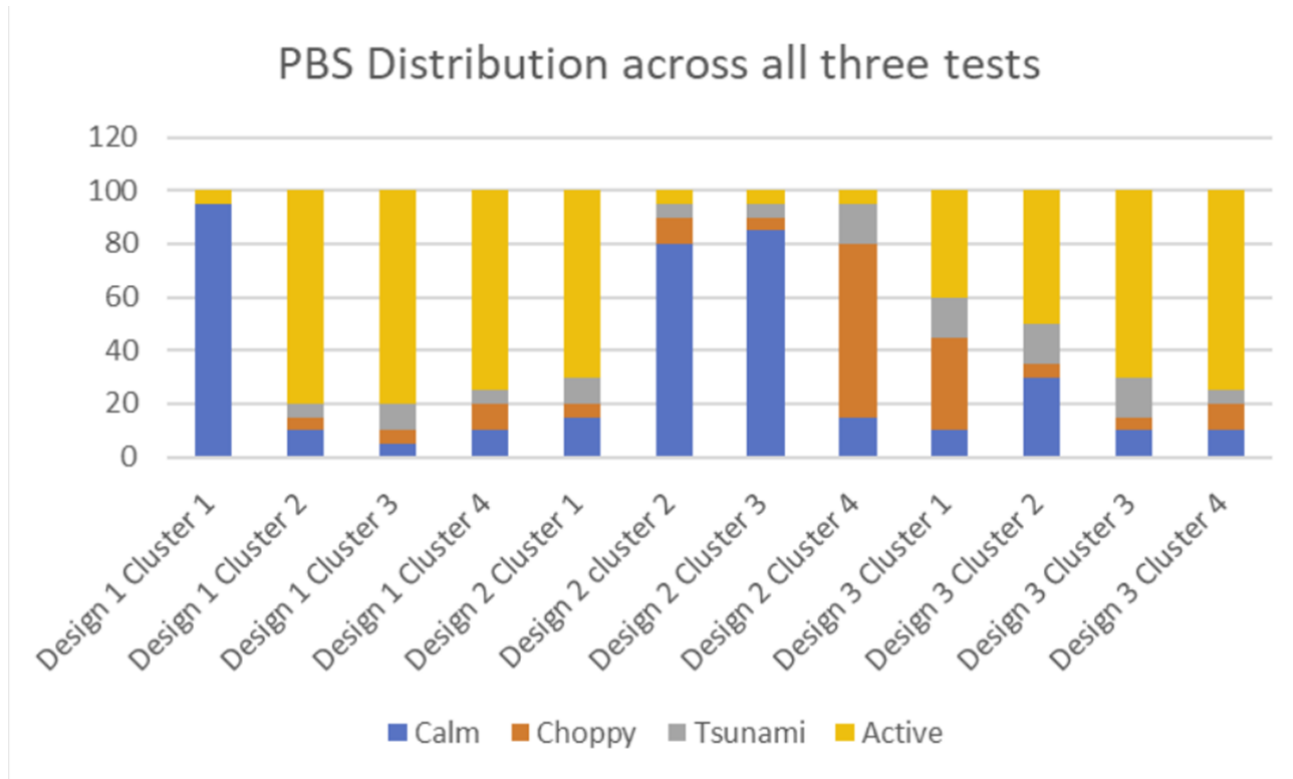
Summary

End-user software applications are a MUST for evaluating power behavior of SoCs.

Regression based power data collection and analysis is essential to the success of new SoCs for power analysis

Both traditional data tracking and new data mining schemes can provide significant value

Higher level of abstraction enables further automation in analyzing power related data

Veloce
Strato

Questions