Activity Trend Guided Efficient Approach to Peak Power Estimation Using Emulation

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Mentor Graphics®

Agenda

- Basics of Power Estimation
- Why emulation for Power Estimation
- Traditional Power estimation approach – File based approach
- Activity plot guided peak power analysis

Power Analysis and Estimation using emulation

- **Basics of Power Estimation**
- Why emulation for Power Estimation
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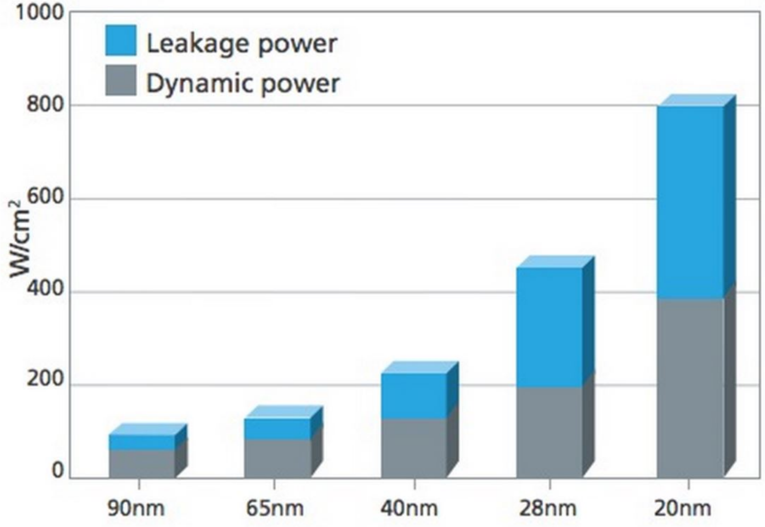
DESIGN AND VERIFICATION™ DVCON CONFERENCE AND EXHIBITION 2016 UNITED STATES

Need of Power Estimation

Industry Trends

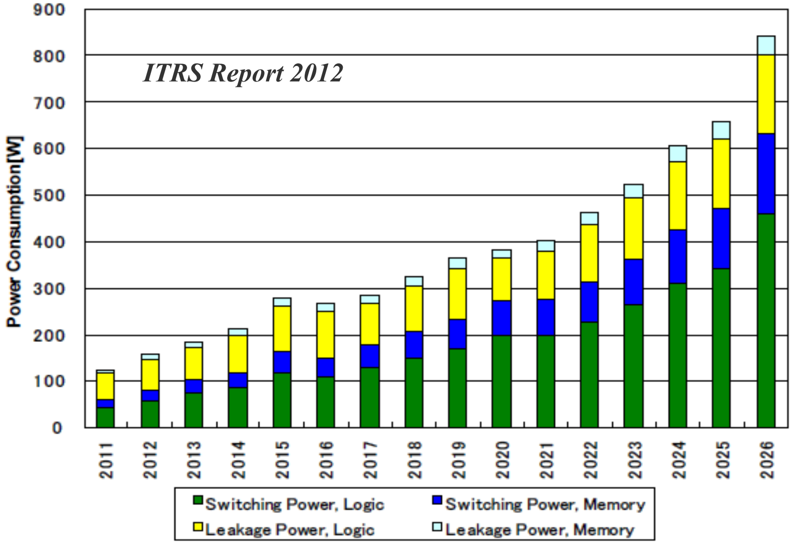
IBS Report 2013



ENERGY STAR

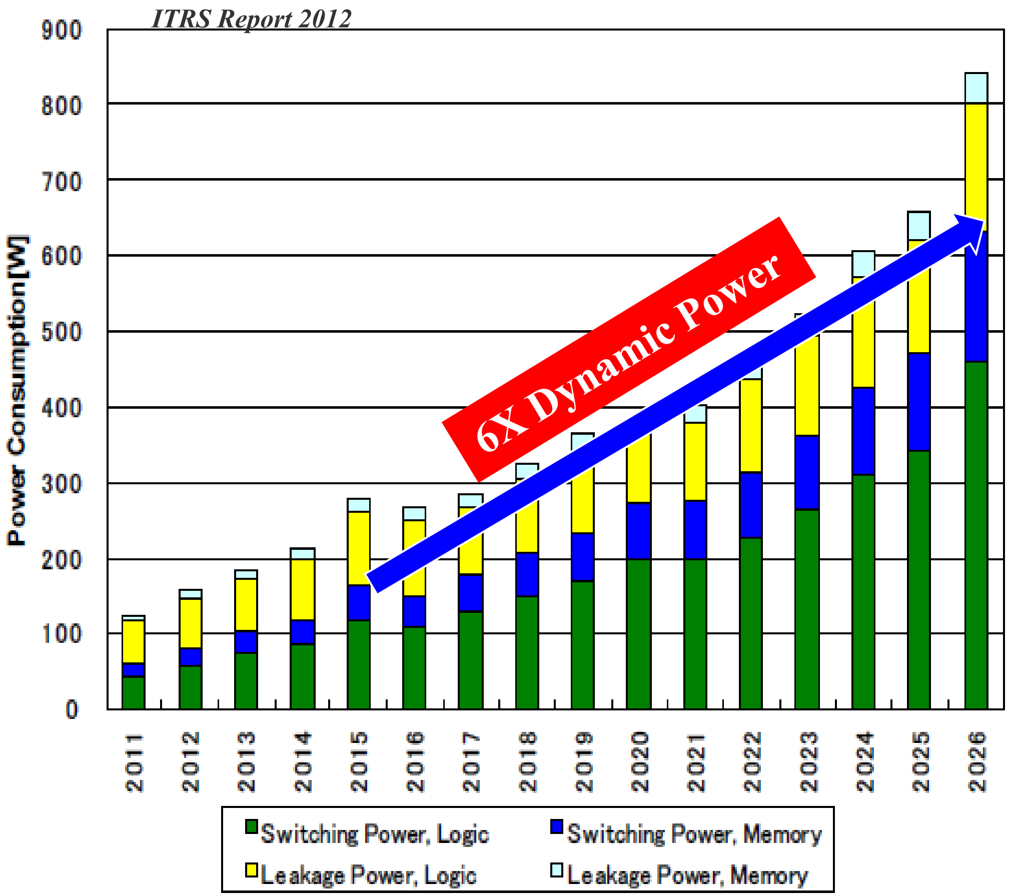
THE GREEN FAN

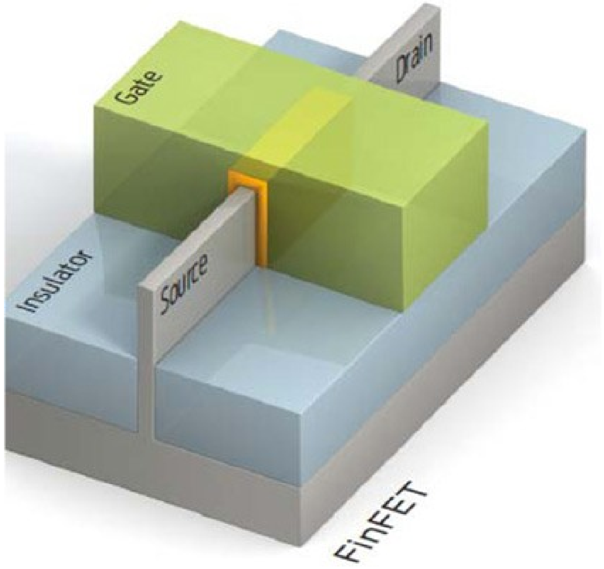
GreenTouch™


ITRS Report 2012

- Requirement: lightweight, high resolution devices, long battery life
- Small devices, Nodes advance – Leakage Power increases
- High resolution and faster devices – Dynamic power increases
- System level Power analysis and management before tape out

Static Power and Dynamic Power





- FinFETs is a great Transistor technology for static leakage
- Dynamic power remains the challenge

Average and Peak Power

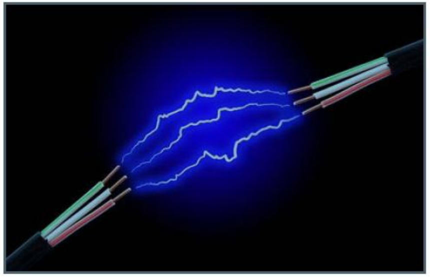
- Average power to decide
  - Die size / package selection
  - Battery life and size (Power over Time)

- Peak power to determine
  - Chip reliability
  - Power rails design for peak power loads
  - Performance and cooling options

Power Analysis and Estimation using emulation

- Basics of Power Estimation
- **Why emulation for Power Estimation**
- Traditional Power estimation approach – File based approach
- Paradigm shift - Streaming Data Flow
- Activity plot guided peak power analysis

Why Emulation for Power



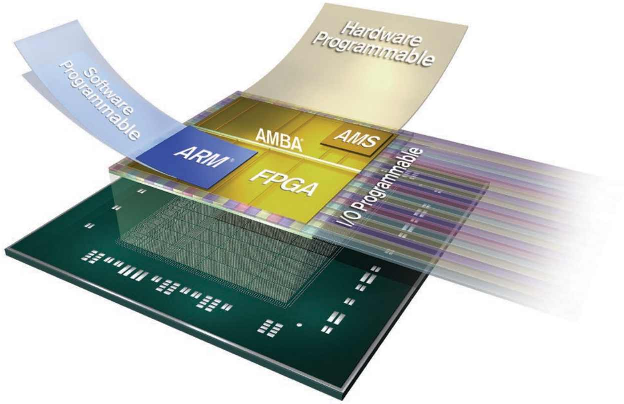
Accurate Power Numbers

Power for Target Applications

- Running live applications is key
- TB based functional verification is not suitable for accurate power measurements

Performance to Complete Verification

- Boot the OS (2-5 Hours)
- Run SW applications



Power with full SoC (RTL/Gate)

Power Analysis and Estimation using emulation

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- **Traditional Power estimation approach – File based approach**
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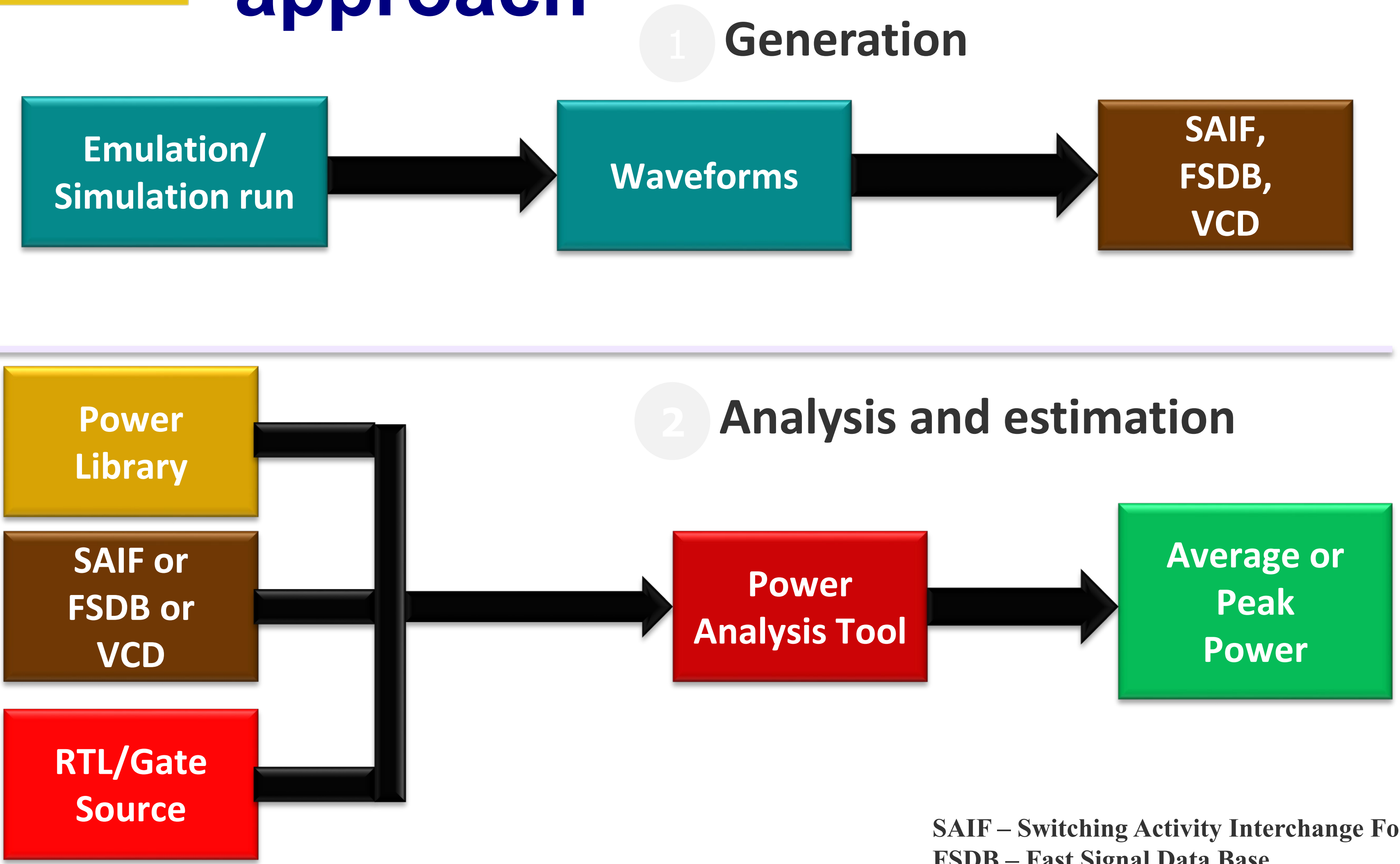
Traditional Power estimation approach


1 Generation

Emulation/ Simulation run → Waveforms → SAIF, FSDB, VCD

2 Analysis and estimation

Power Library, SAIF or FSDB or VCD, RTL/Gate Source → Power Analysis Tool → Average or Peak Power

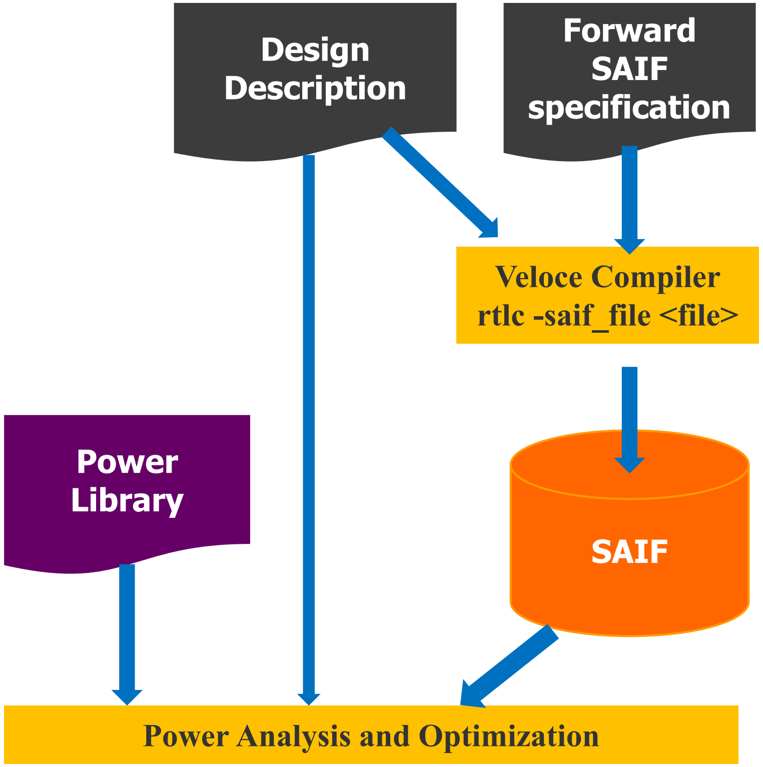
SAIF – Switching Activity Interchange Format
FSDB – Fast Signal Data Base

SAIF based flow

The SAIF(Switching Activity Interface file) file stores the summary of the switching activity of a design in ASCII format for every signal.

- PROS
  - – Quick generation time as compared to FSDB.
  - – Less disk intensive – Faster dump and read time.
- CONS
  - – Temporal data not present, hence only average power estimation feasible.
  - – Less accurate as compared to FSDB.

Forward SAIF



- Forward SAIF is supported for better power accuracy
- Many designs use 3rd party IP and hard macros
- Dump SAIF activity for ports and internal signals for the 3rd party IP and hard macros
- It captures state and path dependent condition data
- Capture switching when the memory is enabled
- Forward SAIF is part of the SAIF specification LRM

Typical waveform format based flow

Typical waveform formats optimized for signal based access. e.g FSDB or VCD

- PROS
  - Complete waveform available for power tool, hence both average and peak power estimation possible.
  - More accurate power estimation possible due to presence of temporal data.
- CONS
  - Disk intensive, hence larger dump and read time.
  - Becomes infeasible for any large testbench run due to huge runtime.

Power Analysis and Estimation using emulation

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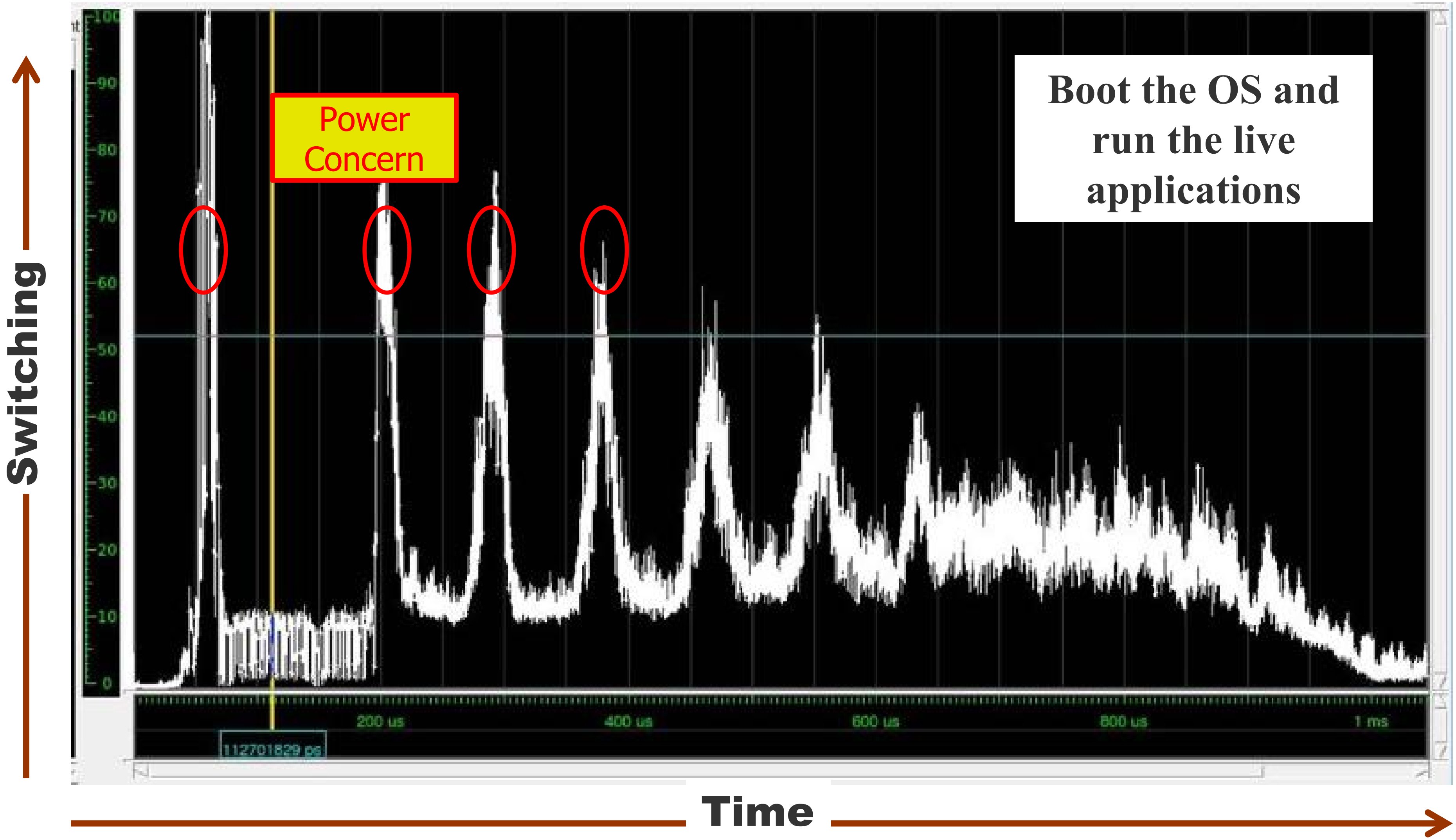
- **Activity plot guided peak power analysis**

Activity plot guided peak analysis

- Step 1
  - Application tests that are run over longer durations and generate activity plot.
  - With activity plot analyze and identifying area of high activity/concerns
- Step 2
  - Run same tests again to ZOOM in the selected time zones and design portion

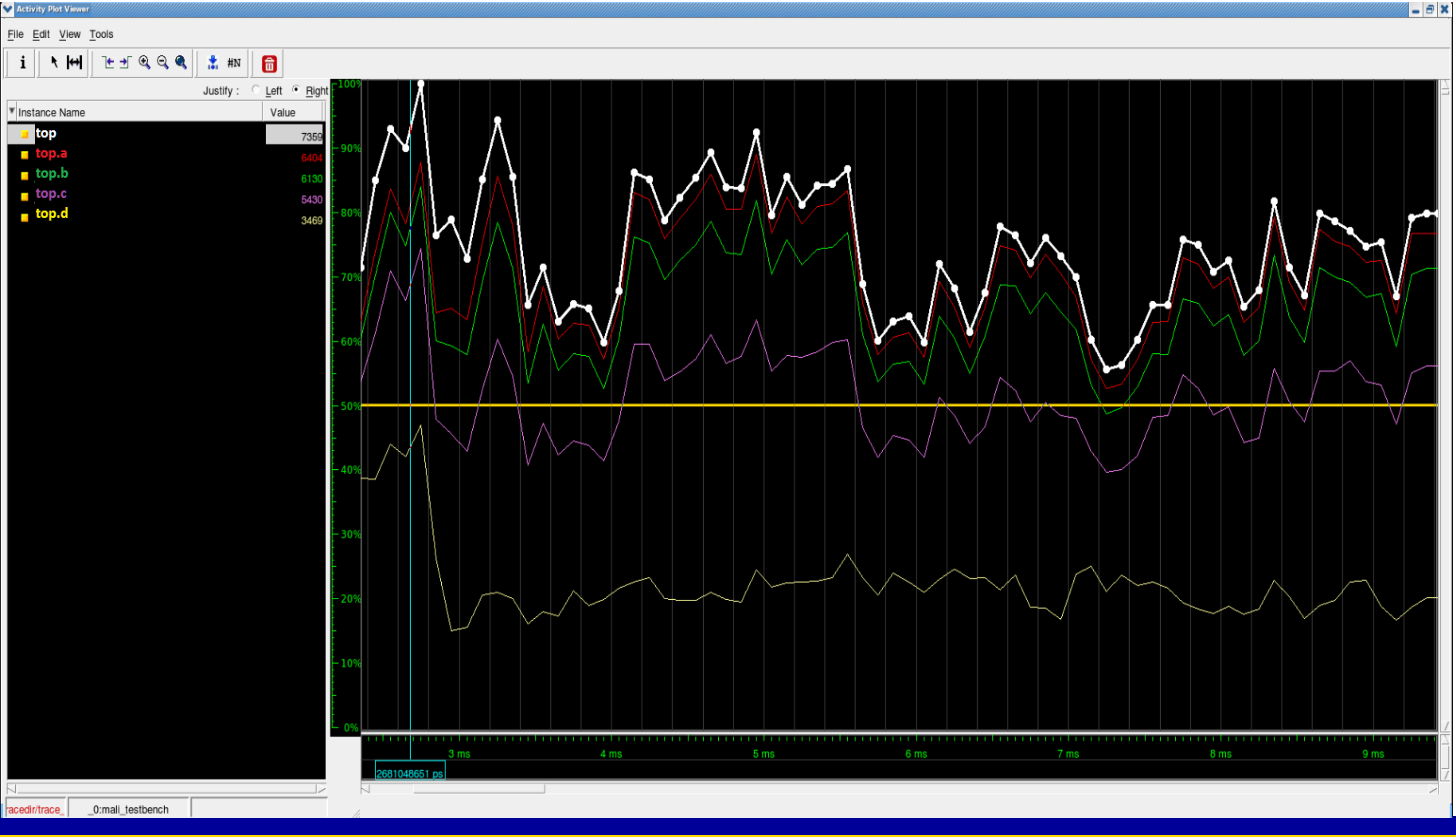
Identify Focus Areas Over Longs Runs



Power Concern

Boot the OS and run the live applications

Identify IPs/instances of concern



Justify : ○ Left ● Right

Instance Name	Value
top	7359
top.a	6404
top.b	6130
top.c	5430
top.d	3469

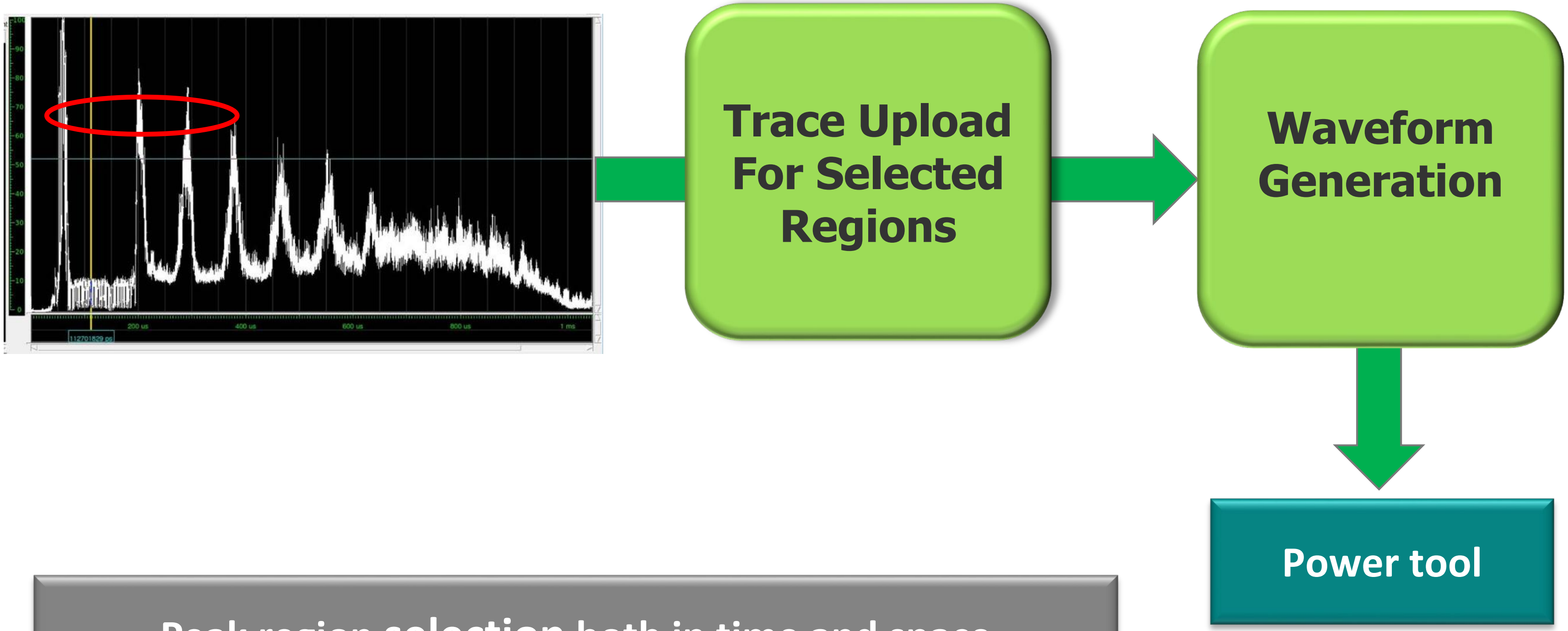
2681048651 ps

Complete flow diagram

Activity plot identifies switching activity peaks

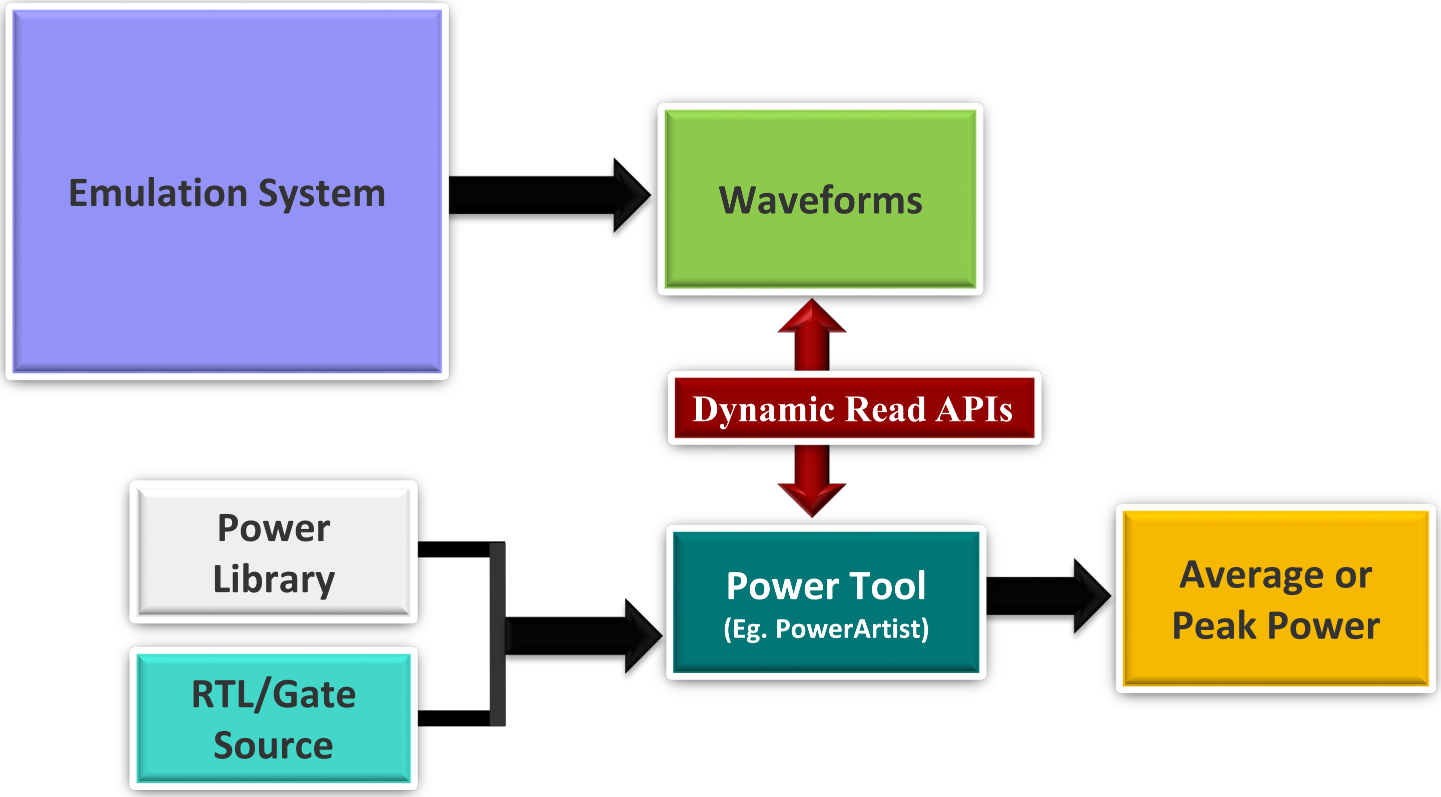
Capture full trace for peak

Build waveform for selected peak



Peak region selection both in time and space

Streaming Data Flow

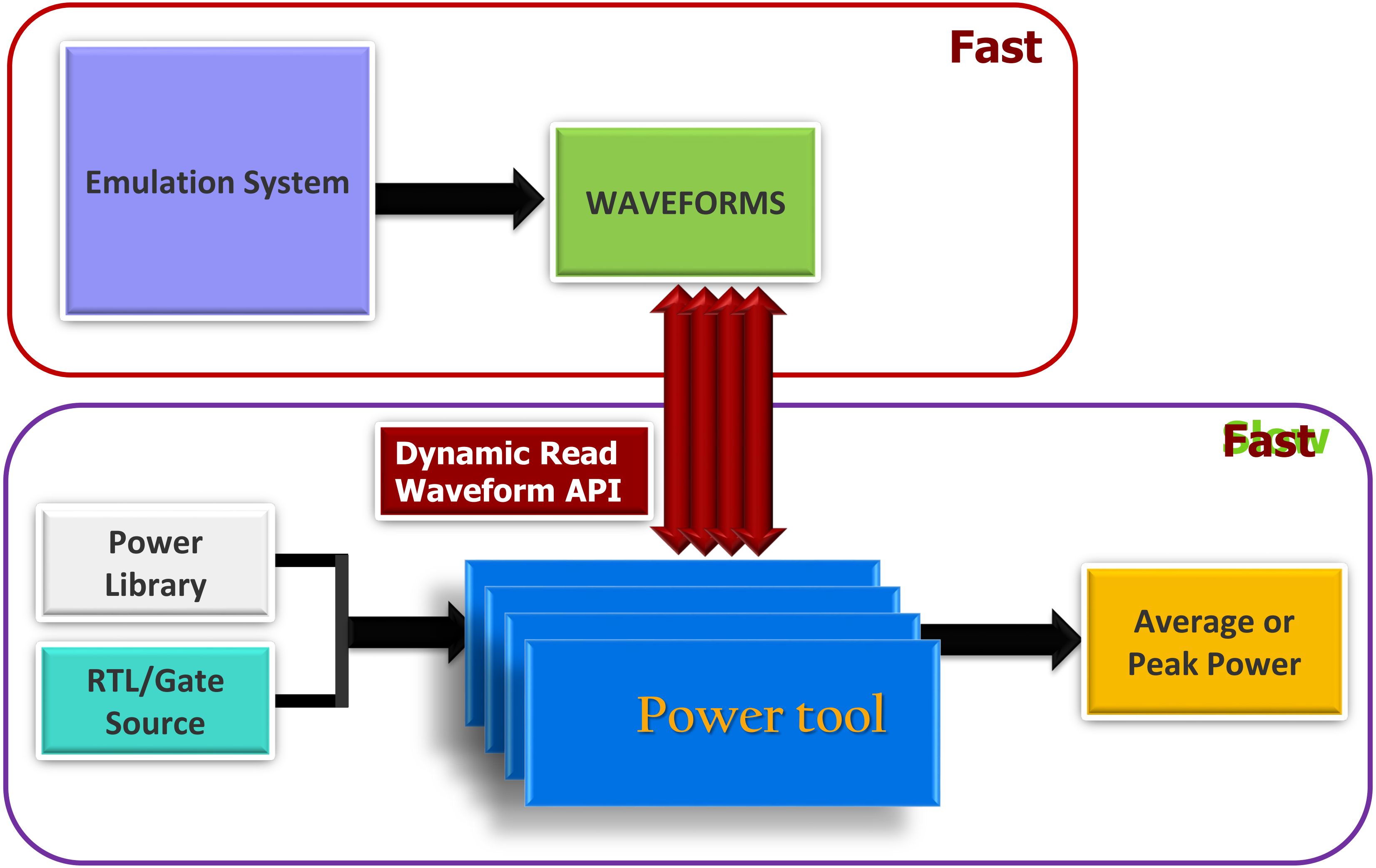


Generation, Analysis and Estimation in One Step

Streaming Data Flow

- Aligned with data generation by Emulator/Simulator with data consumption by Power tool.
- Efficient in terms of performance.
- Disk space efficient.

Parallel Power Generation



Fast

Emulation System

WAVEFORMS

Slow

Fast

Dynamic Read Waveform API

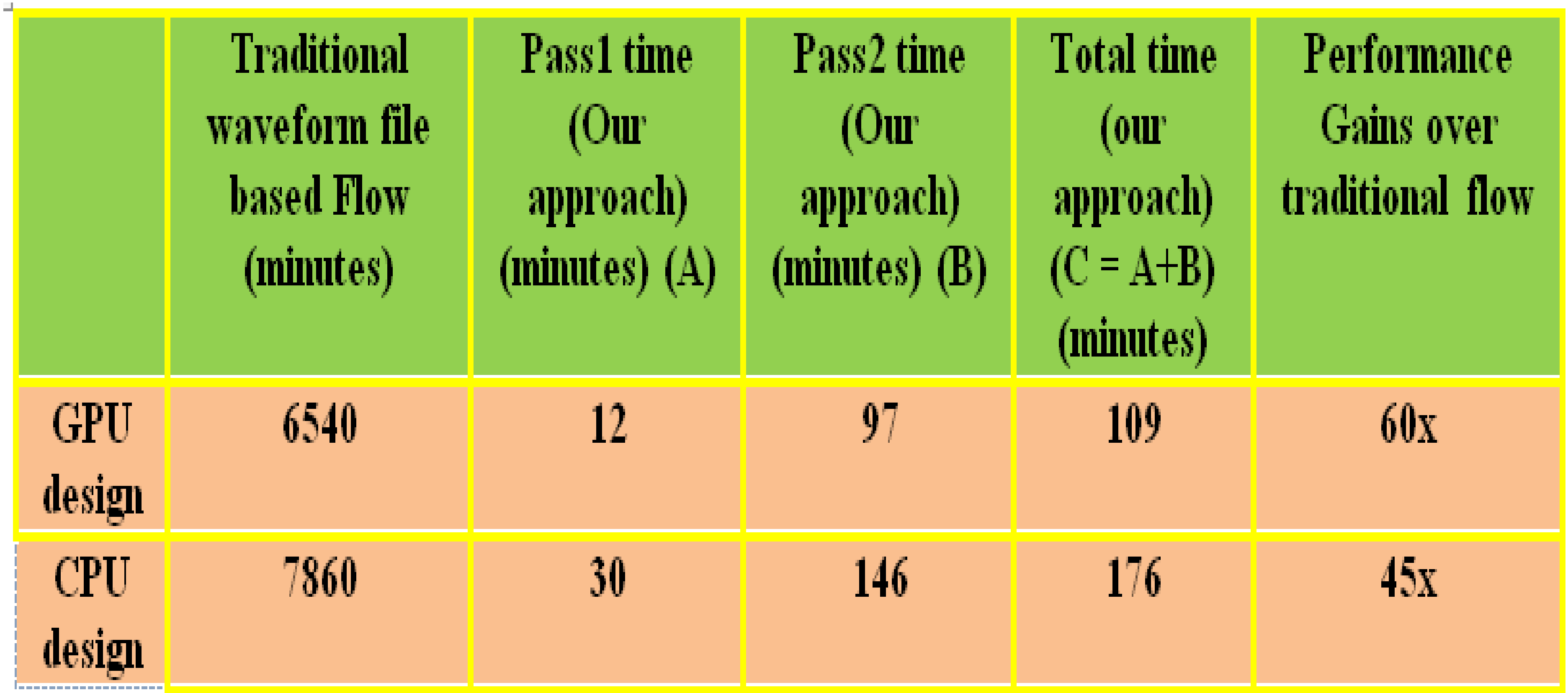
Power Library

RTL/Gate Source

Power tool

Average or Peak Power

Traditional approach Vs proposed approach (Performance gain)



	Traditional waveform file based Flow (minutes)	Pass1 time (Our approach) (minutes) (A)	Pass2 time (Our approach) (minutes) (B)	Total time (our approach) (C = A+B) (minutes)	Performance Gains over traditional flow
GPU design	6540	12	97	109	60x
CPU design	7860	30	146	176	45x

Traditional approach Vs proposed approach (Disk space gain)

	Traditional waveform file based Single Flow solution (GBs)	Our approach(GBs)	Disk space Gains
GPU design	90	8	**11x**
CPU design	122	12	**10x**

Summary

- Basics of power analysis
  - Need of power estimation
  - Static and dynamic power
- Why Emulation?
- Traditional flow
- Activity trend guided peak power analysis flow
  - Step 1 – Generate Activity plot and identify time zones
  - Step 2 – Generate waveforms of selected time zoned and feed them to power tool using streaming data flow

Q & A