QUO VADIS, Power?

Early Power Assessment along Development Cycle

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Agenda

Introduction

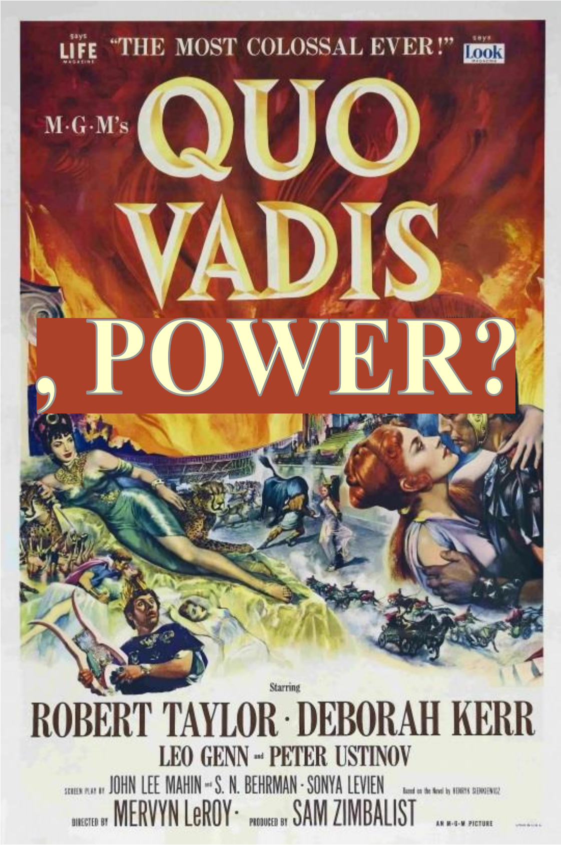
Tracking and Trending

Clock Gating Statistics Pitfall

Conclusion

Introduction

- Quo Vadis
  - LATIN: “Where are you going?”
  - MGM movie from 1951 (https://en.wikipedia.org/wiki/Quo_Vadis_(1951_film))
  - For us, we ask that same question early on about Power, as we don't want to get a surprise just at Tape out


says LIFE
"THE MOST COLOSSAL EVER!"
says Look
M·G·M's
QUO VADIS
, POWER?
Starring
ROBERT TAYLOR · DEBORAH KERR
LEO GENN and PETER USTINOV
SCREEN PLAY BY JOHN LEE MAHIN and S. N. BEHRMAN · SONYA LEVIEN
DIRECTED BY MERVYN LeROY · PRODUCED BY SAM ZIMBALIST
AN M-G-M PICTURE

Introduction

Motivation

Power estimation capability needed early in the development to ensure chosen architectures can meet requirements

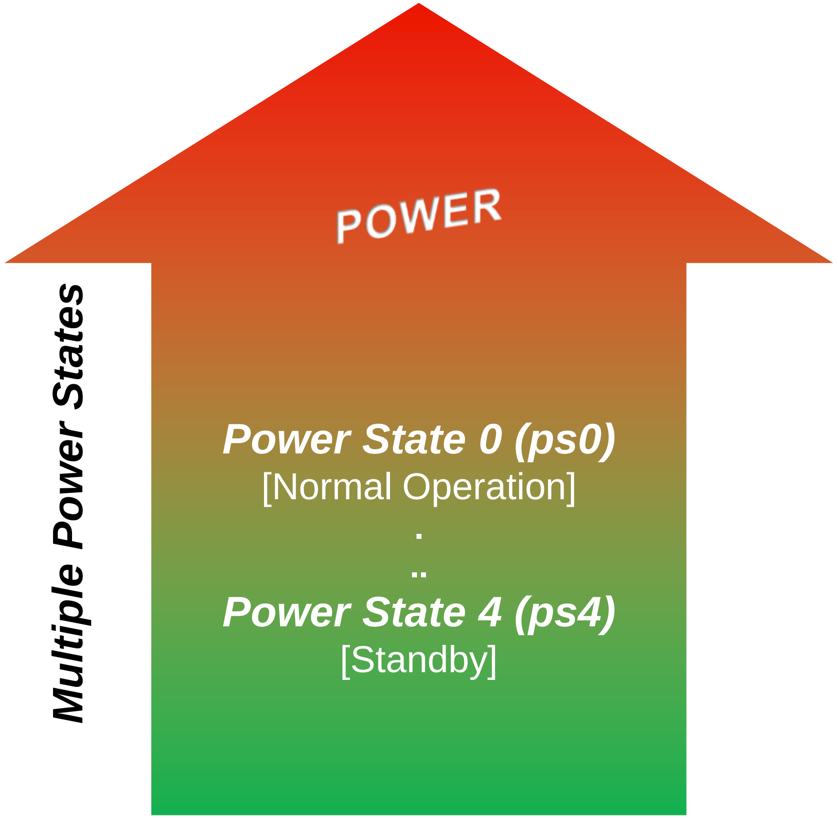
- First design of product line in different technology
  - No baseline power estimate
- New target applications and features requiring new IP
  - Poor incremental power estimates
- Lower power target from marketing / customers
  - E.g. new mode with ~ 10X lower power requirements

➔ Using SpyGlass Power on RTL and tracking power statistics over time

Introduction

Design

- Digital Controller for power management application
- Digital area approximately 1 million gates
- Multiple clock frequencies in the range 1 – 200 MHz
- 1.2V digital supply
- 65nm technology



Multiple Power States

POWER

Power State 0 (ps0)
[Normal Operation]
.
..
Power State 4 (ps4)
[Standby]

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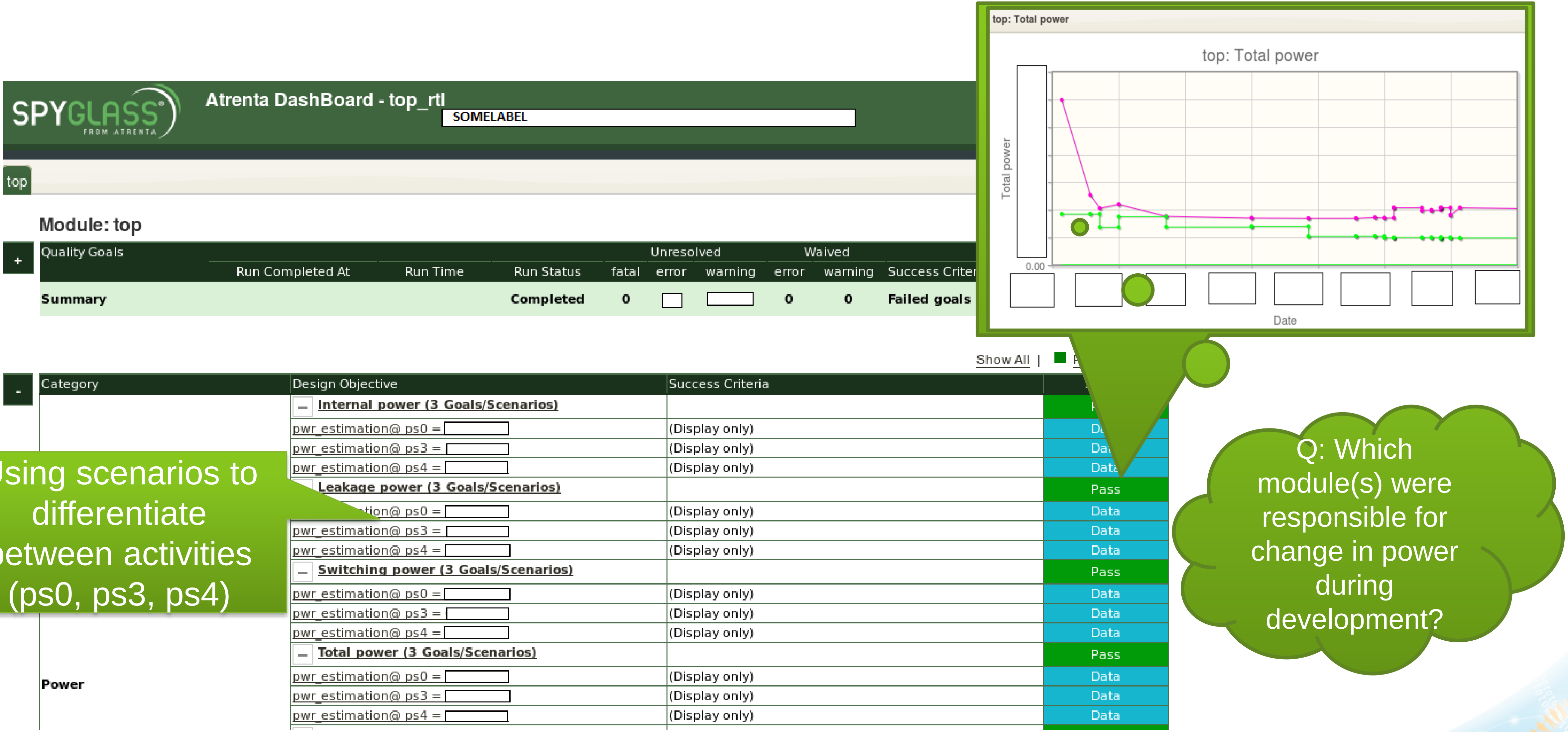
Tracking and Trending

Native Tracking by Tool via HTML reporting



SPYGLASS FROM ATRENTA

Atrenta DashBoard - top_rtl

SOMELABEL

top

Module: top

+ Quality Goals	Run Completed At	Run Time	Run Status	Unresolved fatal	Unresolved error	Unresolved warning	Waived error	Waived warning	Success Criter
Summary			**Completed**	**0**	□	□	**0**	**0**	**Failed goals**

Show All | 🟩 F

- Category	Design Objective	Success Criteria	
	⊟ **Internal power (3 Goals/Scenarios)**		P
	pwr_estimation@ ps0 = □	(Display only)	Da
	pwr_estimation@ ps3 = □	(Display only)	Dat
	pwr_estimation@ ps4 = □	(Display only)	Data
	⊟ **Leakage power (3 Goals/Scenarios)**		Pass
	tion@ ps0 = □	(Display only)	Data
	pwr_estimation@ ps3 = □	(Display only)	Data
	pwr_estimation@ ps4 = □	(Display only)	Data
	⊟ **Switching power (3 Goals/Scenarios)**		Pass
	pwr_estimation@ ps0 = □	(Display only)	Data
	pwr_estimation@ ps3 = □	(Display only)	Data
	pwr_estimation@ ps4 = □	(Display only)	Data
	⊟ **Total power (3 Goals/Scenarios)**		Pass
Power	pwr_estimation@ ps0 = □	(Display only)	Data
	pwr_estimation@ ps3 = □	(Display only)	Data
	pwr_estimation@ ps4 = □	(Display only)	Data

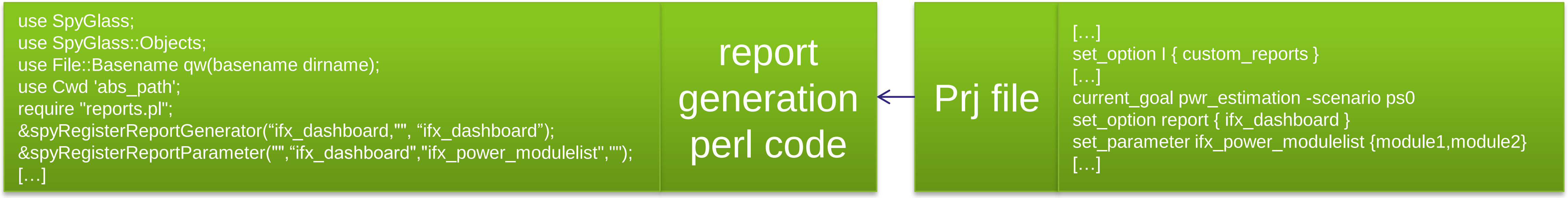
Using scenarios to differentiate between activities (ps0, ps3, ps4)

Q: Which module(s) were responsible for change in power during development?

Tracking and Trending

Extending HTML reporting by using “native custom reporting feature”

1. Generate add-on data with SpyGlass custom report Perl API



```
use SpyGlass;
use SpyGlass::Objects;
use File::Basename qw(basename dirname);
use Cwd 'abs_path';
require "reports.pl";
&spyRegisterReportGenerator(“ifx_dashboard,"", “ifx_dashboard”);
&spyRegisterReportParameter("",“ifx_dashboard","ifx_power_modulelist","");
[…]
```

report generation perl code

Prj file

```
[…]
set_option I { custom_reports }
[…]
current_goal pwr_estimation -scenario ps0
set_option report { ifx_dashboard }
set_parameter ifx_power_modulelist {module1,module2}
[…]
```

2. Configure HTML generator to use add-on data

```
setenv INCLUDE_DASHBOARD_SOURCES
spyglass_reports/ifx_dashboard.rpt
```

ENV

```
SCHEMA@@MYATT1@@module1_::_Total_Power
VALUE@@MYVALUE1@@123e-02
```

Generated Custom dashboard input

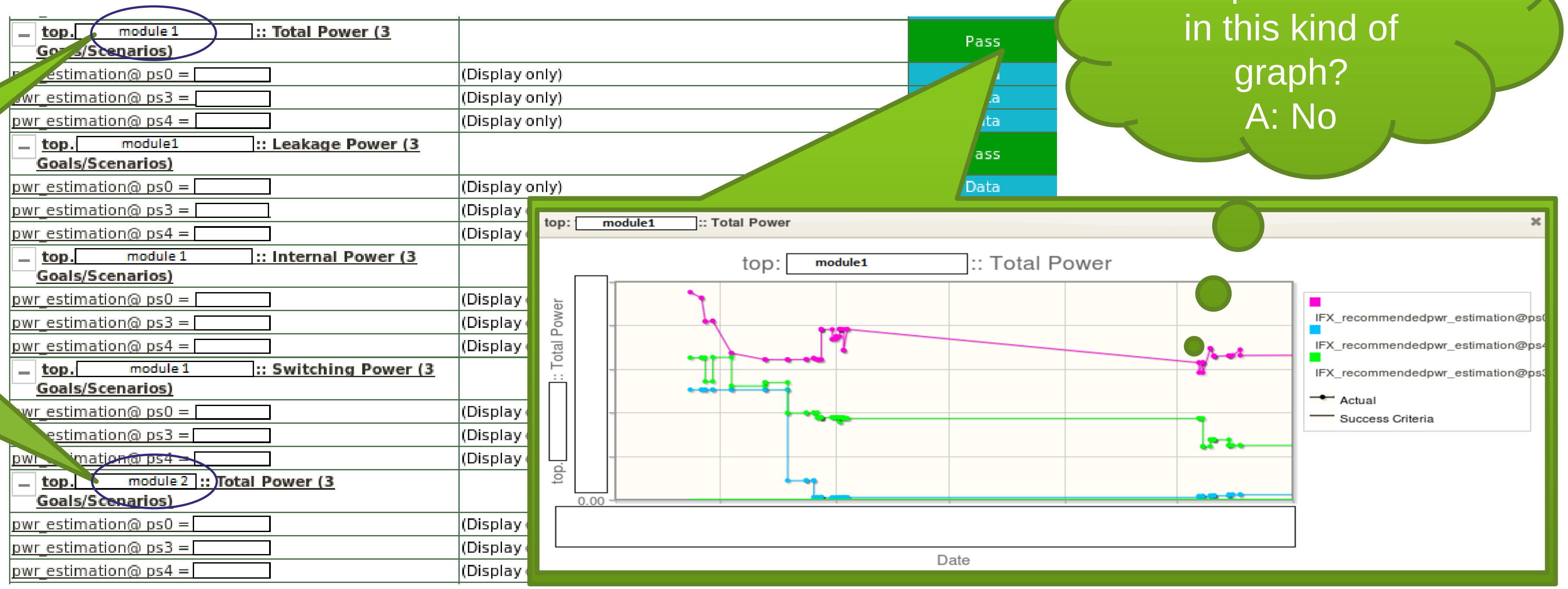
Dashboard Html config file

top_rtl_html_report_dashboard_criteria File Content:

```
[…]
set_design_objective IFX_MODULEPOWER \
-criteria { module1_::_Total_Power=display_only} \
–goal { pwr_estimation}
[…]
```

Tracking and Trending

Extending HTML reporting by using “native custom reporting feature”



IFX_MODULEPOWER	top. module 1 :: Total Power (3 Goals/Scenarios)		Pass
	estimation@ ps0 =	(Display only)	
	pwr_estimation@ ps3 =	(Display only)	a
	pwr_estimation@ ps4 =	(Display only)	ta
	top. module1 :: Leakage Power (3 Goals/Scenarios)		ass
	pwr_estimation@ ps0 =	(Display only)	Data
	pwr_estimation@ ps3 =	(Display	
	pwr_estimation@ ps4 =	(Display	
	top. module 1 :: Internal Power (3 Goals/Scenarios)		
	pwr_estimation@ ps0 =	(Display	
	pwr_estimation@ ps3 =	(Display	
	pwr_estimation@ ps4 =	(Display	
	top. module 1 :: Switching Power (3 Goals/Scenarios)		
	wr_estimation@ ps0 =	(Display	
	estimation@ ps3 =	(Display	
	pwr_ imation@ ps4 =	(Display	
	top. module 2 :: Total Power (3 Goals/Scenarios)		
	pwr_estimation@ ps0 =	(Display	
	pwr_estimation@ ps3 =	(Display	
	pwr_estimation@ ps4 =	(Display	

top: module1 :: Total Power
×
top: module1 :: Total Power
top. :: Total Power
0.00
Date
IFX_recommendedpwr_estimation@ps0
IFX_recommendedpwr_estimation@ps4
IFX_recommendedpwr_estimation@ps3
Actual
Success Criteria

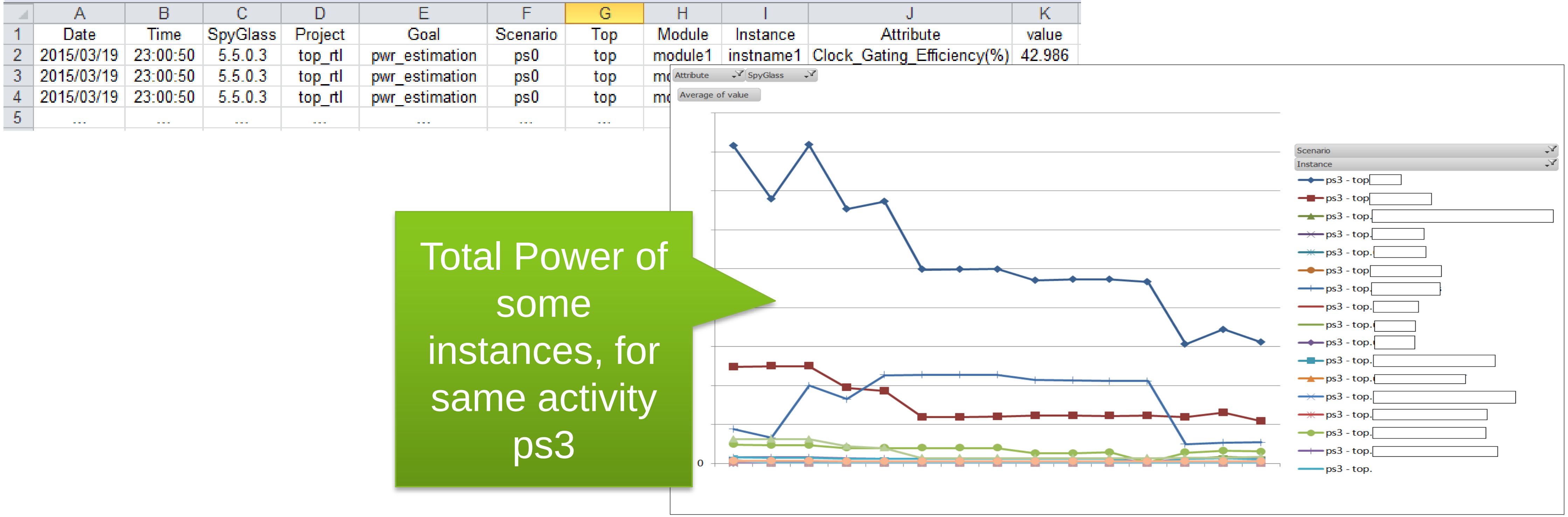
Reporting also important sub hierarchies in HTML trend

Q: Can I get multiple modules in this kind of graph?
A: No

Tracking and Trending

Further number crunching

- Presenting the most widely used number crunching tool once again:
  - Excel (and Pivot tables)!
    - Custom Perl script is datamining same data used for HTML and exporting in Excel, thus allowing all kind of graphs and correlations:

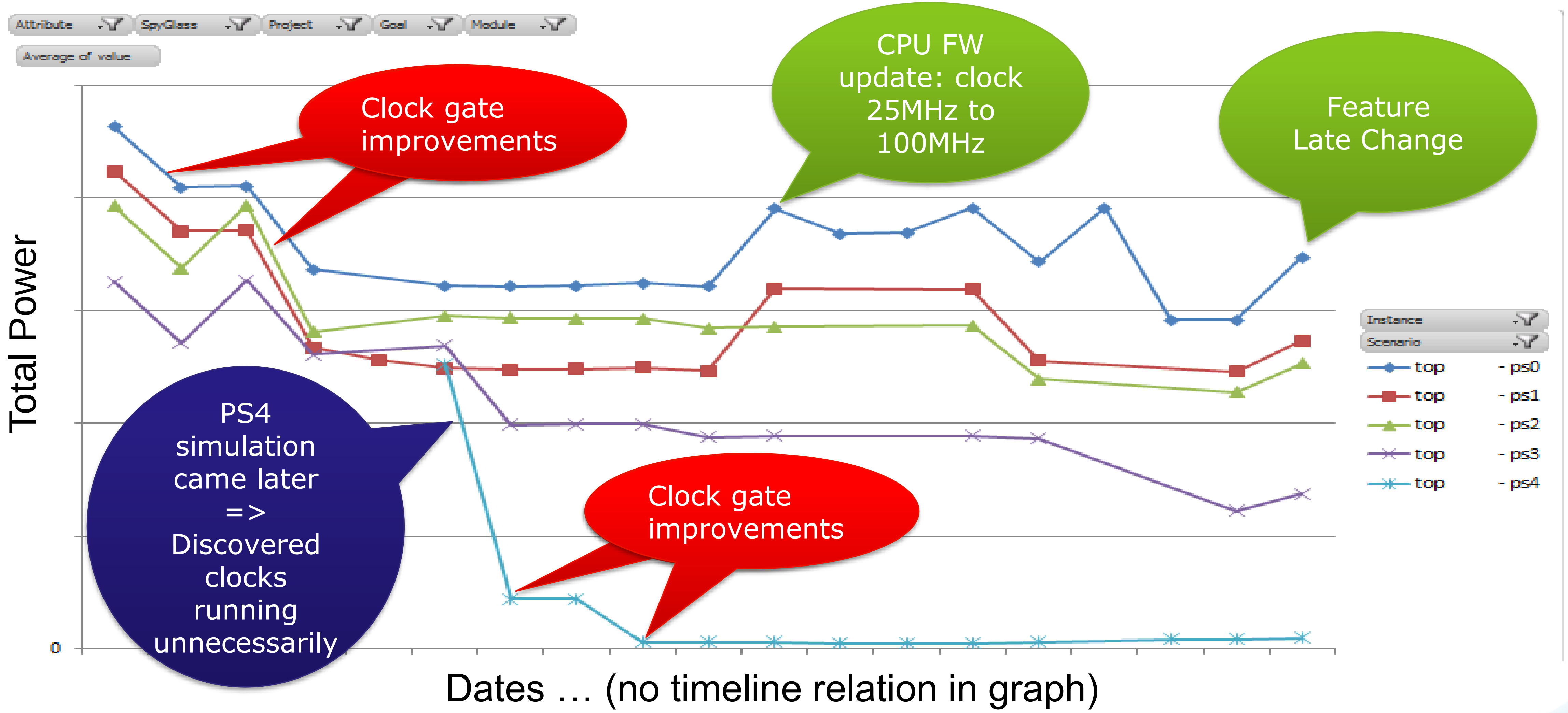


	A	B	C	D	E	F	G	H	I	J	K
1	Date	Time	SpyGlass	Project	Goal	Scenario	Top	Module	Instance	Attribute	value
2	2015/03/19	23:00:50	5.5.0.3	top_rtl	pwr_estimation	ps0	top	module1	instname1	Clock_Gating_Efficiency(%)	42.986
3	2015/03/19	23:00:50	5.5.0.3	top_rtl	pwr_estimation	ps0	top	mo			
4	2015/03/19	23:00:50	5.5.0.3	top_rtl	pwr_estimation	ps0	top	mo			
5	...	...	...	...	...	...	...				

Total Power of some instances, for same activity ps3

Tracking and Trending

Analysis



Clock gate improvements

CPU FW update: clock 25MHz to 100MHz

Feature Late Change

PS4 simulation came later => Discovered clocks running unnecessarily

Clock gate improvements

Tracking and Trending

Benefit?

- Question: So if we end up in excel anyway why all the hassle?
- Answer:
  - We do not just end up in excel, we use also the configurable HTML reporting
  - Automated approach
  - Without user dependency
  - Independent of batch or GUI mode, all result summaries are stored
  - No need for additional infrastructure (just custom report and excel extractor)
  - Concept of custom report and tracking valid also for other topics

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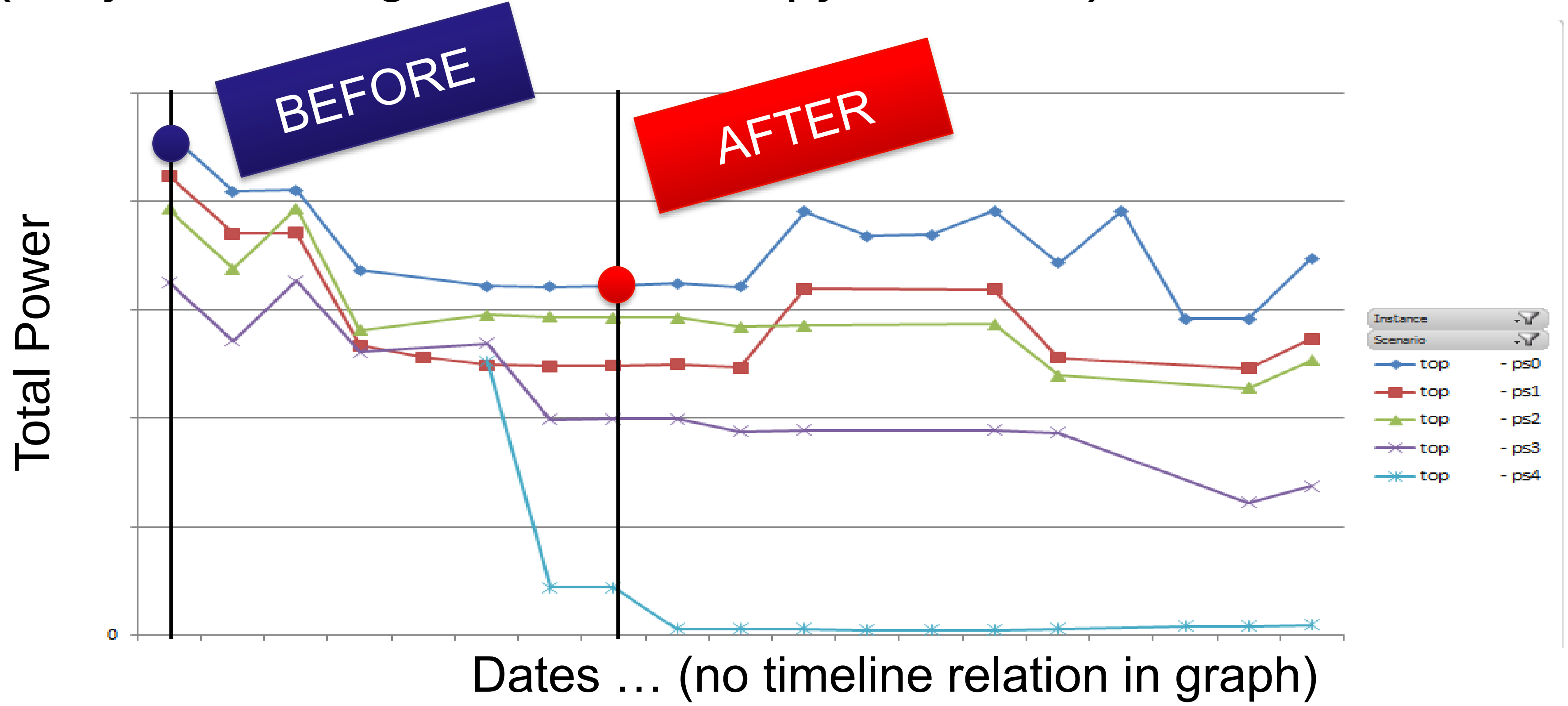
Clock Gating Statistics Pitfall

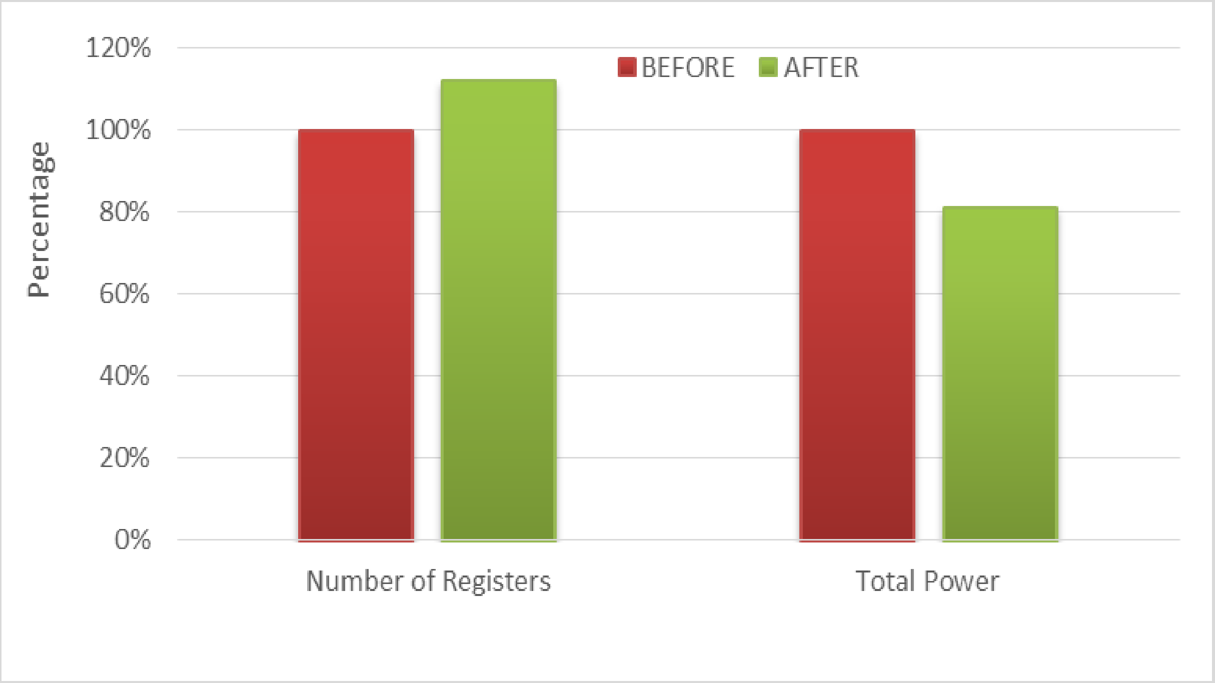
Overview

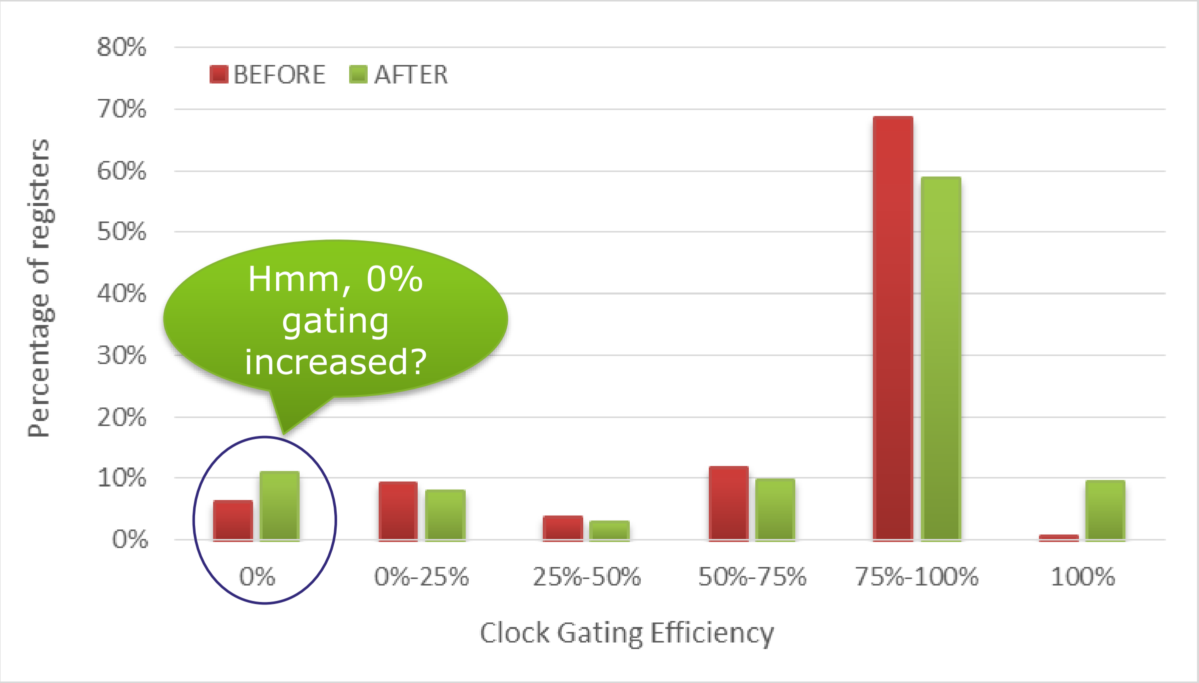
- Two design states were taken post development for demonstration, using SpyGlass 5.5.0.3 on just **ps0** activity
(not just tracking data, but full SpyGlass run)



Clock Gating Statistics Pitfall

Register Count, Total Power and Clock Gating Efficiency

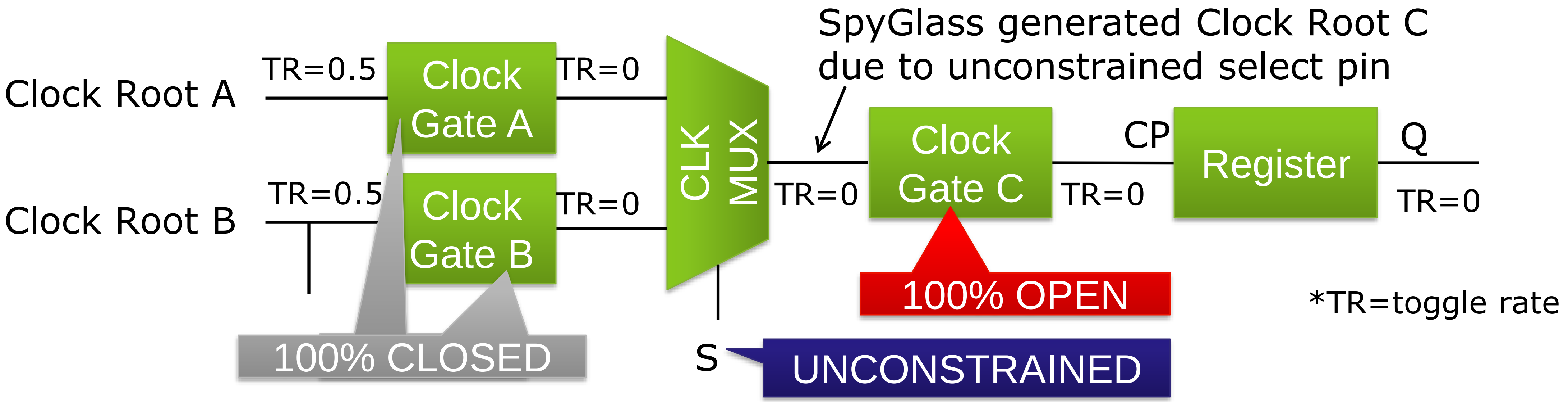




- Number of registers increased (feature development, …)
- Power decreased (majority due to clock gating)

Clock Gating Statistics Pitfall

Explanation of 0% clock gating increase



- SpyGlass infers additional clock roots where not unique
- This may result in some bad statistics although no actual activity:
  - $\text{ClockGateEff}_{\text{ClockRootC}} = \text{Time}_{\text{ClockGateClosed}} / \text{Time}_{\text{overall}} = 0\%$

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- SpyGlass custom report API and HTML configuration is used for tracking and trending design power without need of significant additional infrastructure
- This is just **one** possible use case for the custom report API
- Always analyze and understand root cause for power statistics, as sometimes this can be misleading (e.g. Clock Gating Efficiency)

Thank You