Enhanced timing correlation between PnR and STA by reducing RC gap with StarRC compare parasitic engine

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Agenda

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About Quest Global

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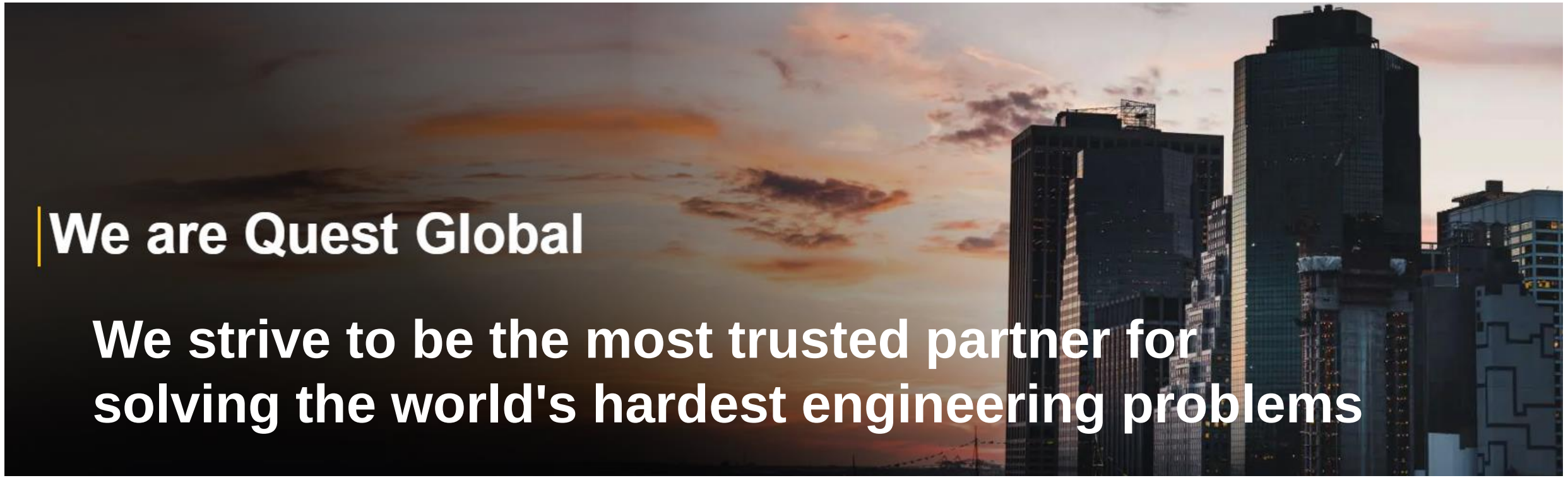

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Engagements with 7 of Top-10 Semiconductor companies	**300+ Tape-outs from 2016 onwards 65nm to 3nm**	**>60% of Semicoductor Engineers work on 7nm or later**	**25+ Tape-outs in 5/4/3nm**

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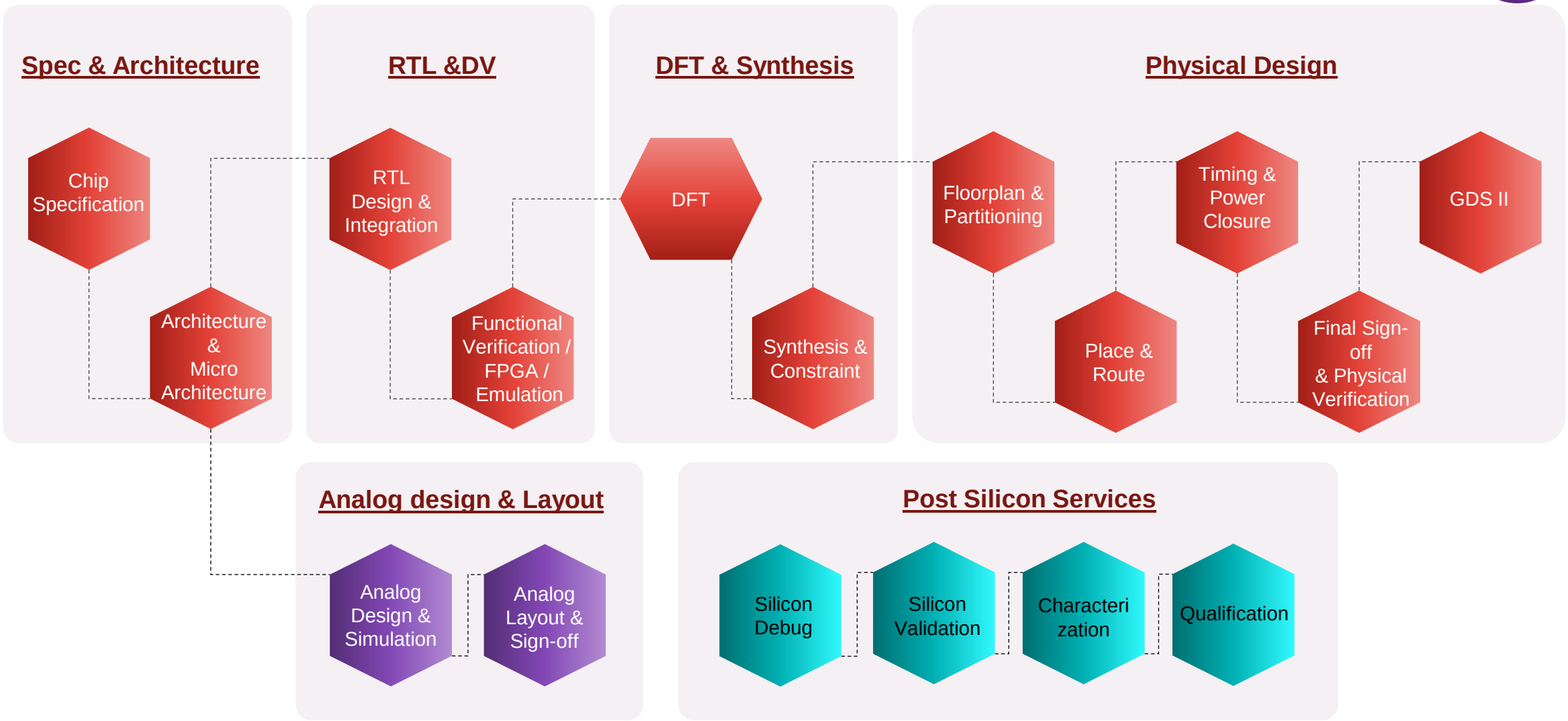

Problem Statement

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Introduction

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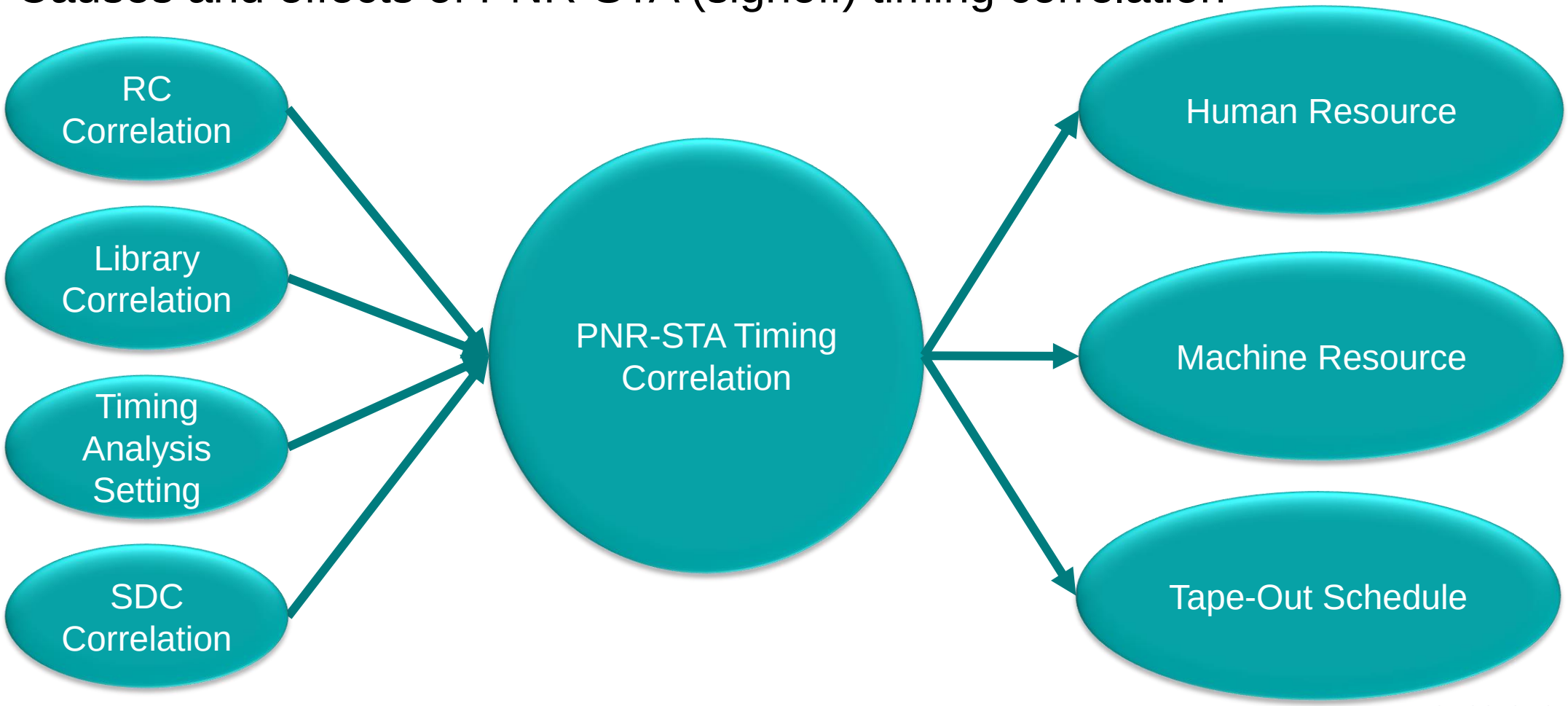
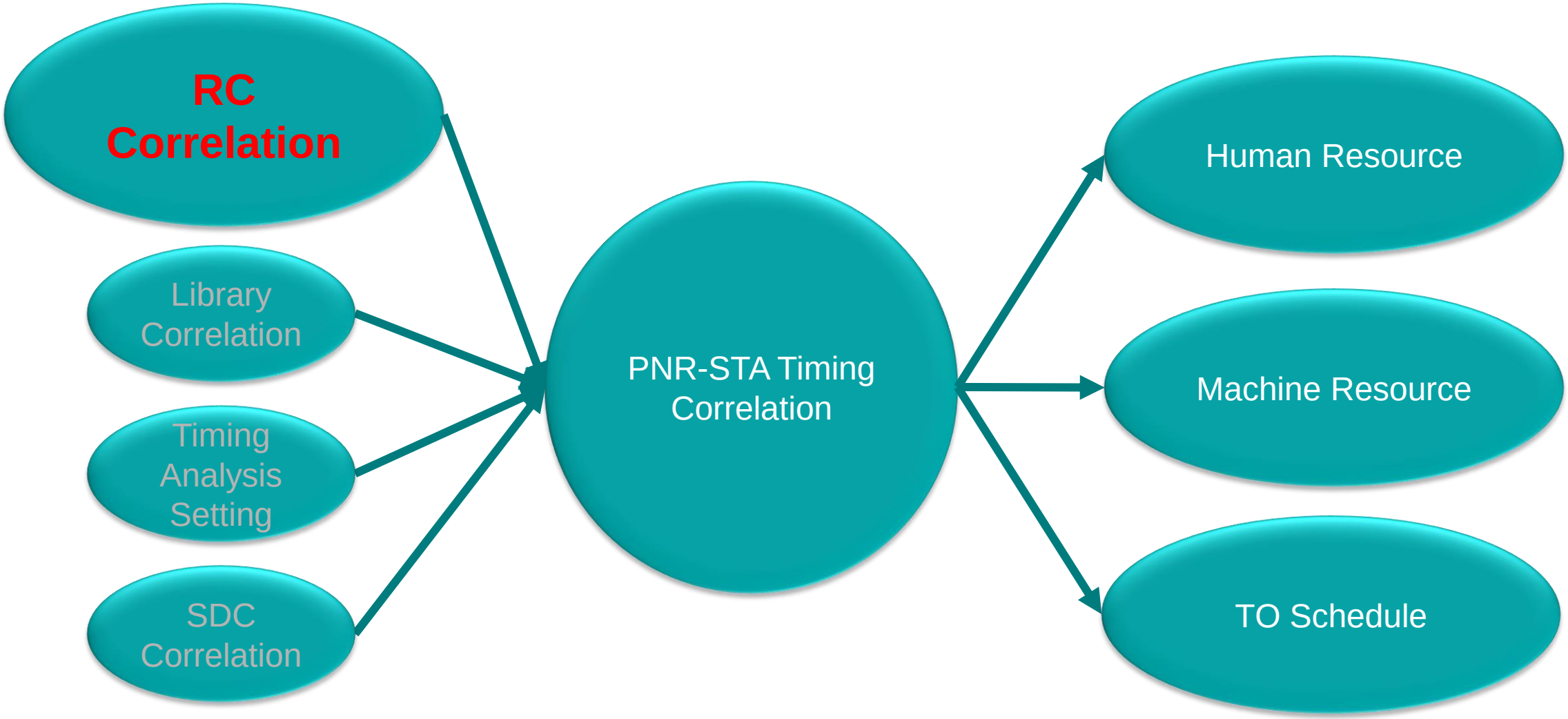
Introduction

- Causes and effects of PNR-STA (signoff) timing correlation



Problem Statement

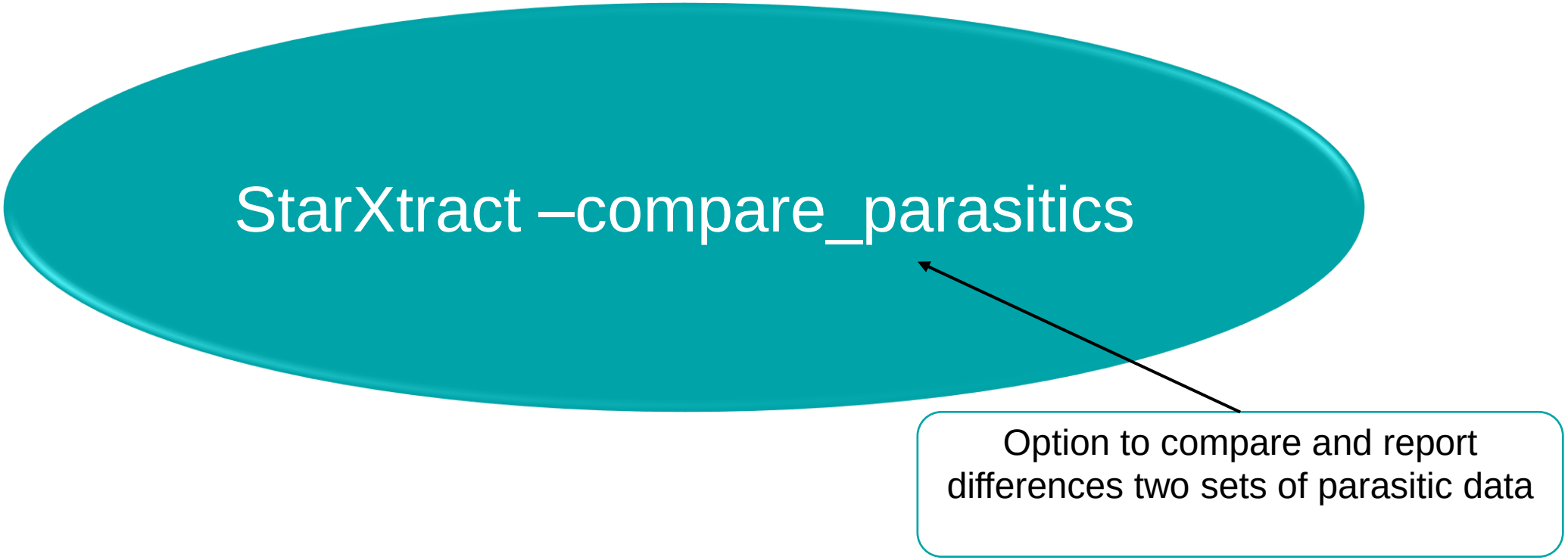
With advanced nodes, RC Correlation is MORE essential to Timing Correlation



Proposed Solution

StarXtract –compare_parasitics

- Synopsys StarRC provided solution for RC Correlation improvement between PnR tool Fusion Compiler (FC) and signoff tool PrimeTime (PT)



How “StarXtract –compare_parasitics” works

General flow

Main engine: StarXtract –compare_parasitics

- Input FC SPEF and StarRC SPEF
- Output RC mean error value between 2 SPEFs by StarXtract –compare_parasitics
- Calculate RC scaling factor
- Update extraction setting with RC scaling factor
- Rerun PNR with updated RC extraction setting
- Confirm RC correlation with starRC and timing correlation with PrimeTime

Output RC mean error value

For both worst and best corners

```
StarXtract -compare_parasitics  ${PNR_SPEF} ${STARRC_SPEF} -ccap 0.1 0.01 -tcap 0.1 -res 50
```

- **StarXtract -compare_parasitics:** Invoke compare parasitics engine of StarXtract
- **${PNR_SPEF}:** Test SPEF to compare
- **${STARRC_SPEF}:** Referenced SPEF
- **-ccap 0.1 0.01:** Constraint for coupling capacitance
- **-tcap 0.1:** Constraint for total capacitance
- **-res 50:** Constraint for point-to-point resistance

Output RC mean error value

```
RC Correlation Overview (worst corner)
Total cap (C)      mean error : -8.631%
Coupling cap (CC) mean error : -0.281%
Pin-Pin res (P2P) mean error : -10.190%
```

We will use these mean errors values as updated Fusion Compiler RC extraction setting

Calculate RC scaling factor

```
set worst_C "-8.631"
set worst_CC "-0.281"
set worst_P2P "-10.190"
set Scale_worst_C [expr 100/ $worst_C + 100]
set Scale_worst_CC [expr 100/ $worst_CC + 100]
set Scale_worst_P2P [expr 100/ $worst_P2P + 100]
```

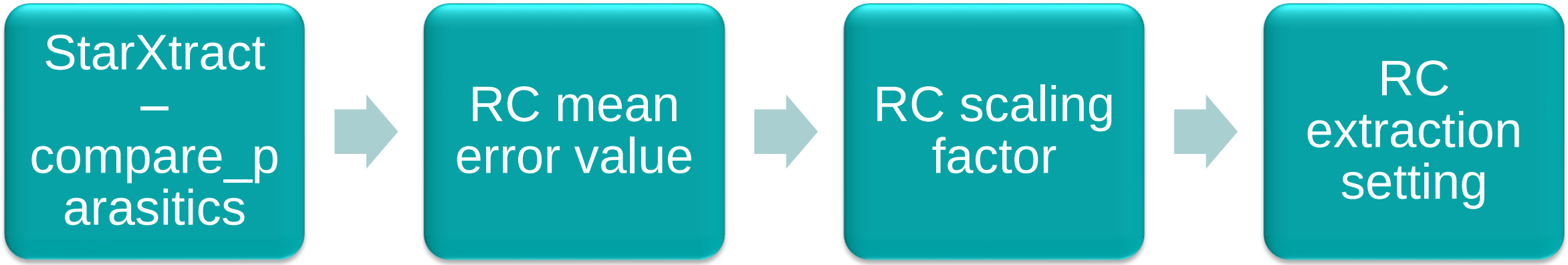
```
Total cap (C)       : -8.631%
Coupling cap (CC)   : -0.281%
Pin-Pin res (P2P)   : -10.190%
```

$$\text{Scale factor} = \frac{100}{\text{MeanError}+100}$$

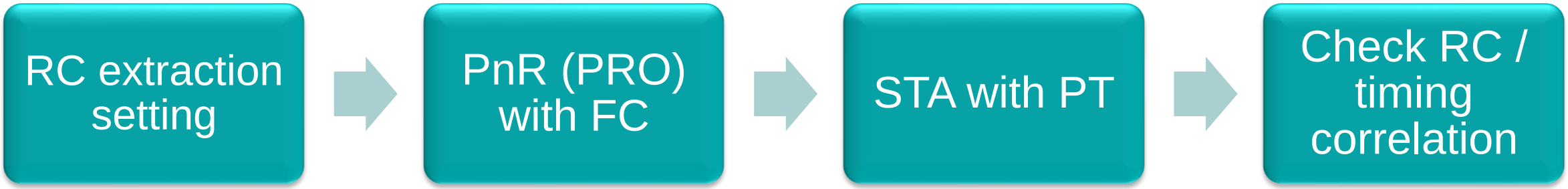
Update FC extraction setting

```
set_extraction_options -corners [get_corners worst*]
-late_vr_horizontal_cap_scale $Scale_worst_C -early_vr_horizontal_cap_scale
$Scale_worst_C
-late_vr_vertical_cap_scale $Scale_worst_C -early_vr_vertical_cap_scale
$Scale_worst_C
-late_vr_horizontal_res_scale $Scale_worst_P2P -early_vr_horizontal_res_scale
$Scale_worst_P2P
-late_vr_vertical_res_scale $Scale_worst_P2P -early_vr_vertical_res_scale
$Scale_worst_P2P
-late_vr_via_res_scale $Scale_worst_P2P -early_vr_via_res_scale $Scale_worst_P2P
-late_rde_cap_scale $Scale_worst_C -early_rde_cap_scale $Scale_worst_C
-late_rde_res_scale $Scale_worst_P2P -early_rde_res_scale $Scale_worst_P2P
-late_cap_scale $Scale_worst_C -early_cap_scale $Scale_worst_C
-late_res_scale $Scale_worst_P2P -early_res_scale $Scale_worst_P2P
-late_ccap_scale $Scale_worst_CC -early_ccap_scale $Scale_worst_CC
```

From SPEFs to RC extraction setting



Check correlation with updated FC extraction setting



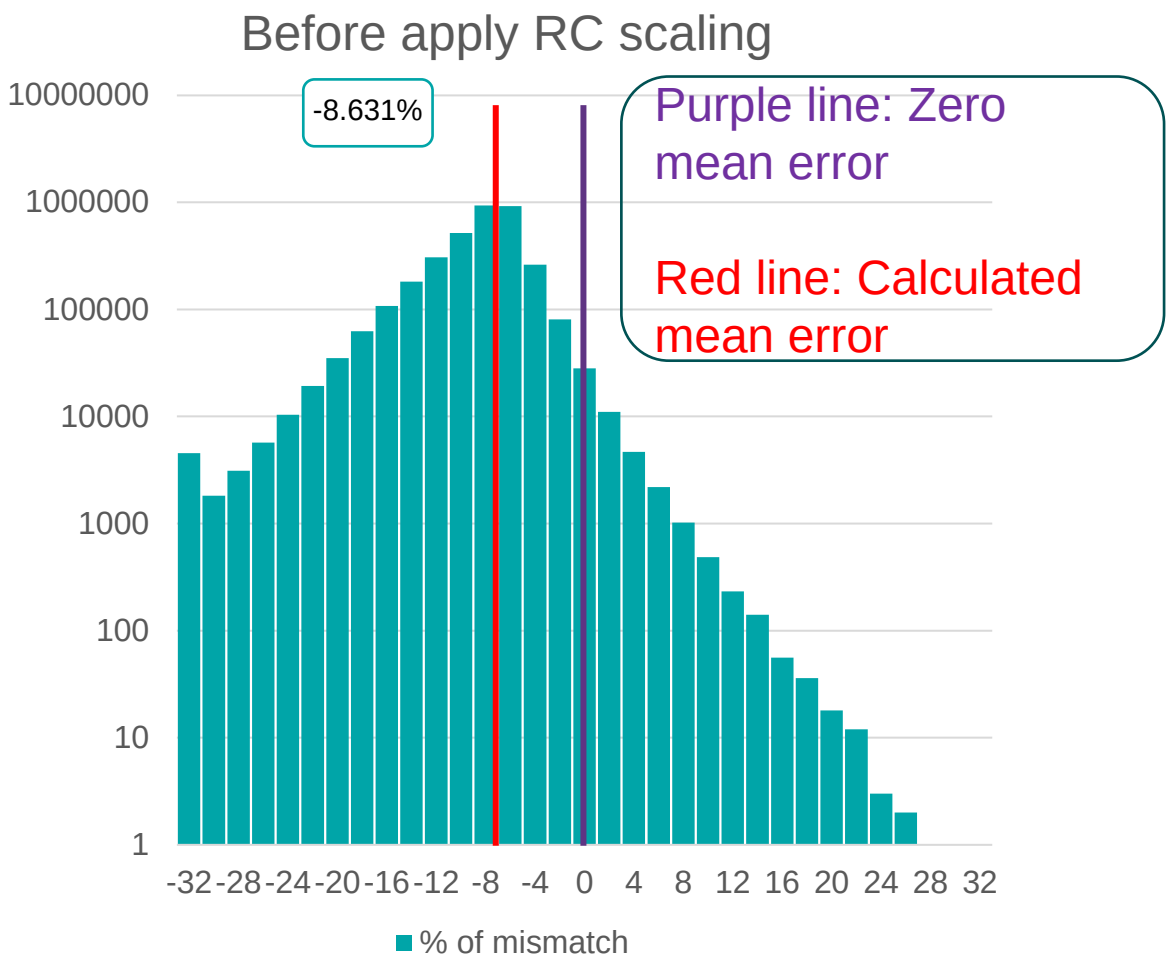
Results

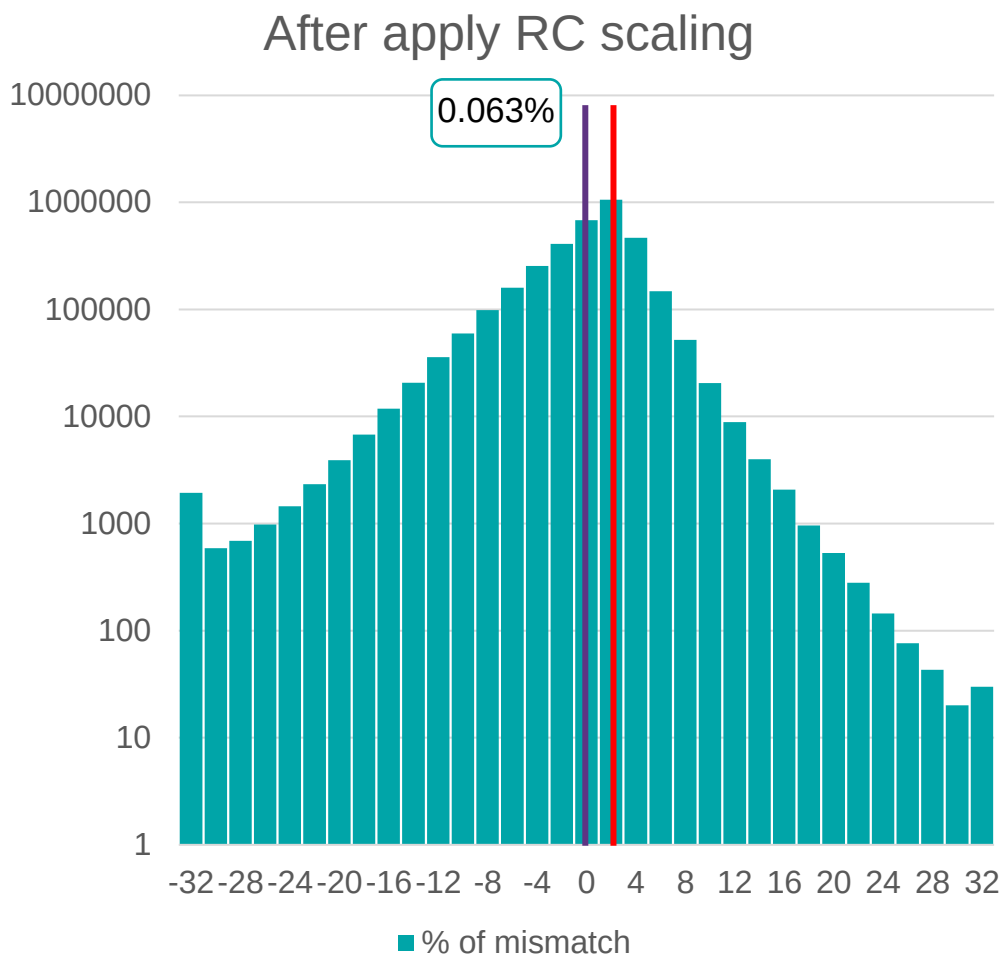
RC Correlation

Timing Correlation

RC Correlation Distribution

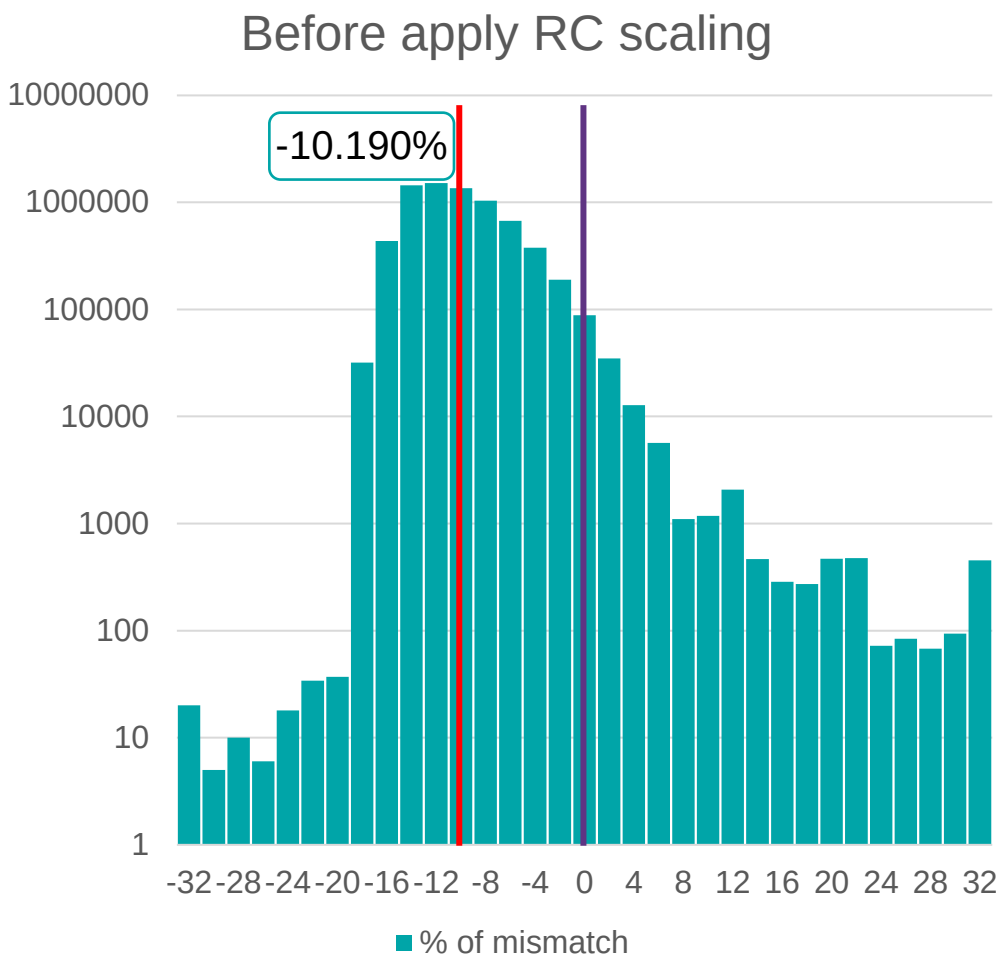
Total Cap - C

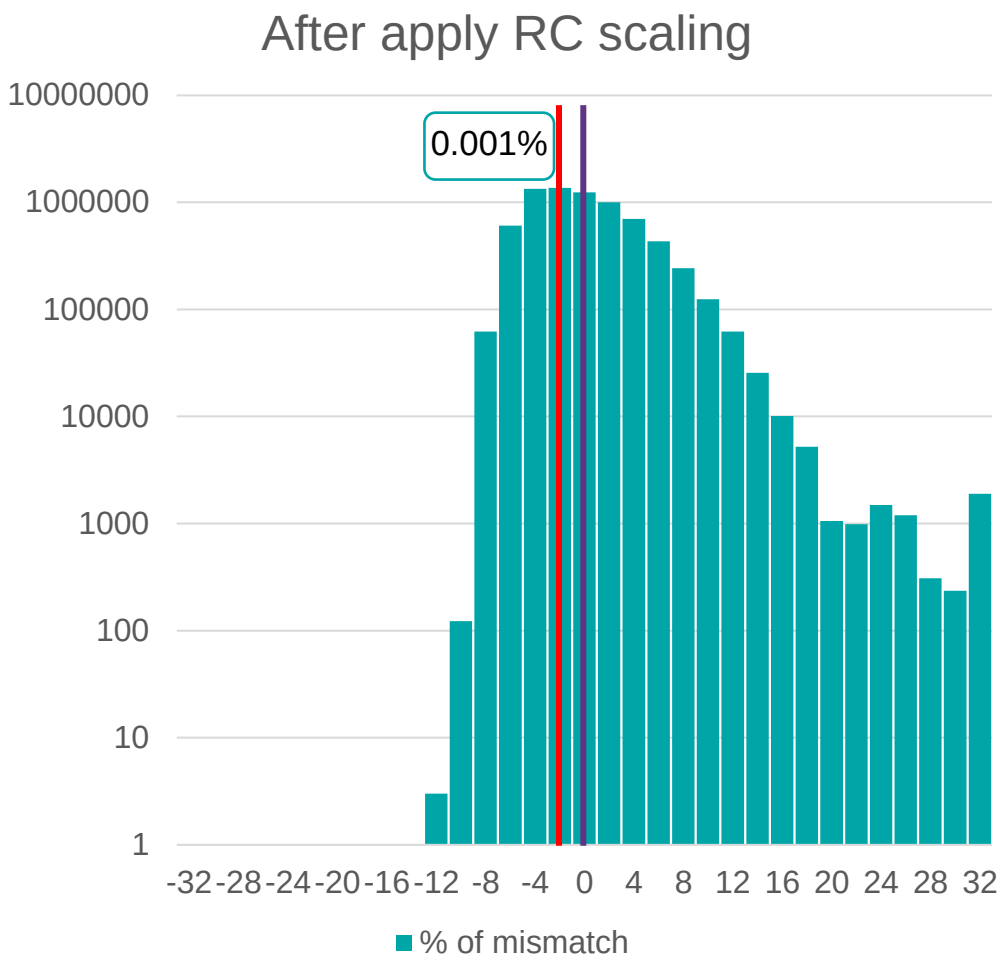




RC Correlation Distribution

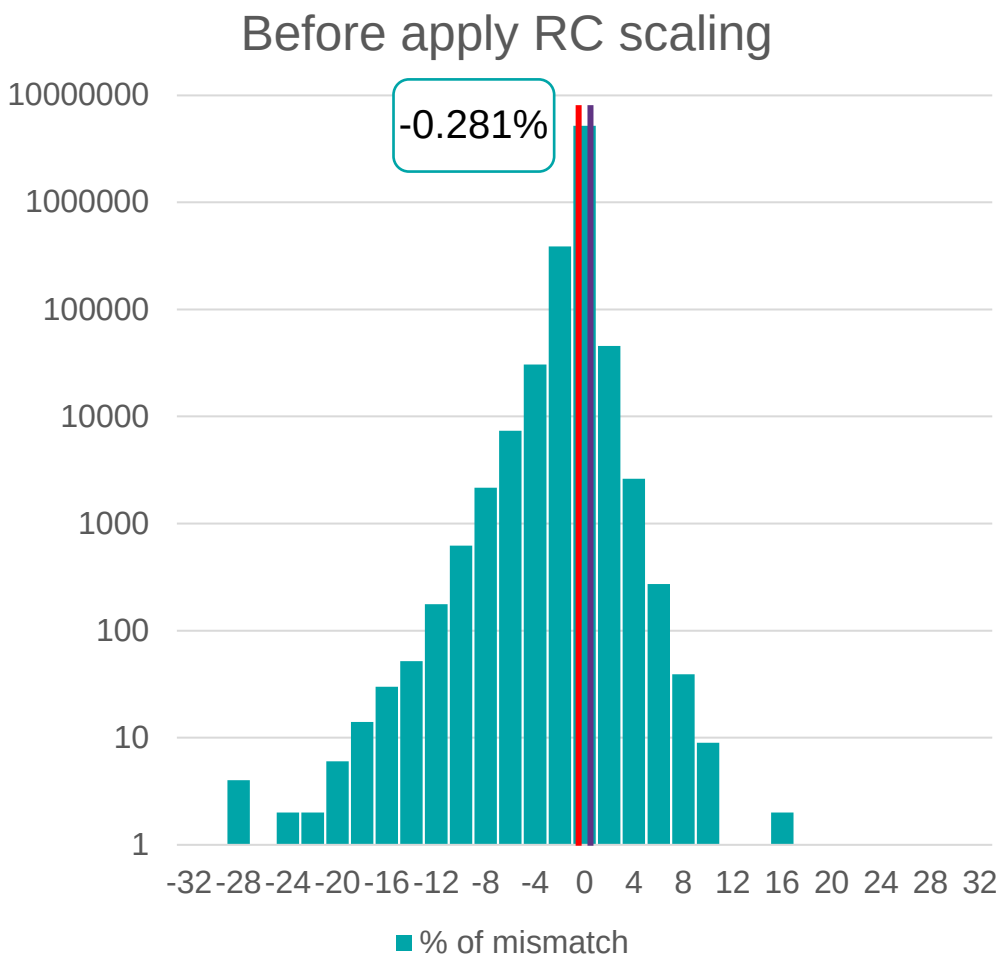
Pin-Pin Resistance – P2P

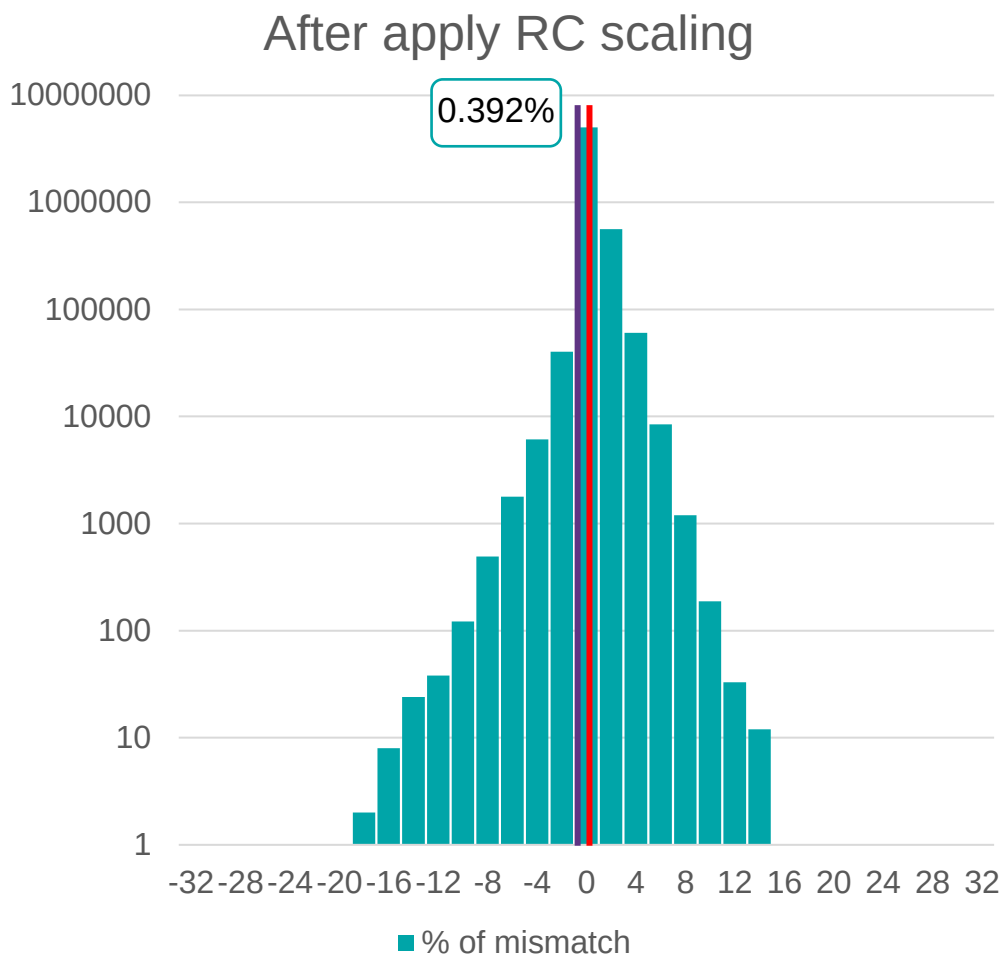




RC Correlation Distribution

Coupling Cap - CC





RC Correlation Distribution

RC Correlation mean error

	Before	After
Total Cap (C)	-8.631%	0.063%
Coupling Cap (CC)	-0.281%	0.392%
Pin-Pin Res (R)	-10.190%	0.001%

RC correlation improve much after apply updated RC extraction setting

Timing Correlation

Before and after applying RC scaling factor

	Setup				Hold			
	Before		After		Before		After	
	FC	PT	FC	PT	FC	PT	FC	PT
WNS(ns)	-0.129	-0.040	-0.145	0	-0.017	-0.016	-0.018	-0.019
TNS(ns)	-1.25	-36.632	-2.15	0	-0.17	-0.16	-0.25	-0.23
NoP	20	4088	43	0	73	119	111	59

Timing correlation improve much after apply updated RC extraction setting

Conclusion

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StarRC StarXtract –compare_parasitics solution

- Is effective in improving RC correlation between FC and StarRC SPEF
- Provides better RC correlation improve FC and PT timing correlation much
- Is productive for timing-difficult, long runtime designs with tight ECO schedule
- Is a mature engine as cost small effort but high return without bugs
- Is stable as shown good results on many HLBs / many projects

References

References

- StarRC™ User Guide and Command Reference


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