Establishing an End-To-End Methodology for Shield Reliability in Leading Tech Node PowerVIA Designs

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Abbreviation

FS	– Front Side
BS	– Back Side
PTAP	– Power Tap
VL	– Via Ladder
APR	– Auto Place & Route
ECO	– Engineering Change Order
EDA	– Electronic Design Automation

Introduction

Power Grid Changes in PowerVia Designs

04

Overhaul in shielding process

No regular FS power grid

Power need to port over to FS

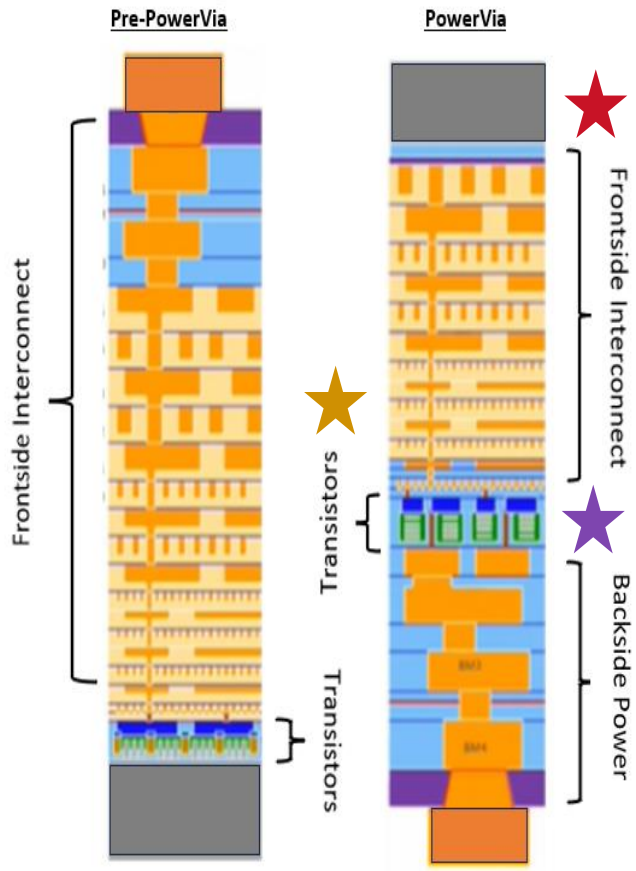
PowerVia Designs

BS interconnect

FS interconnect

Transistor in between

02



03 **Interconnect stacks**

BS for power delivery

FS for transistor and signals routing

01 **PowerVia Technology**

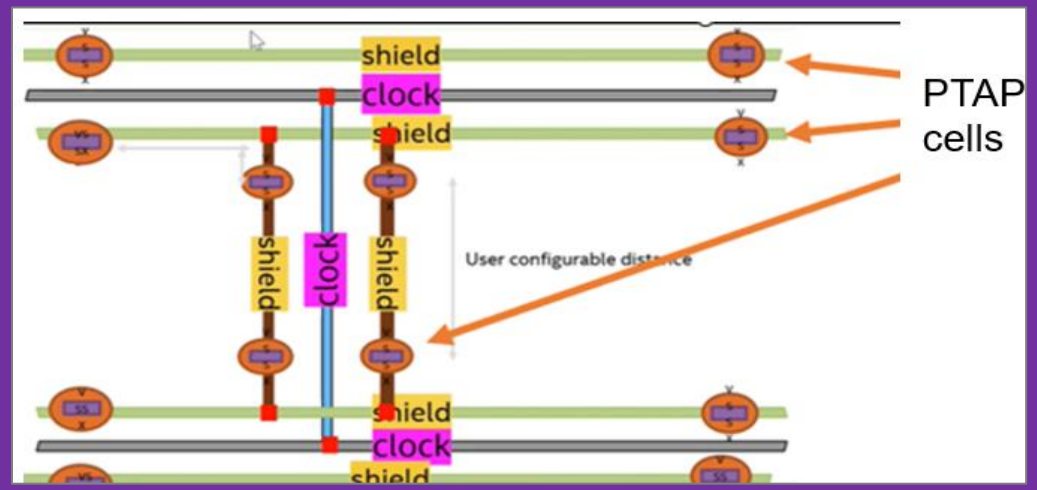
Revolutionize power delivery

Shielding Methodology in PowerVia Designs

Collaboration with EDA vendors in APR flow had enabled two types of Shielding Methodology

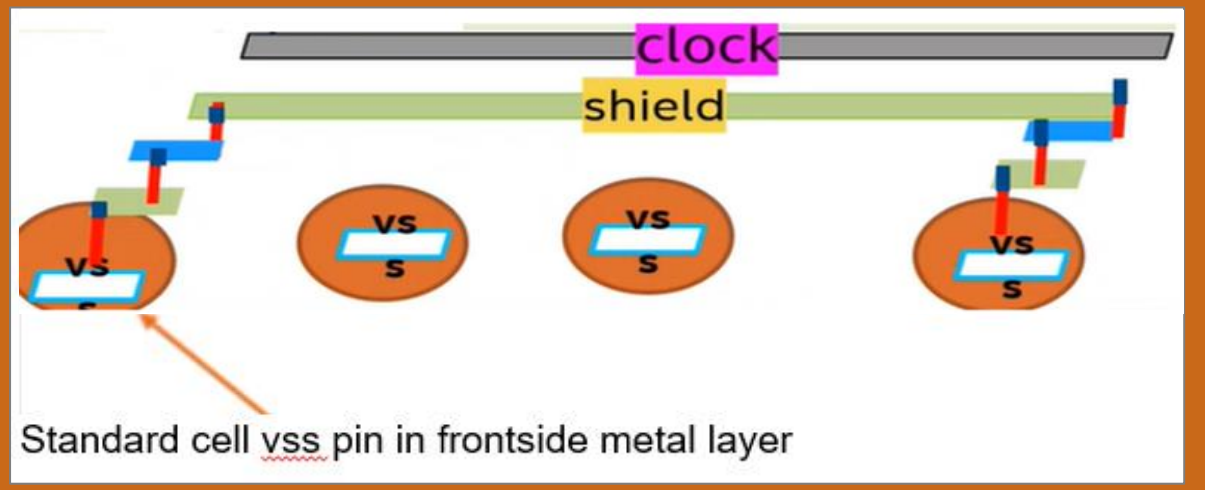
Strong shield

- Deterministic with interval distance of Power Taps (PTAPs) which will bring BS power to FS layer.



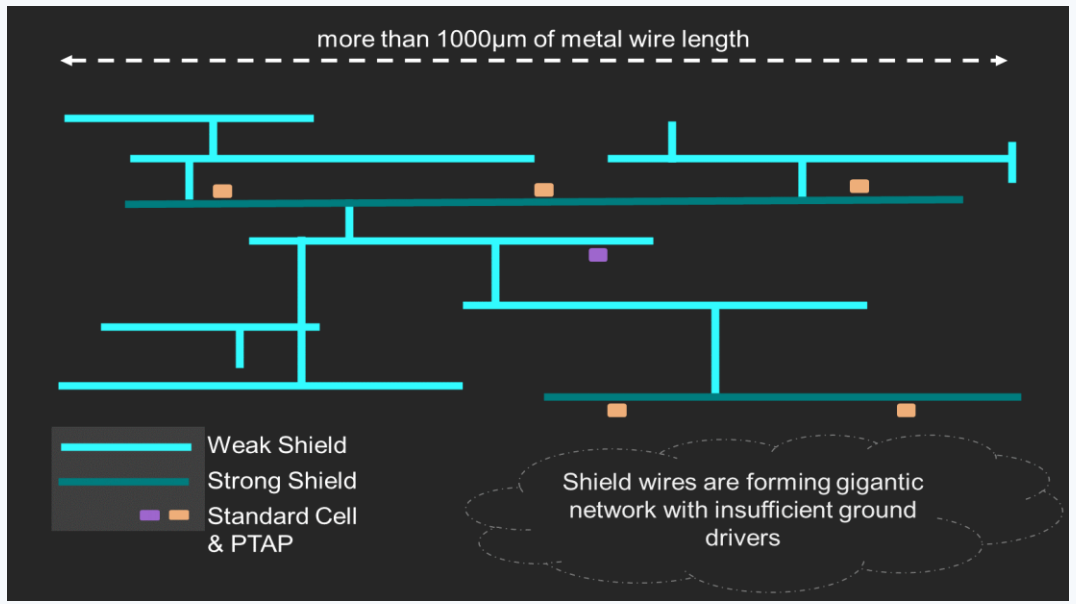
Weak shield

- Shield wires route automatically and connect to any nearby standard cells FS metal layer ground pin.



Shield coverage check - how well a net is shielded

Late Design Discovery : Shield Reliability Concern



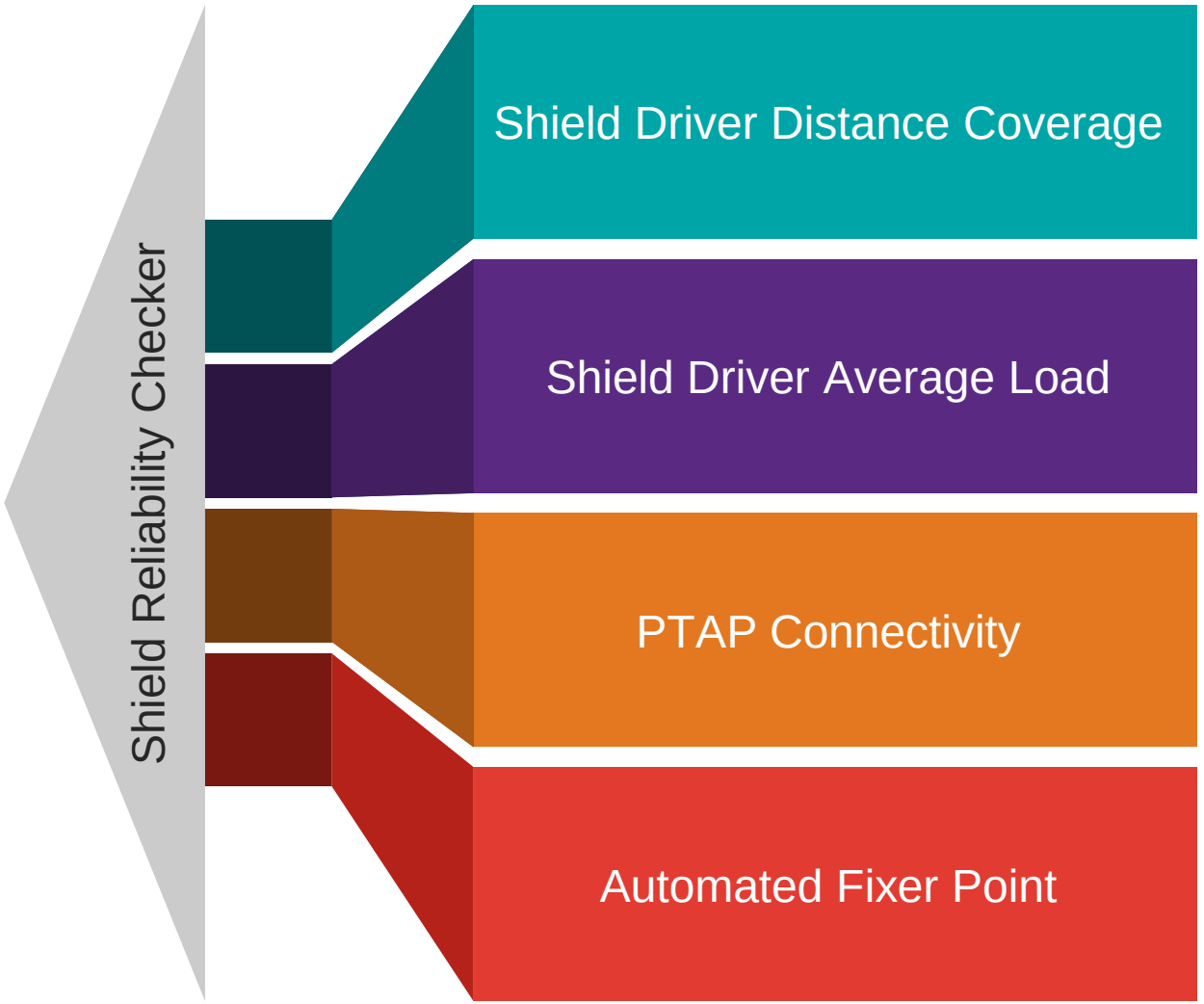
Shield Reliability

No signoff tools can tell whether shield-wire is sufficiently driven

Costly Manual Effort

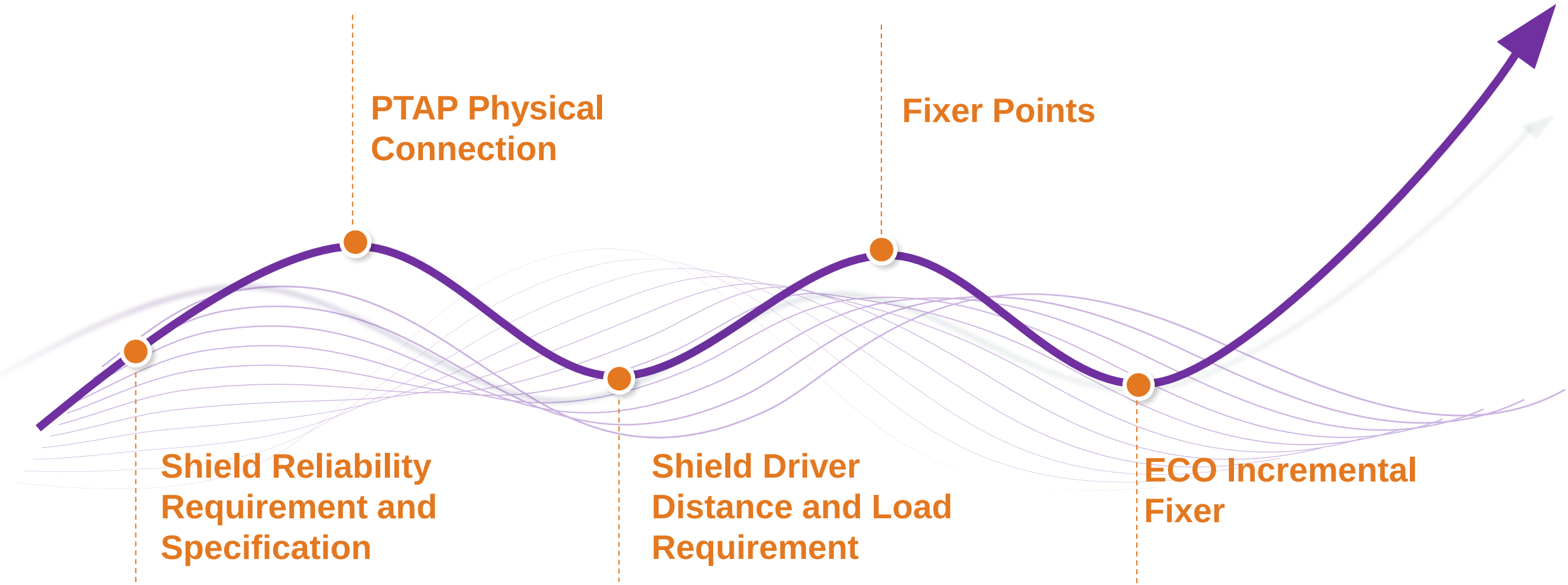
10

violations per day

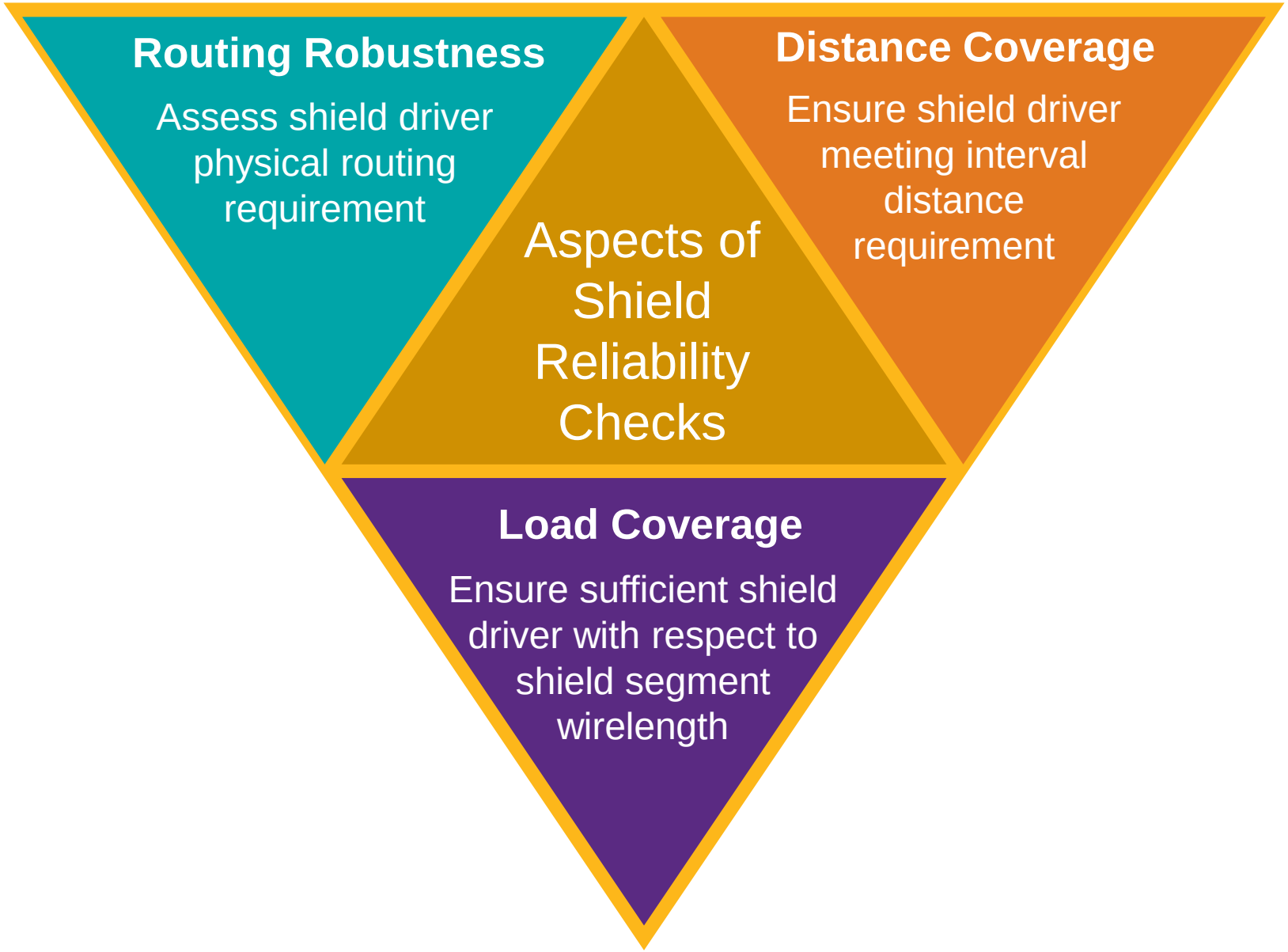


Shield Reliability Checker and Fixer Utility

Overview of Shield Reliability Checker and Utility Fixer



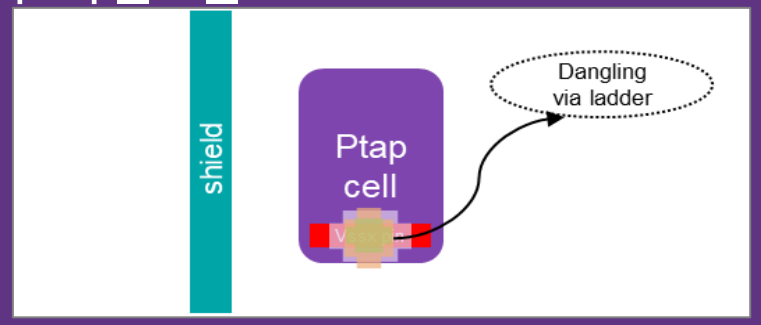
Shield Reliability Requirement



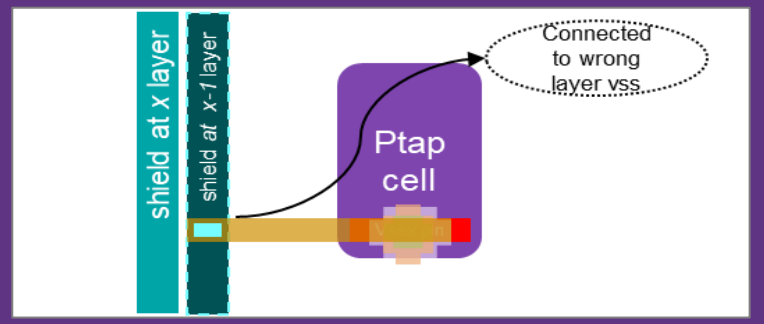
PTAP Physical Connection Checker

Ensure PTAP connectivity meeting requirement

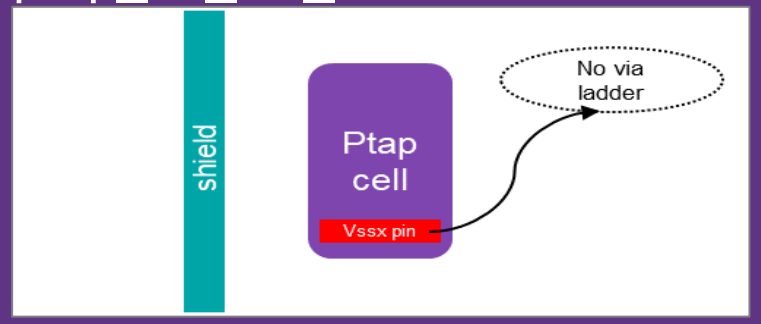
ptap_no_shield



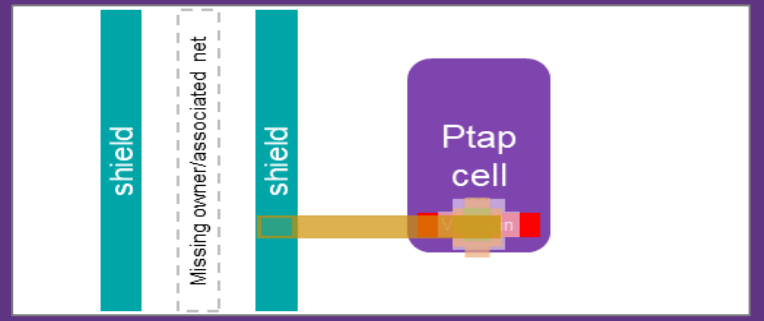
ptap_shield_wrong_layer



ptap_no_via_ladder



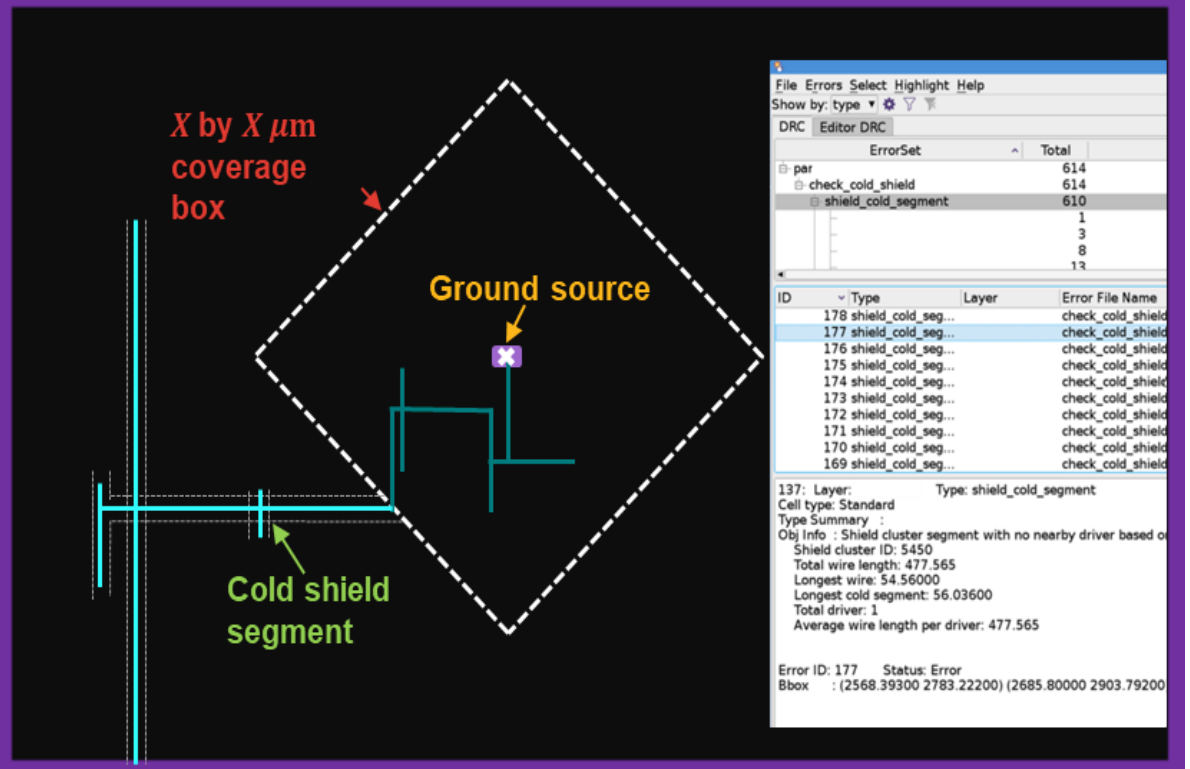
ptap_shield_no_associate_net



Shield Segment Checker

Detect connected shield segment which are out of shield-driver coverage

- Connected shield segments should have shield-driver in every X-µm diamond-shape coverage.
- Shield segments exceeding the coverage are labeled as cold-shield segments with potential of shield reliability risk.
- Checker will generate visual report for cold-shield segments.

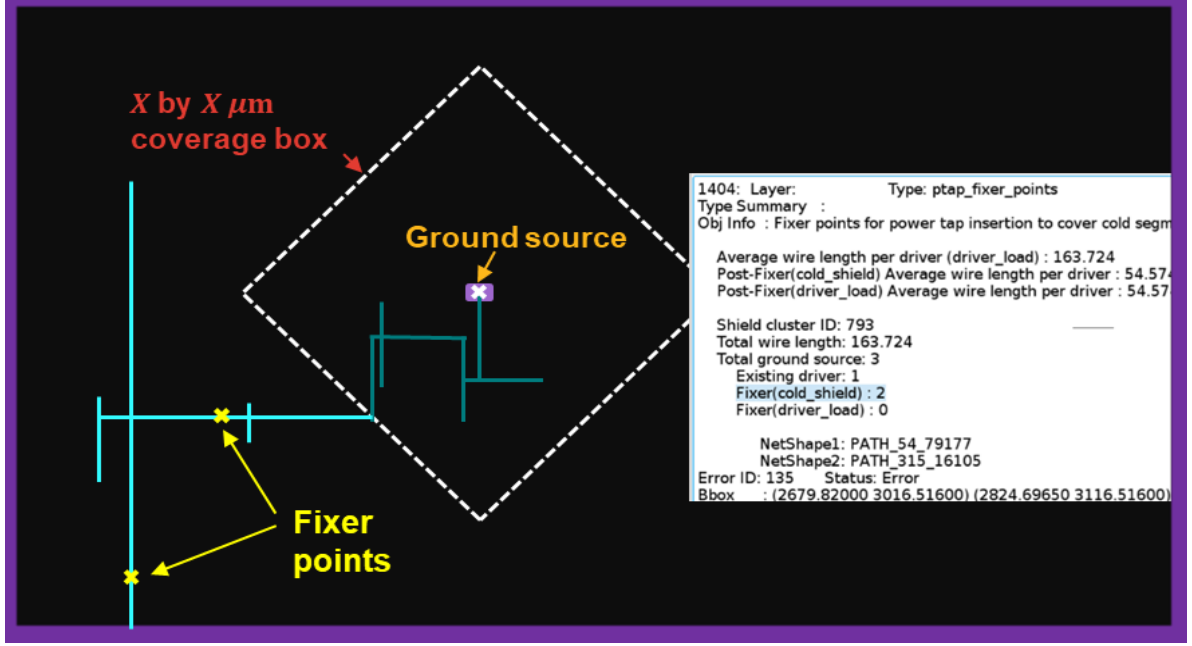


Shield Fixer Points Generation

Generate fixer-points to add ground drivers to the shield network.

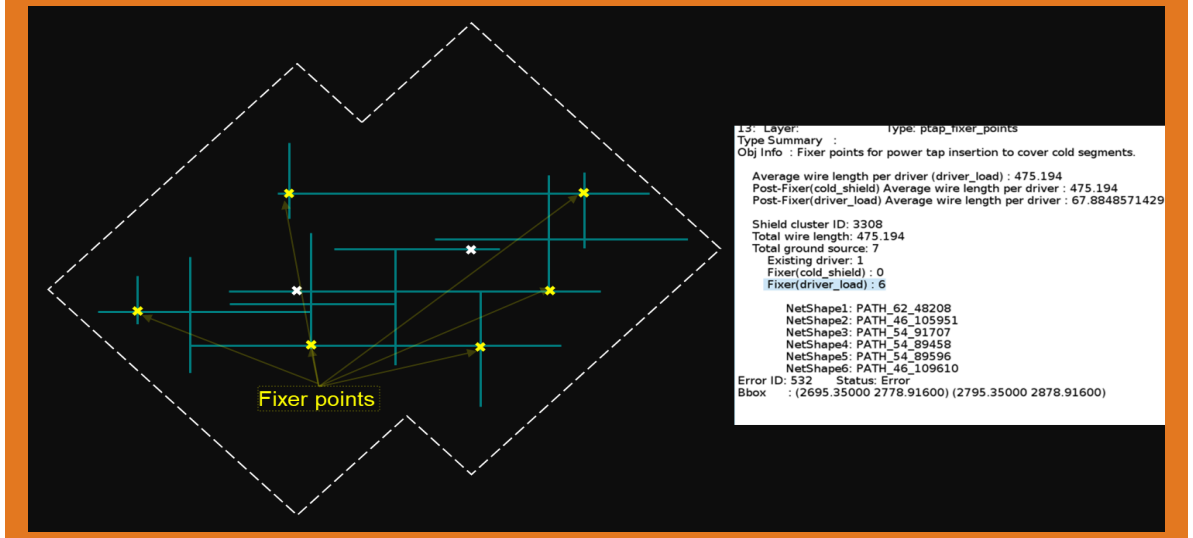
Fixer point #1 (distance coverage):

- Iteratively add shield-driver fixer points on all cold-shield segments to ensure meeting coverage.



Fixer point #2 (load coverage):

- Perform load balancing on all shield segments to prevent web-like wire where total wirelength is significantly more but within diamond-shape coverage.
- Iteratively add fixer points until the ratio $\frac{\sum \textit{shield network wire length}}{(\sum \textit{existing drivers} + \sum \textit{Newfixer points})}$ is less than X-μm.



Incremental Fixer for Shield Reliability

Customized ECO command with via-ladder routing scheme to shield segment

Fixer Points From Shield Segment Checker

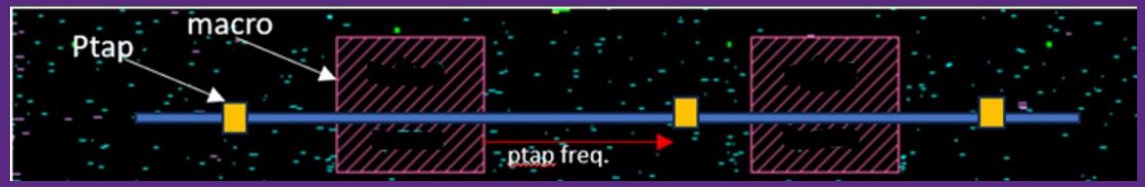
Insert PTAPs on Fixer Points

Legalize PTAPs

Add VL on PTAPs

Connect VL to Shield Wire

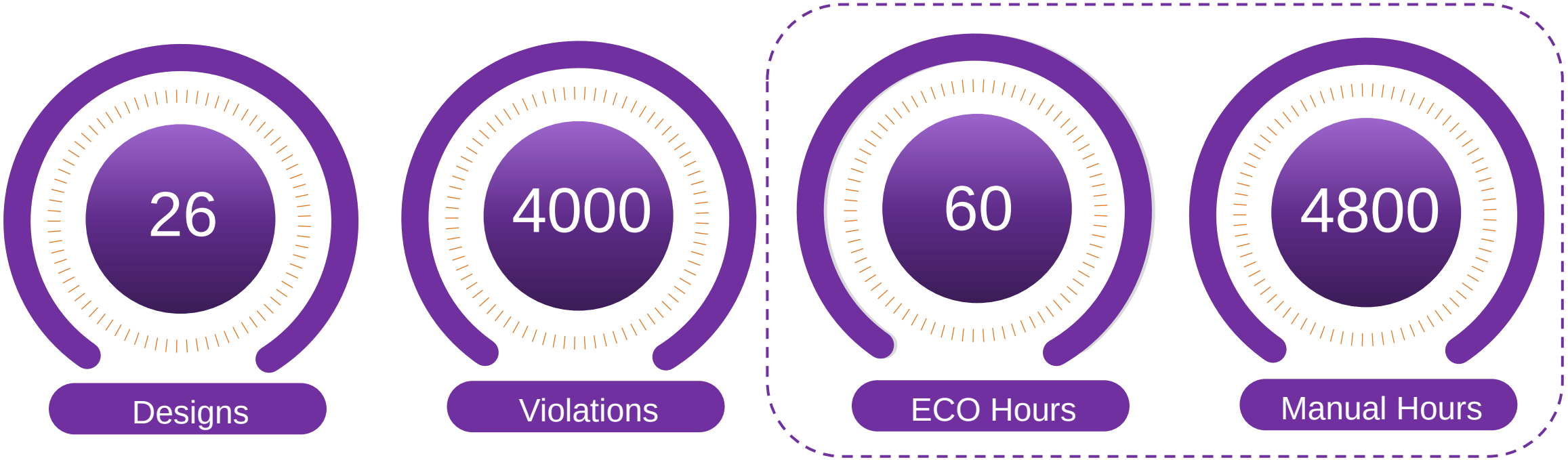
Procedure will check for macro placement and adjust PTAPs to avoid overlap.



Default router cannot route to a specific shield-wires

Results and Summary

Results and Future Use

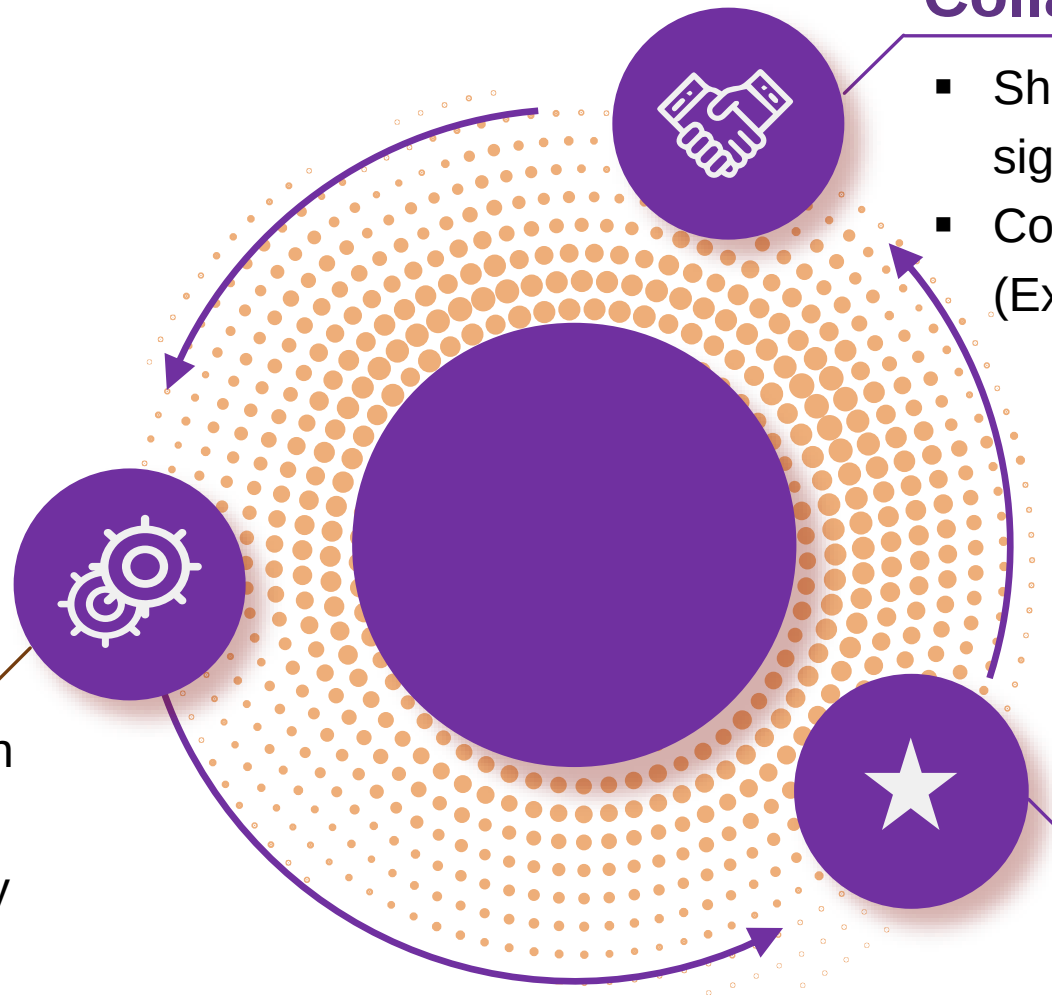


Fully converged design flow with 80x effort savings

Summary and Learnings

EDA Vendor Collaboration

- Shield reliability modelling in signoff tools
- Construction tools enhancement (Ex :checker, router)



PowerVia Designs

- Revolutionary technology in power delivery
- New shielding methodology

Shield Reliability

- New design checks
- Checker and fixer in ECO mode


THANK YOU
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