Integrated IR Shift-left Solution & Improved Coverage in Construction with RedHawk-Fusion

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Agenda

- IR design closure challenges
- Flow overview (Traditional vs proposed “shift-left” flow)
- Redhawk fusion solutions
- RHAF (in-design) vs signoff correlation
- Design QoR Improvement
- Challenges and future works
- Conclusion

IR Design Closure Challenges

Motivation

- With the tech nodes shrink, dynamic voltage drop is an escalating issue & historically IR fixing has been done manually post-route stage due to lack of an integrated in-construction automation.

- Modern SoCs now have billions of instances in addition to PG grid complexity with billion nodes requiring an efficient shift-left methodology to improve the productivity.

- There are correlation challenges between the in-design dynamic analysis and signoff golden analysis causing suboptimal solutions

Flow Overview

Traditional IR fixing flow

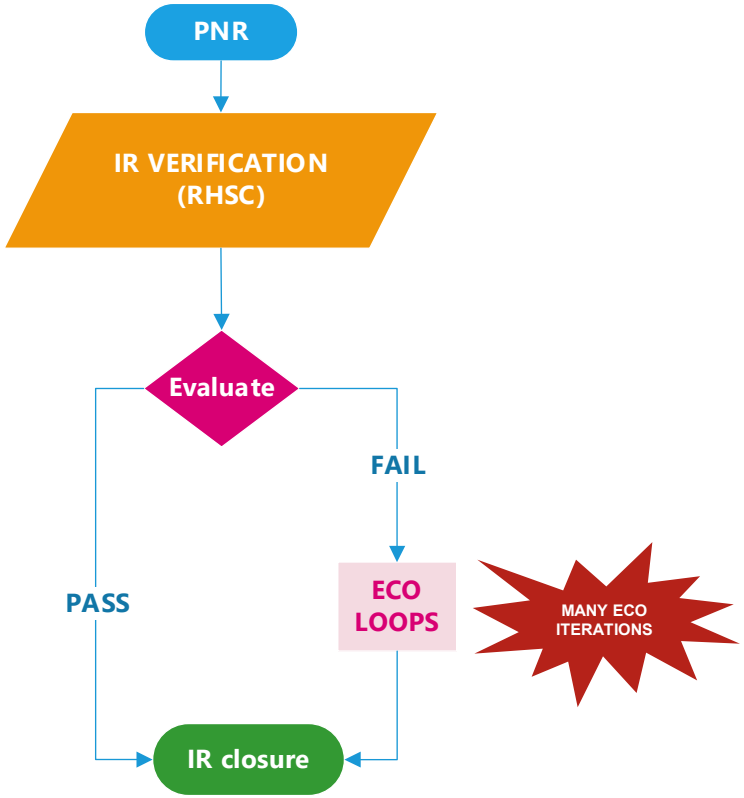


Fig 1 – Traditional IR fixing flow

- IR fixing is done mostly post-route and post-timing convergence
- Many eco iterations are performed to address the IR issues later in the design cycle
- Potentially disturbs timing and other design QoR causing additional eco loops for design closure
- Need to account IR drop as a part of cost function during PNR optimization

Flow Overview

Proposed new “shift-left” flow

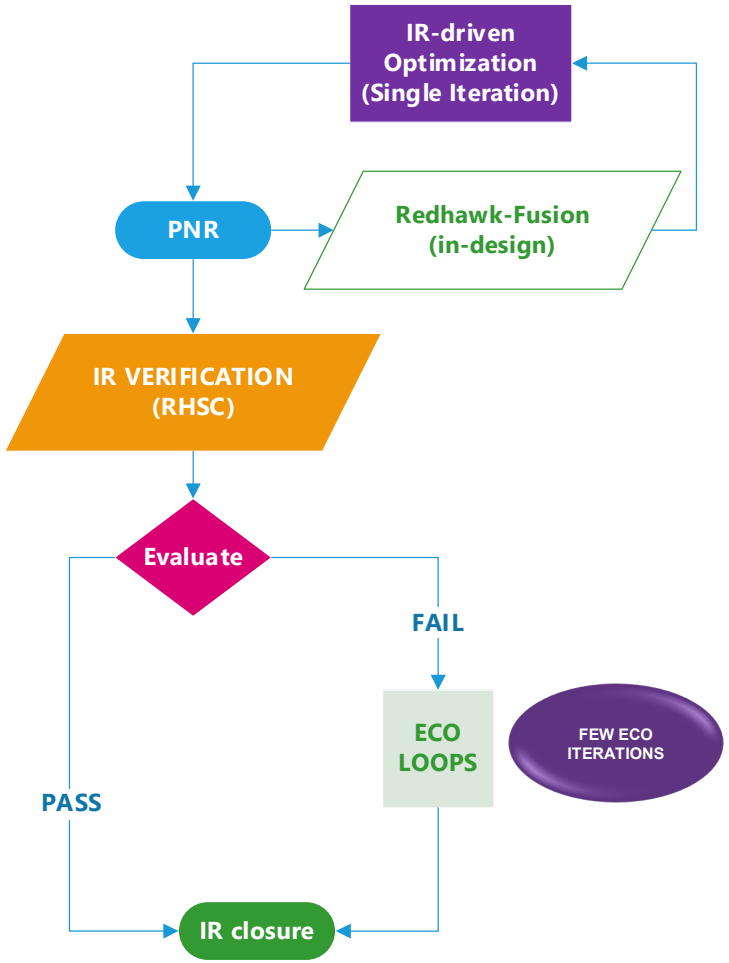


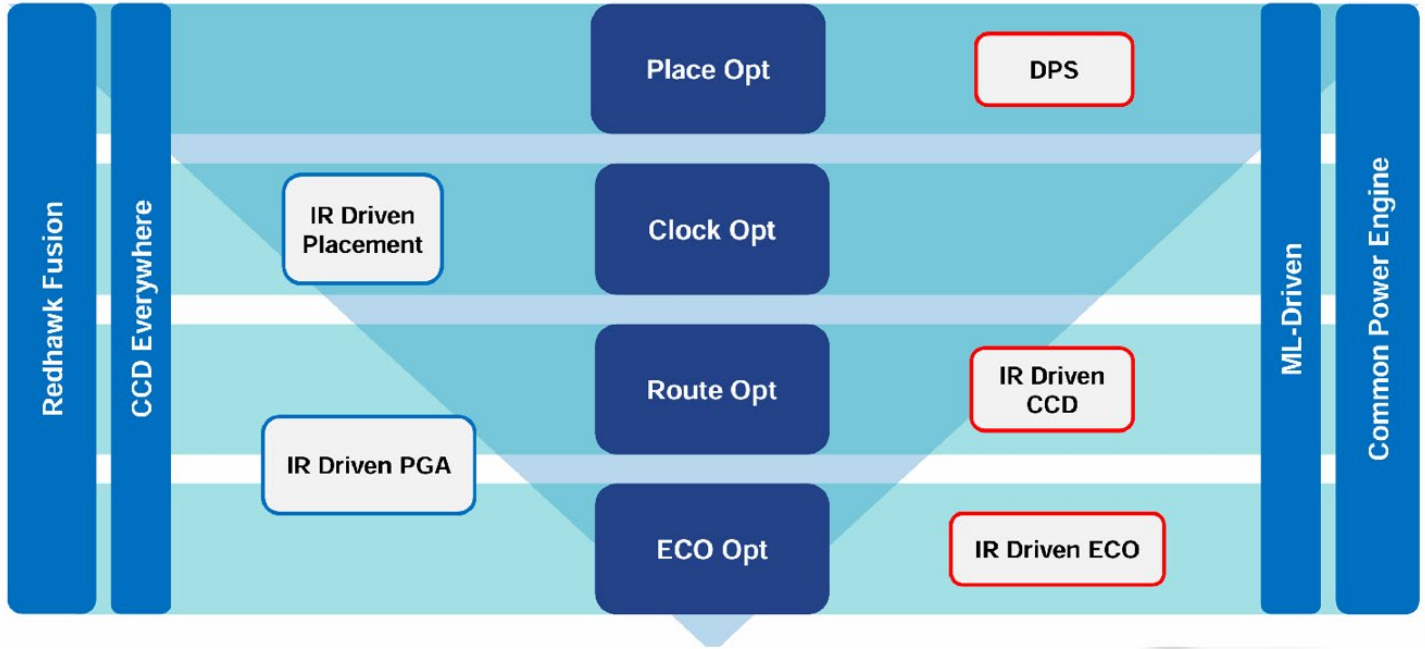
Fig 2 – Proposed new “shift-left” flow

- Optimize the design accounting the IR drop
  - Run IR rail analysis during PNR
  - Completely automated and avoids any user intervention
- Post-route opt fewer violations

Redhawk-Fusion Solutions

Redhawk-Fusion offers plethora of power integrity solution as various in-design block level IR optimization techniques

- DPS (Dynamic power shaping)
- IRDP (IR-Driven placement)
- IRPGA (IR-Driven PGA)



Credit: Synopsys

Fig 3 – Redhawk fusion solutions

IR Driven Placement

- Enabled during the post cts optimization stage of the PNR flow
- Rail analysis is done to generate the Vdrop (static/dynamic) & victim/aggressor (sigma dvd)
- Optimization engine takes the IR information as input spreading/relocating high IR drop cells reducing the voltage drop values
- Reduces the magnitude of the IR drop hotspot

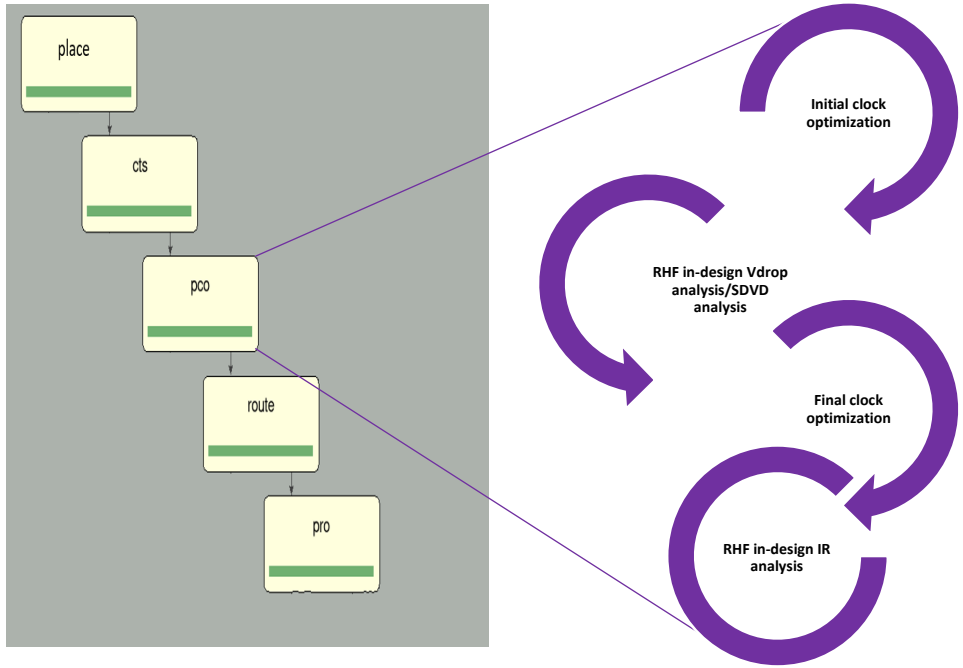


Fig 4 – Flow representing IR driven placement during place & route

Metrics for Evaluation

To evaluate the effectiveness of the Redhawk-Fusion power integrity solutions, follow metrics are considered

RHAF vs Signoff Correlation – Static/Dynamic

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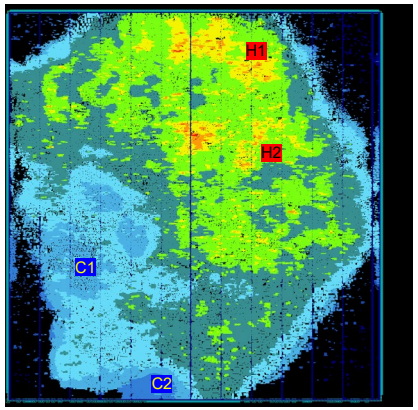
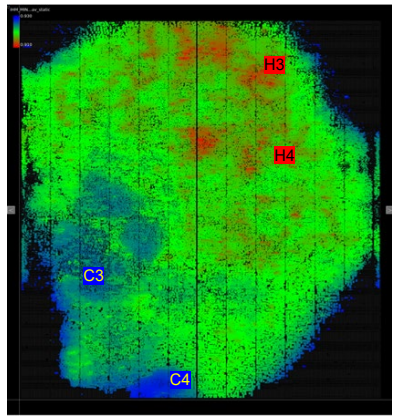
In-design Heatmap

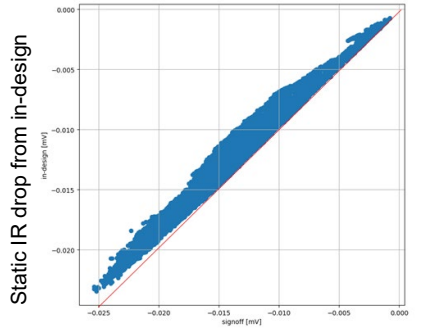
Signoff Heatmap

Instance-wise drop correlation

Static



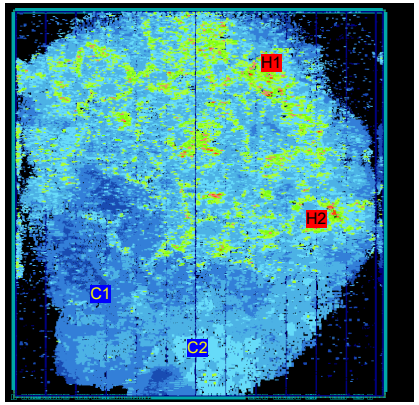


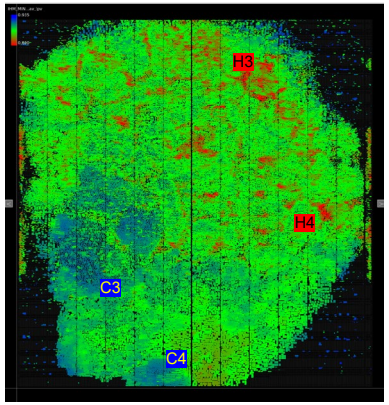


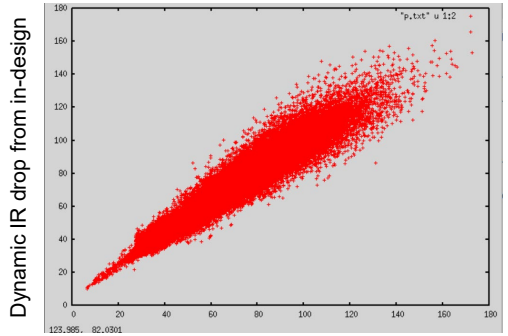
- Most of the instances are within 0.5-2mv of drop difference
- HOT/COLD regions correlate very closely

Fig 5 – In-design vs signoff heatmap correlation(static)

Dynamic







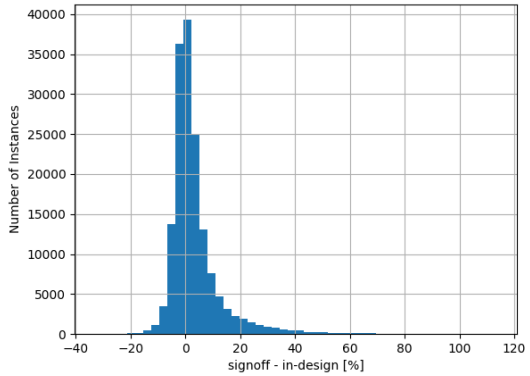


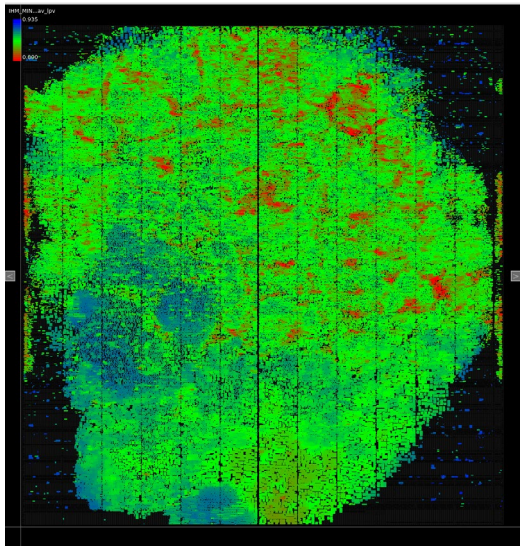
Fig 6 – In-design vs signoff heatmap correlation(dynamic)

- Dynamic IR drop correlation is much difficult than static
- 90% of the instances dynamic IR drop difference seen during optimization is within 10mv delta

Results & Conclusion

Design QoR Improvement

Before fix



After fix

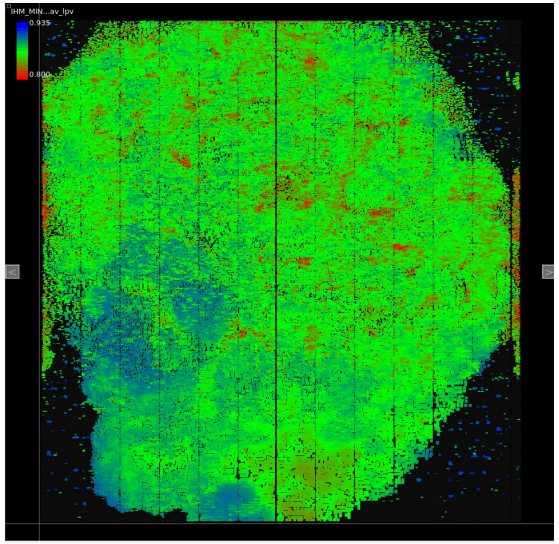


Fig 7 – IR drop heatmap (before and after fix)

IR Result Improvement

		Before	After	Violation Reduction
Static IR	Data Violations	20	0	100%
	Clock Violations	0	0	N/A
Dynamic IR	Data Violations	1856	612	67%
	Clock Violations	58	20	65%
SDVD	All violators	3239	2173	33%

- ❑ For a design of size 200k instances, 100% static and ~ 67% dynamic IR violations are fixed.
- ❑ Sigma DVD showed 33% improvement.
- ❑ Timing fallout: 1.7% degradation for worst path (comparable TNS)
- ❑ DRC fallout: None
- ❑ Runtime overhead: ~2 hours

Challenges & future works

Conclusion

- With the fully automated in-design IR fixing solution, IR violations reduction was observed
- Integrated RHAF solutions were utilized to improve TAT reducing EM/IR drop related ECO cycles, and overall IR drop improvement was observed through fully automated solution.
- Use of Sigma DVD in addition to in-design dynamic analysis can be used to further improve the coverage of IR signoff quality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