iDFM Flow: An ECO Implementation of Metal, Via Filling

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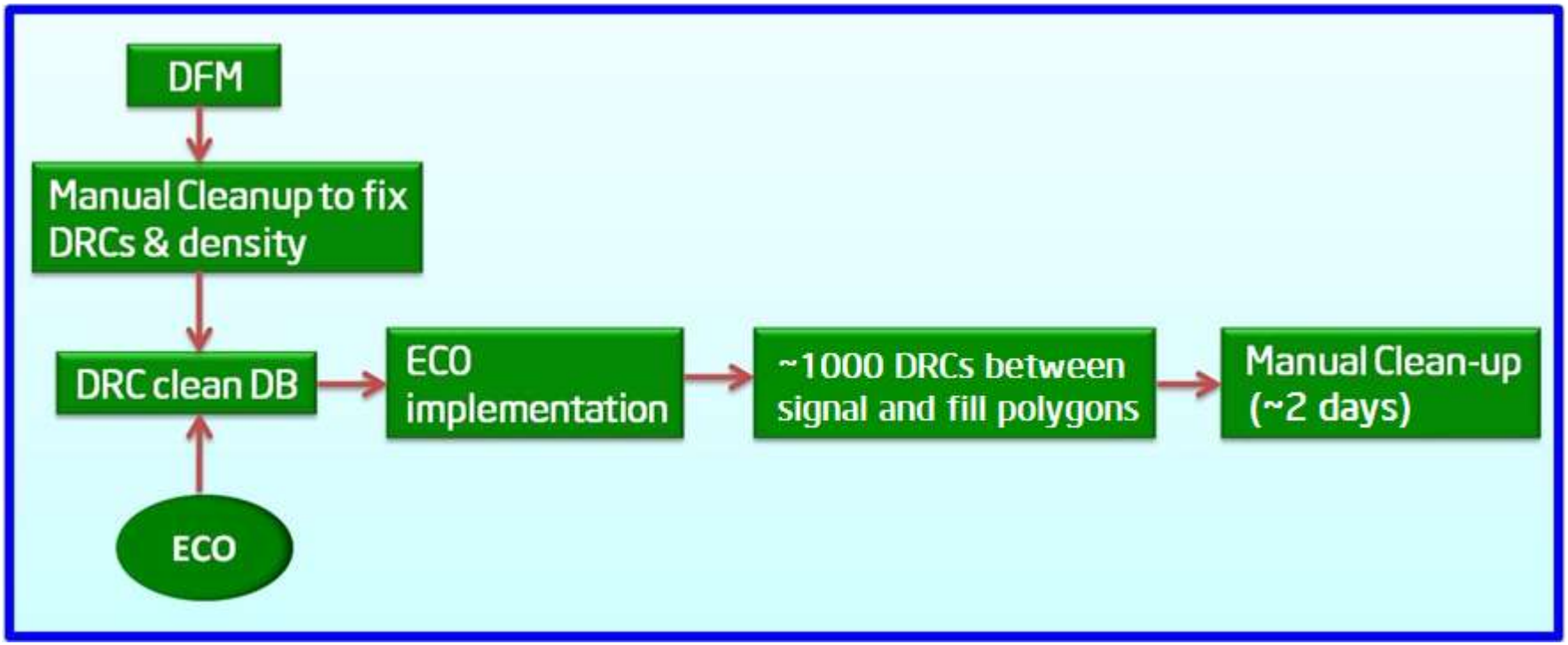
Motivation

- As the complexity of designs and process design rules are growing with every generation, getting a correct by construction DFM fill is becoming increasingly difficult
  - PDEs (Physical Design Engineers) end up spending huge manual effort in cleaning-up DRC and density violations
- All the manual effort is lost when there is a design ECO that makes previous fill polygons obsolete as it could potentially create DRCs, shorts on the ECO-implemented database.
  - Running DFM flows from scratch is not viable as this would require spending the same amount of manual effort as before to clean up the DRCs

Need automation to improve on ECO Layout productivity

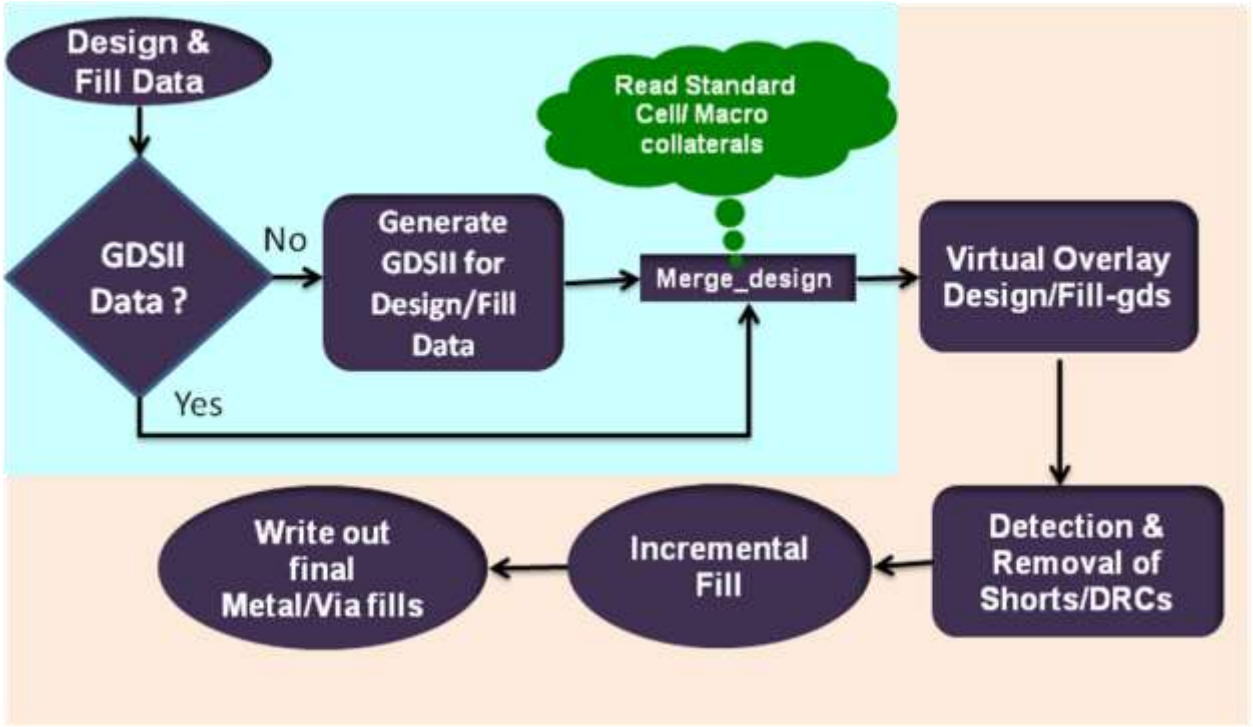
Prior Art

- Manual Effort of cleaning the DRCs, Shorts
  - Spends nearly two days on a typical ECO per partition
  - Tedious and Error Prone



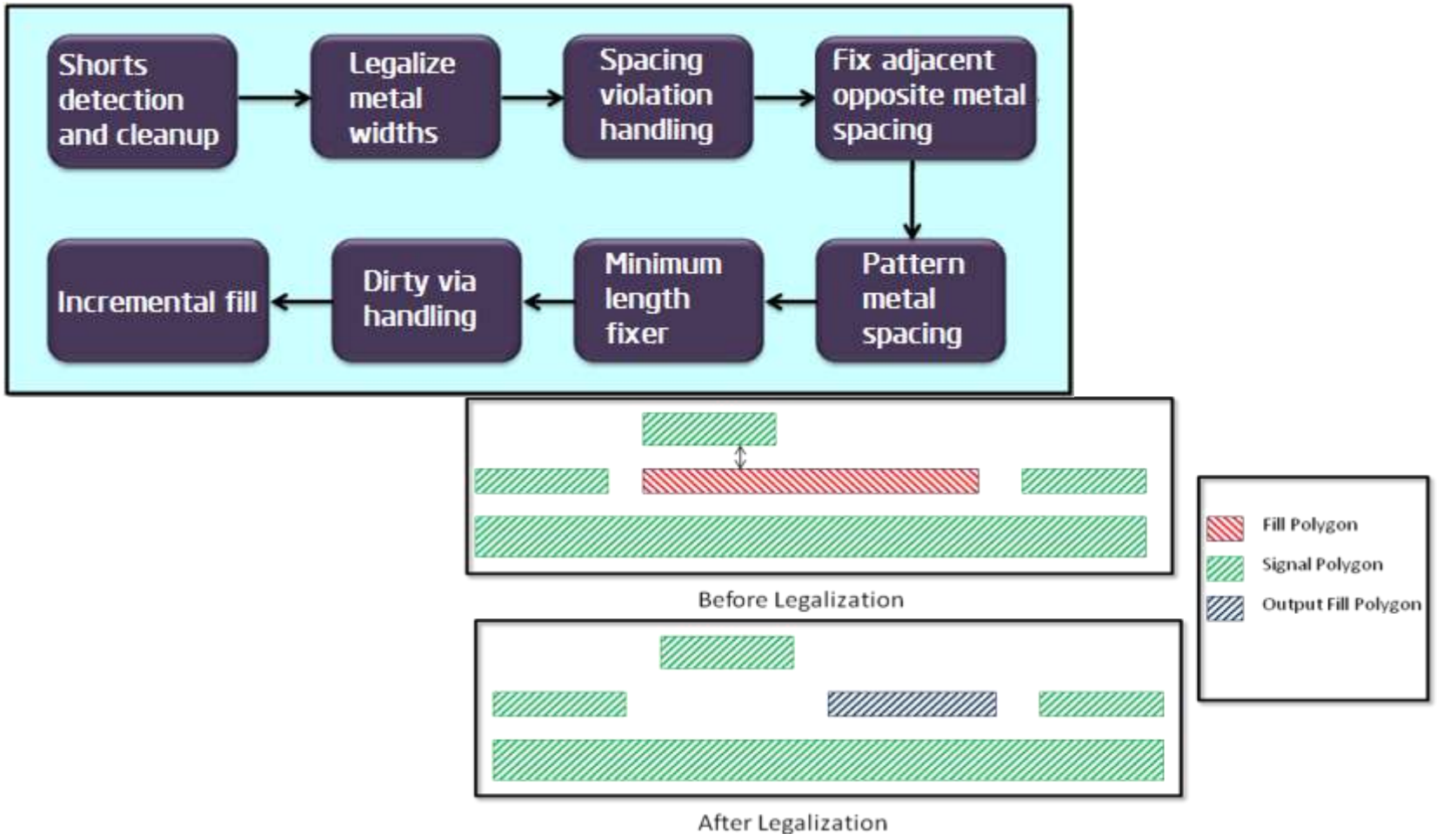
iDFM Filling

- Incremental Fill Flow relies on re-using the old fill data as much as possible
- No re-filling



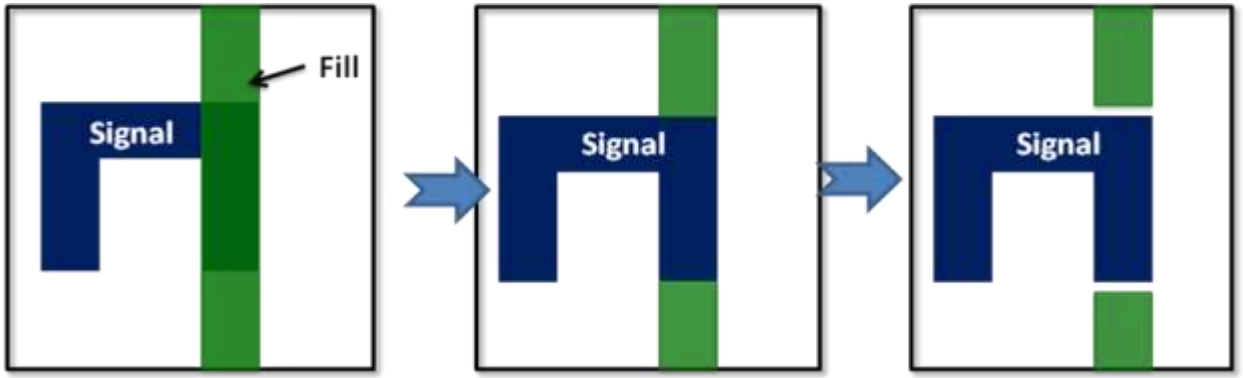
Fill Legalization

- Detection and removal of shorts/DRCs
- DRCs are detected through foundry runset



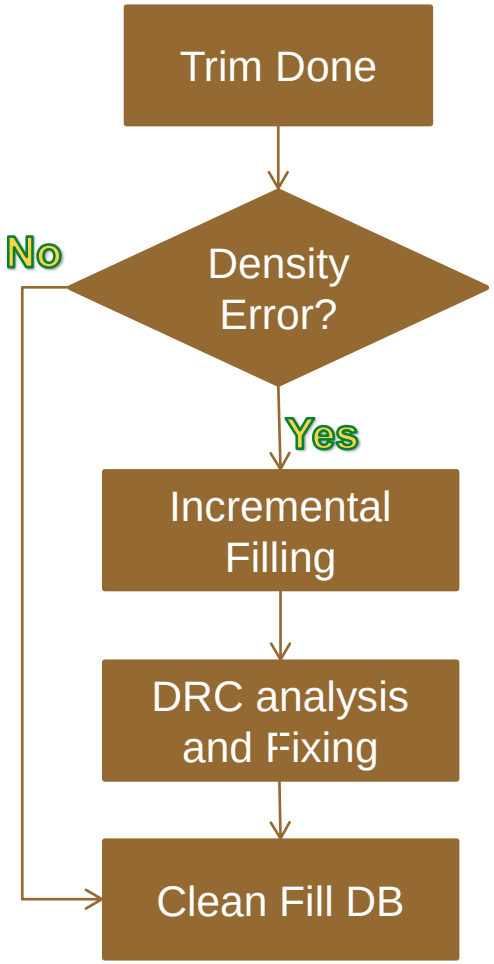
Cleanup of Shorts

- Short is detected if a metX fill polygon overlaps or touches a metX design (route) polygon
- The ‘portion’ of the fill polygon that overlaps the design polygon is removed
- In case of metX fill touching the route polygon, it is shrunk along the preferred routing direction by 1 manufacturing grid so that ‘touch’ can be avoided.
- Any additional DRCs created at this stage are handled in later stages of DRC correction



iDFM Flow Steps

- Identify density failing windows (Metals/Vias) on trimmed database
- incrementally re-fill without creating additional shorts.
- Fill flow doesn't produce clean fill db as it can't comprehend all complicated DRCs at UDSM process nodes.
- Fill trimming cleans shorts, DRCs but refilling introduces more DRCs which are addressed incrementally
- Certain cases need addition of small stubs to fill/cell data depending on the design rule.
- TAT (Turn Around time) of iDFM is 6X faster than rerunning fill from scratch



iDFM Advantages

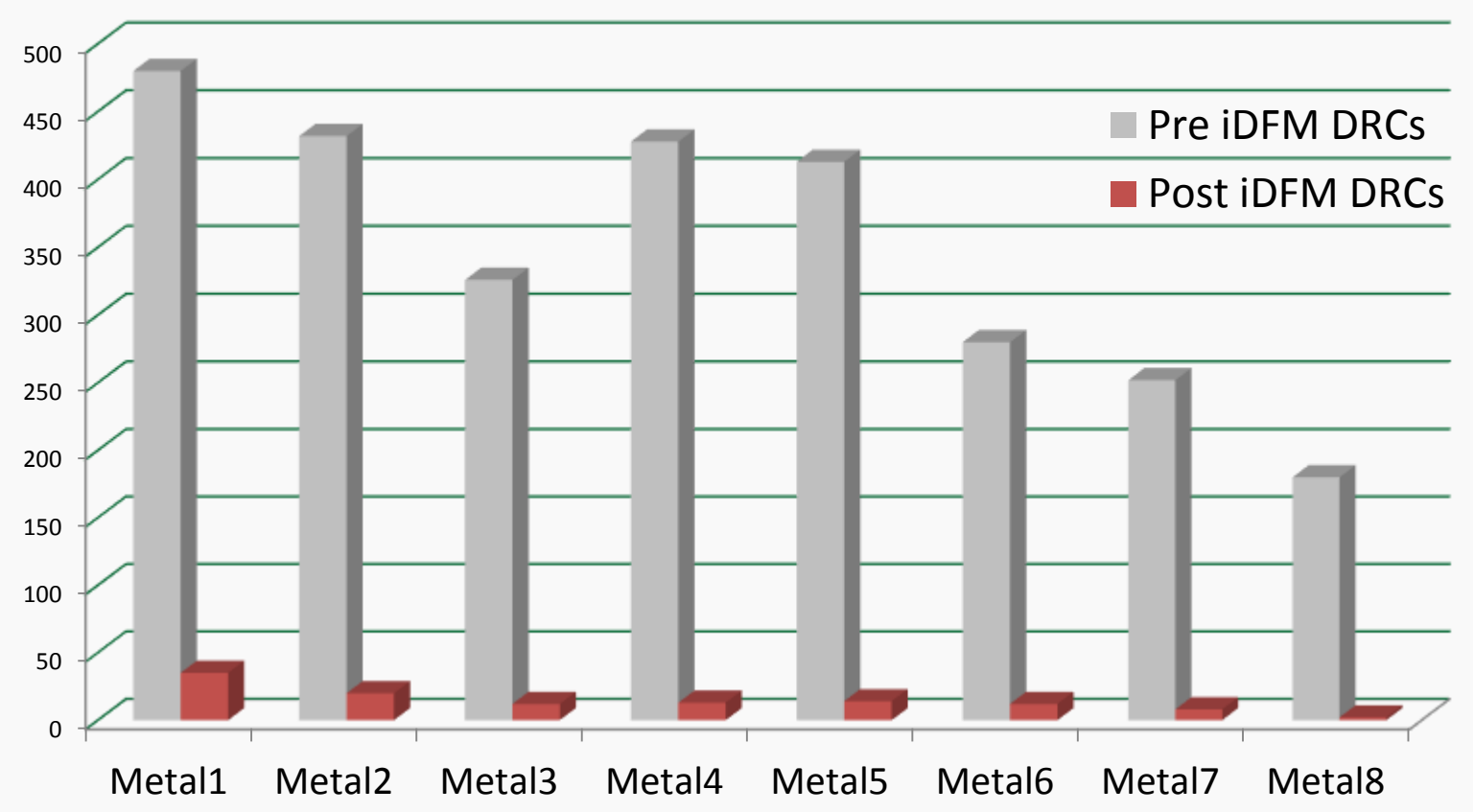
- Short clean fill: Removes the Original FILL polygons overlapping on ECO polygons for avoiding shorts.
- Shorter runtime: Incrementally FILLs Metals and Vias based on density and DRC requirements.
- DRC clean Filling: Set of algorithms to handle individual DRCs.
- Addresses Via density issues: Incrementally generates FILL Vias by connecting only the floating metal fills; without causing any shorts.
- Parallelize filling: Option to independently FILL set of Metal and Vias.
- Region Filling: BBOX option to correct only in the specified window.
- Easily portable: Easy portability to next process nodes.

Results

- ✓ Proved solution for ECO implementation on all in-house projects
- ✓ 99% of the DRCs introduced by the fill are being removed
- ✓ Shorts clean ECO DB with metal fill
- ✓ Very few density errors
- ✓ 6X improvement in TAT (Turn Around time) for ECO implementation.
- ✓ 8 person weeks of manual effort reduction on one of the internal CPU projects.

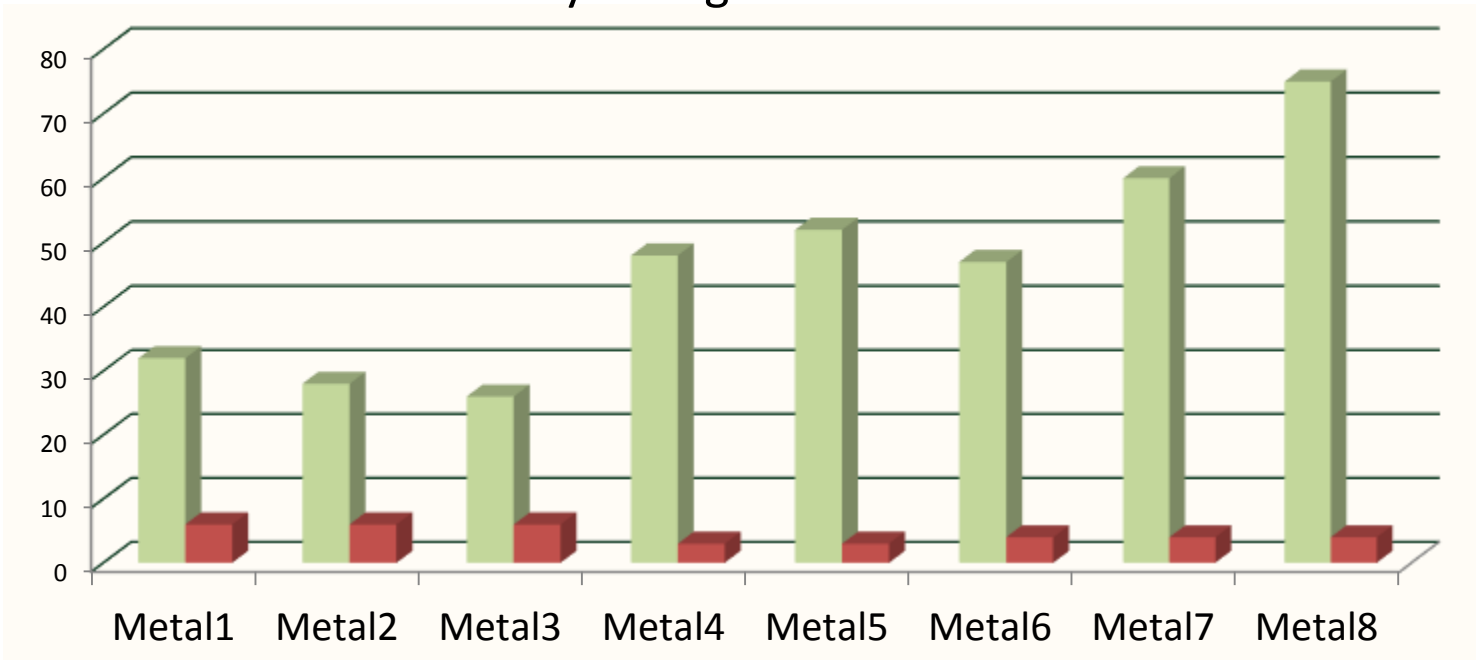
DRC Results

- Addressing DRC requirements through iDFM:



Density Results

- Addressing density requirements through iDFM:



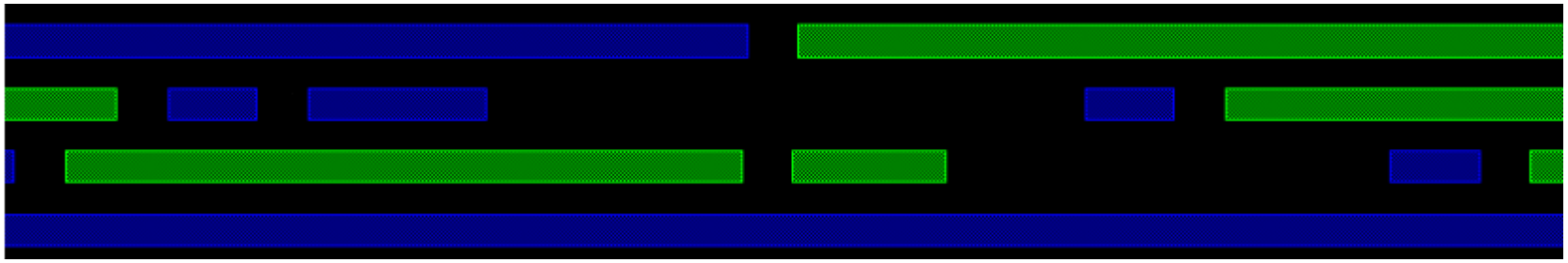
Conclusion

- Automated flow that replaces the tedious and error-prone manual approach of correcting the DRCs, shorts on ECO Database.
- Generic approach : Independent of process node.
- Judicious re-use of Foundry runsets (rules deck)
  - Applied special treatment to the errors that are reported by the runsets to enable Metal/Via DRC and density errors.
- Bounding box and layer specific iDFM to improve throughput
- Incremental Refill on density failing windows

Back up slides for poster presentation

Incremental Refill:

Original FILL and CELL:



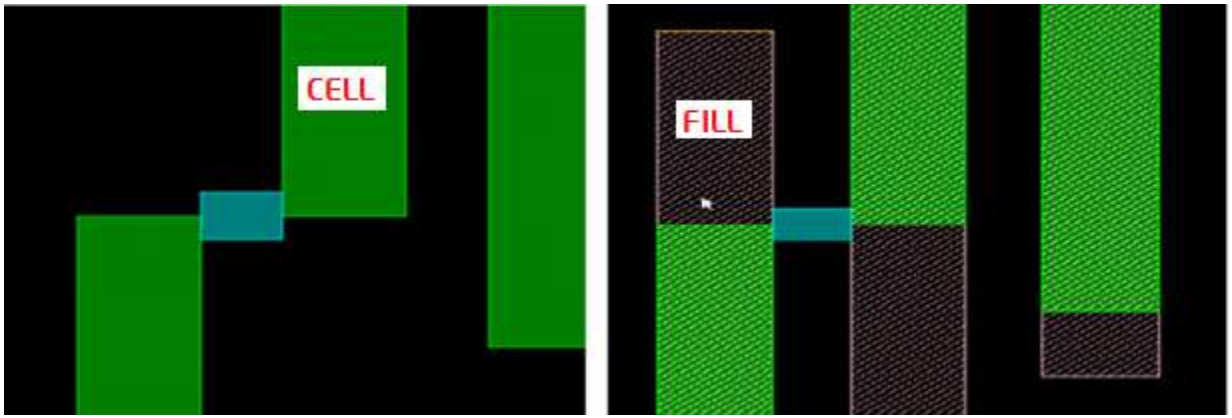
FINAL FILL and CELL after incrementally refilling to correct

Fill Polygon

Signal Polygon

Addressing complex DRVs

- Addition of stubs to Signal/FILL nets for cleaning DRCs.



- Patterning Signal/FILL nets for clean DRCs.