

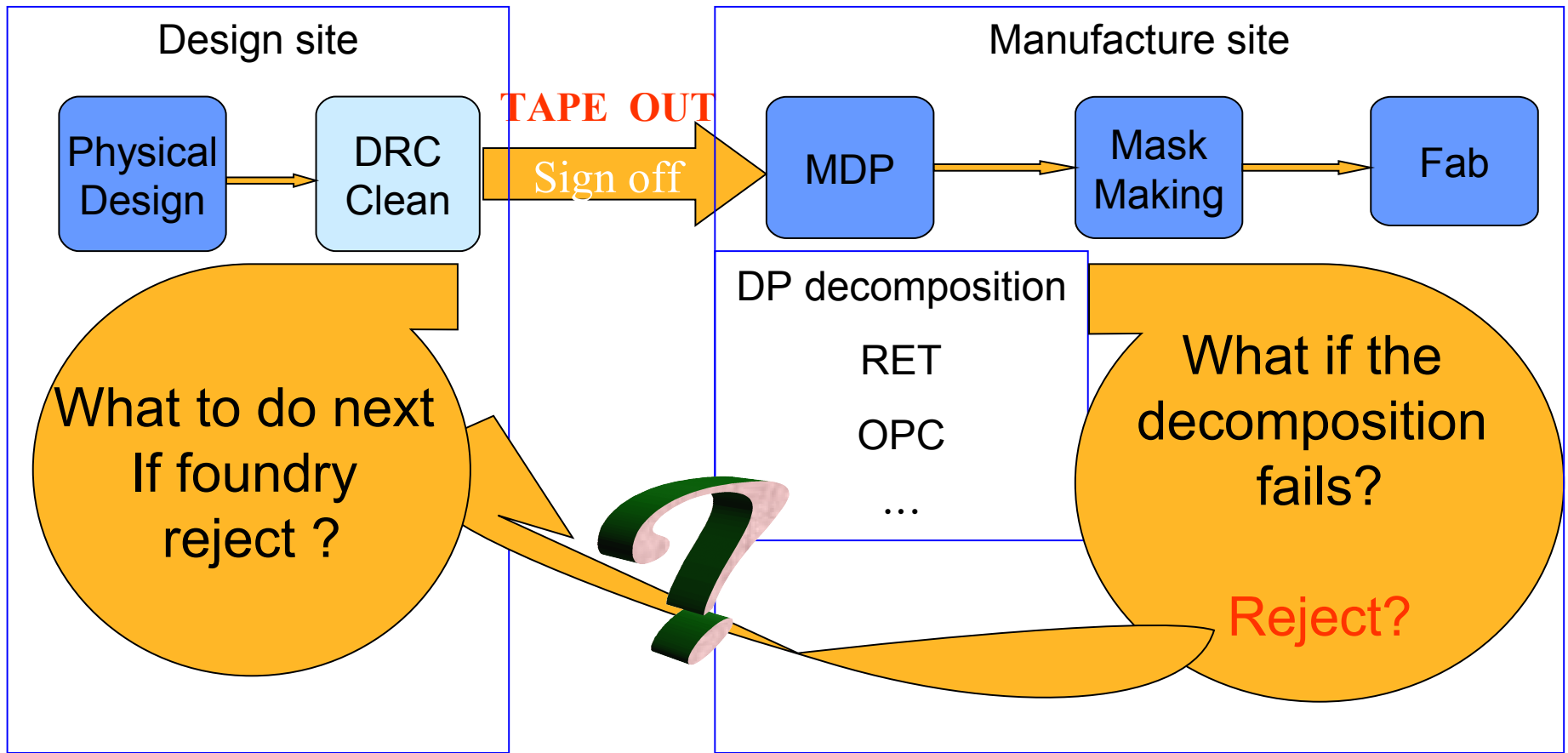


A simple design rule check for DP decomposition

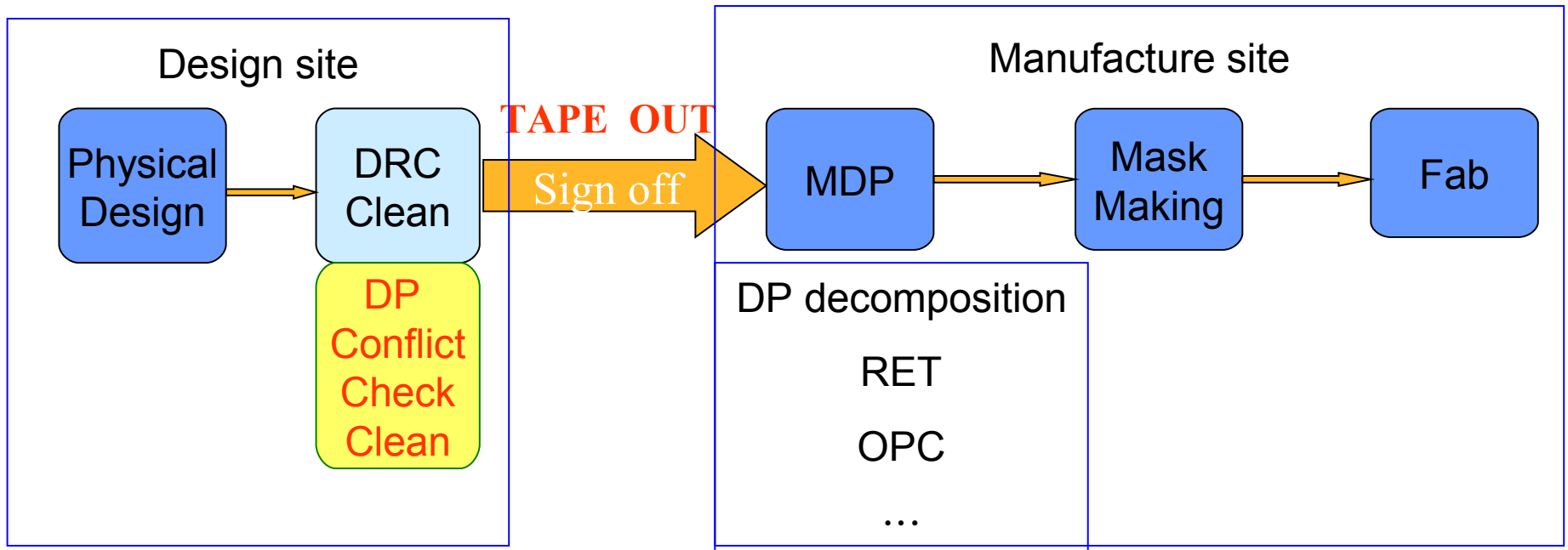
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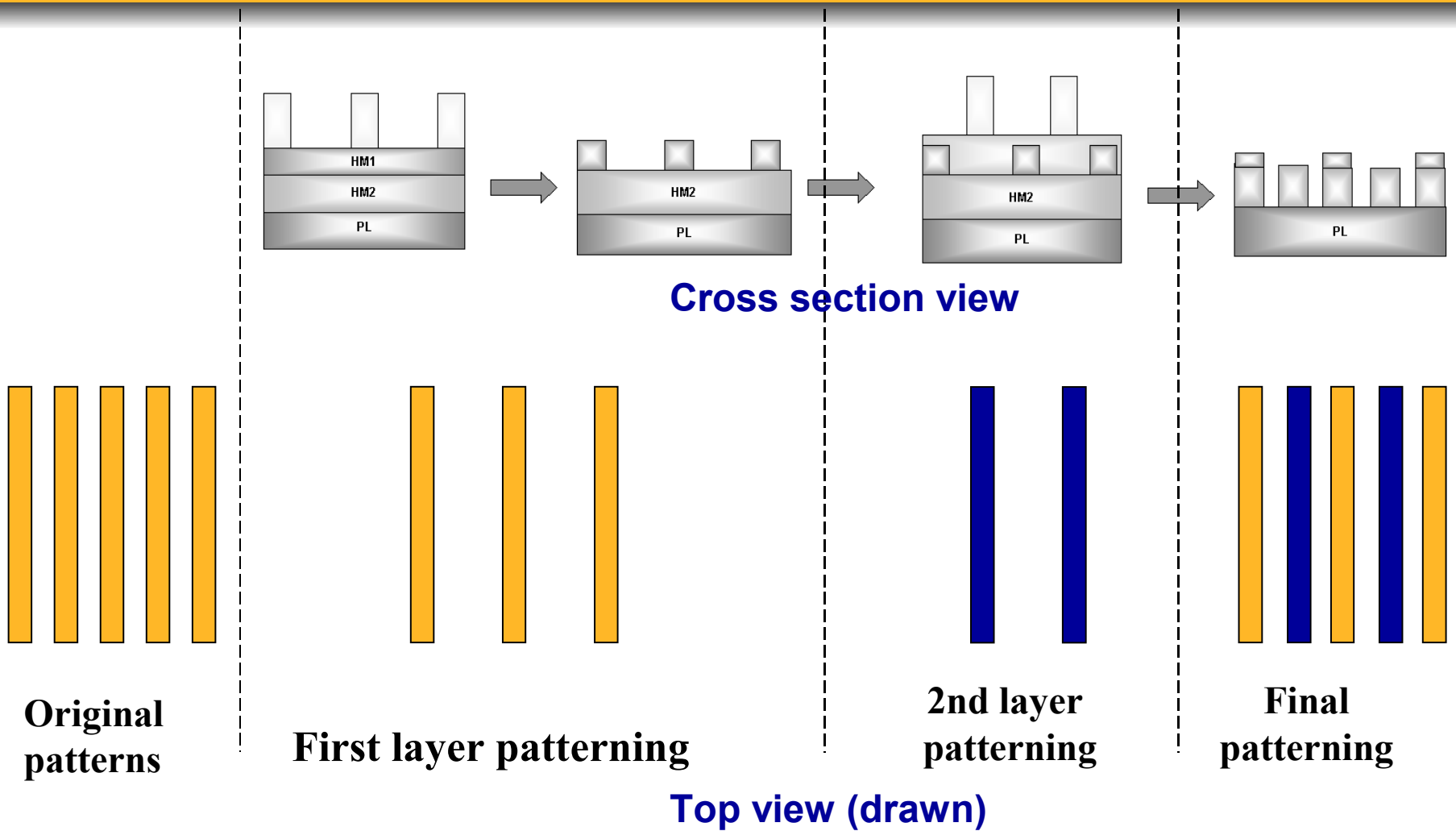
Decomposition can be an serious issue for DPT



Decomposition can be an serious issue

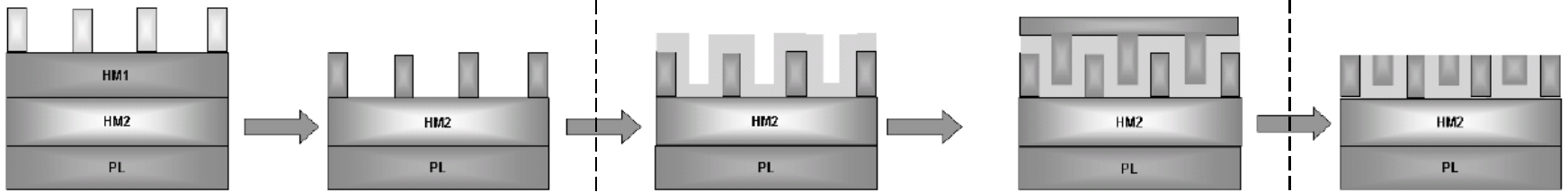


Double Patterning Lithography (target technology)



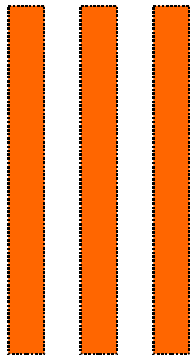
Double Patterning with Spacer (not for this)

■ For very regular fine pitch patterns

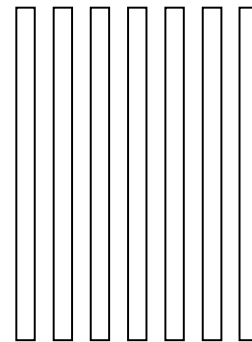


Cross section view

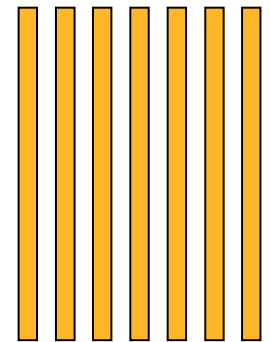
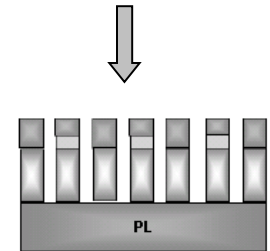
Spacer patterning



Spacer edge forming (twice)



Top view (drawn)

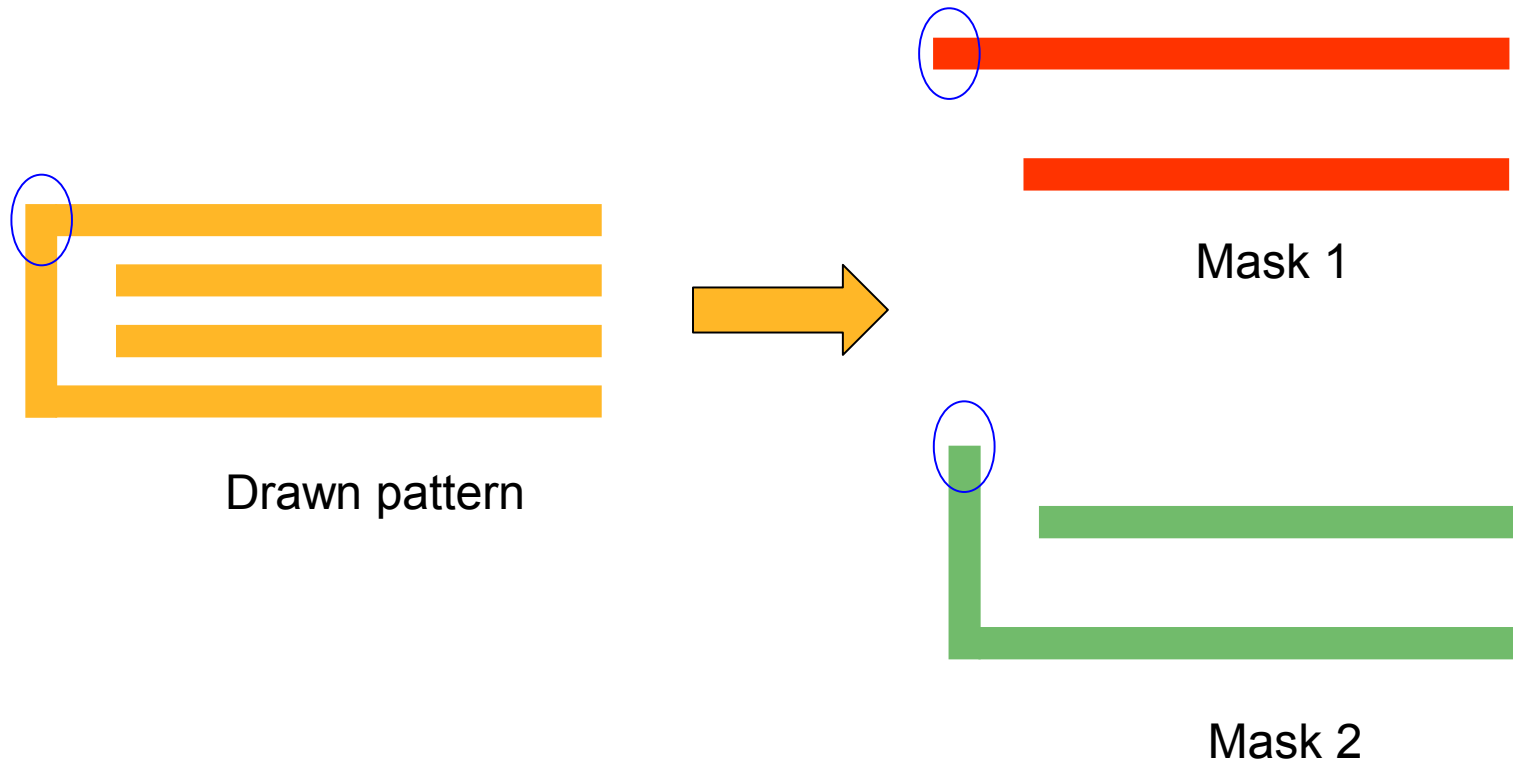


Decomposition guideline

- **Split rule**
 - **Proximity rule:** Two close polygons should be in two masks
 - **Cut rule:** See next page
- **Conflict**
 - Locations where split fails
- **Mask space shortage**
 - After DP decomposition, that space may not enough space for layer overlay guardband

Cut rule

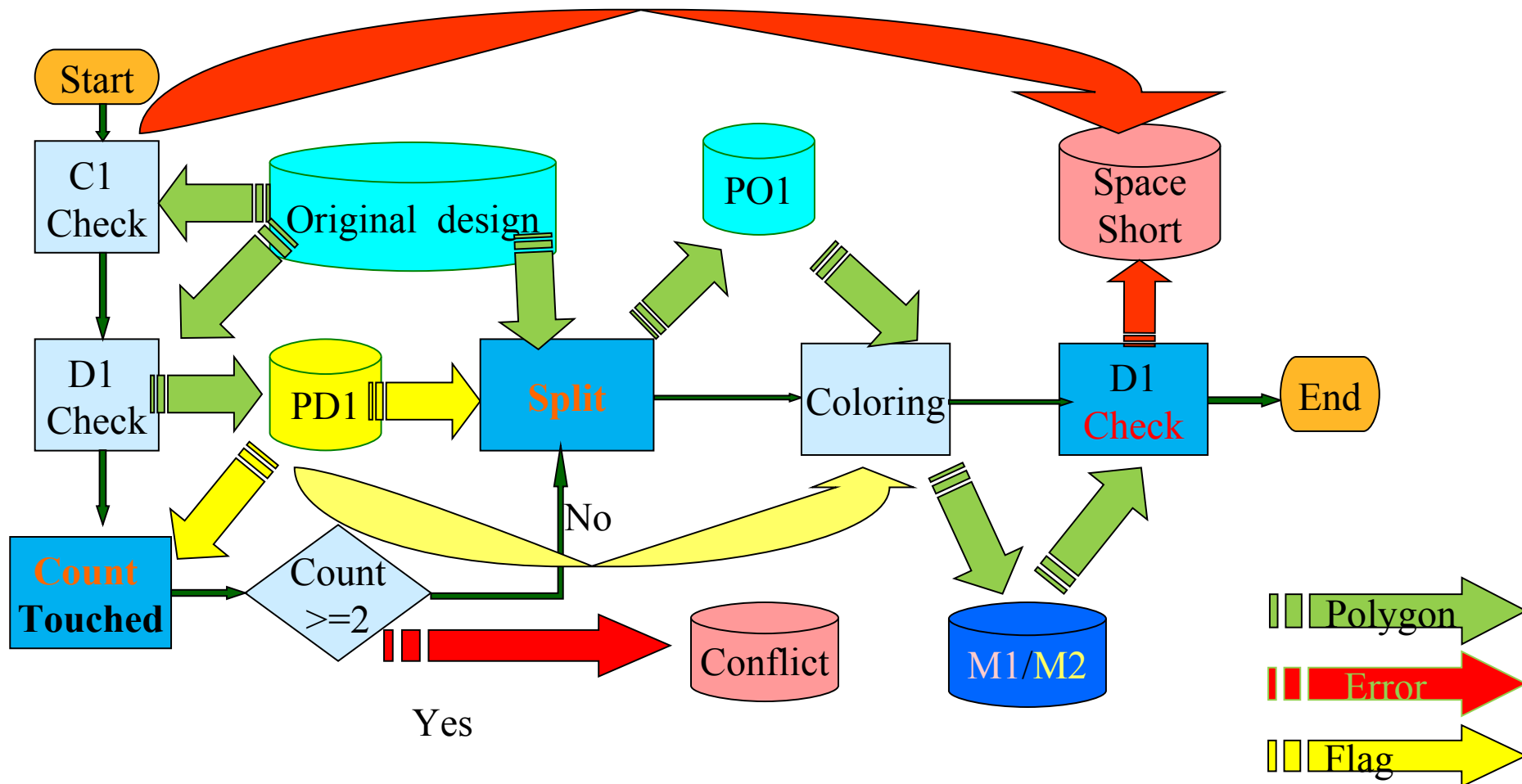
 : an overlay to make sure polygon connection after DP



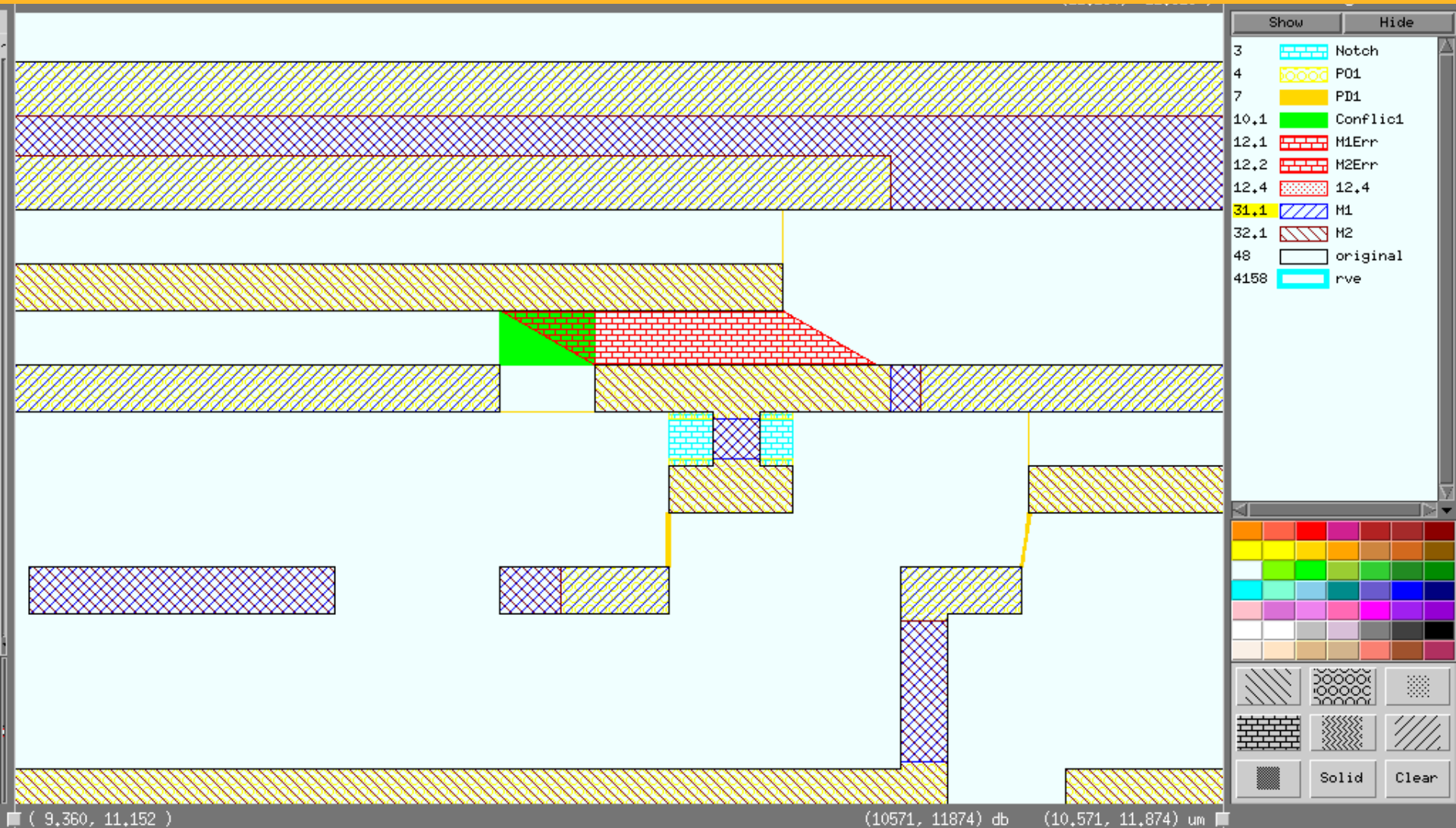
DP-augmented Design Rules

- **Conventional design rules on the drawn pattern**
 - C1 : minimum space rule
 - ...
- **DP-related rules (lithography-specific rule) on the decomposed mask patterns**
 - D1 : minimum space rule
 - v.s. C1 of the conventional design rule.
 - P1 : Mask overlay
 - To ensure connection after decomposition for a split polygon with the cut rule
 - ...

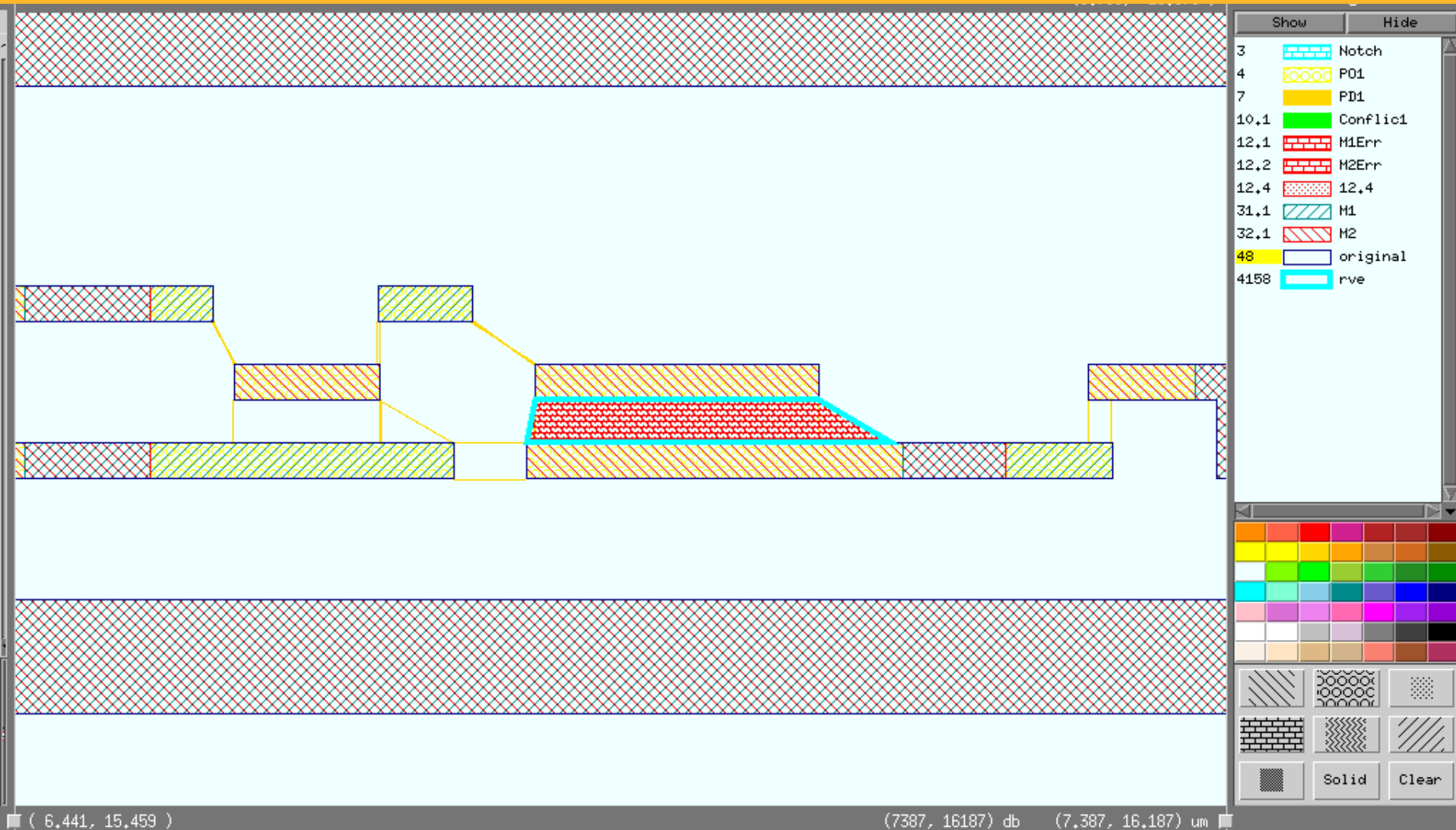
CSC (Count-Split-Check) algorithm



Overview



Trace Errors—Odd loop



Easy corrections

- **For Space shortage**
 - Just move depart from the errors
- **Conflict**
 - Move one edge away from the errors
- **Trace Conflict**
 - Move one edge away from the errors to eliminate a coloring trace odd loop.

Conclusion

- **This simple DRC script can detect the decomposition errors.**
- **Only need two additional process parameters,**
 - The minimum mask space
 - The minimum overlay for two.
 - which is obvious and simple to understand
- **There are two types of the errors in the DP decomposition.**
 - Space error
 - Trace error
- **The errors can be easily corrected with just shift the polygon near the error marker.**
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REFERENCES

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