



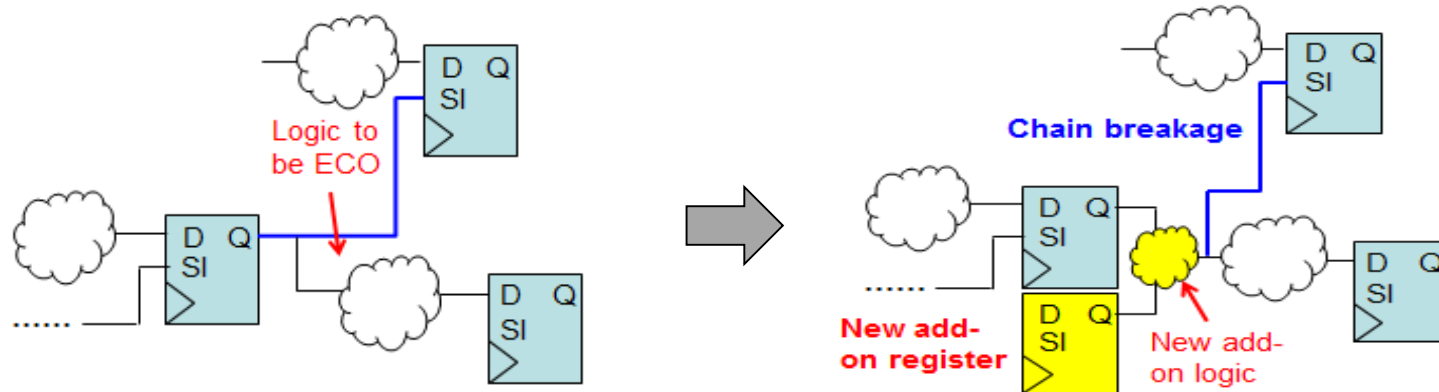
The Flexible ASIC Leader

# Scan Chain Recover and Chain Stitch for Function ECO

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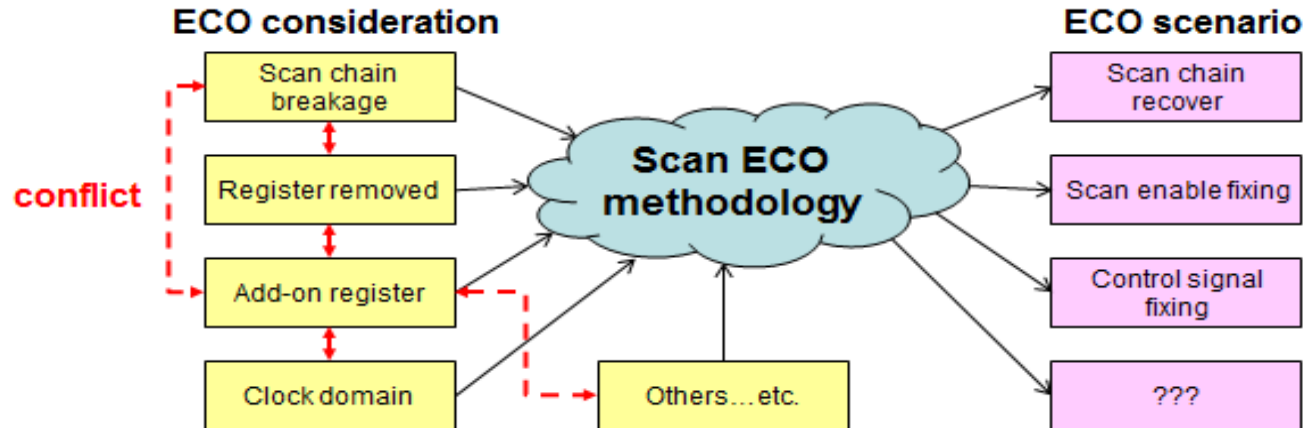
# Motivation

- **Function ECO induces Scan fail and impacts ECO schedule**
  - Unintended scan breakage and unstitched add-on registers
  - Commercial ECO tools only focus on function and not repair scan breakage and coverage loss
- **Complexity: should satisfy various considerations and scenarios**
  - Bad ECO methodology will result in conflict between considerations
  - Require efficient “Scan ECO” methodology to ensure testability and quality of Scan within a limited schedule



# Scan ECO Consideration

- **Considerations for scan ECO might conflict each other**
  - Ex. Scan chain breakage may not be fixed to original structure because registers are removed from function ECO
  - Ex. Add-on registers also needs to be stitched to scan chains without routing/timing issue

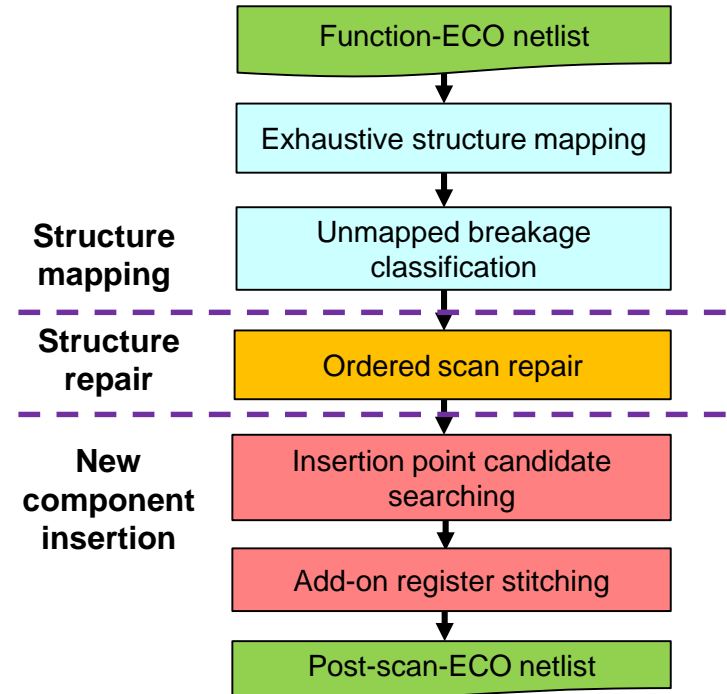


# Problems on Old Method

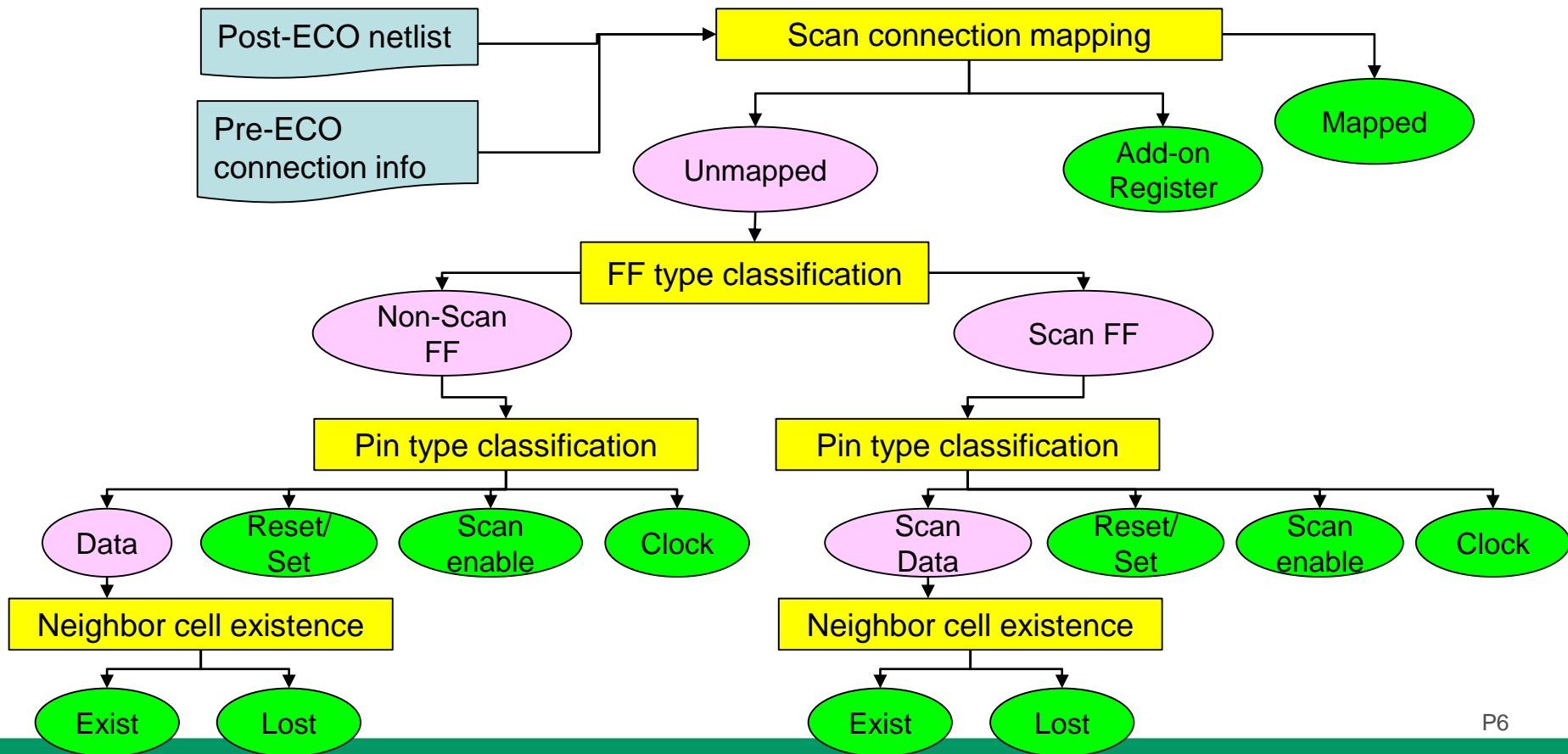
- **Scan ECO relies on designer/DFT engineer's manual effort to recover scan quality traditionally**
  - **Without systematic methodology**
    - Engineers spend lots of time on iteratively scan ECO
    - A lot of scan-ECO scenarios rely on human experience to guarantee ECO correctness
  - **ECO complexity**
    - Huge function ECO scale increases complexity on scan ECO
    - Engineer barely can meet schedule and ensure scan quality on scan ECO in few days
    - Scan re-implementation is another choice to ensure scan quality but need re-do all DFT jobs and APR

# Main Idea

- Provide systematic scan ECO methodology to deal with complex scan breakage scenarios and add-on registers
  - **Structure mapping stage**
    - Exhaustive structure mapping
      - To find scan breakage and add-on registers
    - Unmapped breakage classification
      - Classify scan breakage scenarios
  - **Structure repair stage**
    - Ordered scan repair
      - Repair scan following ordered scenarios
  - **New component insertion stage**
    - Insertion point candidate searching
      - Consider routing, timing, and test cycle impact
    - Add-on register stitching

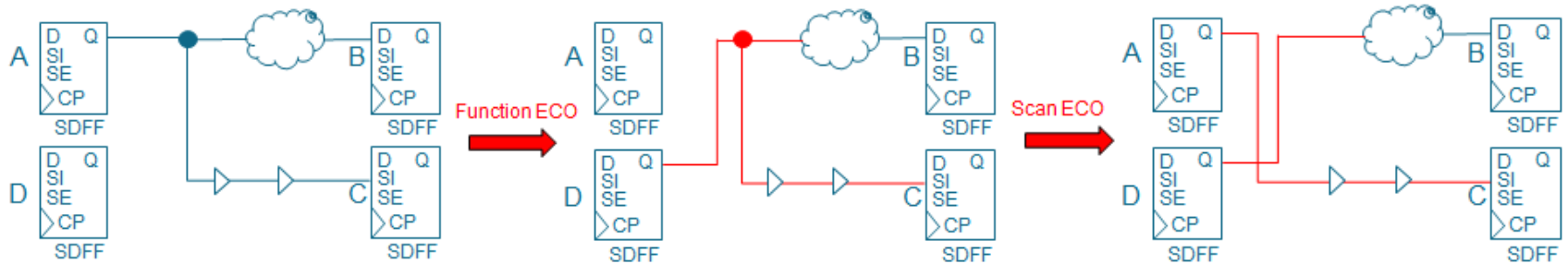


# Scan Structure Mapping and Classification

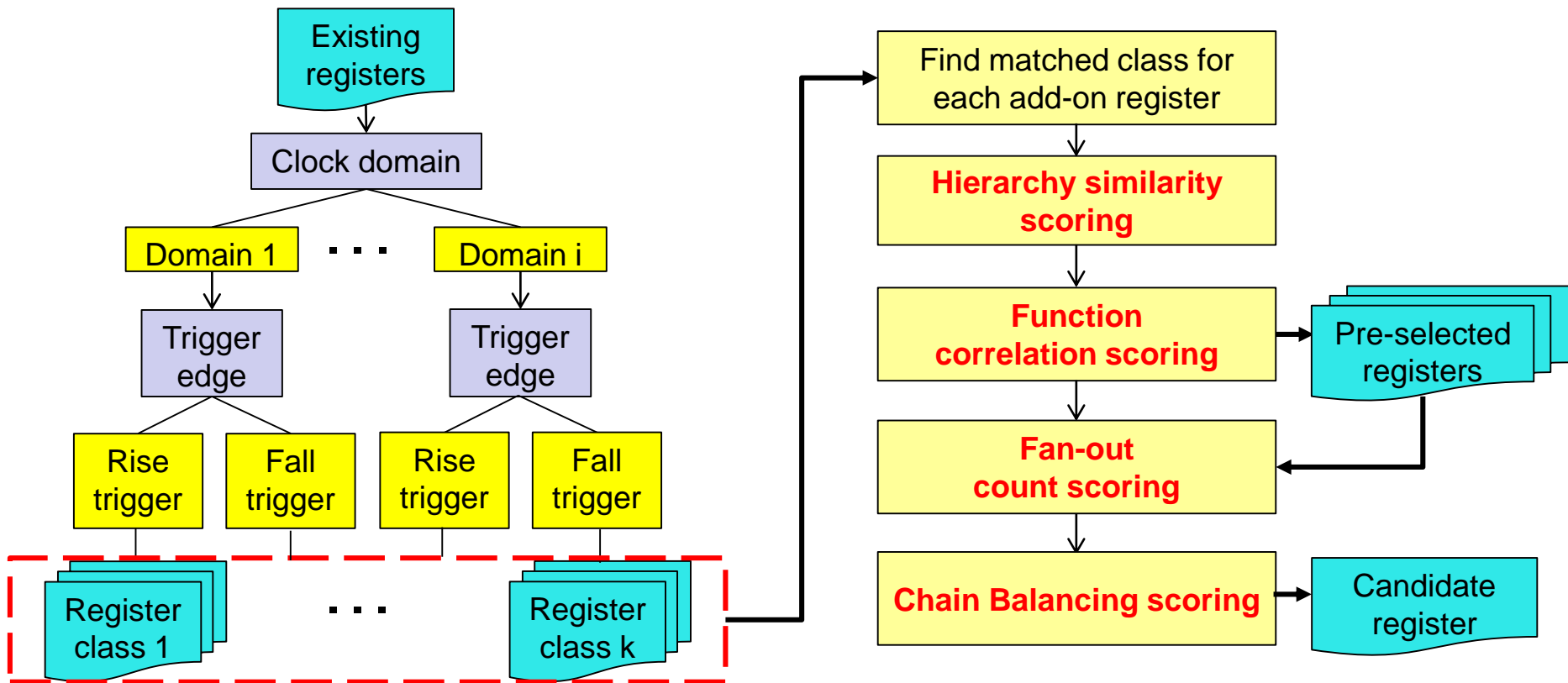


# Ordered Scan Repair

- **This step's purpose is to repair scan structure breakage to make it close to original scan structure**
  - Apply different recover solution for different scenarios
    - Does not include add-on registers
    - Fixing strategy of each scenarios need be defined



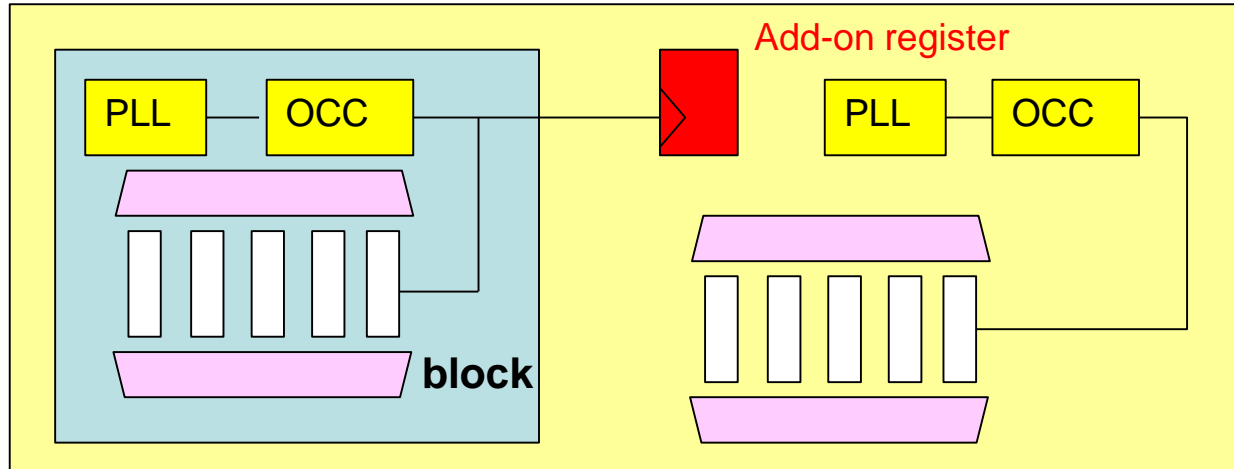
# Insertion Point Candidate Searching





# Add-on Register Stitching

- If candidate is found, insert the add-on register into scan chain after the candidate
- However, it is possible that add-on registers does not have matched clock domain to be stitched
  - Apply different fixing strategy to stitch the register to scan chains



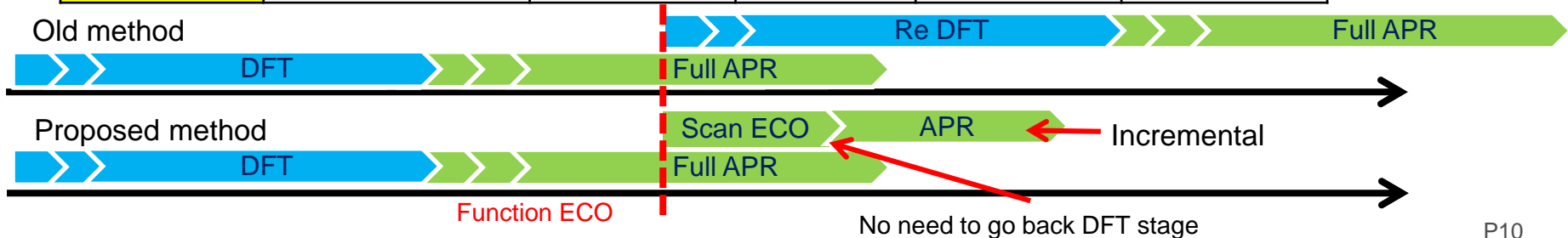
This situation is rare  
but occur before

# Result

- Experiment on 5 ECO designs
- Compare scan ECO runtime with old method

\*Case\_M\* uses manual ECO while Case\_R\* uses scan re-implementation

Case Policy	Case_M1	Case_M2	Case_R1	Case_R2	Case_R3
Recovery	156 scan data 5 add-on registers	2 scan data 1 clock	114 scan data	673 add-on registers	8 add-on registers
Scan ECO Flow Runtime	1.5 hours	1.5 hours	1 hour	2 hours	0.5 hour
*Old Method Runtime	6 hours	4.5 hours	7.5 hours	14.5 hours	4 hours
Time saved	75.0%	66.7%	86.7%	86.2%	87.5%



# Summary

- **Function ECO easily causes scan structure breakage and unstitched add-on registers**
- **Function ECO's impact on scan structure is complex**
- **Proposed methodology contains**
  - Structure mapping
  - Structure repair
  - New component insertion
- **Experiment shows proposed methodology can reduce**
  - 66.7%~75% ECO time compared to manual ECO
  - 86.2%~87.5% ECO time compared to scan re-implementation