

Enhancing Formal Equivalence for Datapath Algorithms: A Proof Strategy with Intermediate Modeling to Address Structural Differences in Implementations

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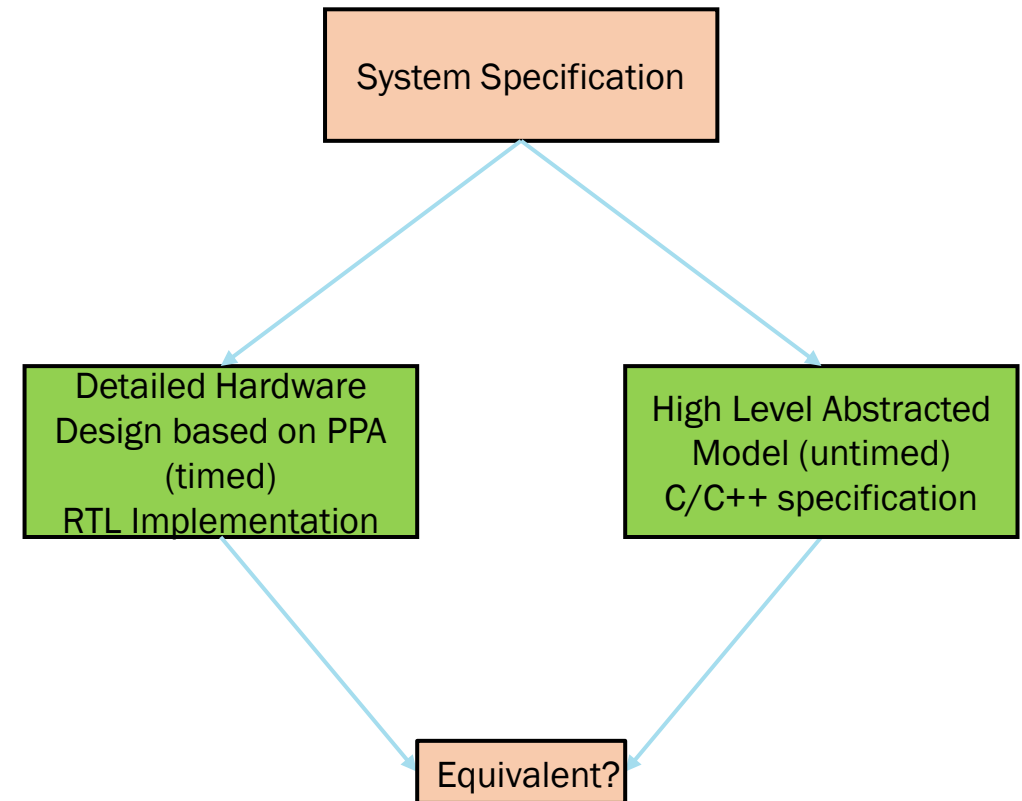
Agenda

- Hardware Design and Importance of Exhaustive Verification
- Formal Equivalence Verification
- Abstraction (Structural) Difference Between spec and impl
- Technique to Reduce (Structural) Abstraction level differences
- Results :- Introduction of Intermediate models
- Results :- FEV Between Specification and Intermediate Models
- Results :- FEV Between Intermediate models and Implementation(RTL)
- Future scope and Conclusion



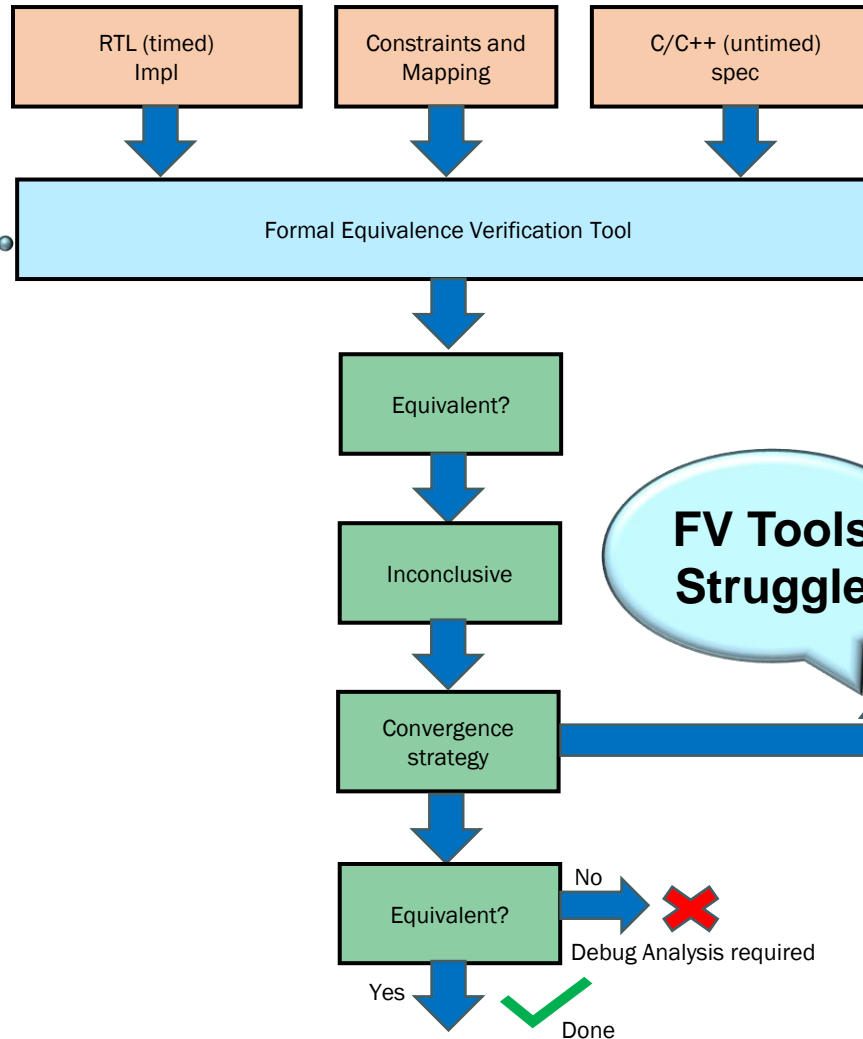
Hardware Design and Importance of Exhaustive Verification

- High-Level Implementation: correctness of architecture intent
- RTL implementation: PPA considerations
- Need for Abstraction high level models
- Exhaustive Verification : large input space
- Is Simulation sufficient??
- FEV to the rescue



Formal Equivalence Verification

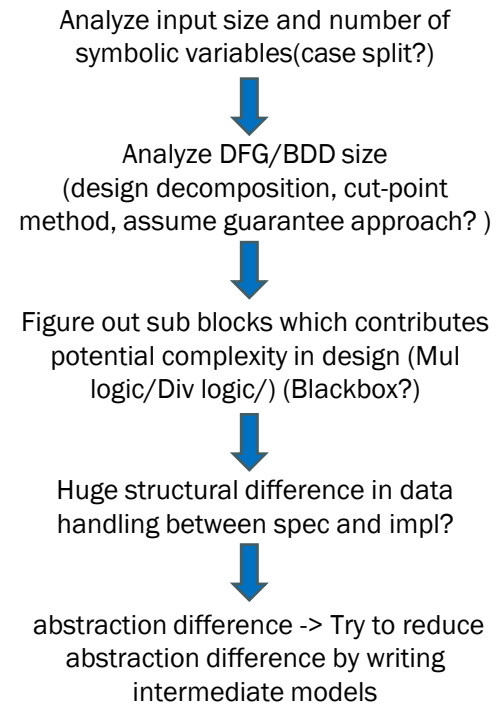
Timed vs
Untimed
FV



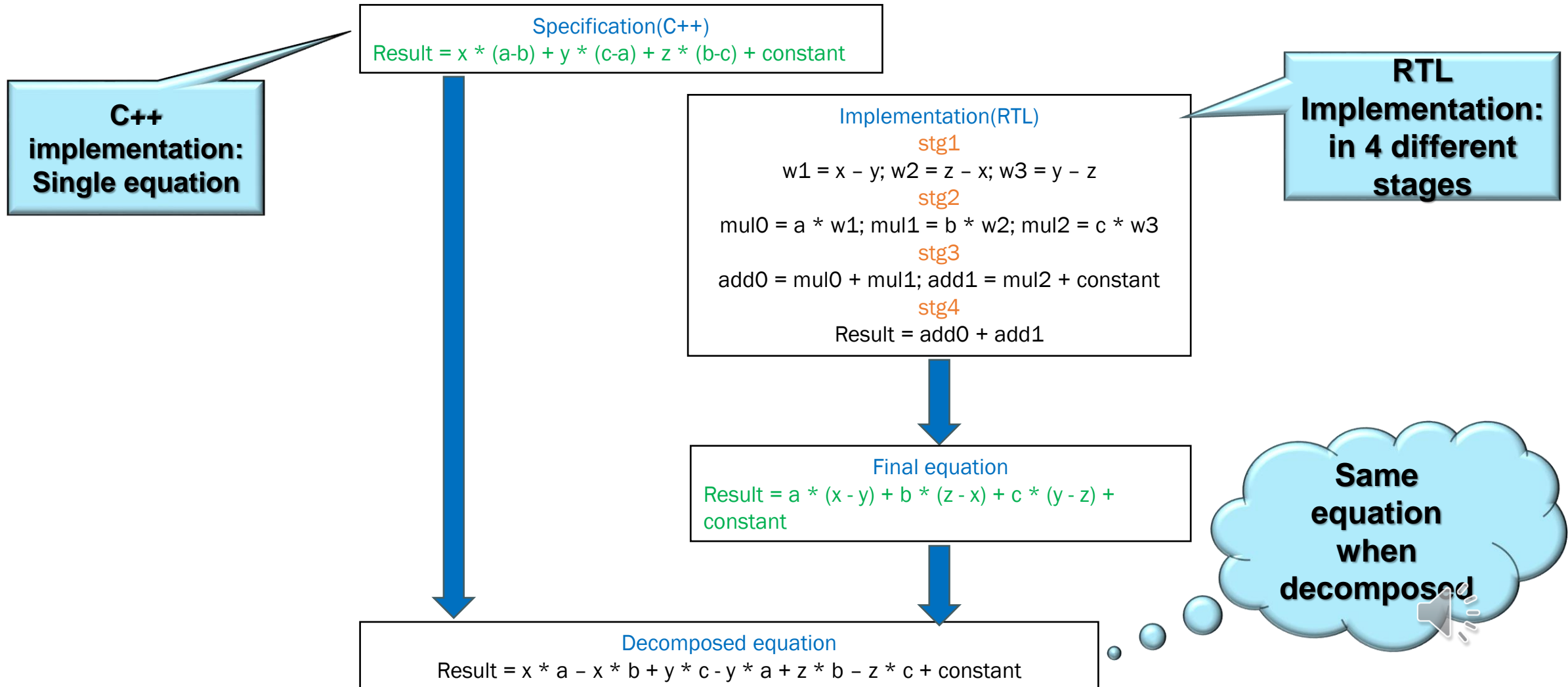
FV Tools
Struggle

To achieve full
proofs

Complexity Analysis in FEV

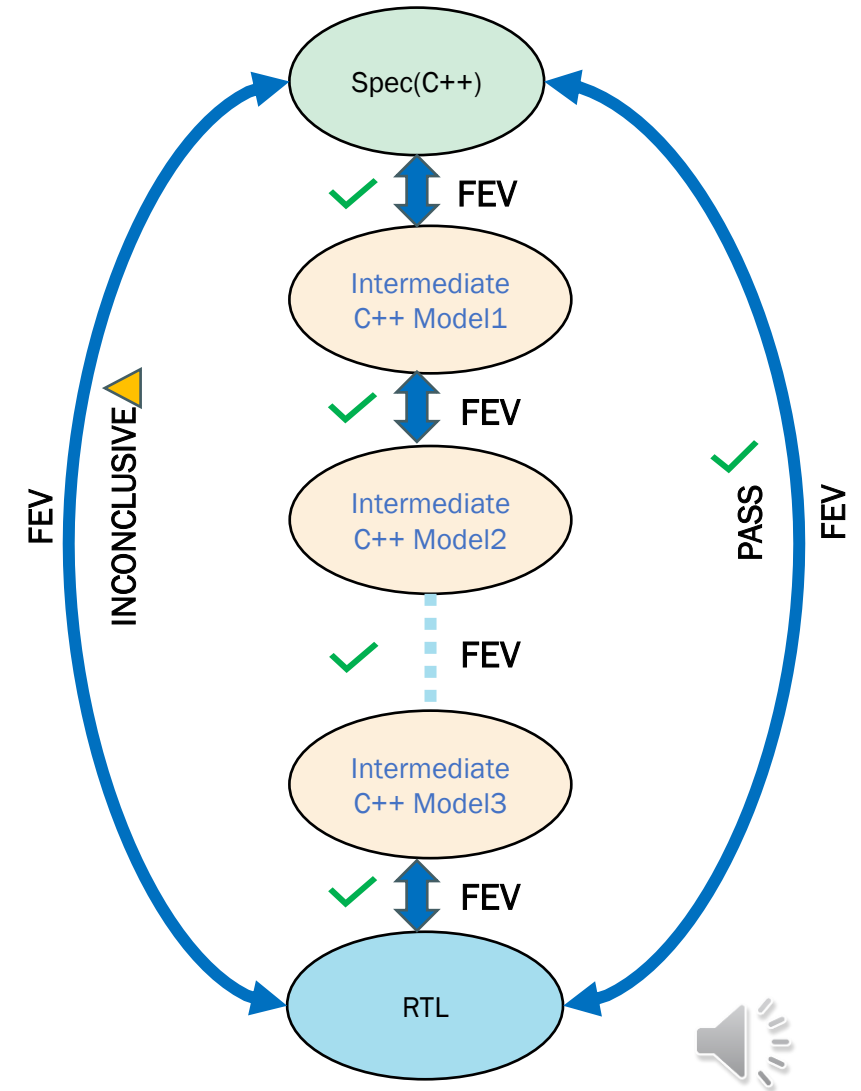


Abstraction (Structural) Difference Between spec and impl

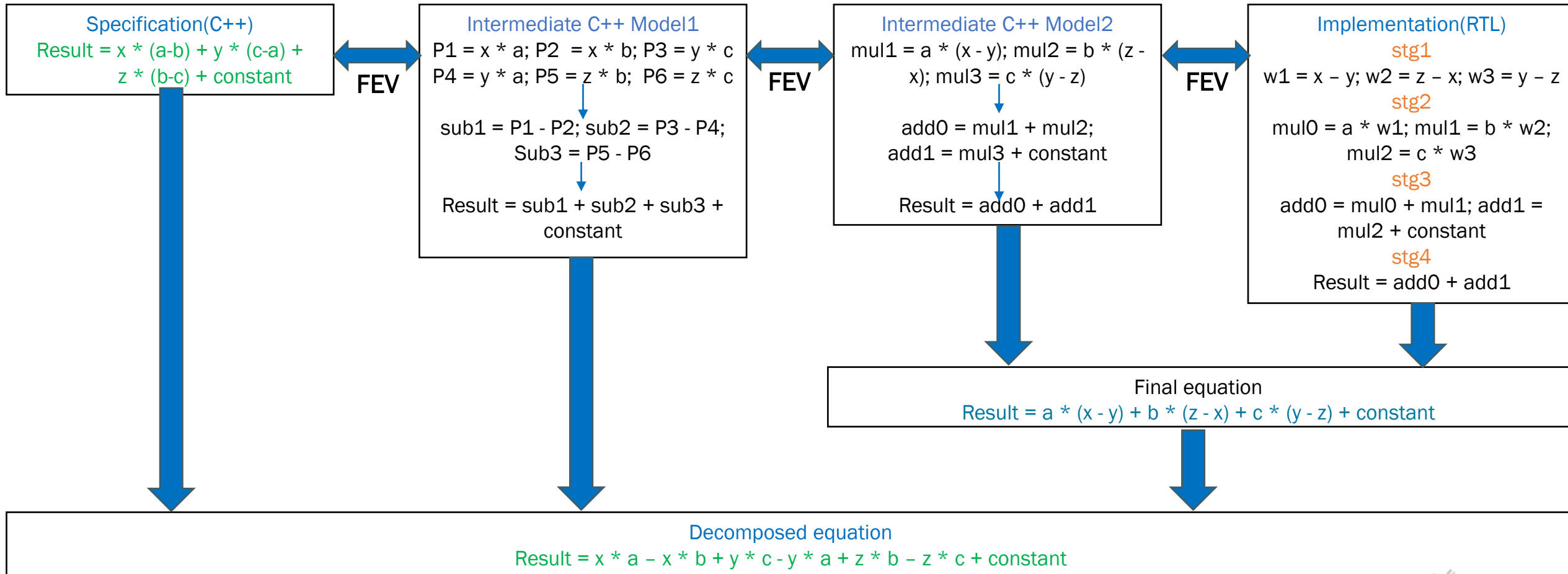


Technique to Reduce (Structural) Abstraction level differences

- Iterative process of creating intermediate models
- FEV link between the golden model & all the intermediate models must be established

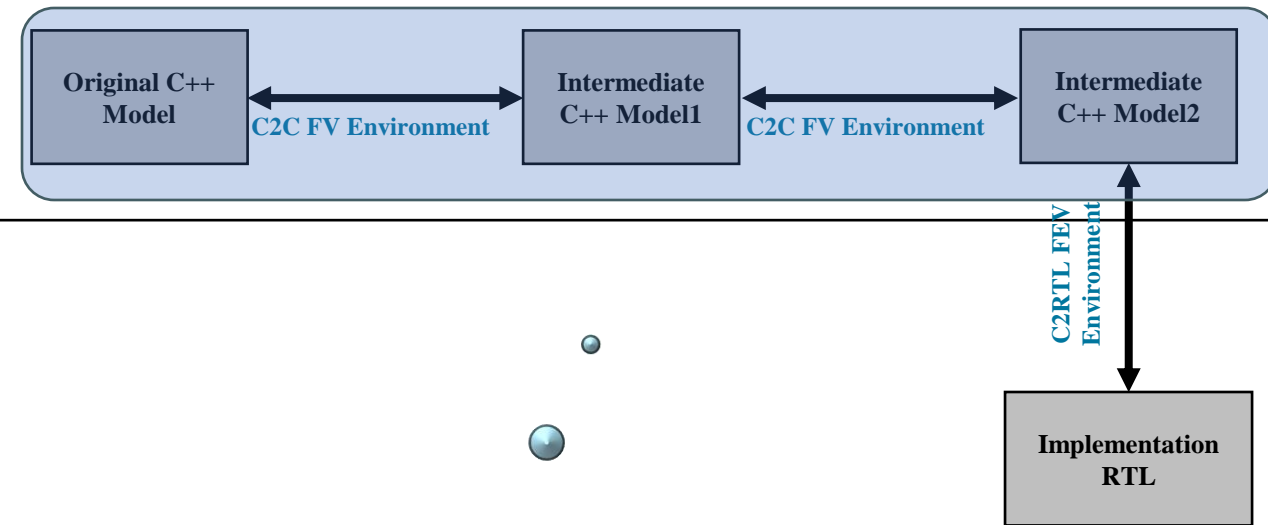


Results :- Introduction of Intermediate models

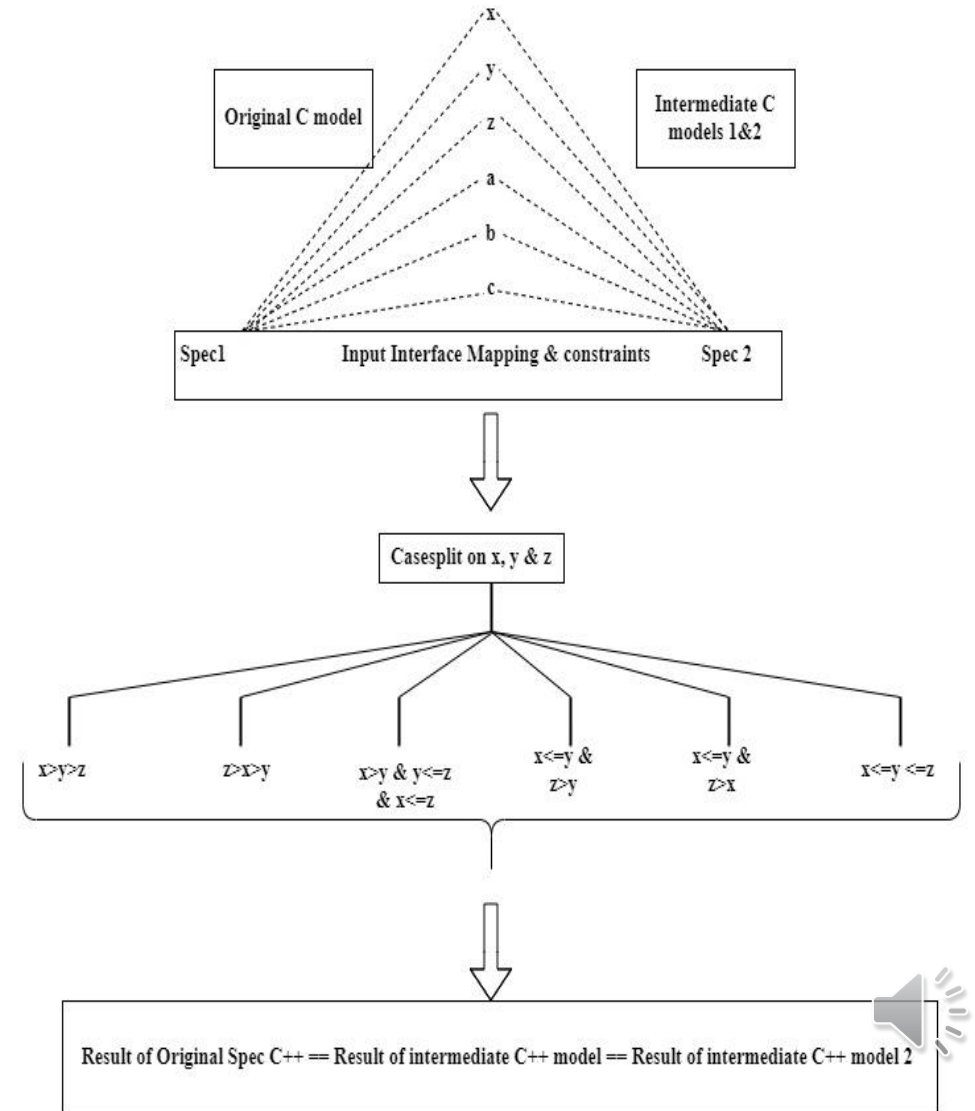


Results :- FEV Between Specification and Intermediate Models

FEV Landscape: C2C Convergence approach

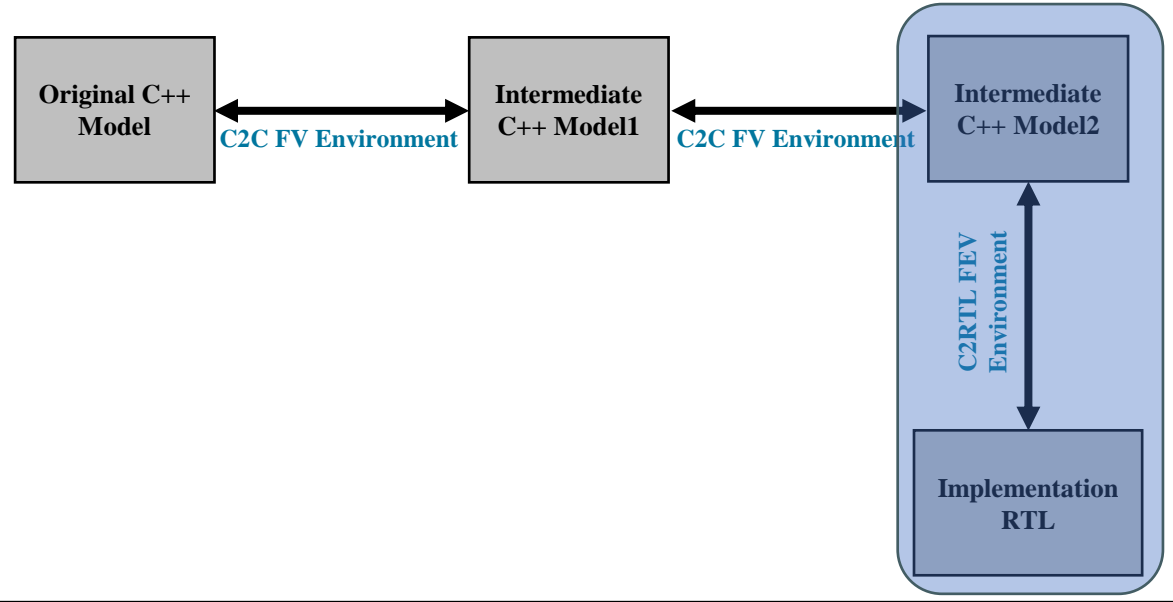


Bridging the abstraction gap

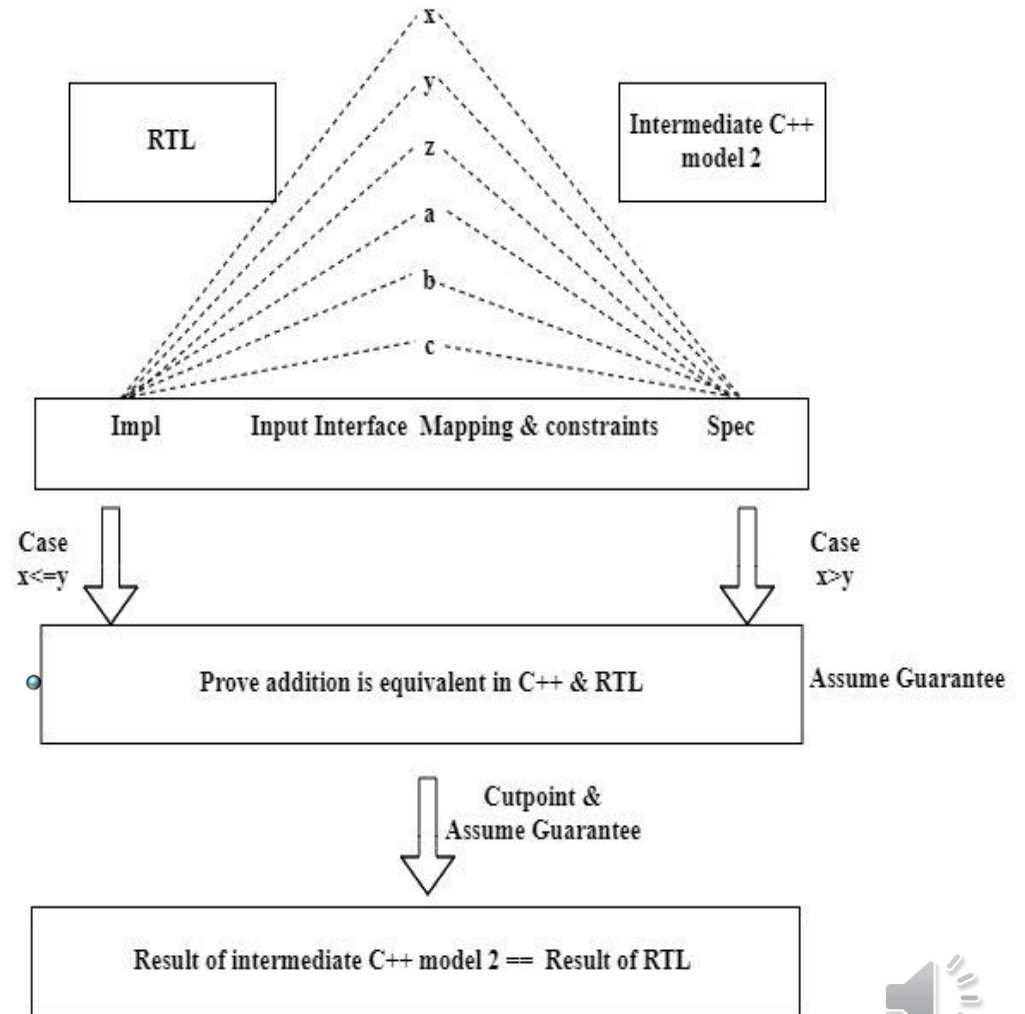


Results :- FEV Between Intermediate Model2 and Implementation(RTL)

FEV Landscape: C2RTL Convergence approach



Use of techniques like case-splitting & assume lemma guarantee



Future scope and Conclusion

- Intermediate modelling methodology
 - Helps to bridge the gap between Implementations
- Iterative reduction in structural differences
 - Leading to better proof strategies
 - Faster convergence in FEV.
- Collaboration with tool vendors
 - To further refine this methodology
 - Integrate it into mainstream verification workflows.

