

Breaking Barriers: Formal Verification in Complex Compressor Controller

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Outlines

-  Introduction
-  Design overview
-  Verification challenges
-  Strategies
-  Results
-  Conclusion
-  Future scope



Introduction



Data as a Catalyst



Storage Limitation



Data Compression



Compression Controller

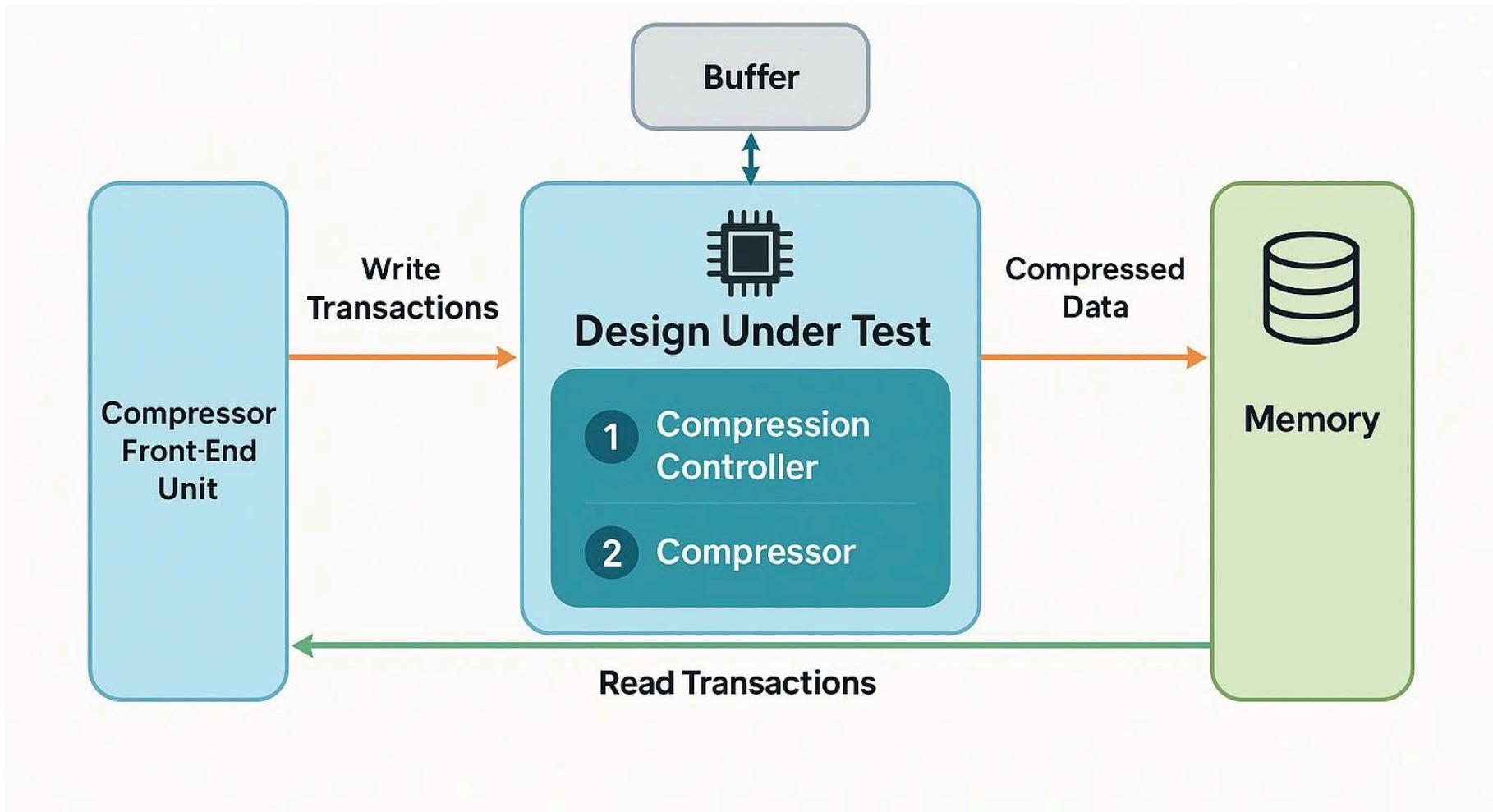


Complex Design

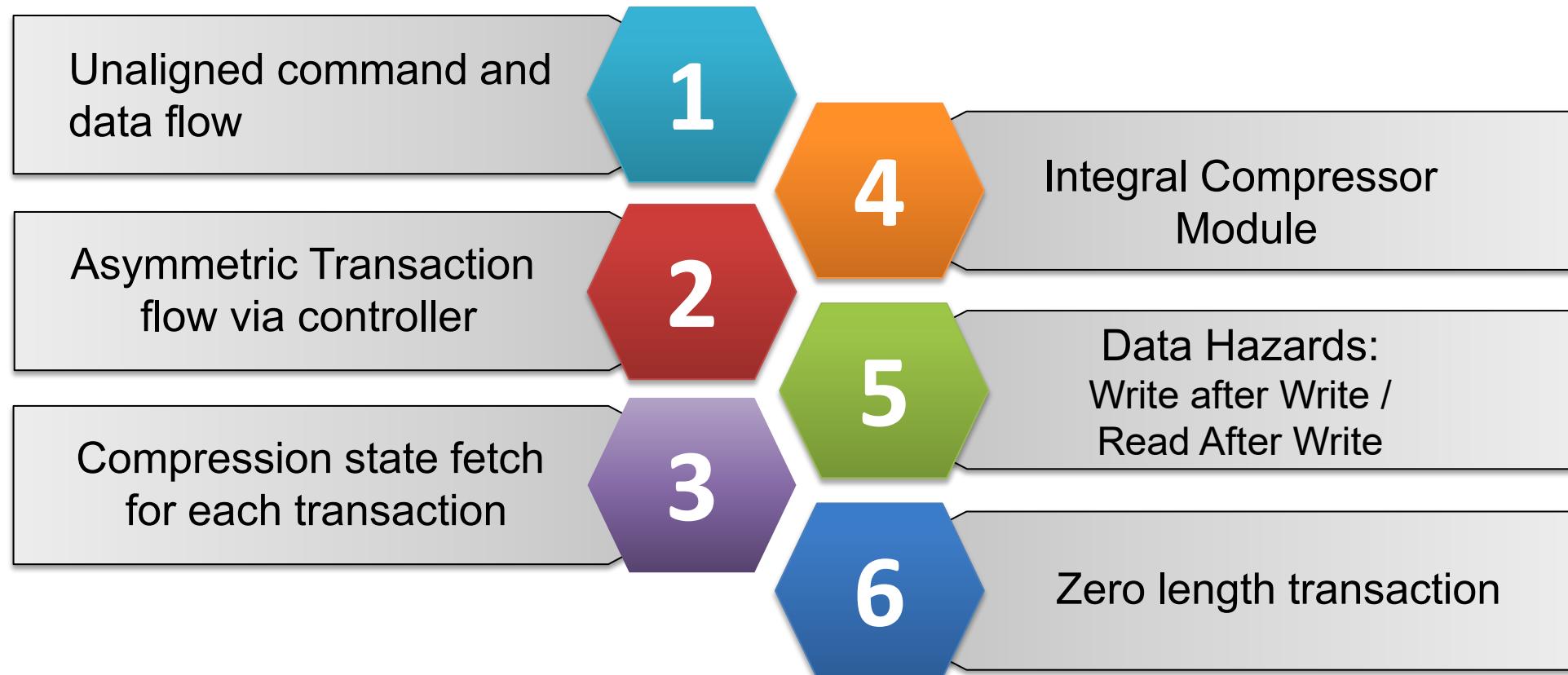


Verification & Complexity Reduction

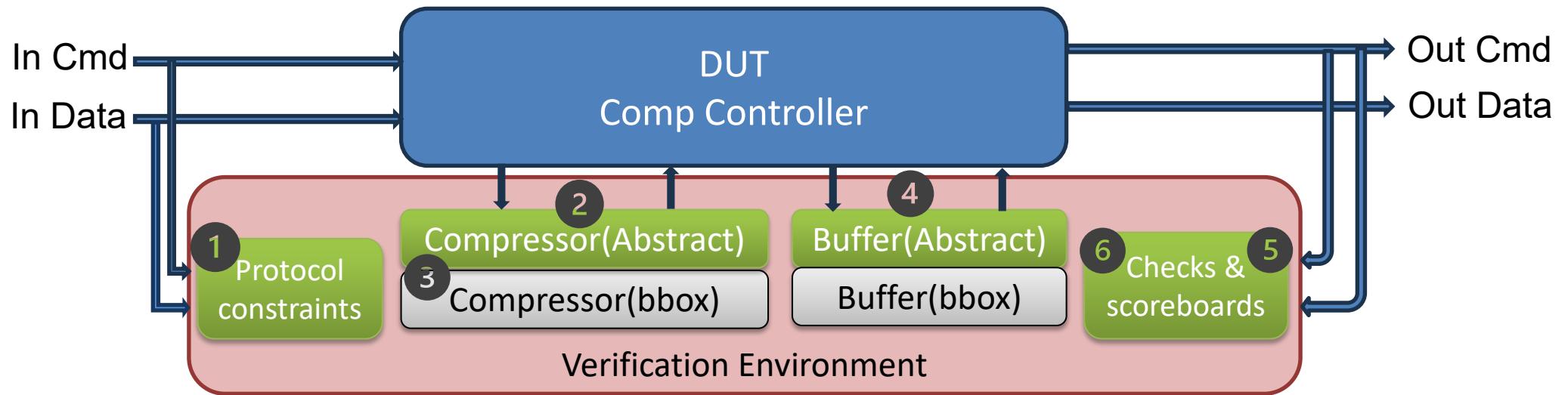
Design Overview



Design Complexity



Verification Strategy



Unaligned cmd and data flow
- Alignment model

1

Asymmetric transaction flow
- Color Coding Algorithm

2

Compression State for txn
- Symbolic & Abstraction

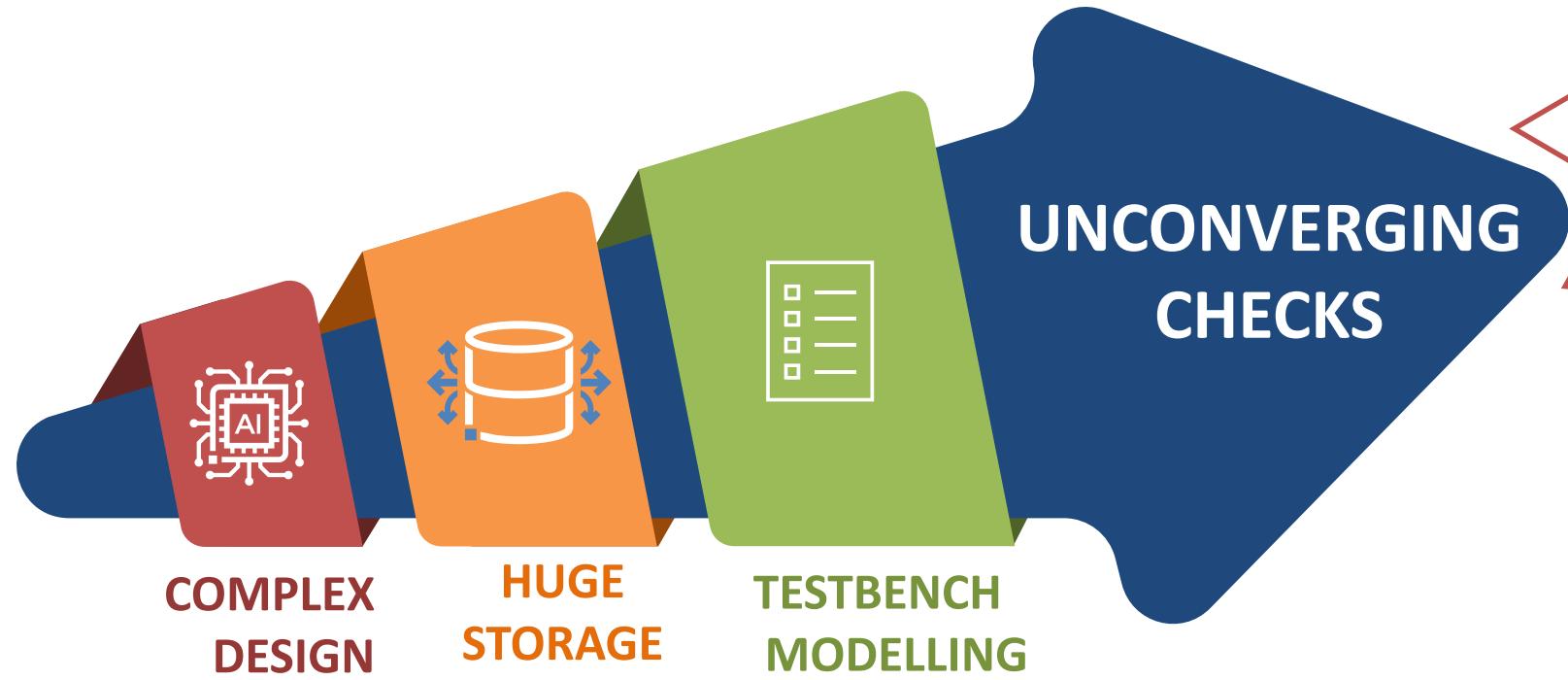
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Integral compressor
4 - C2RTL verif. & Abstraction

WAW/Raw Hazards
5 - Symb tracker & integrity

Zero Length transaction
6 - Symbolic txn tracker

Formal Complexity



Convergence Techniques

Parameter Reduction

- ❖ Optimizes State Space Exploration
- ❖ Deal with less transactions

1

Abstract Modelling

- ❖ Abstract model for compressor and Buffer
- ❖ Preserve essential properties
- ❖ Improve Scalability

2

Convergence Techniques (Cont.)

Symbolic Tracing

- ❖ Deal with a particular transaction at a time
- ❖ Helpful for E2E checks
- ❖ Reduce the testbench complexity

4

3

5

Incremental Flow Checks

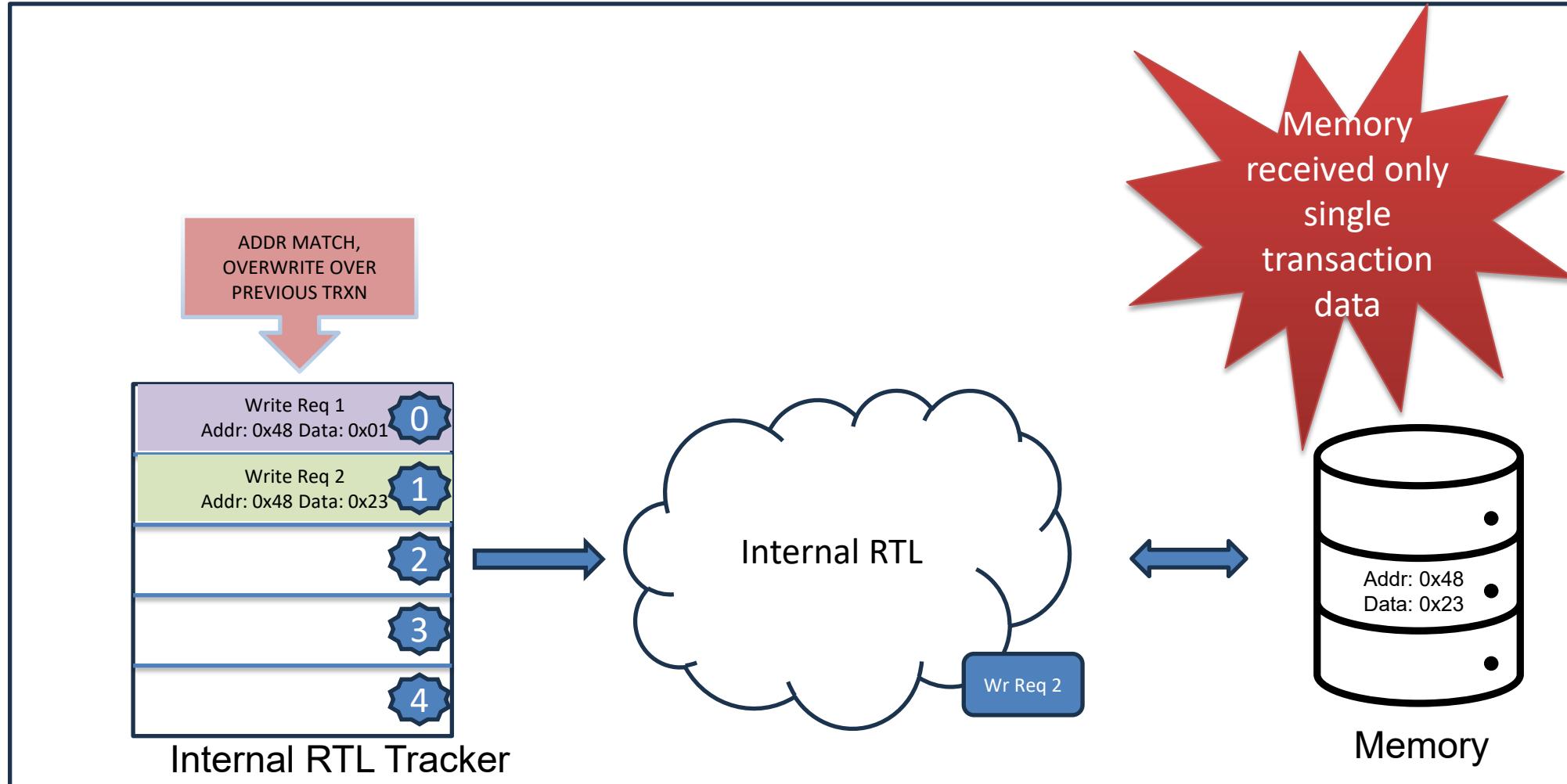
- ❖ Multiple Transactions
- ❖ Multiple Paths
- ❖ Case Splitting
- ❖ Narrow down state space

Helper Assertion

- ❖ Set related properties of checkers as helper
- ❖ Run on unbounded checker

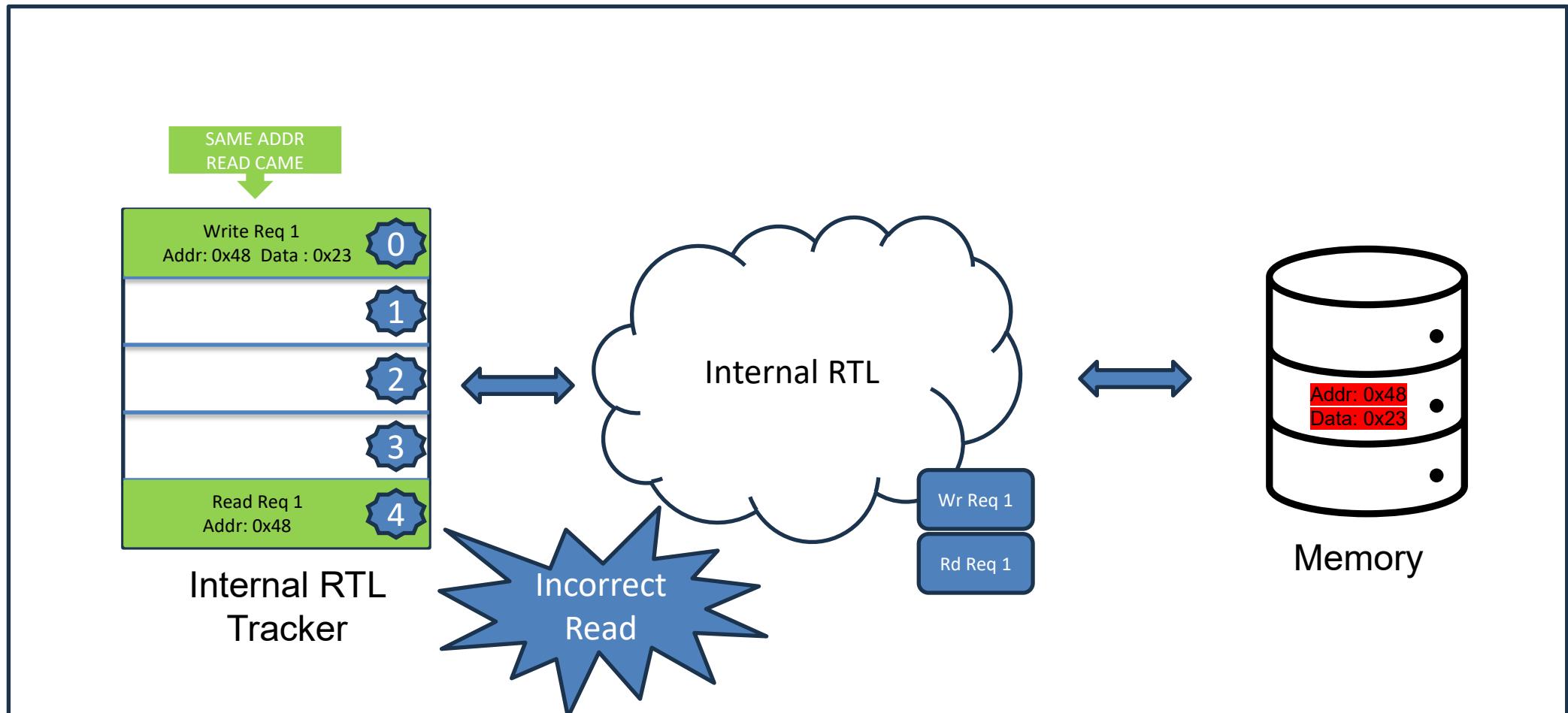
Bug Found Scenarios

WAW Hazard

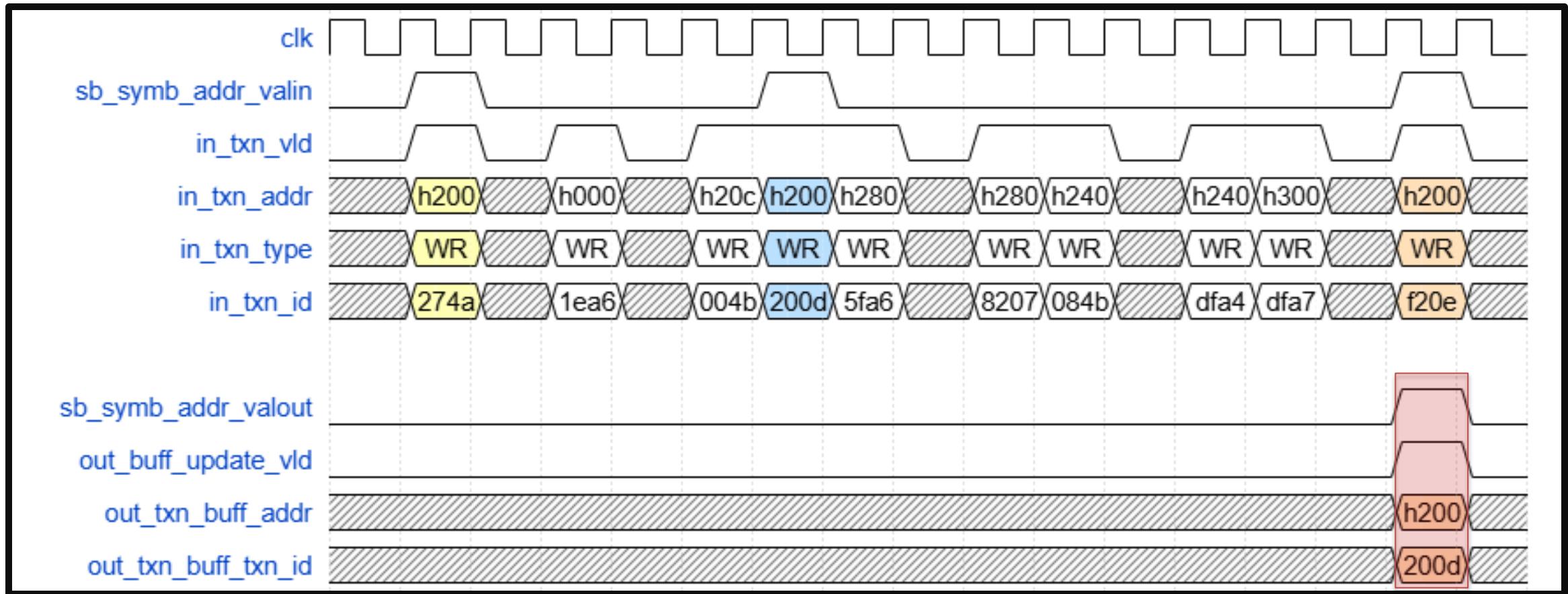


Bug Found Scenarios (Cont.)

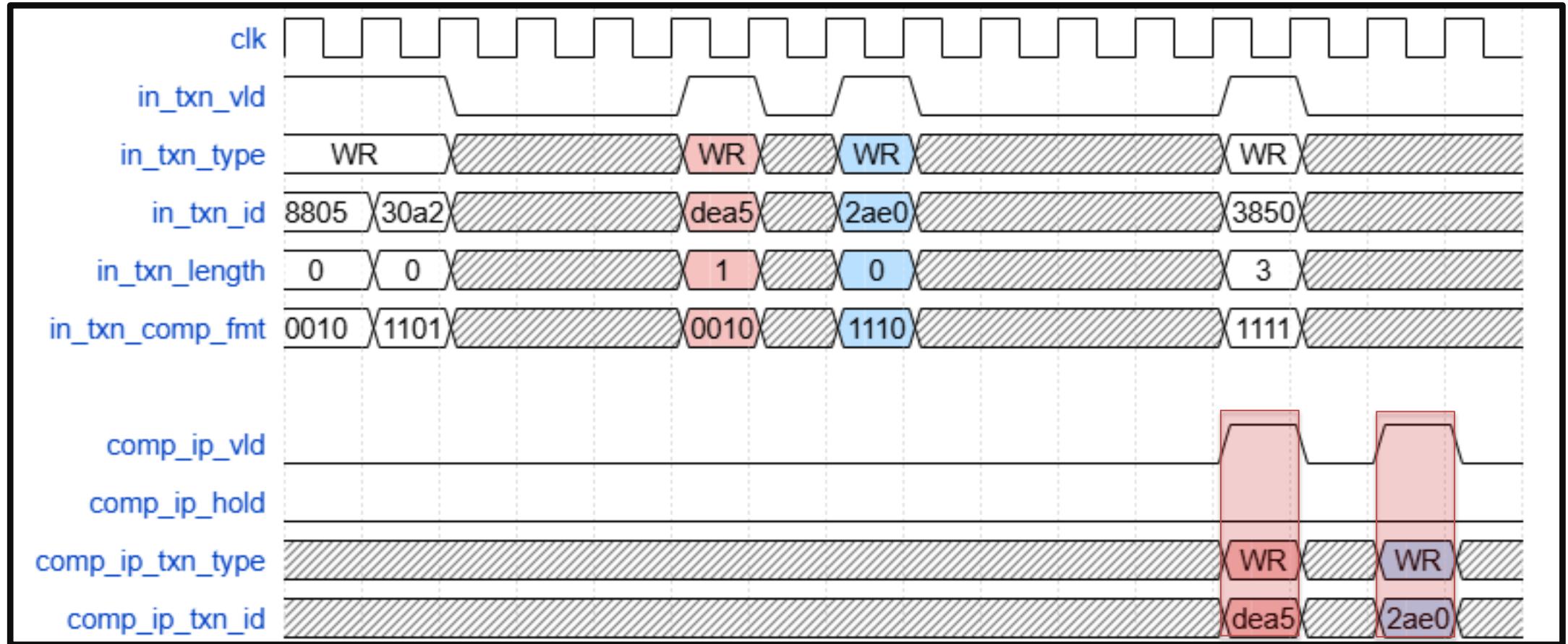
RAW Hazard



Waveform : WAW



Waveform: Missed Zero length



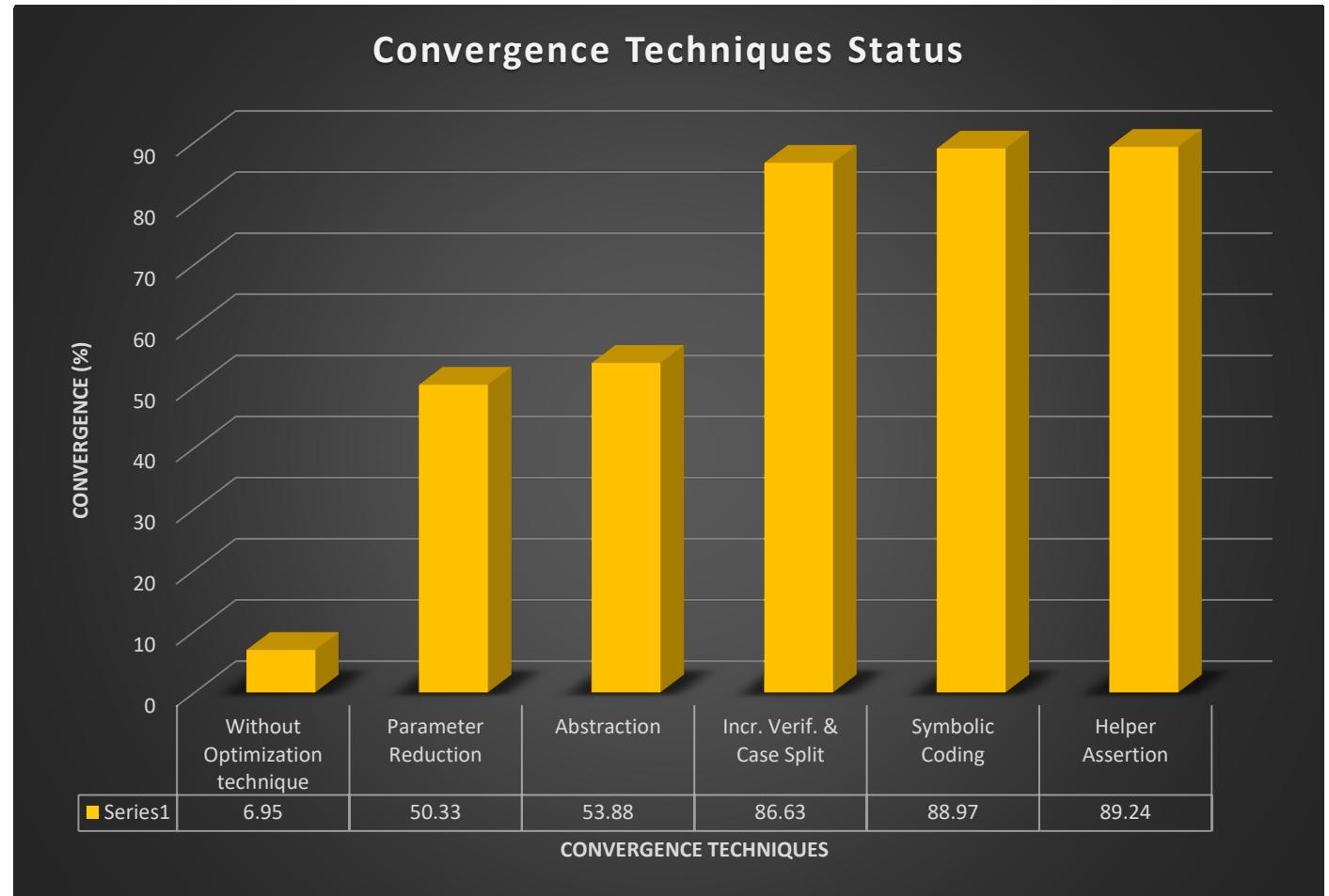
Results

Total Checks : 1496

Bug Counts : 8

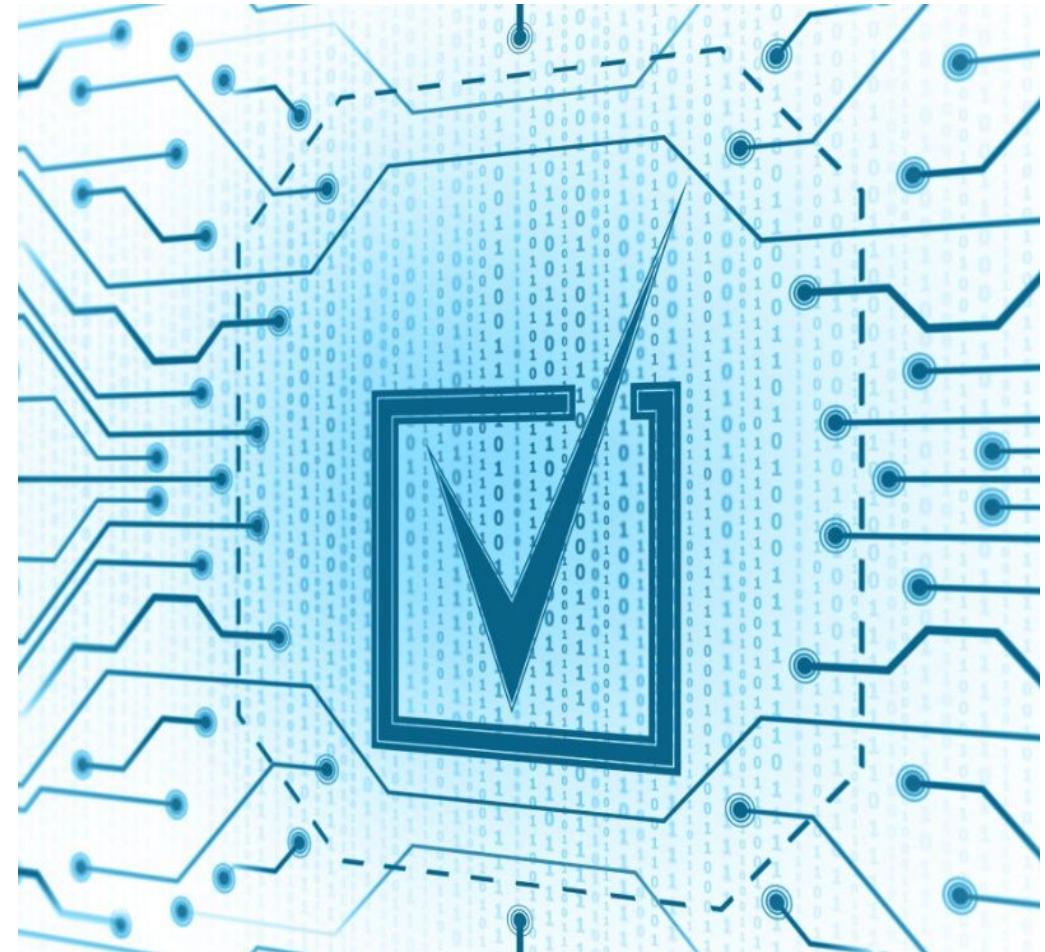
*Convergence Rate
boost up using
techniques: 82.29 %*

Overall effort 1.5 quarter

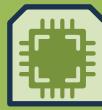


Conclusion

- **Verification Challenges**
 - Complex designs face issues.
- **Effective Verification Strategies**
 - Techniques simplify verification processes.
- **Advanced Convergence Methods**
 - build robust formal environments to catch corner-case bugs.
- **Confidence in Design Quality**
 - Systematic formal verification transforms complexity into confidence



Future Work



Explore other convergence techniques
to achieve full convergence



Extend this verification strategy to
other design with similar complexity



Use architecture formal for left shift

Questions ??

END