AI-aided flow for digital verification of a multiprotocol SerDes PHY

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Outline

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- Motivation
- Main Idea
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Goals

- This work describes the development and implementation of a verification flow that is aided by Artificial Intelligence (AI), supported by Synopsys VSO.ai (Verification Space Optimization).

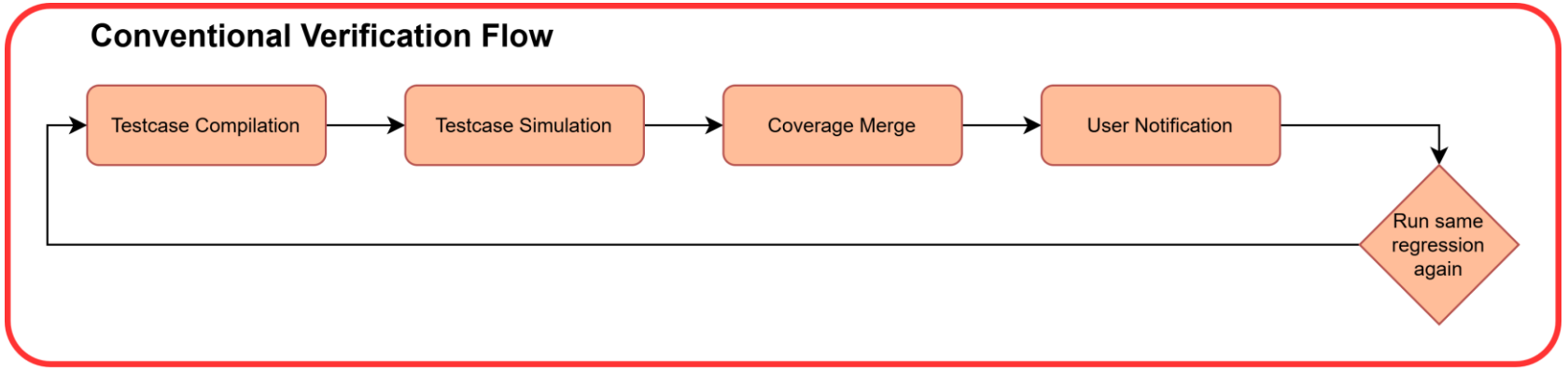
- Introducing AI in the verification flow contributes to:
  - Reduced Time to Results (TTR);
  - Enhanced Quality of Results (QoR);
  - Easier identification of corner case bugs, coverage gaps and redundancies.

- A comparative analysis was made between the conventional and the developed flows, when applied to the verification of a multiprotocol SerDes PHY for automotive and consumer applications.

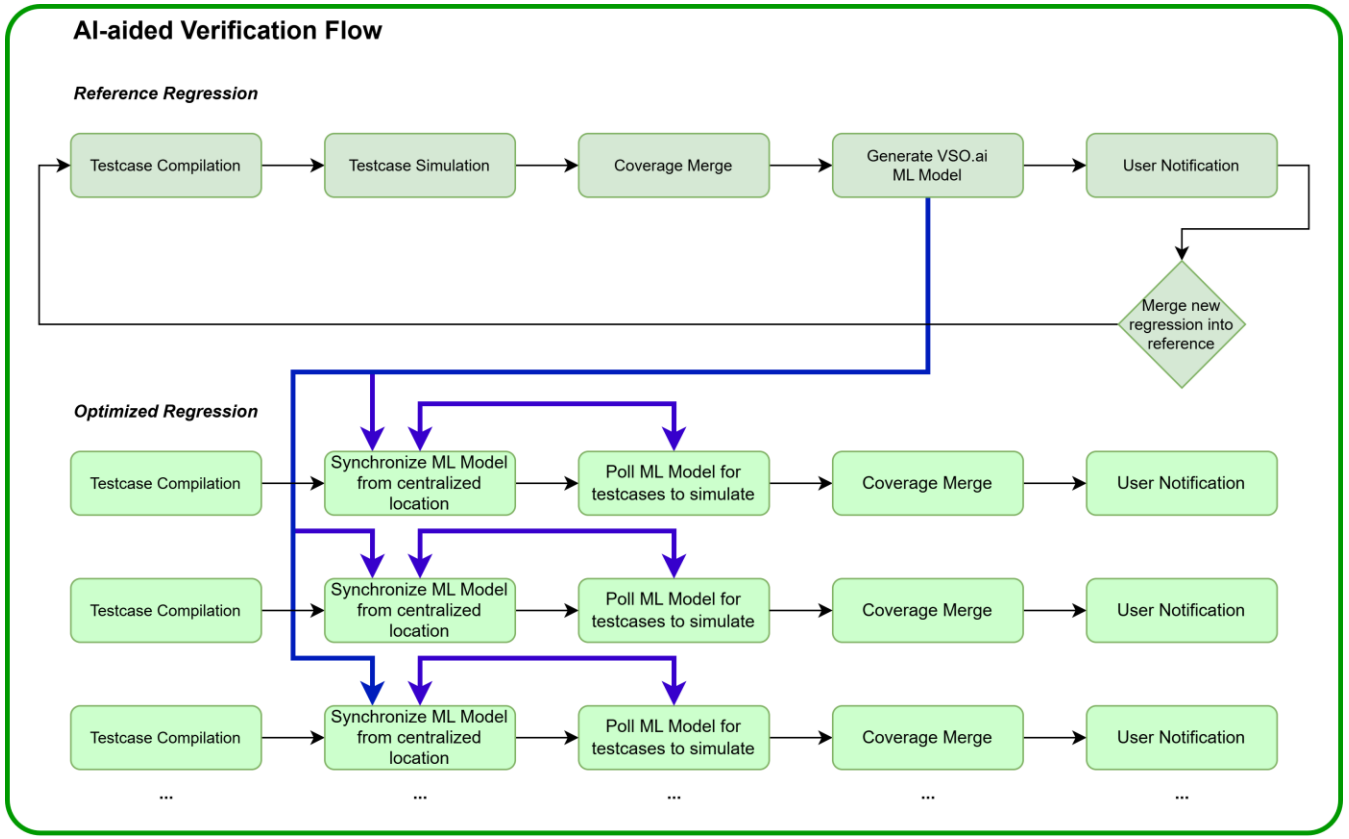
Motivation

- Coverage closure is fundamental in the verification flow, despite being a resource-heavy task.
- It is of special importance in automotive projects, demanding a complete analysis of both code and functional coverage.
- Synopsys VSO.ai is a solution designed to improve the efficiency of verification regressions. It uses Machine Learning (ML) and Artificial Intelligence (AI) to optimally manage regression processes to meet key verification goals, including finding bugs, securing coverage and exploring Register Transfer Level (RTL) functionality.

Main Idea

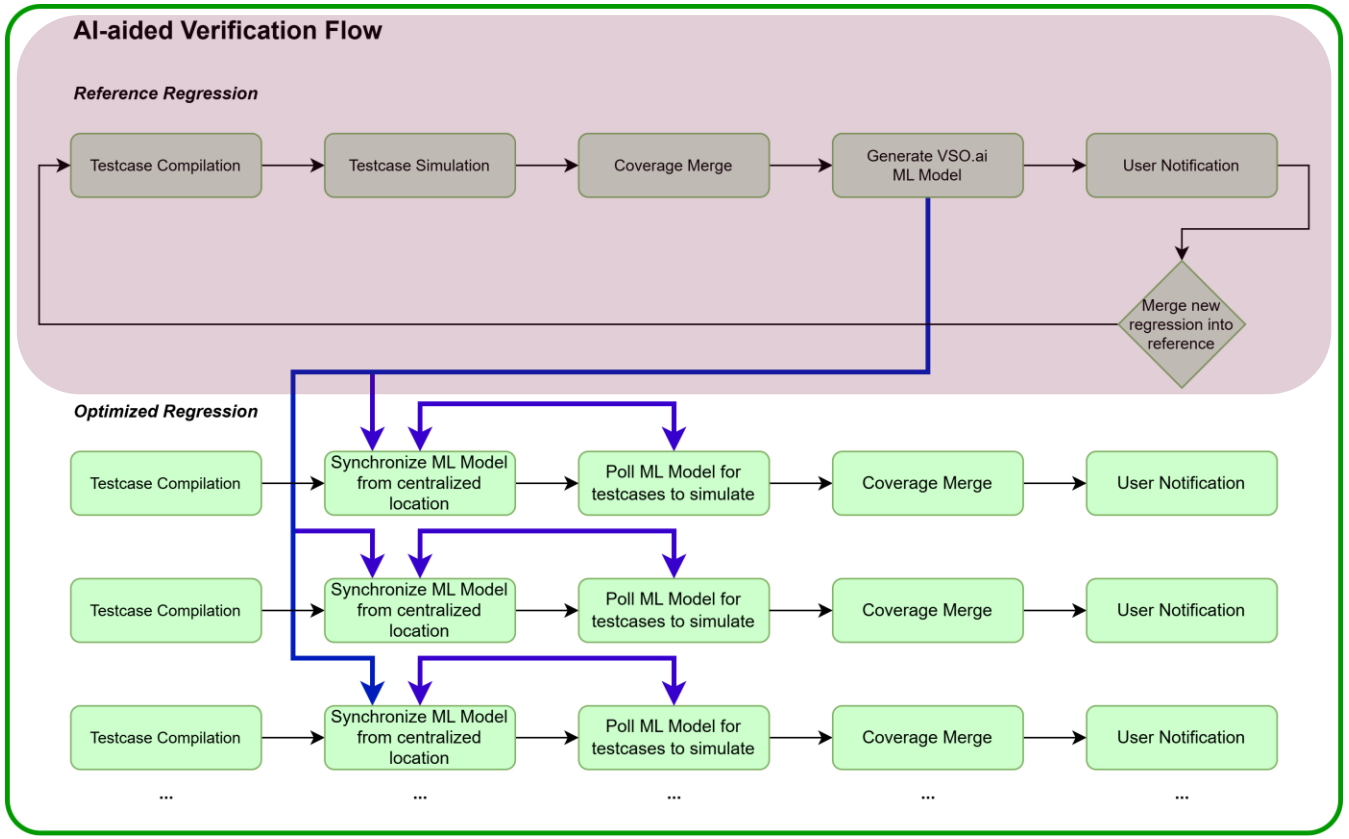

Conventional Verification Flow
Testcase Compilation
Testcase Simulation
Coverage Merge
User Notification
Run same regression again

Main Idea



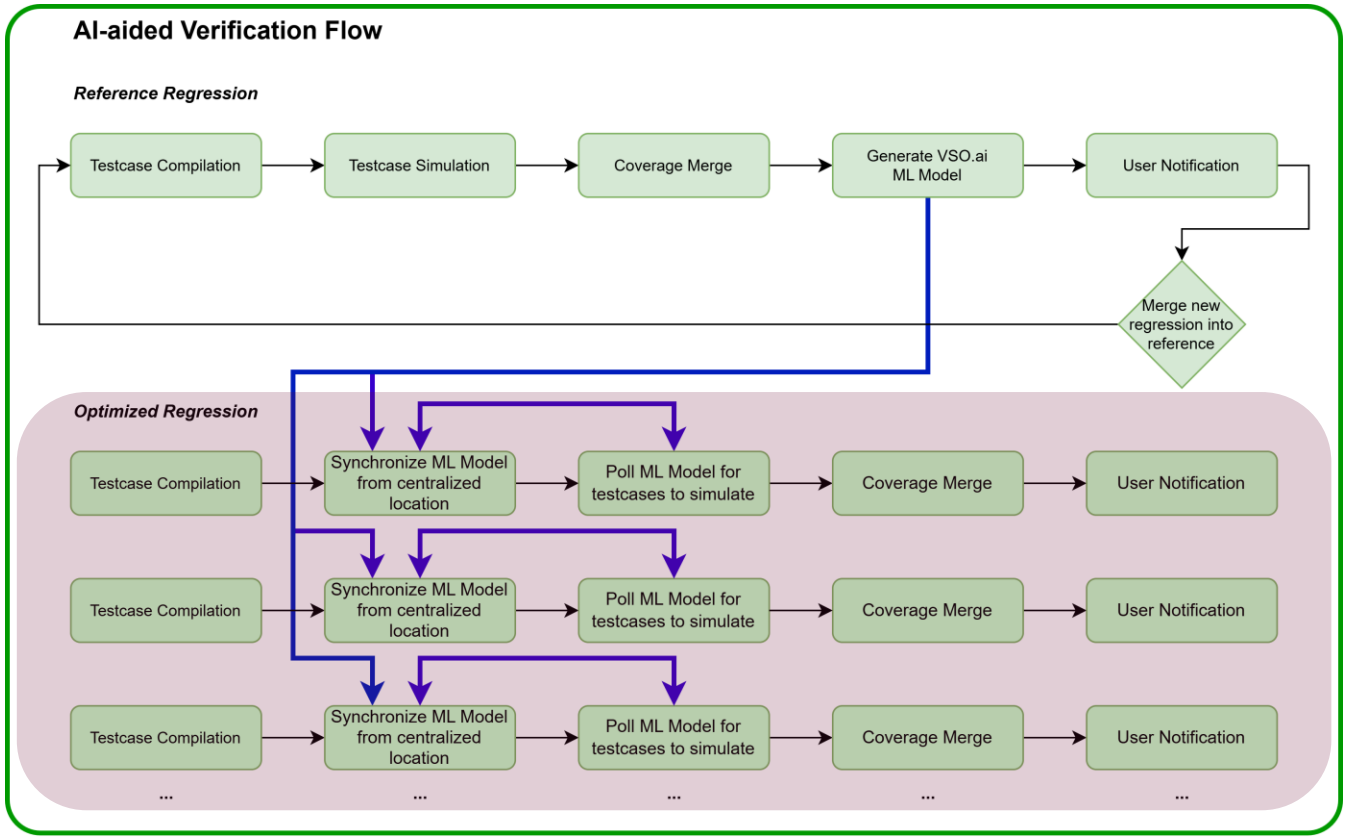
- Migration to an AI-aided verification flow, aiming to:
  - Reduce total number of simulations;
  - Improve saturation of coverage metrics.
- The AI-aided flow consists of 2 automated parts:
  - 1: Reference Regression
  - 2: Optimized Regression(s)

Main Idea



- Reference Regression (1st stage)
  - Full default regression is run;
  - VSO.ai's ML model is generated from the coverage data: it stores learning data across regression runs;
  - The ML model is stored at a centralized location.

Main Idea



- Optimized Regression(s) (2nd stage)
  - Different verification engineers can simultaneously launch regressions that are optimized by VSO.ai's ML model;
  - Automatic report of gains in relation to the reference regression:
    - Simulation runs;
    - Total CPU time;
    - Change in coverage statistics;
    - Insights into rare and unhit coverage targets.

Evidence

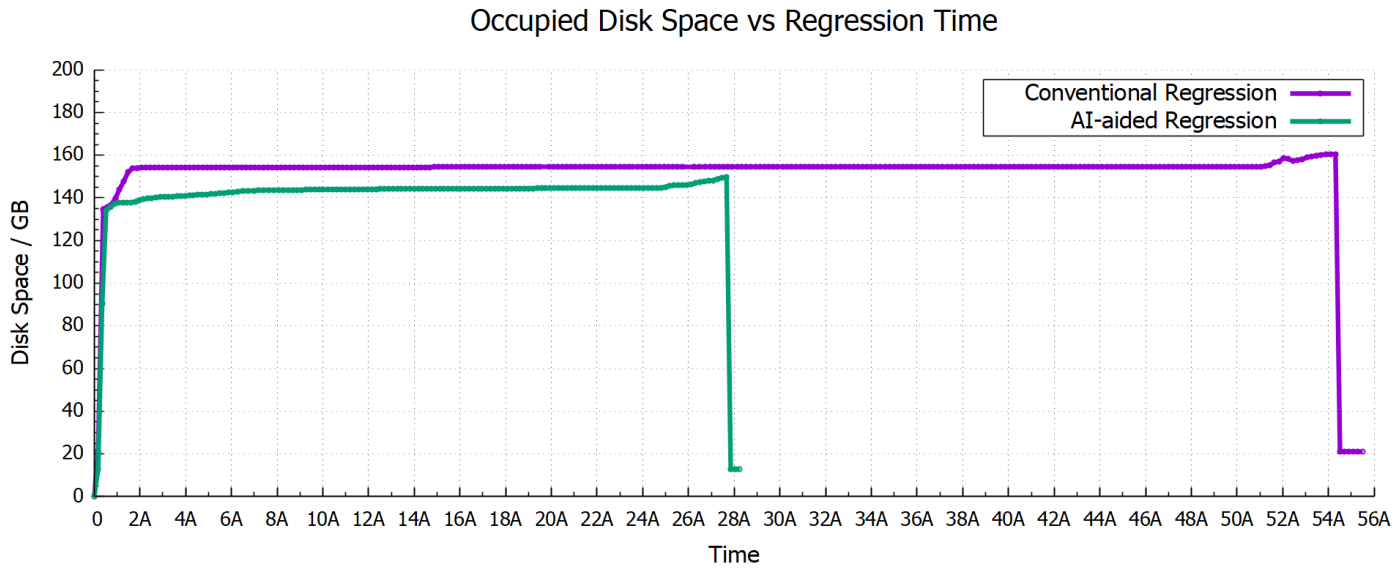
Comparative analysis of regression flows:

	Conventional	AI-Aided	Gain
Total number of testcase simulations	2689	748	**3.59**
Number of unique testcases	1611	392	**4.11**
Total regression time	54.5 A	27.9 A	**1.95**
Cumulative CPU time	2047.8 A	972.7 A	**2.11**
Peak Disk Occupation	160.5 GB	149.6 GB	**1.07**

- The original regression is automotive graded, comprising 2689 tests and 100% functional and code coverage, considering waivers and exclusions.
- Median results from a set of 5 optimized regressions using the same reference ML model.
- The gain in total testcase simulations varied from 2.58 to 4.01.

Evidence

Comparative analysis of resource usage:



- The optimized regression considerably reduces the TTR to about a half.
- A slight reduction in occupied disk space is also observed.

Evidence

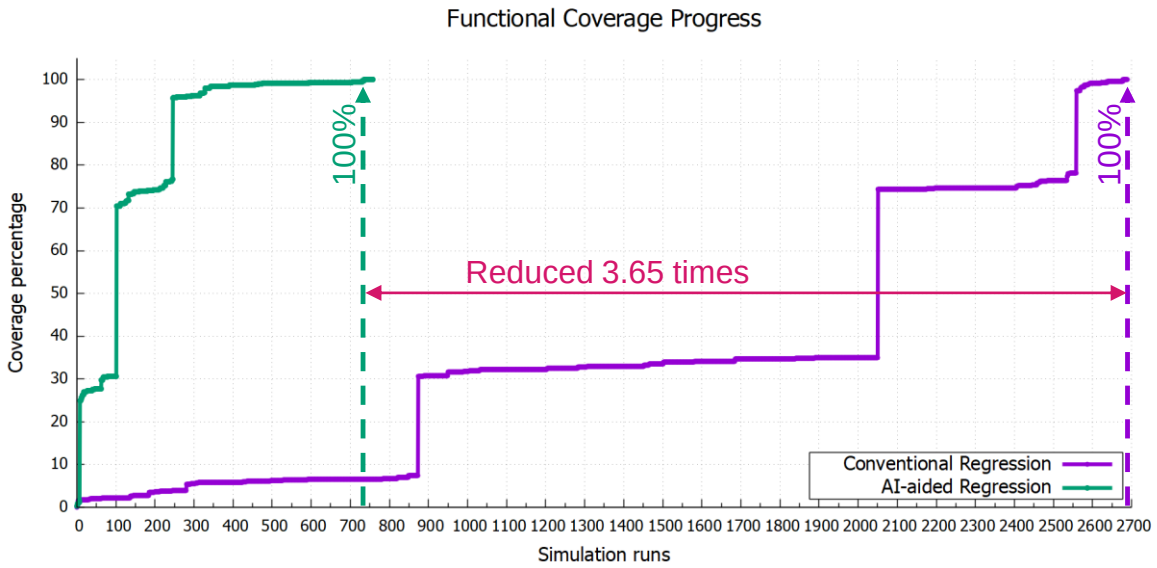
Comparative analysis of regression flows:

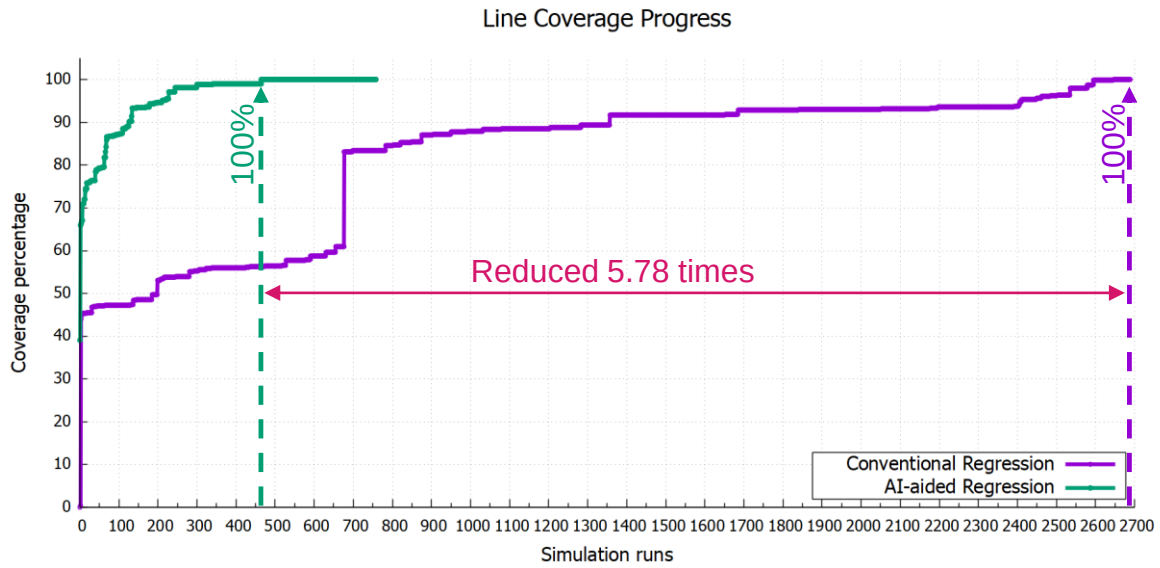
	Conventional	AI-Aided	Gain
Total number of testcase simulations	2689	748	**3.59**
Number of unique testcases	1611	392	**4.11**

- Even though 1219 testcases were excluded, the same aggregated coverage was reached.
- This provides insight on how the testbench can be improved.
- Excluded testcases may indicate these are:
  - lacking specific coverage definition;
  - their related coverage is being redundantly hit by other testcases.

Evidence

Comparative analysis of coverage progress:





- An acceleration in the coverage progress is observed in the AI-aided flow, which can vary across the different coverage metrics.

- The visible step bumps in the coverage progress are due to testcases dedicated to the PHY registers and to firmware.

Summary

- The introduction of AI into the verification flow provided different benefits:
  - Productivity boost, owing to accelerated regression cycles:
    - Reduced TTR by half;
    - Reduced number of total simulations to less than a third;
    - Accelerated coverage convergence;
    - Grants verification engineers more bandwidth to debugging tasks.
  - Optimized Cost of Results (CoR);
  - Better insight into existing coverage gaps and redundancies.

Acknowledgements

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AI

Security

Systems

EDA

Design

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