Introduction

Multi-core parallel simulations work very well on designs that meet certain criteria and these factors help to:
- Qualify the design for multi-core simulations
- Design multi-core-friendly designs

Motivation

Questions raised by customers during QuestaSim MC2 (Multi-core Multi-computer) technology deployments:
- Do multi-core/parallel simulations even work?
- When do parallel simulations work? When do they not work well?
- What should be used to speed-up existing regression suites – a distributed grid job or parallel simulations?

Maximum speed-up possible on multi-core simulations

Introduction to Amdahl’s Law

Design factors that affect multi-core parallel simulations performance

Design factors discussed here are not restricted to any single EDA simulator but provides guidelines to understand what makes multi-core simulations a success.

Load balancing:
Very good load balancing inside the DUT

Concurrency:
Designs such as multi-core SoC with busy cores and independent functions → good candidates

Balanced blocks that are not concurrent and active one after the other → bad candidates

Communication:
Heavy inter-partition communication (IPC) for data transfers and synchronization → negative impact on multi-core simulations.

Designs with high hierarchy or partitioning at a lower hierarchy — many communication ports, increased traffic

Blocks that communicate a lot → keep together in single partition

Results

Results of RTL customer designs charting various performance gains vs. number of parallel partitions used

Performance gain with parallel simulations – 1.2x slower to 5.15x faster

Balanced and parallel activity in partitions

Heavy class-based TB and little to no functional activity in the DUT

Results of Gate Level customer designs charting various performance gains vs. number of parallel partitions used

Performance gain with parallel simulations – 1.19x slower to 3.8x faster

Balanced activity in each partition

Unbalanced simulations with majority of time spent in a small block

Commercial multi-core simulation provider checklist

- Flexible methods to create design partitions – manual, semi-automatic or fully automatic
- Support all HDL languages and language features
- Partition design based on dynamic simulation activity
- Control cross partition synchronization flexibly
- Various analysis reports to provide feedback on design suitability for multi-core simulations as well as performance results
- Fewer number of tool limitations that affect partitioning

Applicability of parallel simulations technology

Design qualification criteria which can help lead to successful multi-core simulations:
- Big designs with long simulation times of more than an hour
- Balanced activity in each partition
- Flat gate-level netlists and designs with little to no hierarchies do not partition well and are not good candidates
- Minimal cross-partition access such as through PLEDFP/FLI/VPI usage
- Race-free designs

Regression suite of tests:
- Large number of tests with small simulation time
  - Multiple simulation jobs in parallel to a distributed grid
- Tests that take multiple hours/days
  - Faster identification and fix of functional issues with shorter design cycle

References

Results and analysis reports from actual evaluations and deployments of QuestaSim MC2 technology on real customer designs

Conclusion

Multi-core/parallel simulations work very well on designs that qualify based on the criteria discussed.