Fault-tolerant FEM-Multigrid Solvers

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Abstract

Technology projections for the upcoming exascale era indicate that future systems will be prone to severe mean time between failures. One reason is the sheer anticipated size of these systems. With billions of "cores" computing simultaneously, a faulty computation that may or may not lead to an erroneous result is simply very likely to happen in the course of a large-scale simulation application. More importantly, hardware architects argue that the strict power envelope of future machines can only be met by actively reducing reliability: Comfortable and established mechanisms like ECC protection of DRAM, the cache hierarchy and signal paths are likely to disappear. Traditionally, the community has relied on checkpoint-restart techniques to mitigate the problem. However, checkpointing to disk is already prohibitively expensive. Thus, fault-tolerance must be build directly into numerical methods.

We introduce a novel fault-tolerance scheme to detect and repair soft faults in multigrid solvers, which essentially combines checksums for linear algebra with multigrid-specific algorithm-based fault-tolerance. To improve efficiency we split the algorithm into two parts. For the smoothing stage, we exploit properties of the full approximation scheme to check and repair the results. Our resulting method significally increases the fault-tolerance of the multigrid algorithm and has only a small impact in the non-faulty case.

This submission substantially extends previous work (see the citation below) to the case of soft faults.

References

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