Pattern-based Modeling of High-Performance Computing Resilience

**Achievement:** Developed mathematical models for the various patterns in the resilience design pattern catalog. We specifically developed quantitative models for the architecture patterns that model the effect of applying these patterns on reliability and performance of the system.

**Significance and Impact:**
The performance and reliability models provide designers with the tools to adopt a quantitative approach to navigate the complexities of emerging landscape of HPC design. The models can be used for evaluating the effectiveness and efficiency of existing and new resilience solutions designed for extreme-scale HPC systems.

**Research Details:**
- Developed models for the reliability and performance characteristics of the various resilience design patterns
- The models provide an approximation of the pattern suitability to a specific problem using analytical means or using a simulation framework such as xSim

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**PI and affiliation:** Christian Engelmann -- Computer Science and Mathematics Division (CSMD), Oak Ridge National Laboratory (ORNL)

**Team:** Saurabh Hukerikar and Christian Engelmann

**Publications:**
Saurabh Hukerikar and Christian Engelmann, *Pattern-based Modeling of High Performance Computing Resilience*, Proceedings of the 23rd European Conference on Parallel and Distributed Computing Euro-Par 2017, 10th Workshop on Resiliency in High Performance Computing (Resilience) in Clusters, Clouds, and Grids, Santiago de Compostela, Spain, August 29, 2017

**Overview:**
Using the resilience design patterns in a hierarchical fashion, we are able to lay the basic foundation of complete resilience solutions through qualitative descriptions of the solution and its constituent patterns. However, fully understanding the impact of a solution at design time in terms of the improvement of protection coverage as well as the trade-off between performance and resilience is a complex problem. Also, for design space exploration, patterns serve as tools for HPC designers to model and evaluate a solution. The use of simulation frameworks, such as the xSim, are valuable tools to investigate various design alternatives and in terms of the resilience and performance characteristics of the various combination of patterns for a specific target system and application. We developed preliminary mathematical models for the various resilience design patterns in our catalog. We specifically developed models for the architecture patterns that quantify the effect of applying these patterns on reliability and performance of the system. The models for the patterns developed are designed to provide a simple...
analytic approximation of the performance and reliability characteristics of the resilience design patterns and that of any solutions developed by combining multiple patterns.