Performance Variability Due to Job Placement on Edison

Dylan Wang¹, Abhinav Bhatele² (advisor), Dipak Ghosal¹ (advisor)
¹University of California, Davis, ²Lawrence Livermore National Laboratory

Abstract

Some scientific applications running on machines like the Edison supercomputer can suffer from high variability in run-time. This leads to difficulties in debugging and optimization for end users and less efficiency for the supercomputing facility. The objective of this research is to characterize the application run-time performance and identify the root cause of the variability on machines with the Aries network.

Edison

• 335,000+ cores
• Global Network
• 5500+ nodes (two 12-core Key Bridge processors per node)

Cray Aries Interconnect

• Aries router = 4 nodes, 40 network tiles with 1 incoming and 1 outgoing port, creating the 3-tier “Dragonfly” topology
• 1) Chassis: 16 Aries routers
• 2) Group: 6 Chassis
• 3) System: 15 Groups
• Aries routers are capable of adaptive, non-minimal routing

Experiment Setup

• The application MLL2 was run on Edison multiple times:
  — Three allocation sizes: 256, 384, and 512 nodes
  — In a null OS noise, skip first last core of each socket
  — MLL2 is computation-constant application that communicates in a weak scaling 4D stencil
  — Our first goal is to find metrics that strongly correlate with the application’s performance.

Data Analysis

• Determining metrics that simultaneously “describe” an allocation and the interference due to congestion on the routers and also correlates with application performance is challenging.
• We identified the following metrics in three categories for correlation tests:
  — Allocation-related
  — The coordinates of the allocation given
  — MPI-related
  — MPI behavior reported by mpirun
  — Counter-related
— The load, bandwidth, and congestion of the routers and links

Visualization

The figures below are 2D visualizations of the entire system at two different machine states.

Figure 6: 2D visualization of the entire system at two different states corresponding to two different states of MLL2 execution. What are the interactions in the system variability between the two states?

Results and Analysis

• Table 2’s CV suggests an approximate 41% in variation for job M17 time
• Our node allocation metrics individually show almost no correlation, meaning placement is not significant or is covered by general interference
• Hardware counters may correlate with MPI performance, though the results are not conclusive

Conclusions

• Run other applications such as pS3D which have different communication patterns
• Controlled experiments such as finding a base case time by reserving a whole group

Future Work

• Exploration of large scale time series analysis on the Edison system

Acknowledgments

Lawrence Livermore National Laboratory is managed by Lawrence Livermore National Security, LLC, for the US Department of Energy under contract DE-AC52-07NA27344. This work was performed under the auspices of the US Department of Energy by the National Nuclear Security Administration of the US Department of Energy. UC Davis is a designated National Science Foundation Supercomputing Research Center and is supported in part by the National Science Foundation under grant numbers PHY-1820683 and ACI-1544344.