CRITICAL STUDY OF PARALLEL PROGRAMMING FRAMEWORKS FOR DISTRIBUTED APPLICATIONS

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ABSTRACT

Parallel programming frameworks such as the Message Passing Interface (MPI), Partitioned Global Address Space (PGAS) languages, Charm++, Legion and High Performance Parallel X **(**HPX) have been used in several scientific domains – such as bioinformatics, physics, chemistry, and others – to implement distributed applications.

This thesis presents a critical study of established and new parallel programming frameworks, including MPI, PGAS-based languages (OpenSHMEM, Chapel, X10, UPC), Cham++, Legion, HPX, and Inter-node Virtual Memory (IVM) – a programming system designed and developed at University of Missouri. I first investigate the main features of these programming systems. I then analyze how these features affect programmability and performance on heterogeneous clusters and for benchmark applications exhibiting different computation and communication patterns. Finally, I develop a benchmark suite where each application is encoded using several programming systems (MPI, Charm++, IVM and OpemSHMEM). The goal of this study is two-fold: first, I want to provide programmers with guidance on the selection of the programming framework which is best suited for their application and cluster setup; second, I aim to provide guidelines for further development of existing and new parallel programming frameworks for distributed systems.