Dissertation Defense

Adaptive Approaches to Utility Computing for Scientific Applications

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Abstract: Coupling scientific applications to heterogeneous computational targets requires specialized expertise and enormous manual effort. To simplify the deployment process, we propose a novel adaptive approach that helps execute unmodified applications on raw computational resources. Our method is based on situation-specific adapter middleware that builds up target capabilities to fulfill application requirements, avoiding homogenization that may conceal platform-specific features. We investigate three dimensions of adaptation: performance, execution paradigm, and software deployment and propose the ADAPT framework as a methodology and a toolkit that automates execution-related tasks. For parallel applications, ADAPT matches logical communication patterns to physical interconnect topology and improves execution performance by reducing use of long-distance connections. In a proof-of-concept demonstration of applicationplatform paradigm transformation, ADAPT enables execution of unmodified MPI applications on the MapReduce Platform as a Service cloud by recreating and emulating missing MPI capabilities. To facilitate software deployment, ADAPT automatically provisions resources by applying soft-install adapters that dynamically transform target capabilities to satisfy application requirements. As a result of these types of transformations, a broader spectrum of resources can smoothly execute scientific applications, which brings the notion of utility computing closer to reality.

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