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**What is Driving Programming System Technology
for Exascale and Beyond**

Projections of exascale architectures point to several features that are driving how such systems must be programmed. Current and future systems exhibit architectural diversity with potentially billions of processor cores, fundamentally different types of CPUs and GPUs, specialized accelerators, and hierarchical memory systems that incorporate new types of storage technologies. Moreover, such large-scale systems must support not only scientific simulation, but also the growing demands of scalable machine learning, particularly since scientific codes are employing machine learning in data analysis. Developing applications for such complex and diverse architectures is daunting and demands new approaches to achieving high performance without exposing low-level architectural details. This talk will discuss recent research, focusing on three themes that are driving programming systems for exascale: (1) achieving performance portability, whereby the same source code can achieve high performance across different platforms; (2) optimizing data movement, the dominant execution-time and energy cost of scalable applications; and, (3) leveraging the significant investment in programming systems for machine learning to capitalize on needs that overlap with HPC.