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KEYNOTE 7: The Future of Computing Will Be non-von Neumann

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Seven decades of HPC has been empowered by the abstraction of "the von Neumann Architecture" and its many derivatives, driven to a significant degree by Moore's Law and the exponential growth of device density and concomitant clock rates yielding a performance gain over that period of more than ten trillion for floating point computation. But a perfect storm of recent technology trends has terminated this unprecedented expansion and challenges the future opportunities beyond exascale computing. But even as the end of conventional processing practices is flat-lining, a new world of non von Neumann execution models and architectures is emerging igniting a revolution for the next generations of computing systems orders of magnitude greater performance than is currently achieved. Even more important is that the reality of HPC users is that approximately 90% of the Top-500 machines measured with the HPL benchmark demonstrate only about 1% of the performance of the fastest machines. Thus we are much further away from exascale than is generally assumed and therefore much greater gains are required to truly bring the major base of HPC users into the exascale era. New non von Neumann architectures and models, such as Quantum Computing, Neomorphic Computing, and Continuum Computing (this last presented at CHPC18) are offering important possibilities for the future. Earlier non von Neumann techniques previously explored in past decades, such as static and dynamic dataflow, cellular automata, systolic arrays, and special purpose designs may also serve as starting points for new classes of useful computing methods even as Moore's Law recedes. Finally, advanced technologies beyond conventional semiconductors such as cryogenic such as single flux quantum logic provides yet another dimension of potential post exascale strategies. This Keynote Address will convey a fast paced odyssey through the near future opportunities of HPC non von Neumann based computers. Questions will be encouraged by participants throughout the presentation as well as the Q&A session at its conclusion.

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