

Using MuMMI to Model and Optimize Energy and Performance of HPC Applications on Power-aware Supercomputers

Xingfu Wu and Valerie Taylor

Department of Computer Science and Engineering, Texas A&M University

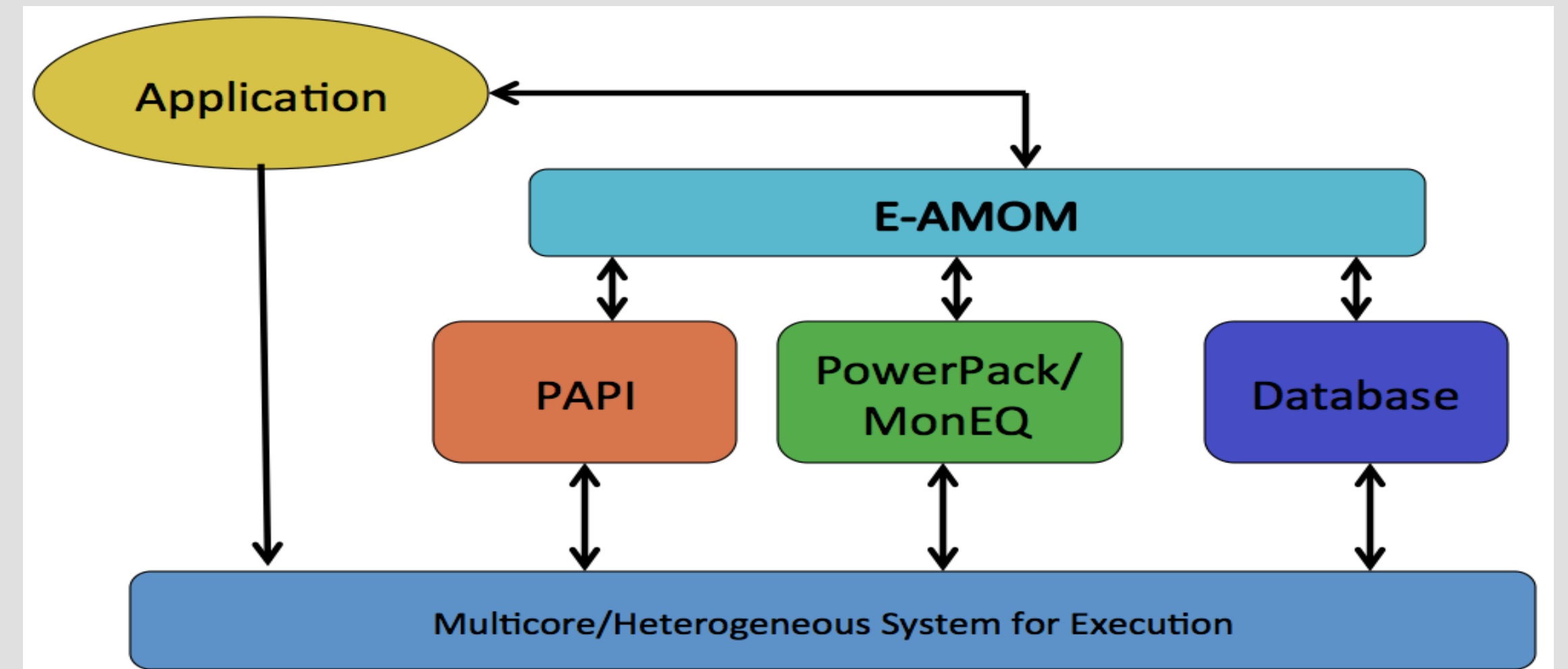


Goals

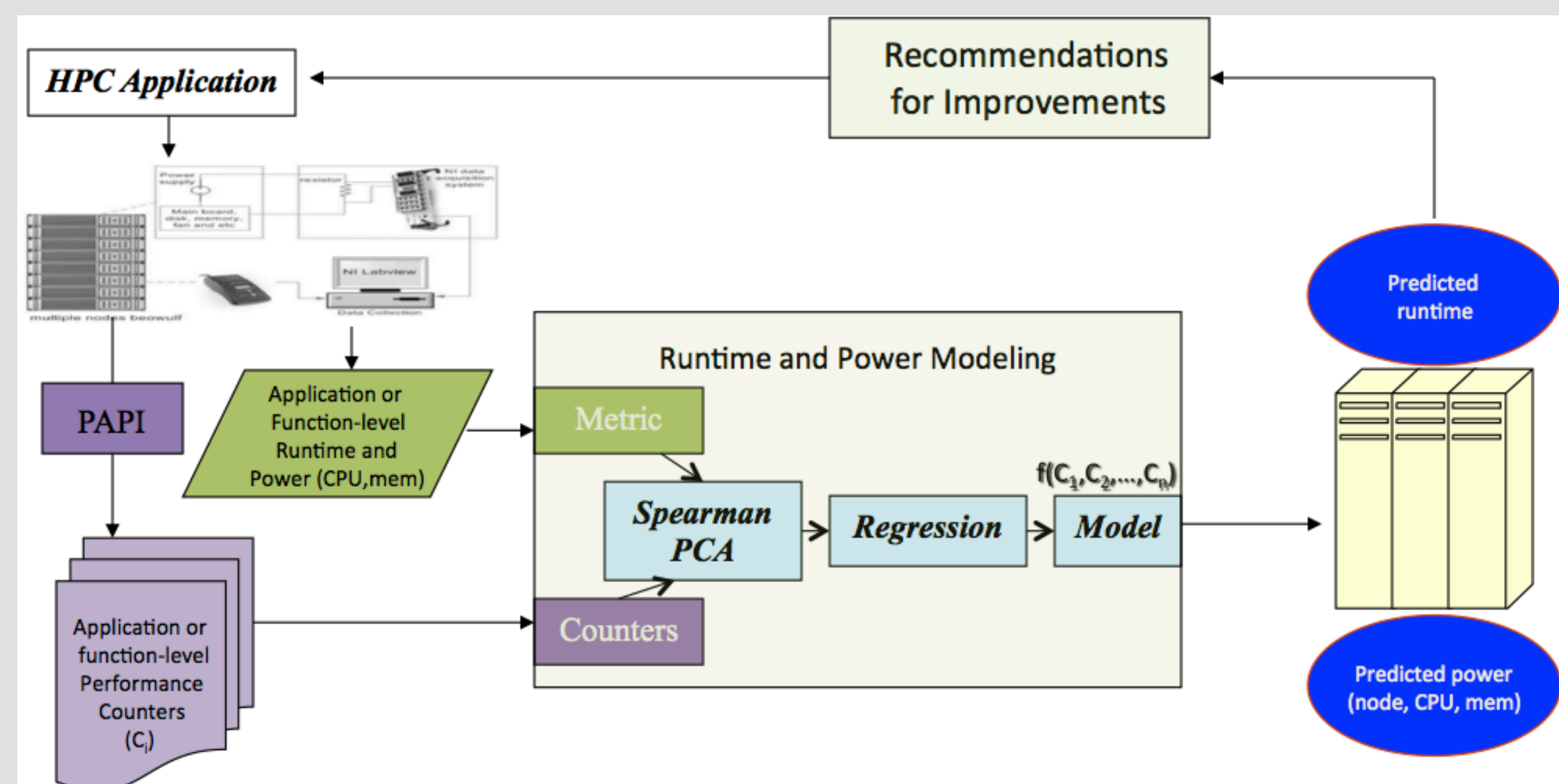
- **Goal:** To develop energy-efficient HPC applications, the MuMMI (Multiple Metrics Modeling Infrastructure) is used to model and optimize their energy and performance on power-aware HPC systems
- MuMMI facilitates systematic measurement, modeling, and prediction of performance and power consumption, and performance-power tradeoffs and optimization for power-aware HPC systems.
- In this work, we use the MuMMI to model and optimize energy and performance of a parallel aerospace application PMLB on two power-aware supercomputers ANL Mira and VT SystemG.

MuMMI Framework

- A multi-level infrastructure for integrated performance and power modeling for HPC systems



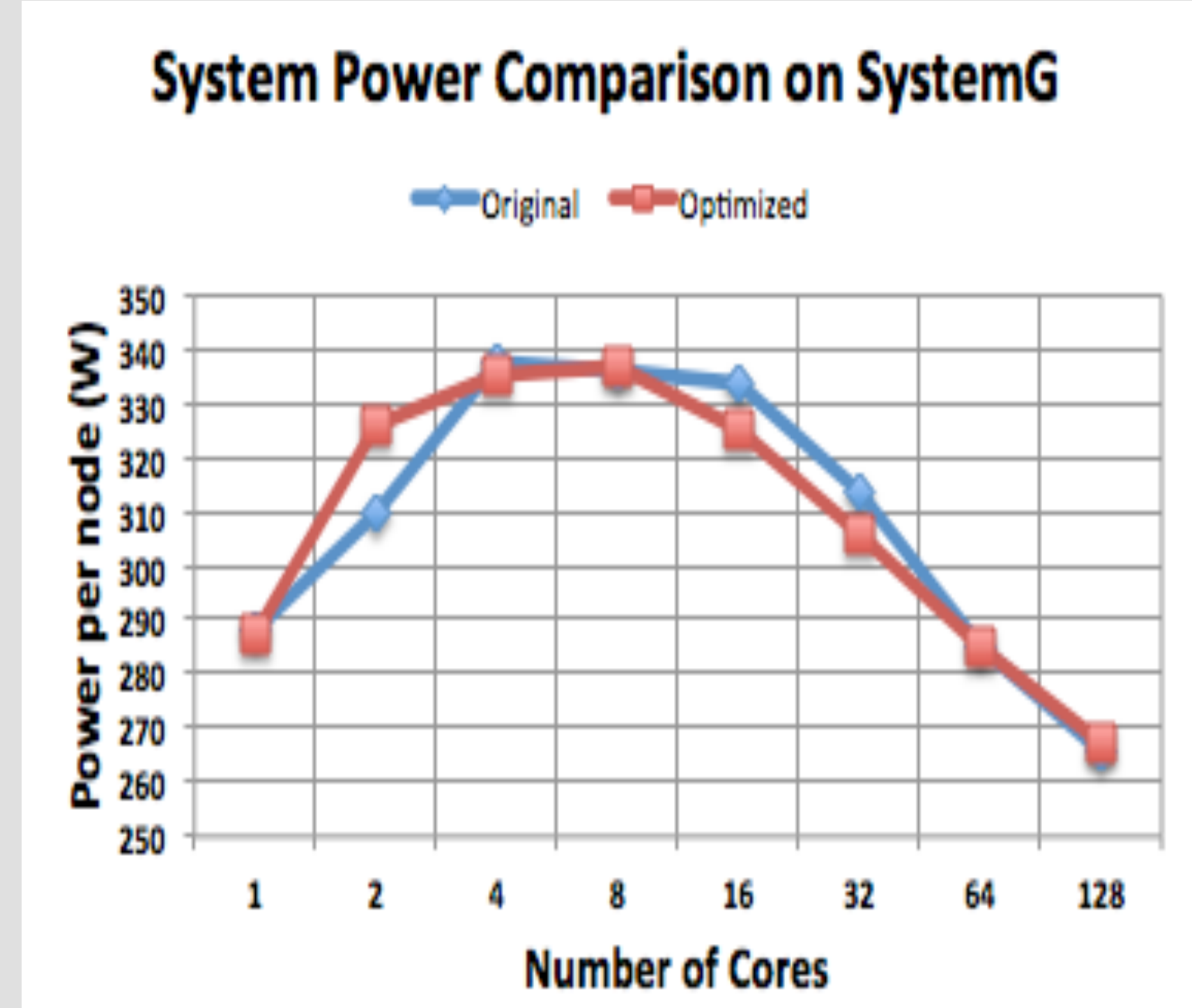
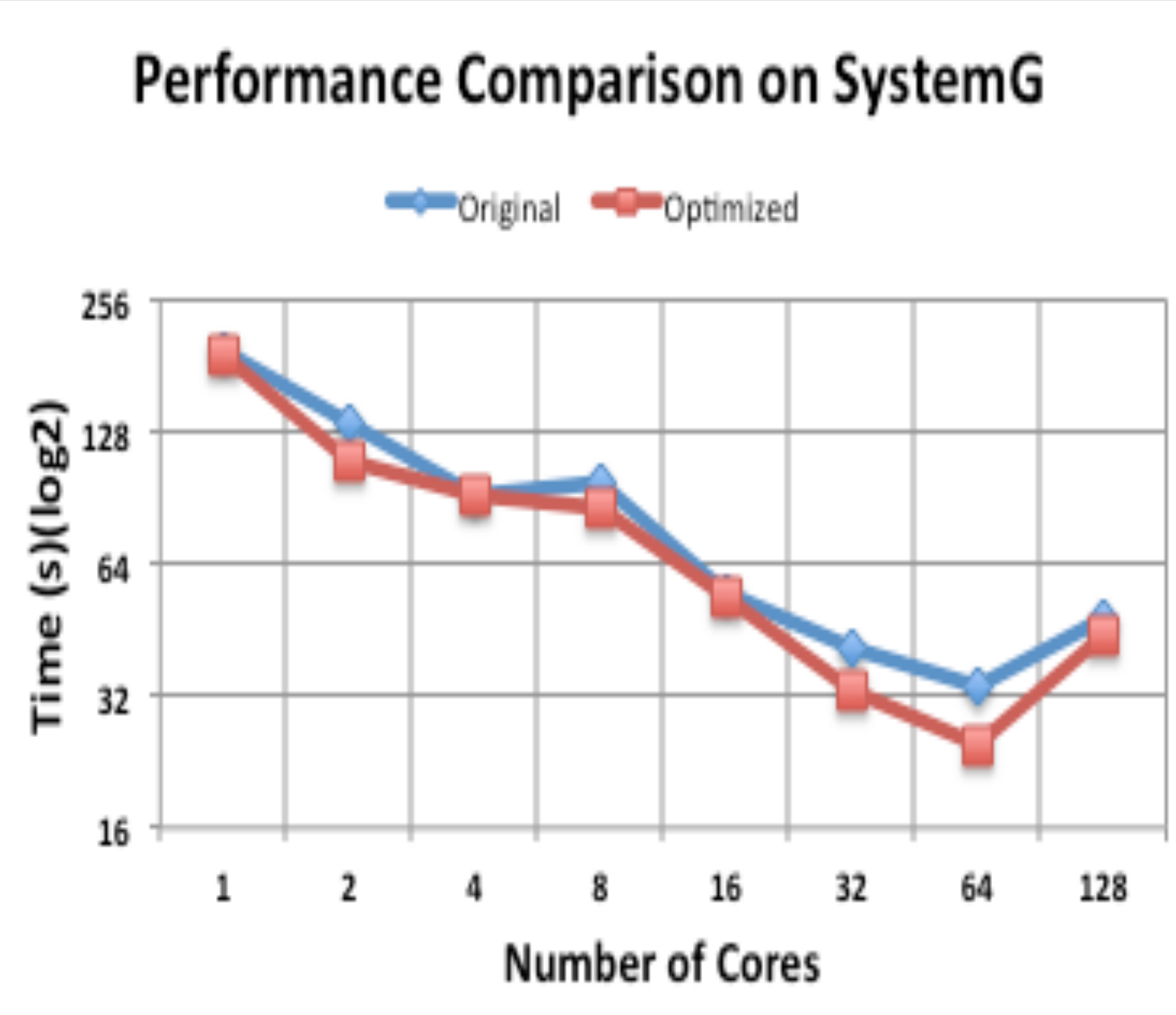
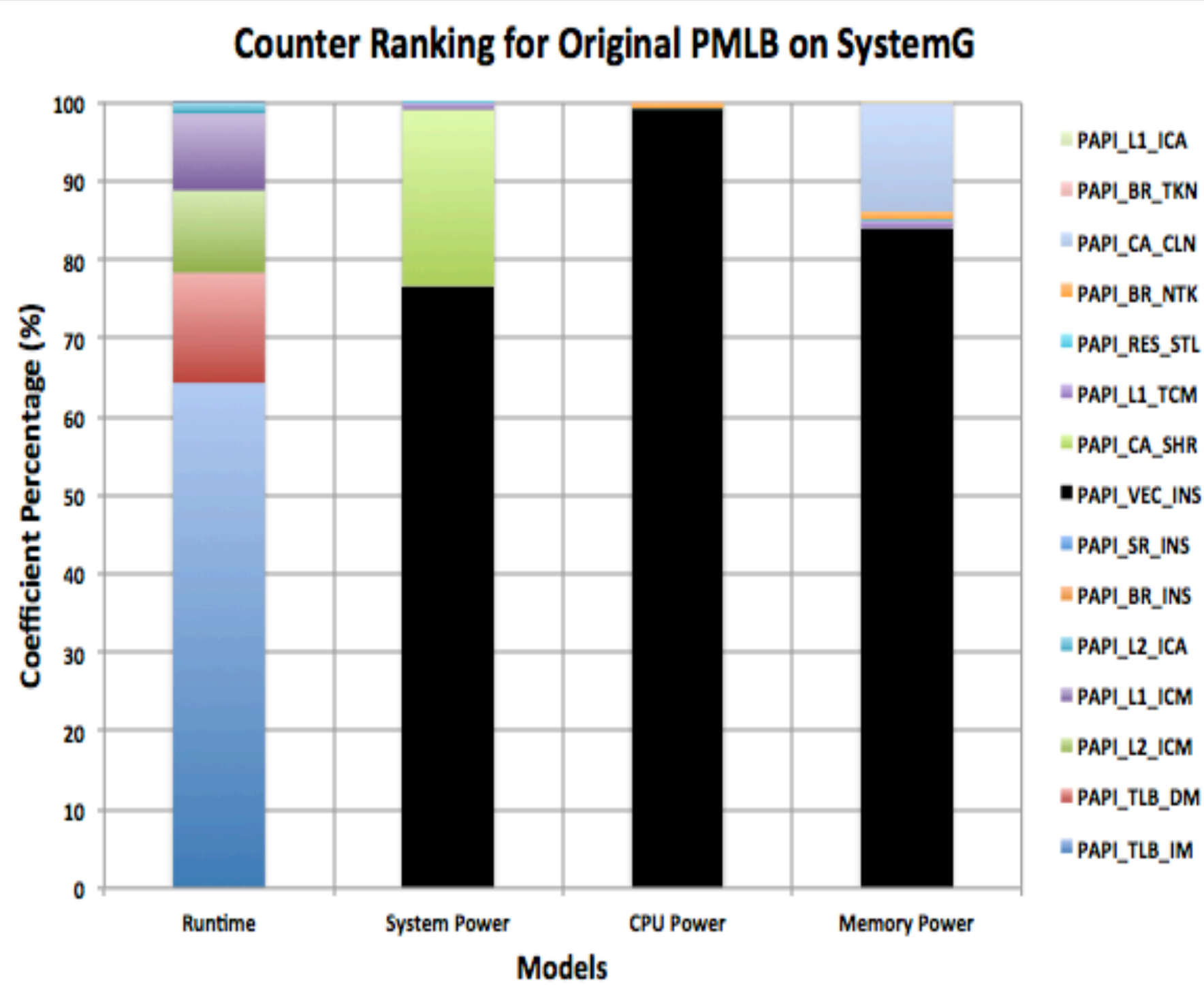
Modeling and Optimization Framework



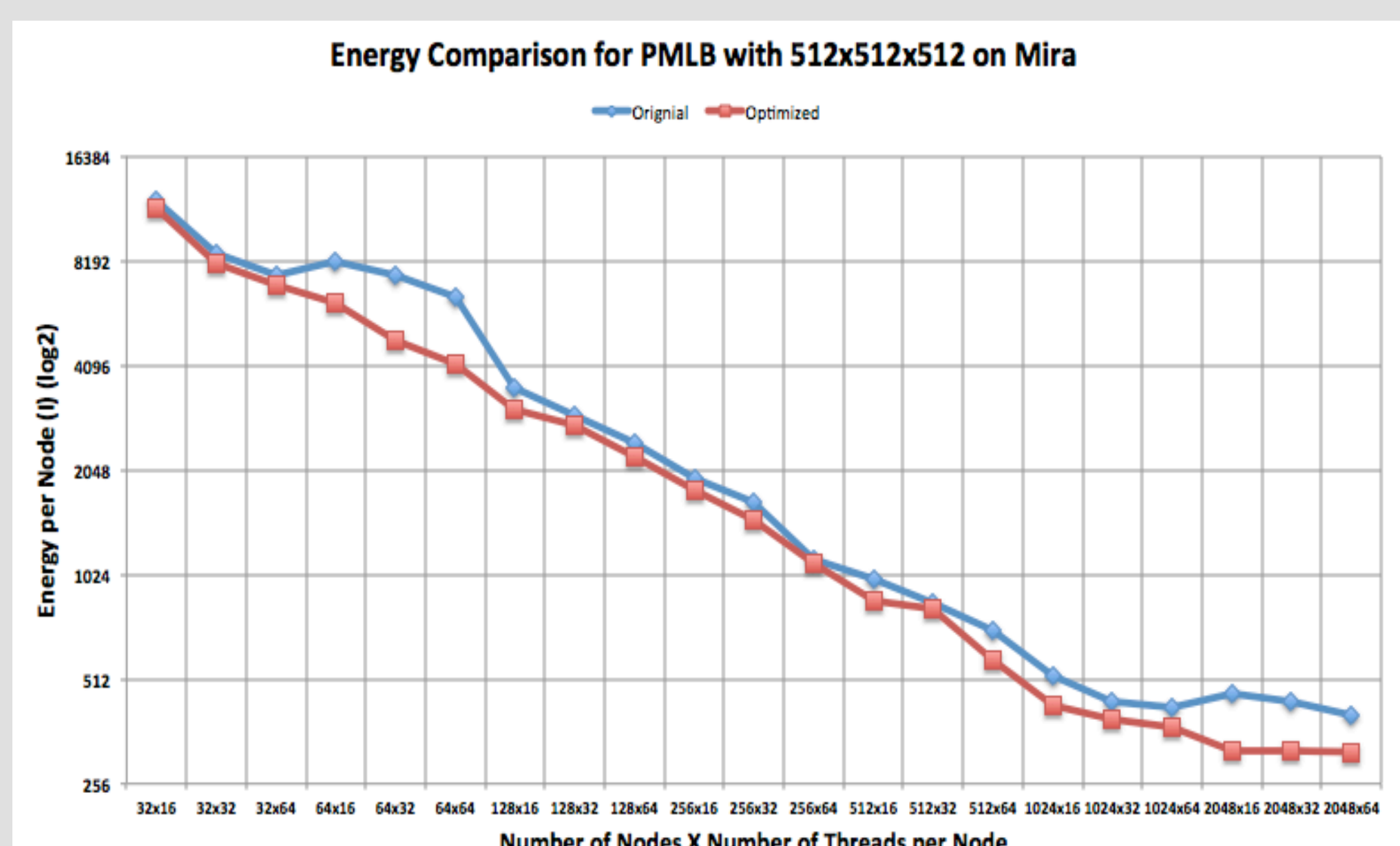
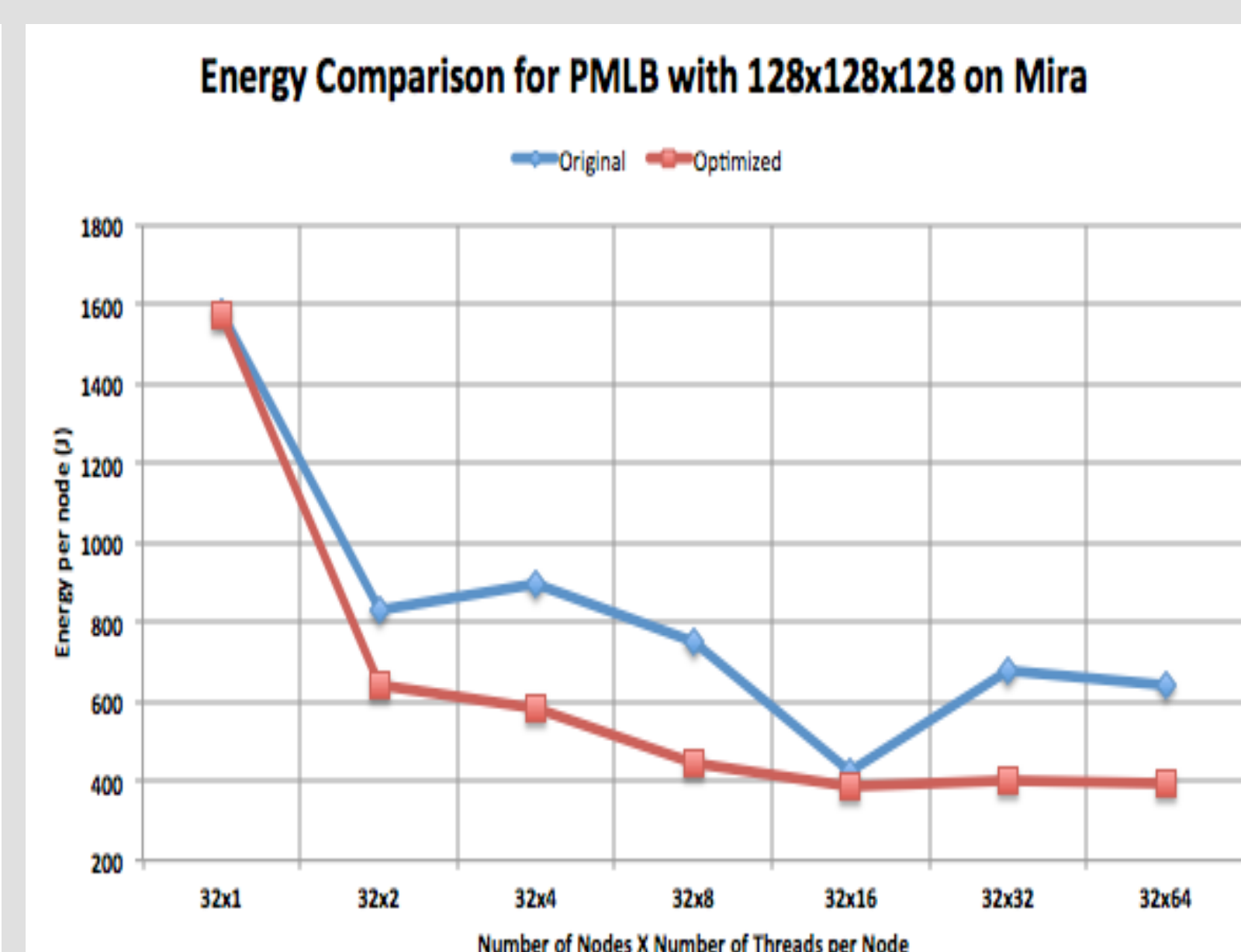
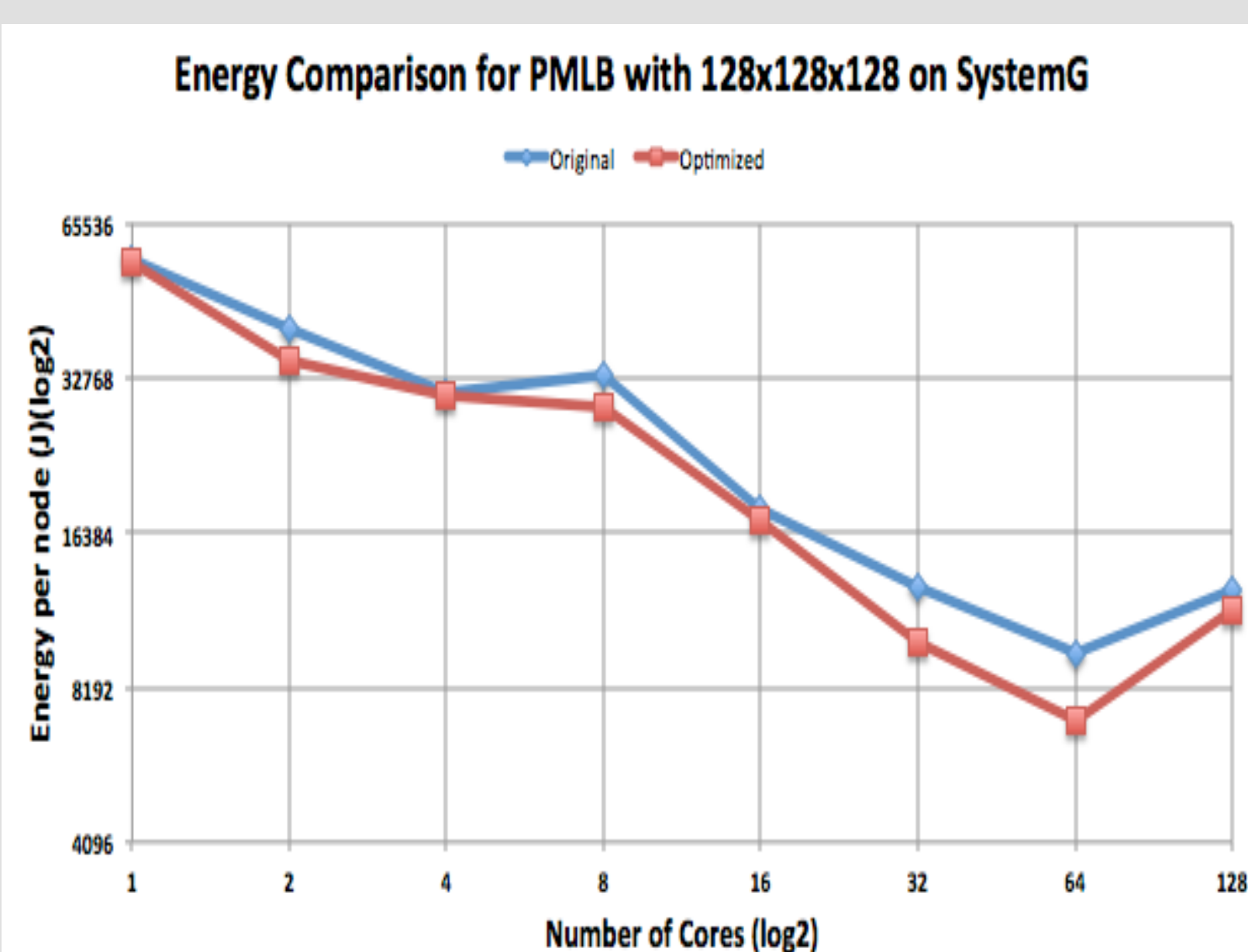
Performance and Power Modeling

Counter	runtime	power_sys	power_cpu	power_mem	Description
Frequency	8.2246952e-10	89.329321	27.833687	4.3234341	Frequency
PAPI_BR_INS	1.8608534e-09				Branch instructions
PAPI_BR_NTK			254.32896		Conditional branch instructions not taken
PAPI_BR_TKN				277.45349	Conditional branch instructions taken
PAPI_CA_CLN				46.534926	Requests for exclusive access to clean cache line
PAPI_CA_SHR		16756.774		3884.0169	Requests for exclusive access to shared cache line
PAPI_L1_ICA				30.367002	Level 1 instruction cache accesses
PAPI_L1_ICM	5.379613e-07				Level 1 instruction cache misses
PAPI_L1_TCM		662.96167			Level 1 cache misses
PAPI_L2_ICA	7.7252534e-08			260.02608	Level 2 instruction cache accesses
PAPI_L2_ICM	5.7886579e-07				Level 2 instruction cache misses
PAPI_RES_STL		18.2394	12.213562	50.475606	Cycles stalled on any resource
PAPI_RES_INS	2.6948407e-10				Store instructions
PAPI_TLB_DM	7.745783e-07				Data translation lookaside buffer misses
PAPI_TLB_IM	3.5487129e-06				Instruction translation lookaside buffer misses
PAPI_VEC_INS		57212.681	31269.201	23725.799	Vector/SIMD instructions (could include integer)

Performance Counter Ranking and Counter-guided Optimization



Energy Saving on Two Power-aware Systems



MuMMI website: <http://www.mummi.org>