Modeling Assertions: Symbolic Model Representation of Application Performance

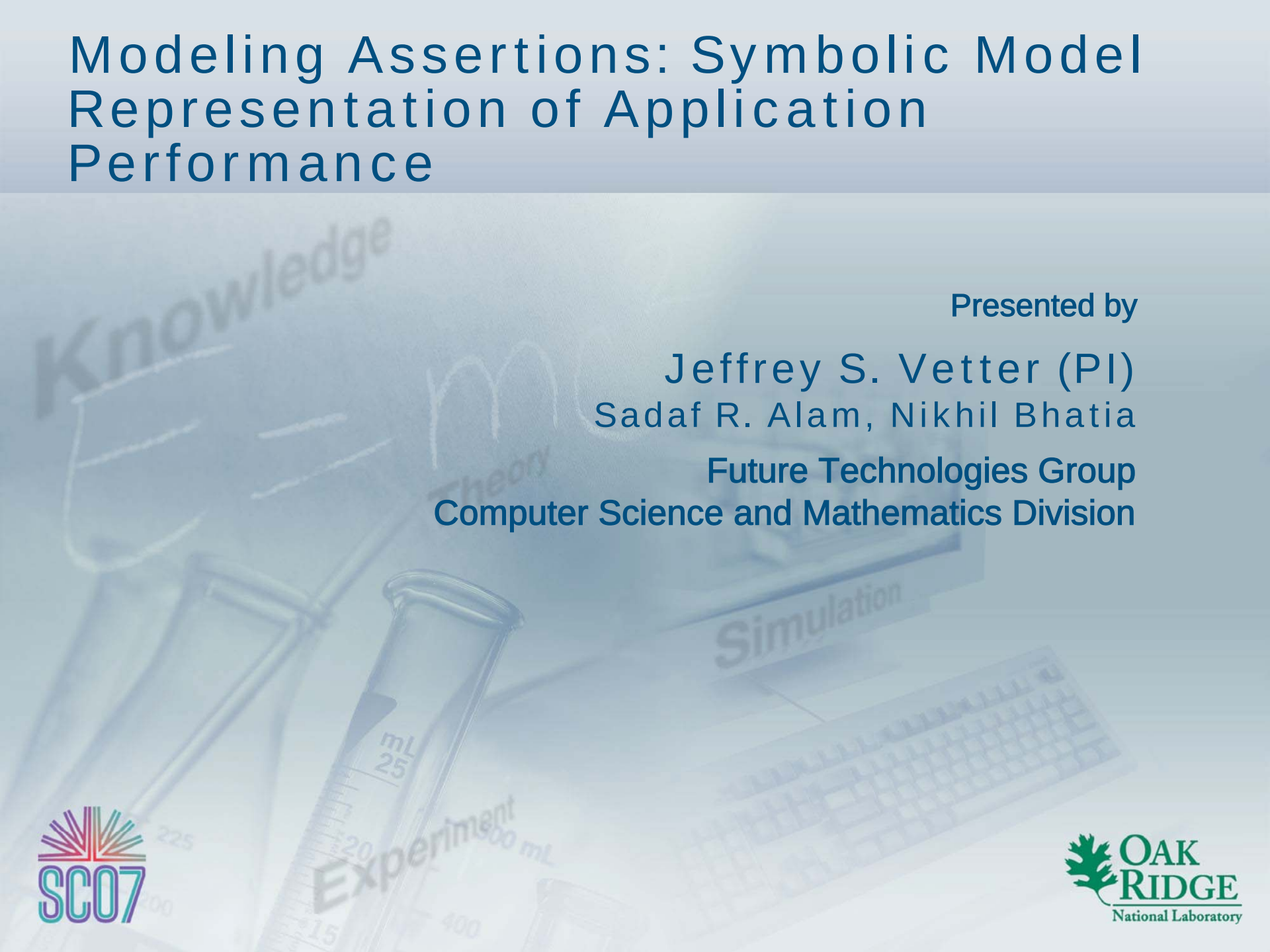
Presented by

Jeffrey S. Vetter (PI)

Sadaf R. Alam, Nikhil Bhatia

Future Technologies Group

Computer Science and Mathematics Division



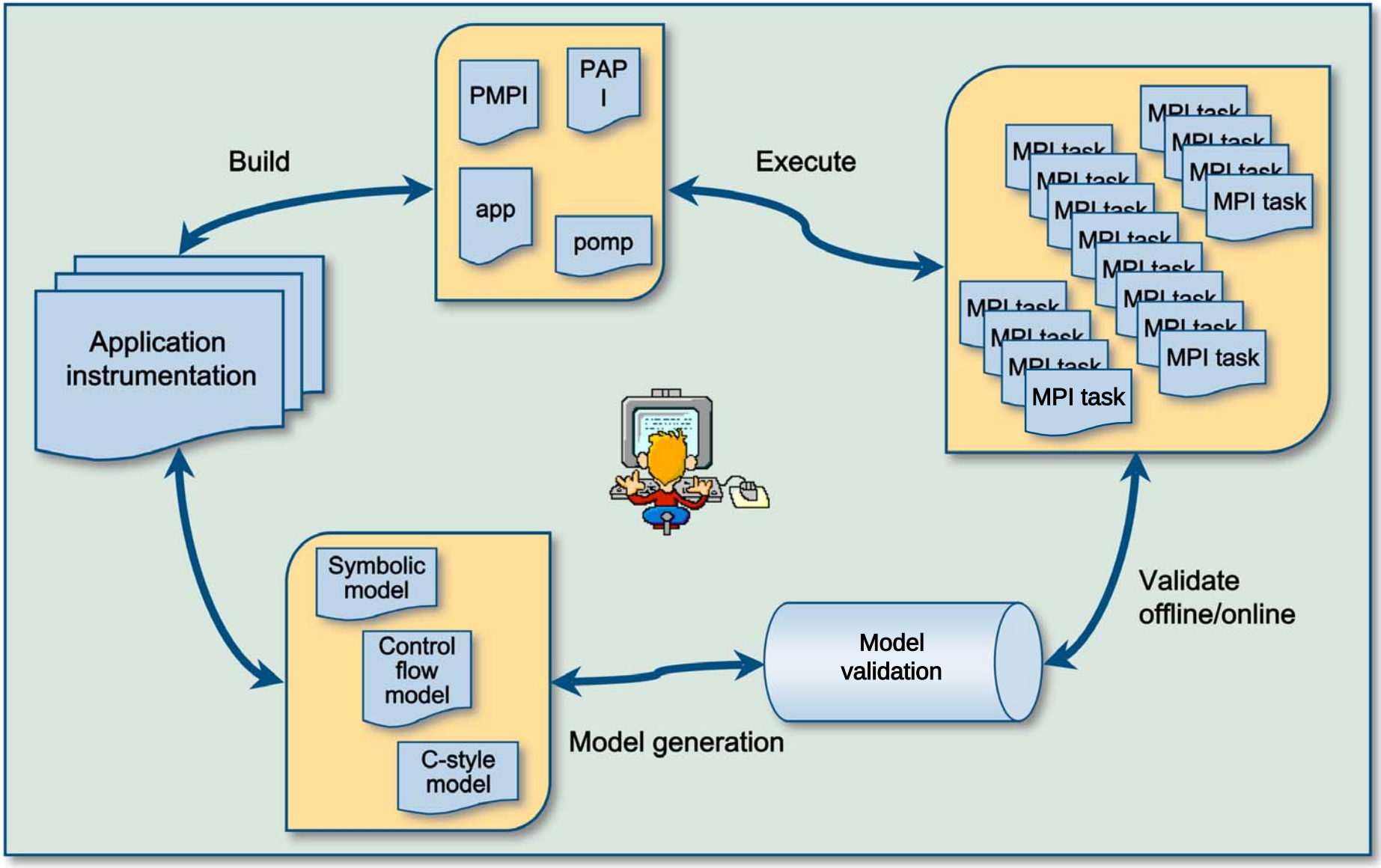
SC07

OAK RIDGE National Laboratory

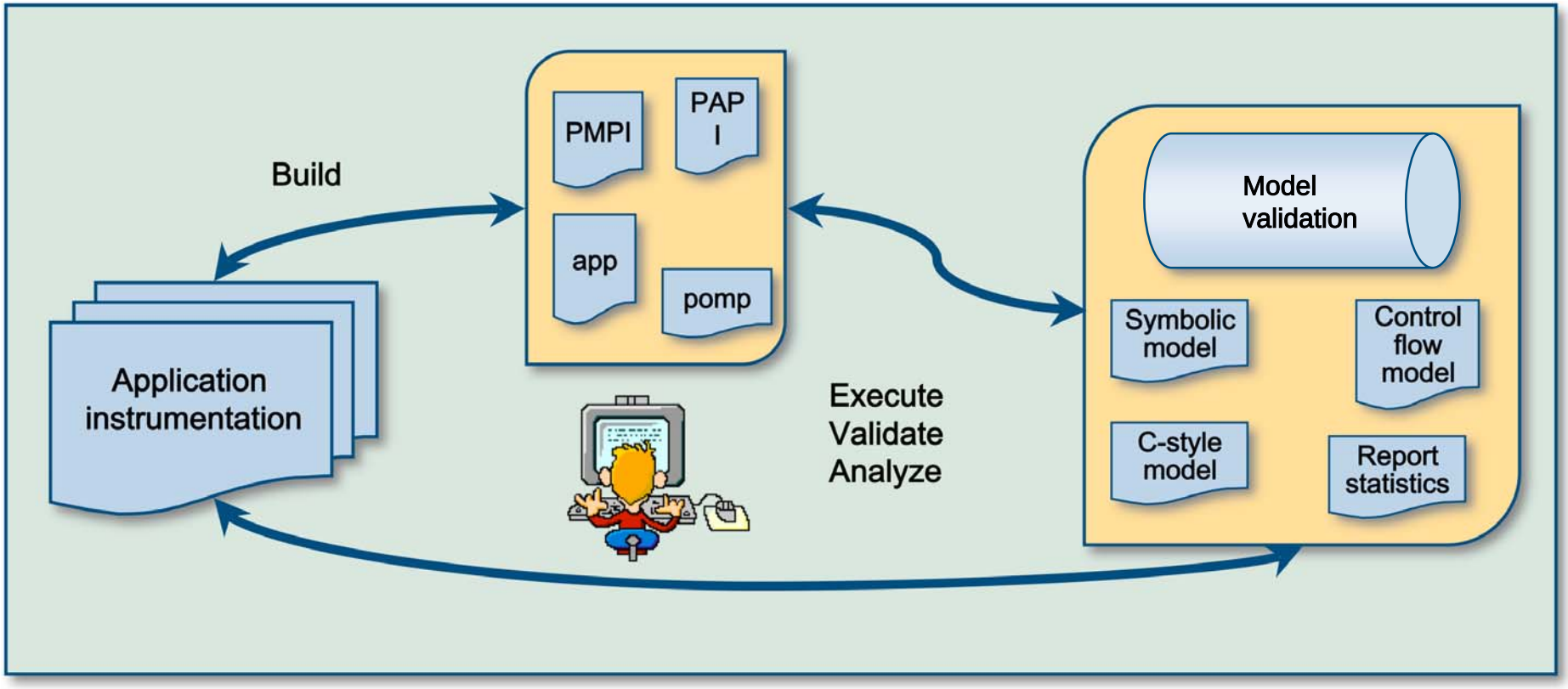
Modeling assertions

- What?
  - Portable and extensible workload and performance modeling framework
- Why?
  - Provide an integrated solution to develop, validate, and experiment with symbolic performance models of large-scale applications
  - Provide an efficient mechanism for sensitivity analysis and workload project growth rates for future problem and system configurations
- Components
  - A portable API for code annotation
  - Post-processing tools
  - Synthetic MPI trace generation with OTF compatible format

Modeling workflow



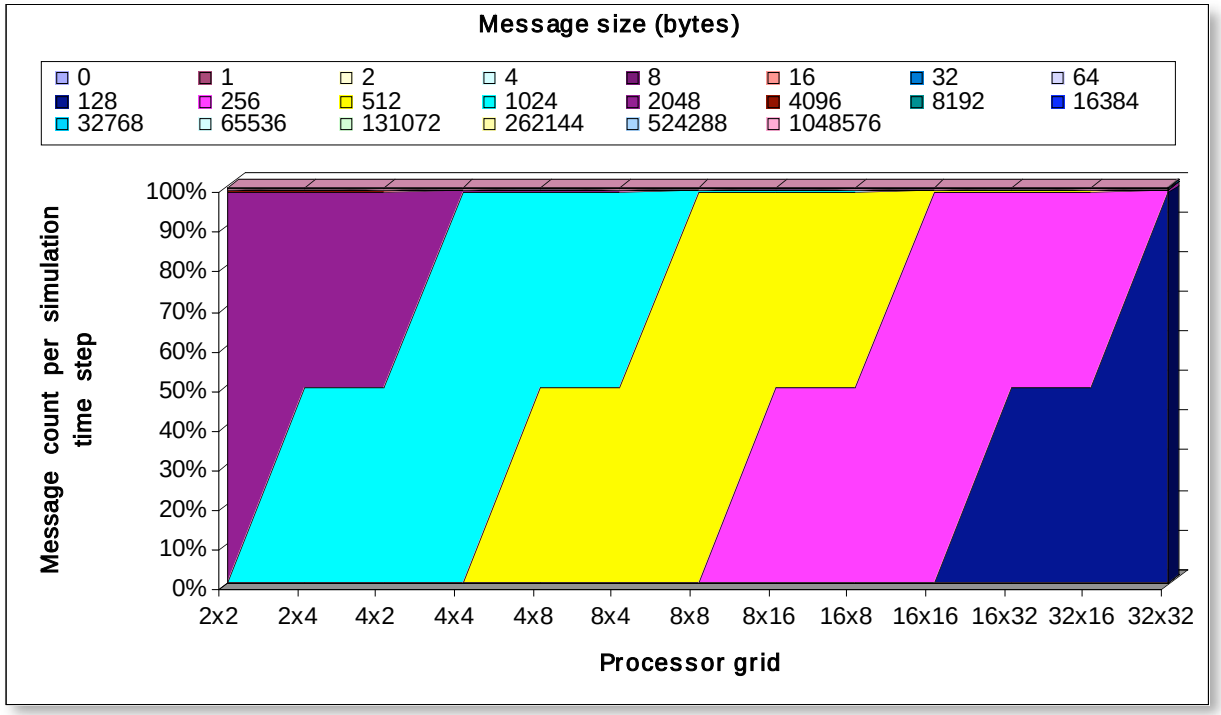
Toward an integrated framework



- Online validation, analysis and prediction
- Pragma-based instrumentation
- Realtime, efficient error reporting mechanisms

Sensitivity analysis of DOE applications

Goal: Identify workload sensitivity at scale before system and application deployment



Message size distribution in the key calculation phases as the MPI grid topology is scaled

Performance and scaling bottlenecks due to

- Application parameters
- System parameters

Modeling on emerging architectures

Goal: Investigate how performance-enhancing features of emerging architecture benefit scientific calculations

Incorporate "application aware" and "architecture aware" parameter in the model

$$T_v = T_{vm} + T_{vc} \qquad T_s = T_{sm} + T_{sc}$$

$$T_{vc} = \left(\frac{VFLOPS}{4.5GHz/18GHz} \right) \qquad T_{sc} = \left(\frac{SFLOPS}{0.565GHz/2.26GHz} \right)$$

$$T_{vm} = \left(\frac{(VLOADS + VSTORES)*8*64}{BW*10^9 * AVL} \right) \qquad T_{sm} = \left(\frac{(SLOADS + SSTORES)*8}{BW*10^9} \right)$$

Vector LS OPS

Vector FP OPS

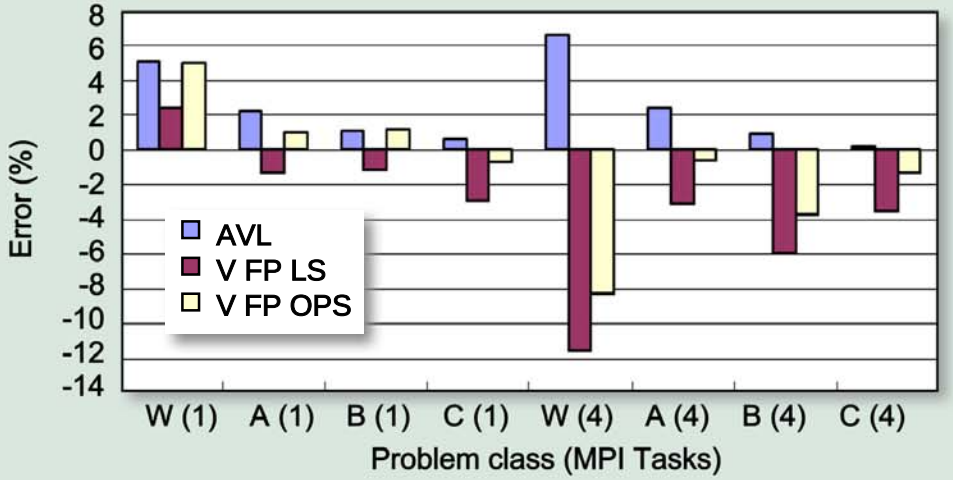
MVScore

AVL

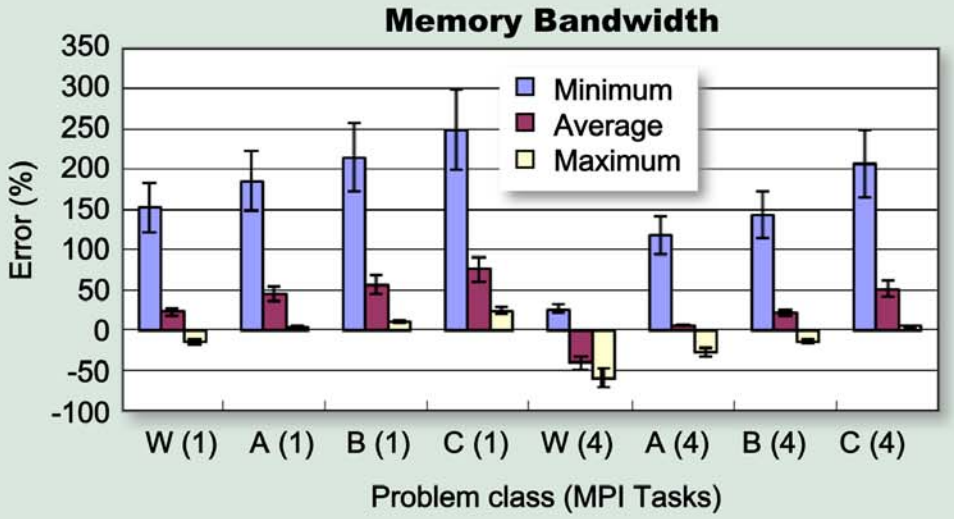
```
 23.                  call maf_vec_loop_start(1,"tzetar","size^2*(size-
1)*26", (size**2)*(size-1)*26," (size^2)*(size-1)*16", (size**2)*(size-
1)*16,"(size-1)/(size/64+1)", (size-1)/(size/64+1),3)
   24.  M-------<        do    k = start(3,c), cell_size(3,c)-end(3,c)-1
   25.  M 2-----<           do    j = start(2,c), cell_size(2,c)-end(2,c)-1
   26.  M 2 Vs--<              do    i = start(1,c), cell_size(1,c)-end(1,c)-1
   27.  M 2 Vs
```

Performance projections

- Average vector length prediction with different
  - Problem configurations
  - MPI task



- Experimented with memory bandwidth values: maximum (stream), minimum (random) and mean of max and min
- Performance prediction

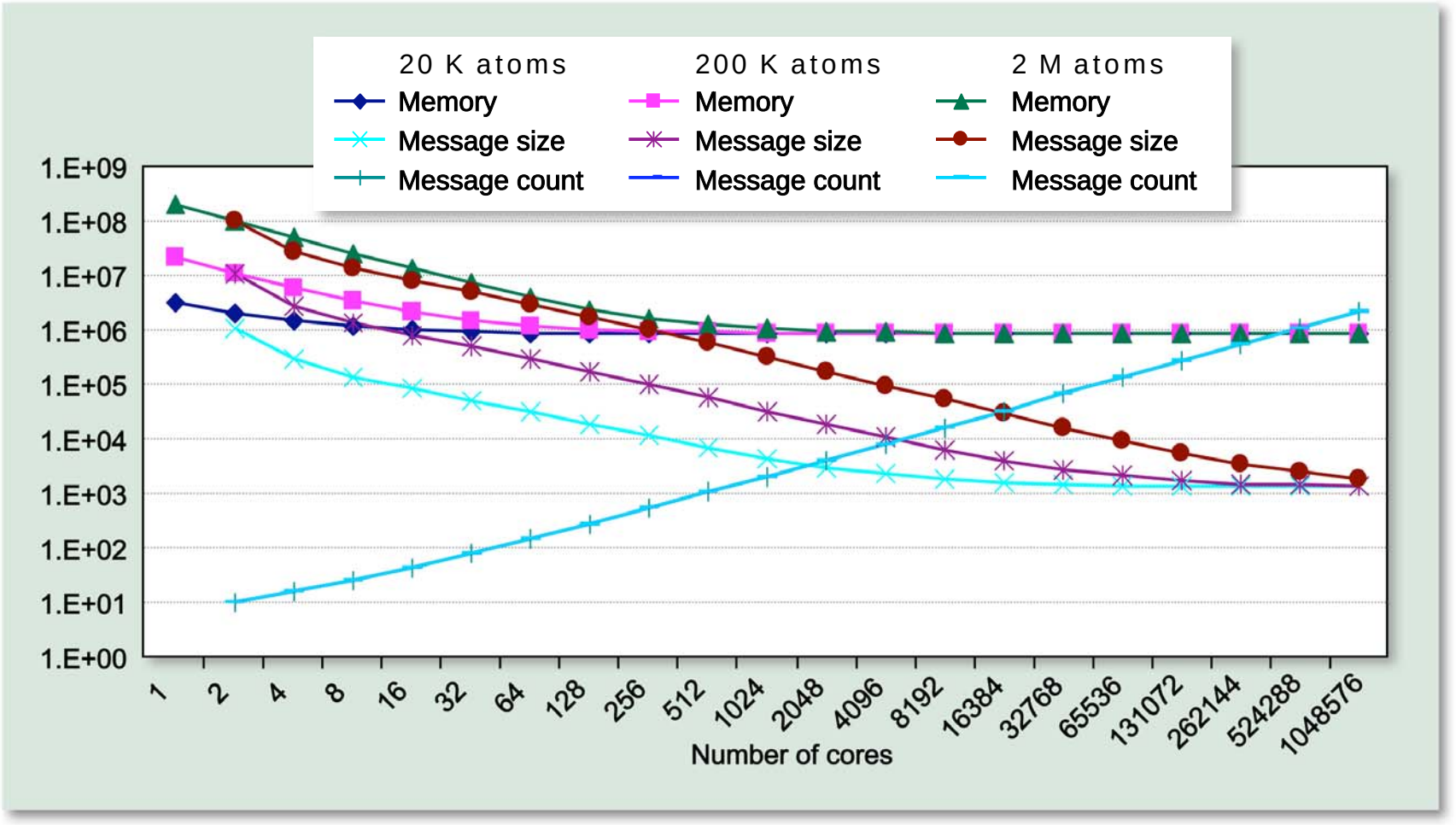


Synthetic trace file generation

Goal: Generate input traces for future problem and system configurations that do not exist

- Prototype for future network design at scale infeasible
  - Issues:
    - Realistic and representative workload for petascale and exascale systems.
    - Problem configurations; for example, input decks for petascale and exascale problems do not exist.
- Solution
  - Generate parameterized network models and traces to drive network simulators.
  - Support common MPI trace file formats like OTF.
  - Identify workload scaling behavior and patterns.
  - Investigate alternate algorithms and implementation.

Workload sensitivity results



Sensitivity analysis for workload requirements of the PME implementation in SANDER for petaflops scale systems

Contacts

Jeffrey S. Vetter

Principle Investigator
Future Technologies Group
Computer Science and Mathematics Division
(865) 356-1649
vetter@ornl.gov

Sadaf R. Alam

(865) 241-1533
alamsr@ornl.gov

Nikhil Bhatia

(865) 241-1535
bhatia@ornl.gov