Automatic Performance Tuning for Multicore Architectures

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Why Autotuning ?
my bias

Ultimate goal: Dynamic Optimization Support For Compilers and More

- Runtime decisions for compilers are necessary because compile-time decisions are too conservative
  - Insufficient information about program input, architecture
  - When to apply what transformation in which flavor?
  - Polaris compiler has some 200 switches

    Example of an important switch: parallelism threshold
  - Early runtime decisions:
    - Multi-version loops, runtime data-dependence test, 1980s
- My goals:
  - Looking for tuning parameters and evidence of performance difference
  - Go beyond the "usual": unrolling, blocking, reordering
  - Show performance on real programs

Is there Potential ?

You bet!

- Imagine you (the compiler) had full knowledge of input data and execution platform of the program

"Amdahl's law of dynamic optimization"

Early Results on Fully-Dynamic Adaptation

- ADAPT system (Michael Voss - 2000)
- Features:
  - Triage
    - tune the most deserving program sections first
  - Used remote compilation
    - Allowed standard compilers and all options to be used
  - AL - adapt language
- Issues:
  - Scalability to large number of optimizations
  - Shelter and re-tune

Recent Work

Offline Tuning - “Profile-time” tuning

Zhelong Pan

Challenges:

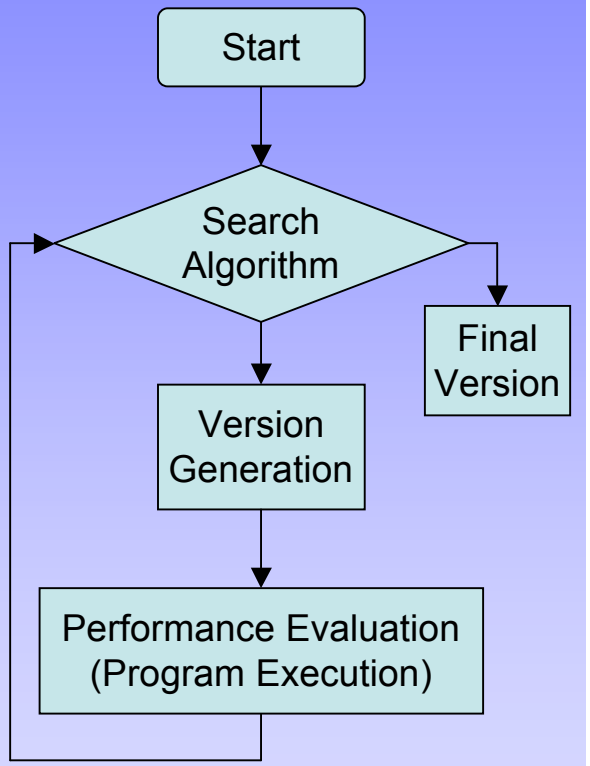
1. Explore the optimization space
   Empirical optimization algorithm - CGO 2006
2. Comparing performance
   Fair Rating methods - SC 2004
   - Comparing two (differently optimized) subroutine invocations
3. Choosing procedures as tuning candidates
   Tuning section selection - PACT 2006
   - Program partitioning into tuning sections

Two goals : increase program performance and reduce tuning time

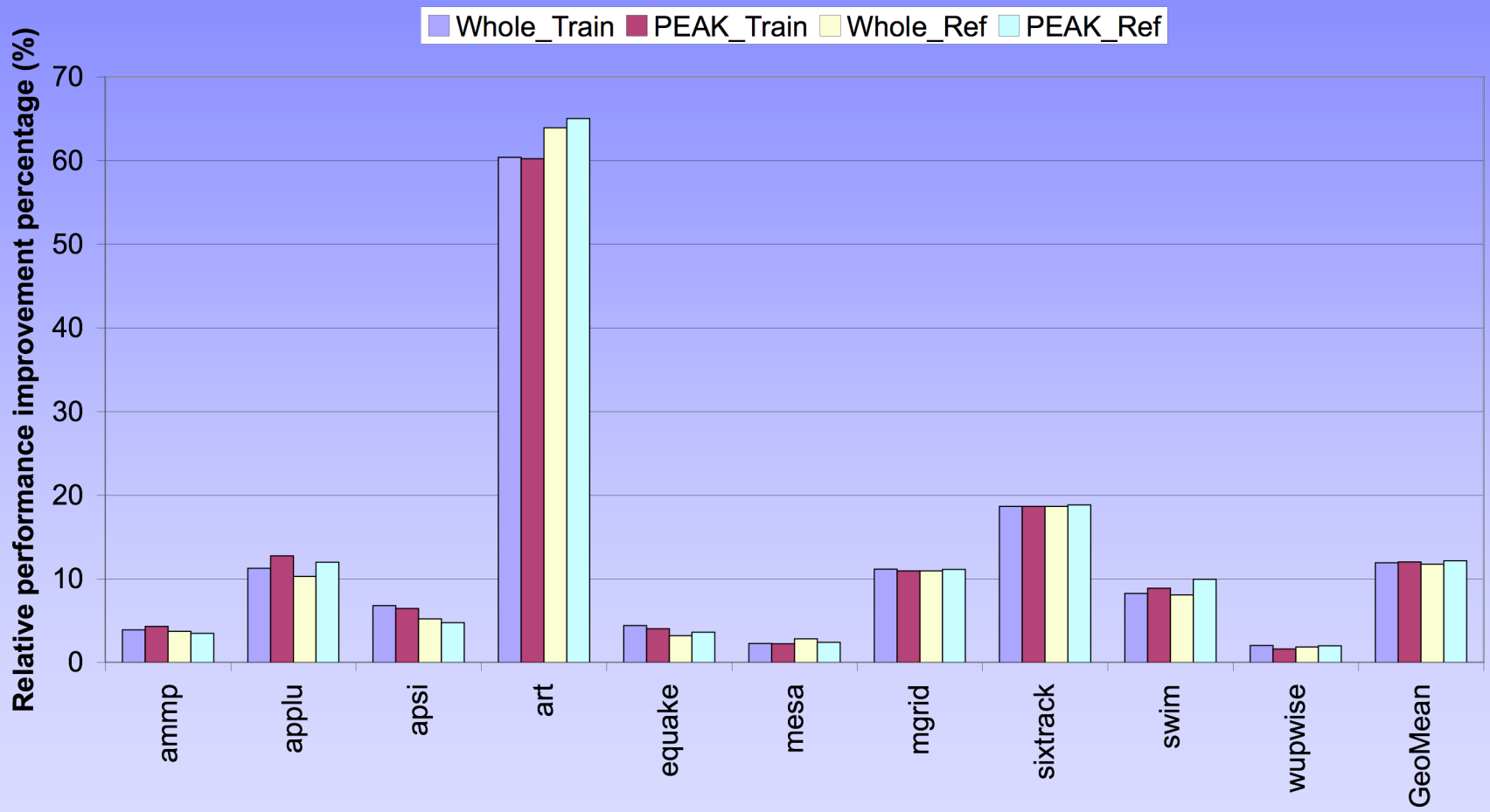
Whole-Program Tuning

Search Algorithms

- BE: batch elimination
  - Eliminates "bad" optimizations in a batch => fast
  - Does not consider interaction => not effective
- IE: iterative elimination
  - Eliminates one "bad" optimization at a time => slow
  - Considers interaction => effective
- **CE: combined elimination (final algorithm)**
  - **Eliminates a few "bad" optimizations at a time**
- Other algorithms
  - optimization space exploration, statistical selection, genetic algorithm, random search

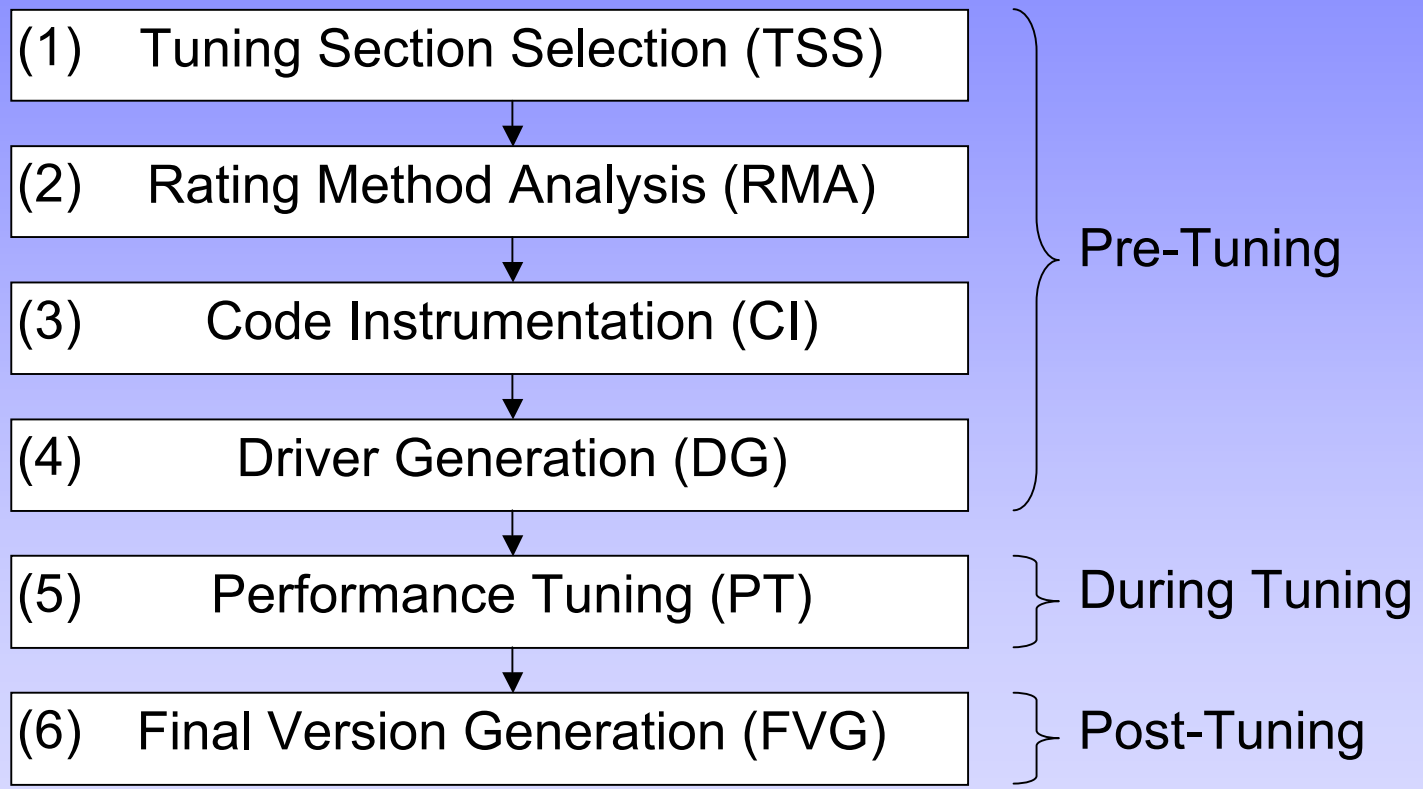


Performance Improvement

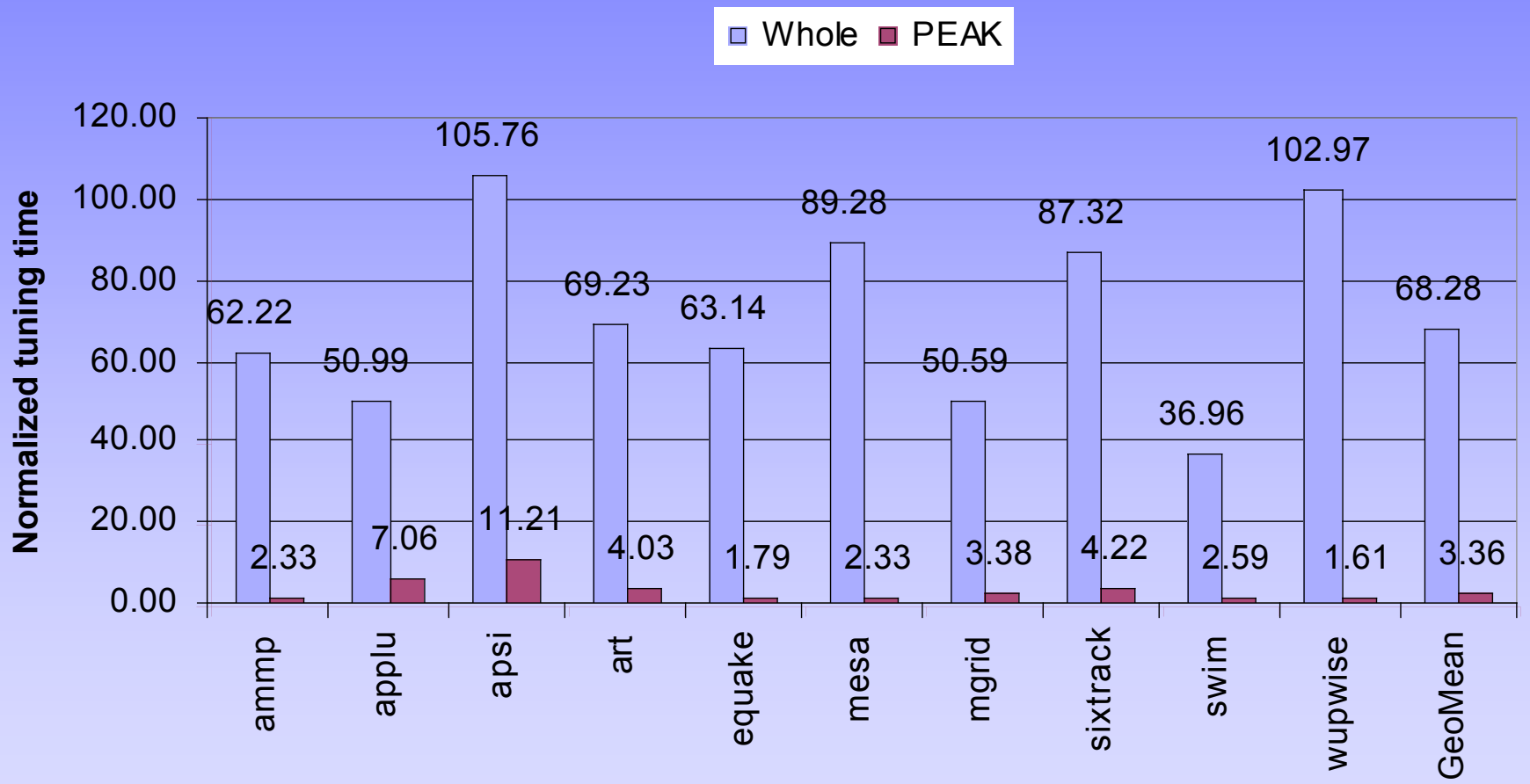


Tuning Goal: determine the best combination of GCC options

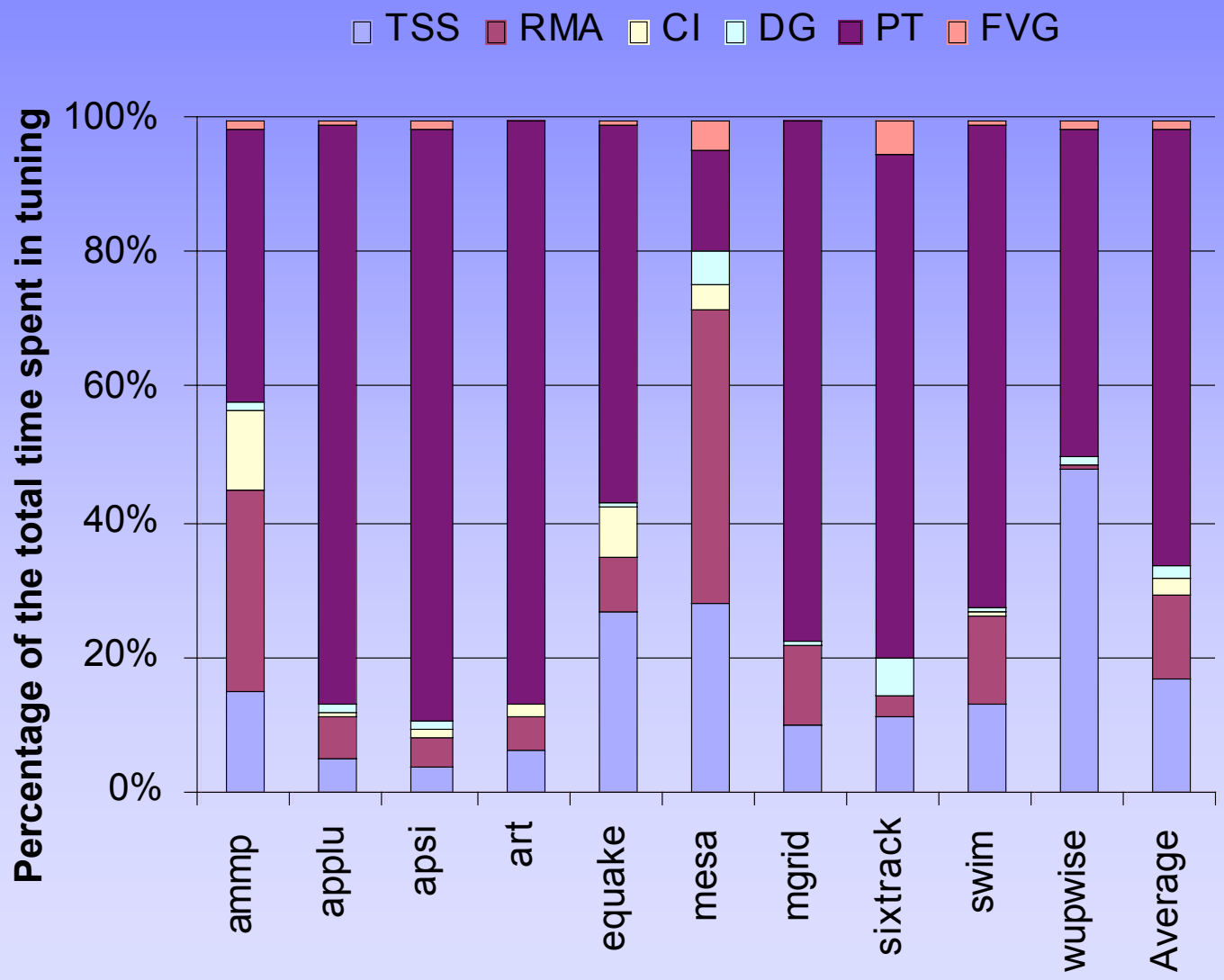
Tuning at the Procedure Level



Reduction of Tuning Time through Procedure-level Tuning



Tuning Time Components



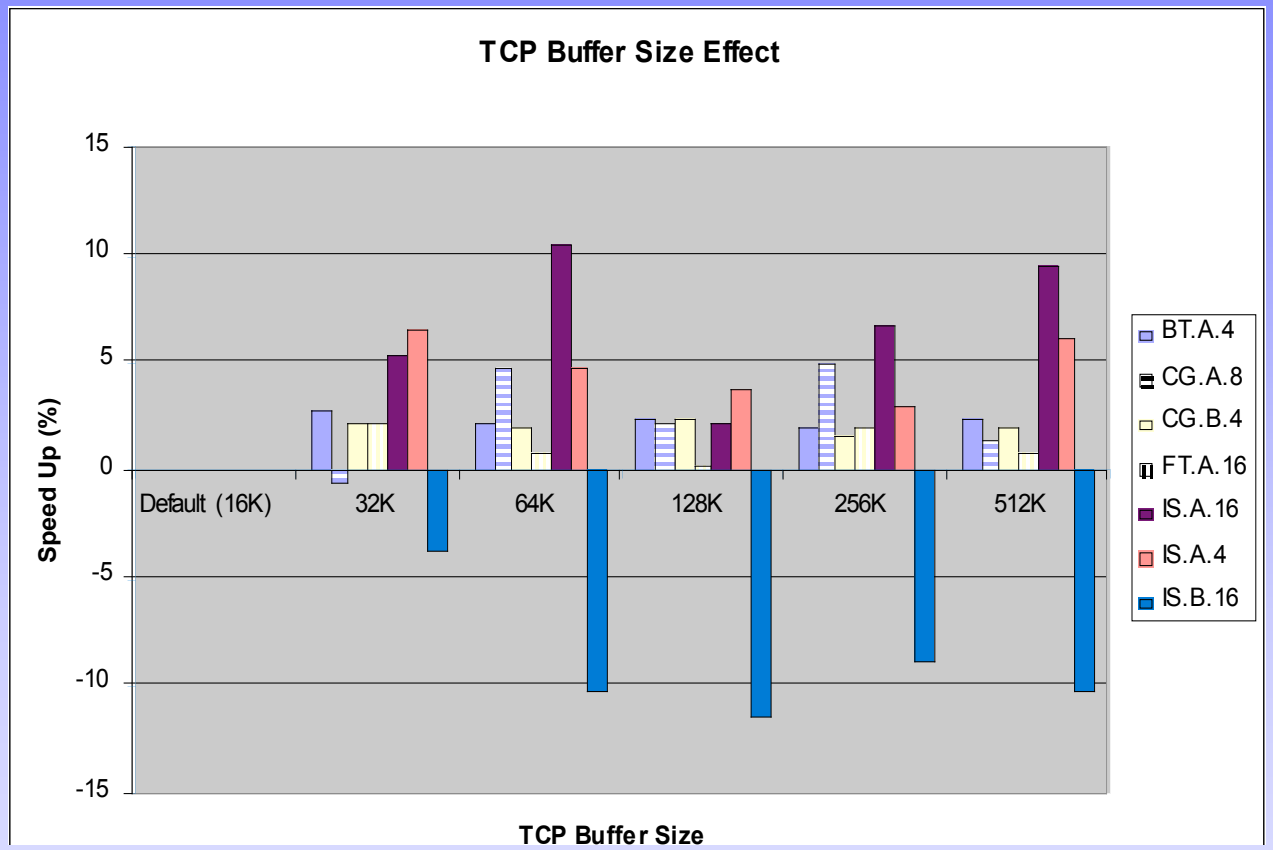
Ongoing Work

Seyong Lee

Beyond autotuning of compiler options

- New applications of the tuning system
  - MPI parameter tuning
  - Tuning library selection - (ScalaPack, ...)
  - OpenMP to MPI translator

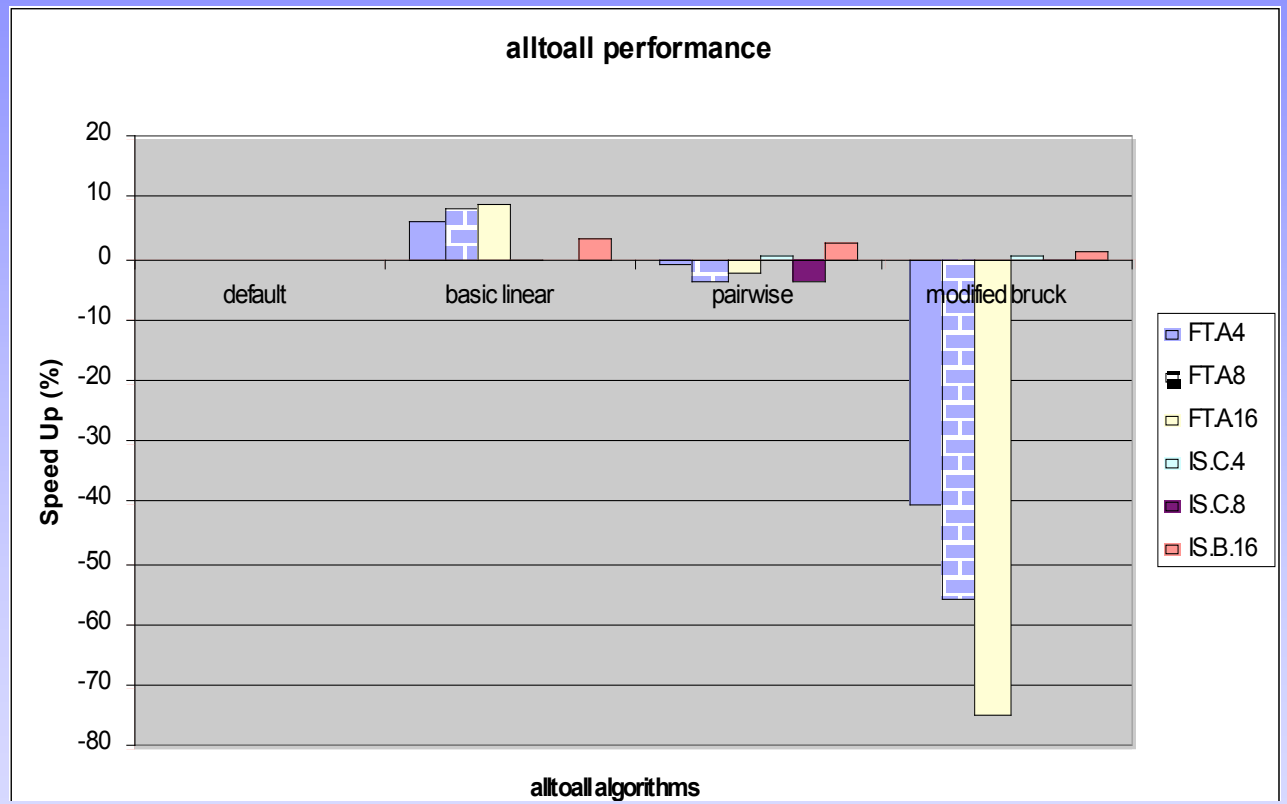
TCP Buffer Size Effect on NPB



Target system: Hamlet (Dell IA-32 P4 nodes) clusters in Purdue RAC

Used MPI: MPICH1

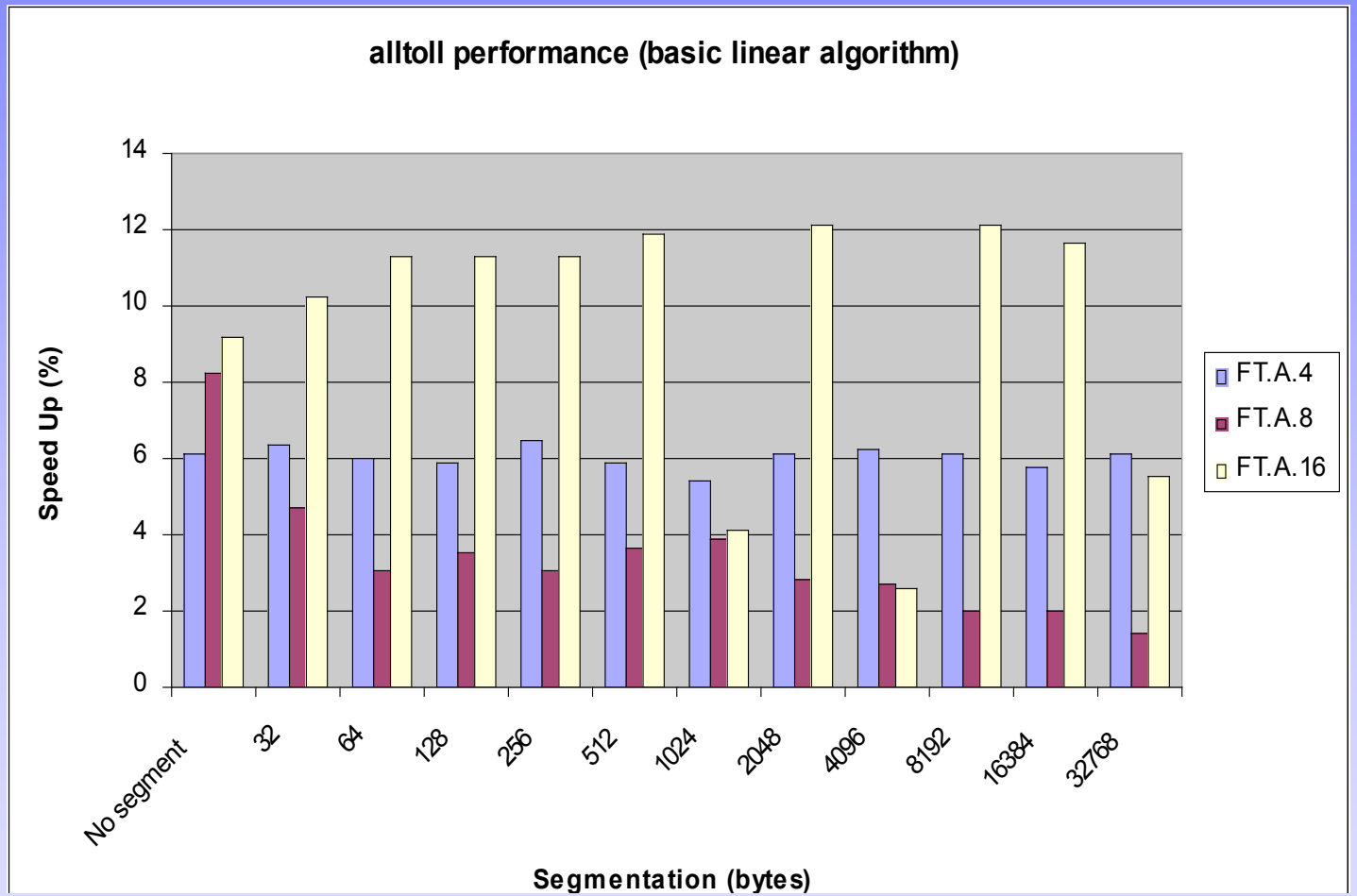
Alltoall collective call performance (without segmentation)



Target system: Hamlet (Dell IA-32 P4 nodes) clusters in Purdue RAC

Used MPI: Open MPI 1.2.2

Segmentation Effect on Basic Linear Alltoall Algorithm



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A Related Project

- Autotuning in iShare - an Internet Sharing System

Publish - Discover - Adapt

1. *Published autotuner (available)*
2. *Tuning upon matching discovered application and platform (current work)*

Automatic Tuning for Multicore

- Starting point was the Polaris compiler - 200 switches
- Early results on dynamic serialization
- Goal: parallelizing compiler that never lowers the performance of a program
- OpenMP to MPI translation
- Tuning NICA architectures
  - Multicore + niche capabilities (accelerators and more)

Conclusions and Discussion

Dynamic Adaptation is one of the most exciting research topics

There are still issues to Sink your Teeth in

- Runtime overhead: when to shelter/re-tune
- Fine-grain tuning
- Model-guided pruning of search space
- Architecture of an autotuner
  - If we could agree, we could plug-in our modules
- AutoAuto - autotuning autoparallelizer
- How to get order(s) of magnitude improvement
  - Wanted: tuning parameters and their performance effects