

SPEC OMP Benchmark Suite

H. Saito, G. Gaertner, W. Jones, R. Eigenmann,
H. Iwashita, R. Lieberman, M. van Waveren,
and B. Whitney

SPEC High-Performance Group

Structure of talk

- Description of SPEC OMP Benchmarks
- Scalability of SPEC OMP Benchmarks
- Conclusion

SPEC OMP

- Benchmark suite developed by SPEC HPG (High Performance Group)
- Benchmark suite for performance testing of shared memory processor systems
- Uses OpenMP versions of SPEC CPU2000 benchmarks and candidates

Why Did SPEC Choose OpenMP?

- Benchmark suite is focused on SMP systems
- OpenMP is a standard, and is applicable to Fortran, C, and C++.
- Directive based OpenMP allows serial version to remain largely intact.
- Quickest path to parallel code conversion.

OMP/CPU2000 Differences

- Larger working set sizes, 1.6GB for OMPM2001, 6.5 GB for OMPL2001; it is 200MB for CPU2000
- Longer run times (>1000 s/cpu for CPU2000 vs >10,000 s/cpu for OMP2000 medium)
- Focus on SMP systems, and issued by HPG
- SPEC OMP based on work for CPU2000, SPEC OMP mixes integer and FP in one suite

OMP/CPU2000 Similarities

- Same tools used to run the benchmarks
- Similar run and reporting rules
- Uses geometric mean to calculate overall performance relative to a baseline system
- Similar output format

OMP vs CPU2000

Characteristic	CPU2000	OMPM2001	OMPL2001
Max. working set	200 MB	1.6 GB	6.5 GB
Memory needed	256 MB	2 GB	8 GB
Benchmark runtime	30 min @ 300 MHz	5 hrs @ 300 MHz	9 hrs @ 300 MHz
Language	C, C++, F77, F90	C, F90, OpenMP	C, F90, OpenMP
Focus	Single CPU	< 16 CPU system	> 16 CPU system
System type	Cheap desktop	MP workstation	Engineering MP sys
Runtime	24 hours	34 hours	75 hours
Runtime 1 CPU	24 hours	140 hours	1000 hours
Run modes	Single and rate	Parallel	Parallel
Number benchmarks	26	11	9
Iterations	Median 3 or more	Worst of 2, median of 3	or more
Source mods	Not allowed	Allowed	Allowed
Baseline flags	Max of 4	Any, same for all	Any, same for all
Reference system	1 CPU @ 300 MHz	4 CPU @ 350 MHz	16 CPU @ 300 MHz

SPEC OMP Benchmark Principles

- Source code based
- Limited code and directive modifications
- Focused on SMP performance
- Requires a base run
 - with no source modifications
 - single set of compiler flags for all benchmarks
- SPEC supplied tools required to run benchmark

OMP2001 Benchmarks

Medium	Benchmark	Lang	What it does
310.wupwise_r	310.wupwise_m	F90	SU(3) HE physics
312.swim_m	312.swim_m	F90	Shallow water model
314.mgrid_m	314.mgrid_m	F90	Multigrid for EM pro
316.applu_m	316.applu_m	F90	Fluid dynamics part
318.galgel_m	318.galgel_m	F90	Fluid dynamics, Ga
320.equake_m	320.equake_m	C	Earthquake dynami
324.apsi_m	324.apsi_m	F90	Lake weather mode
326.gafort_m	326.gafort_m	F90	Genetic algorithm
328.fma3d_m	328.fma3d_m	F90	Finite element mech
330.art_m	330.art_m	C	Image recognition
332.ammp_m	332.ammp_m	C	Molecular dynamics

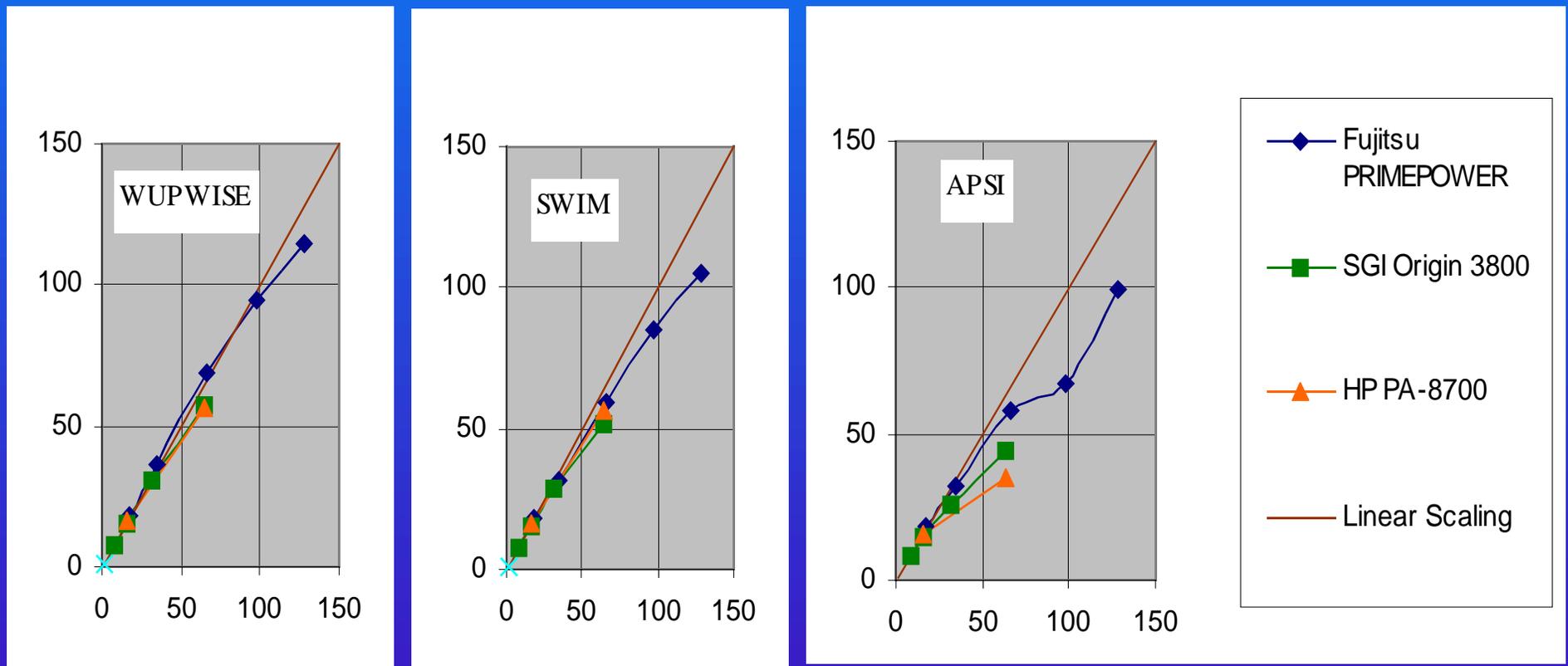
SPEC OMP Benchmark Reference Runtimes

		OMPM2001	OMPL2001
wupwise	F90	6000	9200
swim	F90	6000	12500
mgrid	F90	7300	13500
applu	F90	4000	14500
galgel	F90	5100	
equake	C	2600	13000
apsi	F90	3400	11500
gafort	F90	8700	11000
fma3d	F90	4600	23500
art	C	6400	22000
ammp	C	7000	
Total		61100	130700
Hours*2		34	73
Reference Machine		4 CPU @ 350 MHz	16 CPU @ 350 MHz

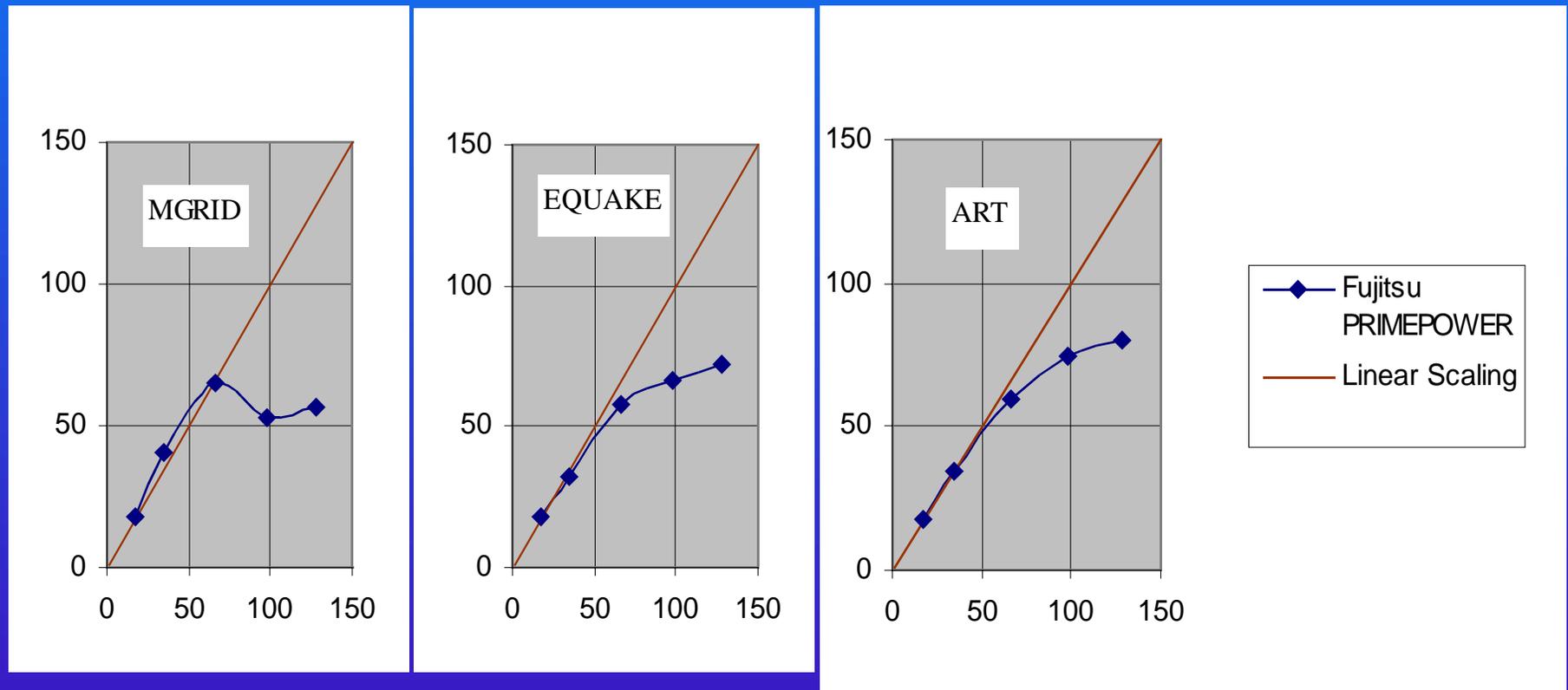
Program Memory Footprints

	OMPM2001 (Mbytes)	OMPL2001 (Mbytes)
wupwise	1480	5280
swim	1580	6490
mgrid	450	3490
applu	1510	6450
galgel	370	
equake	860	5660
apsi	1650	5030
gafort	1680	1700
fma3d	1020	5210
art	2760	10670
ammp	160	

Benchmarks with good scaling

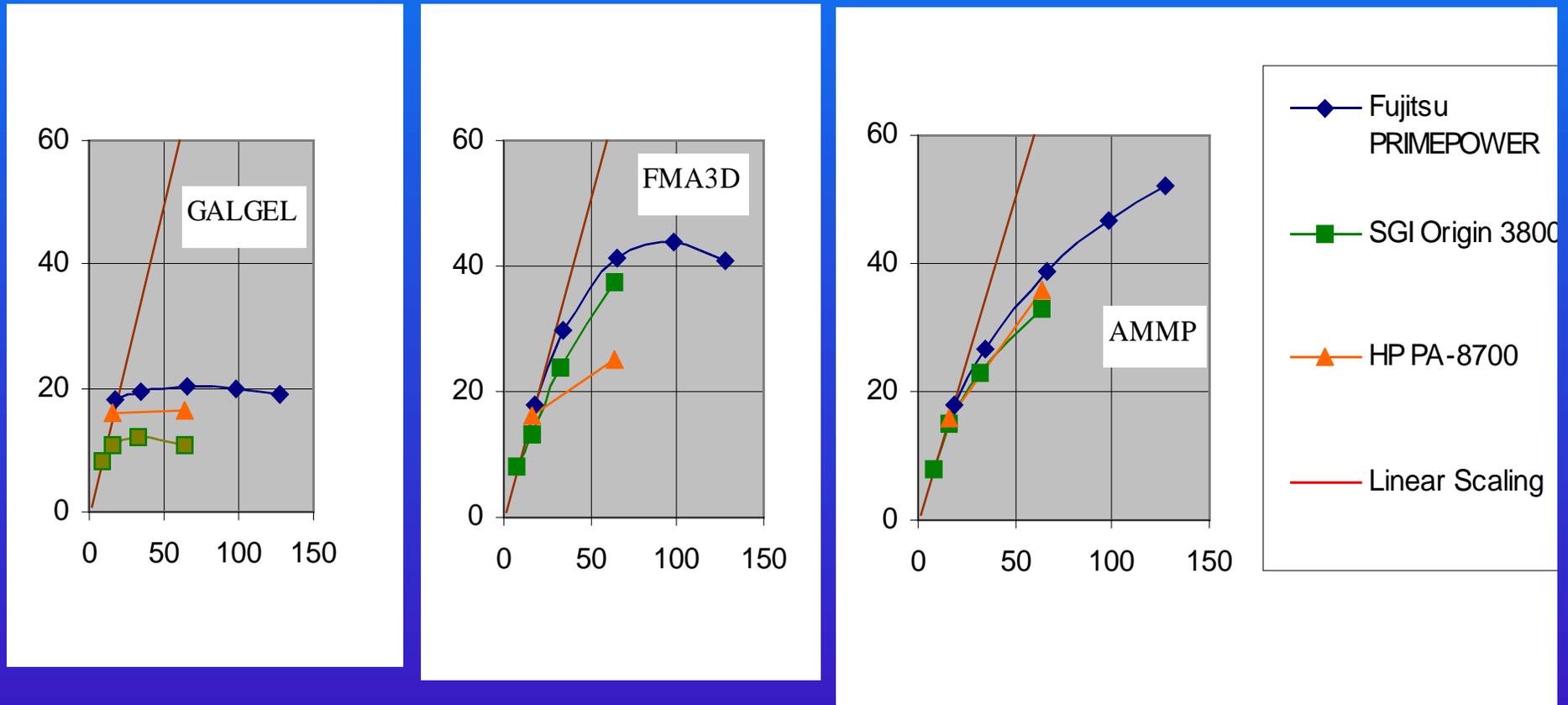


Benchmarks with good scaling up to 64 CPUs



Benchmarks with superlinear scaling

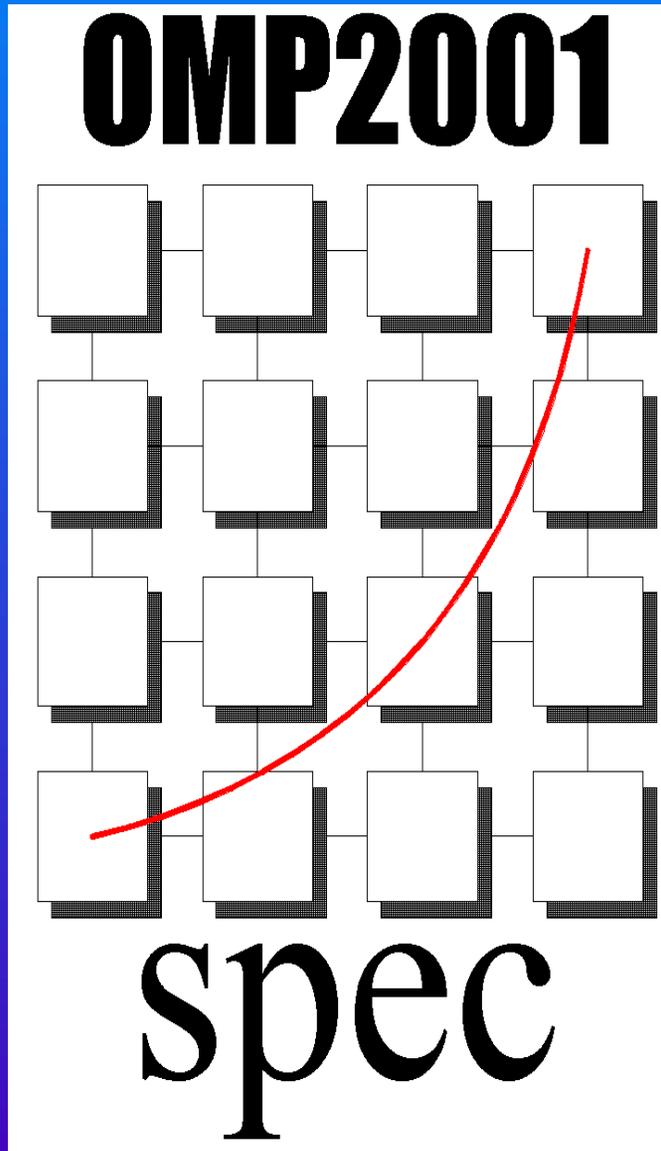
Benchmarks with poor scaling



Conclusion

- SPEC OMP is a realistic set of benchmarks for SMP systems.
- Up to date results are available on the SPEC web site at <http://www.spec.org/hpg/omp2001>
- Parallelization using OpenMP can be done relatively quickly, and on complex sections.
- Scalability up to 128 CPUs is possible using OpenMP.

SPEC OMP is Here



- Purchase through SPEC
- Academic discount available
- Membership encouraged