A Short Note on Benchmarks

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September 18, 1997

1 Introduction

While working for on my report for the Task Force on STAR Computing Requirements I looked through several STAR and RCF computing documents in order to find out what the most suitable CPU measure might be. The more I read the more I got confused. I therefore started to compile all the information I could find regarding this issue. This note is a summary of my findings which, as I hope, might be useful for others in future discussions.
There are two basic questions which I try to address:

1. which of the many benchmarks are relevant for us?
2. what is the relation between the different SPECmarks and GFLOPS – if any? Can one calculate one from the other?

2 What are the relevant benchmarks?

The computing capacities required for STAR are large and challenging. In order to plan for a computing facility which is able to provide sufficient resources one has to find a measure to define a common reference point. This measure should be platform independent, i.e. one should be able to estimate the processing power on every architecture in question.
A simple and straightforward way is to time the execution of a program on a single machine without any load other than the test program itself and then look up the benchmarks for this individual machine. The most common benchmarks provided by the vendors or independent organizations are SPECmarks and MFLOPS.

The question now is how easily can one derive the time the program would run on a different architecture. Unfortunately this is not an easy task. The floating-point and integer requirements for the different STAR programs are very different and so are the performances at different architectures. GSTAR (Geant3), for example, is chiefly dominated by the integer capabilities of a machine (according to CERN) and this is even more significant for 'g2t'. This however does not mean that floating-point operations play absolutely no role. The situation is certainly different for some event reconstruction program where floating-point performances become more and more important. So moving from one architecture which is rather balanced in floating-point and integer performance to a computer with extremely low floating-point but similar integer power might slow down some programs while other are hardly affected. The question is: can one derive the specific floating-point and integer resources a program needs. I think the answer is yes. By running the same program on different architectures with different ratios between integer and floating-point operations one can actually extract a gauge matrix which reflects the individual requirements. This is, admittedly, a very cumbersome procedure which cannot be an issue for STAR at the moment.
To obtain a rough estimate of the requirements, one can use the number commonly used in most of the STAR and RCF write-ups; those of the integer performances. The most common benchmark measure is provided by the SPEC corporation, namely SPECint95. On the other hand we should be aware that such a simplification introduces some errors on the requirement analysis which should not be neglected.

3 SPEC Tools

SPEC, the Standard Performance Evaluation Corporation[1], is a non-profit corporation formed to *"establish, maintain and endorse a standardized set of relevant benchmarks that can be applied to the newest generation of high-performance computers"* (quoted from SPEC's bylaws). This corporation produces series of applications-oriented tests, which can serve as common reference points and be considered during the evaluation process.

[1] Legally, SPEC is a non-profit corporation registered in California.

3.1 SPEC metric

As already discussed above no one benchmark can fully characterize an overall system performance but the results of a variety of realistic benchmarks can give valuable insight into expected real performance.
The SPEC95 tools allow to generate the following composite metrics:

	Speed	Throughput
Aggressive Optimization:	SPECint95 SPECfp95	SPECint_rate95 SPECfp_rate95
Conservative Optimization:	SPECint95_base95 SPECfp95_base95	SPECint_rate95_base95 SPECfp_rate95_base95

Since numbers on the throughput are not very common I will exclude them from the discussion from here on. The meaning of the other benchmarks are:

SPECint95 is derived from the results of eight integer benchmarks compiled with aggressive optimization.[2] It is the geometric mean of eight normalized ratios (one for each integer benchmark).

SPECfp95 is derived from the results of ten floating-point benchmarks compiled with aggressive optimization. It is the geometric mean of ten normalized ratios (one for each floating-point benchmark).

SPECint_base95 is derived from the results of eight integer benchmarks compiled with conservative optimization. It is the geometric mean of eight normalized ratios (one for each integer benchmark).

SPECfp_base95 is derived from the results of ten floating-point benchmarks compiled with conservative optimization. It is the geometric mean of ten normalized ratios (one for each floating-point benchmark).

It's important to know that these benchmarks are CPU-focused and not system-focused benchmarks. These CPU benchmarks focus on only one portion of those factors that contribute to applications performance. A disk or network performance

[2]Note that the level of optimization is not mandated. While highly aggressive optimization is permitted, results derived from benchmarks compiled with conservative optimization (as in SPECbase) can be submitted.

bottleneck within an application, for example, will not be reflected in these benchmarks. A list of SPECmarks for the most common platforms is printed in the appendix.

3.2 SPEC92, SPEC95?

SPEC92 are obsolete. The results published by SPEC were marked as obsolete and since June 1996, SPEC stopped publishing SPEC92 results. For processors/architectures released after June 1996 SPEC92 numbers are hardly available. The SPEC95 benchmarks were improved in several field of which some are of great importance in the context of STAR.

1. Areas such as imaging and database have been added.

2. Several of the SPEC92 benchmarks were running in less than a minute on leading-edge processors/systems. Given the SPEC measurement tools, small changes or fluctuations in the measurements were having significant impacts on the percentage improvements being seen. SPEC95 benchmarks run now longer in time.

3. For SPEC95 programs with larger resource requirements were added.

4 Conversion Factors

4.1 SPEC benchmarks

The official SPEC statement is: *"There is no formula for converting from SPEC92 results to SPEC95 results; they are different products. There might be a high correlation between SPEC92 and SPEC95 results (i.e., machines with higher SPEC92 results might have higher SPEC95 results), but there is no universal formula for all systems."*. Despite these warnings I checked various results on SPEC92 and SPEC95 benchmarks and their relations. The results of the various ratios between floating-point and integer benchmarks in both versions (SPEC92 and SPEC95) for a number of processors are shown in Fig. 1. Most of the numbers were derived by the vendors themself (DEC, HP, Sun, SGI, IBM, Intel); only a few were actually run by independent organizations. I calculated the individual ratios from the lists printed in Appendix A. The *average* ratio SPECfp/SPECint is approximately 1.3. However, Fig. 1 clearly shows that an average value should be used with great care and that rather the individual numbers should be inspected. Errors of factors 2–3 can easily be introduced here. For example the ratio SPECfp95/SPECint95 for an PentiumMMX at 200 MHz is 4.66/6.41 = 0.727 while for an HP/K260 it is 19.4/11.8 = 1.644.

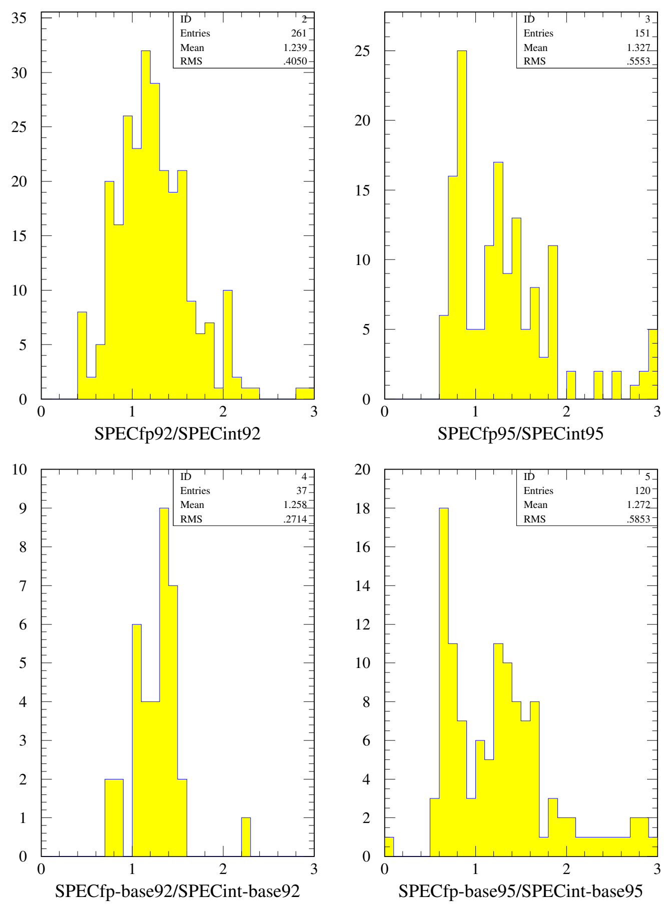

Figure 1: Ratio between the floating-point and integer SPECmarks for various processors.

Fig. 2 shows the ratios between SPEC95 and SPEC92. The statistics here is much lower. Many machines in the SPEC92 list are already outdated and therefore no SPEC95 were generated by the vendors. It is not surprising to observe large fluctuations here as well. This simply reflects one of the reasons why SPEC95 were introduced. Many vendors tuned their compilers (or even hand-coded the assembler) to perform well on the SPEC programs. This can be also seen in the SPECbase benchmarks (conservative optimization) which show much less fluctuations than their aggressive optimized counterparts. The *average* ratio SPEC95/SPEC92 is approximately 40.

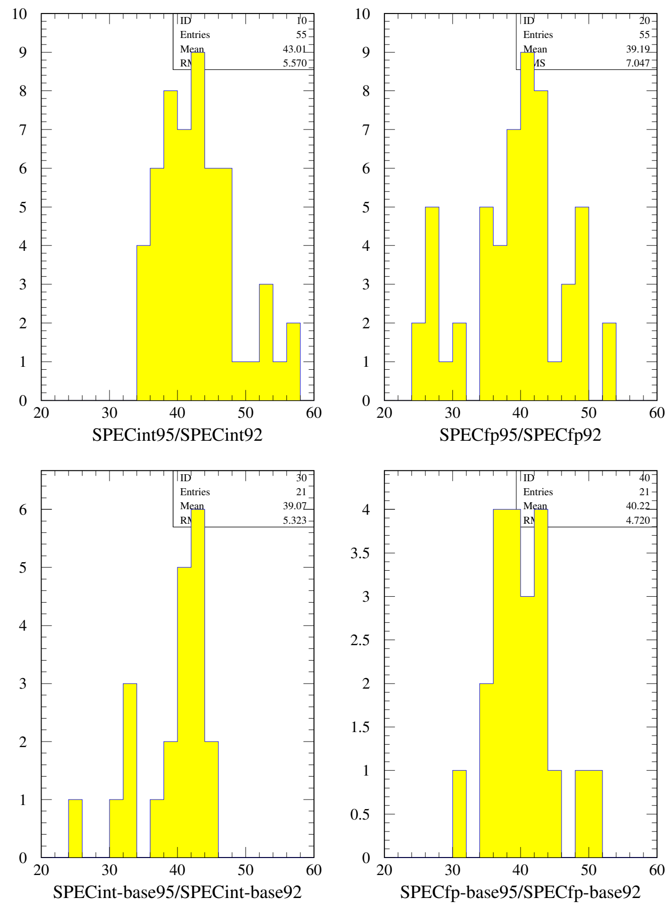

Figure 2: Ratio between the 95 and 92 SPECmarks for various processors.

4.2 MFLOPS

Unfortunately MFLOPS is a rather misleading term. This number strongly depends on: (i) the workload which being referred to, (ii) under what conditions the number was determined (i.e. peak, theoretical, sustained, average, etc.), and (iii) more importantly how a floating point operations is defined by the test person (loads, stores, intermediate steps, etc.). STAR is dealing with full applications not FP kernel loops, thus there is a wide variations in the FLOP count during a run. Overall averages would underestimate badly, sampling would lead to unstable predictions, and the peak rates may or may not be sustainable in other situations. HP for example provides two different numbers for its PA-8000 processors: *(i)* 158 MFLOPS derived from a Linpack run compiled with `f77 +Oall +Oinline=daxpy` and *(ii)* 497 MFLOPS if handcoded in assembly language. It seems obvious that the second number will never be achieved with a STAR program. However, not everyone who publishes FLOPS may tell you how they were obtained. SPEC itself does not calculate or provide FLOP information for the 95 codes. Because of the vagueness of the term one should not try to convert SPEC based measurements to these units. For the sake of those who still want to get at least a feeling, there are approximately 13 MFLOPS per SPECint95 for some typical computers.

5 Conclusions

The optimal way to determine the required processing power/time for STAR would be to study the time critical programs on different machines and extract a matrix which distinguishes between floating-point and integer operations. Since this would take away too much of our time we should rely at least on a *common* single measure, namely SPECint95. A comparison of the conversion factors from or to other benchmarks on different machines shows that this procedure is extremely error-prone. If we aim to obtain reliable computer requirements within a factor of 2, care should be taken on on the issue of benchmarking programs. One easily can introduce uncertainties which exceed the individual errors in the evaluation of the requirements for the different analysis. Keep in mind that the platforms on which most of the benchmarks are derived will very likely not be the platforms finally used at the RCF.

A SPEC marks

A.1 SPECint95 and SPECfp95

System Name	CPU (NUMx)Type	ClkMHz ext/in	SPECint95	SPECfp95	Info Date	Source Obtained
DEC 200/4/100	A21064A	??/100	1.88	2.79	Aug96	Digital
DEC 200/4/166	A21064A	??/166	2.95	3.64	Aug96	Digital
DEC 200/4/233	A21064A	??/233	4.28	4.32	Aug96	Digital
DEC 250/4/266	A21064A	??/266	5.18	6.27	Apr95	www.dec
DEC 255/233	A21064A	??/233	4.27	5.09	Mar96	Digital
DEC 255/300	A21064A	??/300	5.23	5.81	Mar96	Digital
DEC 500/266	A21164	43/266	7.93	11.1	Mar96	Digital
DEC 500/333	A21164	46/333	9.82	12.5	Mar96	Digital
DEC 500/400	A21164	53/400	12.3	14.1	Jun96	Digital
DEC 500/500	A21164	48/500	15.0	20.4	Aug96	Digital
DEC 600/5/266	A21164	38/266	7.91	11.8	Sep95	Digital
DEC 600/5/300	A21164	75/300	9.78	13.4	Sep95	Digital
DEC 600/5/333	A21164	83/333	9.23	13.2	Feb96	Digital
DEC 600A/5/500	A21164	??/500	14.8	17.4	May97	www.dec
DEC PW600AU	A21164	??/600	18.4	21.3	Jun97	www.specb
DEC 3000/500	A21064	30/150	2.15	3.65	Sep95	Digital
DEC 3000/700	A21064A	38/225	3.66	5.71	Sep95	Digital
DEC 3000/900	A21064A	39/275	4.24	6.29	Sep95	Digital
DEC 2[01]00/5/250	A21164	35/250	5.96	8.39	Feb96	Digital
DEC 2[01]00/5/300	A21164	42/300	7.03	9.64	Feb96	Digital
DEC 2[01]00/5/300	2xA21164	42/300	?	14.0	Feb96	Digital
DEC 2100/5/300	4xA21164	42/300	?	19.2	Feb96	Digital
DEC 4100/5/300E	A21164	??/300	7.15	12.0	May96	www.dec
DEC 4100/5/300E	4xA21164	??/300	?	18.4	May96	www.dec
DEC 4100/5/300	A21164	??/300	8.11	12.7	May96	www.dec
DEC 4100/5/300	4xA21164	??/300	?	21.8	May96	www.dec
DEC 4[01]00/5/400	A21164	??/400	12.1	17.2	Sep96	Digital
DEC 4[01]00/5/400	2xA21164	??/400	12.1	24.2	Sep96	Digital
DEC 4100/5/400	4xA21164	??/400	12.1	33.4	Sep96	Digital
DEC 4[01]00/5/466	A21164	??/466	14.1	19.2	Feb97	Digital
DEC 4[01]00/5/466	2xA21164	??/466	14.1	26.5	Feb97	Digital
DEC 4[01]00/5/466	4xA21164	??/466	14.1	36.1	Feb97	Digital

System Name	CPU (NUMx)Type	ClkMHz ext/in	SPECint95	SPECfp95	Info Date	Source Obtained
DEC 8[24]00/5/300	A21164	75/300	7.43	12.4	Feb96	Digital
DEC 8[24]00/5/300	2xA21164	75/300	?	18.1	Feb96	Digital
DEC 8[24]00/5/300	4xA21164	75/300	?	25.9	Feb96	Digital
DEC 8[24]00/5/300	6xA21164	75/300	?	30.1	Feb96	Digital
DEC 8400/5/300	8xA21164	75/300	?	33.5	Feb96	Digital
DEC 8[24]00/5/350	A21164	88/350	10.10	14.2	Feb96	Digital
DEC 8400/5/350	8xA21164	88/350	?	38.5	Feb96	Digital
DEC 8[24]00/5/440	A21164	88/440	13.6	17.0	Oct96	Digital
DEC 8[24]00/5/440	6xA21164	88/440	?	34.3	Oct96	Digital
DEC 8400/5/440	8xA21164	88/440	?	42.6	Oct96	Digital
Dell DimensionXPS	Pentium	66/100	3.16	2.75	Jan96	www.intel
Dell DimensionXPS	Pentium	60/120	3.53	2.92	Jan96	www.intel
Dell DimensionXPS	Pentium	66/133	3.90	3.28	Jan96	www.intel
Dell DimensionXPS	Pentium	66/200	5.10	4.18	Sep96	www.intel
Dell DimensionXPS	PentPro	180	7.28	5.59	Sep96	www.intel
Dell DimensionXPS	PentPro	200	8.20	6.21	Sep96	www.intel
Dell DimensionXPS	PentPro	200	8.58	6.48	Sep96	www.intel
Dell Optiplex	Pentium	60/120	3.51	2.80	Jan96	www.intel
Dell Optiplex	Pentium	66/133	3.90	2.99	Jan96	www.intel
Fuji/ICL J650i	PentPro	200	8.71	6.68	May96	www.spec
Gateway P5-75	Pentium	50/75	2.31	2.02	Jan96	www.intel
Gateway P5-90	Pentium	60/90	2.74	2.39	Jan96	www.intel
Gateway P5-100	Pentium	66/100	3.05	2.72	Jan96	www.intel
HAL 330	SPARC64	100	4.2	7.73	Feb96	www.hal
HAL 350	SPARC64	118	4.9	9.03	Feb96	www.hal
HAL 385	SPARC64II	161	8.40	13.6	Dec96	www.hal
HP 9000/712/60	PA7100LC	60	2.08	2.66	Oct96	www.hp
HP 9000/712/80	PA7100LC	80	3.12	3.55	Oct96	www.hp
HP 9000/712/100	PA7100LC	100	3.76	4.03	Oct96	www.hp
HP 9000/715/100	PA7100LC	100	3.76	4.03	Oct96	www.hp
HP 9000/715/100XC	PA7100LC	100	4.55	4.70	Oct96	www.hp
HP 9000/735	PA7100	99	3.22	4.06	Sep95	SPEC
HP 9000/735	PA7100	125	3.97	4.61	Sep95	SPEC
HP 9000/B132L	PA7300LC	132	5.91	6.23	Oct96	www.hp
HP 9000/B160L	PA7300LC	160	7.75	7.56	Oct96	www.hp

System Name	CPU (NUMx)Type	ClkMHz ext/in	SPECint95	SPECfp95	Info Date	Source Obtained
HP 9000/C160	PA8000	160	10.4	16.3	Jun96	www.hp
HP 9000/C160L	PA7300LC	160	7.75	7.56	Oct96	www.hp
HP 9000/C180XP	PA8000	180	11.8	18.7	Jun96	www.hp
HP 9000/J200	PA7200	100	3.52	6.32	Sep95	SPEC
HP 9000/J210	PA7200	120	4.21	7.60	Sep95	SPEC
HP 9000/J210	2xPA7200	120	?	10.10	Sep95	SPEC
HP 9000/J280	PA8000	180	11.8	19.3	Oct96	www.hp
HP 9000/K420	PA7200	120	4.61	8.24	Feb96	www.hp
HP 9000/K260EG	PA8000	180	11.8	19.4	Jun96	www.hp
HP 9000/K460EG	PA8000	180	11.8	20.2	Jun96	www.hp
IBM 250	MPC601	66	1.82	2.32	Sep96	www.ibm
IBM 380	POWER2	59	2.84	7.20	Sep96	www.ibm
IBM 390	POWER2	67	3.14	7.50	Sep96	www.ibm
IBM 390	POWER2	67	3.25	7.71	Sep96	www.ibm
IBM 590	POWER2	66	3.33	10.4	Sep96	www.ibm
IBM 591	POWER2	77	3.84	12.4	Sep96	www.ibm
IBM 595	POWER2SC	135	6.17	17.6	Oct96	www.ibm
IBM 860	MPC603e	166	3.94	2.71	Oct96	www.ibm
IBM E20	MPC604	100	3.67	3.13	Jun96	www.ibm
IBM [EF]30	MPC604	133	4.74	3.49	Jun96	www.ibm
IBM F40	MPC604e	166	5.73	4.75	Oct96	www.ibm
IBM 39H	POWER2	67	3.29	9.61	Sep96	www.ibm
IBM 39H	POWER2	67	3.42	10.2	Sep96	www.ibm
IBM 42[TW]	MPC604	120	3.21	2.74	Sep95	www.ibm
IBM 42[TW]	MPC604	120	4.01	3.53	Sep95	www.ibm
IBM 43P	MPC604	100	3.59	3.20	Sep96	www.ibm
IBM 43P	MPC604	120	4.24	3.41	Sep96	www.ibm
IBM 43P	MPC604	133	4.72	3.76	Sep96	www.ibm
IBM 43P/140	MPC604e	166	6.15	4.83	Oct96	www.ibm
IBM 43P/140	MPC604e	200	7.22	6.91	Oct96	www.ibm
IBM 43P/140u	MPC604e	233	8.66	5.63	Apr97	www.ibm
IBM 43P/140n	MPC604e	233	9.24	5.75	Apr97	www.ibm
IBM 43P/240	MPC604e	166	5.73	4.60	Oct96	www.ibm
IBM 43P/240	2xMPC604e	166	8.71	5.87	Apr97	www.ibm
IBM 59H/R20	POWER2	66	3.37	9.80	Sep96	www.ibm

System Name	CPU (NUMx)Type	ClkMHz ext/in	SPECint95	SPECfp95	Info Date	Source Obtained
IBM R24	POWER2	71	3.47	10.2	Sep96	www.ibm
IBM SP2/66Thin	POWER2	67	3.31	9.35	Nov96	www.ibm
IBM SP2/77Wide	POWER2	77	3.84	12.4	Nov96	www.ibm
IBM SP2/120Thin	POWER2SC	120	5.61	16.6	Nov96	www.ibm
Intel XXpress	Pentium	66/100	3.30	2.59	Jan96	www.intel
Intel XXpress	Pentium	60/120	3.72	2.81	Nov95	www.intel
Intel XXpress	Pentium	66/133	4.14	3.12	Nov95	www.intel
Intel XXpress	Pentium	60/150	4.27	3.04	Jan96	www.intel
Intel XXpress	Pentium	66/166	4.76	3.37	Jan96	www.intel
Intel 82430VX	Pentium	66/133	4.00	3.44	Apr97	www.intel
Intel 82430VX	Pentium	60/150	4.10	3.42	Apr97	www.intel
Intel 82430VX	Pentium	66/166	4.56	3.84	Apr97	www.intel
Intel 82430VX	Pentium	66/200	5.10	4.18	Apr97	www.intel
Intel 82430VX	PentiumMMX	66/166	5.59	4.30	Apr97	www.intel
Intel 82430VX	PentiumMMX	66/200	6.41	4.66	Apr97	www.intel
Intel Alder	PentPro	150	6.08	5.42	Jan96	www.intel
Intel Alder	PentPro	166	7.11	6.21	Jan96	www.intel
Intel Alder	PentPro	180	7.29	6.08	Jan96	www.intel
Intel Alder	PentPro	200	8.09	6.75	Jan96	www.intel
Intel Aurora	PentPro	150	?	4.71	Jan96	www.intel
Intel Aurora	PentPro	166	?	5.20	Jan96	www.intel
Intel PD440FX	PentiumII	66/233	9.49	6.43	May97	www.intel
Intel PD440FX	PentiumII	66/266	10.8	6.89	May97	www.intel
RDI PowerLite170	TurboSP	85/170	3.08	2.74	Jan97	www.rdi
Ross 200S-100	HyperSP	50/100	2.65	3.39	Apr95	www.ross
Ross 200S-200/512	HyperSP	50/200	5.30	5.05	May97	www.ross
Ross HS20	HyperSP	50/125	3.16	4.35	Dec96	www.ross
Ross HS20	HyperSP	50/150	4.10	4.98	Dec96	www.ross
Ross HS30	HyperSP	66/142	3.97	5.06	Dec96	www.ross
SGI Indy-R5000	R5000	??/150	3.07	4.20	Jul96	www.specb
SGI Indy-R5000	R5000	??/150	3.82	4.78	Jul96	www.specb
SGI Indy-R5000	R5000	??/180	4.32	4.78	Jul96	www.specb
SGI Indigo2-R10k	R10000	175	8.0	10.3	Oct96	www.sgi
SGI Indigo2-R10k	R10000	195	8.88	10.6	Oct96	www.specb
SGI O2-R5kPC	R5000	180	3.70	4.55	Oct96	www.specb

System Name	CPU (NUMx)Type	ClkMHz ext/in	SPECint95	SPECfp95	Info Date	Source Obtained
SGI O2-R5kSC	R5000	180	4.82	5.42	Oct96	www.specb
SGI O2-R10kSC	R10000	175	7.62	6.60	Dec96	www.sgi
SGI PChall-R10k	R10000	195	8.75	12.4	Jul96	www.specb
SGI PChall-R10k	R10000	195	8.85	13.8	Jul96	www.specb
SGI Origin200	R10000	180	8.59	15.6	Nov96	www.specb
SGI Origin2000	R10000	180	9.48	19.0	Nov96	www.specb
SGI Octane	R10000	175	8.4	15.5	Feb97	www.sgi
SGI Octane	2xR10000	175	8.5	15.5	Feb97	www.sgi
SGI Octane	R10000	195	9.3	17.0	Feb97	www.sgi
SGI Octane	2xR10000	195	9.4	17.4	Feb97	www.sgi
SNI/Pyr RM200-225	R4600	133	2.41	?	Sep95	c.bmarks
SNI/Pyr RM200-C20	R4600	133	2.64	?	Dec95	c.bmarks
SNI/Pyr RM300-C20	R4600	133	2.64	?	Dec95	c.bmarks
SNI/Pyr RM300-C40	R5000	90/180	4.75	?	Aug96	SNI/Pyr
SNI/Pyr RM300-C60	R4400	100/200	3.55	?	Dec95	c.bmarks
SNI/Pyr RM400-630	R4400	100/200	3.95	?	Sep95	c.bmarks
SNI/Pyr RM400-C60	R4400	100/200	3.49	?	Dec95	c.bmarks
SNI/Pyr RM400-C70	R4400	100/200	3.92	?	Dec95	c.bmarks
SNI/Pyr RM1000	R4400	120/240	5.04	?	Jul96	SNI/Pyr
Sun SS10/40	SuprSP	40	1.13	1.38	Mar96	c.bmarks
Sun SS[45]/110	MicroSP2	110	1.59	1.99	Mar96	c.bmarks
Sun SS5/170	TurboSP	85/170	3.32	2.91	Jan97	Sun
Sun SS20/71	SuprSP2	50/75	3.11	3.10	Mar96	c.bmarks
Sun SS20/151	HyperSP	50/150	4.02	4.73	Mar96	c.bmarks
Sun Ultra1/140	UltraSP	71/143	4.66	7.90	Mar96	c.bmarks
Sun Ultra1/170	UltraSP	83/167	6.26	9.06	Apr97	Sun
Sun Ultra1/200E	UltraSP	100/200	7.44	10.40	Feb97	Sun
Sun Ultra2/1170	UltraSP	83/167	6.20	9.27	Apr96	Sun
Sun Ultra2/2170	2xUltraSP	83/167	6.39	11.8	Apr96	Sun
Sun Ultra2/1200	UltraSP	100/200	7.67	11.1	Apr96	Sun
Sun Ultra2/2200	2xUltraSP	100/200	7.88	14.7	Apr96	Sun
Sun Ultra2/1300	UltraSP	100/300	12.1	15.5	Apr97	Sun
Sun Ultra2/2300	2xUltraSP	100/300	12.3	20.2	Apr97	Sun
Sun UltraX000	UltraSP	83/167	6.25	8.73	Sep96	Sun
Sun UltraX000	UltraSP	83/167	6.60	9.37	Sep96	Sun

System Name	CPU (NUMx)Type	ClkMHz ext/in	SPECint95	SPECfp95	Info Date	Source Obtained
Sun UltraX000	UltraSP	83/250	9.74	11.7	Jan97	Sun
Sun UltraX000	UltraSP	83/250	10.4	15.0	Apr97	Sun
Sun UltraX000	6xUltraSP	83/167	?	19.3	Apr96	www.sun
Sun UltraX000	12xUltraSP	83/167	?	22.6	Apr96	www.sun

A.2 SPECint_base95 and SPECfp_base95

System Name	CPU (NUMx)Type	ClkMHz ext/in	SPECint base95	SPECfp base95	Info Date	Source Obtained
Sun SS10/40	SuprSP	40	1.00	1.00	Aug95	SPEC
ALR Rev	Quad6	4xPentPro	256+8/8	6.27	2.45	Nov96
DEC 250/4/266	A21064A	??/266	4.18	5.78	Apr95	www.dec
DEC 255/233	A21064A	??/233	3.48	4.76	Mar96	Digital
DEC 255/300	A21064A	??/300	4.11	5.18	Mar96	Digital
DEC 500/266	A21164	43/266	6.32	10.0	Mar96	Digital
DEC 500/333	A21164	46/333	7.94	10.5	Mar96	Digital
DEC 500/400	A21164	53/400	9.77	12.8	Jun96	Digital
DEC 600/5/266	A21164	38/266	6.43	10.64	Sep95	Digital
DEC 600/5/300	A21164	75/300	7.33	11.59	Sep95	Digital
DEC 600/5/333	A21164	83/333	8.42	12.4	Feb96	Digital
DEC 600A/5/500	A21164	??/500	11.4	15.0	May97	www.dec
DEC PW600AU	A21164	??/600	16.0	19.9	Jun97	www.specb
DEC 3000/500	A21064	30/150	2.15	3.65	Sep95	Digital
DEC 3000/700	A21064A	38/225	3.66	5.71	Sep95	Digital
DEC 3000/900	A21064A	39/275	4.24	6.29	Sep95	Digital
DEC 2[01]00/5/250	A21164	35/250	5.96	8.39	Feb96	Digital
DEC 2[01]00/5/300	A21164	42/300	7.03	9.26	Feb96	Digital
DEC 2[01]00/5/300	2xA21164	42/300	?	9.0	Feb96	Digital
DEC 2100/5/300	4xA21164	42/300	?	9.0	Feb96	Digital
DEC 4[01]00/5/400	A21164	??/400	10.1	16.0	Sep96	Digital
DEC 4[01]00/5/400	2xA21164	??/400	10.1	20.7	Sep96	Digital
DEC 4100/5/400	4xA21164	??/400	12.1	26.6	Sep96	Digital
DEC 4[01]00/5/466	A21164	??/466	12.1	17.8	Feb97	Digital
DEC 4[01]00/5/466	2xA21164	??/466	12.1	22.2	Feb97	Digital
DEC 4[01]00/5/466	4xA21164	??/466	12.1	27.8	Feb97	Digital
DEC 8[24]00/5/300	A21164	75/300	7.43	11.7	Feb96	Digital
DEC 8[24]00/5/300	2xA21164	75/300	?	11.9	Feb96	Digital
DEC 8[24]00/5/300	4xA21164	75/300	?	11.7	Feb96	Digital
DEC 8[24]00/5/300	6xA21164	75/300	?	11.8	Feb96	Digital
DEC 8400/5/300	8xA21164	75/300	?	11.8	Feb96	Digital
DEC 8[24]00/5/350	A21164	88/350	8.82	13.2	Feb96	Digital

System Name	CPU (NUMx)Type	ClkMHz ext/in	SPECint base95	SPECfp base95	Info Date	Source Obtained
DEC 8400/5/350	8xA21164	88/350	?	28.9	Feb96	Digital
DEC 8[24]00/5/440	A21164	88/440	11.2	16.0	Oct96	Digital
DEC 8[24]00/5/440	6xA21164	88/440	?	25.9	Oct96	Digital
DEC 8400/5/440	8xA21164	88/440	?	31.5	Oct96	Digital
Dell DimensionXPS	Pentium	66/100	3.16	2.09	Jan96	www.intel
Dell DimensionXPS	Pentium	60/120	3.53	2.26	Jan96	www.intel
Dell DimensionXPS	Pentium	66/133	3.90	2.48	Jan96	www.intel
Dell Optiplex	Pentium	60/120	3.51	2.16	Jan96	www.intel
Dell Optiplex	Pentium	66/133	3.90	2.32	Jan96	www.intel
Fuji/ICL J650i	PentPro	200	8.71	5.95	May96	www.spec
Gateway P5-75	Pentium	50/75	2.31	1.50	Jan96	www.intel
Gateway P5-90	Pentium	60/90	2.74	1.86	Jan96	www.intel
Gateway P5-100	Pentium	66/100	3.05	2.07	Jan96	www.intel
HP C100	PA7200	100	3.67	6.20	Dec95	www.hp
HP C110	PA7200	120	4.41	7.45	Dec95	www.hp
HP 9000/735	PA7100	99	3.13	3.97	Sep95	SPEC
HP 9000/735	PA7100	125	3.88	4.54	Sep95	SPEC
HP 9000/B132L	PA7300LC	132	5.62	6.10	Oct96	www.hp
HP 9000/B160L	PA7300LC	160	7.32	7.38	Oct96	www.hp
HP 9000/C160	PA8000	160	9.4	15.2	Jun96	www.hp
HP 9000/C160L	PA7300LC	160	7.32	7.38	Oct96	www.hp
HP 9000/C180XP	PA8000	180	10.8	17.2	Jun96	www.hp
HP 9000/J200	PA7200	100	3.27	6.22	Sep95	SPEC
HP 9000/J210	PA7200	120	3.93	7.51	Sep95	SPEC
HP 9000/J210	2xPA7200	120	?	9.91	Sep95	SPEC
HP 9000/K260EG	PA8000	180	10.8	17.6	Jun96	www.hp
HP 9000/K460EG	PA8000	180	10.8	18.3	Jun96	www.hp
IBM 250	MPC601	66	1.69	2.23	Sep96	www.ibm
IBM 250	MPC601	80	2.03	2.58	Sep96	www.ibm
IBM 380	POWER2	59	2.71	6.81	Sep96	www.ibm
IBM 390	POWER2	67	3.00	7.20	Sep96	www.ibm
IBM 390	POWER2	67	3.12	7.35	Sep96	www.ibm
IBM 590	POWER2	66	3.19	9.69	Sep96	www.ibm
IBM 591	POWER2	77	3.67	11.2	Sep96	www.ibm
IBM 595	POWER2SC	135	5.90	15.4	Oct96	www.ibm

System Name	CPU (NUMx)Type	ClkMHz ext/in	SPECint base95	SPECfp base95	Info Date	Source Obtained
IBM 860	MPC603e	166	3.62	2.62	Oct96	www.ibm
IBM C10	MPC601	80	2.37	2.97	Sep96	www.ibm
IBM C20	MPC604	120	3.85	3.50	Sep96	www.ibm
IBM E20	MPC604	100	3.43	3.06	Jun96	www.ibm
IBM [EF]30	MPC604	133	4.56	3.34	Jun96	www.ibm
IBM F40	MPC604e	166	5.31	4.60	Oct96	www.ibm
IBM F50	MPC604e	166	6.79	8.11	Apr97	www.ibm
IBM 39H	POWER2	67	3.29	9.61	Sep96	www.ibm
IBM 41W	MPC601	80	2.03	2.58	Sep95	www.ibm
IBM 42[TW]	MPC604	120	2.93	2.57	Sep95	www.ibm
IBM 42[TW]	MPC604	120	3.75	3.37	Sep95	www.ibm
IBM 43P	MPC604	100	3.36	3.04	Sep96	www.ibm
IBM 43P	MPC604	120	4.01	3.23	Sep96	www.ibm
IBM 43P	MPC604	133	4.55	3.59	Sep96	www.ibm
IBM 43P/140	MPC604e	166	5.82	4.66	Oct96	www.ibm
IBM 43P/140	MPC604e	200	6.91	5.07	Oct96	www.ibm
IBM 43P/140u	MPC604e	233	7.77	5.30	Apr97	www.ibm
IBM 43P/140n	MPC604e	233	8.29	5.48	Apr97	www.ibm
IBM 43P/240	MPC604e	166	5.31	4.60	Oct96	www.ibm
IBM 43P/240	2xMPC604e	166	7.80	5.60	Apr97	www.ibm
IBM 59H/R20	POWER2	66	3.25	9.23	Sep96	www.ibm
IBM R24	POWER2	71	3.32	9.47	Sep96	www.ibm
IBM SP2/66Thin	POWER2	67	3.20	8.75	Nov96	www.ibm
IBM SP2/77Wide	POWER2	77	3.67	11.2	Nov96	www.ibm
IBM SP2/120Thin	POWER2SC	120	5.36	14.6	Nov96	www.ibm
Intel XXpress	Pentium	66/100	?	2.06	Jan96	www.intel
Intel XXpress	Pentium	60/120	3.72	2.24	Jan96	www.intel
Intel XXpress	Pentium	66/133	4.14	2.48	Jan96	www.intel
Intel XXpress	Pentium	60/150	4.27	3.04	Jan96	www.intel
Intel XXpress	Pentium	66/166	4.76	3.37	Jan96	www.intel
Intel 82430VX	Pentium	66/133	4.00	2.53	Apr97	www.intel
Intel 82430VX	Pentium	60/150	4.10	2.52	Apr97	www.intel
Intel 82430VX	Pentium	66/166	4.56	2.81	Apr97	www.intel
Intel 82430VX	Pentium	66/200	5.10	3.09	Apr97	www.intel
Intel 82430VX	PentiumMMX	66/166	5.59	3.49	Apr97	www.intel

System Name	CPU (NUMx)Type	ClkMHz ext/in	SPECint base95	SPECfp base95	Info Date	Source Obtained
Intel 82430VX	PentiumMMX	66/200	6.41	3.90	Apr97	www.intel
Intel Alder	PentPro	150	6.08	4.76	Jan96	www.intel
Intel Alder	PentPro	166	7.11	5.47	Jan96	www.intel
Intel Alder	PentPro	180	7.29	5.40	Jan96	www.intel
Intel Alder	PentPro	200	8.09	5.99	Jan96	www.intel
Intel Aurora	PentPro	150	?	4.22	Jan96	www.intel
Intel Aurora	PentPro	166	?	4.72	Jan96	www.intel
Intel PD440FX	PentiumII	66/233	9.49	5.91	May97	www.intel
Intel PD440FX	PentiumII	66/266	10.8	6.43	May97	www.intel
Ross 200S-100	HyperSP	50/100	2.35	3.12	Apr95	www.ross
Ross 200S-200/512	HyperSP	50/200	5.04	4.89	May97	www.ross
Ross HS20	HyperSP	50/125	3.02	4.02	Dec96	www.ross
Ross HS20	HyperSP	50/150	3.91	4.59	Dec96	www.ross
Ross HS30	HyperSP	66/142	3.78	4.66	Dec96	www.ross
SGI Indy-R5000	R5000	??/150	2.89	4.11	Jul96	www.specb
SGI Indy-R5000	R5000	??/150	3.67	4.72	Jul96	www.specb
SGI Indy-R5000	R5000	??/180	4.10	4.72	Jul96	www.specb
SGI O2-R5kPC	R5000	180	3.62	4.54	Oct96	www.specb
SGI O2-R5kSC	R5000	180	4.76	5.37	Oct96	www.specb
SGI Indigo2-R10k	R10000	195	8.50	10.2	Jul96	www.specb
SGI PChall-R10k	R10000	195	8.38	11.8	Jul96	www.specb
SGI PChall-R10k	R10000	195	8.50	13.1	Jul96	www.specb
SGI Origin200	R10000	180	7.85	14.5	Nov96	www.specb
SGI Origin2000	R10000	180	8.66	17.4	Nov96	www.specb
SNI/Pyr RM200-225	R4600	133	2.31	?	Sep95	c.bmarks
SNI/Pyr RM200-C20	R4600	133	2.53	?	Dec95	c.bmarks
SNI/Pyr RM300-C20	R4600	133	2.53	?	Dec95	c.bmarks
SNI/Pyr RM300-C40	R5000	90/180	4.70	?	Aug96	SNI/Pyr
SNI/Pyr RM300-C60	R4400	100/200	3.41	?	Dec95	c.bmarks
SNI/Pyr RM400-630	R4400	100/200	3.79	?	Sep95	c.bmarks
SNI/Pyr RM400-C60	R4400	100/200	3.43	?	Dec95	c.bmarks
SNI/Pyr RM400-C70	R4400	100/200	3.72	?	Dec95	c.bmarks
SNI/Pyr RM400-C90	R10000	200	10.7	?	Nov96	SNI/Pyr
SNI/Pyr RM600-E20	R10000	200	10.3	?	Nov96	SNI/Pyr
SNI/Pyr RM600-E60	R10000	200	10.3	?	Nov96	SNI/Pyr

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SNI/Pyr RM600-420	R4400	125/250	4.91	?	Jul96	SNI/Pyr
SNI/Pyr RM1000	R4400	120/240	4.95	?	Jul96	SNI/Pyr
Sun SS10/40	SuprSP	40	1.06	1.13	Mar96	c.bmarks
Sun SS[45]/110	MicroSP2	110	1.37	1.88	Mar96	c.bmarks
Sun SS20/71	SuprSP2	50/75	2.82	2.96	Mar96	c.bmarks
Sun SS20/151	HyperSP	50/150	3.77	4.73	Mar96	c.bmarks
Sun Ultra1/140	UltraSP	71/143	4.52	7.73	Mar96	c.bmarks
Sun Ultra1/170	UltraSP	83/167	5.26	8.45	Mar96	c.bmarks
Sun Ultra2/2200	2xUltraSP	100/200	6.41	11.6	Mar96	c.bmarks
VAresearch PR/200	PentPro	200	6.41	?	Jul96	www.vares