LSU EE 4720 **Homework 1** **Due: 17 September 2003**

Problem 1: Look at the following SPEC CINT2000 disclosures for these Dell and HP Itanium 2 systems:
HP: `http://www.spec.org/osg/cpu2000/results/res2003q3/cpu2000-20030711-02389.html`
Dell: `http://www.spec.org/osg/cpu2000/results/res2003q3/cpu2000-20030701-02367.html`. (Note: Links are clickable within Acrobat reader.)

The CPU performance equation decomposes execution time into three components, clock frequency, ϕ, instruction count, IC, and CPI. For each component determine if its value on the two systems is definitely the same, probably the same, probably different, definitely different. *Hint: The answer for the clock frequency is easy, the others require a little understanding of what IC and CPI are.* Briefly justify your answers.

Problem 2: Though one may normally think of an implementation as a microprocessor chip, the definition can also include other parts of the system, such as memory and even disk. Why is that important in the problem above?

Problem 3: Differences in ISA, compiler, and implementation all affect the execution time of programs, and the impact of these factors can vary from program to program. For example, an implementation with faster floating point will have a larger impact on programs that do more floating-point computations.

From a look at the SPEC disclosures one can see that the fastest program on one system may not be the fastest program on another. (Use the int2000 results. From the spec CPU2000 results page find the configurable query form and request a page sorted by "Result" in descending order. It would be helpful to include the processor and compiler in the results. If your system is slow omit results before 2002.) For example, the Dell system from the first problem ran vortex fastest (of all the benchmarks), while the HP system ran mcf fastest. In this case the difference in fastest benchmark could not be the ISA, but it could be the compiler or the implementation. Call the speed ranking of benchmarks for a system its *character*. The character of the Dell system is vortex, gcc, eon, ... (benchmarks from fastest to slowest) and the character of the HP system is mcf, vortex, gcc, ...

The differences in character are due in part to the ISA, compiler, and implementation. Using the SPEC CINT2000 disclosures determine which is most important in determining character. Please do not try to look at all disclosures, just enough to determine an answer, even if that answer might change if you were to look at more.

In your answer, state which (ISA, compiler, or implementation) is most important, which disclosures you looked at, and how you drew that conclusion. *This question is easy to answer (once it's understood).*

As best you can explain why a particular factor is most important and why it is least important. *You are not expected to answer this question very well, most of the material has not been covered yet. Don't take too much time and do your best with what has been covered and what you already know.*

Additional Information:

Here are some ISAs and implementations of processors listed:

IA-32 ISA: (includes variations) implemented by Pentium 4 (and other Pentia) Xeon, Athlon, Opteron. Power Architecture ISA: Implementated by POWER4, RS64IV. Itanium ISA: Implementated by Itanium 2. Alpha ISA: Implementated by Alpha 21164, 21264, 21364. SPARC V9 ISA: Implementated by SPARC64V, UltraSPARC III Cu MIPS ISA: Implementated by R14000

Problem 4: The two procedures below are compiled with optimization on but with no special optimization options. Why might the second one run faster? (This is very similar to the classroom example.)

```
void add_array_first_one(int *a, int *b, int *x)
{
  for ( int i = 0;  i < 100;  i++  ) a[i] = b[i] + *x;
}
void add_array_second_one(int *a, int *b, int *x)
{
  int xval = *x;

  for ( int i = 0;  i < 100;  i++  ) a[i] = b[i] + xval;
}
```