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Introduction in High Performance Computing
Sheet 1

Hints

Exercises will be given supplementary to the lecture. They are supervised and solutions are discussed the following week. Exercises should be finished and handed in (email) within two weeks. Please send only sources and images - no object files, no executables.

Get used to work on a remote system

Inform yourself about possibilities to

- transport files from one computer to another
- login on a remote system.

You are prompted for a password during the login on a remote system. You can avoid to enter the password (resp. a passphrase) more than once if you generate a key for your system, copy the public part of this key to the remote system and add it to the file `authorized_keys` in the directory `.ssh`. Then you may set the correspondend passphrase once (perhaps after calling an `ssh_agent`) to the command `ssh_add`.

Please try this to the target HPC-System:

                    elweX.rhrk.uni-kl.de,   X=1,2,3,4.

`ssh` has several options available, one of which allows to specify X-forwarding that is to specify your monitor as terminal and display graphical contents. Please use this feature and open a window (command `xterm &`) on the target system.

You need an editor to create and modify files on the target system. Possible editors are `nedit` and `gedit`. Try one of these editors and write a simple `hello world` program on the target system. Compile this program with `gcc` and the Intel compiler `icc`. Build the executables `world_gcc` and `world_icc` and execute them. Inform yourself about the possibilities of the module environment to activate the Intel compiler suite on the WWW-Site `https://elwe.rhrk.uni-kl.de` (software).

Finally write a job script to be execute in batch processing mode on Elwetritsch. This job script may look like

```
#!/bin/bash
#BSUB -q short
#BSUB -R "rusage[mem=200]"

echo "Executing world_gcc"
module load ... # whatever you used for compilation
./world_gcc
module purge ... # clean environment

echo "Executing world_icc"
module load ... # whatever you used for compilation
./world_icc
```

Inform yourself about the meaning of the BSUB lines and possible other options. Submit the job script to the batch system.

Vectorization

Control vectorization for the following function and change code, insert pragma and choose optimal compile flag to get the loop vectorized.

```
void func(int N, double *a, double *b, double *c, double *e){
 int i;
 for(i=0;i<N;i++) {
    a[i]=b[i];
    c[i]=a[i]+b[i];
    e[i]=c[i+1];
  }
}
```

Check for vectorization in the assembler code.

Peak Performance

Calculate the peak performance for a computer with $CPI = 1$, with 4 independent ALUs running at 3.2 GHz. What is the peak performance of a computer running in normal mode at 2.4 GHz and in so called turbo mode at 2.9 GHz?

Numbers

Assume that your computer stores 8 significant digits and an exponent. Add the following numbers with rounding to the next integer:

A: 3.984375×10^{-1} B: 3.4375×10^{-1} C: 1.771×10^3

Form the sums (A+B)+C, A+(B+C) and compare the results to the exact result.

Take the numbers

A: 1.6660156×10^0 B: 1.9760×10^4 C: -1.9744×10^4

Form and compare A×(B+C) and A×B+A×C.