Lab 1: Experimental setup and tools

par4111
Adrià Cabeza, Xavier Lacasa
Departament d' Arquitectura de Computadors

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Contents

1 Introduction

In order to do properly this subject, first, we have to introduce some new concepts and hardware and software environment that we will use during this semester to do all laboratory assignments. The following document contains an introductory approach, step by step introducing those concepts. We will introduce the *Boada* architecture, some of the most important parallelism concepts and several tests to see its effects.

2 Experimental setup

2.1 Node architecture and memory

Boada is a multiprocessor server located at the Computer Architecture Department divided in different nodes, each of them with different architecture and diffferent uses. *Boada* is composed of 8 nodes (from boada-1 to boada-8) and they can be grouped as the following table:

Node name	Processor generation	Interactive	Queue name
boada-1	Intel Xeon E5645	Yes	batch
boada-2 to 4	Intel Xeon E5645	No	execution
boada-5	Intel Xeon E5-2620 v2 + Nvidia K40c	No	cuida
boada-6 to 8	Intel Xeon E5-2609 v4	No	execution2

However in this course we are going to use mainly from boada-1 to boada-4. The easiest way to obtain the information of the hardware used in each node is using the linux commands lscpu and lstopo(1 and 2). This commands can be easily executed in the boada-1 node (because it is interactive), but if we want to use the other nodes we can use the submit-*.sh script provided by the PAR teachers and use the queue system.

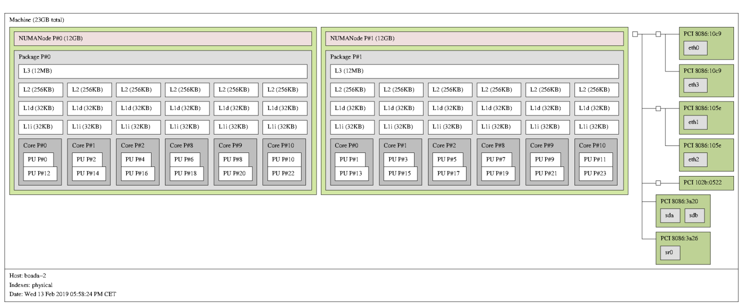


Figure 1: Boada-2 architecture outputed by lstopo.

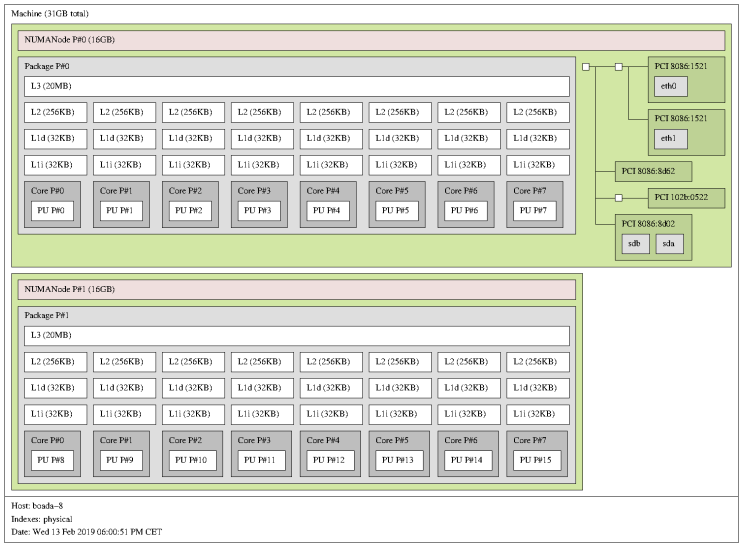


Figure 2: Boada-8 architecture outputed by lstopo.

After creating the scipts and applying them to each of the nodes, we obtained the following hardware information:

	boada-1 to boada-4	boada-5	boada-6 to boada-8
Number of sockets per node	2	2	2
Number of cores per socket	6	6	8
Number of threads per core	2	2	1
L1-I cache size (per-core)	32 KB	32 KB	32 KB
L1-D cache size (per core)	32 KB	32 KB	32 KB
L2 cache size (per-core)	256 KB	256 KB	256 KB
Last-level cache size (per-socket)	12 MB	15 MB	20 MB
Main memory size (per socket)	12 GB	31 GB	16 GB
Main memory size (per node)	23 GB	63 GB	31 GB

The previous table gives us really powerful information that will be necessary in the future to properly use the *boada* system and understand the parallelism decomposition and time we will get.

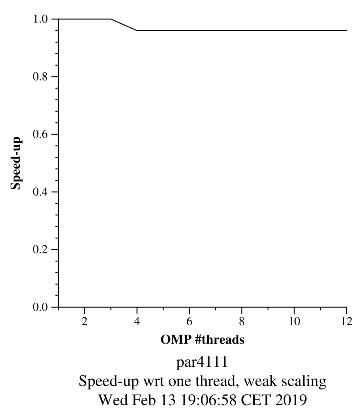
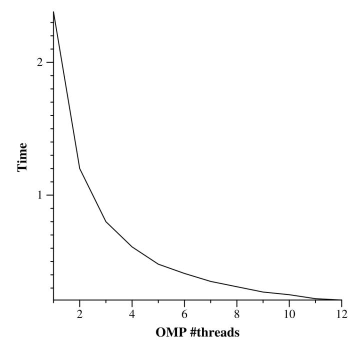
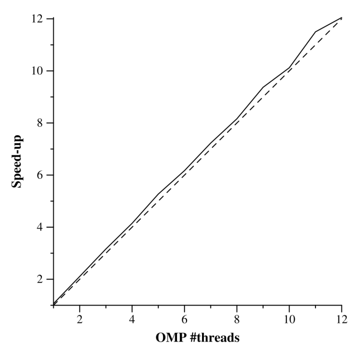


Figure 3: *pi_omp* with 100000000 weak by boada-6



par4111
Min elapsed execution time
Wed Feb 13 19:06:28 CET 2019



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Speed-up wrt sequential time
Wed Feb 13 19:06:28 CET 2019

Figure 4: *pi_omp* with 1000000000 strong by boada-8

2.2 Sequential and parallel executions

2.2.1 Strong scalability

2.2.2 Weak scalability

3 Experimental setup

3.1 Introduction

The objective of this laboratory is learn how to use Tareador, an environment to analyse the potential parallelilsm that can be obtained when a certain task decomposition is applied to a code. We will introduce how it works and we will experiment and analyse decomposition with a sequential code called 3DFFT.

3.2 Analysis of task decompositions for 3DFFT

3.2.1 Version 1

```
tareador_start_task("0");
    ffts1_planes(p1d, in_fftw);
   tareador_end_task("0");

    tareador_start_task("1");
   transpose_xy_planes(tmp_fftw, in_fftw);
   tareador_end_task("1");

    tareador_start_task("2");
    ffts1_planes(p1d, tmp_fftw);
   tareador_end_task("2");

    tareador_start_task("3");
   transpose_zx_planes(in_fftw, tmp_fftw);
   tareador_end_task("3");

    tareador_start_task("4");
    ffts1_planes(p1d, in_fftw);
   tareador_end_task("4");

    tareador_start_task("5");
   transpose_zx_planes(tmp_fftw, in_fftw);
   tareador_end_task("5");

    tareador_start_task("6");
   transpose_xy_planes(in_fftw, tmp_fftw);
   tareador_end_task("6");
```

Once we have created all these tasks, we ... PURO PALO, ja ho faré

3.2.2 Version 2

```
void ffts1_planes(fftwf_plan p1d, fftwf_complex in_fftw[][N][N]) {
    int k,j;

    for (k=0; k<N; k++) {
     tareador_start_task("ffts1_planes_loop_k");
     for (j=0; j<N; j++) {
        fftwf_execute_dft( p1d, (fftwf_complex *)in_fftw[k][j][0], (
            fftwf_complex *)in_fftw[k][j][0]) ;
     }
     tareador_end_task("ffts1_planes_loop_k");
    }
}


int main(){
 ...
  tareador_start_task("1");
    transpose_xy_planes(tmp_fftw, in_fftw);
    tareador_end_task("1");

    ffts1_planes(p1d, tmp_fftw);

    tareador_start_task("3");
    transpose_zx_planes(in_fftw, tmp_fftw);
    tareador_end_task("3");

    ffts1_planes(p1d, in_fftw);

    tareador_start_task("5");
    transpose_zx_planes(tmp_fftw, in_fftw);
    tareador_end_task("5");

    tareador_start_task("6");
    transpose_xy_planes(in_fftw, tmp_fftw);
    tareador_end_task("6");
 ...
}
```

3.2.3 Version 3

```
void transpose_xy_planes(fftwf_complex tmp_fftw[][N][N], fftwf_complex
     in_fftw [][N][N]) {
    int k,j,i;

    for (k=0; k<N; k++) {
     tareador_start_task("transpose_xy_planes_loop_k");
     for (j=0; j<N; j++) {
       for (i=0; i<N; i++)
       {
         tmp_fftw[k][i][j][0] = in_fftw[k][j][i][0];
         tmp_fftw[k][i][j][1] = in_fftw[k][j][i][1];
       }
     }
     tareador_end_task("transpose_xy_planes_loop_k");
   }
}

void transpose_zx_planes(fftwf_complex in_fftw[][N][N], fftwf_complex
     tmp_fftw[][N][N]) {
    int k, j, i;

    for (k=0; k<N; k++) {
     tareador_start_task("transpose_zx_planes_loop_k");
     for (j=0; j<N; j++) {
       for (i=0; i<N; i++)
       {
         in_fftw[i][j][k][0] = tmp_fftw[k][j][i][0];
         in_fftw[i][j][k][1] = tmp_fftw[k][j][i][1];
       }
     }
     tareador_end_task("transpose_zx_planes_loop_k");

    }
}

int main(){
 ...
  tareador_start_task("init_complex_grid");
    init_complex_grid(in_fftw);
    tareador_end_task("init_complex_grid");

    STOP_COUNT_TIME("Init Complex Grid FFT3D");

    START_COUNT_TIME;
```

```
    ffts1_planes (p1d,  in_fftw );
    transpose_xy_planes(tmp_fftw,  in_fftw );
    ffts1_planes (p1d, tmp_fftw);
    transpose_zx_planes( in_fftw ,  tmp_fftw);
    ffts1_planes (p1d,  in_fftw );
    transpose_zx_planes(tmp_fftw,  in_fftw );
    transpose_xy_planes( in_fftw ,  tmp_fftw);
...
}
```

3.2.4 Version 4

```
void init_complex_grid(fftwf_complex  in_fftw [][ N][N]) {
  int k,j,i;

  for (k = 0; k < N; k++) {
    tareador_start_task ("transpose_init_complex_grid_loop_k");
    for (j = 0; j < N; j++) {
      for (i = 0; i < N; i++)
      {
        in_fftw [k][j][i][0] = (float) (sin(M_PI*((float)i)/64.0)+sin(M_PI
            *((float)i)/32.0)+sin(M_PI*((float)i/16.0)));
        in_fftw [k][j][i][1] = 0;
#if TEST
        out_fftw[k][j][i][0]= in_fftw [k][j][i][0];
        out_fftw[k][j][i][1]= in_fftw [k][j][i][1];
#endif
      }
    }

     tareador_end_task("transpose_init_complex_grid_loop_k");
 }
}
int main(){
...

init_complex_grid( in_fftw );
    STOP_COUNT_TIME("Init Complex Grid FFT3D");

    START_COUNT_TIME;

    ffts1_planes (p1d,  in_fftw );
    transpose_xy_planes(tmp_fftw,  in_fftw );
    ffts1_planes (p1d, tmp_fftw);
    transpose_zx_planes( in_fftw ,  tmp_fftw);
```

```
   ffts1_planes (p1d, in_fftw );
   transpose_zx_planes(tmp_fftw, in_fftw );
   transpose_xy_planes( in_fftw , tmp_fftw);
 ...
}
```

3.2.5 Version 5

Version	T_1	T_∞	Parallelism
seq			
v1			
v2			
v3			
v4			
v5			

4 Conclusions