Appendix A: Characteristics of Local Area Networks

This appendix shows the main hardware and software characteristics of local networks and their computers used in the experimentation. The two main reasons for including an appendix dedicated to the description of the hardware and software used are:

1. There are several chapters dedicated to the experimentation carried out to observe different performance indexes and, thus, repeating all the information in each chapter would be redundant.

2. There exist several characteristics which the performance of a computer depends on, and, thus, a single enumeration of each of them would result in a deviation from what is exposed in each experimentation chapter.

In the context of parallel applications running over computer networks is important to know the topology of the computer interconnection network. For this reason, it is also important to include some hardware details of the local networks and their computers - over which the experimentation has been carried out.

A.1 Introduction: Hardware and Software Characteristics

A computer's performance generally depends on several design factors of its architecture and also on the way software makes use of the available hardware (optimization level). In this case, *software* encompasses from the operating system to the very application program implemented to be executed over the computer.

Hardware characteristics considered as essential in terms of a computer's performance usually are:
1. (Micro)Processor.
2. Clock frequency.
3. Main memory size.

This list used to include the cache memory size of first level (*L1 cache size*). However, as integration technologies advances, processors actually include, and univocally defines, this memory level. Furthermore, a great quantity of standard processors also includes the second memory level (*L2 cache*) in the same integrated circuit, and thus this second cache memory level is univocally determined by the processor. Anyway, due to the fact that the complete memory hierarchy (which includes all available cache memory levels) has an important impact on the computers. performance, and also in order to obtain a fast and complete view of each computer.s architecture, this appendix includes the data of:
1. cache memory level (L1, L2, etc.);
2. cache memory size. If the cache memory is divided, the sizes for data (D) and instructions (I) are given separately, if it is unified, the total size is given;
3. location of cache memory (Internall or Externall in relation to the processor),

of all levels of each computer.s available cache memory. Also, in reference to the memory hierarchy, the configured swap space (size) is included for each machine,

In order to have a *complete* (or more general) reference of the type of machine, the following data are included:
1. Computer manufacturer (*Trademark*), in the case of some PCs, we mentioned that are built in parts.
2. Model, indicating the *type* of computer (PC or model determined by the manufacturer-trademark).
3. Name: identification of the computer within the local network. These names are previously assigned in each local network by the administrator of each computer and thus may not be necessarily related to parallel computation.

The most important software characteristics detailed for machines are:

1. Operating system.
2. Compiler.
3. Optimization options used in compiling. When these optimization options are not used, those used will be explicitly mentioned in the appropriate context.

Even though there exist more hardware and software characteristics than could be

mentioned for each computer, it is considered that those detailed might render a rather complete and explicit idea of "machine".

It is quite interesting to make a comment on the bibliography and / or papers of computers. characteristics. Several Unix-derived operating systems have their own command/s for the description of hardware, though they are not generally common to all Unix versions and, thus, they should be looked for in the corresponding guidebooks.

At another level of detail, it is rather simple to find information about processors in each manufacturer.s web page, as well as to find information about computers that are provided by renowned companies. However, the difficulties may dramatically increase depending on:

- Computer-processor.s age. As expected, for computers of more than five years (depending on the manufacturer), it is quite difficult to find detailed information.
- PCs built in parts. Also as expected, the information about each PC is very specific in terms of the moment it was built and also of the supplier in itself. Details such as system bus and RAM speeds usually depend on the respective market situation at the time of the construction of the machine.

A.2 Local Area Networks

Computers are located in three local networks, which will be named according to the laboratory they belong to:

1. CeTAD: Center for Analog-Digital Techniques (*Centro de Técnicas Analógico-Digitales*), Electrontechnics Department, Faculty of Engineering, National University of La Plata. It is the eldest network installed, and its computers are used for several purposes.
2. LQT: Theoretical Chemistry Laboratory (*Laboratorio de Química Teórica*), CEQUINOR, Chemistry Department, Faculty of Exact Sciences, National University of La Plata. This network - installed several years ago - aims at solving numerical problems; sequential and parallel works developed with PVM and Linda are run.
3. LIDI: belongs to the Laboratory of Research and Development in Computer Sciences (*Laboratorio de Investigación y Desarrollo en Informática*), Faculty of Computer Sciences, National University of La Plata. It is dedicated to the teaching of parallel programming and research. It can be directly considered as of Beowulf-type, although not belonging to the most expensive in terms of number of machines and interconnection network.

The two first local networks are connected to Internet, being in fact subnetworks of an Internet class B network. The following subsections show the names of the computers together with the physical setup of each of the local networks.

A.2.1 CeTAD Local Area Network

The local network located in CeTAD might be one of the most representatives of those local networks that have been evolving for many years. In addition, these machines have several purposes, which encompass administrative paper work, signal processing algorithm prototyping and specific purpose integrated circuits design. It started with three or four computers interconnected by coaxial cable and, as from its creation, it has evolved towards four directions:

1. Computers update: replacing or updating them in parts.
2. Computers addition.
3. Shared-networked printer.
4. Computers. shared local disks.

Fig. A.1 schematically shows the physical interconnection of computers together with their names.

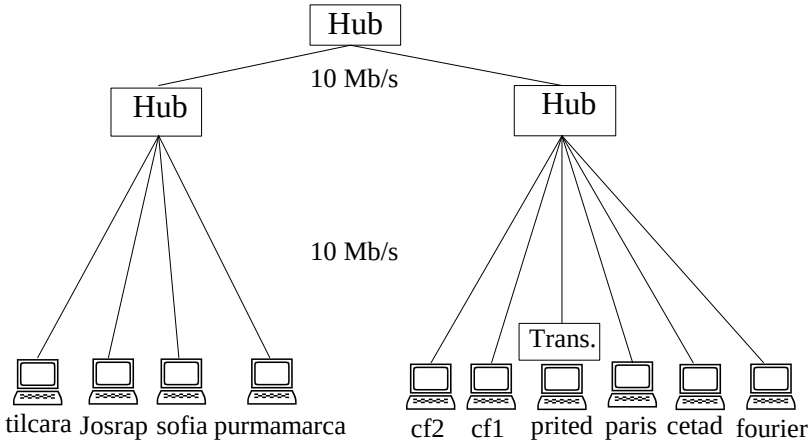

Figure A.1: CeTAD Local Area Network.

Computers appearing in Fig. A.1 with the names **cf1** and **cf2** are in fact referred to as **cetadfomec1** and **cetadfomec2** respectively, but they have been -and, generally, will be- abbreviated for space's sake.

Fig. A.1 only shows those computers in the local area network used for parallel computation. Thus, the following have been excluded:

- other nine computers that are interconnected with those shown but are not used for parallel computation,
- a computer dedicated to *router-gateway* and *spooler* of common printing,
- the shared printer, also connected directly to the network.

As in all hub-based networks, the isolation of a subset of computers from the rest depends on the quantity and distribution of hubs. In the specific case of this local network, the isolation of the ten computers of Fig. A.1 from the rest is quite simple since all machines and hubs are in the same room.

A.2.2 LQT Local Network

The computers of the LQT local network are exclusively used for intensive computing applications and for the same parallel computing applications. As it is a network with relatively few computers, it is not so complex in terms of interconnection wiring. In fact, it only has the minimum and necessary installed for such end, without the *classic* office tools such as text editors/formatters or spreadsheets. However, like the CeTAD local network, it has been installed and in use for several years now and has thus been updated (and *enhanced*) several times.

Fig. A.2 schematically shows the physical interconnection and the names of the six machines of the network which were used for parallel computation. Other three computers, which are not used for parallel computation, and one computer dedicated to the network.s *router-gateway* have also been omitted in this case..

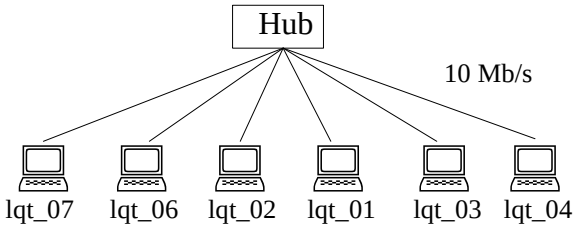

Figure A.2: LQT Local Area Network.

A.2.3 LIDI Local Network

Unlike the two previous local networks:

- LIDI local network has been planned and built exclusively for parallel computation and, for this reason, it also coincides with a Beowulf installation.
- Its installation is less than a year old and has not suffered any change, remaining homogeneous.
- Each computer.s interconnection card (NIC: Network Interface Card) is Ethernet of 10/100 Mb/s.
- An Ethernet switch of 10/100 Mb/s. is used. Consequently, computers not only communicate with each other at 100 Mb/s, but they can also carry out simultaneous and multiple point-to-point data transferences.

Fig. A.3 schematically shows the physical interconnection and the names of the eight computers used for parallel computation. Despite the fact that, from the point of view of the assignation of IP numbers (Internet Protocol), this local network is part of another - which has several other computers, printers, shared disks, etc. -, it can also be considered separately by simply disconnecting the uplink from the communications switch. In fact, the isolation of this local network from the remaining computers and its associated traffic in the network is rather simpler than in the case of CeTAD and LQT local networks.

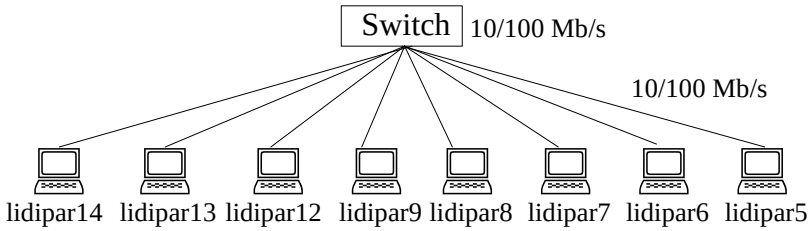

Figure A.3: LIDI Local Area Network.

A.3 Computers' Details

This section provides the characteristics mentioned in the first section of each computer belonging to each local network.

A.3.1 CeTAD Local Area Network's Computers

1) Name: purmamarca
Trademark: Built in parts
Model: PC
Processor: Pentium II
Clock: 400 MHz
Cache L1 Size: 16 KB data + 16 KB instr. Place: Internal
Cache L2 Size: 512 KB Unified Place: Internal
Main memory: 64 MB
Swap space: 128 MB
Operating system: Linux Red Hat 6.0 (kernel 2.2.5-15)
Compiler: gcc egcs-2.91.66 / egcs-1.1.2
Compiler options: -O3 -mcpu=pentiumpro -march=pentiumpro

2)-3) Names: cetadfomec1, cetadfomec2 (usually referred to as cf1 and cf2)
Trademark: IBM
Model: PC 300GL
Processor: Celeron 300A
Clock: 300 MHz
Cache L1 Size: 16 KB data + 16 KB instr. Place: Internal
Cache L2 Size: 128 KB Unified Place: Internal
Main memory: 32 MB
Swap space: 64 MB
Operating system: Linux Red Hat 6.0 (kernel 2.2.5-15)
Compiler: gcc egcs-2.91.66 / egcs-1.1.2
Compiler options: -O3 -mcpu=pentiumpro -march=pentiumpro

4) Name: sofia
Trademark: IBM

Model: RS/6000 43P-140
Processor: Power PC 604e
Clock: 200 MHz
Cache L1 Size: 32 KB data + 32 KB instr. Place: Internal
Cache L2 Size: 1 MB Unified Place: External
Main memory: 64 MB
Swap space: 128 MB
Operating system: AIX 4.3
Compiler: gcc 2.8.1
Compiler options: -O3 -mcpu=604

5) Name: fourier
Trademark: Built in parts
Model: PC
Processor: Pentium MMX
Clock: 200 MHz
Cache L1 Size: 16 KB data + 16 KB instr. Place: Internal
Cache L2 Size: 512 KB Unified Place: External
Main memory: 32 MB
Swap space: 64 MB
Operating system: Winlinux 2000 (kernel 2.2.13)
Compiler: gcc egcs-2.91.66 / egcs-1.1.2
Compiler options: -O3 -mcpu=pentium -march=pentium

6) Name: Josrap
Trademark: Built in parts
Model: PC
Processor: AMD K6-2
Clock: 450 MHz
Cache L1 Size: 32 KB data + 32 KB instr. Place: Internal
Cache L2 Size: 512 KB Unified Place: External
Main memory: 62 MB
Swap space: 64 MB
Operating system: Winlinux 2000 (kernel 2.2.13)
Compiler: gcc egcs-2.91.66 / egcs-1.1.2
Compiler options: -O3 -mcpu=pentium -march=pentium

7) Name: tilcara
Trademark: Built in parts
Model: PC
Processor: Pentium
Clock: 133 MHz
Cache L1 Size: 8 KB data + 8 KB instr. Place: Internal
Cache L2 Size: 256 KB Unified Place: External
Main memory: 32 MB
Swap space: 64 MB
Operating system: Linux Red Hat 6.0 (kernel 2.2.5-15)
Compiler: gcc egcs-2.91.66 / egcs-1.1.2

Compiler options: -O3 -mcpu=pentium -march=pentium

8) Name: paris
Trademark: Sun
Model: SPARCstation 4
Processor: MicroSPARC-II
Clock: 110 MHz
Cache L1 Size: 8 KB data + 16 KB instr. Place: Internal
Main memory: 96 MB
Swap space: 160 MB
Operating system: SunOS 5.5.1 - Solaris 2.5.1
Compiler: gcc 2.8.1
Compiler options: -O3 -mv8

9) Name: cetad
Trademark: Sun
Model: SPARCstation 5
Processor: MicroSPARC-II
Clock: 85 MHz
Cache L1 Size: 8 KB data + 16 KB instr. Place: Internal
Main memory: 96 MB
Swap space: 143640 KB
Operating system: SunOS 4.1.4
Compiler: gcc 2.8.1
Compiler options: -O3 -mv8

10) Name: prited
Trademark: Sun
Model: SPARCstation 2
Processor: CY7C601
Clock: 40 MHz
Cache L1 Size: 64 KB Unified Place: External
Main memory: 32 MB
Swap space: 65520 KB
Operating system: SunOS 4.1.3
Compiler: gcc 2.8.1
Compiler options: -O3

A.3.2 LQT Local Area Network's Computers

1) Name: lqt_01
Trademark: Built in parts
Model: PC
Processor: Pentium III - 550E
Clock: 550 MHz
Cache L1 Size: 16 KB data + 16 KB instr. Place: Internal
Cache L2 Size: 256 KB Unified Place: Internal

Main memory: 512 MB
Swap space: 64 MB
Operating system: Linux Red Hat 7.2 (kernel 2.4.2-2)
Compiler: gcc egcs-2.95.3
Compiler options: -O3 -mcpu=pentiumpro -march=pentiumpro

2) Name: lqt_02
Trademark: Built in parts
Model: PC
Processor: Celeron
Clock: 700 MHz
Cache L1 Size: 16 KB data + 16 KB instr. Place: Internal
Cache L2 Size: 128 KB Unified Place: Internal
Main memory: 512 MB
Swap space: 70 MB
Operating system: Linux Red Hat 7.2 (kernel 2.4.2-2)
Compiler: gcc 2.95.3
Compiler options: -O3 -mcpu=pentiumpro -march=pentiumpro

3) Name: lqt_03
Trademark: Built in parts
Model: PC
Processor: Pentium II
Clock: 400 MHz
Cache L1 Size: 16 KB data + 16 KB instr. Place: Internal
Cache L2 Size: 512 KB Unified Place: Internal
Main memory: 512 MB
Swap space: 128 MB
Operating system: Linux Red Hat 7.2 (kernel 2.4.2-2)
Compiler: gcc 2.95.3
Compiler options: -O3 -mcpu=pentiumpro -march=pentiumpro

4) Name: lqt_04
Trademark: Built in parts
Model: PC
Processor: Pentium II
Clock: 400 MHz
Cache L1 Size: 16 KB data + 16 KB instr. Place: Internal
Cache L2 Size: 512 KB Unified Place: Internal
Main memory: 512 MB
Swap space: 128 MB
Operating system: Linux Red Hat 7.2 (kernel 2.4.2-2)
Compiler: gcc 2.95.3
Compiler options: -O3 -mcpu=pentiumpro -march=pentiumpro

6)-7) Name: lqt_06, lqt_07
Trademark: Built in parts
Model: PC

Processor: Pentium III
Clock: 1 GHz
Cache L1 Size: 16 KB data + 16 KB instr. Place: Internal
Cache L2 Size: 256 KB Unified Place: Internal
Main memory: 512 MB
Swap space: 1 GB
Operating system: Linux Red Hat 7.2 (kernel 2.4.2-2)
Compiler: gcc 2.95.3
Compiler options: -O3 -mcpu=pentiumpro -march=pentiumpro

A.3.3 LIDI Local Network's Computers

Names: lidipar14, lidipar13, lidipar12, lidipar9, lidipar8, lidipar7, lidipar6, lidipar5
Trademark: Built in parts
Model: PC
Processor: Pentium III
Clock: 700 MHz
Cache L1 Size: 16 KB data + 16 KB instr. Place: Internal
Cache L2 Size: 256 KB Unified Place: Internal
Main memory: 64 MB
Swap space: 128 MB
Operating system: Linux Red Hat 6.1 (kernel 2.2.12-20)
Compiler: gcc egcs-2.91.66
Compiler options: -O3 -mcpu=pentiumpro -march=pentiumpro