Universitat Politècnica de Catalunya
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Bachelor Degree in Informatics Engineering
Computer Engineering Specialization
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Thesis management course

Performance analysis and optimization of a combustion simulation

Final Degree Thesis

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Chapter 1

Background

This chapter introduces preliminary concepts needed to understand the work. We will take a look at:

- High Performance Computing (HPC) environment basics.

- Alya and the combustion use case.

- Application analysis methodology.

At first, we will understand how an HPC environment works, and we will contextualize it within the BSC MareNostrum4 infrastructure, which is the target environment for the application. Therefore, we also will work in the same domain. Then an introductory study of Alya and a hands-on is done to understand how to work with the application. Finally, we will discuss the application analysis methodology giving detail about the steps and the concepts behind.

1.1   HPC enviornment

For the sake of completeness concerning the work, I will explain the different
concepts of an HPC environment, contextualized in the BSC infrastructure.
A supercomputer, also known as a cluster, is a set of machines interconnected,
and usually coordinated to solve a problem. The machines are named
nodes, and each has memory, CPU, storage, and is running an operating
system. On the Marenostrum4 platform, each node consists of 2 physical
Intel Xeon Platinum 8160 with 24 cores each and 96 GB of DDR4 RAM.
There are also particular nodes with more memory available which are the
same but with 384 GB of DDR4 RAM.
Each node can send and receive data from the other nodes from the system.
Thus there is an interconnection network underlying. Networks are difficult
to design as we expect low latency and high bandwidth on communication
up to among 150.000 processes concurrently. The MareNostrum4 platform
uses Intel Omni-Path technology for interconnection. It has six routers
that are responsible for handling messages from a group of nodes, precisely
one-sixth of them. Intel Omni-Path allows speeds up to 100Gbps.
To send data, applications, use the Message Passing Interface (MPI) standard.
MPI allow programmers to divide the problem among the nodes in the
machine and do communications and synchronizations via the interconnection
network. HPC industry widely uses MPI, and therefore there are a lot of
implementations. As we work in the MareNostrum4 platform using Intel,
we will use the Intel MPI implementation which is optimized to use the
Intel Omni-Path interconnection network.

1.2 Alya and the combustion use case

1.3 Analysis

Bibliography