Chapter 22

OVERVIEW OF HIGH PERFORMANCE COMPUTERS

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Abstract The overview given here concentrates on the computational capabilities of the systems discussed. To do full justice to all assets of present days high-performance computers one should list their I/O performance and their connectivity possibilities as well. However, the possible permutations of configurations even for one model of a certain system often are so large that they would multiply the volume of this report, which we tried to limit for greater clarity. So, not all features of the systems discussed will be present. Still we think (and certainly hope) that the impressions obtained from the entries of the individual machines may be useful to many. We also omitted some systems that may be characterized as "high-performance" in the fields of database management, real-time computing, or visualization. Therefore, as we try to give an overview for the area of general scientific and technical computing, systems that are primarily meant for database retrieval like the AT&T GIS systems or concentrate exclusively on the real-time user community, like Concurrent Computing Systems, are not discussed in this report. Although most terms will be familiar to many readers, we still think it is worthwhile to give some of the definitions in section 2 because some authors tend to give them a meaning that may slightly differ from the idea the reader already has acquired.
1. Introduction

Before going on to the descriptions of the machines themselves, it is important to consider some mechanisms that are or have been used to increase the performance. The hardware structure or architecture determines to a large extent what the possibilities and impossibilities are in speeding up a computer system beyond the performance of a single CPU. Another important factor that is considered in combination with the hardware is the capability of compilers to generate efficient code to be executed on the given hardware platform. In many cases it is hard to distinguish between hardware and software influences and one has to be careful in the interpretation of results when ascribing certain effects to hardware or software peculiarities or both. In this chapter we will give most emphasis to the hardware architecture. For a description of machines that can be considered to be classified as “high-performance” one is referred to (Culler et al. 1998, van der Steen 1995).

2. The Main Architectural Classes

Since many years the taxonomy of Flynn (1972) has proven to be useful for the classification of high-performance computers. This classification is based on the way of manipulating of instruction and data streams and comprises four main architectural classes. We will first briefly sketch these classes and afterwards fill in some details when each of the classes is described.

- SISD machines: These are the conventional systems that contain one CPU and hence can accommodate one instruction stream that is executed serially. Nowadays many large mainframes may have more than one CPU but each of these execute instruction streams that are unrelated. Therefore, such systems still should be regarded as (a couple of) SISD machines acting on different data spaces. Examples of SISD machines are for instance most workstations like those of DEC, Hewlett-Packard, and Sun Microsystems. The definition of SISD machines is given here for completeness’ sake. We will not discuss this type of machines in this report.

- SIMD machines: Such systems often have a large number of processing units, ranging from 1,024 to 16,384 that all may execute the same instruction on different data in lock-step. So, a single