Chapter 15  Compilation of Parallel Languages

Parallel changes not only happen as social trend, but also happen on science and technology.

15.1 Motivation of the Chapter

This chapter will be totally different from previous chapters as so far there is no really grand new parallel programming language to be used already. What people have are only the parallel facilities parasitically affiliated to the existing languages. The discussions before mainly focus on the issues of compilation of sequential programming languages, and in this chapter and the following chapter we will discuss the issues on the compilation of parallel languages. Is it important? The answer is definitely yes. Because in the new century, no doubt, parallel computers will dominate the whole market of computers. Then developing programs for this kind of computers will be the must if some one wants to be the programmer of the new century. Of course he/she also needs to know how his/her programs are compiled by the corresponding compilers. It is not exaggerating that parallel compilation will become the main theme in compiler field.

15.2 Rising of Parallel Computers and Parallel Computation

The explorations and pursuing of people in science and technology are always continuing without cease. It is also true in computer science and technology. Since 1991 the U.S.A. proposed the plan of developing high performance computing and communication (HPCC). Many countries around the world correspondingly invested huge fund to carry out the development of high performance super computers. So far, the United states has successfully developed the super computer with the speed up to about one thousand trillions per second. China recently has also announced that the scientists and engi-
neers of their country have also successfully developed the super computer with the speed up to one thousand trillions per second. Other countries such as Germany, Japan, Russia, etc. also make their endeavor to develop the computers of this kind.

Since the speeds of the computers with single processor have almost reached the limitation—the information flows inside the computers of this kind cannot exceed 300 thousand kilometers per second. In order to develop high performance super computers, the only approach is depending on parallelism—to develop the cluster of high amount of computers working in parallel. For example, if each unit of the cluster computers has the speed of 10 millions per second, ten thousand units connected together and they are assembled well, then the speed of the cluster definitely will be one trillion per second. It may be said that the high performance computer is parallel in structure. Now the parallel processing modes experienced several phrases, from single instruction stream and multiple data stream (SIMD), parallel vector processors (PVP), storage-sharing symmetric multiprocessors (SSSM), massively parallel processors (MPP) to cluster. These parallel architectures may roughly be divided into five classes [1]:

1) Single instruction multiple data stream array processors: They consist of thousand-thousand processors with very simple functions. Data flow through each processor with certain modes and then are processed. SIMD type parallel computers played an important role in the stimulation development of parallel computers. However, since the development of the micro processing chips, SIMD type parallel computers used in scientific and technological computation have basically retreated from the stage after 1990s.

2) Parallel vector processors: In addition to scalar registers and scalar components, vector processor computers have also special vector registers and vector stream function components that can quickly handle vector computation.

3) Main memory-sharing processors systems: Multi-processors share one centralized memory and also possess special multi-processor synchronous communication component that can support the development of data parallelism and control parallelism. But when there are too many processors, the channels that link each processor with central memory will become bottleneck, so that they constrain the development of the computers of this kind. People then turned to investigate large-scale parallel computers.

4) Distributed memory multi-processor systems: They are computers composed of lots of nodes. Each node has its own processors and memory and Internet is the link among nodes. It mainly supports the parallel development of data, as well as control.

5) Computer cluster systems: They are the sets that consist of all computer nodes physically connected each other by high performance networks and local networks. In usual case, each computer node is a symmetric multi-processor server, a work station (WS), or a PC. The nodes may be isomorphic, they may also be isomeric. The number of the processors generally is several