PART III

Parallel Architectures

and

VLSI Logic
Semantic Specifications for the
Rewrite Rule Machine

Joseph A. Goguen
Programming Research Group, Oxford University
SRI International, Menlo Park CA 94025

Abstract: This paper presents three semantic specifications for the Rewrite Rule Machine. This machine consists of a large number of parallel rewrite processors operating independently, each implemented as a VLSI chip. The first specification, called parallel rewriting, provides an abstract operational semantics for the rewrite processor. The second specification, called the cell machine model, provides a more concrete operational semantics for this processor, using algebraic semantics (in OBJ) and set theory. The third specification, called concurrent rewriting, gives an abstract semantics for the Rewrite Rule Machine as a whole.

1 Introduction

The goal of the Rewrite Rule Machine (RRM) project is

to design, build and test a prototype multi-grain, massively parallel computer architecture especially suited for executing non-homogeneous programs written in declarative ultra high level languages.

The RRM architecture is a multi-grain hierarchy, with several different levels of organization, each having a different structure. These levels may be described as follows:

1. A cell stores one item of data and pointers to two other cells.

2. A tile provides shared communication resources for a small number of cells.

3. An ensemble consists of many tiles executing instructions broadcast from a common central controller.

4. A cluster interconnects many ensembles to cooperate in a larger computation.

5. A network interconnects several clusters to give a complete RRM.

This paper concentrates on the third level, the ensemble. A single ensemble consists of a controller which broadcasts microcode instructions to its array of cells; hence it executes in SIMD (Single Instruction Multiple Data) mode. A complete RRM consists of many such ensembles, each executing its own independent instruction stream; hence it operates in MIMD (Multiple Instruction Multiple Data) mode. In this paper, the Rewrite Rule Machine is presented as an abstract architecture that is not committed to any particular number or structure for the units at each of these levels, and that deliberately fails to model many lower level details. However, a concrete prototype RRM, which of course does make particular choices for these parameters is being constructed at SRI international, as described in [26, 14] and [2].

\footnote{Actually, the terms MIMD and SIMD are somewhat misleading when applied to the RRM, because of its multi-grain architecture, and also because of its autonomous processes.}