Chapter 07: Instruction–Level Parallelism—VLIW, Vector, Array and Multithreaded Processors …

Lesson 02:

Pipeline level and higher level Parallelism Concepts in Parallel Processing

Objective

- To learn effects of parallel pipelines

- To learn superscalar processors

- Understand pipeline and higher levels of parallelisms

Pipeline Parallelism

3

# Pipelining Parallelism Concepts - Superscalar Processor

- Execute several instructions is parallel

- Two or more instructions execute in parallel as well as in pipeline

- The instructions that make up a program are handled in superscalar processors by the instruction issue logic

Instruction issue logic

- The logic issues instructions to the units in parallel

- This allows control flow changes, such as branches, to occur simultaneously across all of the units, making it much easier to write and compile programs for instruction-level parallel superscalar processors

Two or More Parallel Pipelines

Parallel pipelines
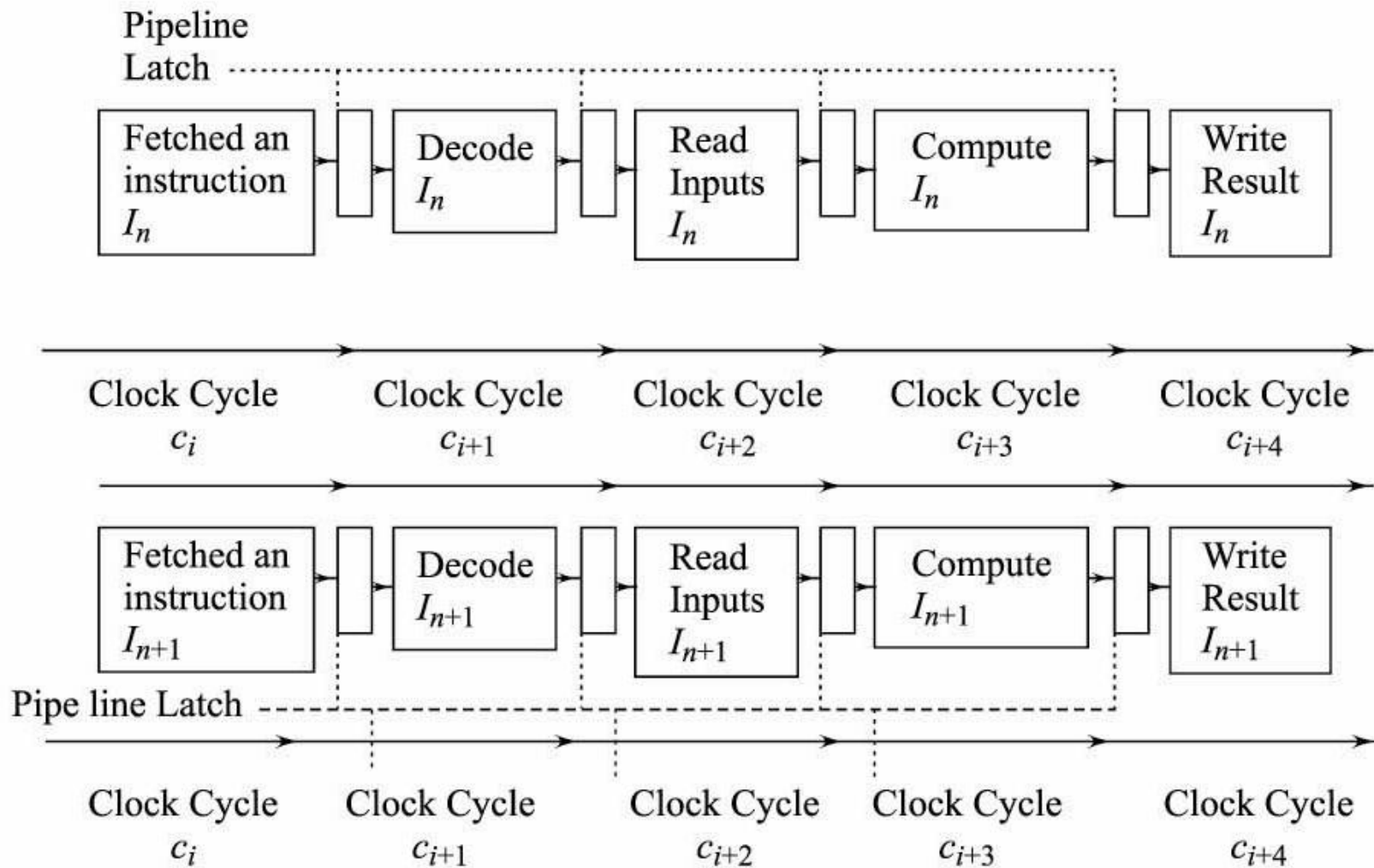
ARM7 pipelines in parallel

- Performance further improves in processors by allowing independent instructions to execute simultaneously (called instruction-level parallelism)

Pipelining and instruction-level parallelism combine in the superscalars

- Most modern processors (called superscalars) employ both techniques to improve performance

Examples of pipelining and parallel processing of instructions

- SunSparc
- Pentium,
- PowerPC
- ARM

Parallel processing techniques to exploit instruction-level parallelism

- Superscalar

- VLIW processing

- Vector processing

- Array processing

Instruction Issue Logic and Four execution units in a superscalar

Instruction Issue (Scheduling) Logic

Register File

4 Execution Units

12
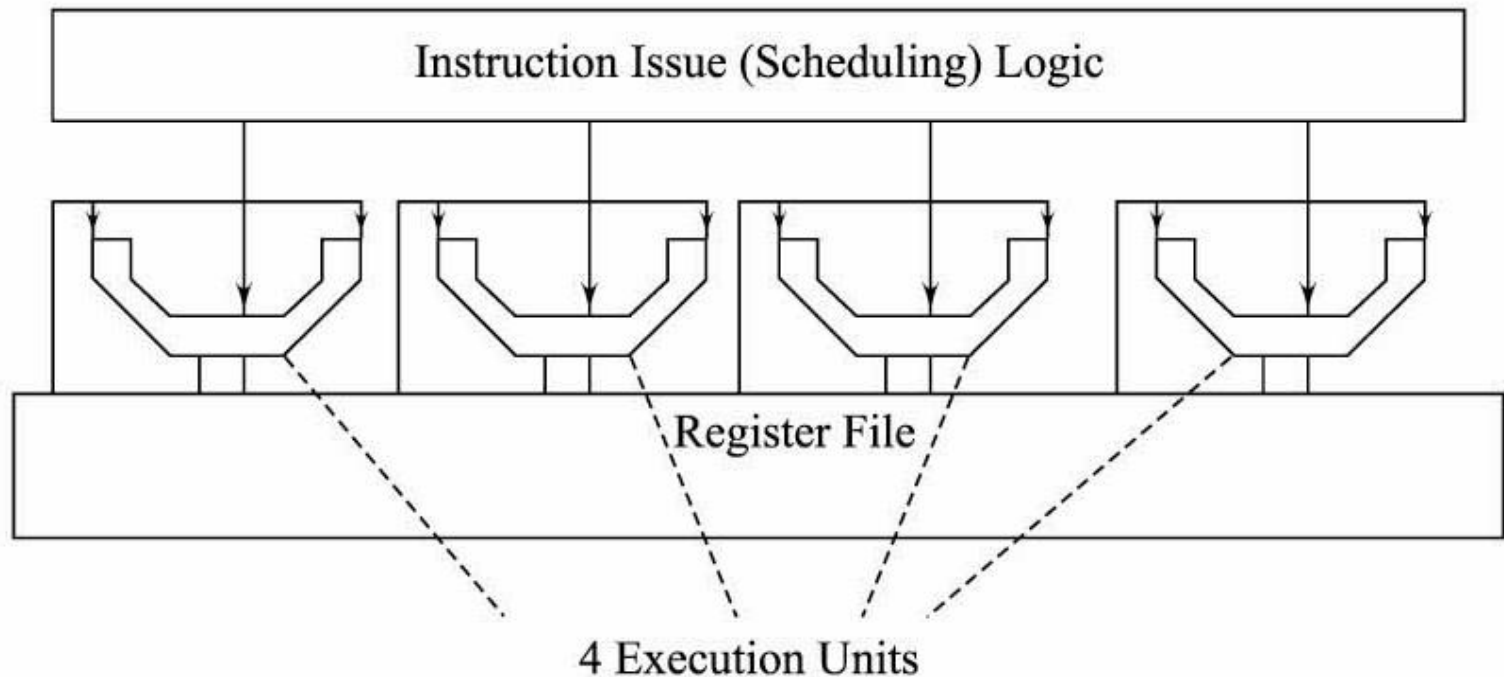
VLIW Processing

- VLIW instruction-level parallelism relies on the compiler to determine which instructions may be executed in parallel and providing that information to the processor hardware (instruction issue logic)

VLIW Processing

- Require that programs be recompiled for the new architecture, but achieve very good performance on programs written in sequential languages such as *C* or FORTRAN when these programs are recompiled for a VLIW processor

Vector Processing

- The operations such as multiply are first divided into several steps and a stream of operands (called vectors) operated in for each step parallel processing units

15

Vector Processing

- A vector processor functions for instruction level parallelism by using instruction-parallel architecture along with vector element operands in the parallel processing pipelines

- It is most common special case of pipelining

Array Processing

- The operations are first divided into several streams of operands (called array elements) and run for each stream in the parallel processing units

- It is a special case of pipelining, where the parallel pipelines operate on different streams of operands

- An array processor functions as data parallelism by using data-parallel architecture. There is single instruction processing multiple data in parallel processing units

Array Processing

- An array processor functions as data parallelism by using data-parallel architecture

- Single instruction processing multiple data in parallel processing units

18

Multithreaded Processing

- The operations─ first divided into several threads, and then each thread is divided into instruction streams

- Instruction streams in parallel

- Concurrent execution of thread

- When a thread is blocked or delayed then another thread instruction-streams run in the pipelines

Thread-issue-logic in Multithreaded Processing

- Can run different threads in time slicing mode or in priority mode

- A special case of parallel processing, where the parallel pipelines operate on instruction streams of a thread

Multiprocessor Systems─ Highest level Coarse-grained Parallelism

- Multiprocessors give parallelism at processor level

- An application divided into number of processes

- Each process may be broken into threads each of which processes by two or more processors or processor cores on single chip

Multiprocessor Systems─ Highest level Coarse-grained Parallelism

- Processors may be identical or heterogeneous and distributed

- Inter-process communication between different processors

- The ration of time spent in computation on one processor << the inter-process communication time

Summary

We Learnt

- Parallel Pipelines improves Performance
- Superscalars has special hardware techniques to enable issue of instructions after resolving conflicts by scheduling the instructions dynamically and by predicting branches by hardware in superscalar
- VLIW processor
- Vector processor
- Array processor

We Learnt

- Multithreaded processor
- Multiprocessor system

Schaum's Outline of Theory and Problems of Computer Architecture
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End of Lesson 02 on

Pipeline level and higher level Parallelism Concepts in Parallel Processing