Computer Architecture

Textbooks for reading:


1. Computer performance metrics
   - Execution time
   - Clock cycle rate
   - Clock cycle time
   - MIPS rate
   - Instruction count
   - Throughput
   - Response time
   - Benchmark programs
   - Amdahl’s Law
   - Moor’s Law

2. Processors

   2.1 Instruction set architectures
      - RISC/CISC designs
      - Various types of instructions
      - Memory addressing modes
      - Performance analysis for the above topics

   2.2 Processor architectures
      - Stack-based architecture processors
      - Register-based architecture processors
      - Accumulator architecture processors
      - Register-Memory architecture processors
      - Register-Register architecture processors
      - Memory-memory architecture processors
      - Performance analysis for the above topics

   2.3 Datapath architectures
      - Scalar, super-scalar, pipeline, super-pipeline architectures
      - VLIW and vector datapath processors
      - Speed-up factor for various datapath architectures
      - Impact of deep pipeline processors
- Different types of pipeline hazards
- Hardware and software solutions for various pipeline hazards
- Dynamic and static solutions for various pipeline hazards
- Different types of data dependency
- Different solutions for different data dependency
- Multi-function unit pipelines
- Dynamic branch prediction and speculative executions
- Score-board dynamic instruction scheduling and out-of-order executions
- Performance analysis for the above topics

3. Memory subsystem

3.1 Memory hierarchy
- Concepts
- Performance analysis for the above topics

3.2 Cache memory
- Average memory access latency
- Write-through and write-back cache policy
- Cache associativity
- Impacts from cache misses
- Solutions for cache misses
- Memory interleaving and memory pipelining
- Performance analysis for the above topics

3.3 Virtual Memory
- Concepts of logical and physical address
- Performance analysis for the above topics
- Paging
- Performance analysis for the above topics

3.4 Segmentation
- Concept of segmentation
- Performance analysis for the above topics

4. Bus

4.1 Basic knowledge of bus
- Concept
- Performance analysis

4.2 Types of wires in bus
- Concept
- Different types of I/O device addressing
- Performance analysis
4.3 Internal and external bus
   • Concept
   • Performance analysis

4.4 Performance metrics in bus
   • Concept
   • Performance analysis

4.5 Bus arbitrations
   • Concept
   • Performance analysis

5. I/O Devices

5.1 Different types of I/O devices

5.2 Methods for I/O device accesses
   • Programmed I/O’s, interrupts, centralized DMA, and cycle-stealing DMA
   • Performance analysis

5.3 Queuing theory
   • Concept
   • Performance analysis

6. Parallel computing

6.1 Different levels of parallel computers
   • Instruction-level parallelism
   • Thread-level parallelism
   • Function-level parallelism
   • Process-level parallelism
   • Computer-level parallelism
   • Performance analysis

6.2 Different models for parallel computing
   • SISD
   • SIMD and vector-multiplication algorithms
   • MISD
   • MIMD
   • Performance analysis

6.3 Cache consistency issues in parallel computers
   • Concept
   • MESI cache consistency protocol
   • Performance analysis
7. Other topics related to the existing processors
   - Intel’s hyper-threading
   - Intel’s micro-operations
   - Performance analysis