

# **AN 1652 COMPUTER ARCHITECTURE & PARALLEL PROCESSING**

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## AN 1652 COMPUTER ARCHITECTURE & PARALLEL PROCESSING PART – A

1. What are the two major stages of development in computer?

Mechanical and electronic

2. Define Flynn's classification?

SISD, SIMD, MIMD, MISD

3. What are the different shared memory multiprocessor models?

Uniform memory access, Non Uniform memory access, Cache only memory access

4. Define vector computer?

A vector computer is often built on top of a scalar processor; the vector processor is attached to the scalar processor as an optional feature

5. What are the 5 tuples of SIMD computer?

$M = \{N, C, I, M, R\}$

6. What are the different PRAM variants?

1. EREW PRAM model

2. ERCW PRAM model

3. CREW PRAM model

4. CRCW PRAM model

7. How conflicting write problem of CW is solved?

By four policies, they are common, minimum, arbitrary, priority

8. Define data dependence?

There are five data dependence they are

1. Flow dependence

2. Anti dependence

3. Output dependence

4. I/O dependence

5. Unknown dependence

9. Define hardware parallelism?

This refers to the type of parallelism defined by machine architecture and hardware multiplicity

10. Define software parallelism?

This parallelism is defined by control and data dependence of programs

11. Define grain size?

Grain size is a measure of the amount of computation involved in a software process

12. Define control flow computers?

They use shared memory to hold program instructions and data objects

13. Define node degree?

The number of edges incident on a node is called node degree  $d$

14. Define network performance?

Functionality, network latency, bandwidth, hardware complexity, scalability

15. Define digital bus?

A bus system is essentially a collection of wires and connectors for data transactions among processors, memory modules and peripheral devices attached to the bus

16. What are the advantages of crossbar network?

The highest bandwidth and interconnection capability are provided by crossbar networks

17. Define Degree of parallelism?

The execution of a program on a parallel computer may use different number of processors at different time periods during the execution cycle for each time period the number of processors used to execute a program is defined as DOP

18. Define 3T performance?

Based on the grand challenges in scientific computing we need to provide computers with 1 teraflops of computing power, 1 tera byte of main memory and 1 tera bytes of I/O bandwidth

19. What are the different speedup performance laws?

Amdahl's law for fixed workload, Gustafsons law and Sun and Nis law

20. Define machine size?

The number of processors employed in a parallel computer system A large machine size implies more resources and more computing power

21. Define memory capacity?

The amount of main memory used in a program execution

22. Define communication overhead?

The amount of time spent for interprocessor communication, synchronization, remote memory access etc.

23. What is CPU?

The central processor of a computer is called CPU

24. Define CISC scalar processor?

A scalar processor executes with scalar data

25. What is a scalar processor?

Scalar processors are those executing one instruction per cycle, only one instruction is issued per cycle and only one completion of instruction is expected from the pipeline per cycle

26. What is a superscalar processor?

In this multiple instruction pipelines are used, this implies that multiple instructions are issued per cycle and multiple results are generated per cycle.

27. What is a vector processor?

A vector processor executes vector instructions on arrays of data. thus each instruction involves a string of repeated operations which are ideal for pipelining with one result per cycle

28. What are the uses of symbolic processors?

It is used in theorem proving, pattern recognition, expert systems, knowledge engineering, text retrieval cognitive science and machine intelligence

29. What are the other names of symbolic processors?

Prolog processors or lisp processors

30. What is temporal locality?

Recently referenced items are likely to be referenced again in the near future .This is often caused by special program constructs such as iterative loops, process stacks, temporary variables or subroutines

31. Define spatial locality?

This refers to the tendency for a process to access items whose addresses are near one another

32. Define sequential locality?

In typical programs, the execution of instructions follows a sequential order

33. What is TLB?

Translation look aside buffer is a high speed lookup table which stores the most recently or likely referenced page entries

34. What is memory swapping?

Memory swapping is the process of moving blocks of information between the levels of memory hierarchy

35. Define sequential consistency?

A multiprocessor system is sequentially consistent if the result of any execution is the same as the operation of all the processors were executed in some sequential order

36. What is a linear pipeline processor?

A linear pipeline processor is a cascade of processing stages which are linearly connected to perform a fixed function over a stream of data flowing from one end to the other

37. Define pipeline throughput?

This is essentially the initiation rate or the average number of task initiations per clock cycle

38. What is pipeline efficiency?

The percentage of time that each pipeline stage is used over a sufficiently long series of task is stage utilization. The accumulated rate of all stage utilization determines the pipeline efficiency

39. What is Fetch stage?

Fetch stage (F) fetches instruction from a cache memory presumably one per cycle

40. What is Decode stage?

Decode stage reveals the instruction function to be performed and identifies the resource needed

41. What is issue stage (I)?

Issue stage reserves resources. pipeline control interlocks are maintained at this stage

42. What is writeback (W) stage?

Writeback is used to write results

43. How fixed point operations are represented?

Fixed point numbers are represented internally in machines in sign magnitude, ones complement or twos complement notation. Most computers use twos complement notation because of its unique representation of all numbers including zero

44. What is pipeline stalling?

This is a problem which may seriously lower pipeline utilization. proper scheduling avoids pipeline stalling

45. What is the use of snoopy protocol?

Snoopy protocol achieve data consistency among the caches and shared memory through a bus watching mechanism

46. What is meant by read miss?

When a processor wants to read a block that is not in the cache a read miss occurs

47. What is the use of adaptive routing?

Main purpose of using adaptive routing is to avoid dead lock

48. What is meant by multicast pattern?

A multicast pattern corresponds to one to many communications

49. Define compound vector function?

Compound vector function is defined as a composite function of vector operations converted from a looping structure of linked scalar operation.

50. What is meant by vector loops or strip mining?

When a vector has a length greater than that of the vector registers, segmentation of the long vector into fixed length segments is necessary. This technique is called strip mining

51. Define systolic array?

Systolic array is formed with a network of functional units which are locally connected and operates synchronously with multidimensional pipelining.

52. What is prefetching technique?

Prefetching uses knowledge about the expected misses in a program to move the corresponding data close to the processor before it is actually needed

53. What is meant by processor consistency?

Goodman introduced the processor consistency model in which writes issued by each individual processor are always in program order

54. What is meant by switch on cache miss?

This policy corresponds to the case where a context is preempted when it causes a cache miss

55. What is meant by critical section?

A critical section is a code segment accessing shared variables which must be executed by only one process at a time and which once started must be completed without interruption.

56. What is meant by multiprogramming?

Multiprogramming is defined as multiple independent programs running on a single processor or on a multiprocessor by time sharing use of the system resources.

57. What is meant by multiprocessing?

When multiprogramming is implemented at the process level on a multiprocessor it is called multiprocessing

58. What is compound vector function?

Compound vector function is defined as a composite function of vector operations converted from a looping structure of linked scalar operations

59. What is meant by mutual exclusion?

At most one process executing the critical section at a time

60. What is meant by multitasking?

A single program can be partitioned into multiple interrelated tasks concurrently executed on a multiprocessor. This has been implemented as multitasking on Cray multiprocessors

61. What is meant by multithreading?

The concept of multithreading is an extension of the concepts of multitasking and multiprocessing. The purpose is to exploit fine grain parallelism in modern multiprocessors built with multiple context processors with multiple instruction issues.

62. What is meant by synchronous message passing?

Synchronous message passing must synchronize the sender process and the receiver process in time and space just like a telephone call.

63. What is meant by asynchronous message passing?

Asynchronous communication does not require that message sending and receiving be synchronized in time and space

64. Define micro tasking?

This corresponds to multitasking at the loop control level with finer granularity.

65. Define Auto tasking?

The auto tasking feature automatically divides a program into discrete tasks for parallel execution on a multiprocessor

66. What is Dekker's protocol?

To guarantee mutual exclusion without unnecessary waiting, Dekker has suggested the use of separate request variables by different processes along the use of a spin lock

67. What are spin locks?

The entrance and exit of a CS can be controlled by a binary spin lock mechanism in which the gate is protected by a single binary variable  $x$ , which is shared by all processes attempting to enter the CS

68. What is meant by system deadlock?

System dead lock refers to the situation in a multiprocessor when concurrent processes are holding resources and preventing each other from completing their execution.

69. What is meant by deadlock avoidance?

Dynamic deadlock avoidance depends on the run time conditions, which may introduce a heavy overhead in detecting the potential existence of a deadlock.

70. What is meant by monitor structure?

A monitor is a high level program construct for structured programming that emphasizes modularity and encapsulation.

71. What is meant by host processes?

Host processes are those located outside the nodes, either in the host machine, which provides a message path between the multicomputer and a network or in other host machines connected via the network

72. What is meant by synchronous communication network?

In a synchronous communication network the sender process and receiver process must be synchronized in time and space

73. What is meant by functional decomposition?

An algorithm can be visualized as a set of interconnected functional modules.

74. What is meant by layered decomposition?

In solving large and complex problems, very often we have to employ a programmatic layered approach to extracting parallelism using different decomposition techniques at different levels .such an approach can be called layered decomposition.

75. What is a kernel?

The portion of the OS that resides continuously in the main memory is called kernel.

76. What is meant by gang scheduling?

The idea of using giant locks to separate the functions of kernel subsystems can be continually expanded until the kernel is fully multithreaded to handle many lightweight processes simultaneously

77. What is meant by semaphored kernels?

Instead of using spin locks one can use semaphores to implement multithreading. Spin locks are usually cheaper to apply and perform well in cases where resources are held for short durations.

78. What is meant by object oriented model?

This model treats an arbitrary number of tasks concurrently, each task using its own address space.

79. What is meant by node addressed model?

In this case only one task is running on each node at a time.

80. What is the use of Mach / OS kernel?

Mach / OS kernel provides task/thread management, multithreaded multitasking and IPC with messages via access ports

81. What is meant by task?

A task defines the resources environment in which threads run. Thus the task is a basic unit of resource allocation.

82. What is meant by threads?

Thread is a basic unit of CPU utilization.

83. What is meant by shared resource multithreading?

The creation of a single task with many threads of control executing in a shared address space using shared memory for communication and synchronization.

84. What is meant by message passing multitasking?

The creation of many tasks most likely on distributed processors communicating via messages.

85. What is meant by discouragement hints?

These hints suggest that the current thread should not run by giving up the processor to any other thread if possible by temporarily depressing the priority of the current thread or by blocking the current thread for a specified period.

86. What is meant by handoff hints?

These hints indicate that a specific thread should run instead of the current one.

87. What is a port?

A port is a communication channel logically a queue for messages protected by the kernel.

88. What is a message?

Messages are used to communicate between objects or among many objects.

89. What is meant by resident page table?

A table used to keep track of information about machine independent pages residing in the main memory

90. What is meant by multitasked clustering?

Clusters allow the user to determine how many processors are needed to work on an application. They permit the separation of interactive and computational tasks

91. Define computer architecture.

Computer architecture encompasses the specifications of an instruction set and the hardware units that implement the instructions.

92. Functional units of computer.

- Input unit
- Output unit
- Memory unit
- Control unit
- Arithmetic & logic unit.

93. What are the functions of PC, IR?

PC (Program Counter): is a specialized register that keeps track of the execution of a program. It contains the memory address of the instruction to be fetched and executed.

IR (Instruction Register): It holds the address of the currently executed instruction. Its output is available to the control circuits which generate the timing signal that control the various processing elements involved in executing the instruction.

94. Define bus.

A group of lines that serves as a connection path for several devices is called a bus.

95. What are the functions of system software?

System software is a collection of programs that are executed as needed to perform functions such as,

- Receiving and interpreting user commands.
- Entering & editing application program and storing the files in secondary storage devices.

96. Define compiler and OS.

Compiler: A system software program called compiler. It translates the high level language program into a suitable machine language program containing instructions such as load, add instructions.

OS: OS is a large program that is used to control the sharing of and interaction among various computer units as they execute application programs.

97. Define multitasking.

The operating system manages the concurrent execution of several application programs to make the best possible use of computer resources. This pattern of concurrent execution called multiprogramming or multitasking.

98. Define clock rate.

Let 'P' be the length of clock cycle. Its inverse is the clock rate,  $R=1/P$  which is measured in cycles per second.

99. Define pipelining.

A substantial improvement in performance can be achieved by overlapping the execution of successive instructions using a technique called pipelining.

100. Write about two possibilities of improving clock rate.

- Improving the IC technology which makes logic circuits faster.
- Reducing the amount of processing done is one basic step.

101. Write about super scalar execution.

A high degree of concurrency can be achieved if multiple instruction pipelines are implemented in the processor. This means that multiple functional units are used, creating parallel paths through which different instructions can be executed in parallel. This mode of operation is called superscalar execution.

102. Differentiate RISC and CISC.

RISC	CISC
Reduced instruction set computer.	Complex instruction set computer.
Large value for N, small value for s	Small value for N, large value for s.
Combined with pipelining, obtain better performance.	Easier to implement, efficient pipelining.

103. What do you mean by Byte addressability?

It is impractical to assign distinct address to individual bit locations in memory. The most practical assignment is to have successive addresses in reference to successive byte locations in the memory.

104. What are the memory operations?

- Load: It transfers a copy of the contents of a specific memory location to the processor. The memory contents remain unchanged.
- Store: It transfers an item of information from the processor to a specific memory location, destroying the former contents of the location.

105. Different types of operations performed by instruction.

- Data transfer between memory and processor.
- Arithmetic & logic unit
- Program sequencing and control
- I/O transfer.

106. Write the four commonly used flags.

- Negative flag – set, if the result is negative.
- Zero flag – set, if the result is 0.
- Carry flag – set, if there is carry
- Overflow flag – set, if there is over flow.

107. What is addressing modes & specify their types.

The different ways in which the location of an operand is specified in an instruction are referred to as addressing mode.

Types:

- Register mode
- Absolute mode
- Immediate mode
- Indirection mode
- Index addressing
- Relative addressing
- Auto increment/decrement.

108. What is assembly language and assembler?

Assembly language: A complete set of symbolic names & rules for their use constitute a programming language called assembly language.

Assembler: Programs written in assembly language can be translated into a sequence of machine instruction by a program called assembler.

109. What is meant by two pass assembler?

During the first pass, it will create complete symbol table. At the end of this pass, all of this pass, all names will have been assigned numerical values. The assembler then goes through the source program a second time and substitute values for all names from the symbol table such as assembler is called two pass assembler.

110. Define loader and debugger.

Loader- The object program must be loaded into the memory of the computer before it is executed. For this, loader performs a sequence of input operations needed to transfer the machine language program from the disk into specified place in the memory.

Debugger – Helps the user for finding programming errors, the system software includes a debugger program.

## **PART B**

1. Explain about speed up performance laws?
2. Explain about Multiprocessors?
3. Explain about Multicomputer?
4. Explain about Superscalar processors?
5. Explain about Vector processors?
6. Explain about TLB, paging and segmentation?
7. Explain about superscalar pipeline design?
8. Explain about message passing mechanism with message passing multicomputer?
9. Explain about multivector multiprocessor?
10. Explain about PRAM models?
11. Explain about VLSI models?
12. Explain about MACH/OS kernel architecture?
13. Explain about OSF/1 architecture and application?