Instruction format

&

Addressing Modes Formats

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Session Meta Data

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Revision History

Date of Revision	Details	Version Number

Session Objectives

- To explain the various Instruction & addressing modes and formats.

Session Outcomes

- At the end of the session, students will be able to

- Understand the various addressing modes and formats.

Outline

- Implied
- Immediate
- Direct
- Indirect
- Register
- Register Indirect
- Displacement (Indexed)
- Stack

Instruction Format

Instruction Formats

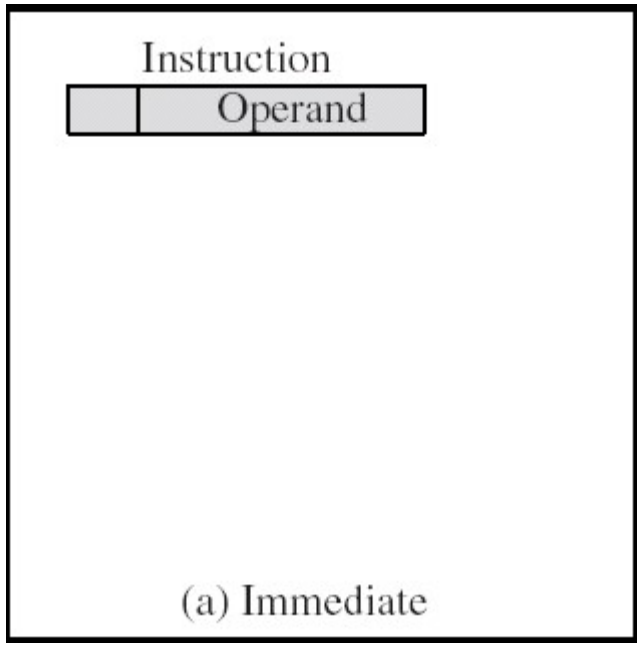
- Layout of bits in an instruction :
  - Includes opcode
  - Includes (implicit or explicit) operand(s)
  - Usually more than one instruction format in an instruction set
- Opcode: specifies type of operation to be executed
- Operand: data field

Instruction Length

- Affected by and affects:
  - Memory size
  - Memory organization
  - Bus structure
  - CPU complexity
  - CPU speed

Immediate Addressing

- Operand is part of instruction
- Operand = address field
- e.g. ADD AX, 5h
- LDA #5
  - Add 5 to contents of accumulator
  - 5 is operand
- No memory reference to fetch data
- Fast
- Limited range



Direct Addressing

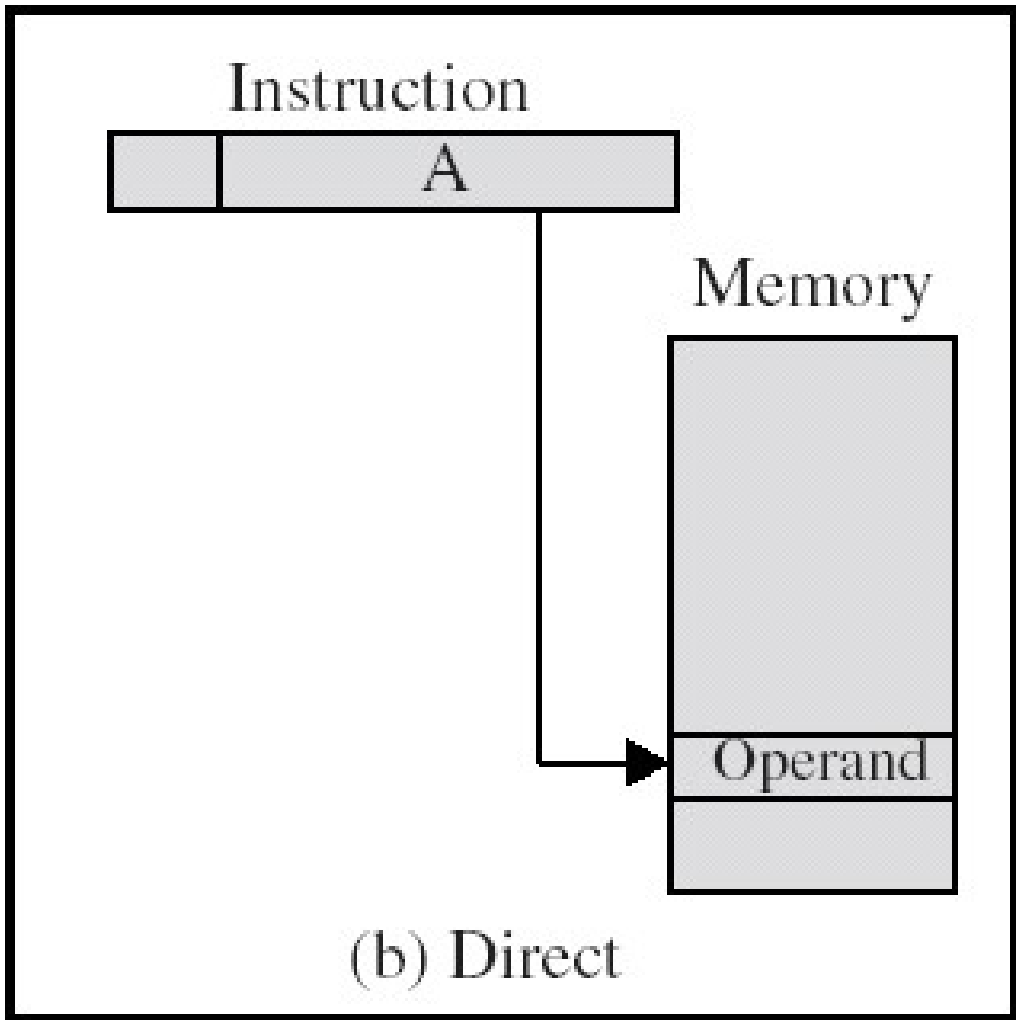
- Address field contains address of operand
- Effective address EA = address field (A)

ADD AX, value

Value DB 05h

  - Add contents of cell value to accumulator AX
  - Look in memory at address value for operand
- Single memory reference to access data
- No additional calculations to work out effective address
- Limited address space

Direct Addressing Diagram



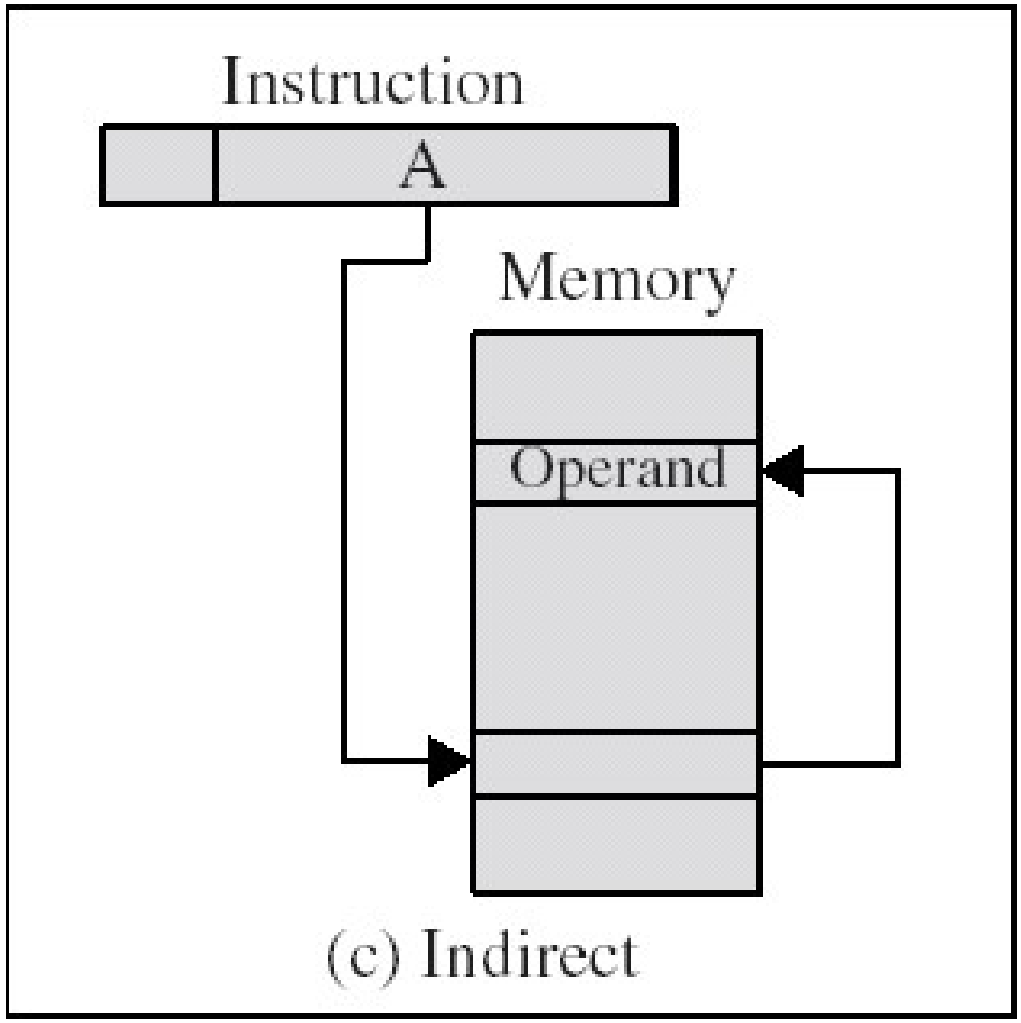
Indirect Addressing (1/2)

- Memory cell pointed to by address field contains the address of (pointer to) the operand
- EA =(A)
  - Look in A, find address (A) and look there for operand
- e.g. ADD AX, (A)
  - Add contents of cell pointed to by contents of A to accumulator

Indirect Addressing (2/2)

- Large address space
- 2^n where n = word length
- May be nested, multilevel, cascaded
  - e.g. EA = (((A)))
- Multiple memory accesses to find operand
- Hence slower

Indirect Addressing Diagram



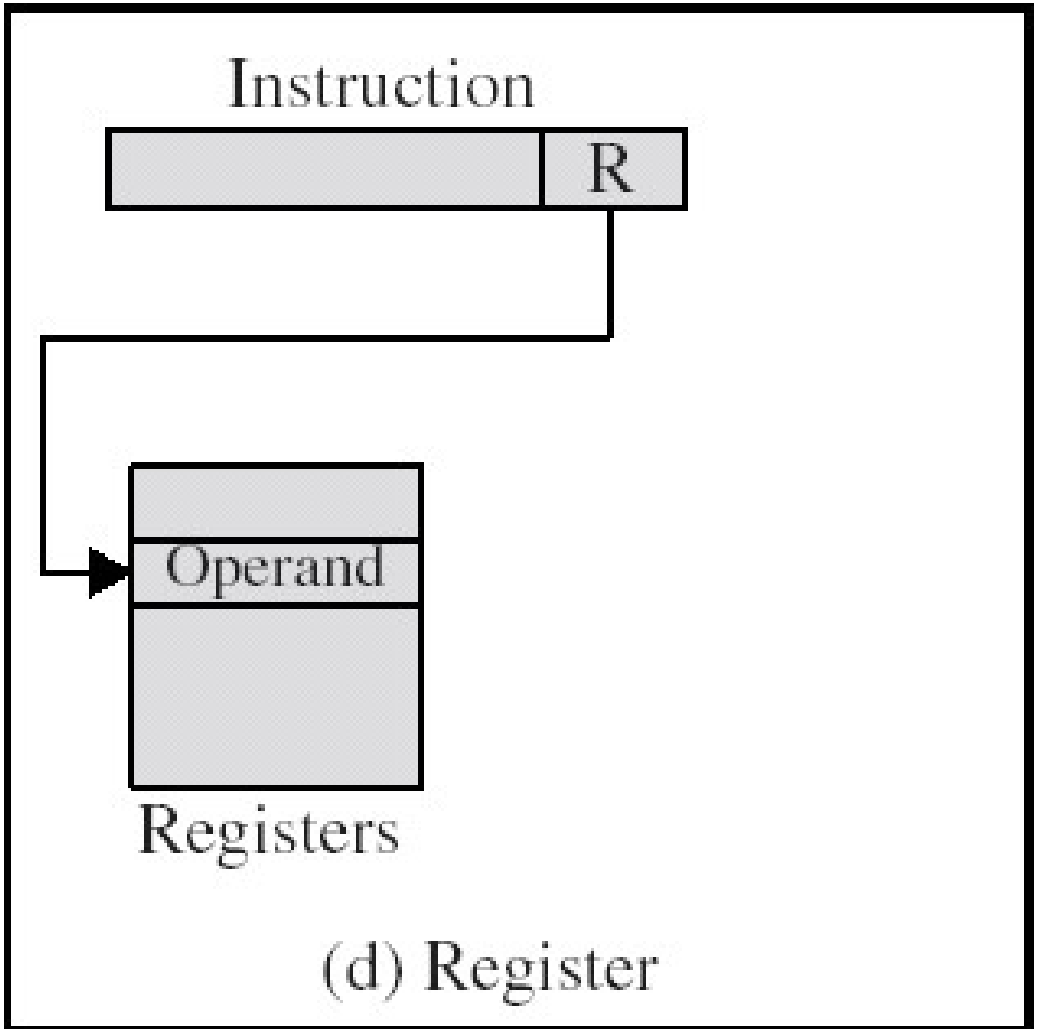
Register Addressing (1/2)

- Operand is held in register named in address filed
- EA = R
- Limited number of registers
- Very small address field needed
  - Shorter instructions
  - Faster instruction fetch
  - MOV AX, BX
  - ADD AX, BX

Register Addressing (2/2)

- No memory access
- Very fast execution
- Very limited address space
- Multiple registers helps performance
  - Requires good assembly programming or compiler writing
  - N.B. C programming
    - register int a;

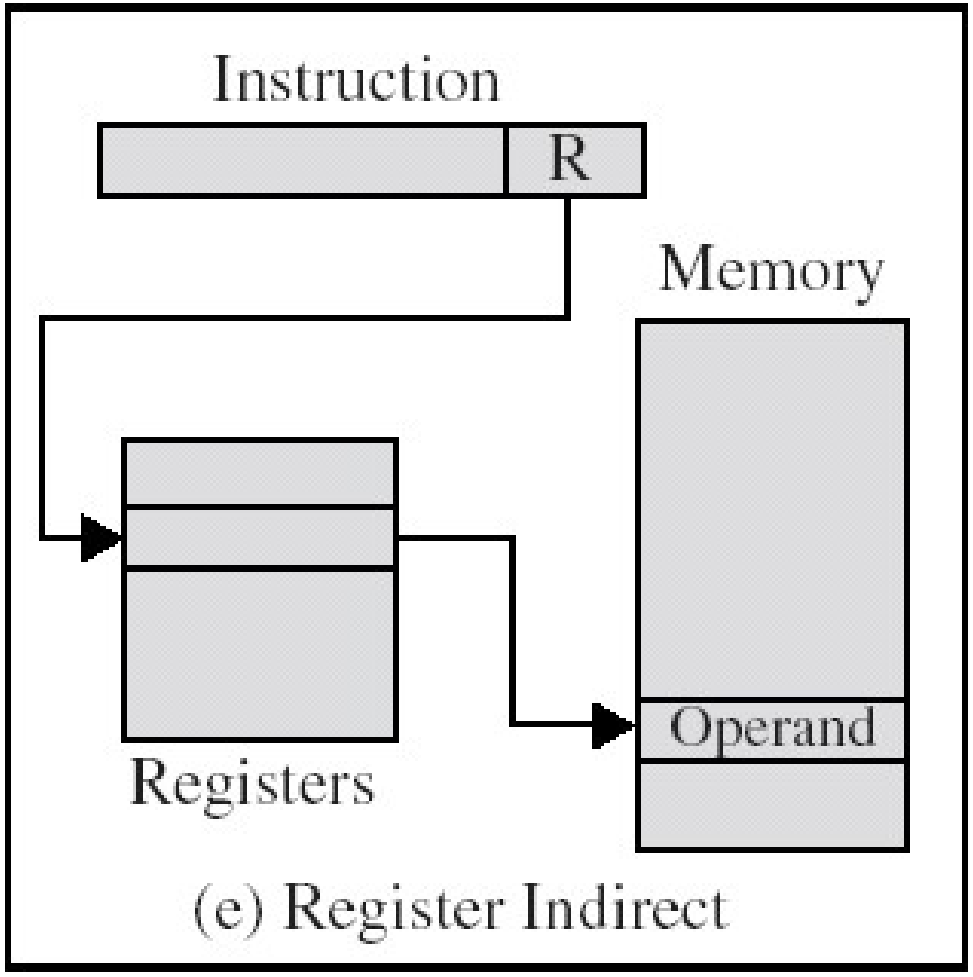
Register Addressing Diagram



Register Indirect Addressing

- indirect addressing
- EA = (R)
- Operand is in memory cell pointed to by contents of register R
- Large address space (2^n)
- One fewer memory access than indirect addressing

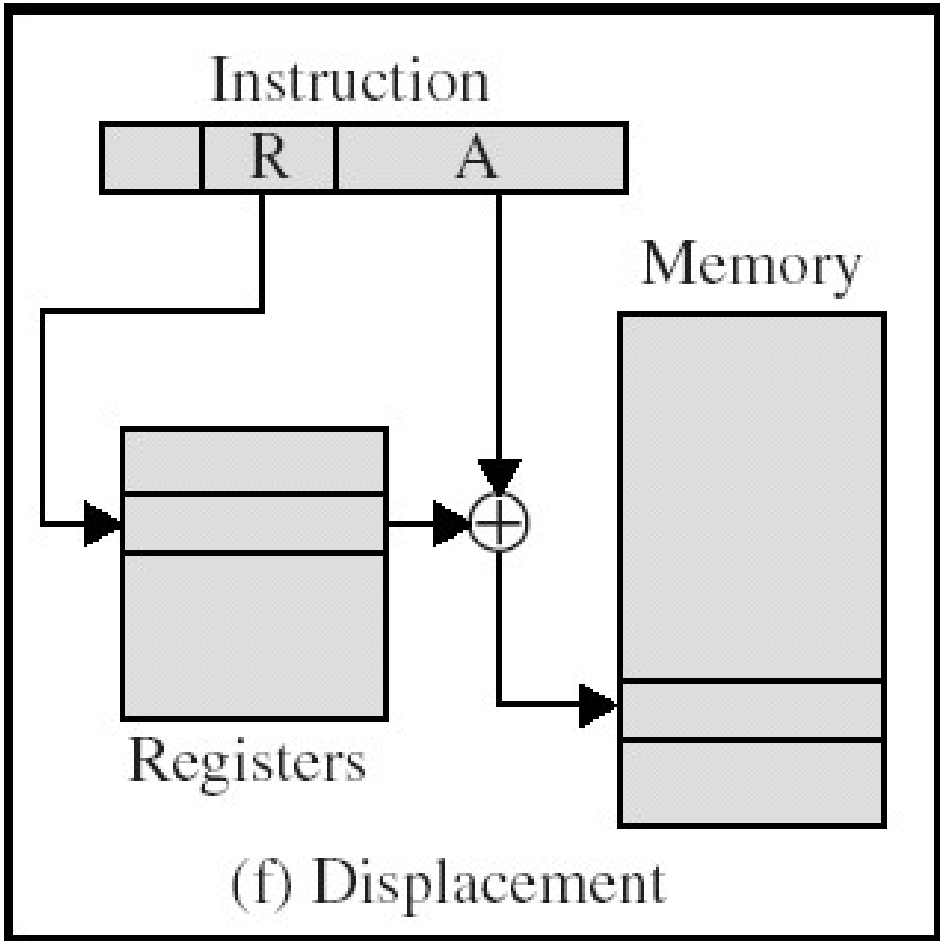
Register Indirect Addressing Diagram



Displacement Addressing

- EA = A + (R)
- Effective address=start address + displacement
- Effective address=Offset + (Segment Register)
- Use direct and register indirect
- Address field hold two values
  - A = base value
  - R = register that holds displacement
  - or vice versa

Displacement Addressing Diagram



Relative Addressing (PC-Relative)

- A version of displacement addressing
- R = Program counter, PC
- EA = A + (PC)
- i.e. get operand from A cells from current location pointed to by PC
- locality of reference & cache usage

Base-Register Addressing

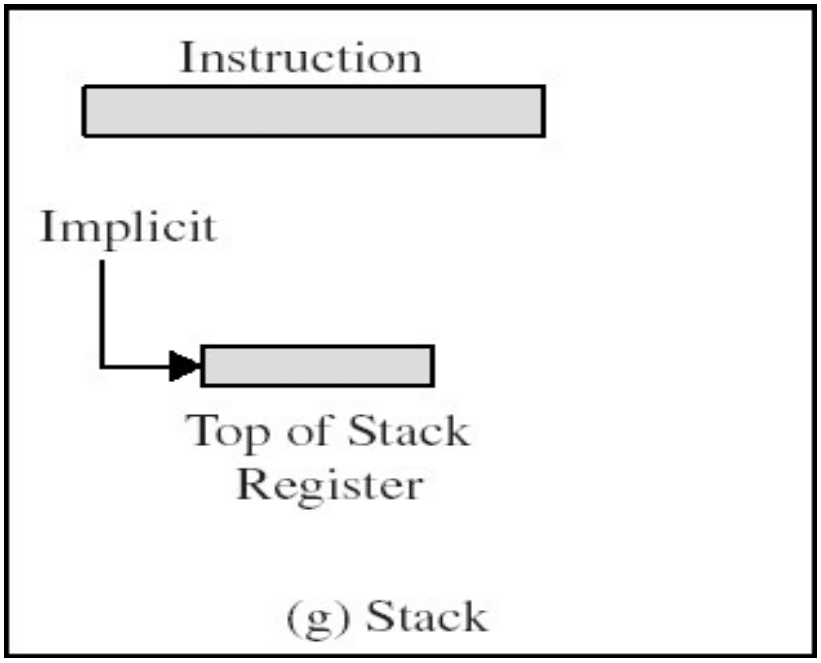
- A holds displacement
  - EA = (CS) + A
- R holds pointer to base address
- R may be explicit or implicit
- e.g. segment registers in 80x86

Indexed Addressing

- A = base
- R = displacement
  - EA = A + (R)
- Good for accessing arrays
  - EA = A + (R)
  - R++

Stack Addressing

- Operand is (implicitly) on top of stack
- e.g.
  - ADD Pop top two items from stack and add and push



Mode	Algorithm	Principal Advantage	Principal Disadvantage
Immediate	Operand = A	No memory reference	Limited operand magnitude
Direct	EA = A	Simple	Limited address space
Indirect	EA = (A)	Large address space	Multiple memory references
Register	EA = R	No memory reference	Limited address space
Register indirect	EA = (R)	Large address space	Extra memory reference
Displacement	EA = A + (R)	Flexibility	Complexity
Stack	EA = top of stack	No memory reference	Limited applicability

Pentium Addressing Modes

- Virtual or effective address is offset into segment
  - Starting address plus offset gives linear address
  - This goes through page translation if paging enabled
- 9 addressing modes available
  - Immediate
  - Register operand
  - Displacement
  - Base
  - Base with displacement
  - Scaled index with displacement
  - Base with index and displacement
  - Base scaled index with displacement
  - Relative

Summary

The various addressing modes and formats was studied.

References

1. David A. Patterson and John L. Hennessey, “Computer Organization and Design‟, Fifth edition, Morgan Kauffman / Elsevier, 2014.

2. V.Carl Hamacher, Zvonko G. Varanesic and Safat G. Zaky, “Computer Organisation“, VI edition, Mc Graw-Hill Inc, 2012.

Thank you