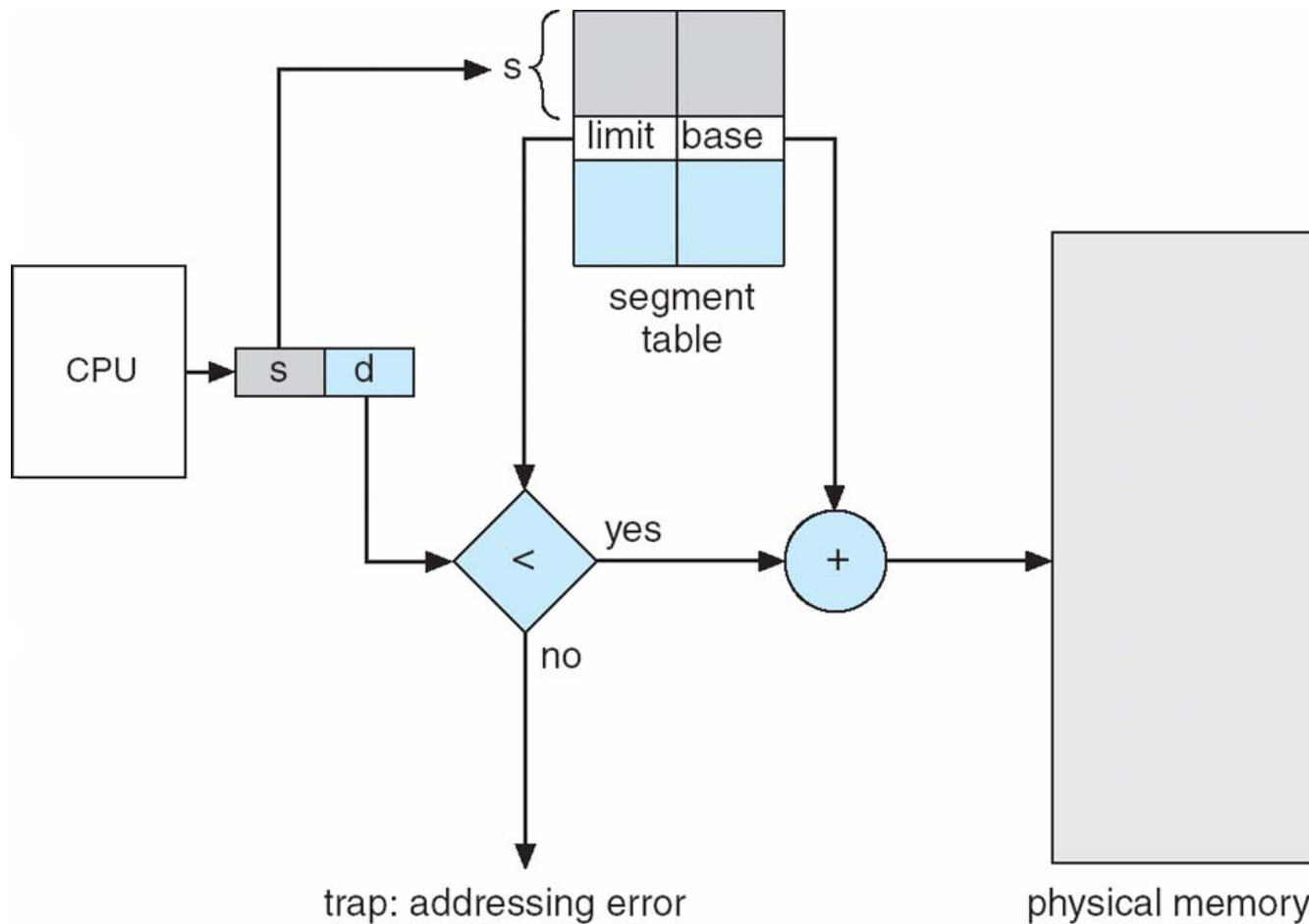

COMPUTER ORGANIZATION (IS F242)

LECT 07: COMPUTER ORGANIZATION

Protected mode Memory Addressing

- 80286 and above only support protected mode
 - Allows access to data and programs located above first 1MB memory
 - Windows operate in protected mode
 - In place of segment address, the segment register contains a selector that selects a descriptor from the descriptor table
 - Descriptor describes the memory segment's location, length and access rights
- In 80386 and above, offset address can be a 32 bit number instead of 16 bit in protected mode
 - Allows data access up to 4GB

Segmentation Hardware



Selectors and Descriptors

- Selector selects one of the 2^{13} descriptors from one of 2 tables of descriptors
- Descriptor describes
 - Location, length and access rights of segment of memory
- Segment register still selects a memory segment
- Descriptor tables
 - Global descriptor or system descriptor table
 - Global descriptors contain segment definitions that apply to all programs
 - Local descriptor or application descriptor table
 - Local descriptors are usually unique to an application
 - Each descriptor table contains 8192 descriptors

Selectors and Descriptors

- Each descriptor table contains 8192 descriptors
- Total descriptors possible for an application 16384
- Each descriptor describes a memory segment
- A memory segment can be up to 4GB in length
- An application can access $4\text{GB} \times 16384 = 64\text{TB}$
- Size of global and local descriptor tables
 - Number of entries 2^{13}
 - Each entry size 8 Bytes
 - Size of global descriptor table = 2^{16} Bytes
 - Size of local descriptor table = 2^{16} Bytes

Selectors and Descriptors

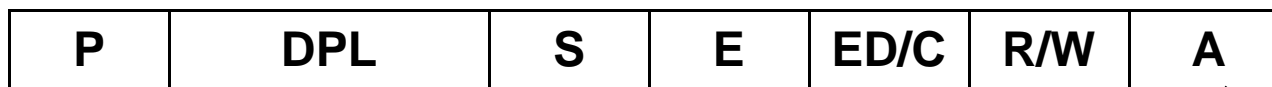
- Granularity bit (G – bit)
 - ❑ Available from 80386
 - ❑ If G=0, the limit specifies a segment limit of 00000H to FFFFFFFH
 - ❑ If G=1, the value of limit is multiplied by 4KB (appended with FFFH)
 - ❑ If G=1, limit is 00000FFFH to FFFFFFFFFFH (4KB to 4GB in steps of 4KB)
- L bit (64 – bit Pentium 4 or Core 2)
 - ❑ L=0, then 32 bit compatibility mode
 - ❑ L=1, no limit or base address, only contain access rights and control bits (all code segments start at address 0)

Selectors and Descriptors

- Available (AV) bit
 - AV = 1, segment is available in memory
 - AV=0, segment is not available in memory
- D bit
 - Indicates how instructions access register and memory data in protected or real mode
 - If D=0, instructions are 16-bit (compatible till 80286)
 - Instructions use 16 bit offset addresses & 16 bit register
 - If D=1, instructions are 32-bit
 - Instructions use 32 bit offset addresses & 32 bit register

Selectors and Descriptors

- Access Rights byte
 - Controls access to the protected mode segment



S=0, System descriptor
S=1, Code and data segment descriptor

DLP= Sets the descriptor privilege level

P=0, descriptor is undefined
P=1, segment contains a valid base and limit

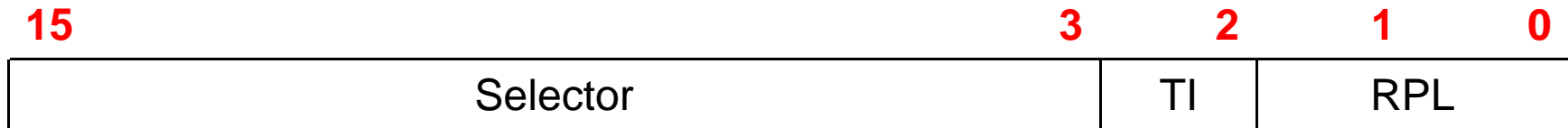
A=0, segment not accessed
A=1, segment accessed

E=0, descriptor describes a data segment
ED=0, data segment expands upward
ED=1, data segment expands downward
W=0, Data may not be written
W=1, Data may be written

E=1, descriptor describes code segment
C=0, ignore descriptor privilege level
C=1, abide by privilege level

R=0, Code segment may not be read
R=1, Code segment may be read

Segment Register in protected mode



Selector

Selects one descriptor from 2^{13} descriptors in either the global or the local descriptor table

RPL = Requested Privilege level where 00 is the highest and 11 is the lowest

TI=0, Global descriptor table

TI=1, Local descriptor table

If the requested privilege level matches or is higher in priority than the privilege level set by the access rights byte, access is granted