Operating Modes of 80386

80386 can operate in 3 modes

1. Real Mode
2. Protected Mode
3. Virtual 8086 Mode

Real Mode:

It is the default mode selected when 80386 is reset. In this mode 80386 µP simply behaves as a fast 8086 machine (fast because its operating frequency is higher than 8086)

All the registers are just like 8086. Even the mly used is only 1MB, just like 8086.

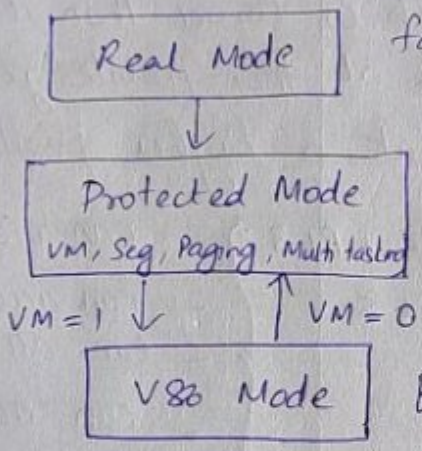
Physical address calculation is also like in 8086:

$$PA = BA \times 10H + \text{Offset Address}$$

This mode is basically used to run the BIOS on reset. ie, 80386 starts in real mode and it creates the environment for protected mode ie, it initializes all the registers and tables like IDT, LDT, TSS, Page table etc so that the protected mode can work.

Once the required registers are initialized, we can switch to Protected Mode by making the Protection Enable (PE bit) = 1 in CR0.

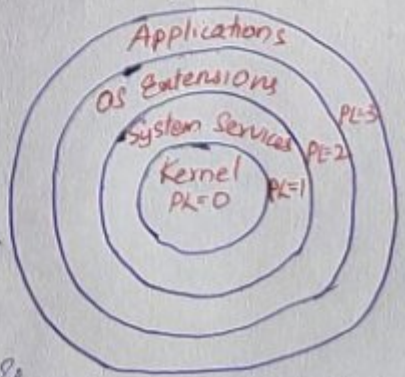
Note :- We can't switch back to real mode from protected mode. But we can go to Virtual 8086 mode by making VM bit in flag register a 1. Here 8086 programs can be run and by making VM=0, we can go back to protected mode.



Protected Mode :

In protected mode, 80386 µP provides dedicated hardware to prevent user programs from affecting other user programs and also safeguards the OS from being affected by user programs.

There are 4 priviledge levels assigned to programs and data to define their priviledges.



Level 0 : Most priviledged - OS Kernel
Level 1 : 2nd most priviledged - S/m Services such as File Handling, Device Drivers etc.
Level 3 : 3rd most priviledged - Custom Extensions of OS
Level 4 : least Priviledged - User applications & programs

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Note :- Any program at Level 0 can access all the data at any priviledge level, whereas a data at this priviledge level can be accessed by a program at priviledge level 0 only.

ie, Any program at a particular level can access the data at any priviledge level which is lower than it (numerically higher), whereas a data at this priviledge level can only be accessed by a program at a higher priviledge level.

PL0 - PL0, PL1, PL2, PL3 - can access
PL1 - PL1, PL2, PL3 - can access
PL2 - PL2, PL3 - Can access
PL1 - PL1 - can access

Real Mode	Protected Mode
Segment Registers: 6, 16 bit segment registers CS, SS, DS, ES, FS and GS segment Registers give base address of respective segments	Segment Registers: 6, 16 bit segment registers Segment Registers do not directly give segment base address. Instead they give a "selector" which is an index in the GDT / LDT from which the descriptor is loaded. It is the descriptor which gives the base address of the segment.

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Offset Registers 5, 16 bit offset registers containing offset addresses for various segments (IP, SP, BP, SI and DI)	Offset Registers: 5, 32 bit extended offset registers (EIP, ESP, EBP, ESI and EDI) They give 32 bit offset addresses
General Purpose Registers 4, 16 bit GPRs (AX, BX, CX and DX) Can also be used as 8, 8 bit registers AL, AH, BL, BH, CL, CH, DL and DH	General Purpose Registers 4 32 bit GPRs (EAX, EBX, ECX and EDX)
Flag Register Only the lower 12-bits of the flag register are used in Real Mode.	Flag Register. 80386 has a 32-bit flag register called EFLAGS used in protected mode
Control Registers Only LSB of CR0 is available in Real Mode.	All 4 Control Registers available CR0, CR1, CR2 and CR3
Debug and Test Registers Not available in Real Mode.	Debug and Test Registers Available only in protected mode.
16 bit operations Default mode after Reset.	32 bit operations Protected mode entered by making LSB of CR0 (PE=1)

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Memory Range:

Size of mly available in real mode is 1 MB and has address range from 00000H .. FFFFFH, just like in 8086.

16 bit offset ∴ Maximum size of a segment is 64 KB

PA = Segment Address × 10H + Offset

No paging, protection and multitasking.

I/O Range: A total of 64K I/O addresses are available having a range from 0000 .. FFFFH, just like in 8086.

Total physical memory $2^{32} = 4$ GB.

32 bit offset ∴ Maximum size of a segment is 4GB.

Complex Segmentation and paging mechanism.

Paging, Protection and Multitasking can be done.

64K I/O addresses available

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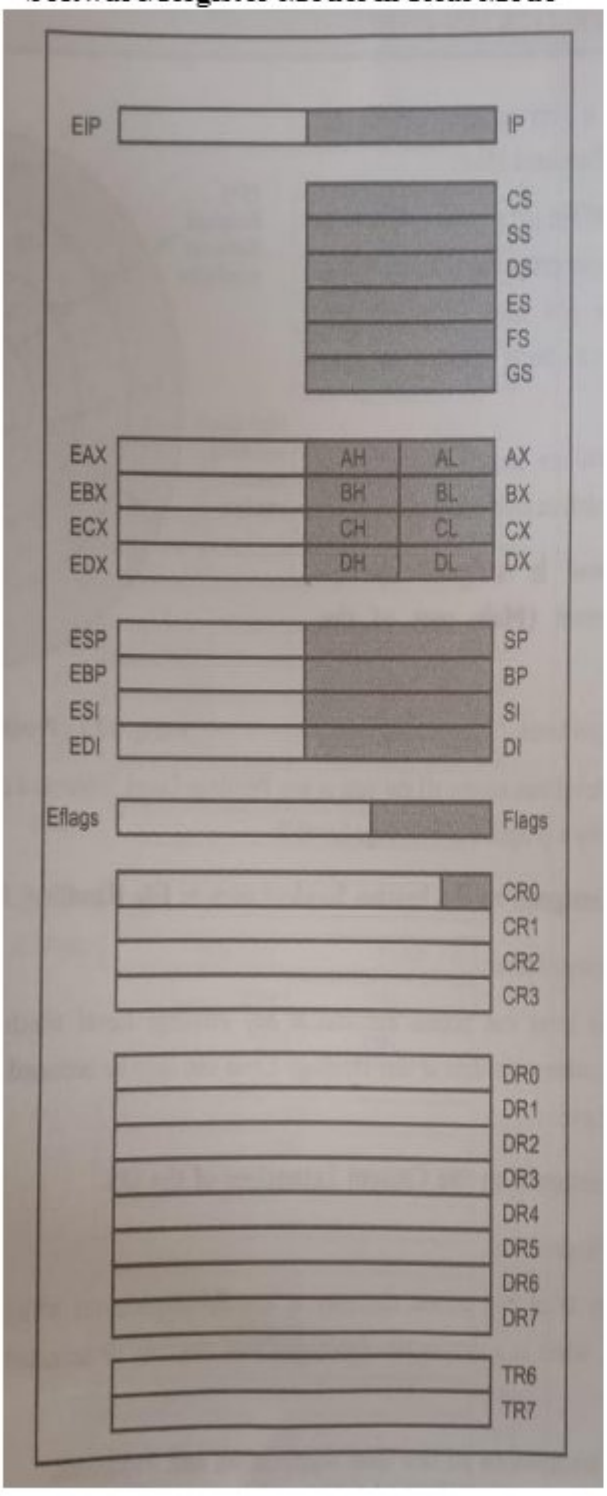
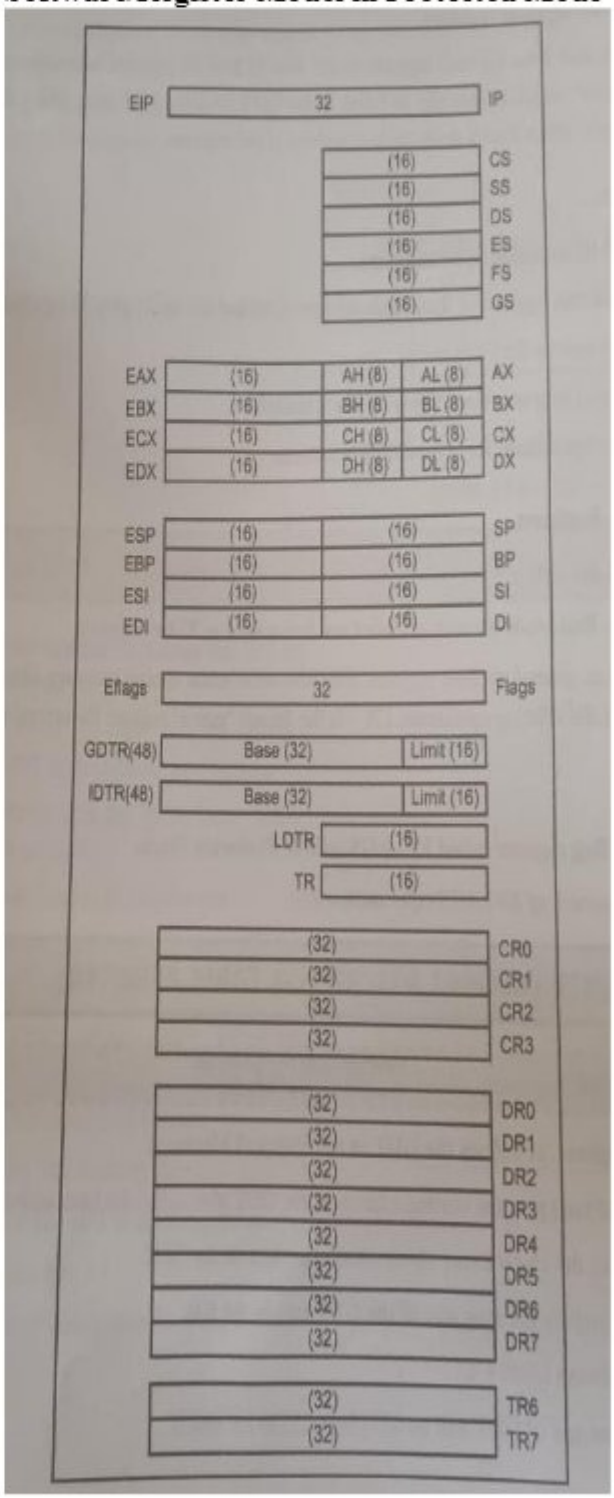
Software/Register Model in Real Mode



Software/Register Model in Protected Mode



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