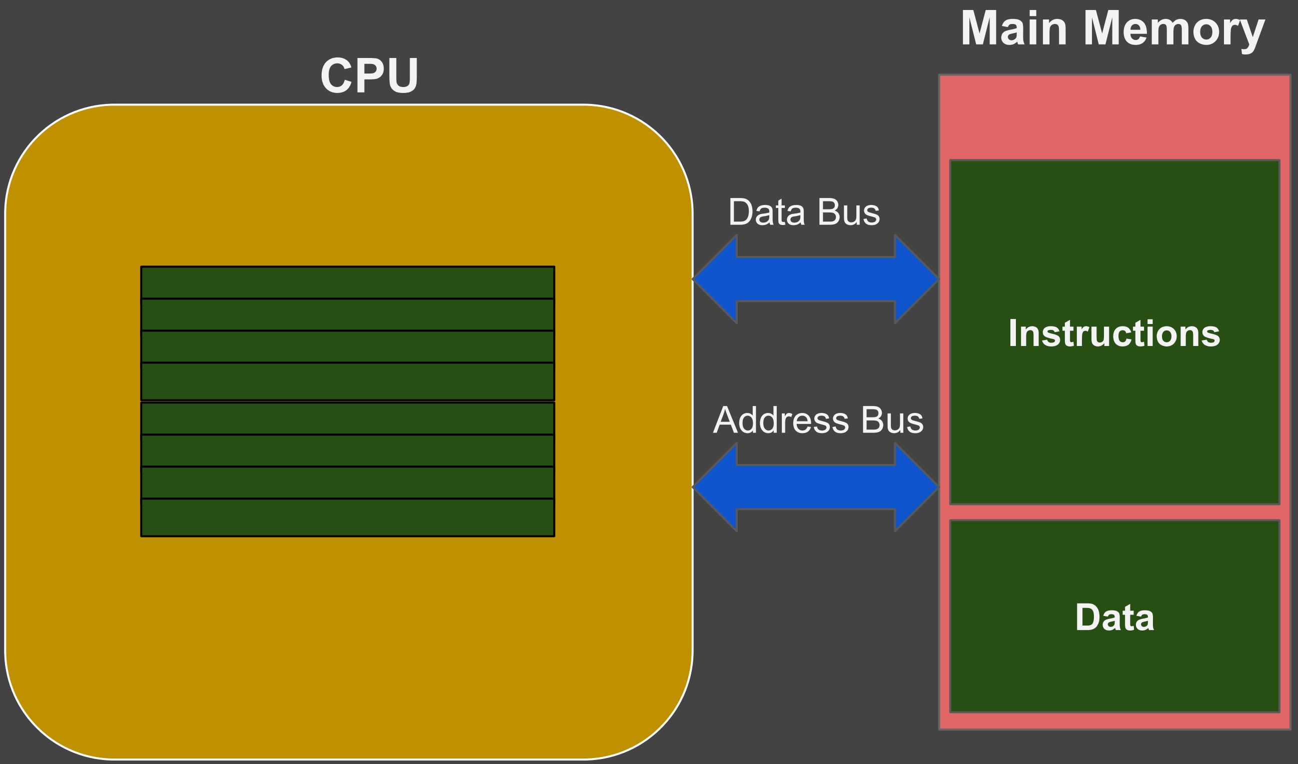
Introduction to x86 Assembly

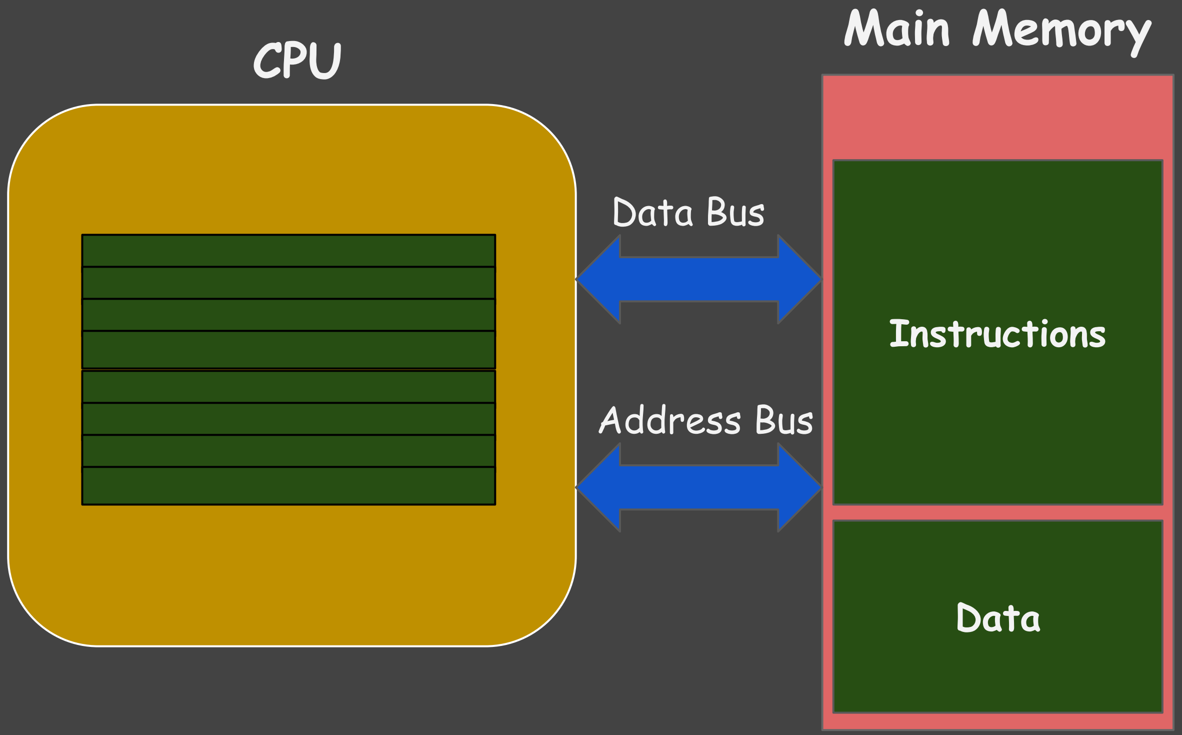
Lecture INT

x86 Interrupts

Remember: fetch-execute cycle



Remember: fetch-execute cycle



Instructions control CPU, or CPU controls instruction?

Remember: fetch-execute cycle

- How the OS can terminate/suspend your application?
- How multiple programs are run on a single CPU?
- How to handle events?
- How to get data from input devices while running?
- Alarm apps?
- real time system?

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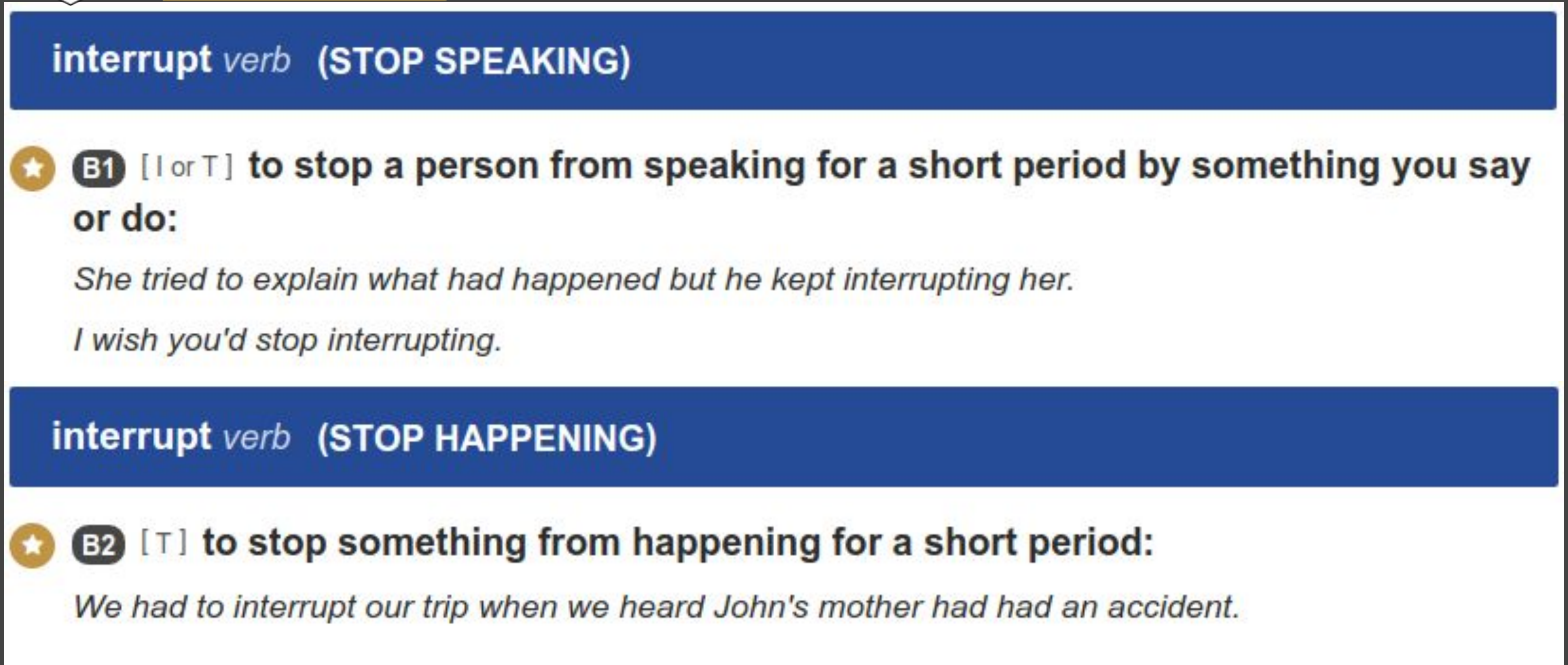
interrupts

Interrupt

Cambridge Dictionary

K. N. Toosi
University of Technology



interrupt *verb* **(STOP SPEAKING)**

★ **B1** [I or T] **to stop a person from speaking for a short period by something you say or do:**

She tried to explain what had happened but he kept interrupting her.

I wish you'd stop interrupting.

interrupt *verb* **(STOP HAPPENING)**

★ **B2** [T] **to stop something from happening for a short period:**

We had to interrupt our trip when we heard John's mother had had an accident.

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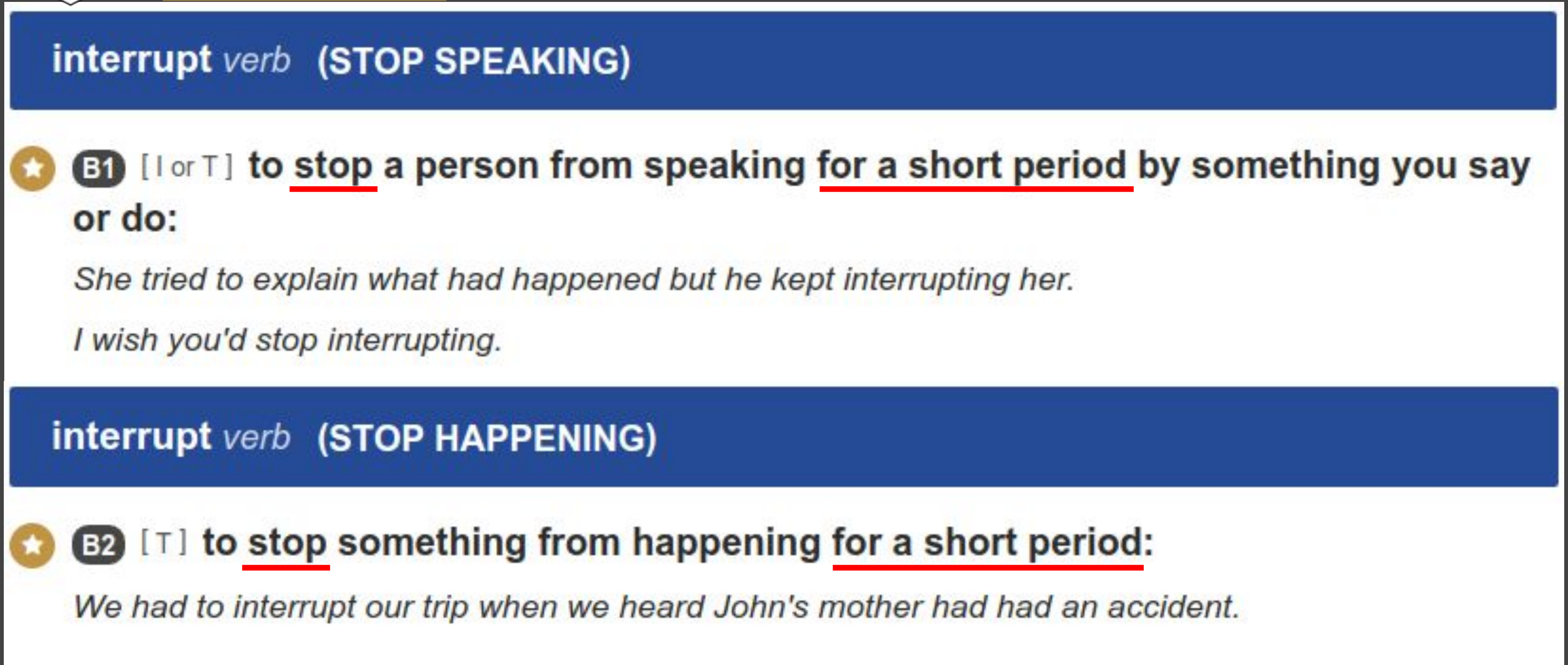

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Interrupt

- A signal to Processor
- Immediate attention
- Interrupt handler (interrupt service routine)

Types of Interrupts

- Hardware Interrupts
- Software Interrupts
- Exceptions

Hardware Interrupts

- A signal from hardware
- Input devices (keyboard, mouse, scanner, network interface,)
- Interrupt Request (IRQ)
- Asynchronous

Software Interrupts

- `int` instruction
- `INT` immed8
    - push EFLAGS
    - push (far) return address (CS + EIP)

Exceptions (traps)

- exceptional conditions in execution
  - divide by zero
  - access a protected memory area.
  - write on read-only memory area

Interrupt

- Hardware/Software Signals CPU
- CPU suspends current activity
- CPU saves its state (registers, flags, etc.)
- CPU calls an Interrupt Service Routine
- CPU retrieves its state
- CPU resumes previous activity

Real Mode: Interrupt Vector Table (IVT)

- 256 4-byte vectors, Address 0x0 to 0x3F of memory
- each vector CS+IP
- when interrupt happens:
  - FLAGS, CS and IP are pushed

Software Interrupts

Software Interrupts

Interrupt service routine (ISR)

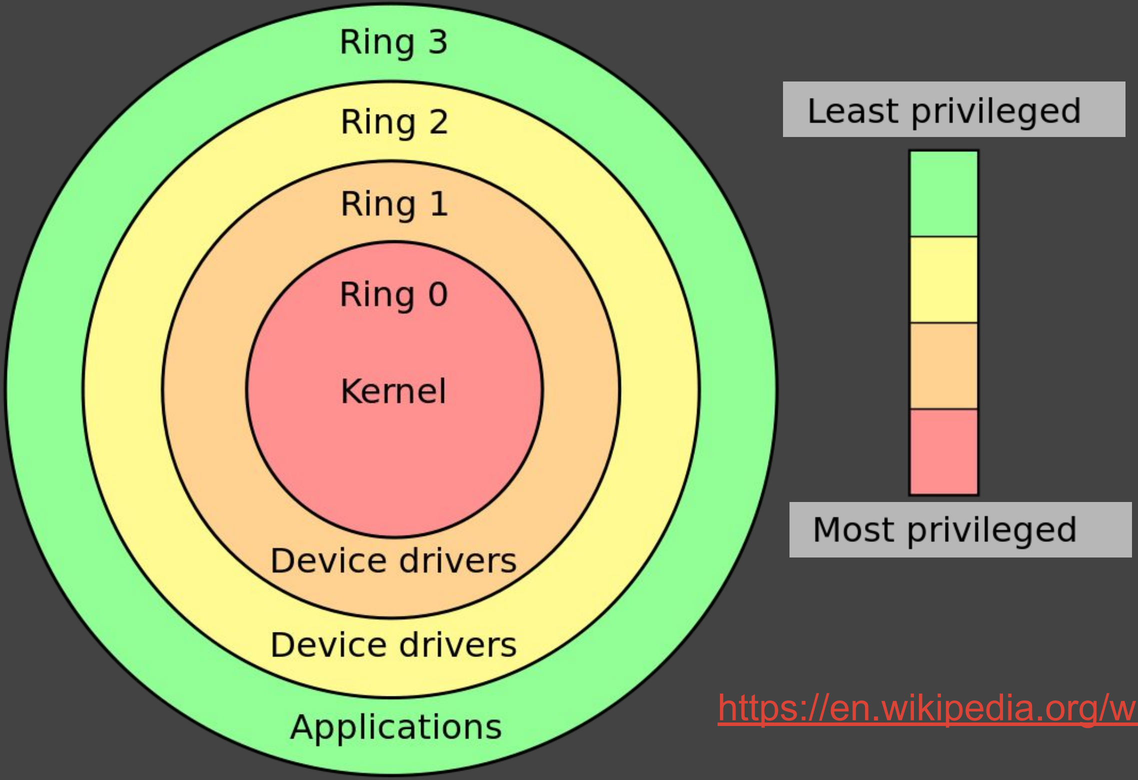
- AKA Interrupt handler
-

Software Interrupts

- IRET (NASM)

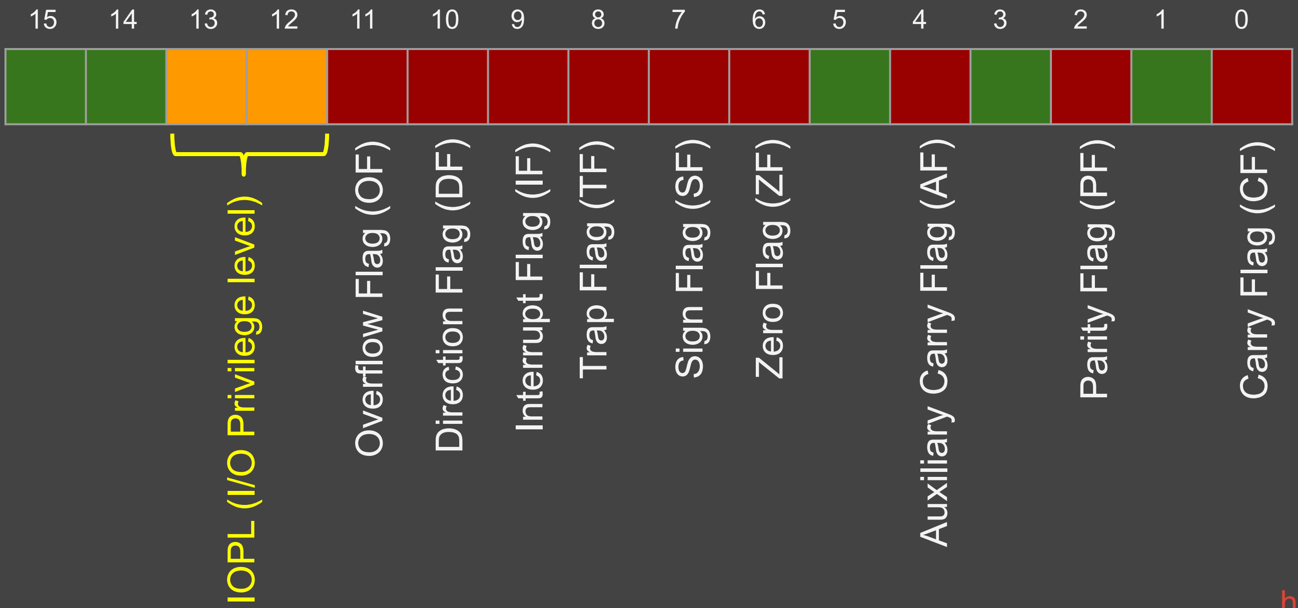
- Some other assemblers
  - IRET
  - IRETD
  - IRETQ

Protection ring

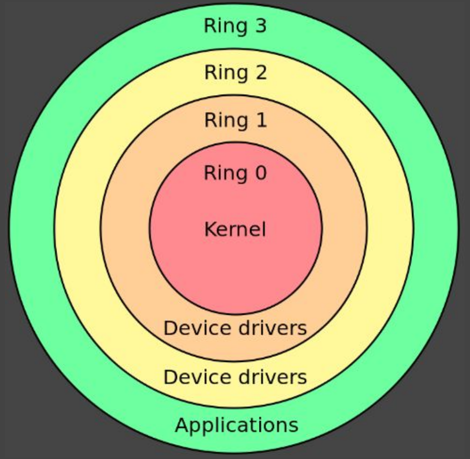


https://en.wikipedia.org/wiki/Protection_ring

The IPOL flag



15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
🟩	🟩	🟧	🟧	🟥	🟥	🟥	🟥	🟥	🟥	🟩	🟥	🟩	🟥	🟩	🟥
		IOPL (I/O Privilege level)		Overflow Flag (OF)	Direction Flag (DF)	Interrupt Flag (IF)	Trap Flag (TF)	Sign Flag (SF)	Zero Flag (ZF)		Auxiliary Carry Flag (AF)		Parity Flag (PF)		Carry Flag (CF)



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Software Interrupts

- INT immed8
- INT3
- INT1
- INT0 (32-bit mode only)
- Most software interrupts cannot be called from user space

User-space programs

- User-space applications are run at privilege 0
- Cannot call most software interrupts
- Use OS API's instead

References

- https://en.wikibooks.org/wiki/X86_Assembly
- https://wiki.osdev.org/Interrupts