



Ch.3 Input and Output



Topics

- Introduction: input and output (I/O)
 - Gaming industry devices
- 3.1.1: I/O device – system interface
- 3.1.2: Program-controlled I/O transfer
- 3.2: Interrupt-based I/O

→ • **3.2.6: Exceptions**



Internal Exceptions vs External Interrupts



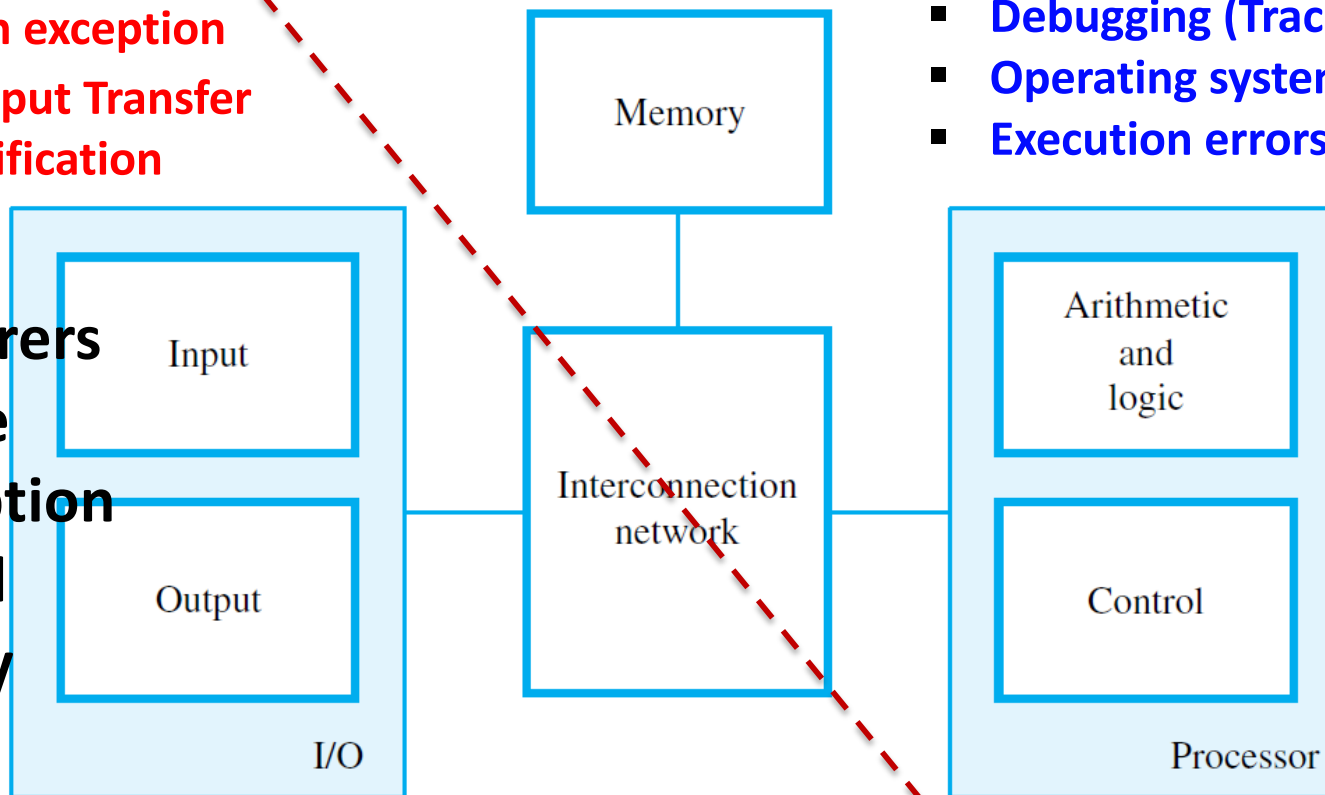
Exception: an interruption to the currently executing program

External Internal

Interrupts: an exception

- **Input/Output Transfer**
- **Event Notification**

Some manufacturers reserve the term exception for internal events only



Exceptions: examples

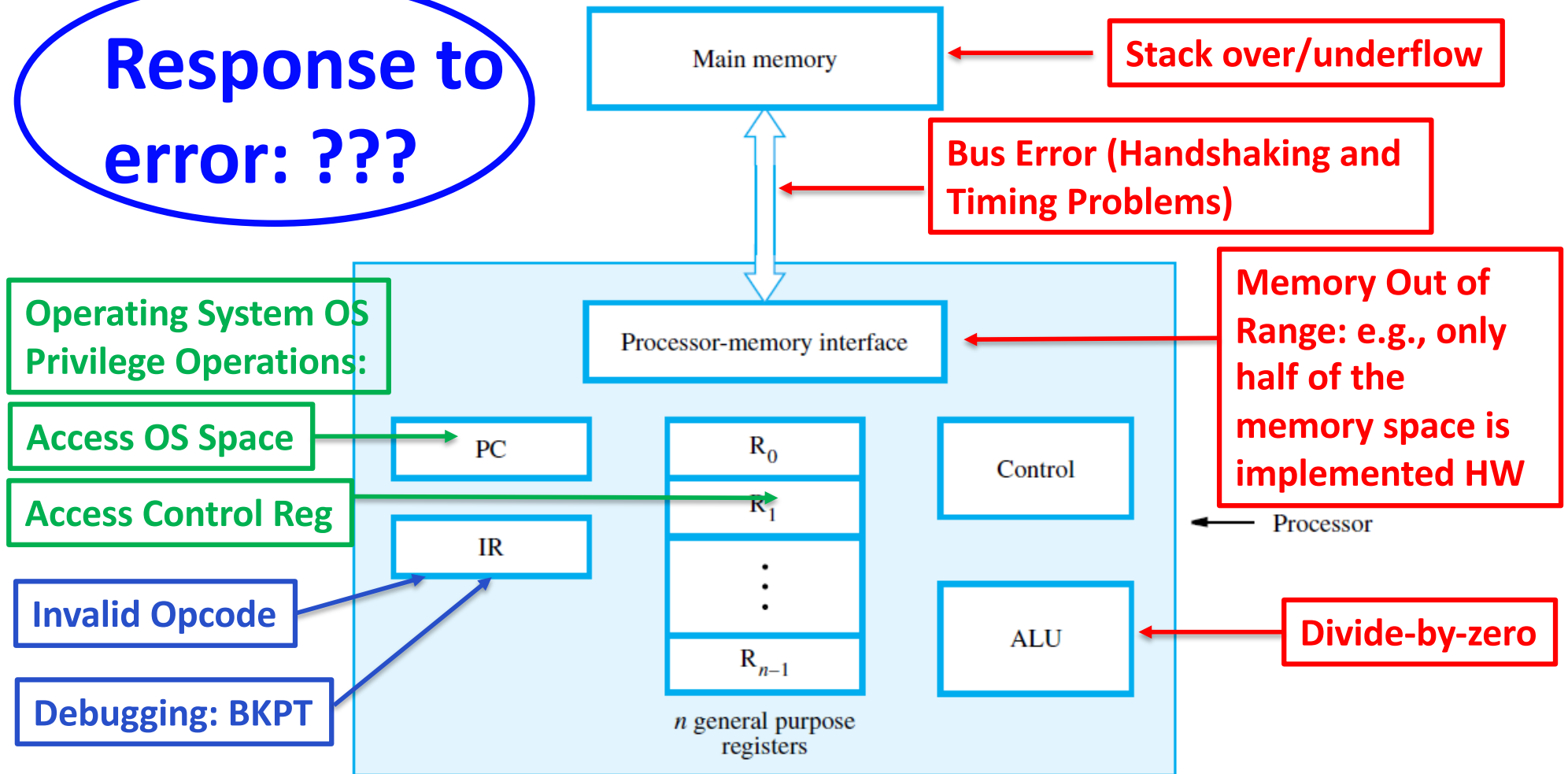
- **Debugging (Trace, BKPT)**
- **Operating system call (SWI)**
- **Execution errors and recovery**



Possible Internal Errors



Response to error: ???





3.2.6 Debugging



- Tracing:
 - Exception after the execution of every instruction
- Breakpoints:
 - Exception at specific points in the program set by the users



Debug (Tracing; Breakpoints)



BKPT

Breakpoint.

Syntax

`BKPT #imm`

where: '*imm*' is an integer in the range 0-255.

Operation

BKPT causes the processor to enter Debug state. Debug tools can use this to investigate system state when the instruction at a particular address is reached.

imm is ignored by the processor. If required, a debugger can use it to store additional information about the breakpoint.

Restrictions: None

Condition flags

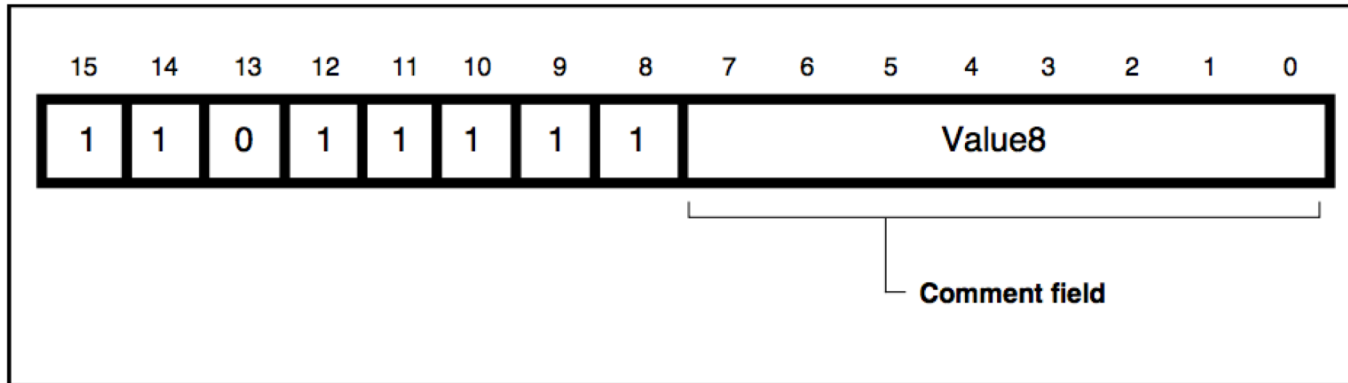
This instruction does not change the flags.

Examples

`BKPT #0 ; Breakpoint with immediate value set to 0x0.`



Software Interrupt (TM-5-38)



```
SWI 18          ; Take the software interrupt exception.  
                ; Enter Supervisor mode with 18 as the  
                ; requested SWI number.
```

Supervisor call:

- An exception triggered by the SWI instruction
- Also known as 'Software Traps'
- Also known as 'Operating System Call'
- 256 possible events/actions



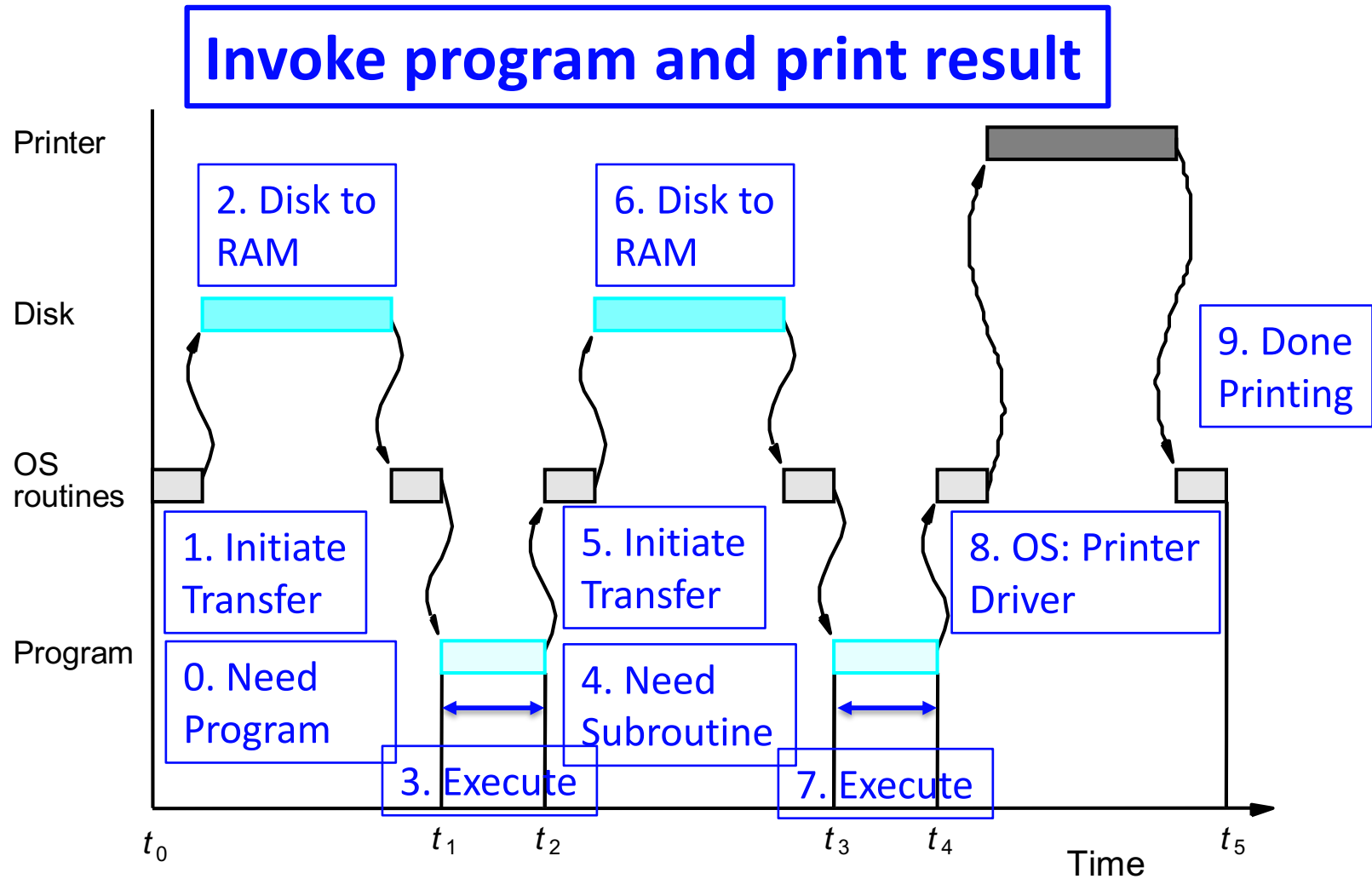
OS/Supervisor Call



- Supervisor or Operating System calls:
- User requests OS to perform certain function on its behalf; examples:
 - Device drivers
 - Memory allocation and transfer
 - Mutual exclusion
 - Information transfer from secondary to primary memory



Program and OS Interaction





Error Exception Examples



- Divided by zero
 - Problems in algorithm or program or data
- Stack overflow
 - Top of stack grows out of assigned boundary (e.g., 2K)
- Memory out of range
 - Memory address not valid **Not valid ? Why ???**
- Privilege exception
 - e.g., user tries to change priority (not allowed)



Error Exception Handling



- Action:

**Not completing the
current instruction ???**

- Suspends current instruction immediately
- Executes exception service routine
 - Terminates user program
 - Informs user of the error
 - Resets system for mission critical applications