

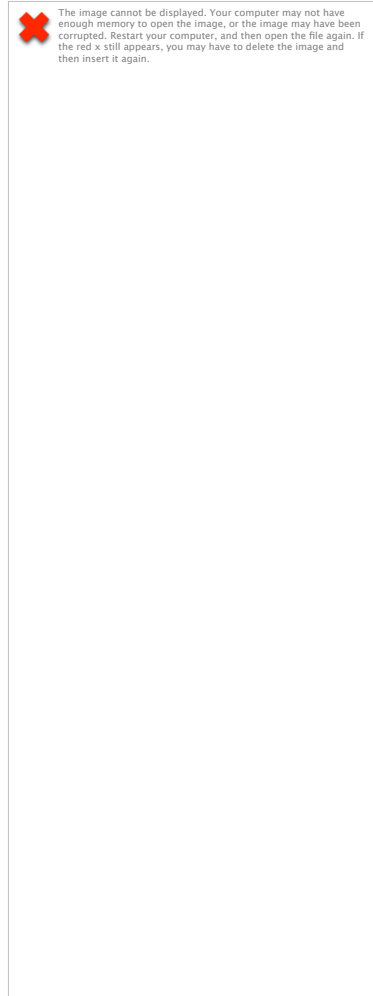
Chapter 6

Digital Design and Computer Architecture, 2nd Edition

David Money Harris and Sarah L. Harris

Chapter 6 :: Topics

- **Introduction (done)**
- **Assembly Language (done)**
- **Machine Language (done)**
- **Programming (done)**
- **Addressing Modes (done)**
- **Lights, Camera, Action: Compiling, Assembling, & Loading (done)**
- **Odds and Ends (now)**



Exceptions

- Unscheduled function call to *exception handler*
- Caused by:
 - Hardware, also called an *interrupt*, e.g., keyboard
 - Software, also called *traps*, e.g., undefined instruction
- When exception occurs, the processor:
 - Records the cause of the exception
 - Jumps to exception handler (at instruction address 0x80000180)
 - Returns to program

Exception Registers

- Not part of register file
 - **Cause**: Records cause of exception
 - **EPC** (Exception PC): Records PC where exception occurred
- EPC and Cause: part of Coprocessor 0
- Move from Coprocessor 0
 - `mfc0 $k0, EPC`
 - Moves contents of EPC into `$k0`

Exception Causes

Exception	Cause
Hardware Interrupt	0x00000000
System Call	0x00000020
Breakpoint / Divide by 0	0x00000024
Undefined Instruction	0x00000028
Arithmetic Overflow	0x00000030



Exception Flow

- Processor saves cause and exception PC in Cause and EPC
- Processor jumps to exception handler (0x80000180)
- Exception handler:

- Saves registers on stack
- Reads Cause register
- Handles exception
- Restores registers
- Returns to program

```
mfc0 $k0, Cause
```

```
jr $k0
```

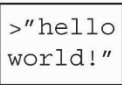


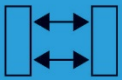
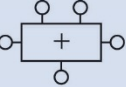
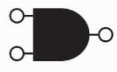
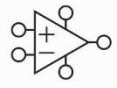


Chapter 7

Digital Design and Computer Architecture, 2nd Edition

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Chapter 7 :: Topics

- Introduction (done)
- Performance Analysis (done)
- Single-Cycle Processor (done)
- Multicycle Processor (done)
- Pipelined Processor (done)
- Exceptions (now)
- Advanced Microarchitecture (later)

Application Software	
Operating Systems	
Architecture	
Micro-architecture	
Logic	
Digital Circuits	
Analog Circuits	
Devices	
Physics	

Review: Exceptions

- Unscheduled function call to *exception handler*
- Caused by:
 - Hardware, also called an *interrupt*, e.g. keyboard
 - Software, also called *traps*, e.g. undefined instruction
- When exception occurs, the processor:
 - Records cause of exception (Cause register)
 - Jumps to exception handler (0x80000180)
 - Returns to program (EPC register)

Example Exception

sequential circuits.¶

Can we design a spiff

Figure 2.11 shows a inputs, A and B, and on box indicates that it is this case, the function is

KeyAccess



The network KeyServer, which is required by KeyServer controlled programs, cannot grant you permission to run this program. If you think you have received this message in error, please contact your KeyServer Administrator.

Visio.exe - Application Error



The exception unknown software exception (0xc06d007e) occurred in the application at location 0x7c81eb33.

OK

words, we say the output Y is a function of the two inputs A and B where the function performed is A OR B.¶


The *implementation* of the combinational circuit is independent of its functionality. Figure 2.1 and Figure 2.2 show two possible implementa-



ELSEVIER

Exception Registers

- Not part of register file
 - Cause
 - Records cause of exception
 - Coprocessor 0 register 13
 - EPC (Exception PC)
 - Records PC where exception occurred
 - Coprocessor 0 register 14
- Move from Coprocessor 0
 - `mfc0 $t0, Cause`
 - Moves contents of Cause into `$t0`

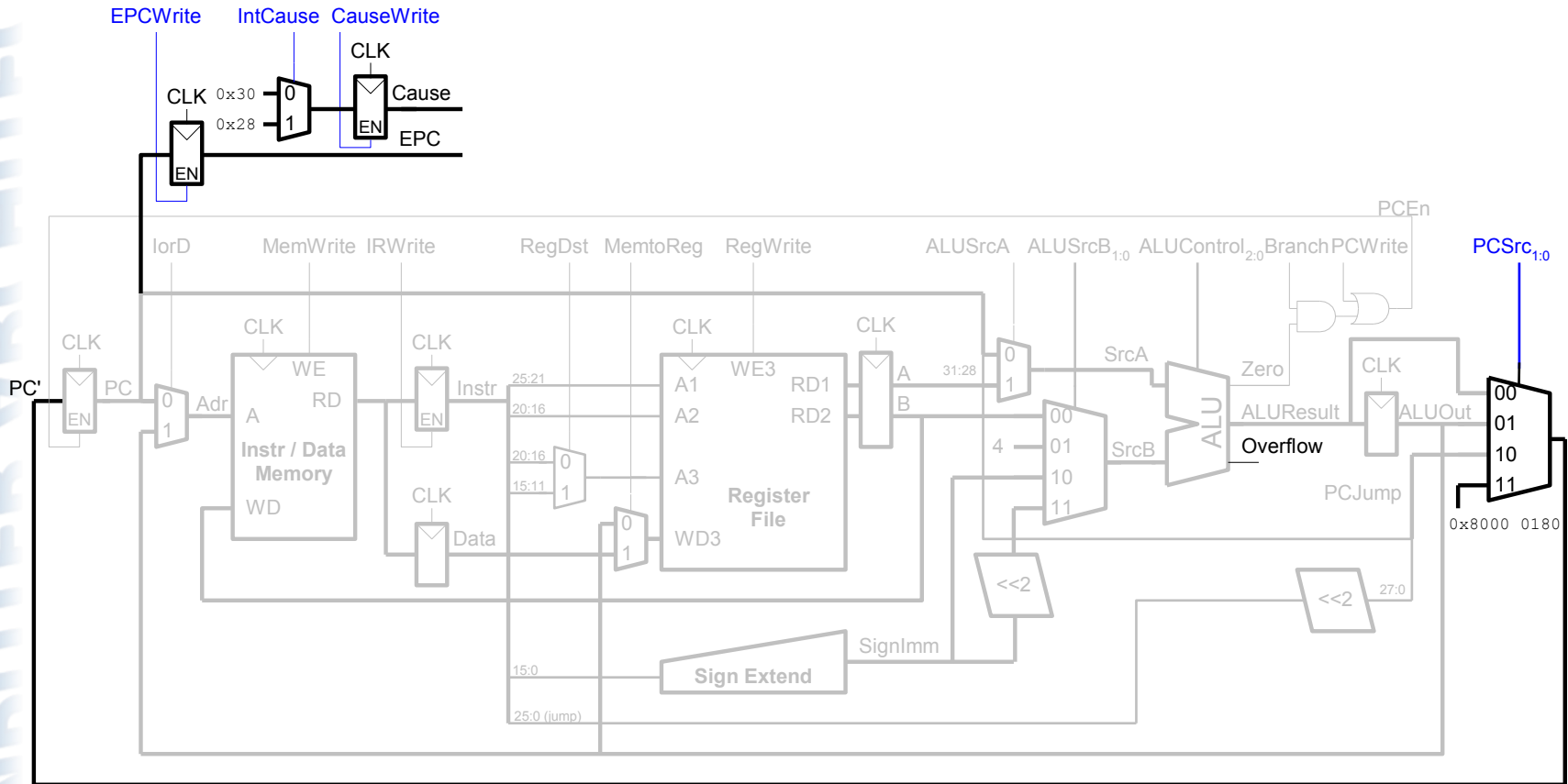
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Exception Causes

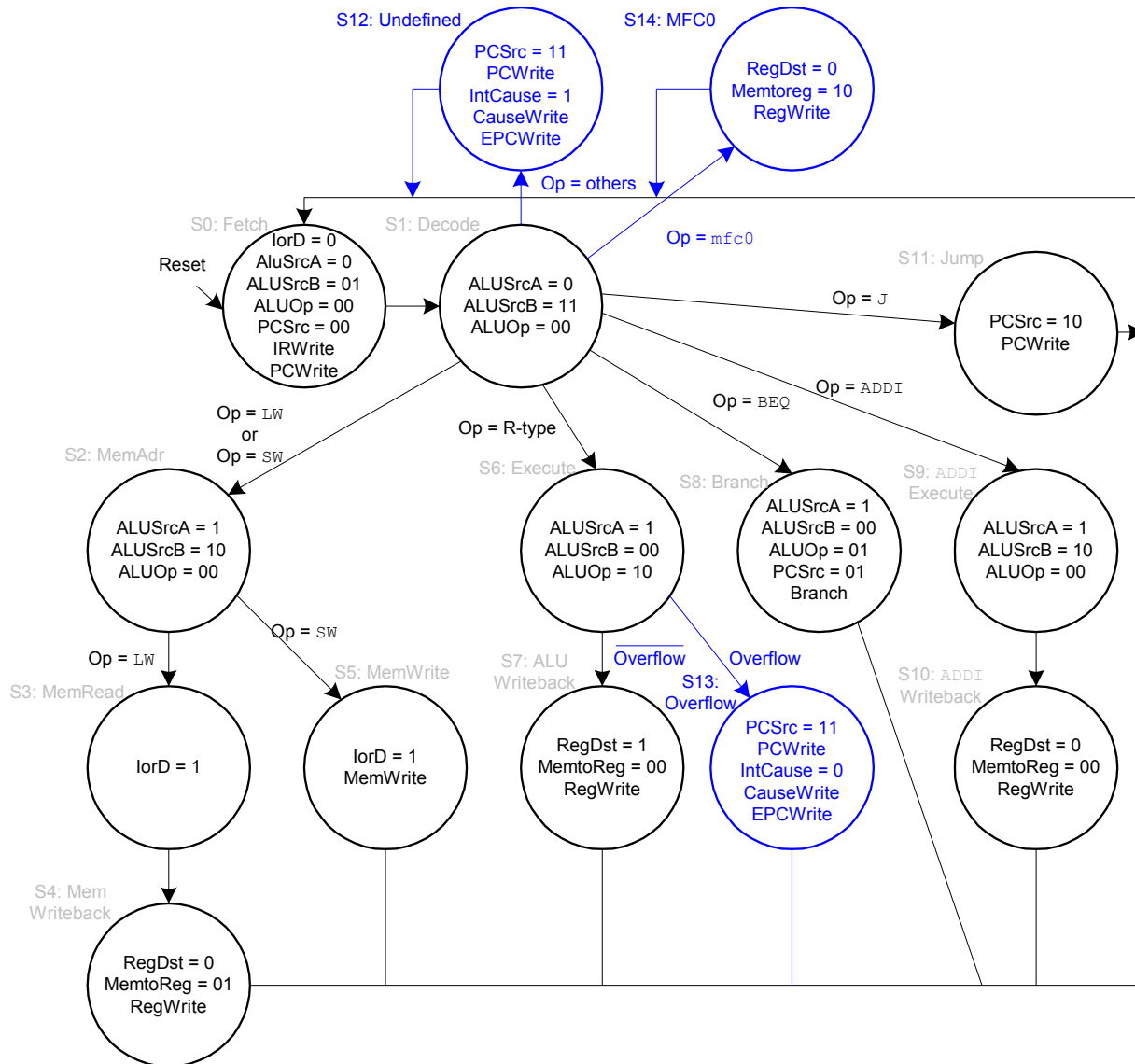
Exception	Cause
Hardware Interrupt	0x00000000
System Call	0x00000020
Breakpoint / Divide by 0	0x00000024
Undefined Instruction	0x00000028
Arithmetic Overflow	0x00000030

Extend multicycle MIPS processor to handle last two types of exceptions

Exception Hardware: EPC & Cause



Control FSM with Exceptions



Exception Hardware: mfc0

