Computer Architecture ECS-355

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(Week 13) Lecture 25-26

Learning objectives:

- Review of the last lecture
- RISC Instruction Pipeline
- Vector Processors
- Intro to Peripheral Devices

Resources: Beside these lecture handouts, this lesson will draw from the following

Text Book: Computer System Architecture by Morris Mano (3rd Edition) and **Reference book: Computer Architecture, by William Stallings (4th Edition)**.

Lecture:

Peripheral Devices

The input-output subsystem of a computer, referred to as I/O, provides an efficient mode of communication between the central system and the outside environment. Programs and data must be entered into computer memory for processing and results obtained from computations must be recorded or displayed for the user. A computer serves no useful purpose without the ability to receive information from an outside source and to translate results in a meaningful form.

Devices that are under the direct control of the computer are said to be **connected on-line**. These devices are designed to read information into or out of the memory unit upon command from the CPU and are considered to be part of the total computer system. Input or output devices attached to the computer are also called **peripherals**. Among the most common peripherals are keyboards, display units, and printers. Peripherals that provide auxiliary storage for the system are magnetic disks and tapes. Peripherals are electromechanical and electromagnetic devices of some complexity. Only a very brief discussion of their function will be given here without going into detail of their internal construction.

ASCII Alphanumeric Characters

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Input and output devices that communicate with people and the computer are usually involved in the transfer of alphanumeric information to and from the device and the computer.

The 34 control characters are designated in the ASCII table with abbreviated names. They are listed again below the table with their functional names. The control characters are used for routing data and arranging the printed text into a prescribed format. There are three types of control characters:

- Format effectors
- Information separators
- Communication control characters

Format effectors are characters that control the layout of printing. They include the familiar typewriter controls, such as backspace (BS), horizontal tabulation (Hf), and carriage return (CR).

Information separators are used to separate the data into divisions like paragraphs and pages. They include characters such as record separator (RS) and file separator (FS).

The communication control characters are useful during the transmission of text between remote terminals. Examples of communication control characters are STX (start of text) and ETX (end of text), which are used to frame a text message when transmitted through a communication medium.

	$b_7b_6b_5$							
$b_4b_3b_2b_1$	000	001	010	011	100	101	110	111
0000	NUL	DLE	SP	0	@	P	`	p
0001	SOH	DC1	!	1	A	Q	a	q
0010	STX	DC2	"	2	B	R	b	r
0011	ETX	DC3	#	3	C	S	c	s
0100	EOT	DC4	$	4	D	T	d	t
0101	ENQ	NAK	%	5	E	U	e	u
0110	ACK	SYN	&	6	F	V	f	v
0111	BEL	ETB	'	7	G	W	g	w
1000	BS	CAN	(	8	H	X	h	x
1001	HT	EM	)	9	I	Y	i	y
1010	LF	SUB	*	:	J	Z	j	z
1011	VT	ESC	+	;	K	[	k	{
1100	FF	FS	,	<	L	\	l	|
1101	CR	GS	-	=	M	]	m	}
1110	SO	RS	.	>	N	^	n	~
1111	SI	US	/	?	O	—	o	DEL

Control characters

NUL	Null	DLE	Data link escape
SOH	Start of heading	DC1	Device control 1
STX	Start of text	DC2	Device control 2
ETX	End of text	DC3	Device control 3
EOT	End of transmission	DC4	Device control 4
ENQ	Enquiry	NAK	Negative acknowledge
ACK	Acknowledge	SYN	Synchronous idle
BEL	Bell	ETB	End of transmission block
BS	Backspace	CAN	Cancel
HT	Horizontal tab	EM	End of medium
LF	Line feed	SUB	Substitute
VT	Vertical tab	ESC	Escape
FF	Form feed	FS	File separator
CR	Carriage return	GS	Group separator
SO	Shift out	RS	Record separator
SI	Shift in	US	Unit separator
SP	Space	DEL	Delete

Input-output interface

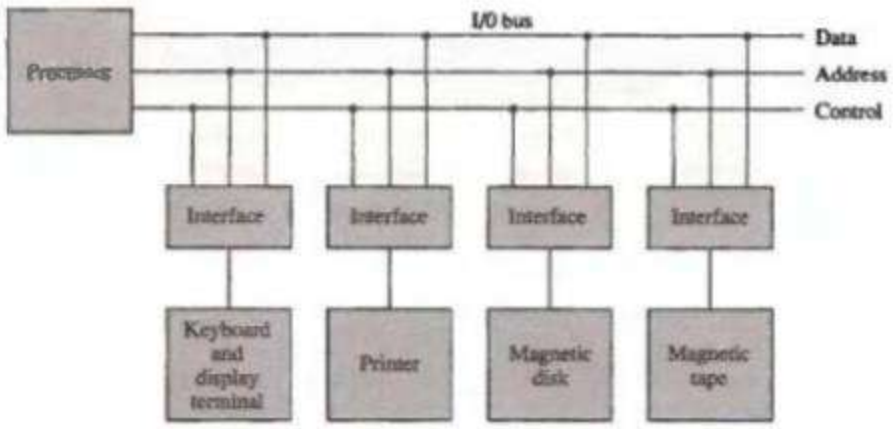
Input-output interface provides a method for transferring information between internal storage and external I/0 devices. Peripherals connected to a computer need special communication links for interfacing them with the central processing unit. The purpose of the communication link is to resolve the differences that exist between the central computer and each peripheral. The major differences are:

1. Peripherals are electromechanical and electromagnetic devices and their manner of operation is different from the operation of the CPU and memory, which are electronic devices. Therefore, a conversion of signal values may be required.
2. The data transfer rate of peripherals is usually slower than the transfer rate of the CPU, and consequently, a synchronization mechanism may be needed.
3. Data codes and formats in peripherals differ from the word format in the CPU and memory.
4. The operating modes of peripherals are different from each other and each must be controlled so as not to disturb the operation of other peripherals connected to the CPU.

I/O Bus and Interface Modules

A typical communication link between the processor and several peripherals is shown in Fig. **The I/O bus** consists of data lines, address lines, and control lines.

The I/O bus from the processor is attached to all peripheral interfaces. To communicate with a particular device, the processor places a device address on the address lines. Each interface attached to the I/O bus contains an address decoder that monitors the address lines. When the interface detects its own address, it activates the path between the bus lines and the device that it controls. All peripherals whose address does not correspond to the address in the bus are disabled by their interface.



I/O versus Memory Bus

In addition to communicating with I/O, the processor must communicate with the memory unit. Like the I/O bus, **the memory bus** contains data, address, and read/write control lines. There are three ways that computer buses can be used to communicate with memory and I/O:

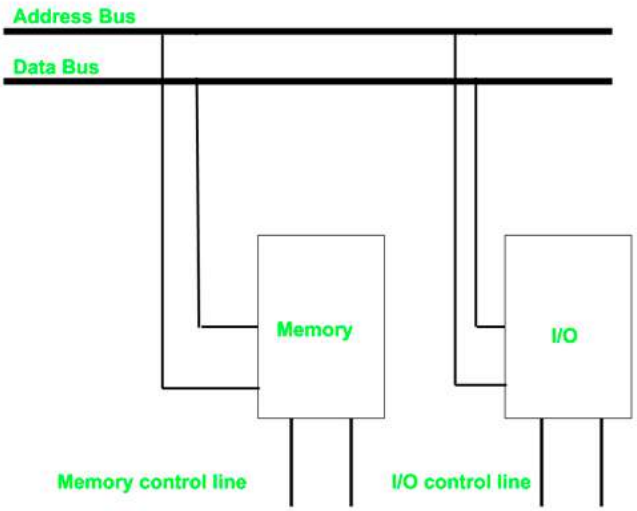
1. Use two separate buses, one for memory and the other for I/O.
2. Use one common bus for both memory and I/O but have separate control lines for each.
3. Use one common bus for memory and I/O with common control lines.

In the first method, the computer has independent sets of data, address, and control buses, one for accessing memory and the other for I/O. This is done in computers that provide a separate **I/O processor (IOP)** in addition to the central processing unit (CPU). The memory communicates with both the CPU and the IOP through a memory bus. The IOP communicates also with the input and output devices through a separate I/O bus with its own address, data and control lines. The purpose of the IOP is to provide an independent pathway for the transfer of information between external devices and internal memory.

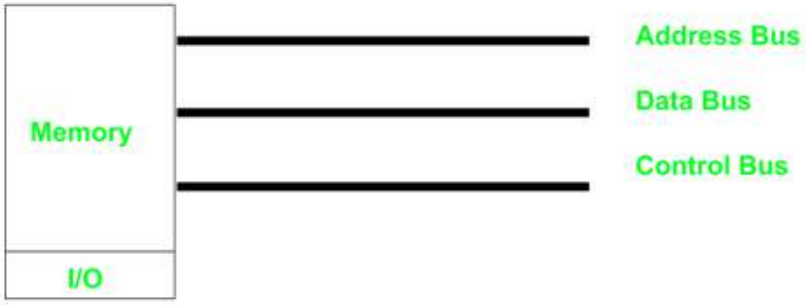
Isolated VS Memory mapped I/O

Then we have Isolated I/O in which we have common bus (data and address) for I/O and memory but separate read and write control lines for I/O. So when CPU decode instruction then if data is for I/O then it places the address on the address line and set I/O read or write control line on due

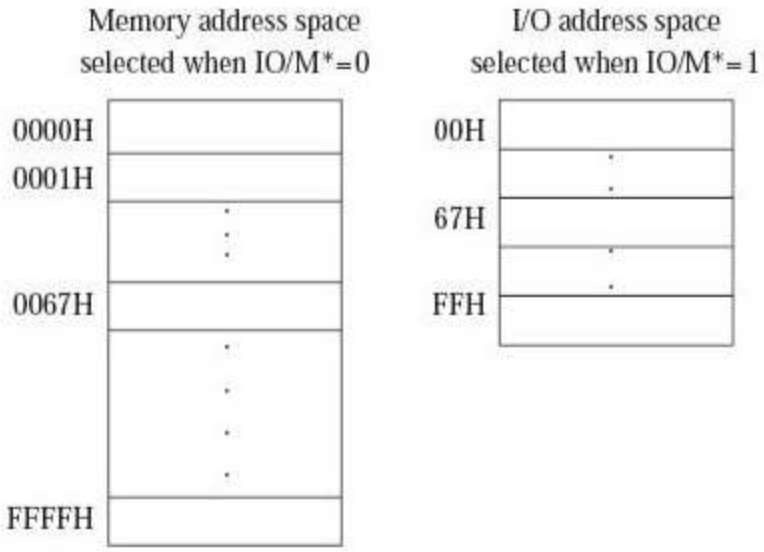
to which data transfer occurs between CPU and I/O. As the address space of memory and I/O is isolated and the name is so. The address for I/O here is called ports. Here we have different read-write instruction for both I/O and memory.



In memory mapped case every bus in common due to which the same set of instructions work for memory and I/O. Hence we manipulate I/O same as memory and both have same address space, due to which addressing capability of memory become less because some part is occupied by the I/O.



Memory Space discussion in memory mapped


Memory address space
selected when IO/M*=0
0000H
0001H
0067H
FFFFH
I/O address space
selected when IO/M*=1
00H
67H
FFH