ECE 220 Computer Systems & Programming

Lecture 2 – Memory-mapped I/O

August 31, 2017

- MP1 will be released this evening and due next Thursday at 10pm
- Register for ECE 220 online at CBTF - notification will be sent when quizzes are available to schedule

ECE ILLINOIS

ILLINOIS

Memory-Mapped I/O

- Assign a memory address to each device register
- Use data movement instructions (LD/ST) for control and data transfer

LC-3 Input and Output Device Registers

_____ -- store ASCII value entered from **keyboard**

_____ -- let processor know a new value is entered

_____ -- store ASCII value to be displayed on **monitor**

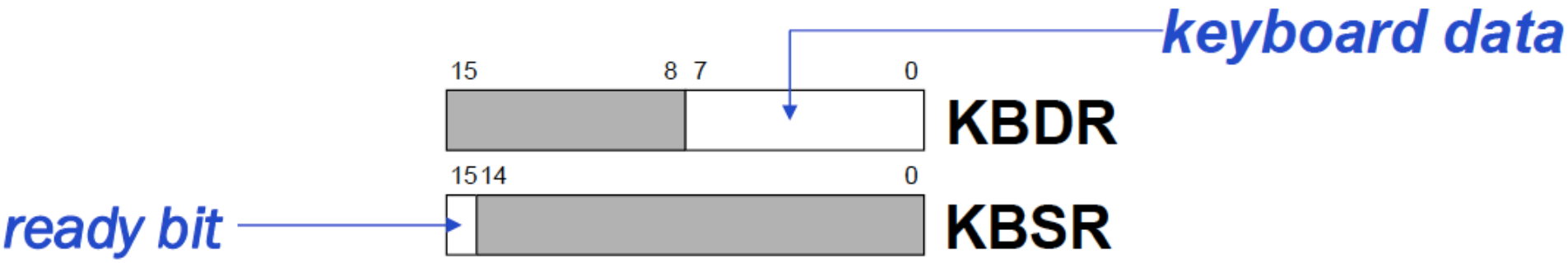
_____ -- let processor know a new value is ready to be displayed

LC-3 Memory-mapped Device Registers

Address	Contents	Comments
x0000		; system space
…		
x3000		; user space
		; programs
		; and data
…		
xFE00	KBSR	; Device register
xFE02	KBDR	
xFE04	DSR	
xFE06	DDR	
…		
xFFFF		

- These are the memory addresses to which the device registers (KBDR, etc.) are mapped
- But the device registers physically are separate from the memory.
- Memory-mapping device registers is a very common way to design interfaces for computing systems

Reading from the Keyboard



When a character is typed in

-

-

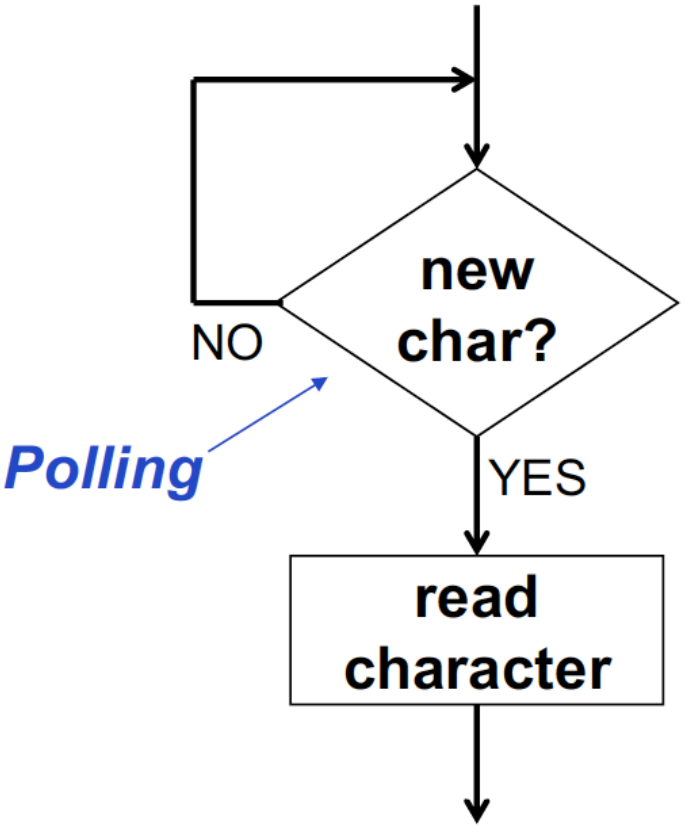
-

When KBDR is read

-

-

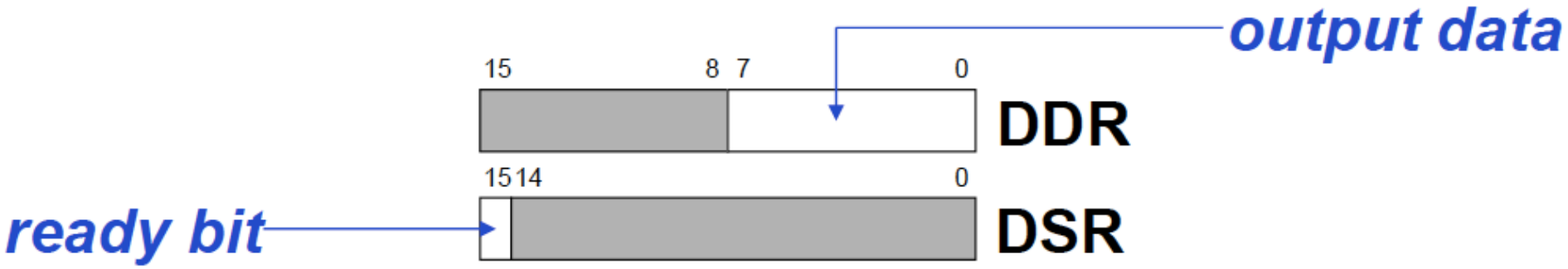
Reading from the Keyboard – Basic LC-3 Routine




```
.ORIG x3000


KBSR    .FILL  xFE00
KBDR    .FILL  xFE02
.END
```

Output to the Monitor



When monitor is ready to display another character

-

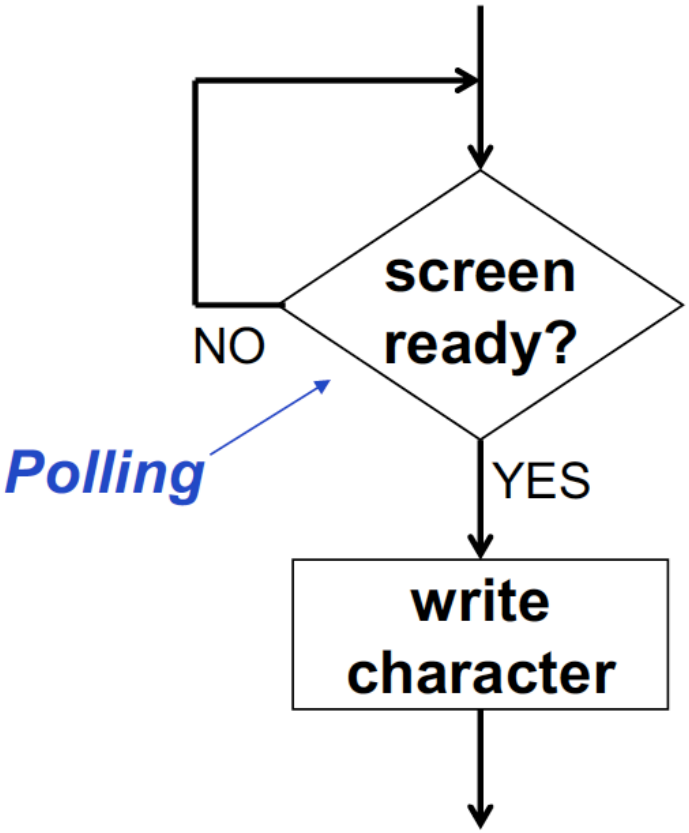
When data is written to DDR

-

-

-

Output to the Monitor – Basic LC-3 Routine

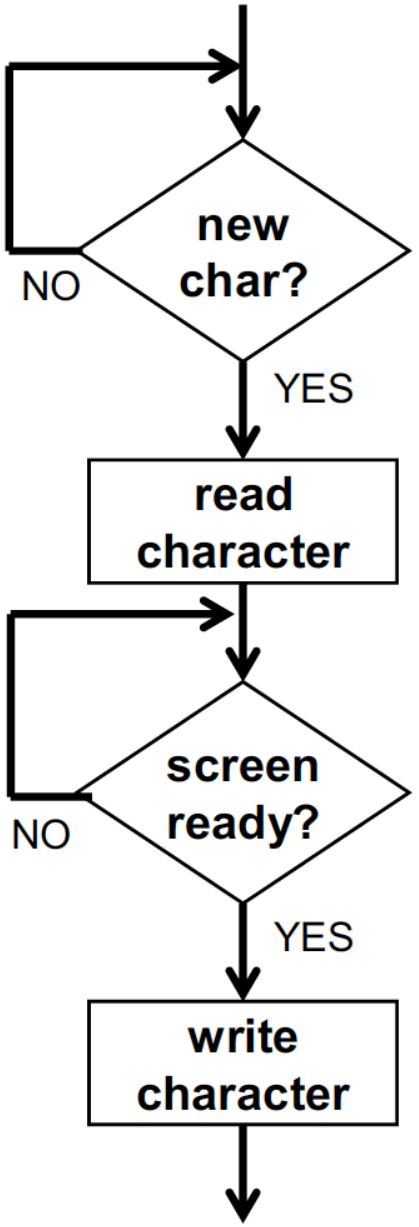



```
.ORIG x3000

DSR     .FILL  xFE04
DDR     .FILL  xFE06
.END
```

Echo Routine Implementation

```
.ORIG x3000
```




```
KBSR    .FILL xFE00
KBDR    .FILL xFE02
DSR     .FILL xFE04
DDR     .FILL xFE06
.END
```

LC-3 TRAP Routines for Handling I/O

- Trap Routines for Input

- Trap Routines for Output

LC-3 Exercise: Write String to Display

.ORIG x3000

MY_STRING .STRINGZ “Hello, World!”

.END