SISTEMI EMBEDDED

SOPC DE2 Basic Computer

Parallel port

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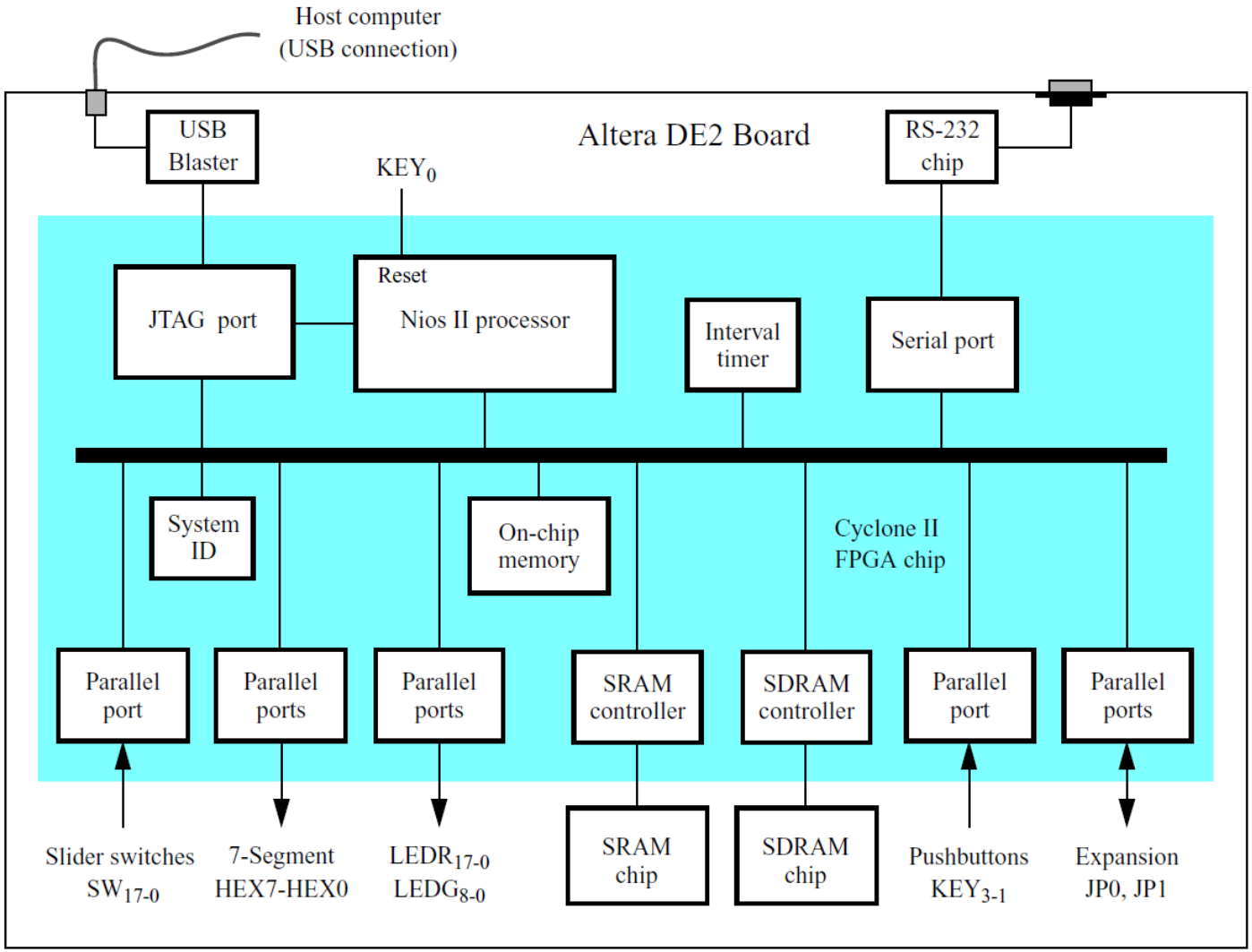
DE2 Basic Computer

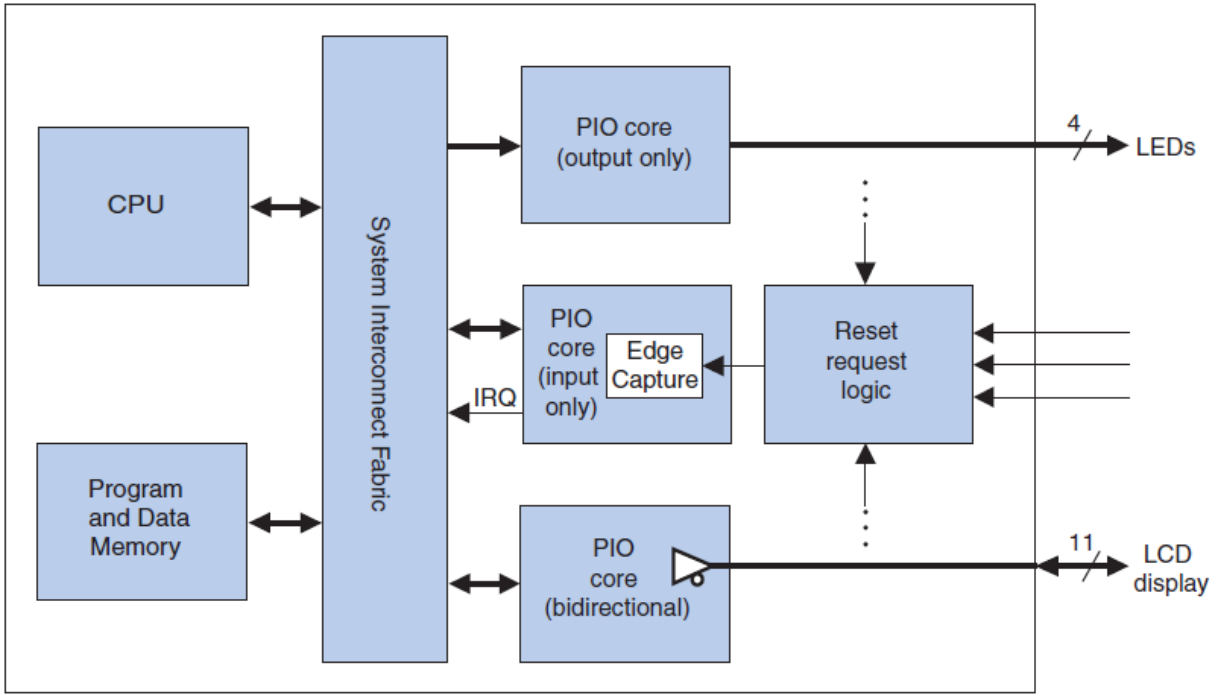
- Computer provided by Altera University Program
  - Processor: Nios II/e
  - Memory: SDRAM, SRAM, On-chip memory
  - I/O:
    - Parallel ports: red_LEDs, Green_LEDs, HEX3_HEX0, HEX7_HEX4, sliders, Pushbuttons, etc.
    - Other peripherals: JTAG UART, Serial_port, Interval_timer, sysid

DE2 Basic Computer (cont.)



Parallel port (1)

- Interface for general purpose I/O
  - Based on Altera's PIO core customized for DE-series boards
  - Controlling LEDs, acquiring data from Switches, etc.



Parallel port (2)

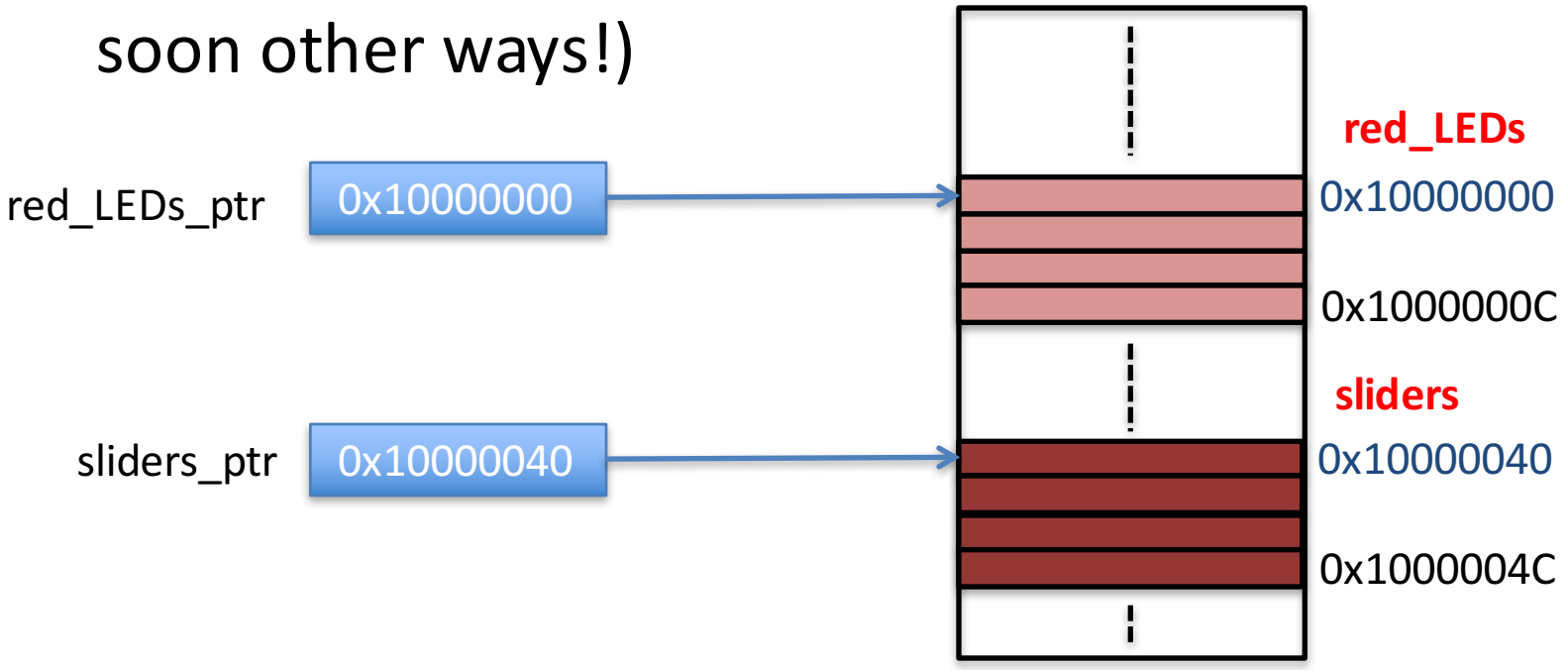
- 4x 32-bit memory-mapped registers
- *n* actual number of I/O pins

Table 2. Parallel Port register map

Offset in bytes	Register name		Read/Write	Bits $(n-1)\ldots 0$
0	`data`	Input	R	Data value currently on Parallel Port inputs.
		Output	W	New value to drive on Parallel Port outputs.
4	`direction`		R/W	Individual direction control for each I/O port. A value of 0 sets the direction to input; 1 sets the direction to output.
8	`interruptmask`		R/W	IRQ enable/disable for each input port. Setting a bit to 1 enables interrupts for the corresponding port.
12	`edgecapture`		R/W	Edge detection for each input port.

Parallel port (3)

- Managing PIO in C program:
  - Use of pointers to *unsigned int* initialized with PIO base memory address (we'll learn soon other ways!)




```
volatile unsigned int *red_LED_ptr = (unsigned int *) 0x10000000; //red LED address
volatile unsigned int *sliders_ptr = (unsigned int *) 0x10000040;
                                                      //SW slider switch address
```

Parallel port (4)

- Why **volatile** attribute?
  - I/O registers may change even if the program does not modify them!
    - The peripheral hardware may modify their contents
  - **Volatile** tells the compiler do not make any optimization to the code involving an object declared with the **volatile** attribute

Parallel port (5)

- Reading/Writing I/O registers:

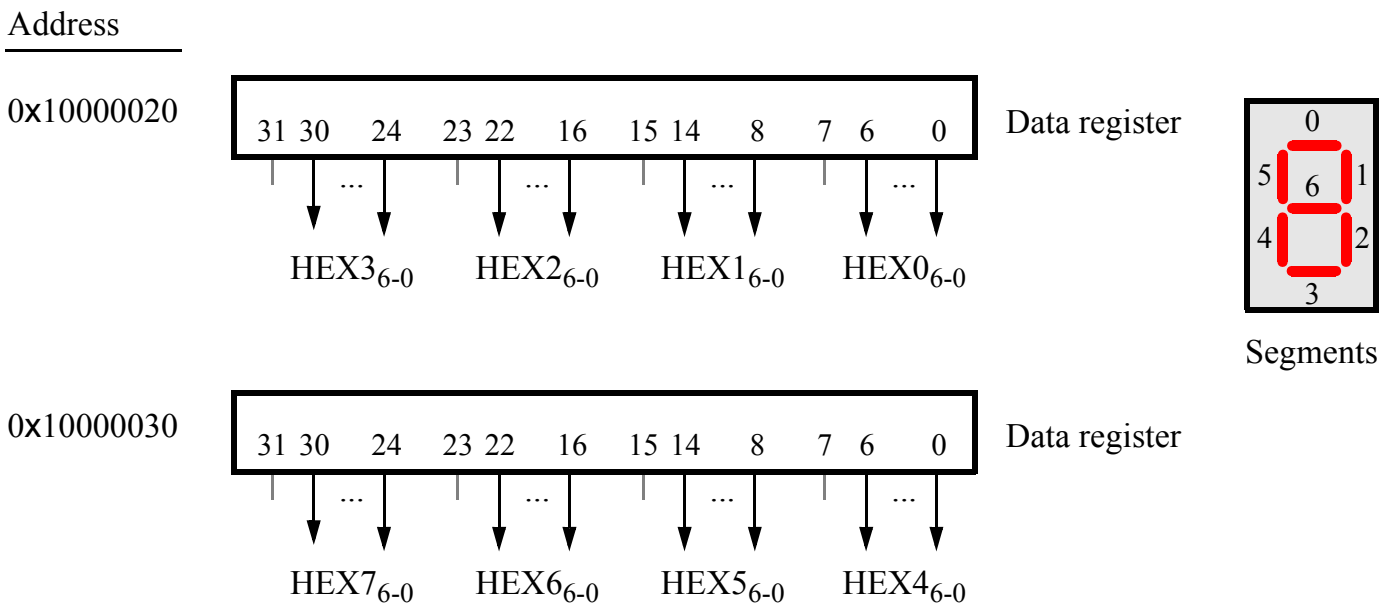
```
*red_LED_ptr = *slider_ptr;
```

Putting into practice (1)

- Let's start our first program with Nios II processor
  - Control the status of each DE2 red LED through the corresponding slider switch ($LEDR_i = Sw_i$)

Putting into practice (2)

- To go on:
  1. Show on the **4x 7-Seg HEX3_HEX0 display** the 4 hexadecimal digits of the 16-bit unsigned number (Sw_{15}-Sw_0)



Putting into practice (3)

- To go on:
  2. Show on the **4x 7-Seg HEX3_HEX0 display** the 4 decimal digits of the 16-bit unsigned number (Sw_{15}-Sw_0) if the number can be represented; **E** otherwise
  3. Allow the user to choice the representation between hexadecimal and decimal by the slider Sw_{17}

Putting into practice (4)

- To go on:
  4. Show on the **4x 7-Seg HEX3_HEX0 display** the module of the 16-bit signed number (Sw_{15}-Sw_0) and on $LEDG_8$ the sign of the number ($LEDG_8$ is ON if and only if the number is negative). Show the module using hexadecimal and decimal digits as before
  5. Allow the user to choice if (Sw_{15}-Sw_0) code an unsigned or signed number by the slider Sw_{16}
  6. Combine all the features in a single program

References

- Altera “Basic Computer System for the Altera DE2 Board”
- Altera “Parallel Port for Altera DE-Series Boards”