Embedded Systems Lab 0 - HS 2020

23.9.2020

Yun Cheng

Lab structure

- **Goal of today's lab:**
  - Gather hands-on experience with an embedded system.
- **Agenda:**
  - Wednesday 16:15 - 18:00 Introduction (recorded) and questions
  - Friday 16:15 - 18:00 Questions & Answers
- **Available assistants:**
  - Yun Cheng - TA
  - Adrian Schneebeli - SA
  - Michael Lustenberger - SA

Lab structure

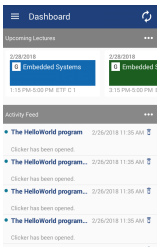
- **Interactions:**
  - **Exercise Zoom:** Questions can be asked throughout the lab in this room by raising your hand. Please feel free to write in the chat in case we oversee your question.
  - **Help Zoom:** Student assistants are available throughout the session for 1-on-1 meetings under the Zoom Meeting ID 917 6971 5701.
  - **Matrix Chatroom:** Questions that are relevant for everyone can be asked in the Matrix chatroom where the responsible assistants can answer as quickly as possible.
  - **In-person:** Students can come to ETZ D96 to ask questions in person.

Goals of the Prelab – *Filling the gaps*

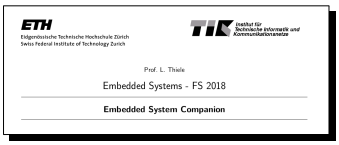
- Numeral systems
- Ordering and Endianness
- Generics types
- C operators
- Overflows

⇒ and *apply* on test examples

Warm-up – *Clicker Questions #1*



Feel like some things are not clear?



Go look it up!

1. Definitions
2. C Programming Crash Course
3. Good Programming Practices

Goals of the Prelab – *Filling the gaps*

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⇒ and *apply* on test examples

Binary, decimal and hexadecimal systems and how they convert into one another

Table 1: Main numberal systems for embedded programming

Numeral system	Base	Symbols	Interpretation of "11"
Binary	2	0 1	3
Decimal	10	0 1 2 3 4 5 6 7 8 9	11
Hexadecimal	16	0 1 2 3 4 5 6 7 8 9 a b c d e f	17

Goals of the Prelab – *Filling the gaps*

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⇒ and *apply* on test examples

Most and least significant bits and their usage in practice

```
//  0b _ _ _ _ _ _ _ _
//     ^               ^
//     MSB             LSB
```

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Goals of the Prelab – *Filling the gaps*

- Numeral systems
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⇒ and *apply* on test examples

	Unsigned types	
Type	Min value	Max value
uint8_t	0	255
uint16_t	0	65535
uint32_t	0	4294967295

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Goals of the Prelab – *Filling the gaps*

- Numeral systems
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- Generics types
- C operators
- Overflows

⇒ and *apply* on test examples

- Arithmetic operators
- Increment/Decrement
- Assignment and Tests
- Logical and Bitwise operators
- Left- and right-shifts
- `sizeof`

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Goals of the Prelab – *Filling the gaps*

- Numeral systems
- Ordering and Endianness
- Generics types
- C operators
- Overflows

⇒ and *apply* on test examples

Meaning and consequence of a *variable overflow*

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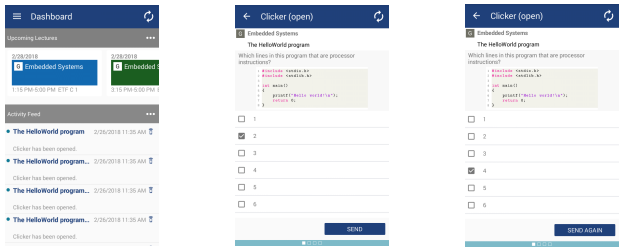
Let's see if that's clear! – *Clicker Questions #2*



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How is `0b0110` written in decimal?

Binary	0b	0	1	1	0
Decimal		$0*2^3$	$1*2^2$	$1*2^1$	$0*2^0$

(c) **6**

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How is `0b1110` written in hexadecimal?

Decimal	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Hexadecimal	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F

(a) **0x0E**

(c) **0xE**

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How is `0xC` written in binary?

Decimal	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Hexadecimal	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F

`0xC` = 12 = 8 + 4 = `0b1100`

(c) **0b1100**

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How is `0xD3` written in binary?

Decimal	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Hexadecimal	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F

`0xD` = 13 = 8 + 4 + 1 = `0b1101`
`0x3` = 3 = 2 + 1 = `0b0011`

(d) **0b1101 0011**

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What is the output of the printf instruction (line 8)?

```
1  int main()
2  {
3      uint8_t counter = 10;
4      /*
5       * Some code...
6       */
7      reset(counter);
8      printf("%u", counter);
9
10     return 0;
11 }
12 void reset(uint8_t x)
13 {
14     x = 0;
15 }
```

(b) **10**

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What is the value of `sizeof(int)`?

In C, the **number of bits used to encode interger types is not fixed**. This varies between implementations (e.g., depending on the platform or the CPU).

(d) **Impossible to know**

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What is the value of `sizeof(uint16_t)`?

The type uintN_t is used to store an unsigned interger number encoded with N bits.

(b) **2**

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Which instructions lead to `REG = 0b 1100 0011`?

`REG = 0xC3 = 0b1100 0001`

- Need to raise the second rightmost bit
- Use the bitwise `OR: |`
- Use the left-shift `<<` to put the bit in the right position

(c) `REG = ( REG | (0x01 << 1))`

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Addresses or values?

`pointerGrade = &studentA_grade ;`

	Address	Memory	
(0)	0x0000	156	
(1)	0x0001	0	
(2)	0x0002	75	
(3)	0x0003	4096	pointerGrade
	...	...	
(4096)	0x1000	6	studentA_grade
	...	...	

```
1  int main()
2  {
3      uint8_t *ptr;
4      uint8_t x = 0;
5      ptr = &x;
6
7      printf("%u", *ptr);
8      printf("%u", &ptr);
9      printf("%u", &x);
10
11     return 0;
12 }
```

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Addresses or values?

(b) **Line 7 prints the value of `x`.**

(g) **Line 8 prints the address of `ptr`.**

(i) **Line 9 prints the address of `x`.**

(l) **Line 9 prints the value of `prt`.**

```
1  int main()
2  {
3      uint8_t *ptr;
4      uint8_t x = 0;
5      ptr = &x;
6
7      printf("%u", *ptr);
8      printf("%u", &ptr);
9      printf("%u", &x);
10
11     return 0;
12 }
```

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Introduction is over

- The assistants are now available **until 18:00** to answer questions.
  - **Zoom:** Either ask in this channel or use the Zoom Meeting ID 917 6971 5701 to talk individually with an assistant.
  - **Matrix-Chatroom:** Ask a question in the chatroom so other students can also profit from the response (or respond even quicker!)
  - **Email:** For individual questions, you can also reach me under `chengyu@ethz.ch`.
- On **Friday from 16:15 - 18:00**, we will also be available for questions.

Happy coding!

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Feel free to ask questions!

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Happy coding!

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Questions?
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