Memory, Data, & Addressing I
CSE 351 Autumn 2023

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Relevant Course Information

❖ Upcoming deadlines
  ▪ Pre-Course Survey and HW0 due tonight
  ▪ HW1 due Monday (10/2)
  ▪ Lab 0 due Monday (10/2)
    • This lab is exploratory and looks like a HW; the other labs will look a lot different

❖ Ed Discussion etiquette
  ▪ For anything that doesn’t involve sensitive information or a solution, post publicly (you can post anonymously!)
  ▪ If you feel like you question has been sufficiently answered, make sure that a response has a checkmark
EPA

❖ Encourage class-wide learning!

❖ Effort
  ▪ Attending support hours, completing all assignments
  ▪ Keeping up with Ed Discussion activity

❖ Participation
  ▪ Making the class more interactive by asking questions in lecture, section, support hours, and on Ed Discussion

❖ Altruism
  ▪ Helping others in section, support hours, and on Ed Discussion
Lesson Summary (1/2)

❖ Memory is a long, \textit{byte-addressed} array
  ▪ Word size bounds the size of the \textit{address space} and memory
  ▪ Address of chunk of memory given by address of lowest byte in chunk

❖ Endianness determines memory storage order for multi-byte data
  ▪ Least significant byte in lowest (little-endian) or highest (big-endian) address of memory chunk

❖ Programming Data
  ▪ Variable declaration allocates space for data type size
  ▪ Assignment results in value being put in memory location
Lesson Summary (2/2)

❖ Terminology:
  ▪ byte-oriented memory, word size, address, address space
  ▪ most-significant bit (MSB), least-significant bit (LSB), big-endian, little-endian

❖ Learning Objectives:
  ▪ (Define the concept of pointers and) their significance in computer memory organization.
  ▪ (Design code that can correctly) interpret and manipulate multi-byte data in both little-endian and big-endian byte orderings.

❖ What lingering questions do you have from the lesson?
Memory & Data I — Context
Modern System Details

- Current x86-64 systems use **64-bit (8-byte) words** ("64-bit machines")
  - Potential address space: $2^{64}$ addresses
    - $2^{64}$ bytes $\approx 1.8 \times 10^{19}$ bytes
    - $= 18$ billion billion bytes $= 18$ EB (exabytes)
  - Actual physical address space: **48 bits**
    - This is sufficient space for now and allows for some operating system tricks
    - Example address: `0x 7f f 3d d5 06 94`

- There’s a lot more to this story... stay tuned for virtual memory!
Discussion Question

❖ Discuss the following question(s) in groups of 3-4 students
  ▪ I will call on a few groups afterwards so please be prepared to share out
  ▪ Be respectful of others’ opinions and experiences

❖ Over time, computers have grown in word size:

<table>
<thead>
<tr>
<th>Word size</th>
<th>Instruction Set Architecture</th>
<th>First? Intel CPU</th>
<th>Year Introduced</th>
</tr>
</thead>
<tbody>
<tr>
<td>8-bit</td>
<td>??? (Poor &amp; Pyle)</td>
<td>Intel 8008</td>
<td>1972</td>
</tr>
<tr>
<td>16-bit</td>
<td>x86</td>
<td>Intel 8086</td>
<td>1978</td>
</tr>
<tr>
<td>32-bit</td>
<td>IA-32</td>
<td>Intel 386</td>
<td>1985</td>
</tr>
<tr>
<td>64-bit</td>
<td>IA-64</td>
<td>Itanium (Merced)</td>
<td>2001</td>
</tr>
<tr>
<td>64-bit</td>
<td>x86-64</td>
<td>Xeon (Nocona)</td>
<td>2004</td>
</tr>
</tbody>
</table>

▪ What do you think were some of the causes, advantages, and disadvantages of this trend?
Group Work Time

During this time, you are encouraged to work on the following:

1) If desired, continue your discussion
2) Work on the lesson problems (solutions at the end of class)
3) Work on the homework problems

Resources:

- You can revisit the lesson material
- Work together in groups and help each other out
- Course staff will circle around to provide support
Practice Questions (1/2)

❖ By looking at the bits stored in memory, I can tell what a particular 4 bytes is being used to represent.
   A. True   B. False

❖ We can fetch a piece of data from memory as long as we have its address.
   A. True   B. False

❖ Which of the following bytes have a most-significant bit (MSB) of 1?
   A. 0x63   B. 0x90   C. 0xCA   D. 0xF
Practice Questions (2/2)

❖ We store the value 0x 01 02 03 04 as a word at address 0x100 in a big-endian, 64-bit machine.
❖ What is the byte of data stored at address 0x104?

A. 0x04
B. 0x40
C. 0x01
D. 0x10
E. We’re lost...