Overview

COMP 3221

Microprocessors and Embedded Systems

Lecture 4: Programmer's Model of Microprocessors http://www.cse.unsw.edu.au/~cs3221

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[°] Programmer's Model of a Microprocessor

- Address Space
- Registers
- Instruction Set
- ° Fetch Decode Execute Cycle
- ° Programmer's Model of ARM 7TDMI
- ° Translation of C to ASM

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Review: What is Subject about?



Review:Programming Levels of Representation



Review: 5 Classic Components of a Computer



An Expanded View of the Memory Systems





are not visible to the programmer

Fetch Decode Execute Cycle



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16 Visible Registers (ARM 7TDMI)



Instruction Set (ARM 7TDMI)

rO Set of instruction that a r1 Registers processor can execute r2 r3 ο **Instruction Categories** r4 r5 Data Processing or r6 Computational (Logical and r7 Arithmetic r8 r9 • Load/Store (Memory Access: r10 or transferring data between r11 memory and registers) r12 **Control Flow (Jump and** r13 r14 Branch) r15 (PC) Floating Point coprocessor CPSR Memory Management 87654 28 27 31 ١F Ιт mode NZCV unused

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Data Processing Instructions

Registers

- **Data Processing Instructions:**
 - · operate ONLY on registers
 - store result ONLY on registers
 - Category: Arithmetic, Logical, Data movement
 - Examples:

mov	r1 ,	r2		;	r1	←	r2		
add	r1,	r2,	r3	;	r1	←	r2	+	r3
and	r3,	r3,	r4	;	r3	←	r3	A	1D

unused

All covered in details later



rO

r1 r2

r3

r4

r5

r6

r7

r8

r9

r10

r11

r12 r13

r14 r15 (PC)

r4

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NZCV

28 27

31

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Memory Access Instructions

- **Memory Access Instructions:**
 - Transfer data from a memory address to a register (load instructions)
 - Transfer data from a register to a memory address (store instructions)
 - Examples:

ldr r1, [r2] Address of memory location is in register r2 str r1, [r3] ; r1 \rightarrow mem[r3]

Address of memory location is in register r3

All covered in details later

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Control Flow Instructions

Control Flow Instruction: 0

Generally next Instructions are fetched from Sequential addresses in Mem Ox8000000	E0832004 add r2, r3, r4	instruction			
Some Instructions cause 0x8000004	E0452006 sub r2, r5, r6	instruction			
from non sequential 0x8000000	E5920000 Idr r0, [r2]	instruction			
flow or branch instructions ⁽⁸⁰⁰⁰⁰⁰⁰	EA000004 br 0x80000018	instruction			
• Examples:					
br there					
All covered in details later	E0852005 8 add r2, r5, r5	instruction			
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What's this stuff good for? GameBoy!

[°] Nidendo Executive GameBoy

- Power by ARM Processor
- Color LCD240 x 160 pixel (32 000 colors)
- USD100

Is This the Executive's GameBoy?

intendo's newest handheld Game Boy ditches the just-a-toy look in favor of a clamshell design that an adult player might use in public without embarrassment. The GameBoy Advance SP has the appearance of a smallish DVD player, and, except for its shape and a couple of extras, has the same features as the GameBoy Advance, introduced in June 2001.

Remedying a complaint about its older model, Nintendo has added a front unit's pair of AA alkaline batteries didn't last long. So this time around, Nintendo powers the unit with a rechargeable for 18 hours



Nintendo's GameBoy Advance SP was light to the color screen to make playing unvelled last month in Tokyo. The silver easier in poor lighting. Also, the older version promises to please the jetsetting executive who has everything.

lithium-ion battery good for 10 hours of 2.9-inch reflective thin-film transistor

and displays some 32 000 colors. But it can be folded like a laptop to take up less space on your palm than a 3.5-inch floppy disk: around 8.5 by 8.2 cm by less than 2.54 cm in height. It weighs about 140 grams. Nintendo styles its colors as metallic cobalt, a blue, or, for that executive look, a high-end-looking platinum. more usually called silver.

Nintendo promises that all current and future games for GameBoy Advance-and the list is already hugewill be compatible with the SP. The unit will list for ¥12 500 in Japan when it becomes available on 14 February, and for US \$99.95 in the United States

Like its predecessor, the SP has a when it bows there on 23 March. For more information, see Nintendo's play, with a three-hour recharge period; LCD screen and is powered by a zippy Web site at http://www.nintendo.com, or switch off the front light, and it's good 32-bit ARM microprocessor. It has the order from GameBoy vendor EBgames. same resolution-240 by 160 pixels- com at http://www.ebgames.com/.

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IEEE Spectrum Feb 2003

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COMP 3221 Reading Materials

- ° Printed Laboratory booklets (Highly Recommended)
 - Buy from the Bookshop for \$10 (Available from Week #2)
 - Available on-line as well
- [°] Companion CD-ROM (Highly Recommended)
 - Present your Lab booklet to CSE's store staff (in K17-B08) to be stamped and collect your CD.(Available from Week #2)
 - · All Software tools and user manuals used in the lab
 - All relevant documentation relating to hardware development board used in the lab
 - Copies of all relevant data sheets for the processor and other devices on the hardware development board used in the lab
 - Copy of ARM Processor Reference Manual
 - All the Laboratory Exercises documentations
 - Many programming examples
 - And LOT MORE...

Available on-line as well
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COMP 3221 Laboratory Session

Laboratory:

- Monday: 14:00 16:00 EE233
- Monday: 17:00 19:00 EE233
- Tuesday: 11:00 13:00 EE233
- Wednesday: 13:00 15:00 EE233
- Thursday: 12:00 14:00 EE233
- Friday: 14:00 16:00 EE233
- You will be only allowed into the lab session that you are enrolled in. No exception allowed.
- You have until TOMARROW to enroll into a lab session
- Wednesday, Thursday, Friday lab sessions are full!
- Starts from week #3
- Special Open Access labs
- Wednesday : 16:00 18:00 EE233
- Friday: 16:00 18:00 EE233
- Not assessed

• It is only for those who need a bit of extra time COMP3221 lec04-prog-model.18 Saeid Nooshabadi

Laboratory Groups

° Linux Lab Group Account

0

Day	Time	Group User Name
Monday:	14:00 – 16:00	ua1 – ua18 & pa1 – pa18
Monday:	17:00 – 19:00	ub1 – ub18 & pb1 – pb18
Tuesday:	11:00 – 13:00	uc1 – uc18 & pc1 – pc18
Wednesday:	13:00 – 15:00	ud1 – ud18 & pd1 – pd18
Thursday:	12:00 – 14:00	ue1 – ue18 & pe1 – pe18
Friday:	14:00 – 16:00	uf1 – uf18 & pf1 – pf18

PASSWORD: group_X

With X being the group number, eg group_ua1, group_pe18

You must change your password the first time you log in.

ELEC 2041 Laboratory Schedule

[°]Laboratory:

- •Sign up and Experiment #1 next Week for all Sessions:
- Special Open Access lab Sessions
- Wednesday: 16:00 18:00 EE233
- Friday: 16:00 18:00 EE233
- Starts from week #4
- Not assessed
- It is only for those who need a bit of extra time

Laboratory Documentation

[°]Written Extensively

[°]They Server as:

- Lecture Notes
- Tutorials
- AND Practical exercise

[°]Careful Reading Enables you to:

- Understand the Subject material
- Do tutorial practice
- AND get practical experience

DO TAKE THEM VERY SERIOUS!

Compilation

- [°] How to turn notation programmers prefer into notation computer understands?
- [°] Program to translate C statements into Assembly Language instructions: called a compiler
- [°] Example: compile by hand this C code: a = b' + c: d = a - e;
- ° Easy: add r1, r2, r3 sub r4, r5, r6

[°] Big Idea: compiler translates notation from 1 level of abstraction to lower level

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Conclusion

°ARM has 16 32-bit registers

° Instructions are all 32 bits

[°]Instruction Categories

- Data Processing or Computational (Logical and Arithmetic
- Load/Store (Memory Access: or transferring data between memory and registers)
- Control Flow (Jump and Branch)
- °Access to memory is only through 1dr and str instructions

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