



2016 Architecture

Project 1 – Instruction simulator



Outline

- ▣ Workstation setting : MobaXterm
- ▣ Project

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- ▣ Project



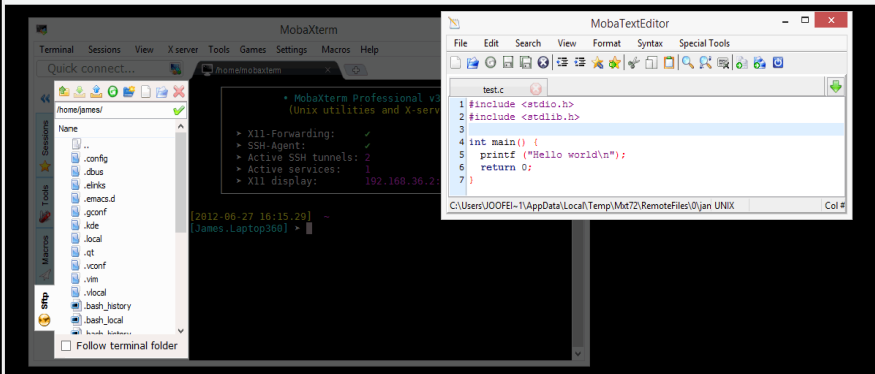
MobaXterm Download

Download the free version of MobaXterm

- <http://mobaxterm.mobatek.net/>

MobaXterm

Enhanced terminal for Windows with X11 server, tabbed SSH client, network tools and much more



SSH/SFTP browser: edit and transfer remote files through secured connection

1.

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2.

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MobaXterm Home Edition

Select the version you want to download (installable or portable version)

MobaXterm Home Edition v8.2
(Portable edition)

3.

MobaXterm Home Edition v8.2
(Installer edition)

By clicking on the above buttons, you accept [MobaXterm terms and conditions](#)

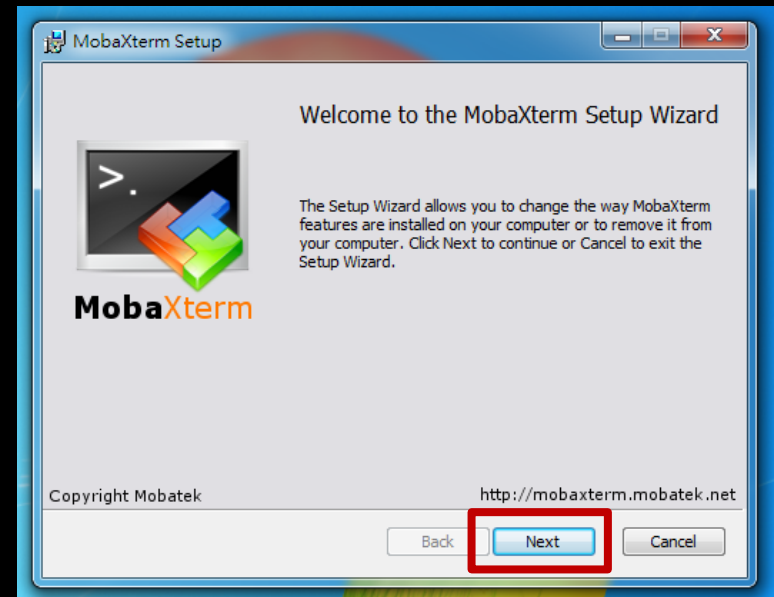
You can download MobaXterm and plugins sources [here](#)



MobaXterm Installation

■ Installation

- Next & Accept → Finish

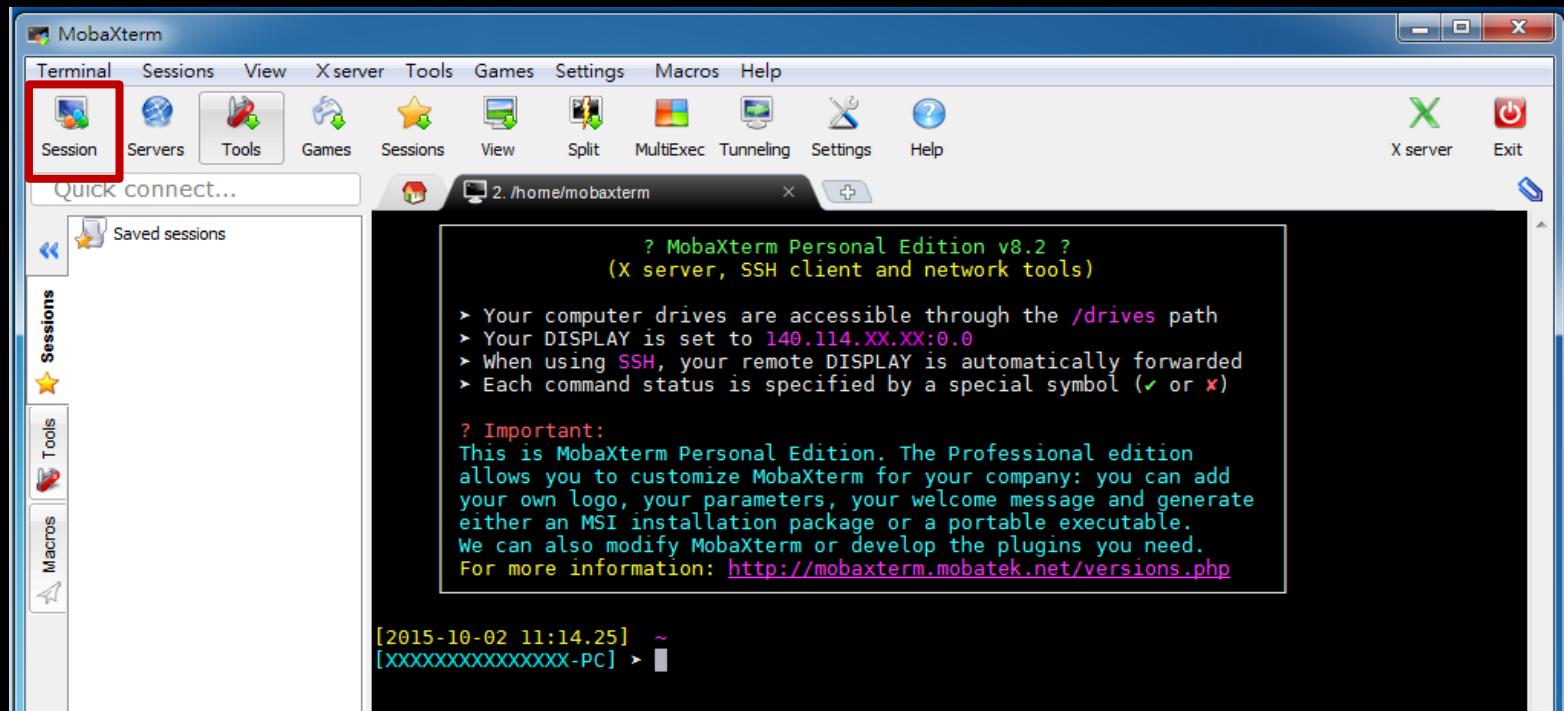


■ Click the icon on desktop



Workstation Setup

1.

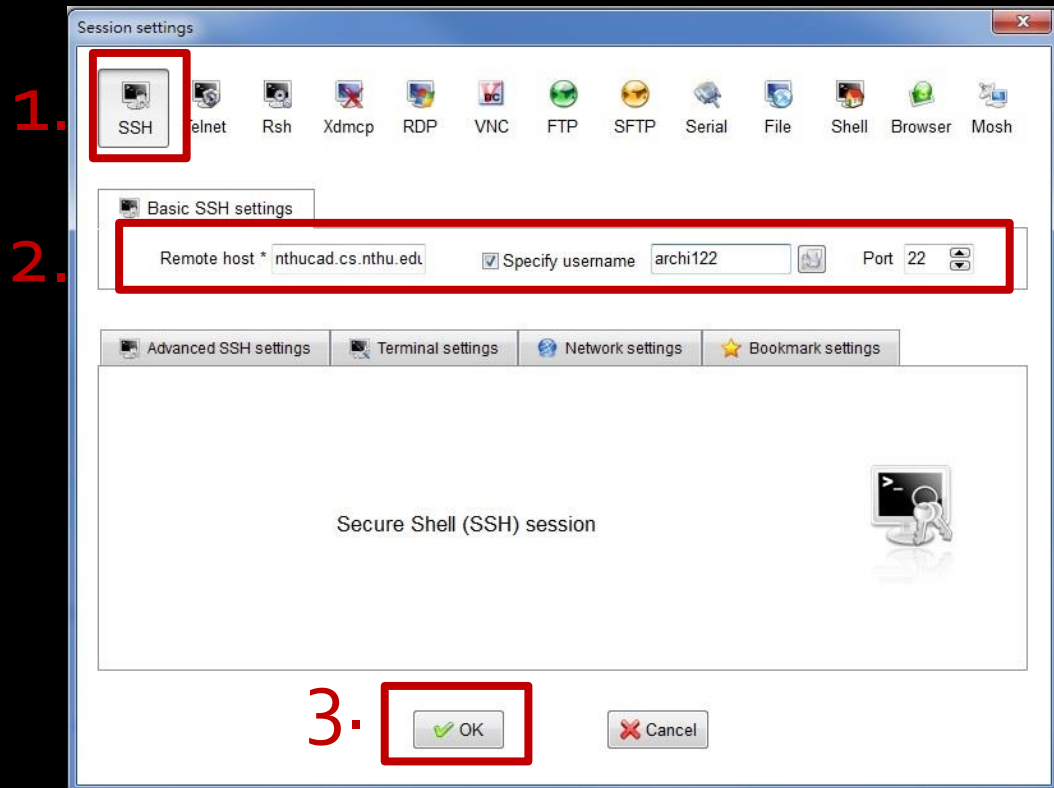


Workstation Setup (Cont.)

■ Enter the following blank

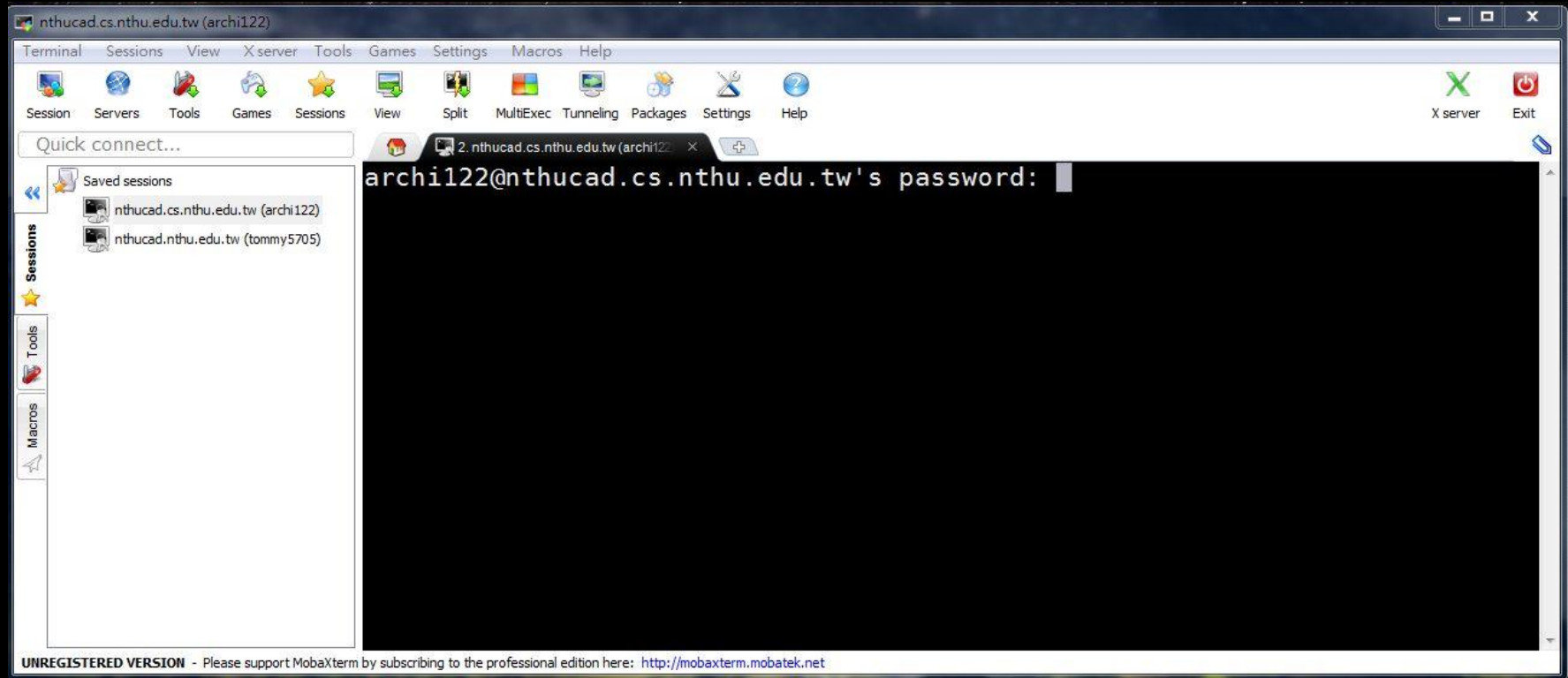
- Remote host : nthucad.cs.nthu.edu.tw
- Specify username : archiXX (your account)
- Port : 22

■ Click “OK”



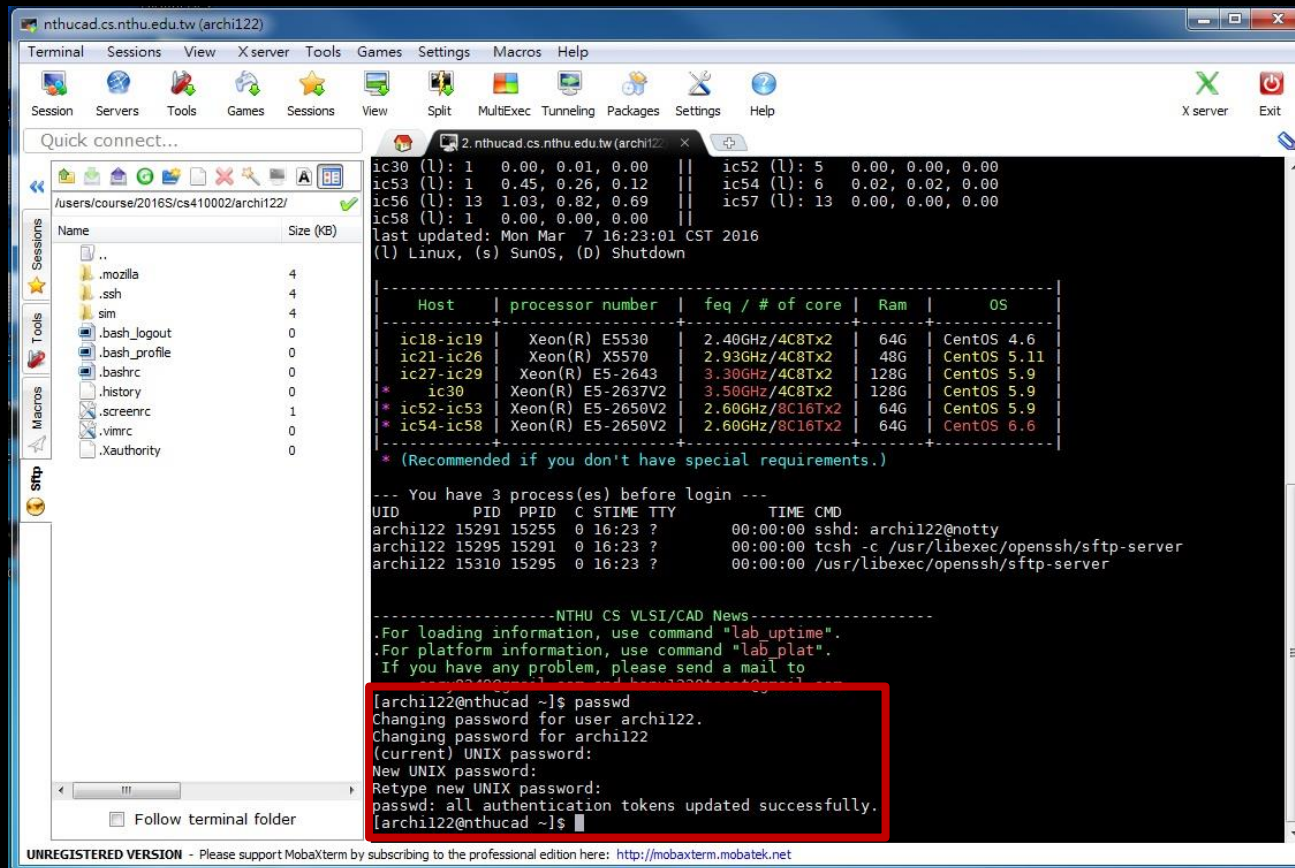
Login at the First Time

□ Key in your **initial password** from e-mail



Change Your Password

■ Type “passwd” to change your password



```
nthucad.cs.nthu.edu.tw (archil22)
Terminal Sessions View X server Tools Games Settings Macros Help
Session Servers Tools Games Sessions View Split MultiExec Tunneling Packages Settings Help
Quick connect...
/users/course/2016S/cs410002/archil22/
Name Size (KB)
.. 4
.mozilla 4
.ssh 4
sim 4
.bash_logout 0
.bash_profile 0
.bashrc 0
.history 0
.screenrc 1
.vimrc 0
.Xauthority 0
Follow terminal folder

ic30 (l): 1 0.00, 0.01, 0.00 || ic52 (l): 5 0.00, 0.00, 0.00
ic53 (l): 1 0.45, 0.26, 0.12 || ic54 (l): 6 0.02, 0.02, 0.00
ic56 (l): 13 1.03, 0.82, 0.69 || ic57 (l): 13 0.00, 0.00, 0.00
ic58 (l): 1 0.00, 0.00, 0.00
Last updated: Mon Mar 7 16:23:01 CST 2016
(l) Linux, (s) SunOS, (D) Shutdown

Host | processor number | freq / # of core | Ram | OS
-----|-----|-----|-----|-----
ic18-ic19 | Xeon(R) E5530 | 2.40GHz/4C8Tx2 | 64G | CentOS 4.6
ic21-ic26 | Xeon(R) X5570 | 2.93GHz/4C8Tx2 | 48G | CentOS 5.11
ic27-ic29 | Xeon(R) E5-2643 | 3.30GHz/4C8Tx2 | 128G | CentOS 5.9
* ic30 | Xeon(R) E5-2637V2 | 3.50GHz/4C8Tx2 | 128G | CentOS 5.9
* ic52-ic53 | Xeon(R) E5-2650V2 | 2.60GHz/8C16Tx2 | 64G | CentOS 5.9
* ic54-ic58 | Xeon(R) E5-2650V2 | 2.60GHz/8C16Tx2 | 64G | CentOS 6.6
* (Recommended if you don't have special requirements.)

--- You have 3 process(es) before login ---
UID PID PPID C STIME TTY TIME CMD
archil22 15291 15255 0 16:23 ? 00:00:00 sshd: archil22@notty
archil22 15295 15291 0 16:23 ? 00:00:00 tcsh -c /usr/libexec/openssh/sftp-server
archil22 15310 15295 0 16:23 ? 00:00:00 /usr/libexec/openssh/sftp-server

-----NTHU CS VLSI/CAD News-----
.For loading information, use command "lab_uptime".
.For platform information, use command "lab_plat".
.If you have any problem, please send a mail to
nssn03100@mail.nthu.edu.tw or hsu410002@nthu.edu.tw

[archil22@nthucad ~]$ passwd
Changing password for user archil22.
Changing password for archil22
(current) UNIX password:
New UNIX password:
Retype new UNIX password:
passwd: all authentication tokens updated successfully.
[archil22@nthucad ~]$
```

Connecting to Workstation

- You can only choose on workstation from **ic21 ~ ic29**
- Find a workstation with **less user**

```
2. /home/mobaxterm 9. nthucad.cs.nthu.edu.tw
Last login: Fri Oct 2 12:07:19 2015 from cad62.cs.nthu.edu.tw

      NTHU
    VLSI/CAD

-----users---load average-----users---load average---
ic4  (s): 0   0.00, 0.00, 0.00 || ic5  (l): 0   0.00, 0.01, 0.05
ic18 (l): 2   0.00, 0.00, 0.00 || ic19 (l): 1   0.00, 0.00, 0.00
ic21 (l): 4   0.11, 0.04, 0.01 || ic22 (l): 4   0.00, 0.01, 0.00
ic23 (l): 0   0.00, 0.00, 0.00 || ic24 (l): 1   0.02, 0.01, 0.00
ic25 (l): 1   0.03, 0.04, 0.00 || ic26 (l): 0   0.99, 0.98, 0.96
ic27 (l): 11  1.02, 1.04, 1.05 || ic28 (l): 1   1.00, 1.00, 1.00
ic29 (l): 0   1.09, 1.03, 1.01 || ic30 (l): 0   0.00, 0.00, 0.00
ic52 (l): 9   1.00, 1.00, 1.00 || ic53 (l): 0   2.00, 2.00, 2.00
ic54 (l): 4   0.02, 0.01, 0.00 || ic56 (l): 4   3.01, 2.97, 2.44
ic57 (l): 13  2.00, 1.86, 1.46 || ic58 (l): 4   1.99, 1.94, 1.86
last updated: Fri Oct 2 13:49:01 CST 2015
(l) Linux. (s) SunOS. (D) Shutdown
```

These are the only workstation you can use (ic21~ic29)

of users on the workstation



Connecting to Workstation (Cont.)

■ Connect to a workstation

- ssh -X icXX

1.

```
-----NTHU CS VLSI/CAD News-----
.For loading information, use command "lab_uptime".
.For platform information, use command "lab_plat".
.If you have any problem, please send a mail to
  cory8249@gmail.com and hsnul220toast@gmail.com

[archil22@nthucad ~]$ ssh -X ic21
The authenticity of host 'ic21 (192.168.75.51)' can't be established.
RSA key fingerprint is e0:06:4a:9a:6d:b2:a1:c7:f6:49:b0:39:54:8c:7a.
Are you sure you want to continue connecting (yes/no)? yes
Warning: Permanently added 'ic21,192.168.75.51' (RSA) to the list of known hosts.
archil22@ic21's password:
-----users-----load average-----
ic5 (l): 1 0.00, 0.01, 0.05 || ic18 (l): 3 0.00, 0.00, 0.00
ic19 (l): 3 0.00, 0.00, 0.00 || ic21 (l): 3 0.02, 0.01, 0.00
ic22 (l): 2 0.00, 0.00, 0.00 || ic23 (l): 17 2.03, 1.97, 1.57
ic24 (l): 2 0.00, 0.00, 0.00 || ic25 (l): 1 0.00, 0.00, 0.00
ic26 (l): 3 0.00, 0.00, 0.00 || ic27 (l): 1 0.08, 0.07, 0.02
ic28 (l): 2 0.00, 0.00, 0.00 || ic29 (l): 2 0.01, 0.02, 0.00
ic30 (l): 1 0.00, 0.00, 0.00 || ic52 (l): 5 0.00, 0.03, 0.05
ic53 (l): 1 0.01, 0.09, 0.08 || ic54 (l): 6 0.63, 0.18, 0.05
ic56 (l): 13 1.02, 0.79, 0.74 || ic57 (l): 13 0.00, 0.00, 0.00
ic58 (l): 1 0.00, 0.00, 0.00 ||
Last updated: Mon Mar 7 16:07:01 CST 2016
(l) Linux, (s) SunOS, (D) Shutdown

-----NTHU CS VLSI/CAD News-----
.For loading information, use command "lab_uptime".
.For platform information, use command "lab_plat".
.If you have any problem, please send a mail to
  cory8249@gmail.com and hsnul220toast@gmail.com
Synopsis licenses have set!
Cadence licenses have set!
[archil22@ic21 ~]$
```

Type "yes"

2. Should be [XXX@icXX ~]\$ after connecting



Run simulation

- Use “NC verilog” as standard simulation platform
 - Commercial software by Cadence
- You can use any IDE/Editor to program

Run simulation

▣ \$ ncverilog *all .v file you need*

- Ex: \$ncverilog Simulator.v Test_Bench.v

```
2.nthucad.cs.nthu.edu.tw
Initial blocks:      2      2
Pseudo assignments: 1      1
Simulation timescale: 1ps
Writing initial simulation snapshot: worklib.Test_Bench.v
Loading snapshot worklib.Test_Bench.v ..... Done
*Verdi3* Loading libsscore_ius141.so
*Verdi3* : Enable Parallel Dumping.
ncsim> source /usr/cad/cadence/INCISIV/cur/tools/inca/files/ncsimrc
ncsim> run
$0: 0
$1: 0
$2: 0
$3: 0
$4: 0
$5: 0
$6: 0
$7: 0
$8: 0
$9: 0
$10: 0
$11: 0
$12: 0
$13: 0
$14: 0
$15: 0
$16: 0
$17: 0
$18: 0
$19: 0
$20: 0
$21: 0
$22: 0
$23: 0
$24: 0
$25: 0
$26: 0
$27: 0
$28: 0
$29: 0
$30: 0
$31: 0
Simulation complete via $finish(1) at time 2010 NS + 0
./Test_Bench.v:45      #(`CYCLE_TIME*`END_CYCLE) $finish;
ncsim> exit
```



Create directory

- Right click to create new directory “*sim*” or by command line “*mkdir sim*”

The screenshot shows the MobaXterm interface with a terminal window and a file explorer. A right-click context menu is open in the file explorer, with 'New directory' highlighted. A dialog box titled '2. Type "sim"' is overlaid, showing the directory name 'sim' entered in a text field. Below the text field, a '3.' label points to the 'OK' button. The terminal window in the background displays system information and a table of host specifications.

1. Right click to create new directory “*sim*”

2. Type “*sim*”
Please enter the new directory name

3. OK

Host	processor	number	freq / # of core	Ram	OS
ic18-ic19	Xeon(R) E5530		2.40GHz/4C8Tx2	64G	CentOS 4.6
ic21-ic26	Xeon(R) X5570		2.93GHz/4C8Tx2	48G	CentOS 5.11
ic27-ic29	Xeon(R) E5-2643		3.30GHz/4C8Tx2	128G	CentOS 5.9
ic30	Xeon(R) E5-2637V2		3.50GHz/4C8Tx2	128G	CentOS 5.9
* ic52-ic53	Xeon(R) E5-2650V2		2.60GHz/8C16Tx2	64G	CentOS 5.9
* ic54-ic58	Xeon(R) E5-2650V2		2.60GHz/8C16Tx2	64G	CentOS 6.6

UNREGISTERED VERSION - Please support MobaXterm by subscribing to the professional edition here: <http://mobaxterm.mobatek.net>

Uploading .v Files

Upload files

- Upload your .v files by dragging them into directory

The screenshot illustrates the process of uploading .v files to a remote directory. On the left, a Windows File Explorer window shows a local directory 'Project1' containing three files: 'example1.v', 'example2.v', and 'example3.v'. These files are highlighted with a red box. A red arrow points from this box to a corresponding box in the MobaXterm window on the right. The MobaXterm window shows a terminal session with the command `/users/course/2016S/cs410002/archi122/sim/` entered. Below the command, the files 'example1.v', 'example2.v', and 'example3.v' are listed, indicating they have been successfully uploaded to the remote directory. The terminal also displays system information for the remote host, including processor details, frequency, RAM, and OS version.

Host	processor number	freq / # of core	Ram	OS
ic18-ic19	Xeon(R) E5530	2.40GHz/4C8Tx2	64G	CentOS 4.6
ic21-ic26	Xeon(R) X5570	2.93GHz/4C8Tx2	48G	CentOS 5.11
ic27-ic29	Xeon(R) E5-2643	3.30GHz/4C8Tx2	128G	CentOS 5.9
* ic30	Xeon(R) E5-2637V2	3.50GHz/4C8Tx2	128G	CentOS 5.9
* ic52-ic53	Xeon(R) E5-2650V2	2.60GHz/8C16Tx2	64G	CentOS 5.9
* ic54-ic58	Xeon(R) E5-2650V2	2.60GHz/8C16Tx2	64G	CentOS 6.6

last updated: Mon Mar 7 15:50:01 CST 2016
(l) Linux, (s) SunOS, (D) Shutdown

-----NTHU CS VLSI/CAD News-----
For loading information, use command "lab_uptime".
For platform information, use command "lab_plat".
If you have any problem, please send a mail to
cory8249@gmail.com and hsnul220toast@gmail.com
[archi122@nthuacad ~]\$

UNREGISTERED VERSION - Please support MobaXterm by subscribing to the professional edition here: <http://mobaxterm.mobatek.net>

Edit with MobaXterm

Quick connect...

2. nthuacad.cs.nthu.edu.tw

> For more info, ctrl+click on [help](#) or visit our [website](#)

Last login: Thu Mar 10 02:35:00 2016 from sd236097.ching-de.ab.nthu.edu.tw

NTHU INCA2

age-----users---load average---

0.05		ic18 (l): 6	4.00, 3.97, 3.85
0.00		ic21 (l): 3	0.00, 0.04, 0.00
0.00		ic23 (l): 3	0.00, 0.00, 0.00
0.00		ic25 (l): 0	0.00, 0.00, 0.00
0.00		ic27 (l): 0	0.00, 0.02, 0.00
0.00		ic29 (l): 3	0.03, 0.03, 0.00
0.04, 0.02, 0.00		ic52 (l): 4	0.10, 0.05, 0.01
0.00, 0.00, 0.00		ic54 (l): 6	0.55, 0.23, 0.08
0.00, 0.00, 0.00		ic57 (l): 15	0.00, 0.00, 0.00
0.00, 0.00, 0.00			

last updated: Thu Mar 10 21:03:01 CST 2016
(l) Linux, (s) SunOS, (D) Shutdown

Host	processor number	freq / # of core	Ram	OS
ic18-ic19	Xeon(R) E5530	2.40GHz/4C8Tx2	64G	CentOS 4.6
ic21-ic26	Xeon(R) X5570	2.93GHz/4C8Tx2	48G	CentOS 5.11
ic27-ic29	Xeon(R) E5-2643	3.30GHz/4C8Tx2	128G	CentOS 5.9
* ic30	Xeon(R) E5-2637V2	3.50GHz/4C8Tx2	128G	CentOS 5.9
* ic52-ic53	Xeon(R) E5-2650V2	2.60GHz/8C16Tx2	64G	CentOS 5.9
* ic54-ic58	Xeon(R) E5-2650V2	2.60GHz/8C16Tx2	64G	CentOS 6.6

* (Recommended if you don't have special requirements.)

Useful tool

▣ Makefile

- No need to type “ncverilog ...” all the time

▣ Screen

- Multiscreen in linux

▣ 鳥哥的Linux 私房菜

- Linux introduction and instruction

Outline

- ▣ Workstation setting : MobaXterm
- ▣ Project

Goal

□ Implement chosen instructions

- We've implemented ADD without error detection
 - Simulator.v
 - Test_Bench.v

R-type instruction

Instruction	Example	Meaning	Op field	Function field
ADD (Addition)	add r1, r2, r3	$r1 = r2 + r3$	0x00	32(0x20)
SUB (Subtraction)	sub r1, r2, r3	$r1 = r2 - r3$	0x00	34(0x22)
AND (Logic And)	and r1, r2, r3	$r1 = r2 \& r3$	0x00	36(0x24)
OR (Logic Or)	or r1, r2, r3	$r1 = r2 r3$	0x00	37(0x25)
SLT (Set on Less Than) signed comparison	slt r1, r2, r3	if ($r2 < r3$) $r1 = 1$ else $r1 = 0$	0x00	42(0x2a)

I-type instruction

Instruction	Example	Meaning	Op field
ADDI (Add Immediate)	addi r1, r2, 100	$r1 = r2 + 100$	0x08
LW (Load word)	lw r1, o(s1)	$R1 = 4 \text{ byte from Mem}[s1+o]$	0x23
SW (Store word)	sw r1, o(s1)	$4 \text{ byte from Mem}[s1+o] = r1$	0x2B
SLTI (Set on Less Than Immediate)	slti r1, r2, 10	if($r2 < 10$) $r1 = 1$ else $r1 = 0$	0x0A
BEQ (Branch On Equal)	beq r1, r2, 25	if ($r1 == r2$) go to $PC+4+100$	0x04

Immediate is signed for these instructions

Error instruction detection

- ▣ Write to register \$zero
- ▣ Access I/D memory out of address bound
 - I/D memory size: 1KB
- ▣ Data misaligned
 - Ex: LW \$5 2(\$0)
- ▣ Instruction considered as No Operation if one of situations happen

Initial status

- Data memory and register should be set to 0 at the beginning
- PC start with 0
- Be able to reset program by rst_i

Notice

- ▣ Please upload all your .v file **without** being compressed and **without** Test_Bench.v to iLMS
 - No file I/O
 - No clk and rst setting
- ▣ There shouldn't be \$stop in your code

Violate: -40 points

Notice

- ▣ Don't modify name, usage, size
 - Top module Simulator.v Name: Simulator
 - Register file : [32-1:0] Reg_File [0:32-1]
 - ▣ Store value of register
 - ▣ Simulator.Reg_File
 - Instruction memory: [32-1:0] Instr_Mem [0:256-1]
 - ▣ Store value of instruction memory
 - ▣ Simulator.Instr_Mem

Violate: -40 points

Grade

▣ Three test case

- Completely correct or wrong

Test case	Points
ADD, SUB, AND, OR, SLT ADDI, SLTI	60%
+BEQ	20%
+LW,SW	20%

Test case example

Test case format

- Each line occupied by one assembly code

```
testcase.txt x
1 00100000000000010000000000001010
2 00100000000000010000000000000100
3 00000000001000100001100000101010
4 00000000001000100010000000100000
5 00000000001000100010100000100010
```

testcase.txt

```
addi $1, $0, 10
addi $2, $0, 4
slt $3, $1, $2
add $4, $1, $2
sub $5, $1, $2
```

Result

```
$1=10, $2=4, $3=0,
$4=14, $5=6
```

Test case example

testcase_1.txt

```
addi $1, $0, 10
addi $2, $0, 4
slt $3, $1, $2
beq $3, $0, 1
add $4, $1, $2
sub $5, $1, $2
```

Result

\$1=10, \$2=4, \$3=0,
\$4=0, \$5=6

testcase_2.txt

```
addi $9, $0, 10
addi $10, $0, 4
sw $10, 0($11)
slt $12, $9, $10
sub $13, $9, $10
lw $14, 0($11)
```

Result

\$9=10, \$10=4, \$12=0,
\$13=6, \$14=4

Deadline

- Deadline : 3/31, 23:59
- No late submission is allowed