

# 演習1

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# Ubuntu の環境準備

- Ubuntu 20.04 LTS の環境を用意
- Windows → WSL2 や VirtualBox など
- Mac → VirtualBox
- Linux → LXC, Docker など(LXCを強く推奨)

# Java ランタイムのインストール

- OpenJDK 11 をインストール

sudo apt install openjdk-11-jdk

```
ubuntu@seccamp-2021:~/seccamp2021-l3/ex1$ sudo apt install openjdk-11-jdk
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following additional packages will be installed:
  at-spi2-core ca-certificates-java fontconfig-config fonts-dejavu-core fonts-dejavu-extra java-common
  libatk-bridge2.0-0 libatk-wrapper-java libatk-wrapper-java-jni libatk1.0-0 libatk1.0-data libatspi2.0-0
  libavahi-client3 libavahi-common-data libavahi-common3 libcups2 libdrm-amdgpu1 libdrm-intel1 libdrm-nouveau2
  libdrm-radeon1 libfontconfig1 libfontenc1 libfreetype6 libgif7 libgl1 libgl1-mesa-dri libglapi-mesa libglvnd0
  libglx-mesa0 libglx0 libgraphite2-3 libharfbuzz0b libice-dev libice6 libjpeg-turbo8 libjpeg8 liblcms2-2 libllvm12
  libpciaccess0 libpcsclite1 libpthread-stubs0-dev libsensors-config libsensors5 libsm-dev libsm6 libvulkan1
  libwayland-client0 libx11-dev libx11-xcb1 libxau-dev libxaw7 libxcb-dri2-0 libxcb-dri3-0 libxcb-glx0 libxcb-present0
  libxcb-randr0 libxcb-shape0 libxcb-shm0 libxcb-sync1 libxcb-xfixes0 libxcb1-dev libxcomposite1 libxdmcp-dev
  libxfixes3 libxft2 libxi6 libxinerama1 libxkbfile1 libxmu6 libxpm4 libxrandr2 libxrender1 libxshmfence1 libxt-dev
  libxt6 libxtst6 libxv1 libxxf86dga1 libxxf86vm1 mesa-vulkan-drivers openjdk-11-jdk-headless openjdk-11-jre
  openjdk-11-jre-headless x11-common x11-utils x11proto-core-dev x11proto-dev xorg-sgml-doctools xtrans-dev
Suggested packages:
  default-jre cups-common libice-doc liblcms2-utils pcscl lm-sensors libsm-doc libx11-doc libxcb-doc libxt-doc
  openjdk-11-demo openjdk-11-source visualvm libnss-mdns fonts-ipafont-gothic fonts-ipafont-mincho fonts-wqy-microhei
  | fonts-wqy-zenhei fonts-indic mesa-utils
The following NEW packages will be installed:
  at-spi2-core ca-certificates-java fontconfig-config fonts-dejavu-core fonts-dejavu-extra java-common
  libatk-bridge2.0-0 libatk-wrapper-java libatk-wrapper-java-jni libatk1.0-0 libatk1.0-data libatspi2.0-0
  libavahi-client3 libavahi-common-data libavahi-common3 libcups2 libdrm-amdgpu1 libdrm-intel1 libdrm-nouveau2
  libdrm-radeon1 libfontconfig1 libfontenc1 libfreetype6 libgif7 libgl1 libgl1-mesa-dri libglapi-mesa libglvnd0
```

# sbt のインストール

- sbt : Scala のライブラリマネージャ

```
echo "deb https://repo.scala-sbt.org/scalasbt/debian all main" | sudo tee /etc/apt/sources.list.d/sbt.list
```

```
echo "deb https://repo.scala-sbt.org/scalasbt/debian /" | sudo tee /etc/apt/sources.list.d/sbt_old.list
```

```
curl -sL "https://keyserver.ubuntu.com/pks/lookup?op=get&search=0x2EE0EA64E40A89B84B2DF73499E82A75642AC823" | sudo apt-key add
```

```
sudo apt-get update
```

```
sudo apt-get install sbt
```

# sbt のインストール

```
ubuntu@seccamp-2021:~$ echo "deb https://repo.scala-sbt.org/scalasbt/debian all main" | sudo tee /etc/apt/sources.list.d/sbt.list
deb https://repo.scala-sbt.org/scalasbt/debian all main
ubuntu@seccamp-2021:~$ echo "deb https://repo.scala-sbt.org/scalasbt/debian /" | sudo tee /etc/apt/sources.list.d/sbt_ol
d.list
deb https://repo.scala-sbt.org/scalasbt/debian /
ubuntu@seccamp-2021:~$ curl -sL "https://keyserver.ubuntu.com/pks/lookup?op=get&search=0x2EE0EA64E40A89B84B2DF73499E82A7
5642AC823" | sudo apt-key add
OK
ubuntu@seccamp-2021:~$ sudo apt update
Hit:1 http://security.ubuntu.com/ubuntu focal-security InRelease
Hit:2 http://archive.ubuntu.com/ubuntu focal InRelease
Hit:3 http://archive.ubuntu.com/ubuntu focal-updates InRelease
Hit:4 http://archive.ubuntu.com/ubuntu focal-backports InRelease
Get:5 https://scala.jfrog.io/artifactory/debian all InRelease [3558 B]
Ign:6 https://scala.jfrog.io/artifactory/debian InRelease
Get:8 https://scala.jfrog.io/artifactory/debian all/main amd64 Packages [972 B]
Get:7 https://scala.jfrog.io/artifactory/debian Release [815 B]
Get:9 https://scala.jfrog.io/artifactory/debian Release.gpg [821 B]
Get:10 https://scala.jfrog.io/artifactory/debian Packages [5122 B]
Fetched 11.3 kB in 4s (2806 B/s)
Reading package lists... Done
Building dependency tree
Reading state information... Done
All packages are up to date.
```

# sbt のインストール

```
ubuntu@seccamp-2021:~$ sudo apt install sbt
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following package was automatically installed and is no longer required:
  libfreetype6
Use 'sudo apt autoremove' to remove it.
The following NEW packages will be installed:
  sbt
0 upgraded, 1 newly installed, 0 to remove and 0 not upgraded.
Need to get 19.6 kB of archives.
After this operation, 48.1 kB of additional disk space will be used.
Get:1 https://scala.jfrog.io/artifactory/debian all/main amd64 sbt all 1.5.5 [19.6 kB]
Fetched 19.6 kB in 2s (12.4 kB/s)
Selecting previously unselected package sbt.
(Reading database ... 31635 files and directories currently installed.)
Preparing to unpack ../apt/archives/sbt_1.5.5_all.deb ...
Unpacking sbt (1.5.5) ...
Setting up sbt (1.5.5) ...
Creating system group: sbt
Creating system user: sbt in sbt with sbt daemon-user and shell /bin/false
Processing triggers for man-db (2.9.1-1) ...
ubuntu@seccamp-2021:~$ |
```

# 演習用プログラムのダウンロード

- <https://github.com/naoki9911/seccamp2021-l3>から演習用のプログラムをダウンロード (git clone)

```
ubuntu@seccamp-2021:~$ git clone https://github.com/naoki9911/seccamp2021-l3
Cloning into 'seccamp2021-l3'...
remote: Enumerating objects: 13, done.
remote: Counting objects: 100% (13/13), done.
remote: Compressing objects: 100% (8/8), done.
remote: Total 13 (delta 0), reused 13 (delta 0), pack-reused 0
Unpacking objects: 100% (13/13), 1.43 KiB | 146.00 KiB/s, done.
ubuntu@seccamp-2021:~$ ls -l
total 0
drwxrwxr-x 1 ubuntu ubuntu 14 Aug  4 08:12 seccamp2021-l3
ubuntu@seccamp-2021:~$ |
```

# 演習用プログラムのダウンロード

- seccamp2021-l3/ex1 に正常に clone 出来ていることを確認する

```
ubuntu@seccamp-2021:~/seccamp2021-l3$ cd ex1/  
ubuntu@seccamp-2021:~/seccamp2021-l3/ex1$ ls -l  
total 4  
-rw-rw-r-- 1 ubuntu ubuntu 459 Aug  4 08:12 build.sbt  
drwxrwxr-x 1 ubuntu ubuntu  16 Aug  4 08:12 src  
ubuntu@seccamp-2021:~/seccamp2021-l3/ex1$ |
```



# 演習プログラムのダウンロード

- src/main/scala/Addr8bit.scala に 8bit 加算器が実装されている

```
ubuntu@seccamp-2021:~/seccamp2021-l3/ex1$ cat src/main/scala/Addr8bit.scala
import chisel3._

class Addr8bit extends Module {
  val io = IO(new Bundle{
    val inA = Input(UInt(8.W))
    val inB = Input(UInt(8.W))
    val out = Output(UInt(8.W))
  })

  io.out := io.inA + io.inB
}ubuntu@seccamp-2021:~/seccamp2021-l3/ex1$ |
```

# 回路の変換

sbt run

で 8bit 加算器(Addr8bit.scala)を変換する

```
ubuntu@seccamp-2021:~/seccamp2021-l3/ex1$ sbt run
copying runtime jar...
[info] [launcher] getting org.scala-sbt sbt 1.5.5 (this may take some time)...
[info] [launcher] getting Scala 2.12.14 (for sbt)...
[info] Updated file /home/ubuntu/seccamp2021-l3/ex1/project/build.properties: set sbt.version to 1.5.5
[info] welcome to sbt 1.5.5 (Private Build Java 16.0.1)
[info] loading project definition from /home/ubuntu/seccamp2021-l3/ex1/project
[info] Updating
https://repo1.maven.org/maven2/jline/jline/2.14.6/jline-2.14.6.pom
 100.0% [#####] 19.4 KiB (90.8 KiB / s)
https://repo1.maven.org/maven2/org/fusesource/jansi/jansi/1.12/jansi-1.12.pom
 100.0% [#####] 3.6 KiB (7.3 KiB / s)
https://repo1.maven.org/maven2/org/fusesource/jansi/jansi-project/1.12/jansi-project-1.12.pom
 100.0% [#####] 11.5 KiB (68.9 KiB / s)
https://repo1.maven.org/maven2/org/fusesource/fusesource-pom/1.11/fusesource-pom-1.11.pom
 100.0% [#####] 14.2 KiB (87.3 KiB / s)
[info] Resolved dependencies
[info] Fetching artifacts of
https://repo1.maven.org/maven2/jline/jline/2.14.6/jline-2.14.6.jar
 100.0% [#####] 262.5 KiB (1.6 MiB / s)
[info] Fetched artifacts of
```

# 回路の変換

```
[info] compiling 2 Scala sources to /home/ubuntu/seccamp2021-l3/ex1/target/scala-2.12/classes ...
[info] Non-compiled module 'compiler-bridge_2.12' for Scala 2.12.8. Compiling...
[info]   Compilation completed in 16.635s.
[info] running Main
[info] [0.003] Elaborating design...
[info] [0.159] Done elaborating.
Total FIRRTL Compile Time: 2181.6 ms
[success] Total time: 24 s, completed Aug 4, 2021, 8:24:25 AM
```

# 回路の変換

- Addr8bit.v が生成されていることを確認する

```
ubuntu@seccamp-2021:~/seccamp2021-l3/ex1$ cat Addr8bit.v
`ifdef RANDOMIZE_GARBAGE_ASSIGN
`define RANDOMIZE
`endif
`ifdef RANDOMIZE_INVALID_ASSIGN
`define RANDOMIZE
`endif
`ifdef RANDOMIZE_REG_INIT
`define RANDOMIZE
`endif
`ifdef RANDOMIZE_MEM_INIT
`define RANDOMIZE
`endif

module Addr8bit( // @[:@3.2]
    input      clock, // @[:@4.4]
    input      reset, // @[:@5.4]
    input [7:0] io_inA, // @[:@6.4]
    input [7:0] io_inB, // @[:@6.4]
    output [7:0] io_out // @[:@6.4]
);
    wire [8:0] _T_5; // @[Addr8bit.scala 10:22:@8.4]
    wire [7:0] _T_6; // @[Addr8bit.scala 10:22:@9.4]
    assign _T_5 = io_inA + io_inB; // @[Addr8bit.scala 10:22:@8.4]
    assign _T_6 = _T_5[7:0]; // @[Addr8bit.scala 10:22:@9.4]
    assign io_out = _T_6;
endmodule
```

# 回路の試験

- src/test/scala/Addr8bit.scala に回路のテストが記述されている

```
ubuntu@seccamp-2021:~/seccamp2021-l3/ex1$ cat src/test/scala/Addr8bit.scala
import chisel3.iotesters.{ChiselFlatSpec, Driver, PeekPokeTester}
import org.scalatest.freespec.AnyFreeSpec
import org.scalatest.matchers.should.Matchers

class Addr8bitTester(c: Addr8bit) extends PeekPokeTester(c) {
  for {
    i <- 0 until 255
    j <- 0 until 255
  } {
    poke(c.io.inA, i)
    poke(c.io.inB, j)
    expect(c.io.out, (i+j)&0xFF)
  }
}

class Addr8bitSpec extends AnyFreeSpec with Matchers {
  "tester should returned values with interpreter" in {
    Driver.execute(Array("--backend-name", "firrtl"), () => new Addr8bit()) { c =>
      new Addr8bitTester(c)
    } should be (true)
  }
}
ubuntu@seccamp-2021:~/seccamp2021-l3/ex1$ |
```

# 回路の試験

sbt test でテストを実行し、パスすることを確認する

```
ubuntu@seccamp-2021:~/seccamp2021-l3/ex1$ sbt test
[info] welcome to sbt 1.5.5 (Ubuntu Java 11.0.11)
[info] loading project definition from /home/ubuntu/seccamp2021-l3/ex1/project
[info] loading settings for project ex1 from build.sbt ...
[info] set current project to circuit-chisel (in build file:/home/ubuntu/seccamp2021-l3/ex1/)
[info] compiling 1 Scala source to /home/ubuntu/seccamp2021-l3/ex1/target/scala-2.12/test-classes ...
[info] [0.001] Elaborating design...
[info] [0.154] Done elaborating.
Total FIRRTL Compile Time: 1684.4 ms
Total FIRRTL Compile Time: 28.8 ms
End of dependency graph
Circuit state created
[info] [0.002] SEED 1628065576060
test Addr8bit Success: 65025 tests passed in 5 cycles taking 1.306132 seconds
[info] [1.296] RAM 0 CYCLES PASSED
[info] Addr8bitSpec:
[info] - tester should returned values with interpreter
[info] Run completed in 4 seconds, 382 milliseconds.
[info] Total number of tests run: 1
[info] Suites: completed 1, aborted 0
[info] Tests: succeeded 1, failed 0, canceled 0, ignored 0, pending 0
[info] All tests passed.
[success] Total time: 13 s, completed Aug 4, 2021, 8:26:20 AM
ubuntu@seccamp-2021:~/seccamp2021-l3/ex1$ |
```