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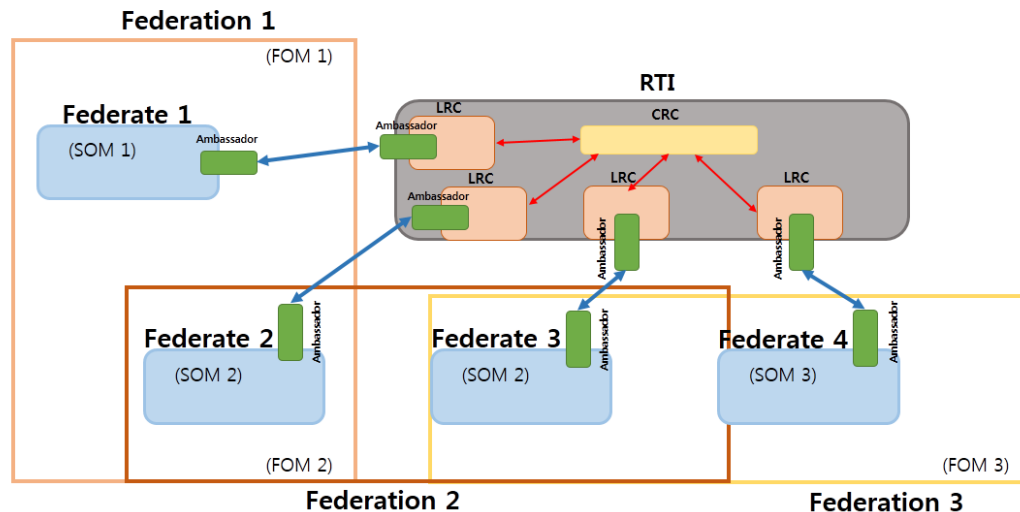
# 통신 미들웨어 HLA RTI

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컴퓨터 통신 실습  
홍석준

# HLA RTI의 구성도

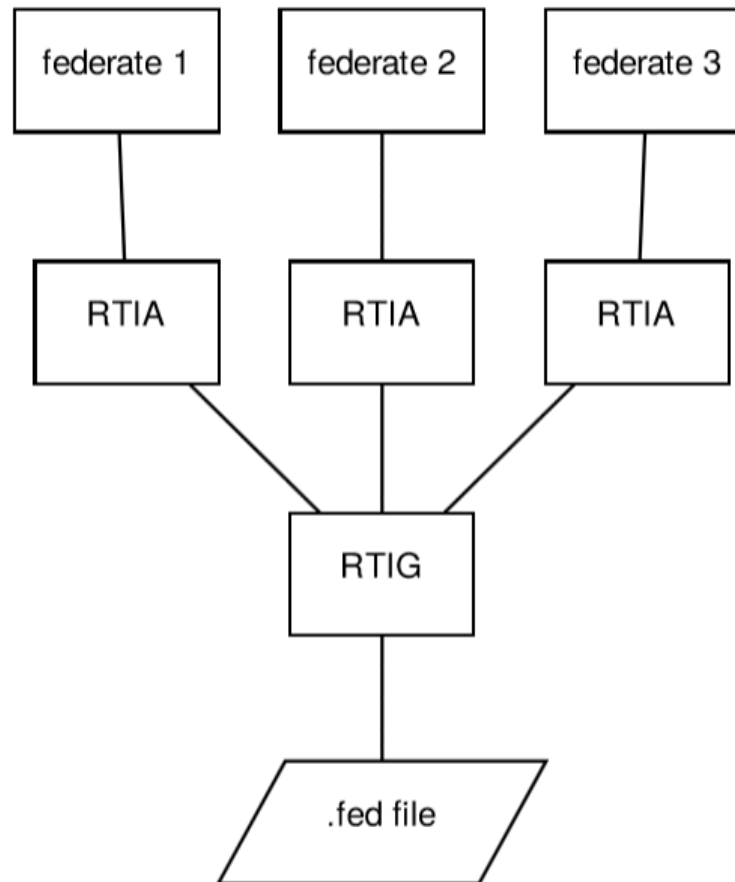
- ❑ 각 Federate(프로세스, 주로 시뮬레이션 단위 프로그램)는 Ambassador를 통해 RTI(하나의 프로세스)를 통해서 HLA RTI 표준 스펙에 의한 Interface(API)를 통해서 다른 Federate와 데이터 송수신을 할 수 있음
- ❑ Publisher/Subscriber 방식으로 통신
  - 특정 Federate가 자신이 Pub하고 싶은 데이터를 설정하고 또 다른 Federate가 Sub하고 싶은 데이터를 설정하면 통신이 이루어짐
  - 여러 Federate 간 복잡한 구조의 통신이 쉽게 될 수 있음(클라이언트/서버 방식의 경우 구현하기가 복잡)



- CRC - Centric RTI Component
- LRC - Local RTI Component
- FOM - Federation Of Management
- SOM - Simulation Of Management

# CERTI의 구성도

- ❑ 오픈 소스 코드
- ❑ 여러 HLA RTI 구현된 프로그램 중의 하나
- ❑ CERTI 프로그램 구성은 아래와 같음

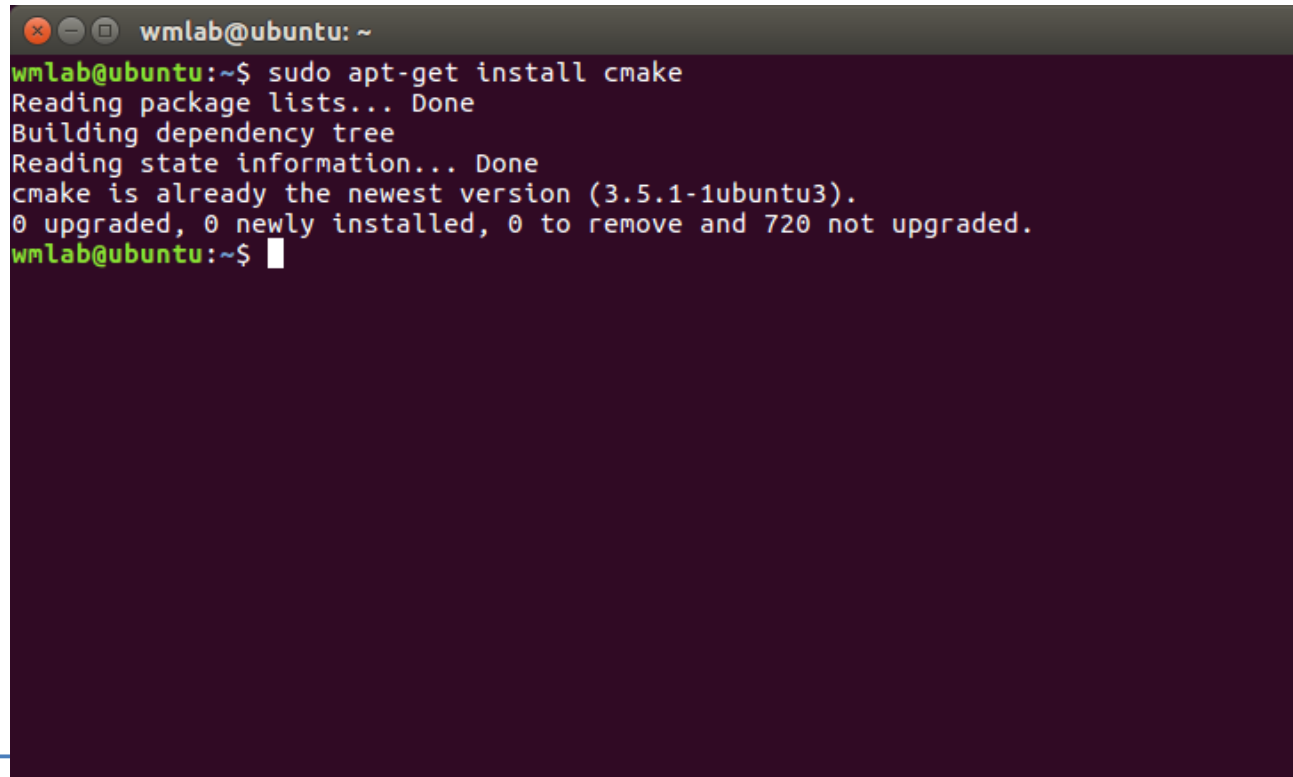


# HLA RTI 설치하기

## CERTI 오픈 소스 코드 설치하기

### ❑ 설치 전 준비 하기

- cmake 설치
- sudo apt-get install cmake로 설치(아래 그림은 설치된 경우)
  - 중간에 Y/N로 물어보면 Y 입력

A terminal window titled 'wmlab@ubuntu: ~' showing the output of the command 'sudo apt-get install cmake'. The output indicates that cmake is already installed at version 3.5.1-1ubuntu3 and no action is required.

```
wmlab@ubuntu: ~  
wmlab@ubuntu:~$ sudo apt-get install cmake  
Reading package lists... Done  
Building dependency tree  
Reading state information... Done  
cmake is already the newest version (3.5.1-1ubuntu3).  
0 upgraded, 0 newly installed, 0 to remove and 720 not upgraded.  
wmlab@ubuntu:~$
```

## 리눅스 dpkg 에러 날때

Linux 2014.11.03 09:02

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E: Could not get lock /var/lib/dpkg/lock - open(11 Resource temporarily unavailable)

E: Unable to lock the administration directory (/var/lib/dpkg/), is another process  
와 같은 메시지가 뜬다.

`sudo rm -rf /var/lib/dpkg/lock`

```
sudo apt-get autoclean $$ apt-get clear cache
```

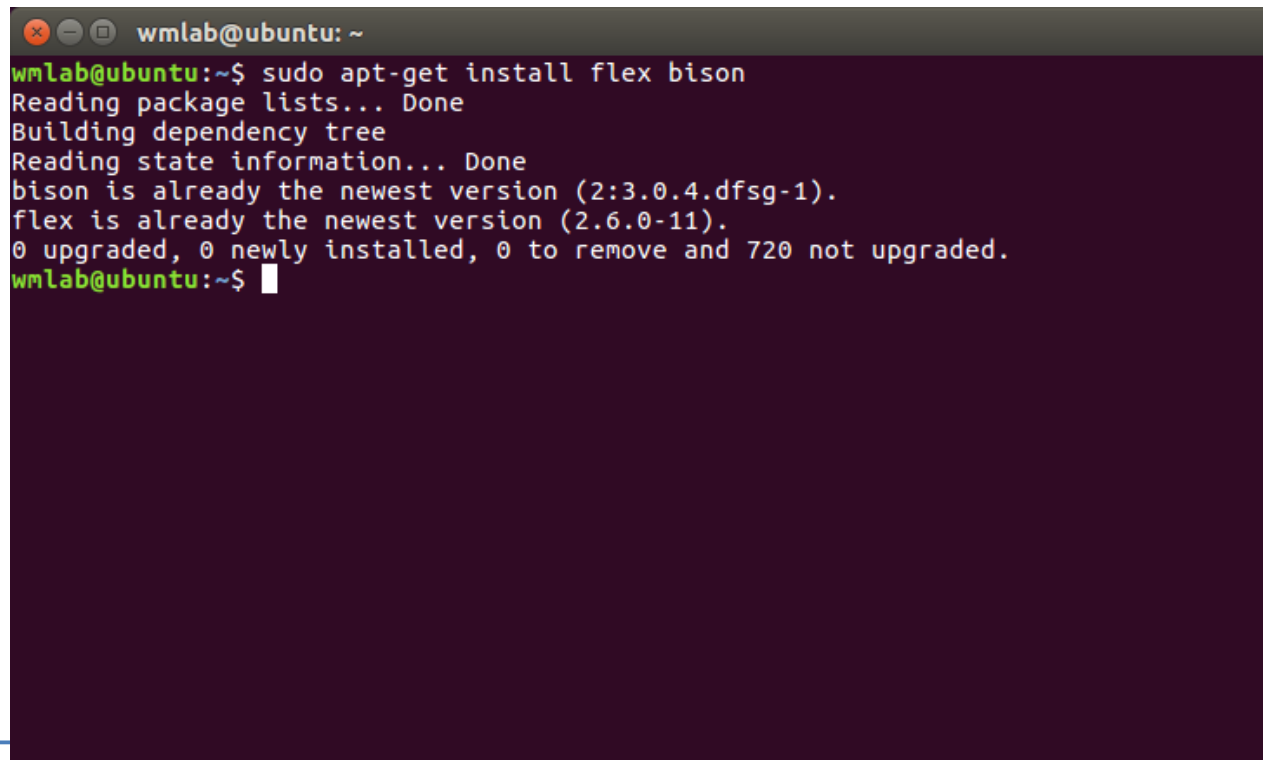
`sudo reboot`

# HLA RTI 설치하기

## CERTI 오픈 소스 코드 설치하기

### ❑ 설치 전 준비 하기

- Flex, Bison 설치
- `sudo apt-get install flex bison`으로 설치(아래 그림은 설치된 경우)
  - 중간에 Y/N로 물어보면 Y 입력



```
wmlab@ubuntu: ~  
wmlab@ubuntu:~$ sudo apt-get install flex bison  
Reading package lists... Done  
Building dependency tree  
Reading state information... Done  
bison is already the newest version (2:3.0.4.dfsg-1).  
flex is already the newest version (2.6.0-11).  
0 upgraded, 0 newly installed, 0 to remove and 720 not upgraded.  
wmlab@ubuntu:~$
```

# HLA RTI 설치하기

## CERTI 오픈 소스 코드 설치하기

### ❑ 설치 전 준비 하기

- libxml2 설치
- `sudo apt-get install libxml2` 로 설치(아래 그림은 설치된 경우)
  - 중간에 Y/N로 물어보면 Y 입력

```
wmlab@ubuntu: ~  
wmlab@ubuntu:~$ sudo apt-get install libxml2-dev  
Reading package lists... Done  
Building dependency tree  
Reading state information... Done  
libxml2-dev is already the newest version (2.9.3+dfsg1-1ubuntu0.5).  
0 upgraded, 0 newly installed, 0 to remove and 720 not upgraded.  
wmlab@ubuntu:~$
```

# HLA RTI 설치하기

## CERTI 오픈 소스 코드 설치하기

### ❑ 설치 전 준비 하기

- X11설치
- `sudo apt-get install libx11-dev xbitmaps` 로 설치(아래 그림은 설치된 경우)
  - 중간에 Y/N로 물어보면 Y 입력

```
wmlab@ubuntu: ~  
wmlab@ubuntu:~$ sudo apt-get install libx11-dev xbitmaps  
Reading package lists... Done  
Building dependency tree  
Reading state information... Done  
libx11-dev is already the newest version (2:1.6.3-1ubuntu2).  
xbitmaps is already the newest version (1.1.1-2).  
0 upgraded, 0 newly installed, 0 to remove and 720 not upgraded.  
wmlab@ubuntu:~$
```

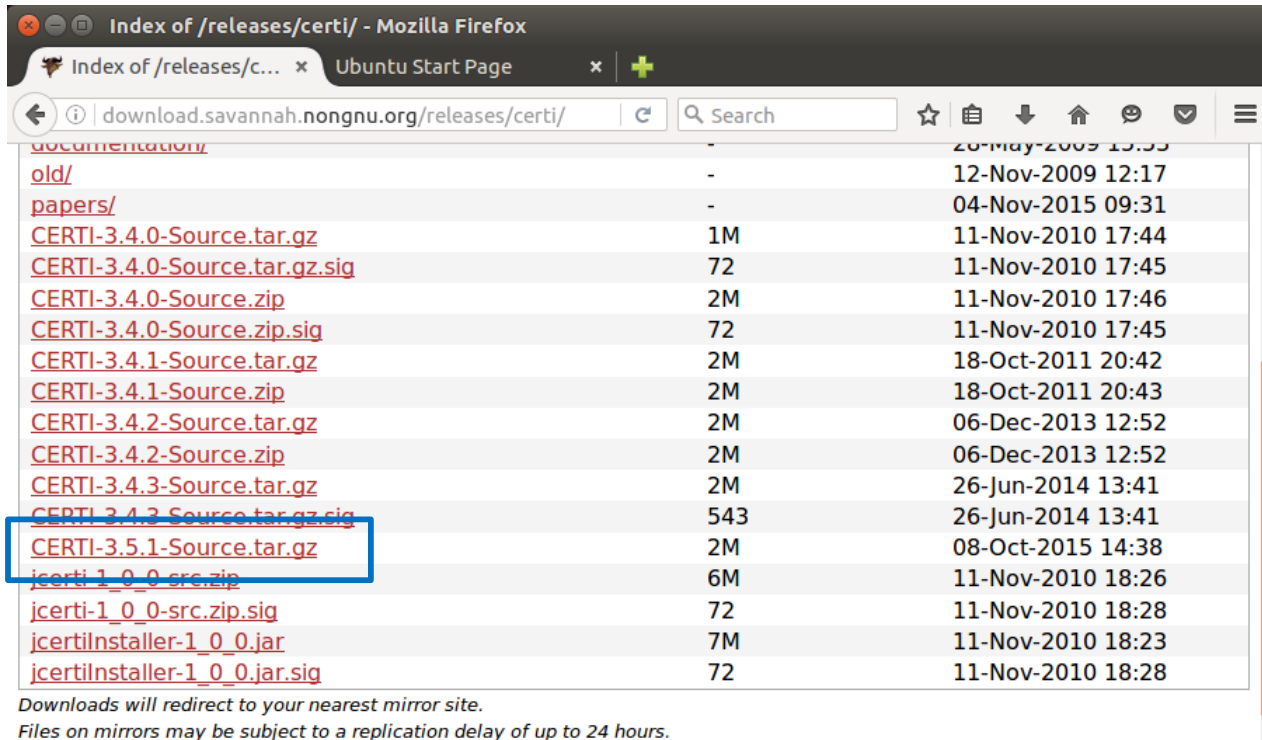


# HLA RTI 설치하기

## CERTI 오픈 소스 코드 설치하기

### ❑ CERTI 오픈 소스 다운 받기

- 파이어 폭스에서 <http://download.savannah.nongnu.org/releases/certi/> 입력 및 다운로드
- CERTI-3.5.1-Source.tar.gz파일을 클릭해서 다운로드



# HLA RTI 설치하기

## CERTI 오픈 소스 코드 설치하기

### ❑ CERTI 오픈 소스 다운 받기

- 다운로드 폴더로 이동 후 자신의 홈 디렉토리로 복사 후 압축 풀기
  - `cp CERTI-3.5.1-Source.tar.gz ~/`
  - `tar zxvf certi-3.4.0-Source.tar.gz`

```
wmlab@ubuntu: ~  
wmlab@ubuntu:~/Downloads$ ls  
CERTI-3.5.1-Source.tar.gz  
wmlab@ubuntu:~/Downloads$ cp CERTI-3.5.1-Source.tar.gz ~/  
wmlab@ubuntu:~/Downloads$ ls  
CERTI-3.5.1-Source.tar.gz  
wmlab@ubuntu:~/Downloads$ cd  
wmlab@ubuntu:~$ ls  
CERTI-3.5.1-Source.tar.gz  Downloads      Pictures      RLCircuit.mo  
Desktop                   examples.desktop Public        Templates  
Documents                 Music          pyjmi        Videos  
wmlab@ubuntu:~$ tar zxvf CERTI-3.5.1-Source.tar.gz
```

# HLA RTI 설치하기

## CERTI 오픈 소스 코드 설치하기

### ❑ CERTI 오픈 소스 컴파일 준비

- 소스 폴더로 이동 후 mkdir build로 build폴더를 생성
  - cd CERTI-3.5.1-Source
  - mkdir build

```
wmlab@ubuntu: ~/CERTI-3.5.1-Source
CERTI-3.5.1-Source.tar.gz Downloads Pictures RLCircuit.mo
Desktop examples.desktop Public Templates
wmlab@ubuntu:~$ cd CERTI-3.5.1-Source/
wmlab@ubuntu:~/CERTI-3.5.1-Source$ ls
AUTHORS config.h.cmake README
CERTIBuildTreeSettings.cmake.in COPYING.txt ReleaseNotes.txt
CERTIConfig.cmake.in CTestConfig.cmake ReleaseProcess.txt
CERTIConfigVersion.cmake.in doc RTIA
CERTICPackOptions.cmake.in gpl.txt RTIG
CERTI_DESCRIPTION.txt include scripts
certi-small.xpm lesser.txt test
ChangeLog libCERTI TODO
CMakeLists.txt libHLA xml
cmake_uninstall.cmake.in libRTI
wmlab@ubuntu:~/CERTI-3.5.1-Source$ mkdir build
wmlab@ubuntu:~/CERTI-3.5.1-Source$ ls
AUTHORS cmake_uninstall.cmake.in libRTI
build config.h.cmake README
CERTIBuildTreeSettings.cmake.in COPYING.txt ReleaseNotes.txt
CERTIConfig.cmake.in CTestConfig.cmake ReleaseProcess.txt
CERTIConfigVersion.cmake.in doc RTIA
CERTICPackOptions.cmake.in gpl.txt RTIG
CERTI_DESCRIPTION.txt include scripts
certi-small.xpm lesser.txt test
```

# HLA RTI 설치하기

## CERTI 오픈 소스 코드 설치하기

### ❑ CERTI 오픈 소스의 Makefile만들기

- build폴더로 이동 후 아래와 같은 cmake 명령어 입력
  - cd build
  - cmake -DCMAKE\_INSTALL\_PREFIX=~/.certi(한칸띄고)  
-DCMAKE\_CXX\_COMPILER=clang++-3.8 ~/.CERTI-3.5.1-Source

```
wmlab@ubuntu: ~/CERTI-3.5.1-Source/build
wmlab@ubuntu:~/CERTI-3.5.1-Source$ cd build/
wmlab@ubuntu:~/CERTI-3.5.1-Source/build$ ls
wmlab@ubuntu:~/CERTI-3.5.1-Source/build$ cmake -DCMAKE_INSTALL_PREFIX=~/.certi
-DCMAKE_CXX_COMPILER=clang++-3.8 ~/.CERTI-3.5.1-Source
-- The CXX compiler identification is Clang 3.8.0
-- Check for working CXX compiler: /usr/bin/clang++-3.8
-- Check for working CXX compiler: /usr/bin/clang++-3.8 -- works
-- Detecting CXX compiler ABI info
-- Detecting CXX compiler ABI info - done
-- Detecting CXX compile features
-- Detecting CXX compile features - done
-- The C compiler identification is GNU 5.3.1
-- Check for working C compiler: /usr/bin/cc
-- Check for working C compiler: /usr/bin/cc -- works
-- Detecting C compiler ABI info
-- Detecting C compiler ABI info - done
-- Detecting C compile features
-- Detecting C compile features - done
-- Native build.
-- Target is 64 bits
-- Check if the system is big endian
-- Searching 16 bit integer
-- Looking for sys/types.h
-- Looking for sys/types.h - found
```

# HLA RTI 설치하기

## CERTI 오픈 소스 코드 설치하기

### ❑ CERTI 오픈 소스 Makefile 만들기

- build폴더로 이동 후 아래와 같은 cmake 명령어 입력
  - Build폴더에 Makefile 생성을 확인

```
wmlab@ubuntu: ~/CERTI-3.5.1-Source/build
-- libRTI variant: HLA 1.3 NG
-- libRTI variant: HLA 1516
-- libRTI variant: HLA 1516e
-- INHIBIT Compiler (GCC) warning for gengetopt generated files: Billard_cmdli
ne.c;Billard_cmdline.h.
-- INHIBIT Compiler (GCC) warning for gengetopt generated files: /home/wmlab/C
ERTI-3.5.1-Source/test/testFederate/testFederate_cmdline.c;/home/wmlab/CERTI-3
.5.1-Source/test/testFederate/testFederate_cmdline.h.
-- Found PythonInterp: /usr/bin/python (found version "2.7.11")
-- *** CERTI has been successfully configured *****
-- Configuring done
-- Generating done
-- Build files have been written to: /home/wmlab/CERTI-3.5.1-Source/build
wmlab@ubuntu:~/CERTI-3.5.1-Source/build$ ls
CERTIBuildTreeSettings.cmake  CPackConfig.cmake          Makefile
CERTIConfig.cmake             CPackSourceConfig.cmake    PackageBackup.cmake
CERTIConfigVersion.cmake      CTestTestfile.cmake        RTIA
CERTICPackOptions.cmake       DartConfiguration.tcl       RTIG
CMakeCache.txt                doc                           scripts
CMakeFiles                    include                       test
cmake_install.cmake           libCERTI                     Testing
cmake_uninstall.cmake         libHLA                        xml
config.h                      libRTI
```

# HLA RTI 설치하기

## CERTI 오픈 소스 코드 설치하기

### ❑ CERTI 오픈 소스에서 make 및 make install로 소스 코드를 빌드함

- Build폴더로 에서 make 명령어 및 make install 수행
  - make는 make install은 sudo 없이 아래 그림과 같이 실행
    - make는 정상 수행, make install은 중간에 권한 문제로 수행 중단됨(sudo권한으로 하면 수행되지만, 나중에 프로그램 실행이 안되서 우선그냥 놔둬)

```
wmlab@ubuntu: ~/CERTI-3.5.1-Source/build
cmake_uninstall.cmake      libHLA      xml
config.h                  libRTI
wmlab@ubuntu:~/CERTI-3.5.1-Source/build$ make
Scanning dependencies of target HLA
[ 0%] Building CXX object libHLA/CMakeFiles/HLA.dir/HLAbuffer.cc.o
[ 1%] Building C object libHLA/CMakeFiles/HLA.dir/sha1.c.o
[ 2%] Building CXX object libHLA/CMakeFiles/HLA.dir/MurmurHash2.cpp.o
[ 2%] Building CXX object libHLA/CMakeFiles/HLA.dir/MurmurHash3.cpp.o
[ 3%] Building C object libHLA/CMakeFiles/HLA.dir/PMurHash.c.o
...
-- Installing: /home/wmlab/certi/share/xml/ieee1516-2000
-- Installing: /home/wmlab/certi/share/xml/ieee1516-2000/1516_2-2000
-- Installing: /home/wmlab/certi/share/xml/ieee1516-2000/1516_2-2000/OMT-DIF.xml
-- Installing: /home/wmlab/certi/share/xml/ieee1516-2000/1516_2-2000/HLA.dtd
CMake Error at cmake_install.cmake:84 (file):
  file failed to open for writing (Permission denied):

    /home/wmlab/CERTI-3.5.1-Source/build/install_manifest.txt

Makefile:82: recipe for target 'install' failed
make: *** [install] Error 1
```

# HLA RTI 설치하기

## CERTI 오픈 소스 코드 설치하기

### ❑ CERTI 오픈 소스 빌드 파일 확인

- make install 성공하면 아래 그림처럼 install 폴더(앞에서 cmake에서 ~/certi로 지정)에 bin include lib share폴더가 생성된 것을 확인

```
wmlab@ubuntu: ~/certi/bin
tFOMmodule.xml
-- Installing: /home/wmlab/certi/share/xml/ieee1516-2010/1516_2-2010/IEEE1516-
OMT-2010.xsd
-- Installing: /home/wmlab/certi/share/xml/ieee1516-2010/1516_1-2010
-- Installing: /home/wmlab/certi/share/xml/ieee1516-2010/1516_1-2010/IEEE1516-
FDD-2010.xsd
-- Installing: /home/wmlab/certi/share/xml/ieee1516-2010/1516_1-2010/hla1516e.
wsdl
-- Installing: /home/wmlab/certi/share/xml/ieee1516-2010/1516_1-2010/HLAstanda
rdMIM.xml
-- Installing: /home/wmlab/certi/share/xml/ieee1516-2000
-- Installing: /home/wmlab/certi/share/xml/ieee1516-2000/1516_2-2000
-- Installing: /home/wmlab/certi/share/xml/ieee1516-2000/1516_2-2000/OMT-DIF.x
ml
-- Installing: /home/wmlab/certi/share/xml/ieee1516-2000/1516_2-2000/HLA.dtd
wmlab@ubuntu:~/CERTI-3.5.1-Source/build$ cd
wmlab@ubuntu:~$ cd certi/
wmlab@ubuntu:~/certi$ ls
bin include lib share
wmlab@ubuntu:~/certi$ cd bin/
wmlab@ubuntu:~/certi/bin$ ls
billard          CertiProcessus_A      hlaomtdif2cpp.py
billard-nogui    CertiProcessus_B      MessageBufferTests
CertiCheckHostAndIP CertiTestFederate-HLA13 MsgBufferTests
```



# HLA RTI 설치하기

## CERTI 오픈 소스 코드 설치하기

### ❑ CERTI 오픈 소스 빌드 파일 확인 및 환경 설정

- cd bin으로 bin폴더로 이동 후
- export LD\_LIBRARY\_PATH=\$LD\_LIBRARY\_PATH:~/certi/lib입력 후
- export로 library의 path가 잘 잡혔는지 확인(새 창을 띄울때마다 수행필요)

```
wmlab@ubuntu: ~/certi/bin
wmlab@ubuntu:~/certi$ cd bin/
wmlab@ubuntu:~/certi/bin$
wmlab@ubuntu:~/certi/bin$ export LD_LIBRARY_PATH=$LD_LIBRARY_PATH:~/certi/lib
wmlab@ubuntu:~/certi/bin$ export
declare -x CLUTTER_IM_MODULE="xim"
declare -x COMPIZ_BIN_PATH="/usr/bin/"
declare -x COMPIZ_CONFIG_PROFILE="ubuntu"
declare -x DBUS_SESSION_BUS_ADDRESS="unix:abstract=/tmp/dbus-KdxFXGPbbv"
declare -x DEFAULTS_PATH="/usr/share/gconf/ubuntu.default.path"
declare -x DESKTOP_SESSION="ubuntu"
declare -x DISPLAY=":0"
declare -x GDMSESSION="ubuntu"
declare -x GDM_LANG="en_US"
declare -x GNOME_DESKTOP_SESSION_ID="this-is-deprecated"
declare -x GNOME_KEYRING_CONTROL=""
declare -x GNOME_KEYRING_PID=""
declare -x GPG_AGENT_INFO="/home/wmlab/.gnupg/S.gpg-agent:0:1"
declare -x GTK2_MODULES="overlay-scrollbar"
declare -x GTK_IM_MODULE="ibus"
declare -x GTK_MODULES="nail:atk-bridge:unity-gtk-module"
```



# HLA RTI 설치하기

## CERTI 오픈 소스 코드 설치하기

### ❑ CERTI 오픈 소스 빌드 파일 실행

- cd bin으로 bin폴더로 이동 후
- 아래 명령으로 bin폴더로 Test.fed를 복사해옴
  - cp ~/certi/share/federations/Test.fed ./

```
wmlab@ubuntu: ~/certi/bin
wmlab@ubuntu:~/certi/bin$
wmlab@ubuntu:~/certi/bin$ cp ~/certi/share/federations/Test.fed ./
wmlab@ubuntu:~/certi/bin$ ls
billard                CertiProcessus_B      MsgBufferTests
billard-nogui          CertiTestFederate-HLA13  rtia
CertiCheckHostAndIP    CertiTestFederate-IEEE1516_2000  rtig
CertiCheckXML          CertiTestFederate-IEEE1516_2010  RTIG.log
certi-config           hlaomtdif2cpp.py       Test.fed
CertiProcessus_A       MessageBufferTests
wmlab@ubuntu:~/certi/bin$
wmlab@ubuntu:~/certi/bin$
```

# HLA RTI 설치하기

## CERTI 오픈 소스 코드 설치하기

### ❑ CERTI 오픈 소스 빌드 파일 실행

- cd bin으로 bin폴더로 이동 후
- ./rtig로 certi의 rtig프로세스를 수행 (아래와 같이 수행되면 성공)

```
wmlab@ubuntu: ~/certi/bin
wmlab@ubuntu:~/certi/bin$ ls
billard          CertiProcessus_B      MsgBufferTests
billard-nogui    CertiTestFederate-HLA13  rtia
CertiCheckHostAndIP CertiTestFederate-IEEE1516_2000 rtig
CertiCheckXML    CertiTestFederate-IEEE1516_2010 RTIG.log
certi-config     hlaomtdif2cpp.py
CertiProcessus_A MessageBufferTests
wmlab@ubuntu:~/certi/bin$ ./rtig
CERTI RTIG 3.5.1 - Copyright 2002-2008 ONERA
This is free software ; see the source for copying conditions. There is NO
warranty ; not even for MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.

CERTI RTIG up and running ...
```

# HLA RTI 설치하기

## CERTI 오픈 소스 코드 설치하기

### ❑ CERTI 오픈 소스 빌드 파일 실행

- rtig는 실행되도록 그대로 두고
- 다른 커멘트 창을 새로 띄워서 cd certi/bin으로 들어가서 export 명령( 위 슬라이드 참조) 후 아래와 같이 billiard-nogui 프로그램을 수행
  - ./billiard-nogui -n 1 -fTest -FTest.fed -e
  - 아래 그림과 같이 대기하면서 ENTER를 누르라고 하면 “성공”

```
wmlab@ubuntu: ~/certi/bin
1 NetworkMessage::ANNOUNCE_SYNCHRONIZATION_POINT (MSG#13)
1 NetworkMessage::START_REGISTRATION_FOR_OBJECT_CLASS (MSG#89)

Number of Federate messages : 26
Number of RTIG messages : 6

RTIA: Received signal 13. Exiting peacefully.
TCP Socket(EmettreTCP) : Broken pipe
RTIA:: End execution.

wmlab@ubuntu:~/certi/bin$ ./billard-nogui -n 1 -fTest -FTest.fed -e
CERTI Billard 3.5.1
without TIMESTAMP. If you want TIMESTAMP remove -e option.
Display(400, 25, 500, 100)
Press ENTER to start execution...
█
```

# HLA RTI 설치하기

## CERTI 오픈 소스 코드 설치하기

### ❑ CERTI 오픈 소스 빌드 파일 실행

- ENTER 키를 입력하지 말고 또 다른 창을 띄워서 새로운 billiard-nogui를 수행
  - 이번에는 -n 입력 후 다른 숫자(federate 이름)를 입력하고 나머지는 동일
  - 아래 그림과 같이 프로그램의 끝에 Synchronization....하고 대기하고 있으면 성공

```
wmlab@ubuntu: ~/certi/bin
declare -x XDG_SESSION_TYPE="x11"
declare -x XDG_VTNR="7"
declare -x XMODIFIERS="@im=ibus"
wmlab@ubuntu:~/certi/bin$ ls
billard                      CertiProcessus_B             MsgBufferTests
billard-nogui                CertiTestFederate-HLA13      rtia
CertiCheckHostAndIP          CertiTestFederate-IEEE1516_2000 rtig
CertiCheckXML                CertiTestFederate-IEEE1516_2010 RTIG.log
certi-config                 hlaomtdif2cpp.py            Test.fed
CertiProcessus_A             MessageBufferTests
wmlab@ubuntu:~/certi/bin$ ./billard-nogui -n 2 -fTest -FTest.fed -e
CERTI Billard 3.5.1
with TIMESTAMP. If you want without TIMESTAMP add -e option.
BILLARD Note : FederationExecutionAlreadyExists Reason is : Test. OK I ca
n join it
Display(400, 145, 500, 100)
Synchronization...
```

# HLA RTI 설치하기

## CERTI 오픈 소스 코드 설치하기

### ❑ CERTI 오픈 소스 빌드 파일 실행

- 아래 그림과 같이 3개의 프로세스가 수행되고 있을때,
- 첫번째 federate에서 ENTER키를 입력하면 전체 프로그램이 연동되어 동작

```
wmlab@ubuntu: ~/certi/bin
(interactions
  (interaction "InteractionRoot" (id 1) best_effort receive
    (interaction "RTIprivate" (id 2) best_effort receive
    )
  )
  (interaction "Bing" (id 3) reliable timestamp
    (sec_level "Public")
    (parameter "BoulNum" (id 1))
    (parameter "DX" (id 2))
    (parameter "DY" (id 3))
  )
)

billard          CertiProcessus_B      MsgBufferTests
billard-nogui    CertiTestFederate-HLA13            rtia
CertiCheckHostAndIP CertiTestFederate-IEEE1516_2000    rtig
CertiCheckXML    CertiTestFederate-IEEE1516_2010    RTIG.log
certi-config     hlaomtdif2cpp.py                  Test.fed
CertiProcessus_A MessageBufferTests

wmlab@ubuntu:~/certi/bin$ ./billard-nogui -n 2 -fTest -FTest.fed -e
CERTI Billard 3.5.1
with TIMESTAMP. If you want without TIMESTAMP add -e option.
BILLARD Note : FederationExecutionAlreadyExists Reason is : Test. OK I can join it
Display(400, 145, 500, 100)
Synchronization...

wmlab@ubuntu: ~/certi/bin
1 NetworkMessage::START_REGISTRATION_FOR_OBJECT_CLASS (MSG#89)

Number of Federate messages : 26
Number of RTIG messages : 6

RTIA: Received signal 13. Exiting peacefully.
TCP Socket(EmettreTCP) : Broken pipe
RTIA:: End execution.

wmlab@ubuntu:~/certi/bin$ ./billard-nogui -n 1 -fTest -FTest.fed -e
CERTI Billard 3.5.1
without TIMESTAMP. If you want TIMESTAMP remove -e option.
Display(400, 25, 500, 100)
Press ENTER to start execution...
```

# HLA RTI 설치하기

## CERTI 오픈 소스 코드 설치하기

### ❑ CERTI 오픈 소스 빌드 파일 실행

- ENTER키를 입력 후 정상 동작된 모습
- 각 프로세스는 Ctrl-C로 멈출 수 있음

```
wmlab@ubuntu: ~/certi/bin
(parameter "BoulNum" (id 1))
(parameter "DX" (id 2))
(parameter "DY" (id 3))
)
)
)
)
ERROR : FederatesCurrentlyJoined reason : < 2 >
TCP Socket 7 : total = 736100 Bytes sent
TCP Socket 7 : total = 677891 Bytes received
UDP Socket 4 : total = 0 Bytes sent

wmlab@ubuntu: ~/certi/bin
^
Collision between Ball <2> and <1>
Collision between Ball <2> and <1>
Collision between Ball <2> and <1>
Collision between Ball <2> and <1>
Collision between Ball <2> and <1>
Collision between Ball <2> and <1>
Collision between Ball <2> and <1>
Collision between Ball <2> and <1>
Collision between Ball <2> and <1>
Collision between Ball <2> and <1>
Collision between Ball <2> and <1>
Collision between Ball <2> and <1>
Collision between Ball <2> and <1>

wmlab@ubuntu: ~/certi/bin
Collision between Ball <1> and <2>
Collision between Ball <1> and <2>
Collision between Ball <1> and <2>
Collision between Ball <1> and <2>
Collision between Ball <1> and <2>
Collision between Ball <1> and <2>
Collision between Ball <1> and <2>
Collision between Ball <1> and <2>
Collision between Ball <1> and <2>
Collision between Ball <1> and <2>
Collision between Ball <1> and <2>
Collision between Ball <1> and <2>
Collision between Ball <1> and <2>
```

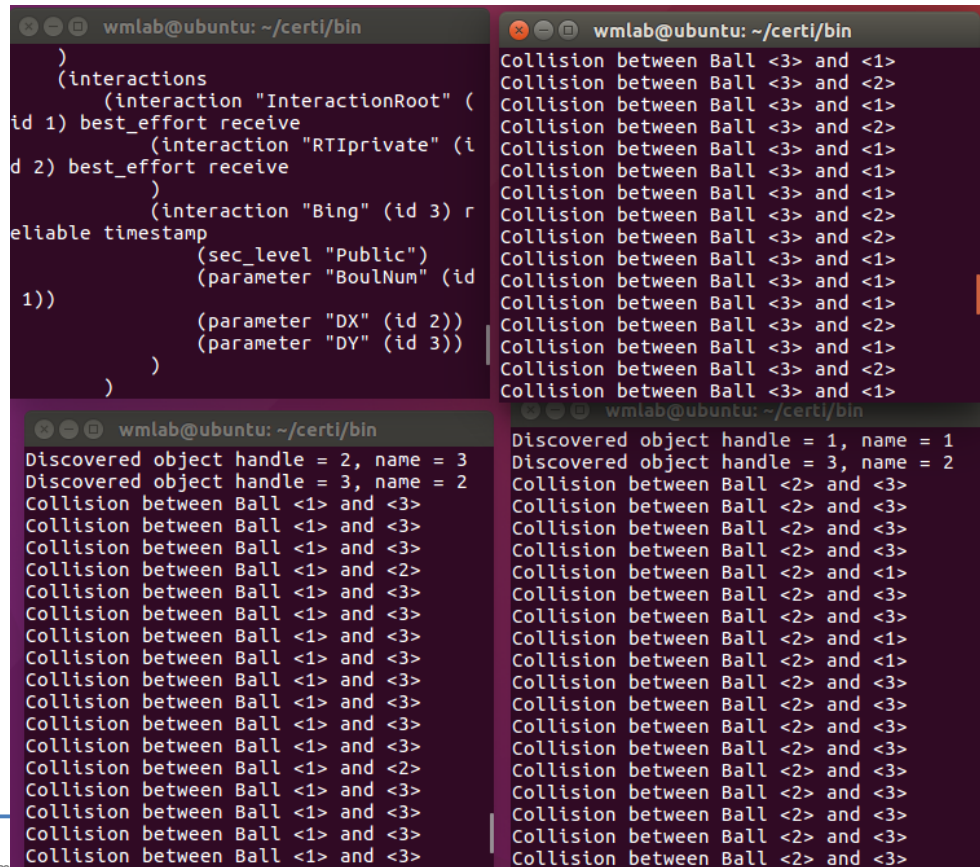


# HLA RTI 설치하기

## CERTI 오픈 소스 코드 설치하기

### ❑ CERTI 오픈 소스 빌드 파일 실행

- 동일한 방법으로 federate를 3개까지 실행한 모습(아래 그림)
  - 첫번째 federate에서 ENTER 키를 입력하지 않고 다른 federate를 여러 개 생성하고 ENTER키를 입력하면 여러 federate가 연동이 가능함



```
wmlab@ubuntu: ~/certi/bin
)
(interactions
  (interaction "InteractionRoot" (
id 1) best_effort receive
    (interaction "RTIprivate" (i
d 2) best_effort receive
      )
      (interaction "Bing" (id 3) r
eliable timestamp
        (sec_level "Public")
        (parameter "BoulNum" (id
1))
        (parameter "DX" (id 2))
        (parameter "DY" (id 3))
      )
    )
  )
)

wmlab@ubuntu: ~/certi/bin
Collision between Ball <3> and <1>
Collision between Ball <3> and <2>
Collision between Ball <3> and <1>
Collision between Ball <3> and <2>
Collision between Ball <3> and <1>
Collision between Ball <3> and <1>
Collision between Ball <3> and <1>
Collision between Ball <3> and <2>
Collision between Ball <3> and <2>
Collision between Ball <3> and <1>
Collision between Ball <3> and <1>
Collision between Ball <3> and <1>
Collision between Ball <3> and <1>
Collision between Ball <3> and <2>
Collision between Ball <3> and <1>
Collision between Ball <3> and <2>
Collision between Ball <3> and <1>

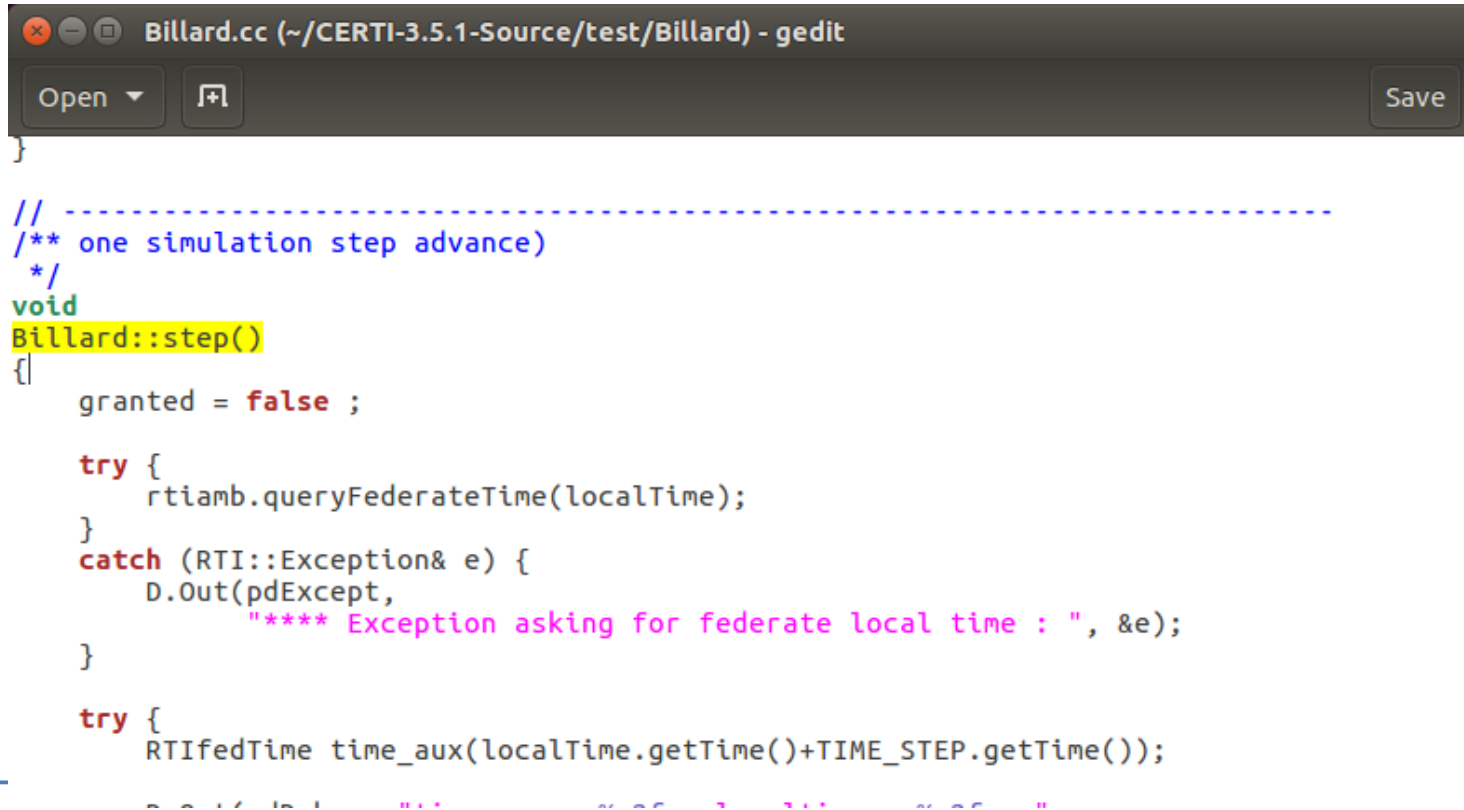
wmlab@ubuntu: ~/certi/bin
Discovered object handle = 2, name = 3
Discovered object handle = 3, name = 2
Collision between Ball <1> and <3>
Collision between Ball <1> and <3>
Collision between Ball <1> and <3>
Collision between Ball <1> and <2>
Collision between Ball <1> and <3>
Collision between Ball <1> and <3>
Collision between Ball <1> and <3>
Collision between Ball <1> and <3>
Collision between Ball <1> and <3>
Collision between Ball <1> and <3>
Collision between Ball <1> and <3>
Collision between Ball <1> and <3>
Collision between Ball <1> and <3>
Collision between Ball <1> and <2>
Collision between Ball <1> and <3>
Collision between Ball <1> and <3>
Collision between Ball <1> and <3>

wmlab@ubuntu: ~/certi/bin
Discovered object handle = 1, name = 1
Discovered object handle = 3, name = 2
Collision between Ball <2> and <3>
Collision between Ball <2> and <3>
Collision between Ball <2> and <3>
Collision between Ball <2> and <3>
Collision between Ball <2> and <1>
Collision between Ball <2> and <3>
Collision between Ball <2> and <3>
Collision between Ball <2> and <1>
Collision between Ball <2> and <1>
Collision between Ball <2> and <3>
Collision between Ball <2> and <3>
Collision between Ball <2> and <3>
Collision between Ball <2> and <3>
Collision between Ball <2> and <3>
Collision between Ball <2> and <3>
Collision between Ball <2> and <3>
Collision between Ball <2> and <3>
```

## CERTI 오픈 소스 코드 수정 및 테스트

### ❑ CERTI 오픈 소스 코드 수정하기

- cd CERTI-3.5.1-Source/test/Billiard로 소스 폴더로 이동
- gedit Billard.cc 소스코드 편집기를 오픈 (아래 그림)
  - Billard::step()을 검색하여 이동



```
// -----  
/** one simulation step advance)  
*/  
void  
Billard::step()  
{  
    granted = false ;  
  
    try {  
        rtiamb.queryFederateTime(localTime);  
    }  
    catch (RTI::Exception& e) {  
        D.Out(pdExcept,  
            "**** Exception asking for federate local time : ", &e);  
    }  
  
    try {  
        RTIfedTime time_aux(localTime.getTime()+TIME_STEP.getTime());  
    }
```

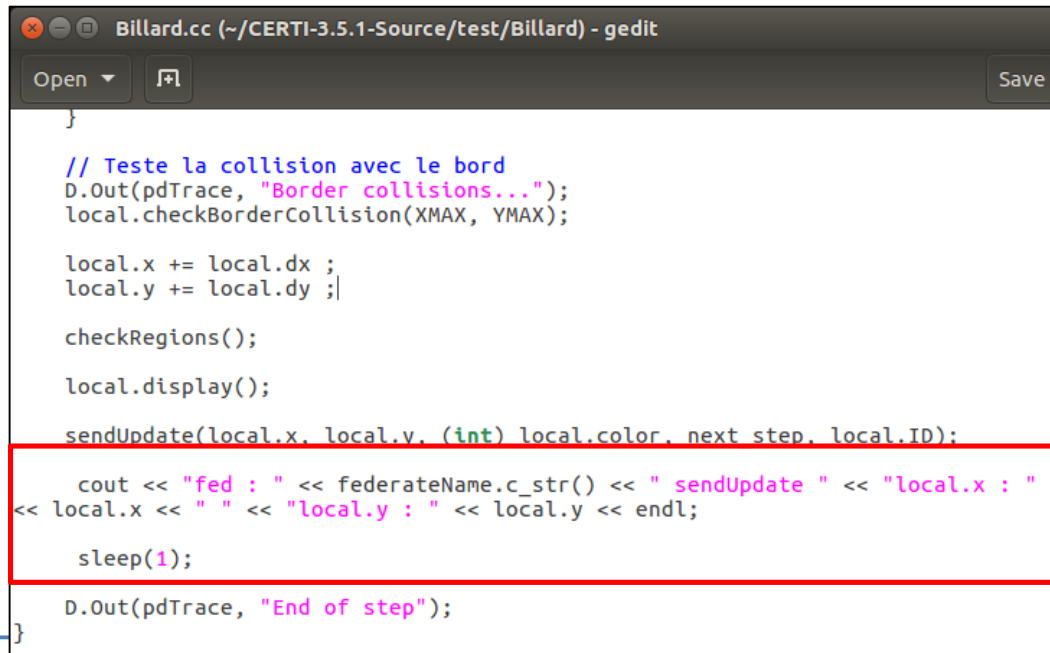


# HLA RTI 설치하기

## CERTI 오픈 소스 코드 수정 및 테스트

### ❑ CERTI 오픈 소스 코드 수정하기

- cd CERTI-3.5.1-Source/test/Billiard로 소스 폴더로 이동
- gedit Billard.cc 소스코드 편집기를 오픈 (아래 그림)
  - Billard::step() 메소드(함수)에서 아래와 같이 코드를 추가
    - cout << "fed : " << federateName.c\_str() << " sendUpdate " << "local.x : " << local.x << " " << "local.y : " << local.y << endl;
    - sleep(1);



```
Billard.cc (~/.CERTI-3.5.1-Source/test/Billiard) - gedit
Open Save

}

// Teste la collision avec le bord
D.Out(pdTrace, "Border collisions...");
local.checkBorderCollision(XMAX, YMAX);

local.x += local.dx ;
local.y += local.dy ;

checkRegions();

local.display();

sendUpdate(local.x, local.y, (int) local.color, next step, local.ID);

cout << "fed : " << federateName.c_str() << " sendUpdate " << "local.x : "
<< local.x << " " << "local.y : " << local.y << endl;

sleep(1);

D.Out(pdTrace, "End of step");
}
```

# HLA RTI 설치하기

## CERTI 오픈 소스 코드 수정 및 테스트

### ❑ CERTI 오픈 소스 코드 수정하기

- cd CERTI-3.5.1-Source/test/Billiard로 소스 폴더로 이동
- gedit Billard.cc 소스코드 편집기를 오픈 (아래 그림)
  - Billard::reflectAttributeValues()로 이동 및 아래와 같이 vector<Ball>::iterator 코드 위에 아래 코드를 추가 (위 주석에서 callback: reflect attribute values **without time**로 표시된 것)

```
// .....  
/** Callback : reflect attribute values without time  
 */  
void  
Billard::reflectAttributeValues(  
    RTI::ObjectHandle theObject,  
    const RTI::AttributeHandleValuePairSet& theAttributes,  
    const char /*theTag*/)  
    throw (RTI::ObjectNotKnown,  
          RTI::AttributeNotKnown,  
          RTI::FederateInternalError)
```

```
    else {  
        D.Out(pdError, "Fed: ERREUR: handle inconnu.");  
    }  
}  
  
cout << "reflectAttributeValues without time" << endl;  
cout << "from fed:" << rtiamb.getObjectInstanceName(theObject) << " x : "<<  
x1 << ", y : " << y1 << endl;  
  
vector<Ball>::iterator it = remote.begin() ;  
while (it != remote.end() && it->ID != theObject)  
    ++it ;
```

# HLA RTI 설치하기

## CERTI 오픈 소스 코드 설치하기

### ❑ CERTI 오픈 소스에서 make 및 make install로 소스 코드를 빌드함

- Build폴더로 에서 make 명령어 및 make install 수행
  - make는 make install은 sudo 없이 아래 그림과 같이 실행
    - make는 정상 수행, make install은 중간에 권한 문제로 수행 중단됨(sudo권한으로 하면 수행되지만, 나중에 프로그램 실행이 안되서 우선그냥 놔둬)

```
wmlab@ubuntu: ~/CERTI-3.5.1-Source/build
cmake_uninstall.cmake      libHLA      xml
config.h                  libRTI
wmlab@ubuntu:~/CERTI-3.5.1-Source/build$ make
Scanning dependencies of target HLA
[ 0%] Building CXX object libHLA/CMakeFiles/HLA.dir/HLAbuffer.cc.o
[ 1%] Building C object libHLA/CMakeFiles/HLA.dir/sha1.c.o
[ 2%] Building CXX object libHLA/CMakeFiles/HLA.dir/MurmurHash2.cpp.o
[ 2%] Building CXX object libHLA/CMakeFiles/HLA.dir/MurmurHash3.cpp.o
[ 3%] Building C object libHLA/CMakeFiles/HLA.dir/PMurHash.c.o
...
-- Installing: /home/wmlab/certi/share/xml/ieee1516-2000
-- Installing: /home/wmlab/certi/share/xml/ieee1516-2000/1516_2-2000
-- Installing: /home/wmlab/certi/share/xml/ieee1516-2000/1516_2-2000/OMT-DIF.xml
-- Installing: /home/wmlab/certi/share/xml/ieee1516-2000/1516_2-2000/HLA.dtd
CMake Error at cmake_install.cmake:84 (file):
  file failed to open for writing (Permission denied):

    /home/wmlab/CERTI-3.5.1-Source/build/install_manifest.txt

Makefile:82: recipe for target 'install' failed
make: *** [install] Error 1
```

# HLA RTI 설치하기

## CERTI 오픈 소스 코드 실행 및 테스트하기

### ❑ CERTI 오픈 소스 코드의 실행 분석

```
wmlab@ubuntu: ~/certi/bin
reflectAttributeValues without time
from fed:3 x :187. y :76
fed : 1 sendUpdate local.x : 136 local.y : 53
reflectAttributeValues without time
from fed:2 x :28, y :75
reflectAttributeValues without time
from fed:3 x :190, y :73
fed : 1 sendUpdate local.x : 133 local.y : 50
reflectAttributeValues without time
from fed:2 x :25, y :78
reflectAttributeValues without time
from fed:3 x :193, y :70
fed : 1 sendUpdate local.x : 130 local.y : 47
reflectAttributeValues without time
from fed:3 x :196, y :67
```

Federate1

pub(송신) to Fed2, Fed3

Sub(수신) from Fed2

Sub(수신) from Fed3

```
wmlab@ubuntu: ~/certi/bin
reflectAttributeValues without time
from fed:3 x :187, y :76
fed : 2 sendUpdate local.x : 28 local.y : 75
reflectAttributeValues without time
from fed:1 x :136, y :53
reflectAttributeValues without time
from fed:3 x :190, y :73
fed : 2 sendUpdate local.x : 25 local.y : 78
reflectAttributeValues without time
from fed:1 x :133, y :50
reflectAttributeValues without time
from fed:3 x :193, y :70
reflectAttributeValues without time
from fed:3 x :196, y :67
reflectAttributeValues without time
```

Federate2

Sub(수신) from Fed1

pub(송신) to Fed1, Fed3

Sub(수신) from Fed3

# HLA RTI 설치하기

## CERTI 오픈 소스 코드 실행 및 테스트하기

### ❑ CERTI 오픈 소스 코드의 실행 분석

```
wmlab@ubuntu: ~/certi/bin
reflectAttributeValues without time
from fed:3 x :187, y :76
fed : 2 sendUpdate local.x : 28 local.y : 75
reflectAttributeValues without time
from fed:1 x :136, y :53
reflectAttributeValues without time
from fed:3 x :190, y :73
fed : 2 sendUpdate local.x : 25 local.y : 78
reflectAttributeValues without time
from fed:1 x :133, y :50
reflectAttributeValues without time
from fed:3 x :193, y :70
reflectAttributeValues without time
from fed:3 x :196, y :67
reflectAttributeValues without time
```

Federate2

pub(송신) to Fed1, Fed3

Sub(수신) from Fed1

Sub(수신) from Fed3

```
wmlab@ubuntu: ~/certi/bin
reflectAttributeValues without time
from fed:1 x :133, y :50
reflectAttributeValues without time
from fed:2 x :25, y :78
fed : 3 sendUpdate local.x : 196 local.y : 67
reflectAttributeValues without time
from fed:1 x :130, y :47
reflectAttributeValues without time
from fed:2 x :22, y :81
fed : 3 sendUpdate local.x : 199 local.y : 64
reflectAttributeValues without time
from fed:1 x :127, y :44
reflectAttributeValues without time
```

Federate3

Sub(수신) from Fed2

pub(송신) to Fed1, Fed2

---

*Thank you for your attention !!*

---