



CERTI

an Open Source RTI, why and how?

Eric NOULARD, Jean-Yves ROUSSELOT
eric.noulard@onera.fr , rousselot@cert.fr
ONERA/DTIM/SER
ONERA Centre de Toulouse

Pierre SIRON
pierre.siron@isae.fr
DMIA Department
Université de Toulouse, ISAE



ONERA
THE FRENCH AEROSPACE LAB

return on innovation

(09S-SIW-015)

Plan

- CERTI History & Status
 - History
 - Security
 - Multi-resolution
 - High Performance
 - Hard Real-time
 - Project Current Status
- Open Source CERTI
 - Why
 - How
 - Stakeholders
 - Collaborative tools
 - Software components
 - RTI
 - HLA Test Suite
 - Contributions

CERTI History - Why an ONERA RTI ?

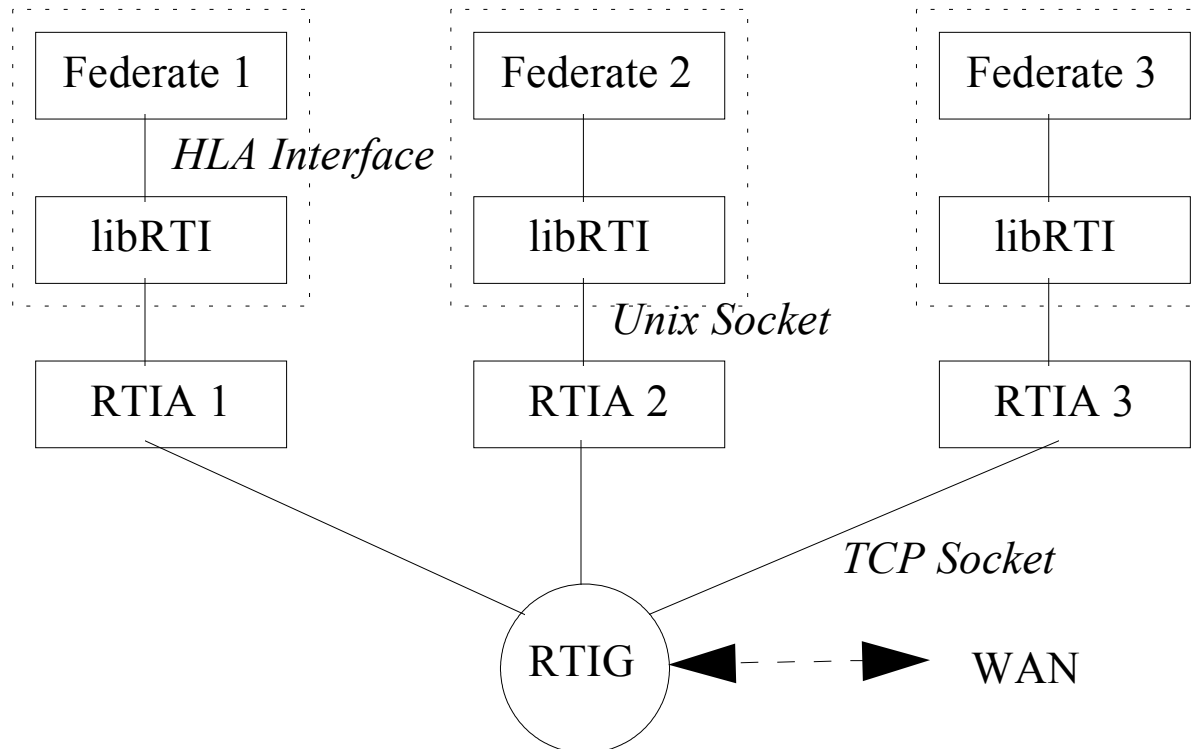
- Initial motivations :
 - To get a better understanding of HLA
 - To promote its use at ONERA
 - To initialize new researches
 - To study security features

Design and Implementation of a HLA RTI Prototype at ONERA (98f-siw-036)

<ftp://ftp.cert.fr/pub/siron/98f-siw-036.ps>

CERTI History - fundamental choices

- An incremental development
- Architecture: set of communicating processes
- Standard and portable: C++, TCP/IP



CERTI History - key dates

- **1996 CERTI project start at ONERA**
- 1997 First prototype (federation, declaration, object and time management)
- 1998 Communication optimizations
- 2000 HLA 1.3 migration
- 2001 Ownership management
- **2002 Open Source (GPL+LGPL)**
- 2003 DDM
- **2007 performances optimizations (tick, ...)**
- 2007 Windows version
- **2008 heterogeneous environment simulation**
- 2008/2009 Towards IEEE-1516/HLA Evolved

Today :

majority of 1.3 services

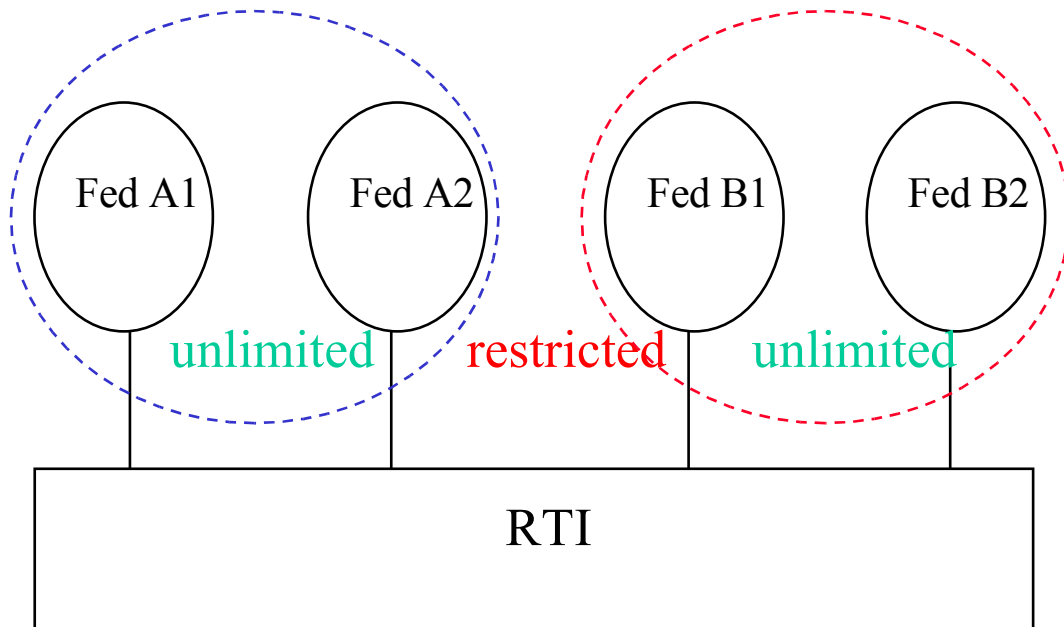
not certified but
developed federations
compatible with other
RTIs

not yet implemented:

- some notification services
- optimistic time management
- MoM

Security and distributed simulation

- Problematics: simulations involving several (possibly concurrent) companies



A complete security study:

Threat analysis

Security objectives

Security architecture

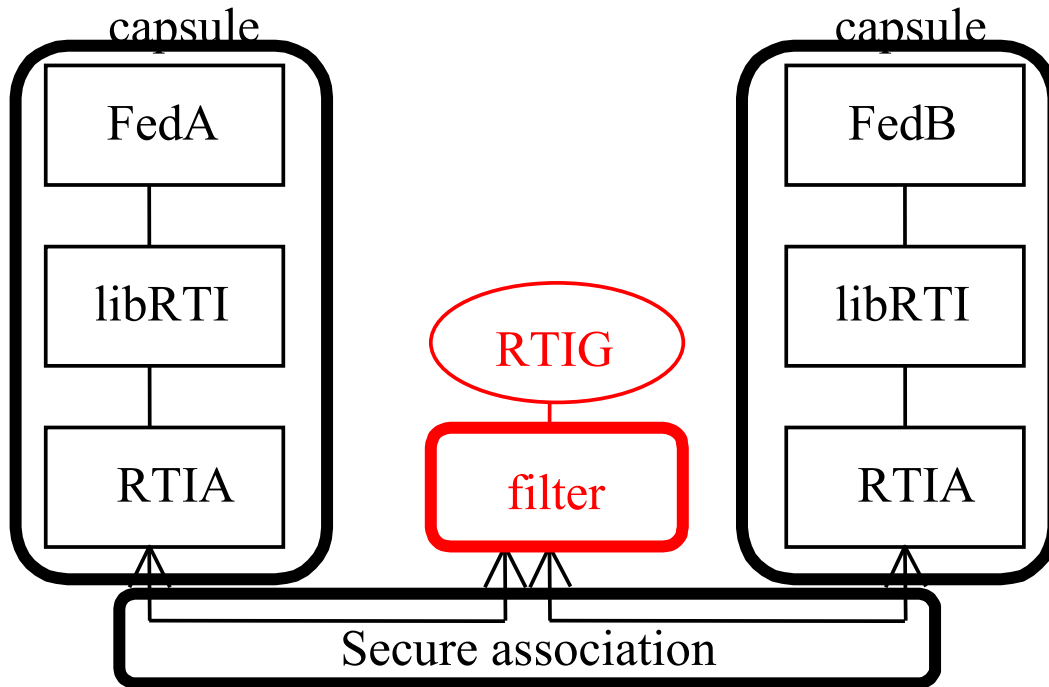
Security functions

Implementation and test

98f-SIW-086: Security Extensions to ONERA HLA RTI Prototype

<ftp://ftp.cert.fr/pub/siron/98f-siw-086.ps>

Security and distributed simulation



A **Trusted Third Party** implements the RTIG process

secure association: use of cryptographic protocols

filter: addition of access control mechanisms

capsule: static code analysis

TTP Security Architecture

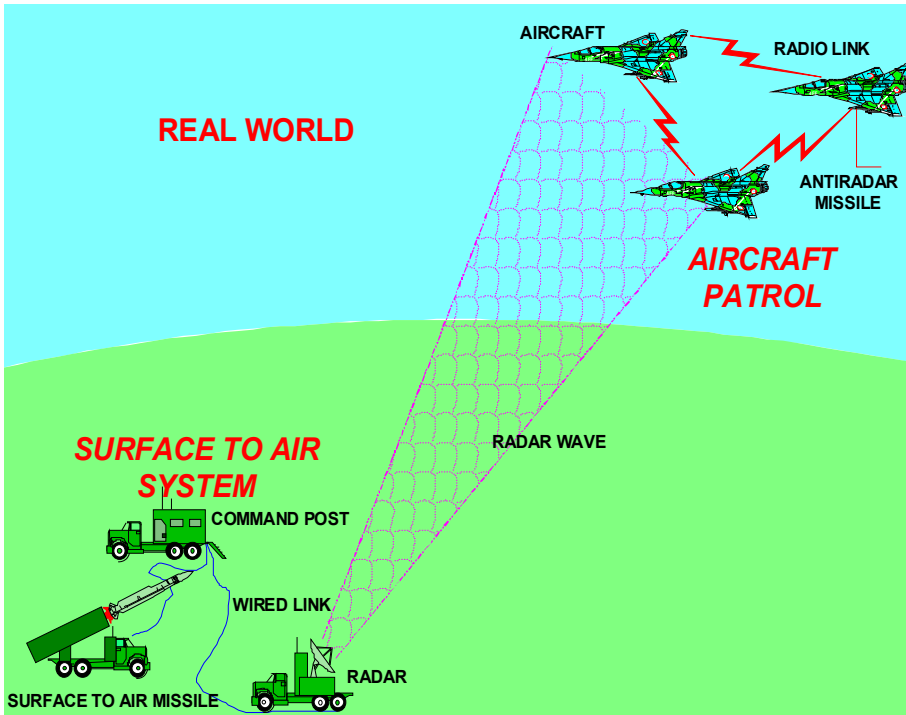
Security and distributed simulation

- It is mandatory to master an RTI:
 - To make the communication secure
 - Cryptographic protocols
 - To go through existing security mechanisms (firewalls, etc.)
 - To add access control mechanisms
 - To perform some code analysis and review (to avoid Trojan horses)

Multi-Resolution

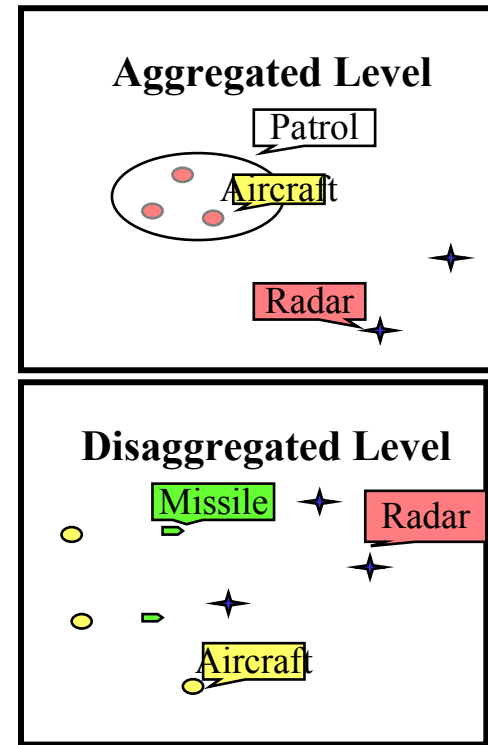
Case study:

- Air Defense System



Problematics:

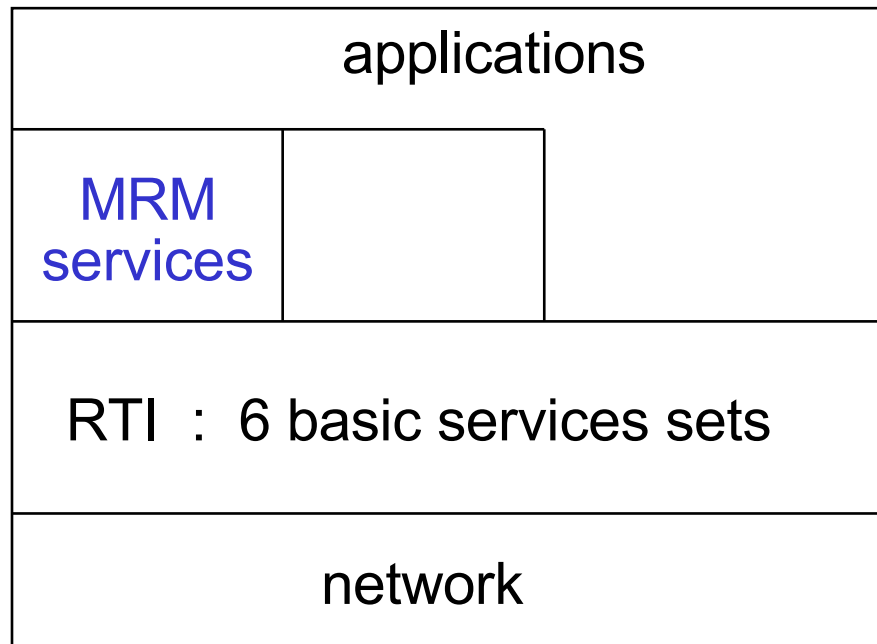
- to implement aggregation / disaggregation mechanisms



01S-SIW-12: Multiresolution Modeling and Simulation of an Air-Ground Combat Application (<ftp://ftp.cert.fr/pub/siron/01S-SIW-012.doc>)

Multi-Resolution

Specification, implementation and test of Multi-Resolution Management services



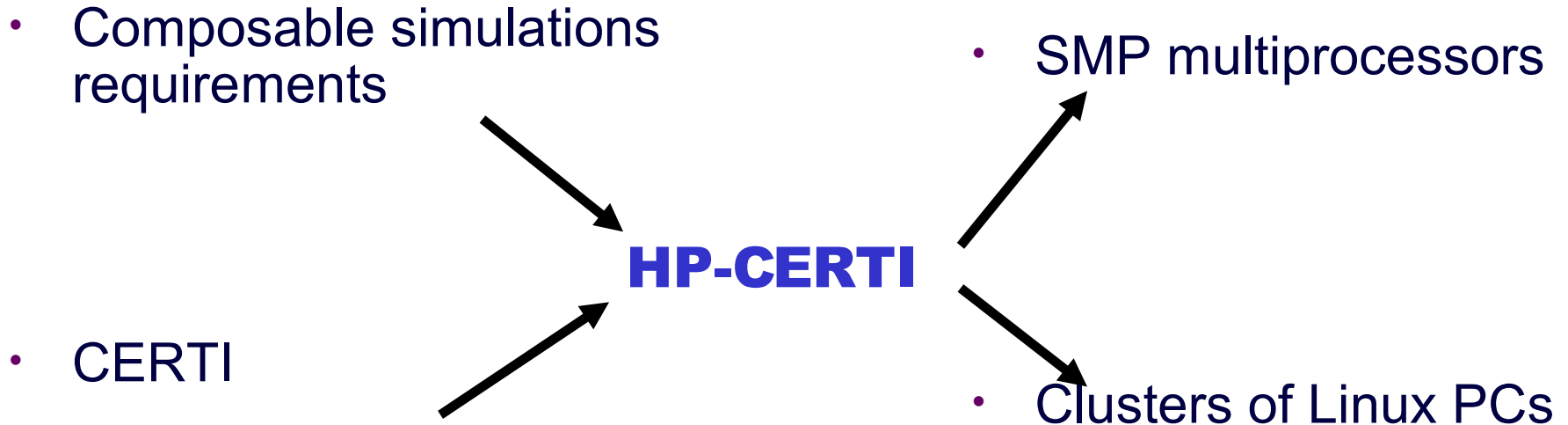
Multi-Resolution

- It is mandatory to master an RTI:
 - To add new services to the libRTI
 - To implement these services (these services have been implemented with the existing HLA services)

High Performance simulation

Problematics:

Distributed simulations for research and engineering

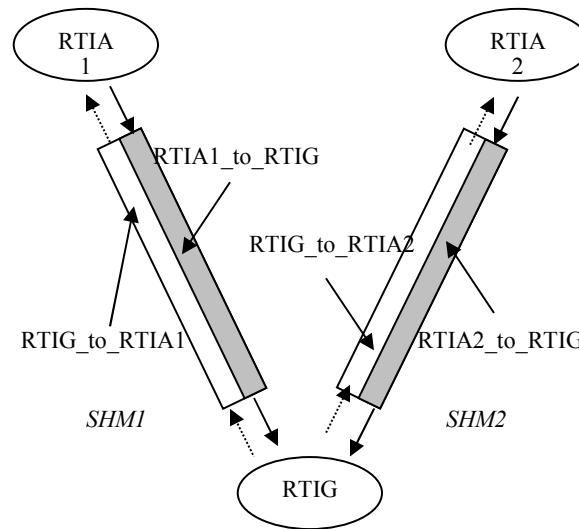


04F-SIW-014: HP-CERTI: Towards a high Performance, high Availability
Open Source RTI for Composable Simulations

<ftp://ftp.cert.fr/pub/siron/04F-SIW-014.pdf>

High Performance simulation

- One aspect: to replace TCP sockets by SHM segments



Difficulties:

- Update of the CERTI kernel
- Synchronization (producer / consumer)

High Performance simulation

- It is mandatory to master an RTI:
 - To optimize some services
 - To adapt the services implementations to specific execution architectures
 - To use specialized execution environments (operating systems)

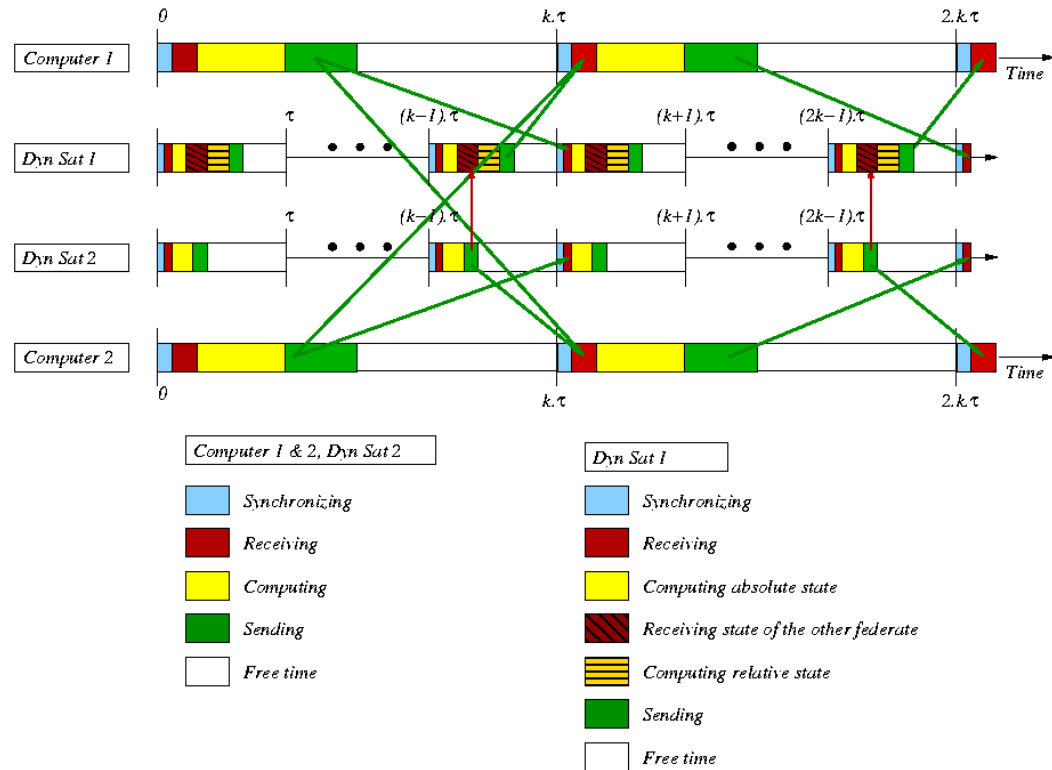
Hard real-time simulation

Applications: hybrid simulations, "in formation" flight of satellites

Timing constraints:

Exchanges of Data

Federate steps
synchronization



source CNES

08E-SIW-021: Running Real Time Distributed Simulations under Linux and CERTI

<ftp://ftp.cert.fr/pub/siron/08E-SIW-061.pdf>

Hard real-time simulation

- New Real Time Mechanisms
- Operating system
 - Real Time scheduling
 - RT Linux
 - etc.
- CERTI
 - new tick function
- Federate programming
 - use of the time management services

Hard real-time simulation

- It is mandatory to master an RTI:
 - To optimize some services
 - To use specialized execution environments (RT operating systems)

- To have a global model of the RTI and the federates
- To perform a global analysis of the tasks of the RTI and the federates
- To demonstrate the schedulability (or not)
- (work in progress)

CERTI Project Status

- 2/3 stable release per year:
 - **CERTI 3.2.3, 3.2.4, 3.2.5 – 6 feb 2007, 4 may 2007, 19 november 2007**
 - **CERTI 3.2.6, 3.3.0, 3.3.1 – 22 march 2008, 2 july 2008, 21 september 2008**
 - **CERTI 3.3.2, 3.3.x, ... – ?? april 2009**
- Registered project members did go from **3 up to 15** 12/2006 → 03/2009
<https://savannah.nongnu.org/projects/certi>
7 people from ONERA/DTIM, 2 from ONERA/DPRS, 3 students and 3 major contributors
- The « current estimate value » of CERTI by OHLOH is **13 Person Years**
<http://www.ohloh.net/projects/6472?p=CERTI>
- Project Statistics
 - 57 open bugs, 42 assigned or fixed (26) in next release.
 - 35 bugs fixed in CERTI 3.3.0
 - 14 open tasks, 6 assigned & running, 9 unassigned
 - 47 subscribers to the mailing list, certi-devel@nongnu.org
<http://lists.nongnu.org/mailman/listinfo/certi-devel>
 - 200+ exchanged messages in 2008 (30+ in 2007, 1 in 2006, 14 in 2005)

CERTI Open Source : Why ?

- Having an RTI for which we can make **fast modification** or add-on for **specific project needs**: real-time simulation, embedded middleware, ...
- Federating an international user community which contributes to the enhancement and maintenance of the open source software component,
- Having freely usable HLA tools for teaching (used at <http://www.isae.fr>) and/or doing contractual study,
- Having some piece of software usable for pursuing research in the area of distributed and/or high-performance simulation



- The IESTA project carried out by ONERA/DPRS needs a RTI which can be used on several platform. ONERA decided to update CERTI in order to make suit the project needs (on-going work).
- CERTI on Windows has been used by the IESTA project for "*Using the HLA, Physical Modeling and Google Earth for Simulating Air Transport Systems Environmental Impact*", Martin Adelantado, Jean-Baptiste Chaudron, Armand Oyzel, **09-SIW-045**.
- The classical Win/Win open source contract
 - The IESTA project enables (i.e. pay) the Windows port of CERTI because it **needs** CERTI on Windows
 - The Windows port **enables** (not paid by the project) the development of the XPlane/HLA plugin (*Jean-Michel MATHE from ONERA*).
 - The IESTA project **and** the Open Source CERTI community can now use **both** CERTI on Windows and the XPlane/HLA plugin.

Open Source for the community ?

A CERTI user (and contributor) testimonial (Sept. 2008) :

I'm using CERTI because I need a free HLA RTI with C++ API that could be used by individuals/organizations that cannot afford purchasing a commercial HLA RTI.

[...]

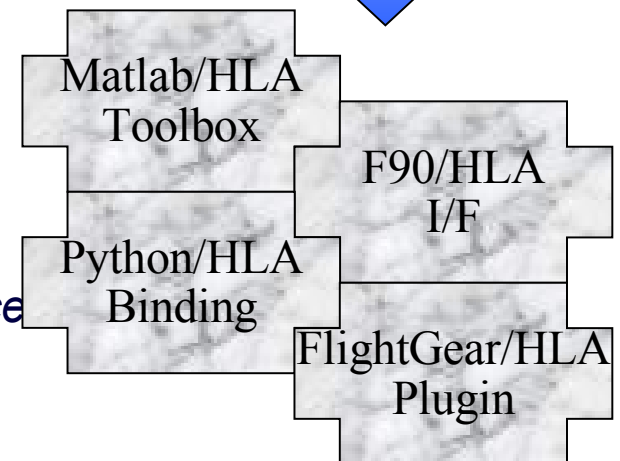
I need C++ API because most of the simulation software I'm using is in C/C++.

I like CERTI because

- it's free (see above)*
- it's open, so we can fix it quickly if necessary*
- the license allows inclusion of CERTI in a proprietary software*
- it has satisfying quality*
- it's still evolving*
- it works both under Linux and Windows*
- it has no Java inside, so it doesn't have poor performance complex installation and startup*
- it has a friendly and supportive mailing list ;-)*

*Pleased
Community*

Gives



HLA Teaching, training and more

- Teaching

- ISAE, <http://www.isae.fr>

- The « Institut Supérieur de l’Aéronautique et de l’Espace », higher teaching institute with an expertise in the field of aerospace engineering

- EISTI, <http://www.eisti.fr/>

- an Engineering “Grande Ecole” specializing in Information Processing and Computer Science

- Training

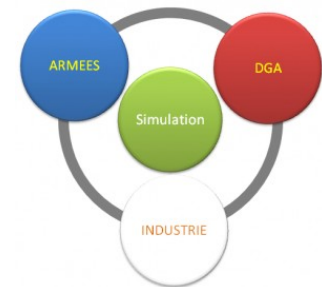
- EUROSAE Advanced Training, <http://www.eurosae.fr/>



- Invited Communications

- ADIS, French Minister of Defence Working Group

- Industrials, etc...

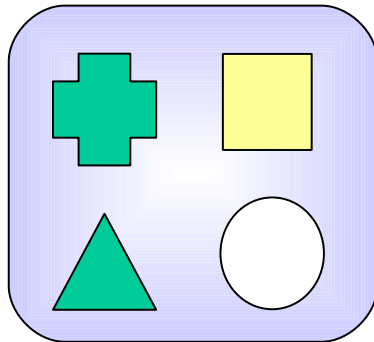


CERTI Open Source for research

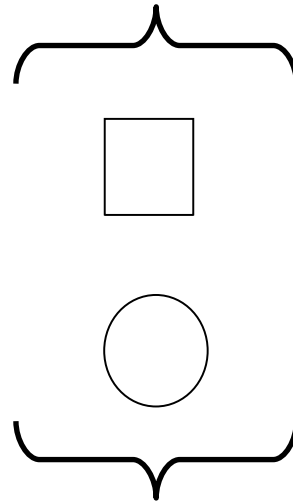
- **Realtime Distributed Simulation, Joint work CNES/ONERA**
Bruno d'Ausbourg, Pierre Siron, Eric Noulard: "*Running Real Time Distributed Simulations under Linux and CERTI*", 2008 Euro Simulation Interoperability Workshop Proceedings, 08E-SIW-061,
<ftp://ftp.cert.fr/pub/siron/08E-SIW-061.pdf>
- **Realtime distributed simulation architecture**
Jean-Baptiste CHAUDRON ONERA/DTIM PhD (2009-2011)
- **Predictible & embedded middleware**
ONERA/DTIM long term research (2009—2011)
we may try build an embedded CERTI version.
- **Distributed Simulation in Technical Applications**
Christian STENZEL, PhD at Wismar University (Germany)
<http://www.mb.hs-wismar.de/~stenzel>
- **Integrating Openmodelica simulator with HLA**
Hassen Jawhar Hadj-Amor, PhD at LISMMA (France)
- *May be other we don't know ?*

The Open Source contribution model

User/Contributor 1

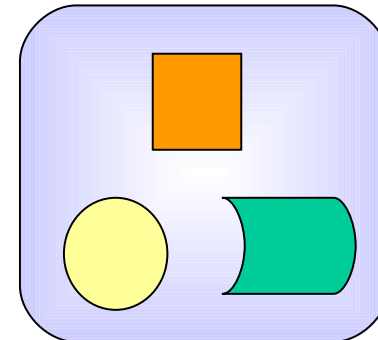
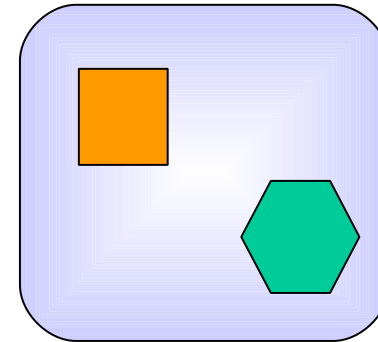


Make+Test
Make
Test
Reuse



The Open World

User 2



User/Contributor 3

CERTI Open Source : How ?

<https://savannah.nongnu.org/projects/certi>

The screenshot shows a web browser window displaying the Savannah project page for CERTI. The browser's address bar shows the URL <https://savannah.nongnu.org/projects/certi>. The page has a navigation menu with links for Group, Main, Homepage, Download, Docs, Mailing Lists, Source Code, Bugs, Tasks, Patches, and News. The main content area is titled "CERTI - Summary" and includes a description of the project, its registration date, license, and development status. There are also sections for "Administration: CERTI Project", "Quick Overview", and "Latest News". A sidebar on the left contains links for user account management and search. The bottom of the page features a search bar and navigation controls.

CERTI - Summary

Group | Main | Homepage | Download | Docs | Mailing Lists | Source Code | Bugs | Tasks | Patches | News

This project is not part of the GNU Project.

CERTI is a free HLA RTI. HLA (High-Level Architecture) is a general purpose architecture for distributed computer simulation systems. In HLA systems, the RTI (RunTime Infrastructure) manages data exchange between simulations. CERTI focuses on HLA 1.3 specification and its C++ API (IEEE 1516 will be supported too) CERTI is free software (GPL, libraries are LGPL).

Registration Date: Thu 11 Jul 2002 03:35:20 PM CEST
License: GNU General Public License v2 or later
Development Status: 4 - Beta

Membership Info

Project Admins:
- Pierre Siron
- Eric NOULARD
14 active members
[View Members]

Group Identification

Id: #2464
System Name: certi
Name: CERTI
Group Type: non-GNU software & documentation

Search In This Group

in Cookbook

Administration: CERTI Project

As administrator of this project, you can manage members and activate, deactivate and configure your project's tools.

[Project Main Administration Page](#)

Quick Overview

- [Project Homepage](#)
- [Download Area](#)
- [Docs](#)

Latest News

CERTI 3.3.0 release
posted by erk, Wed 02 Jul 2008 12:18:42 PM CEST - 2 replies

CERTI 3.3.0 has been release and is available in download area:
<http://download.savannah.gnu.org/releases/certi/>

This release includes 36 bugs fixes, and terminates 3 registered tasks:
#6911 Write a First Federate with CERTI tutorial ...

Open Source CERTI : Stakeholders

- **Project administrators:** people who have the right to perform administrative actions (add a member, remove a member, lower or raise privilege for a member regarding the usage of the different collaborative tools, moderate messages on project mailing lists ...). CERTI project currently has **2 administrators** representing one institution (ONERA). A project administrator usually defines the project roadmap and ensures the consistency of the project when merging contributions.
- **Project developers:** people who have [autonomous] **write access to the source code** of one or several software components in the project. They may add/remove/modify software. They **integrate external contributions**, they **fix bugs**, carry out the **release**, etc... Note that a "developer" may be someone who only takes care of **documentation**; he may not be a computer scientist even if most of them are. A developer reports bugs. A developer will **voluntarily answer questions raised** on the mailing list, etc... There is at least one developer responsible for the development of **each software component** in the project.
- Project contributors
- Project users

Project Users/Contributors

- **Project contributors:** people who use the software components and **sometimes provide bug fixes** and/or new features such as a patch (a piece of source code), **documentation**, translation, new companion software modules... **The contribution may be merged (or not)** by a project developer. The decision to include or reject the contribution is discussed with potentially all interested project stakeholders using collaborative tools (mailing list, trackers); the developers plus the administrator make the final decision.
- **Project users:** people who **use any software component** found in the project. Users do **ask and answer** questions on the mailing lists, they are invited to **directly report bugs** using project **trackers**. They are invited to contribute; they may become developers if they apply for it and have recognized knowledge within the project.

Open Source:
Any user is a contributor

Example of tracker usage : a bug report

- A bug may anything like:
 - Some unexpected runtime error when using CERTI for its federation
 - A possibly wrong behaviour of the CERTI RTI when regarding HLA specification
 - Missing or wrong documentation
 - ...
- A bug may be filed by ANYBODY using the CERTI project at Savannah bug tracker:
<https://savannah.nongnu.org/bugs/?group=certi>
- Better be logged into Savannah in order to get automatic e-mail follow-up
- A bug will be assigned and handled by administrators & developpers who will discuss the issue directly using the tracker.

Bug report: the tracker explained

File Edit View History Bookmarks Tools Help Simpy

https://savannah.nongnu.org/bugs/?group=certi

Logged In



Authentifié(e) en tant que erk

- Mes nouveaux items
- Mes items
- Mes groupes
- Mes préférences
- Retour à l'anonymat

CERTI - Anomalies : Consulter les items

Groupe Accueil Site web Téléchargement Documentation Listes de discussion Code source Anomalies Tâches Patches Dépêches

(+) Critères d'affichage

Status and Developer in charge

Reporter of the bug

← Début ← Résultats précédents 57 items correspondants - Items de 1 à 50 Résultats suivants → Fin →

Item ID	Summary	Category	Severity	Status	Assigned To	Submitted By	Submitted On
#25497	NextEventRequest to a timestamp smaller than last grant time + lookahead	CERTI	5 - Blocker	None	adele	None	jeu 05 fév 2009 14:55:29 CET
#25465	windows debug dlls required	CERTI	3 - Normal	None	None	None	lun 02 fév 2009 16:41:04 CET
#25119	neither stdint.h nor cstdint available on all platforms	CERTI	3 - Normal	Ready For Test	gotthardp	gotthardp	jeu 18 déc 2008 13:41:52 CET
#24930	Win32 build is broken: Circular dependencies between libCERTI and libRTI-NG	CERTI	5 - Blocker	In Progress	gotthardp	gotthardp	mar 25 nov 2008 23:15:57 CET
#24914	FindRTI.cmake is not robust to "unable to execute RTIG"	CERTI	3 - Normal	Ready For Test	gotthardp	erk	lun 24 nov 2008 13:06:44 CET
#24904	Wrong shared library versioning	CERTI	2 - Minor	None	gotthardp	gotthardp	sam 22 nov 2008 20:34:38

Bug report: the tracker explained



CERTI - Anomalies : bug #24691, Bug in getParameterName

Groupes Accueil Site web Téléchargement Documentation Listes de discussion Code source Anomalies Tâches Patches Dépêches

Vous êtes technicien et gestionnaire sur cet outil de suivi.

bug #24691 : Bug in getParameterName

Posté par : Christian Stenzel <approx>

Posté le : mer 29 oct 2008 16:54:29 CET

Poster et consulter d'autres items

Poster et revenir à cet item

Bug Reporter

CERTI

Software error

Severity: *

3 - Normal

Status:

Ready For Test

Bug Status

Privacy: Public

Assigned to: erk

Open/Closed: Open

Discussion Lock: Unlocked

Release: * 3.3.1

Reproducibility: None

Fixed Release: * CVS

Summary: * Bug in getParameterName

* Champs obligatoires

Automatic E-mail Follow-up for:

- Reporter
- Developer
- Anyone which puts a comment

(+) Poster un commentaire

Bug Discussion

(anyone can comment)

jeu 30 oct 2008 11:13:07 CET, commentaire #7 :

I've just checked in the fix.

Eric NOULARD <erk>

jeu 30 oct 2008 11:02:13 CET, commentaire #6 :

Hi Florian,

Yes your are damn right.

Eric NOULARD <erk>

Open Source: collaboration

- Every trackers (bugs, tasks, patches etc...) work the same way
- Using trackers, users do have a **DIRECT** link to the developer of the software they are using and **any** user may freely answer to a question on the mailing list. This is the community power. That's why any **user** may be a **contributor**, 1 reported bug will be 1 bug less.
- An Open Source software/project **IS NOT A PRODUCT**, which means you **may** ask for help but won't be able to **require** a fast bug fix or anything else you currently **want**. However, you are invited to propose **your own fix for the bug**, you have the source at hands just as developers do 😊.

If you want a « classical » HLA product, just buy one, there exist good HLA products providers, open source is not competing them.

- Whenever you step into the CERTI open source community you'll soon be pleased by the way it works

CERTI Project Components

Matlab/HLA
Toolbox
S. Pawletta
C. Stenzel

HLA TestSuite
CERTI WorldWide Team

F90/HLA I/F
C. Stenzel

CERTI
ONERA/DTIM

HLA Tutorial
C. Stenzel

libHLA
P. Gotthard

Python/HLA
Binding
P. Gotthard

FlightGear/HLA
Plugin
P. Gotthard

XPlane/HLA
Plugin
JM. Mathe

HLA Test Suite

- We needed some kind of regression test suite for CERTI
- HLA Test Suite is:
 - A collection of simple HLA federate applications
 - Which may be systematically run for regression testing and continuous integration using
DTest: <http://nongnu.askapache.com/tsp/dtest/>
CTest: http://www.cmake.org/Wiki/CMake_Testing_With_CTest
 - They should be RTI-agnostic, currently used by CERTI, but should be usable with other RTI
 - Contributed from several CERTI developers, but we would be glad to accept any other external contributions
- HLA Test Suite is not:
 - A benchmark suite
 - A normative HLA test suite (but we may think about it)

Python/HLA Binding

- **Python Bindings for M&S HLA, A CERTI companion project**
<http://www.nongnu.org/certi/PyHLA/index.html>
from Petr Gotthard, Masaryk University

The PyHLA module aims at enabling rapid development of HLA federates. Developed with CERTI but may be used with other RTIs (HLA 1.3 with C++ DLC API).

- The PyHLA module provides Python language bindings for the Modeling&Simulation High Level Architecture (M&S HLA).
- The PyHLA module provides
 - Python language HLA API, that is compliant with the HLA 1.3 standard (implemented as a Python wrapper for the C++ HLA API),
 - pack/unpack methods providing IEEE 1516.2 encoding,
 - HLAuse function that is able to directly import OMT DIF datatypes (the XML format described in IEEE 1516.2)
- The PyHLA module can be build on a variety of platform/compiler combinations, including Windows, Linux and Sun Solaris. The module relies on the Classic Python interpreter (version 2.4 or higher) and requires a HLA 1.3 compliant RTI with C++ DLC API.

CERTI Project Components

- Look in: <http://download.savannah.nongnu.org/releases/certi/contrib/>
- Flight Simulator Plugins (proof of concept)
Those may take output from the simulator and generate UAV to an HLA simulation and conversely HLA simulation UAV could be directed to command the simulator input
 - XPlane : <http://www.x-plane.com/>
 - FlightGear : http://wiki.flightgear.org/index.php/Virtual_Air
- Matlab/HLA plugin
 - <http://www.mb.hs-wismar.de/~stenzel/software/MatlabHLA.html>
 - It provides HLA connectivity within Matlab under Linux and Windows
- F90/HLA interface
 - <http://www.mb.hs-wismar.de/~stenzel/software/F90HLA.html>
 - Use HLA from within F90 code
- HLA Tutorial:
 - A small and interactively self-explaining HLA application
 - A simple example on how to write and compile an HLA federate using CERTI (cross platform build example using CMake <http://www.cmake.org>)

Using CERTI : Go ahead!!

- Go to the CERTI project portal on Savannah
<https://savannah.nongnu.org/projects/certi>
- Communicate with the community using the collaborative tools
 - Mailing list
 - Bugs tracker
 - Tasks tracker
 - Patches trackers
 - Download area
- Direct and confidential relationship with ONERA about CERTI may be done whenever needed: <http://www.cert.fr/CERTI/>



CERTI

ONERA

THE FRENCH AEROSPACE LAB

pierre.siron@onera.fr
eric.noulard@onera.fr

Questions?

