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# IRATI


Investigating RINA as an Alternative to TCP/IP

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## D1.2.1 First Quarterly Progress Report: January – March 2013

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## Abstract

This report explains the main activities carried out by the IRATI consortium during the first quarter of the project, and the progress related to the planned objectives for the reporting period.

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## 1 Executive summary

### 1.1 WP1 Project Management

The project kick-off was held on January 21<sup>st</sup> 2013. WP1 was in charge of its organisation, meeting room rental, services and subsistence of the attendees. All the official documents that setup the legal framework for running the project (Grant Agreement, Consortium Agreement, etc) are signed and in place. The project management procedures are in place. The tools to support these procedures as well as the collaboration within the consortium members such as mailing lists, document templates, Skype chats, FTP and a private wiki have been set up.


### 1.2 WP2 Architecture, Use cases and Requirements

During this period the work in WP2 has been focused in four different activities, summarized in the following paragraphs:

- The description of the use cases for the first phase of the project, and the analysis of the requirements they impose to the RINA implementation that will be carried out by WP3. Most of the use cases are based on the scenario of a hybrid Network and Cloud service provider. The use cases report has been released as Milestone 3 at the end of the reporting period.
- The analysis of the current state of the art of the RINA specifications, with the goal of identifying the main ones that are missing or that are not complete enough in order to carry out IRATI's work. For the first period of IRATI two new specifications will be drafted (the shim DIF over Ethernet and the Forwarding Table Generator), and two specifications will be updated with concrete policies for the IRATI scenarios (the Inter DIF Directory and the Flow Allocator).
- The design of the high-level software architecture for the IRATI prototype, targeting the Linux and FreeBSD platforms. The goals of the design are to create an open, reference implementation of RINA, that can be later used for further research or as a basis for commercial products. In order to provide a low performance penalty for the "fast-path" operations (read/write), the implementation components will be spread between the user-space and the kernel.
- The technical coordination of the project, to ensure coherence and correctness of the work carried out by IRATI. To this end, right after the project kick-off, WP2 and WP5 organized a RINA workshop (January 22<sup>nd</sup> – January 24<sup>th</sup> 2013) in order to provide a rich RINA tutorial to the IRATI consortium and to disseminate the work of RINA and IRATI to a set of invited parties from all over the world. WP2 covered the tutorial part, discussing the current state of the art of the RINA specifications and prototypes with the audience.

### 1.3 WP3 Software design and implementation

WP3 started the last month of the reporting period (March 2013). This first month, WP3 has been working in close collaboration with WP2 (T2.3) in order to setup a proper project

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development environment, choosing the most adequate platforms, programming languages and tools for the implementation of the IRATI prototype. The following lines provide a summary of the decisions taken for the first period of the project (some decisions are project-wide, others may vary in other phases).

- C has been selected as the programming language of the kernel components and the libraries supporting the daemons at user-space.
- Java has been selected as the programming language of the daemons at user-space.
- GIT has been selected as the technology for code repositories. IRATI repositories will be hosted at github<sup>1</sup>, initially as private repositories. Once the results are mature enough, the repositories will be made public.
- The github issue tracker will be used as the tool to plan the development of the different components, as well as to report bugs and feature enhancement requests.
- Autotools<sup>2</sup> will be used to build the user-space components of the prototype.
- SWIG<sup>3</sup> will be used as a tool to automatically generate the Java bindings for the user-space C libraries.
- The main development platform will be a Linux Virtual Machine that WP3 will prepare, including all the development tools properly installed and configured.

## 1.4 WP4 Deployment into OFELIA testbed, Experimentation and Validation

No activity has taken place in WP4, since it will start in month 5 (May 2013).

## 1.5 WP5 Dissemination, Standardisation and Exploitation

WP5 work during the first reporting period has been focused in T5.1 activities, related to dissemination and project image. Concretely, WP5 has performed the following activities:


- Design, setup and implement the project online presence. The portal to the project online presence is the IRATI website, hosted at <http://irati.eu>. The website provides an introduction to the project (objectives, goals, partners, work packages), and more important, rich dynamic content related to IRATI news, deliverables, presentations, publications and blog posts. The project also has twitter and slideshare accounts.
- Co-organize with WP2 and the Pouzin Society a 3-days RINA workshop, with presence of about 50 researchers from around the globe interested in RINA research and development activities (including the IRATI consortium members). During the workshop the IRATI project goals and approach were presented and discussed.
- Prepare the initial dissemination plan, published as Milestone 4 in the IRATI website.
- Perform various dissemination activities such as presenting IRATI at the FIRE Engineering conference (Ghent, November 2012), at the IEEE ANTS 2012 (Bangalore, December 2012) and write a short article for the Digital Agenda for Europe (DAE) website<sup>4</sup>.

<sup>1</sup> <https://github.com>

<sup>2</sup> <http://www.lrde.epita.fr/~adl/autotools.html>

<sup>3</sup> <http://www.swig.org>

<sup>4</sup> <https://ec.europa.eu/digital-agenda/en/blog/exploring-rina-recursive-internet-network-architecture>

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## 2 Beneficiaries

The beneficiaries of the IRATI project are listed in the table below.

<b>Participant number</b>	<b>Participant organisation name</b>	<b>Participant short name</b>	<b>Country</b>
1 (Coordinator)	Fundacio Privada i2CAT, Internet i Innovació Digital a Catalunya	i2CAT	ES
2	Nextworks	NXW	IT
3	Interdisciplinary Institute for Broadband Technology	IBBT	BE
4	Interoute Communications Ltd.	ICL	UK

**Table 1 List of IRATI beneficiaries**



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### 3 Overall project concept and objectives

The IRATI project will evolve the RINA architecture reference model and draft, incomplete specifications in order to enable RINA deployments that can potentially obsolete TCP/IP in the near future. To achieve this main goal, IRATI will design and implement a RINA prototype on top of Ethernet, targeted to the Linux and FreeBSD operating systems. The design and implementation of this prototype is an experimental research exercise itself, since the current state of the art of the RINA specifications is not mature enough to enable such an implementation. Therefore the holes in the specifications will have to be completed before being able to carry out the detailed design of the prototype. The prototype will be a vehicle for experimentation and validation of the completed specifications. OFELIA will be the FIRE facility of choice for conducting IRATI experimentation activities.

The specific objectives of IRATI are introduced in the following paragraphs.


**Objective 1: Enhancement of the RINA architecture reference model and specifications, focusing on DIFs over Ethernet.** The enhancement of the RINA specifications carried out within IRATI will be driven by three main forces: i) the specification of a DIF over Ethernet as the underlying physical media; ii) the completion of the specifications that enable RINA to provide a level of service similar to the current Internet (low security, best-effort) and iii) the project use cases targeting ambitious scenarios that are challenging for current TCP/IP networks (targeting features like multi-homing, security or quality of service). The industrial partners in the consortium will be leading the elaboration of the use cases, with the input of the External Advisory Board.

Means of verification: Deliverables **D2.1, D2.3, D2.4, D4.1, D4.2, D4.3**. Milestones **MS5, MS12, MS17**.

**Objective 2: RINA open source prototype over Ethernet for Linux.** This is the goal that can better contribute to IRATI's impact and the dissemination of RINA. Besides being the main experimentation vehicle of the project, the prototype will provide a solid baseline for further RINA work after the project. By the end of the project the IRATI partners plan to setup an open source community in order to attract external interest and involve other organizations in RINA R&D.

Means of verification: Deliverables **D3.1, D3.2, D3.4**. Milestones **MS7, MS13, MS18**.

**Objective 3: Experimental validation of RINA and comparison against TCP/IP.** This objective is enabled due to the availability of the FIRE facilities, which provide the experimentation environment for a meaningful comparison between RINA and TCP/IP. IRATI will follow iterative cycles of research, design, implementation and experimentation, with the experimental results retrofitting the research of the next phase. Experiments will collect and analyse data to compare RINA and TCP/IP in various aspects like: application API, programmability, cost of

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supporting multi-homing, simplicity, vulnerability against attacks, hardware resource utilization (proportional to energy consumption). The industrial partners in the consortium will be leading the choice of benchmarking parameters, with the input of the External Advisory Board.

Means of verification: Deliverables **D4.1, D4.2, D4.3**. Milestones **MS10, MS15, MS20**.

**Objective 4: RINA open source prototype over Ethernet for FreeBSD.** The RINA implementation within the FreeBSD operating system, will allow IRATI to increase the platforms supported by the RINA prototype. Moreover, this can be an intermediate step towards porting the IRATI implementation to core routers, since some router operating systems (such as JunOS) are based on FreeBSD.


Means of verification: Deliverable **D3.3**. Milestone **MS13**.

**Objective 5: Interoperability with the Pouzin Society RINA prototype over UDP/IP.** The achievement of interoperability between independent implementations is a good sign that a specification is well done and complete. Therefore, achieving interoperable RINA implementations is both a necessity and a validation of the RINA specifications; even more taking into account that PSOC and IRATI prototypes target different programming platforms (middleware vs. OS kernel) and work over different underlying technologies (UDP/IP vs. Ethernet).

Means of verification: Deliverables **D2.4, D3.4, D4.3**. Milestones **MS16-MS20**.

**Objective 6: Provide feedback to OFELIA in regards to the prototyping of a clean slate architecture.** Apart from the feedback to the OFELIA facility in terms of bug reports and suggestions of improvements, IRATI will contribute an OpenFlow controller capable of dynamically setting up Ethernet topologies to the project. IRATI will be using this controller in order to setup different topologies for the various experiments conducted during the project. Moreover, experimentation with a non-IP based solution is an interesting use case for the OFELIA facility, since IRATI will be the first to conduct these type of experiments in the OFELIA testbed.

Means of verification: Deliverables **D4.1, D4.2, D4.3**. Milestones **MS8, MS10, MS14, MS15, MS19, MS20**.

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## 4 Project objectives for the reporting period


The formal project objectives for the reporting period can be deduced from the deliverables and milestones planned to be achieved, in accordance with the tables in Sections 7.1 and 7.2.

During this first reporting period, it has been important to start up the project effectively. The Kick-off meeting was held (21<sup>st</sup> January, Barcelona) to remind partners about the early commitments, explain the procedures for video-conferencing meetings, reporting, clarify WP responsibilities, etc. It was also key to celebrate the initial RINA workshop (22<sup>nd</sup>-24<sup>th</sup> January, Barcelona), to consolidate the RINA knowledge of all the consortium members and share a common vision of the technical goals to be achieved by the project.

During the quarter January – March 2013, two deliverables and four milestones were due:

- **D1.1 Project Presentation** (Month 1). Public description of the project in terms of main goals, key issues, technical approach and achievements. It is intended for publication on the Websites of the Commission.
- **D1.2.1 First quarterly project report** (Month 3). First progress report of the project, informing the Commission about the project activities during the first quarter.
- **MS1 Management procedures in place and project started successfully** (Month 1). This milestone will be verified once the project kick-off meeting has been celebrated, the collaboration tools are operational and the first payments have been transferred to the partners.
- **MS2 First version of project website ready** (Month 1). This milestone will be verified when the initial version of the project website is reachable through the Internet.
- **MS3 Use cases and requirements analysis report for phase 1 ready** (Month 3). The milestone will be verified through the publication of the report.
- **MS4 Initial dissemination plan ready** (Month 3). The milestone will be verified through the publication of the report.

Apart from this, during the first period the project also has worked to prepare deliverable D2.1, which will provide an update of the RINA specifications and the initial high-level software architecture of the prototype at month 4.

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## 5 Work breakdown structure

The IRATI project activities are distributed into five work packages, as illustrated by table 2. The project lifetime has been divided into three phases; implementing iterative cycles of research, design and large-scale experimentation. During each phase: i) WP2 will select and analyse a set of use cases that showcase the features of RINA and are relevant for the consortium partners; analyse the requirements; improve the RINA specifications so that they comply with the requirements and design a high-level software architecture for developing a RINA prototype, ii) WP3 will take the requirements, enhanced RINA specifications and high-level software architecture and design, implement and test a RINA prototype and iii) WP4 will design experiments within OFELIA to validate and showcase WP2 use cases; setup the designed experiments within OFELIA, deploy the WP3 prototype and measure the experiment outputs; and finally analyse the results and provide feedback to WP2 and WP3.

<i>Activity</i>	<i>Task</i>
WP1 Project Management	T1.1 Establishing the project management procedures and collaboration tools
	T1.2 Performing the project management duties
WP2 Architecture, use cases and requirements	T2.1 Use cases and requirements analysis
	T2.2 Refinement of the RINA architecture reference model and specifications
	T2.3 High level software architecture
	T2.4 Technical project coordination
WP3 Software design and implementation	T3.1 Development environment setup and software integration
	T3.2 Enrollment, authentication, access control and SDU protection
	T3.3 CDAP, RIB, RIB Daemon, flow allocation and routing
	T3.4 Data transfer, data transfer control, relaying and multiplexing
	T3.5 Application interface
WP4 Deployment into OFELIA testbed, experimentation and validation	T4.1 Experiment design and deployment into testbed
	T4.2 Experimentation and validation
	T4.3 Feedback to the RINA specifications and software design
WP5 Dissemination, standardisation and exploitation	T5.1 Dissemination and project image
	T5.2 Exploitation
	T5.3 Standardisation

Table 2 Work plan activities and tasks

**WP1 (Project Management)** is responsible for the overall strategic and day-to-day management of the project. It will ensure that all work packages operate in a coordinated and

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coherent way, and involves various administrative tasks, such as: time and resource management, progress reporting and organization of plenary meetings.

**WP2 (Architecture, Use Cases and Requirements)** is responsible for the elaboration of the use cases that will drive the experimentation work of the project, the refinement of the RINA reference model and the current specifications and also, the definition of a high-level software architecture for the design and the implementation of the RINA prototypes.

**WP3 (Software Design and Implementation)** is in charge of setting up the development environments, conducting the detailed design, the implementation and the integration testing of the RINA prototypes for IRATI's two target platforms: Linux and FreeBSD.

**WP4 (Deployment into OFELIA testbed, Experimentation and Validation)**'s main goal is to design experimentation scenarios to validate the hypothesis of use cases defined in WP2, as well as conducting such experiments. WP4 will deploy the prototypes implemented by WP3 into the OFELIA facility. Then, it will perform the experimentation and validation work and, based on the achieved results, it will provide feedback to the refined specifications and high-level architecture of WP2.

**WP5 (Dissemination, Standardisation and Exploitation)** will co-ordinate the project's interaction with the academic and business community by ensuring that the innovations of the project are reported in high-quality venues, influence international organisations defining standards – specially PSOC, the Pouzin Society-, and are otherwise exploited by the project partners.

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## 6 Description of work package objectives and achievements during the reporting period

### 6.1 WP1 Project Management (M1-M24)

#### 6.1.1 General Description

The aim of WP1 is to provide the internal project management and the overall co-ordination of activities, financial- and technical- planning and control. It ensures that the project objectives are met and represents the contact point of the project to the Commission, the FP7 community and the external world. It provides guidance for the process of registering IPR, especially in cases where joint ownership is involved. It also addresses any issues concerning access rights, including cases where partners join or leave the project during its duration. It is assisted in its tasks by other bodies established as part of the management structure.

The work to be performed consists in the following tasks:

- **T1.1 Establishing the project management procedures and collaboration tools** (Start: M1, End: M1; Leader: **i2CAT**)
- **T1.2 Performing the project management duties** (Start: M1, End: M24, Leader: **i2CAT**)


#### 6.1.2 Achievements during the reporting period (M1-M3)

The project kick-off was held on January 21<sup>st</sup> 2013. WP1 was in charge of its organisation, meeting room rental, services and subsistence of the attendees. The project management procedures are in place, and all the official documents that govern the project's life have been signed. The main collaboration tools as mailing lists, project directory, project calendar, document templates, Skype chats and the technical wiki have been set up. Initial payments have been transferred to the consortium members. Work package leaders have been nominated, with the following results:

<b>Work Package</b>	<b>Leader</b>
WP1	Sergi Figuerola (i2CAT)
WP2	Eduard Grasa (i2CAT)
WP3	Francesco Salvestrini (Nextworks)
WP4	Dimitri Staessens (iMinds)
WP5	Adam Chappell (Interoute)

Table 3 IRATI Work package leaders

The External Advisory Board has been setup with the presence of Boston University, Atos, Telecom Italia, Cisco Systems and Juniper Networks. The following table contains the contact people for each member of the EAB.

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<i>EAB institution</i>	<i>Contact people</i>
Boston University	Loubomir T. Chitkushev, John Day
Atos	Felicia Lobillo
Telecom Italia	Antonio Manzalini
Juniper Networks	Renaud Larsen
Cisco Systems	Gary Berger, David Lake

Table 4 Members of the External Advisory Board

## 6.2 WP2 Architecture, use cases and requirements (M1-M24)

### 6.2.1 General Description

WP2 is the overarching work package that will define the scope of the use cases to be validated, propose a set of refinements and enhancements to the RINA architecture reference model and specifications, and elaborate a high level software architecture for the implementation. For each phase of the project, WP2 will:


- Elaborate the use cases to be showcased during the experimentation phases, analyze them and extract requirements. Use cases will try to focus at first on the availability/integration of core RINA functionalities in basic experimental setups; then, more complex scenarios that are challenging with the current Internet will be targeted to explore the full RINA functionalities and thus meet the expectations/take-up strategies of network operators and cloud service providers (like Interoute). The use cases will drive the experiment design and provide requirements for the completion/validation of the RINA architecture reference model and specifications.
- Analyse the RINA architecture reference model and specifications, identify holes in the mechanisms or missing policies, and propose enhancements/refinements.
- Based on the RINA architecture reference model and specifications on one side and the phase scenario and targeted platform on the other side, provide a high-level software architecture for the design and implementation of the prototype. This high-level software architecture will be the unifying document for the WP3 implementation tasks.

Last but not least, this WP will provide technical supervision of the work in the other technical work packages by hosting the technical board and performing audits of the project technical progress.

The work to be performed consists in the following tasks:

- **T2.1 Use cases and requirements analysis** (Start: M1, M11, M18; End: M3, M12, M19; Leader: **Interoute**)
- **T2.2 Refinement of the RINA architecture reference model and specifications** (Start: M2, M11, M18; End: M4, M13, M20; Leader: **i2CAT**)



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- **T2.3 High level software architecture** (Start: M2, M11, M12; End: M4, M13, M20; Leader: **Nextworks**)
- **T2.4 Technical project coordination** (Start: M1; End: M24; Leader: **i2CAT**)

### 6.2.2 Achievements during the reporting period (M1-M3)

Work on WP2 has been focused in four activities: i) providing a common technical understanding of RINA and a shared vision on the goals to be achieved (T2.4); ii) the use cases and requirements analysis for phase 1 (T2.1); iii) the updates to the draft RINA specifications (T2.2) and iv) the high-level software architecture of the Linux prototype (T2.3).

The first activity of WP2 was, in collaboration with WP5 and the Pouzin Society, to organize a RINA workshop (held in Barcelona from January 22<sup>nd</sup> to January 28<sup>th</sup>) – in the scope of task **T2.4**. WP2's goals for the workshop were to ensure that the IRATI partners had a good understanding of the RINA architecture and its benefits, its state of the art in terms of draft specifications and the degree of maturity of the RINA prototypes available. The workshop served as a great tool to clearly establish the project baseline and identify the major directions of WP2 for the next few months.

The work on **T2.1** has been directed towards providing a detailed description and requirements analysis of IRATI use cases for the first phase on the project. High-level requirements are extracted from the use cases analysis, defining the overall service characteristics that the DIFs developed by the project should have. The uses cases have been divided into three categories:


- *Integration-test use cases.* Specify the basic scenarios that the prototype has to fulfil before being able to be deployed in the experimentation environment.
- *Interoute scenario use cases.* The project focuses on the operation of the “Unified Connectivity” and “Virtual Data Center” services offered by Interoute; describing how these services are provided today and what advantages would RINA bring into the table.
- *Cloud bursting use case.* An advanced scenario that showcases the dynamicity provided by the Inter DIF Directory, enabling the creation of DIFs that support a particular set of applications on the fly.

The use cases and requirements analysis report for phase 1 is available at the IRATI website as Milestone 3 report. It will be later integrated into D2.1.

Based on the use cases report and the current draft RINA specifications available to the IRATI consortium, task **T2.2** has identified the more interesting specifications to be updated and/or added to the RINA specification set during the first phase of the project. These specifications included:

- *Shim IPC Process over 802.1q layer (new specification).* This specification wraps a 802.1q layer (a VLAN) with the DIF interface, enabling RINA to be overlaid on top of



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802.1q layers. The goal is not to enhance 802.1q layers with enough functionality to make them a DIF, but to add the minimal functionality that enables an IPC Process to use a 802.1q layer as an underlying transport.

- *PDU Forwarding table generator (routing, new specification)*. This specification will define a simple strategy to compute the PDU forwarding tables of IPC Processes in a DIF. The developed routing scheme is targeted to small-medium sized DIFs (first phase scenario).
- *Policies for the search phase of the Inter-DIF Directory (update to current specification, proposing concrete policies)*. This specification will provide policies to implement a strategy for the application-search phase of the IDD. This strategy is based on exhaustive search, targeted to a simple scenario with a reduced number of DIFs and applications (first phase scenario).
- *Policies for the directory and search phase of the Flow Allocator (update to current specification, proposing concrete policies)*. Similar to the IDD policies, this specification will provide a set of policies to implement the distributed directory of the Flow Allocator for small DIFs with few applications. The strategy will be based on a combination of exhaustive search and caching (first phase scenario).


The work of T2.2 for the first phase of IRATI will culminate in D2.1 (delivered at month 4).

**T2.3** has started to draft the high-level architecture for building the RINA prototype targeted to Linux and FreeBSD operating systems (the architecture will be valid for both systems, even though the implementation of phase 1 will only be for Linux). After an analysis of the requirements of the IRATI project and learning of the experiences of past RINA implementation efforts, T2.3 is working on software architecture with components spread around the user-space and the kernel-space.

User-space components include daemons and libraries that hide the interactions between user-space components, and user-space and the kernel. The daemons in user-space include the IPC Manager (management agent, instantiation, configuration and monitoring of IPC Process components), the Inter DIF Directory (discover what DIF has to be used to reach a certain application) and an a daemon for each IPC Process (that provides the functionality to implement the IPC Process layer management components: RIB & RIB Daemon, CDAP, Flow Allocator, Enrollment Task, Resource Allocator and Forwarding Table Generator).

The components in the kernel implement the “fast-path” of the IPC Processes, minimizing the overhead in terms of context switches and data copying for the read and write operations. The prototype components in the kernel will be: the Kernel IPC Manager (to handle creation/deletion/configuration of other kernel components and handling the read/write system calls), EFCP (the RINA data transfer protocol), the Relaying and Multiplexing Task, SDU Protection and the shim IPC Processes (for 802.1q layers and for TCP/UDP layers).

The work of T2.3 for the first phase of IRATI will culminate in D2.1 (delivered at month 4).

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## 6.3 WP3 Software design and implementation (M3-M24)

### 6.3.1 General Description

WP3 is the development workpackage of the project. Its overall objective is to translate the WP2 specifications and high-level software design into a set of prototypes that will be used by WP4 for its test-bed activities and experimentation. The main objectives of this WP are:

- To provide a common development environment
- To implement a RINA prototype over Ethernet for two platforms: Linux and FreeBSD
- To integrate the various functionalities and components into a demonstrable system (at node -level)


The architecture releases at the various project phases and the related functional decompositions delivered by WP2 are the starting point of work for WP3. Software prototypes are the major WP3 outcomes to be delivered to WP4. Moreover, it is expected that WP3 will produce a number of feedbacks on previous or concurrent activities, both internally (i.e. among tasks) and externally (i.e. towards other WPs). The feedbacks produced by WP3 to either internal or external tasks will have eventually an impact on the work produced by the target task, i.e. its deliverable. As a general rule, it is expected that major feedbacks on a task could lead to fix and reissue the deliverable(s) produced by that task previously.

The work to be performed consists in the following tasks:

- **T3.1 Development environment setup and software integration** (Start: M3; End: M24; Leader: **Nextworks**)
- **T3.2 Enrollment, authentication, access control and SDU Protection** (Start: M4, M12, M19; End: M10, M12, M23; Leader: **i2CAT**).
- **T3.3 CDAP, RIB, RIB Daemon, Flow Allocation and Routing** (Start: M4, M12, M19; End: M10, M12, M23; Leader: **iMinds**).
- **T3.4 Data transfer, data transfer control, relaying and multiplexing, SDU delimiting** (Start: M4, M12, M19; End: M10, M12, M23; Leader: **Nextworks**).
- **T3.5 Application interface** (Start: M4, M12, M19; End: M10, M12, M23; Leader: **i2CAT**).

### 6.3.2 Achievements during the reporting period (M1-M3)

During the reporting period only **T3.1** was active. This first month, WP3 has been working in close collaboration with WP2 (T2.3) in order to setup a proper project development environment, choosing the most adequate platforms, programming languages and tools for the implementation of the IRATI prototype. The following lines provide a summary of the decisions taken for the first period of the project (some decisions are project-wide, others may vary in other phases).

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- C has been selected as the programming language of the kernel components and the libraries supporting the daemons at user-space.
- Java has been selected as the programming language of the daemons at user-space.
- GIT has been selected as the technology for code repositories. IRATI repositories will be hosted at github, initially as private repositories. Once the results are mature enough, the repositories will be made public.
- The github issue tracker will be used as the tool to plan the development of the different components, as well as to report bugs and feature enhancement requests.
- Autotools will be used to build the user-space components of the prototype.
- SWIG will be used as a tool to automatically generate the Java bindings for the user-space C libraries.
- The main development platform will be a Linux Virtual Machine that WP3 will prepare, including all the development tools properly installed and configured.

## 6.4 WP4 Deployment into OFELIA testbed, Experimentation and Validation (M5-M24)

### 6.4.1 General Description

WP4 is the experimentation and validation work package, responsible of the following goals:

- Design the experiments required to validate the use cases and deploy WP3 prototypes into the OFELIA facility for experimentation.
- Validate the correctness of the prototype with respect to its compliance with the use cases through experimentation.
- Compare and document RINA benefits against TCP/IP in different areas: application interface, multi-homing, use of CPU resources and memory (directly related to energy efficiency), support of heterogeneous applications, security and others identified by WP2.
- Based on the experiments result analysis, provide feedback to the RINA specifications enhancement and high-level software architecture design activities in WP2.


The work to be performed consists in the following tasks:

- **T4.1 Experiment design and deployment into testbed** (Start: M5, M14, M21; End: M10, M17, M23; Leader: **iMinds**)
- **T4.2 Experimentation and validation** (Start: M7, M15, M22; End: M10, M17, M23; Leader: **i2CAT**)
- **T4.3 Feedback to the RINA specifications and software design** (Start: M8, M16, M23; End: M11, M18, M24; Leader: **Nextworks**)

### 6.4.2 Achievements during the reporting period (M1-M3)

WP4 starts at month 5 and therefore was not active during the reporting period.



	<b>D1.2.1</b>	Doc	IRATI D1.2.1
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## 6.5 WP5 Dissemination, Standardisation and Exploitation (M1-M24)

### 6.5.1 General Description

The goals of WP5 are:

- Dissemination of project results, already starting in the early stages of the project, culminating in the organisation of a final workshop, in which project results, prototypes and discussions around further RINA directions will take place.
- Preparation of publications, brochures, press handouts, project posters and other material.
- Presentation of IRATI at several types of events, including conferences, seminars and user group meetings.
- Collaboration with ICT projects.
- Launch of an open-source community around the RINA prototype for the UNIX-like OS and the IP-RINA gateway.
- Participate at the RINA standardisation efforts carried out within the Pouzin Society and make established standard bodies more aware about RINA.

Produce an exploitation plan comprising the exploitation plans of each partner and the joint marketing plans, which will mainly target the project's key industrial partners. Wherever possible, potential users of the project results will be contacted and exploitation activities will be initiated early in the project.


The work to be performed consists in the following tasks:

- **T5.1 Dissemination and project image** (Start: M1; End: M24; Leader: **i2CAT**)
- **T5.2 Exploitation** (Start: M7; End: M24; Leader: Nextworks)
- **T5.3 Standardization** (Start: M4; End: M24; Leader: **Interoute**)

### 6.5.2 Achievements during the reporting period (M1-M3)

During the reporting period only **T5.1** was active. WP5 work during the first reporting period has been focused in T5.1 activities, related to dissemination and project image. Concretely, WP5 has performed the following activities:

- Design, setup and implement the project online presence. The portal to the project online presence is the IRATI website, hosted at <http://irati.eu>. The website provides an introduction to the project (objectives, goals, partners, work packages), and more important, rich dynamic content related to IRATI news, deliverables, presentations, publications and blog posts. The project also has twitter and slideshare accounts.
- Co-organize with WP2 and the Pouzin Society a 3-days RINA workshop, with presence of about 50 researchers from around the globe interested in RINA research and development activities (including the IRATI consortium members). During the workshop the IRATI project goals and approach were presented and discussed. The WP5 goals for the workshop where to identify liaisons and collaboration with other projects and/or institutions interested in RINA research and development. One of the

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outcomes of the workshop was the submission of a RINA-based research proposal to ICT call 11, that would further enhance the outcomes of the IRATI project.

- Prepare the initial dissemination plan, published as Milestone 4 in the IRATI website.
- Perform various dissemination activities such as presenting IRATI at the FIRE Engineering conference (Ghent, November 2012), IEEE ANTS (Bangalore, December 2012) and write a short article for the Digital Agenda for Europe (DAE) website<sup>5</sup>.

### 6.5.2.1 Statistics of IRATI's online presence

Twitter (<https://twitter.com/iratiproject>)

- Number of tweets: 18
- Number of followers: 27



Figure 1 Screenshot of the IRATI twitter account

Slideshare (<http://www.slideshare.net/irati-project>)

- Number of presentations: 3
- Number of views per presentation
  - “RINA detailed components overview and implementation discussion”: 89
  - “IRATI Project presentation”: 120
  - “IRATI presentation at FIRE Engineering workshop”: 171

<sup>5</sup> <https://ec.europa.eu/digital-agenda/en/blog/exploring-rina-recursive-internet-network-architecture>

Website (<http://irati.eu>)

- Number of visits: 1028
- Number of unique visits: 500
- Pageviews: 4614
- Average visit duration: 02:21

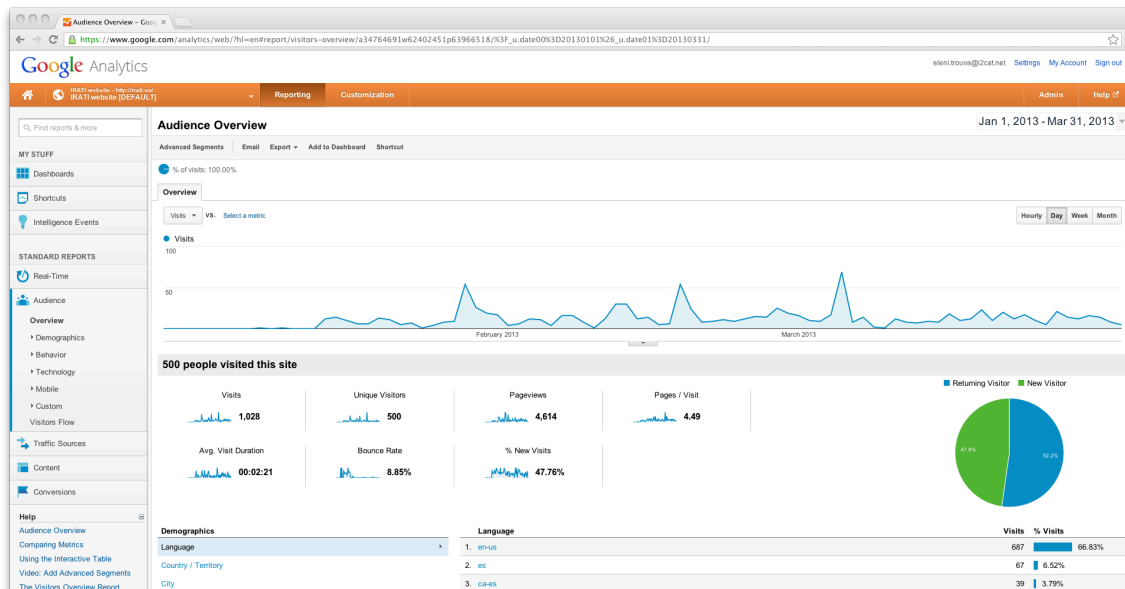


Figure 2 Screenshot of IRATI website statistics

**6.5.2.2 Dissemination of the IRATI kick-off and the RINA workshop at the Spanish media**

The news about the IRATI kick-off and goals have been published in the following Spanish and Catalan media.

- <http://www.lavanguardia.com/local/barcelona/20130206/54366424657/i2cat-coordinara-un-proyecto-europeo-para-una-nueva-arquitectura-de-internet.html>
- [http://www.telecinco.es/informativos/tecnologia/coordinara-proyecto-europeo-arquitectura-Internet\\_0\\_1552950487.html](http://www.telecinco.es/informativos/tecnologia/coordinara-proyecto-europeo-arquitectura-Internet_0_1552950487.html)
- [http://www.computing.es/internet/noticias/1065576001901/i2cat-coordina-proyecto-europeo.1.html?utm\\_source=rss&utm\\_medium=feed&utm\\_campaign=20130206%22](http://www.computing.es/internet/noticias/1065576001901/i2cat-coordina-proyecto-europeo.1.html?utm_source=rss&utm_medium=feed&utm_campaign=20130206%22)
- <http://www.telecomkh.com/es/comunicaciones-empresariales/noticias/i2cat/interoute/irati/rina/5160>
- <http://www.redeszone.net/2013/02/08/rina-la-arquitectura-de-red-del-futuro/>
- <http://www.digitalavmagazine.com/2013/02/06/i2cat-coordina-el-primer-proyecto-europeo-sobre-rina-la-arquitectura-de-red-del-futuro/>
- [http://www.teinteresa.es/catalunya/barcelona/coordinara-proyecto-europeo-arquitectura-Internet\\_0\\_860915473.html](http://www.teinteresa.es/catalunya/barcelona/coordinara-proyecto-europeo-arquitectura-Internet_0_860915473.html)
- <http://www.gentedigital.es/barcelona/noticia/1053530/i2cat-coordinara-un-proyecto-europeo-para-una-nueva-arquitectura-de-internet/>
- <http://www.milesnoticias.com/noticia-i2cat-coordinara-un-proyecto-europeo-para-una-nueva-arquitectura-de-internet/>

- <http://www.que.es/barcelona/201302061719-i2cat-coordinara-proyecto-europeo-para-epi.html>
- <http://www.cineytele.com/noticia.php?nid=38768>
- <http://noticias.lainformacion.com/economia-negocios-y-finanzas/redes/i2cat-coordinara-un-proyecto-europeo-para-una-nueva-arquitectura-de-internet BCM0TtpaddzNLOKJzGhBi7/>
- <http://noticias.terra.es/espana/comunidades-autonomas/cataluna/i2cat-coordinara-un-proyecto-europeo-para-una-nueva-arquitectura-de-internet%3C/td%3E%3Ctd%20%3Ed47f395e67bac310VgnCLD2000000ec6eb0aRCRD.html>
- <http://es.finance.yahoo.com/noticias/i2cat-coordinar%C3%A1-proyecto-europeo-arquitectura-162047084.html>
- <http://ar.noticias.yahoo.com/i2cat-coordinar%C3%A1-proyecto-europeo-arquitectura-internet-162047378.html>
- <http://www.iberamerica.net/espana/prensa-generalista/lavanguardia.com/20130206/noticia.html?id=PRIGiFe>
- [http://www.tic.cat/web/i-digital/coneixement/noticies/detall/-/asset\\_publisher/SyO6/content/noticia\\_i2cat-coordinara-un-projecte-europeu-per-a-una-nova-arquitectura-d-internet](http://www.tic.cat/web/i-digital/coneixement/noticies/detall/-/asset_publisher/SyO6/content/noticia_i2cat-coordinara-un-projecte-europeu-per-a-una-nova-arquitectura-d-internet)
- <http://www.europapress.es/portaltic/internet/noticia-i2cat-coordinara-proyecto-europeo-nueva-arquitectura-internet-20130206172046.html>
- <http://www.europapress.cat/economia/noticia-i2cat-coordinara-projecte-europeu-per-nova-arquitectura-dinternet-20130206175658.html>
- <http://www.vilaweb.cat/ep/economia/4081766/20130206/i2cat-coordinara-projecte-europeu-nova-arquitectura-dinternet.html>
- <http://www.eleconomista.es/tecnologia/noticias/4582225/02/13/i2Cat-coordinara-un-proyecto-europeo-para-una-nueva-arquitectura-de-Internet.html>
- [http://www.innovaspain.com/detalle\\_noticia.php?noticia=1776&pag=1](http://www.innovaspain.com/detalle_noticia.php?noticia=1776&pag=1)
- <http://www.elmundodigital.es/ciencia/i2cat-coordinara-un-proyecto-europeo-para-una-nueva-arquitectura-de-internet/#.URN4uKXK6Hg>
- <http://www.dicyt.com/noticias/en-busca-de-un-nuevo-concepto-de-internet>
- <http://www.catalunyapress.cat/es/EuropaPress-Noticia.php?lang=es&IDN=20130206171910>
- [http://www.diariobarcelona.com/n2487641\\_i2Cat\\_coordinara\\_un\\_proyecto\\_europeo\\_para\\_una\\_nueva\\_arquitectura\\_de\\_Internet.html#.URN38aXK6Hg](http://www.diariobarcelona.com/n2487641_i2Cat_coordinara_un_proyecto_europeo_para_una_nueva_arquitectura_de_Internet.html#.URN38aXK6Hg)
- [http://foro.elhacker.net/noticias/rina\\_la\\_arquitectura\\_de\\_red\\_del\\_futuro-t382732.0.html](http://foro.elhacker.net/noticias/rina_la_arquitectura_de_red_del_futuro-t382732.0.html)
- <http://www.innovaticias.com/tic/13153/fundacion-i2cat-trabajara-arquitectura-red-futuro>
- <http://www.asturiasmundial.com/noticia/38155/en-busca-de-un-nuevo-concepto-internet/>
- <http://diariodesalamanca.es/2013/02/07/en-busca-de-un-nuevo-concepto-de-internet/>
- <http://hispabyte.net/2013/02/rina-la-arquitectura-de-red-del-futuro/>



## 7 Status of deliverables and milestones

### 7.1 Deliverables list

The following table shows the complete deliverables list, in chronological order.

Del. No.	Deliverable name	WP no.	Lead Beneficiary	Nature <sup>6</sup>	Dissemination level <sup>7</sup>	Delivery date (proj.-month) <sup>8</sup>	Effective delivery date (A actual, F forecast)
D1.1	Project Presentation	WP1	1	R	PU	M1	30.01.2013 (A)
D1.2.1	First project quarterly report	WP1	1	R	PU	M3	24.04.2013 (A)
D2.1	Use cases, requirements analysis, refined RINA specifications and high level software architecture for phase 1	WP2	1	R	PU	M4	30.04.2013 (F)
D1.2.2	Second project quarterly report	WP1	1	R	CO	M6	30.06.2013 (F)
D5.1	Project website	WP5	4	O	PU	M6	30.06.2013 (F)
D1.2.3	Third project quarterly report	WP1	1	R	PU	M9	30.09.2013 (F)
D3.1	First phase integrated RINA prototype over Ethernet for a UNIX-like OS	WP3	2	P/R	PU	M11	30.11.2013 (F)
D4.1	Deployment, experimentation and validation report for phase 1	WP4	3	R/P	PU	M11	30.11.2013 (F)
D1.3	First year periodic report	WP1	1	R	CO	M12	31.12.2013 (F)
D2.2	First year technical coordination report	WP2	1	R	CO	M12	31.12.2013 (F)
D5.2	First year report on dissemination, standardisation and exploitation and updates on related plans	WP5	4	R	PU	M12	31.12.2013 (F)
D2.3	Use cases, requirements analysis, refined RINA specifications and high level software architecture for phase 2	WP2	1	R	PU	M13	31.01.2014 (F)
D1.2.4	Fourth project quarterly report	WP1	1	R	PU	M15	31.03.2014 (F)
D1.2.5	Fifth project quarterly report	WP1	1	R	PU	M18	30.06.2014 (F)
D3.2	Second phase integrated RINA prototype over Ethernet for a UNIX-like OS	WP3	2	P/R	PU	M18	30.06.2014 (F)

<sup>6</sup> R = Report, P = Prototype, D = Demonstrator, O = Other

<sup>7</sup> PU = Public; PP = Restricted to programme participants, including commission; RE = Restricted to a group specified by the consortium; CO = Confidential

<sup>8</sup> Measured in months since the project starts



D3.3	Second phase integrated RINA prototype over Ethernet for JunOS	WP3	2	P/R	CO	M18	30.06.2014 (F)
D4.2	Deployment, experimentation and validation report for phase 2	WP4	3	R/P	PU	M18	30.06.2014 (F)
D2.4	Use cases, requirements analysis, refined RINA specifications and high level software architecture for phase 3	WP2	1	R	PU	M20	31.08.2014 (F)
D1.2.6	Sixth project quarterly report	WP1	1	R	PU	M21	30.09.2014 (F)
D1.4	Second year periodic report	WP1	1	R	CO	M24	31.12.2014 (F)
D1.5	Final project report	WP1	1	R	PU	M24	31.12.2014 (F)
D2.5	Second year technical coordination report	WP2	1	R	CO	M24	31.12.2014 (F)
D3.4	Third phase integrated RINA prototype over Ethernet for a UNIX-like OS	WP3	2	P/R	PU	M24	31.12.2014 (F)
D4.3	Deployment, experimentation and validation report for phase 3	WP4	3	R/P	PU	M24	31.12.2014 (F)
D5.3	Final report on dissemination, exploitation and standardisation	WP5	4	R	PU	M24	31.12.2014 (F)

**Table 5 Deliverables list**

## 7.2 Milestones list

The following table shows the complete deliverables list, in chronological order.


Milestone number	Milestone name	Work package involved	Means of verification <sup>9</sup>	Expected date <sup>10</sup>	Effective achievement date (A actual, F forecast)
MS1	Management procedures in place and project started successfully	WP1	Project kick-off meeting celebrated, collaboration tools operational, first payments transferred to partners	M1	31.01.2013 (A)
MS2	First version of the project website online	WP5	Project website reachable through the Internet	M1	15.01.2013 (A)
MS3	Use cases and requirements analysis report for phase 1 ready	WP2	Report available. It will be later integrated into D2.1	M3	31.03.2013 (A)
MS4	Initial dissemination plan ready	WP5	Report available. An updated version will be later integrated into D5.2	M3	31.03.2013 (A)

<sup>9</sup> Show how you will confirm that the milestone has been attained. Refer to indicators if appropriate. For example: a laboratory prototype completed and running flawlessly; software released and validated by a user group; field survey complete and data quality validated.

<sup>10</sup> Measured in months since the project starts

MS5	Updated RINA architecture reference model and specifications for phase 1 ready	WP2	D2.1 delivered	M4	30.04.2013 (F)
MS6	Initial standardisation plan ready	WP5	Report available. An updated version will be later integrated into D5.2	M6	30.06.2013 (F)
MS7	First phase integrated prototype ready to start experimentation	WP3	Prototype passes integration tests and can be delivered to WP4	M7	31.07.2013 (F)
MS8	Phase 1 experiments designed and slices allocated. Experimentation can start	WP4	Report on experimentation plans available. OFELIA slices created.	M7	31.07.2013 (F)
MS9	Initial exploitation plan ready	WP5	Report available. An updated version will be later integrated into D5.2	M9	30.09.2013 (F)
MS10	Phase 1 experimentation successfully finished	WP4	All the planned experiments have taken place. Results analysis will be delivered as part of D4.1	M10	31.10.2013 (F)
MS11	Use cases and requirements analysis report for phase 2 ready	WP2	Report available. It will be later integrated into D2.2	M12	31.12.2013 (F)
MS12	Updated RINA architecture reference model and specifications for phase 2 ready	WP2	D2.2 delivered	M13	31.01.2014 (F)
MS13	Second phase integrated prototype ready to start experimentation	WP3	Prototype passes integration tests and can be delivered to WP4	M15	31.03.2014 (F)
MS14	Phase 2 experiments designed and slices allocated. Experimentation can start	WP4	Report on experimentation plans available. OFELIA slices created.	M15	31.03.2014 (F)
MS15	Phase 2 experimentation successfully finished	WP4	All the planned experiments have taken place. Results analysis will be delivered as part of D4.2	M17	30.05.2014 (F)
MS16	Use cases and requirements analysis report for phase 3 ready	WP2	Report available. It will be later integrated into D2.3	M19	31.07.2014 (F)
MS17	Updated RINA architecture reference model and specifications for phase 3 ready	WP2	D3.3 delivered	M20	31.08.2014 (F)
MS18	Third phase integrated prototype ready to start experimentation	WP3	Prototype passes integration tests and can be delivered to WP4	M22	31.10.2014 (F)
MS19	Phase 3 experiments designed and slices allocated. Experimentation can start	WP4	Report on experimentation plans available. OFELIA slices created.	M22	31.10.2014 (F)
MS20	Phase 3 experimentation successfully finished	WP4	All the planned experiments have taken place. Results analysis will be delivered as part of D4.3	M23	30.11.2014 (F)

MS21	Final project workshop organised	WP5	Workshop organised, project results presented and discussed with attendees.	M24	31.12.2014 (F)
MS22	Project completed successfully	WP1	All the project documentation delivered to the EC	M24	31.12.2014 (F)

	<b>D1.2.1</b> <b>First quarterly progress report</b>	Doc	IRATI D1.2.1
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## 8 Risks, issues, solutions, partner changes and meetings

### 8.1 Risks

No specific risks have been identified by the time of writing this report.

### 8.2 Issues and solutions proposed

The initial objective of developing a RINA prototype for the JunOS SDK has been considered not realistic since the i) JunOS SDK does not allow a deep enough access inside the JunOS operating system to develop the prototype and ii) even if it was possible the amount of effort required would be too high. For that reasons the JunOS SDK prototype has been dropped from the planning in favour of a FreeBSD prototype. Since JunOS is based on FreeBSD, Juniper engineers could take the FreeBSD prototype and port it to the JunOS platform.

### 8.3 Partner changes


Boston University, currently a member of the External Advisory Board, has requested to join the project as an unfunded partner, in order to provide guidance on RINA and participate in some IRATI research and development activities. The change will be effective after a DoW amendment planned for the first technical review (tentatively scheduled by mid-September 2013).

### 8.4 Project-related meetings

#### 8.4.1 IRATI kick-off and RINA workshop. Barcelona, January 21<sup>st</sup> – 24<sup>th</sup>

Summary: The kick-off meeting and the RINA workshop was held to remind partners about the early commitments, to explain the reporting procedures, clarify WP responsibilities, achieve a common understanding concerning the project goals, etc. The RINA workshop that followed the kick-off allowed the partners to consolidate their RINA knowledge and get a clear understanding of the RINA specifications and prototypes state of the art. All partners attended this meeting.

- **i2CAT:** Eleni Trouva, Miquel Tarzan, Leonardo Bergesio, Eduard Grasa.
- **Nextworks:** Francesco Salvestrini, Nicola Ciulli.
- **iMinds:** Dimitri Staessens, Sander Vrijders.
- **Interoute:** Adam Chappell, Jonathan Graham.

	<b>D1.2.1</b> <b>First quarterly progress report</b>	Doc	IRATI D1.2.1
		Date	April 24 <sup>th</sup> , 2013

## 9 Dissemination activities

### 9.1 Summary of dissemination activities performed during the reporting period (or not previously reported)

Date, Place	Type	Type of audience	Countries addressed	Approximate size of audience	Partner involved
November 2012, Ghent	FIRE Engineering workshop	European Commission, industry, academia	Broad spectrum of European countries	50-75	i2CAT
December 2012, Bangalore	IEEE ANTS 2012	Indian industry and academy	India	30-50	iMinds
January 2013, Barcelona	RINA Workshop	Industry and academia interested in RINA, European Commission	Norway, Czech Republic, UK, Germany, US, Brazil, Italy, Belgium, Spain, France	50	i2CAT, Nextworks, iMinds, Interoute