Deliverable-7.3

Second stage dissemination, standardisation and exploitation activities report and updated plans

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Synopsis:	This deliverable describes the work performed in WP7 during the first 18 months of the PRISTINE project, reporting on dissemination, standardization and exploitation activities executed by the partners both individually and jointly in teams.

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List of Contributors

Deliverable Editor: Miquel Tarzan, i2CAT
NXW: Vincenzo Maffione, Gina Carrozzo
i2CAT: Francisco Miguel Tarzan Lorente, Eduard Grasa
TSSG: Ehsan Elahi, Miguel Ponce de Leon
ATOS: James Ahtes
TRT: Hamid Asgari, Sarah Haines
iMINDS: Dimitri Staessens
IMT: Fatma Hrizi, Anis Laouiti
CN: Roberto Riggio, Kewin Rausch
UiO: Peyman Teymoori, Michael Welzl
BISDN: Marc Sune
FIT-BUT: Vladimir Vesely, Marcel Marek, Ondrej Rysavy
LMI: Sven van der Meer
NEX: Jean-Paul Smets

Disclaimer

Executive Summary

This deliverable describes the project' second-stage activities performed by Work Package WP7. It provides detailed reports and updates on the dissemination (task T7.1), standardisation (task T7.2) and exploitation (task T7.3) activities. The document is structured into three main sections: section 1 contains the dissemination plans and reports, section 2 presents the standardisation plans, while section 3 illustrates the exploitation plans.

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Acronyms

CSA	Coordination and Support Action
DIF	Distributed IPC Facility
EAB	External Advisory Board
ETSI	European Telecommunications Standards Institute
FIRE	Future Internet Research and Experimentation
FIA	Future Internet Assemblies
FN	Future Network
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronic Engineers
IETF	Internet Engineering Task Force
ICCRG	Internet Congestion Control Research Group
IG	Interest Group
IP	Internet Protocol
ISG	Industry Specification Group
ISO	International Organization for Standardization
IRTF	Internet Research Task Force
JTC	Joint Technical Committee
MoU	Memorandum of Understanding
NCRG	Network Complexity Research Group
NFV	Network Functions Virtualization
NFVRG	Network Functions Virtualization Research Group
NMRG	Network Management Research Group
PSOC	Pouzin Society
QoS	Quality of Service
R&D	Research and Development
RG	Research Group
RINA	Recursive InterNetwork Architecture
SDN	Software Defined Networking
SDO	Standards Development Organization

STREP	Specific Targeted Research Project
TCP	Transmission Control Protocol
UDP	User Datagram Protocol
VNF	Virtual Network Functions
VNRG	Virtual Networks RG
WG	Working Group
WP	Work Package
ZOOM	Zero-touch Orchestration, Operations and Management

Introduction

Given the innovative nature of RINA architecture, dissemination and exposure within the scientific, professional, standardisation communities and general public is key measure to achieve impact. PRISTINE dissemination activities during the first 18 months have been structured in order to strengthen the RINA awareness in the scientific and industrial communities, with a number of workshops, summer schools, demonstrations and seminars directed to researchers from academia and network industry and EC officials. These initiatives aimed at establishing the image of PRISTINE as the reference project for RINA implementation on Linux and setting the roots for potential follow up activities beyond the project, both in terms of research and potential commercialization. The different dissemination channels (website and Twitter account) have been periodically updated to keep the pace of results produced by technical workpackages, both in terms of RINA specifications, code development and, eventually, stack performances. Publications in highly ranked conferences and submissions to scientific journals (IEEE Network) have further supported PRISTINE awareness in the scientific community and stimulated a number of networking events with international organizations among those particularly interested in RINA and PRISTINE results. The team also leveraged on an intense cooperation with companion EC-funded projects on RINA (namely IRATI and IRINA), discussing and defining the more efficient ways for advancing the functionalities of the stack released as open source at http://irati.github.io/stack/.

Regarding standardisation, PRISTINE has started leveraging on the presence of key partners within Standards Development Organisations (SDOs) to raise awareness of the project and to introduce relevant project foreground where possible. The RINA core specifications have been discussed with the members of the Pouzin Society (PSOC). A group of PRISTINE partners, in common with the IRATI project, has also promoted the RINA architecture within ISO JTC1 SC6 WG 7 (Future Network) and two partners (iMinds and i2CAT) have undertaken a process of more continuous enrollment in ISO to further progress these activities.

In terms of exploitation, the consortium has worked towards identifying a set of research assets and results/outcomes from the project, analyzing potentials and initial strategies for further research, commercialization, business and societal impact. In addition, MSc and PhD theses have been activated to sustain the huge amount of development work to be done on the different parts of the RINA architecture. The continuation of PRISTINE developments over the IRATI open sources stack and the maintenance of that software on GitHub is an cornerstone of the PRISTINE exploitation strategy, both at project level and for individual partners. In fact, this is opening the RINA stack advanced by PRISTINE to re-use by a wide community of interested parties.

This document reports in detail all these elements, providing information on the strategy, actions and plans of the consortium to achieve impact.

Dissemination

PRISTINE is an ambitious project that strives towards the development of new performance enhancing functions and protocols in a variety of research domains, including: DIF congestion control, distributed resource allocation techniques, topological addressing and associated routing mechanisms, strategies for authentication and access control, distributed DIF internal security mechanisms, support of multi-homing for load balancing and failure recovery, and multi-layer management (i.e. DIF configuration, performance, and security management in multi-layer systems).

PRISTINE's dissemination plan is designed to act in conjunction with the larger RINA roadmap. RINA has a core following, but effort must be made to grow the community and gain traction with external stakeholders. PRISTINE dissemination leverages its use cases and trials to help close this gap and present the technology on a larger stage:

- to extend beyond the core following of RINA and help catalyse community growth to other research communities, leveraging key results such as the SDK to facilitate further research.
- to help disseminate RINA research towards industry targets, translating the technological benefits of the architecture to business impact via market relevant use cases and trials, which such stakeholders need for further validation.
- to identify and disseminate to standards related groups that can act as conduits to further .advance RINA's roadmap, leveraging PRISTINE results.

Significant efforts within the project have been devoted to disseminate the results obtained, using the different media available, which are the matter of the following sections. The dissemination activities presented in this section aims at highlighting the relevant activities undertaken by PRISTINE partners to pursue the highest visibility for project results, raise awareness about RINA among R&D communities, industry and relevant stakeholders.

The dissemination targets of PRISTINE include all sectors, institutions, organisations and individuals that are interested in the research carried out in PRISTINE, that would contribute to its work, or that can affect or be affected by this research. Therefore, the target audience for the dissemination of project results is identified at the following levels:

- Corporate level. This is aimed at the industrial partners that will use the results and knowledge gained from the project within their companies. Initial internal dissemination targets can be found in the deliverable's partner exploitation plans. This level of dissemination also applies to the industrial members of the External Advisory Board (EAB).
- Consortium level. Intra-consortium dissemination enables all project partners to use and expand the technologies and tools developed within the project.

- Special communities. This is targeted at Interest Groups (IGs) and stakeholders who are directly related with the project. IG dissemination can provide a unique vehicle for project promotion and further exploitation. The project initially targeted the following groups: datacenter operators, network service providers and distributed application providers that implement their own communication overlays (e.g. p2p applications, Skype, etc.), since they are directly related to the project use cases and some consortium members have contacts with these communities. However, as the project has advanced, two new IGs have been added to the initial set:

  # *5G community*. 5G is a vision towards a set of capabilities that should provide a unified architecture for a fully converged network unifying mobile, wireless, sensor and fixed networks. Current research directions for 5G point to the investigation of a combination of virtualisation (both virtual networking and Network Functions Virtualisation, NFV), Software Defined Networking (SDN) and enhanced radio interfaces and radio resource management. However, no overarching network architecture that can fully realize the 5G vision for convergence has been proposed to date. RINA fits like a glove in a 5G scenario, as introduced in [rina5g]. Engagement of this IG benefits from common partners active in both PRISTINE and the 5G-PPP, a joint effort by the EC and the European telecom industry. As it will be explained later in this section, PRISTINE has already started to disseminate RINA to this IG.

  # *Internet of Things (IoT) community*. IoT requirements for flexible, optimized and secure networking environments can be optimally addressed with RINA. As part of the feedback received during the RINA tutorial to the EC, IoT was identified as one of the areas with the biggest potential for early RINA adoption. Therefore PRISTINE will analyse the most efficient way to start disseminating RINA and PRISTINE's result to this community, as well as ways to engage with some of the key stakeholders. The telecom and surrounding IT industry is quickly ramping up their IoT portfolios in both initial solutions and a heavy investment in R&D, and the overlap with already existing dissemination targets will help PRISTINE reach this target at common venues and media.

- Wider research. PRISTINE's dissemination to wider network-related research communities is important to expand the existing core RINA community. This also reflects the adoption value of some of the project's primary assets, such as the SDK that helps alleviate the barrier of entry for newcomers to experiment with RINA.

- Wider public. While PRISTINE and RINA is rather technical in nature when reaching its primary stakeholders, the high-level benefits and impact can be translated to the wider public. Both industry vertical sectors and consumers can relate as the final beneficiaries / end-users in the telecom value chain.

Project brochure, leaflet and posters

The 4-page project brochure was prepared and delivered in M12, at a date that allowed the inclusion of the first project outputs. It has been put online [pristine-leaflet] and printed for dissemination through project partners and on the occasion of events the project will contribute to. Two new posters were designed and printed for the EUCNC SDK and RINAsim demos [pristine-poster].

Project website and social networking tools

One of the aims of the dissemination task has been to ensure the broad external impact of the project. For this reason has been useful to identify the number of access users that navigate through the website. These statistics have been used as an indicator of the amount of interest in the PRISTINE project. To implement this analysis we added the Google Analytics tracking code in the template of PRISTINE's website, enabling the tracking of statistics of the project's website. Figure Figure 1 shows a screenshot of the Audience overview of the Google Analytics web interface during the second period of the project (M9-M18).

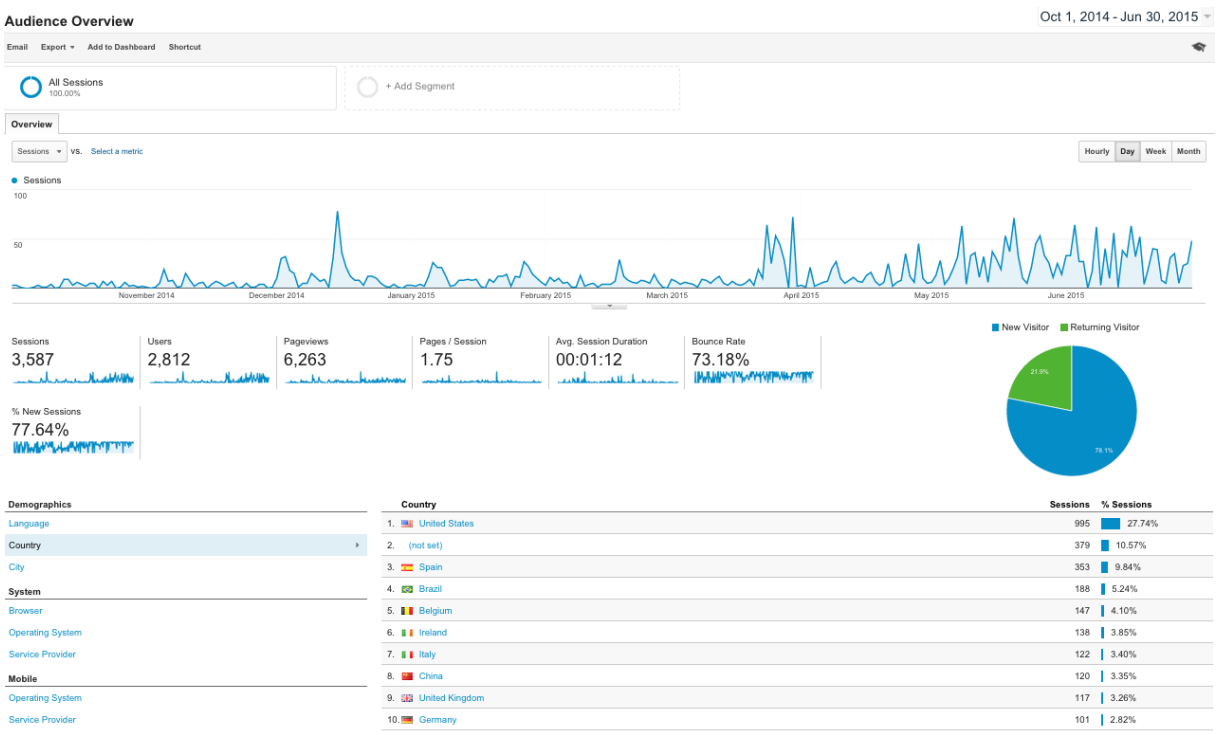

Figure 1. Statistics of visits to the PRISTINE website, October 2014 - June 2015

During the second period of the project (M10-M18) the number of sessions has multiplied by 2.4 and the number of visits by 3.8 with respect to the M1-M9 (illustrated in Figure 2), showing an increased interest in PRISTINE results. In terms of the origin of the visitors, 27.7% came from the US, 9.8% from Spain, 5.2% from Brazil, 4.1% from Belgium, 3.8% from Ireland,

3.4% from Italy and 3.3% from China. The spikes in visitors shown in the graph are mostly due PRISTINE presence in international events such as the RINA tutorial at the IEEE Globecom 2014, NetFutures 2015 or the TNC 2015.

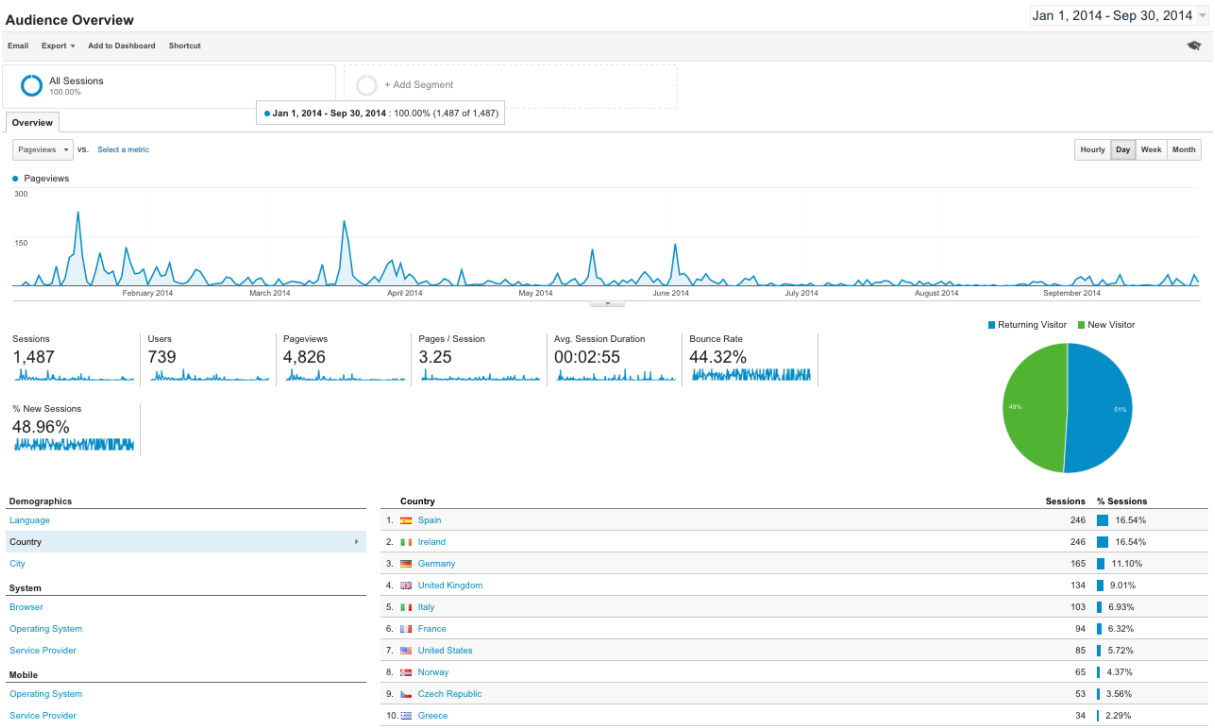

Figure 2. Statistics of visits to the PRISTINE website, January 2014 - September 2014

In order to improve the visibility of the research carried out, PRISTINE is making use of social networks. Thus, special accounts for the project in the Twitter [pristine-twitter] and Slideshare [pristine-slideshare] communities have been created. The project has used Twitter to post short messages relevant to the project's content, promote results and events. PRISTINE is right now followed by 63 users, which is on the average for an EC project of this budget, and interacts with its followers usually on a weekly basis. Table Table 1 shows the PRISTINE presentations available at Slideshare, when they were uploaded and the number of visualizations.

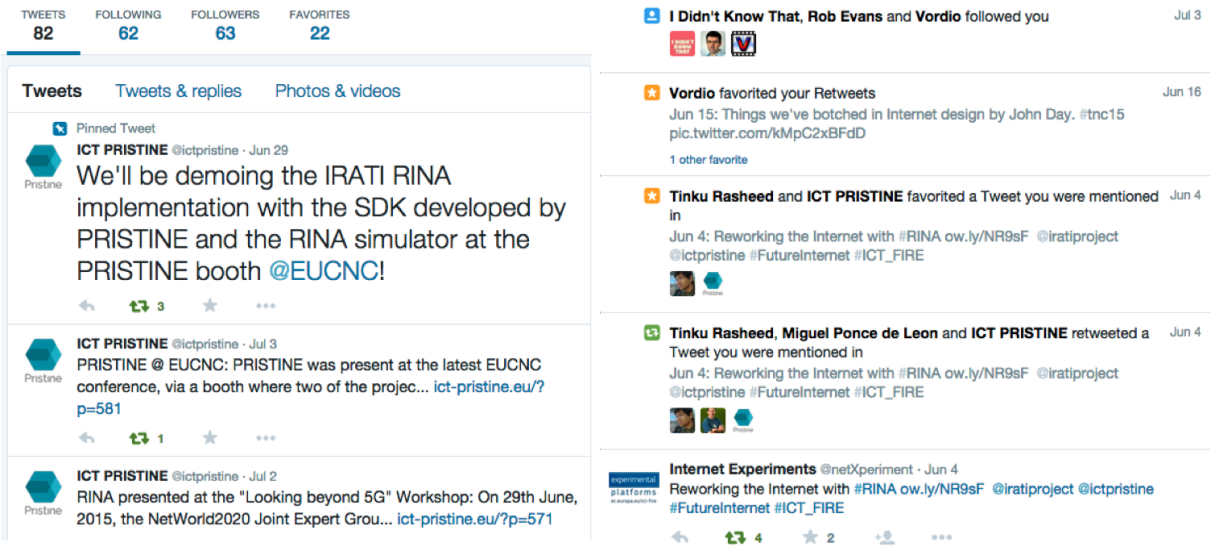

Figure 3. Screenshot of PRISTINE Twitter acccount, June 2015

Table 1. PRISTINE presentations online

Title	Upload date	Number of visualizations
Reconstructing computer networking with RINA: how solid scientific foundations can allow Europe to become a world leader in internetworking	June 2015	14
RINA as a Clean-Slate Approach to Software Networks	June 2015	21
EC Net Tech FI Cluster meeting October 23 2014 PRISTINE	December 2014	55
PRISTINE presentation at the Net-Tech Future Coordination meeting	November 2014	176
EU-Taiwan Workshop on 5G Research, PRISTINE introduction	November 2014	245
Brief introduction to RINA and PRISTINE	November 2014	55
PRISTINE @ FIA Athens 2014	April 2014	317
ICT Pristine Project Overview	February 2014	207
Pristine Intro SDN Concertation Workshop	February 2014	471

PRISTINE presentations, tutorials and videos have been conveyed on SlideShare often to complement participation in events with a public access to project material. Another social media used by the project has been its blog, which can be accessed from the project site [pristine-homepage], as already presented in deliverable D7.1.

Publications in conferences and journals

In Deliverable D7.2 a number of conferences and journals were identified as targets for submitting the project's research results worth disseminating. A significant number of these publications has been tried with results reported in the following.

Submitted publications

Three of the four articles submitted to date whose evaluation result has been communicated to PRISTINE members have been rejected (the other is under evaluation). The main reasons are the lack of simulation and/or experimental evaluation results. During the first iteration the consortium has focused on getting the first operational versions of the Simulator, the SDK, the Network Management System and the first version of policies for different areas (data transfer, routing, authentication, encryption, etc.). Armed with these results, PRISTINE partners foresee a number of successful publications for the second iteration of the project, as explained in the planned papers.

Article no. 1

Journal: IEEE Communications Magazine[1]

Title: Security in RINA: authentication, access control and confidentiality in a multi-layer emerging recursive internetwork architecture

Submission: Oct. 1st 2014

Abstract: Security in the current Internet has proven a complex topic often attributed to the fact that security was not a requirement in the Internet's original trusted environment. However, we argue that it is the fixed Internet's layering structure and proliferation of independently designed but operationally interdependent protocols what makes Internet security so brittle. This paper discusses security aspects of RINA, the Recursive InterNetwork Architecture, an emerging network architecture that is based on i) having flexible layering, ii) providing maximum commonality in its structure and iii) achieving flexibility and adaptability through programmability of each layer's functions. The structural and functional properties of RINA make it inherently more secure than the current Internet. Existing techniques for authentication, authorization and confidentiality are sufficient to allow RINA to provide a foundation for distributed computing that is more secure, robust and less complex than the current Internet.

Status: Rejected, missing results (simulations and/or experiments).

[1] http://www.comsoc.org/commag

Article no. 2

Conference: IFIP IEEE IM 2015[2]

Title: The future of SDN: there is no network - and the two items still missing today

Submission: Oct 3rd 2014

Abstract: Software Defined Networks (SDN) has taken the world by storm. Only a few years old as technology, most of the big players have SDN in their product portfolio or in their strategic roadmap. SDN has changed the way we virtualize the network fabric in data centers, provided new features for cloud computing, and arguably plays a big role in facilitating Network Function Virtualization (NFV). Looking ahead, SDN has the potential to make the network disappear altogether, similar to Mark Weiser's vision for computing. However, while SDN's main contribution is a new south-bound interface for TCP/IP flow control, little work has been done on the north-bound interface for the interaction with and the management of an SDN network. Two essential items are still missing. First, SDN does currently not provide means to expose network capabilities to applications (e.g. a QoS cube), thus it fails to bridge the gap between the network and services. Second, SDN does not help to advance network management while introducing many new challenges for it. In this paper, we start discussing the disappearing network and discuss how to address the two missing items in the progress. Our contribution is to examine the Recursive InterNetworking Architecture (RINA) as an evolutionary step for SDN, which we present in the form of three use cases.

Status: Rejected, results missing (simulations and/or experiments).

Article no. 3

Conference: IFIP Networking[3]

Title: Applying RINA as an overlay virtual networking solution to support highly available distributed clouds

Submission: December

Abstract: Distributed cloud systems offer important advantages over centralized ones. Intrinsic resilience to network and electricity cuts, green nature, scalability and a more jurisdictionally secure environment for trading secrets are some of these advantages. However, because of its open and exposed nature, networking in highly available distributed clouds have to address

[2] http://im2015.ieee-im.org/

[3] http://www.irit.fr/networking2015/

a number of challenges. In this paper, deep analysis of the networking aspects of a real distributed cloud use case is performed, identifying its most important issues and limitations. The core of the paper discusses a detailed case study of the application of the Recursive InterNetwork Architecture (RINA) as a (virtual) networking solution for the distributed cloud, tailoring routing, resource allocation and security policies to the specific needs of supported cloud service. The paper concludes by highlighting the advantages of the RINA approach over current network virtualization solutions in terms of simplicity, programmability, scalability, manageability and network application integration.

Status: Rejected, results missing (simulations and/or experiments).

Article no. 4

Conference: 2nd OMNeT++ Community Summit[4]

Title: Skip This Paper - RINASim: Your Recursive InterNetwork Architecture Simulator

Submission: 10th June 2015

Abstract: Recursive InterNetwork Architecture is a clean-slate approach how to deal with the current issues of Internet based on traditional TCP/IP networking stack. Instead of fixed number of layers with dedicated functionality, RINA proposes a single generic layer with programmable functionality that may be recursively stacked. We introduce a brand new framework for modeling and simulation of RINA that is intended for OMNeT++.

Status: being reviewed

Planned papers (short term, already in preparation)

HotNets 2015[5]

Title: Recursive Congestion Control

Submission: July 2015, lead by UiO

Abstract: RINA, the Recursive InterNetwork Architecture, is a novel “back to basics” type approach to networking. It shows great potential in many aspects of networking, e.g. by simplifying management and providing better security. The recursive nature of RINA calls for radically different approaches to how networking is performed, including congestion control and routing. In this paper, we will show how recursion in RINA affects congestion control, and

[4] https://summit.omnetpp.org/2015/

[5] http://conferences.sigcomm.org/hotnets/2015/

demonstrate that this naturally leads to more efficiency because it is applied closer to where the problem happens. This also makes it easier to combine it with routing, enabling a straightforward implementation of in-network resource pooling.

Network of the Future (NoF) Conference 2015[6]

Title: Scalable distributed clouds with RINA

Submission: July 2015, lead by IMT-TSP

Abstract: This paper focuses on the specification of the addressing and routing architecture. Basically, it proposes generic architectures in line on one hand with the requirements of the to replace current re6net architecture with RINA in the scope of the distributed clouds use case. In order to support scalability which is the main constraint when dealing with distributed clouds, the proposed architectures rely on the concept of divide and conquer of RINA.

IEEE Systems Journal[7]

Title: Threat Identification and Security Risk Assessments for Networked Systems, with a focus on RINA Architecture

Submission: July 2015, lead by Thales

Abstract: The use of a security risk assessment methodology is proposed in order to identify runtime threats to networked systems and define measures to mitigate them. There are several types of attacks on network communications such as eavesdropping, disrupting or blocking communication, injecting fabricated packets, modifying the storage, tables or packets. The identification of run-time threats and vulnerabilities to a recursive inter-network architecture (RINA) is carried out. We then perform a security risk assessment to evaluate the impact and likelihood of the occurrence of the attacks relevant to the identified threats, validate the existing and define additional mitigation measures and functions that are required to combat such attacks. This include enhancement to the security enablers in the network, execution of new functions and strategies, and threat monitoring mechanisms which should be put in place.

IEEE/IFIP Network Operations and Management Symposium[8]

Title: Autonomous Management of RINA networks applied to Data Center Networking scenarios

[6] http://www.network-of-the-future.org/
[7] http://www.ieeesystemsjournal.org/
[8] http://noms2016.ieee-noms.org/

Submission: September 2015, lead by WIT-TSSG.

Abstract: Autonomic Network Management (ANM) approaches can be employed within RINA based data centers (DC) to optimize the resource management operations in order to make energy efficient, intelligent and cost effective use of resources. Within each recursive layer, self-orchestration components could perform the traditional functions of monitor, analyze, plan and execute (MAPE), updating routing configurations if required and monitoring performance. ANM mechanisms can be leveraged to enable optimization (possibly layer initialization) and dynamic reconfiguration of each recursive network layer as required. These mechanisms react to events by monitoring network traffic within data center, analyzing the underlying traffic patterns and, depending on the pre-defined high-level objectives (e.g. QoS policies) stored in a policy repository, may trigger remedial actions on the DC systems. The objective of this paper is to provide a guideline for deployment of autonomic management principles in order to optimize the RINA based data centers resource and traffic management.

Conference TBD

Title: Soft-state Approach for Transport Protocol in Recursive InterNetwork Architecture

Submission: TBD (looking for a suitable conference), lead by FIT-BUT

Abstract: This paper describes basic principles of Recursive InterNetwork Architecture RINA with main concern on its Error and Flow Control Protocol based on Delta-T soft-state transport protocol. The paper outlines EFCP’s relation to currently used transport protocols like TCP, DCCP, SCTP and MP-TCP. EFCP implementation for OMNeT++ is introduced and simulation results are discussed.

Planned papers (mid term, 2016)

ACM SIGCOMM 2016

This paper will be based on the outcomes of T3.2 and will describe a performance isolation architecture for data-centres networks. The paper will report on a proof-of-concept performance isolation implementation (using the RINA SDK) and on its evaluation over the Virtual Wall. The paper aims at showing how the implementation of this solutions in RINA compares with similar implementations based on the traditional Linux TCP/IP. Preliminary results already show a one order of magnitude reduction in the number of Kernel lines of code required to implement such techniques.

DRCN 2016 or a journal article (IEEE NETWORK, IEEE Communications Magazine)

This paper will be based on results from T4.3 and will report the work on resiliency and high availability. Depending on the quality and extent of the obtained results this will be sent to a leading conference on reliable networks such as DRCN 2016 or a high-impact journal. Lead by iMinds.

Conference/Journal: TBD

Title: On Whatever-Cast Name and Load Balancing in Recursive Networks

Unlike anycast and multicast, whatevercast comprises of a set of rules which may return one or more results against a name resolution request. The objective of this paper is to propose the whatevercast name resolution specifications and set of rules and how whatevercast name and Name space Manager (NSM) can be exploited for load balancing inside the RINA based data center transparent from the end user application.

Conference/Journal: IEEE Conf./Journal TBD

Title: Achieving Multi-Level Security in RINA

This paper proposes an MLS (Multi-Level Security) solution for implementation over a clean-slate networking architecture called Recursive InterNetwork Architecture (RINA). RINA is a policy-based architecture where the MLS solution is dictated by policy in order to achieve more flexibility, greater security, and ease of configuration. The MLS solution is a policy-controlled feature that facilitates information sharing between different organisations and across security domains. The solution can also be used as an overlay RINA-based service function over any networking technologies (e.g., Ethernet, IP) with the support and realisation of RINA's distributed inter-process communication facilities sitting on the top of these network technologies.

Conference: TBD

Title: Key Management for Authentication, Authorisation, and Content-based Security in RINA

Key Management (KM) is an important part of security in RINA. Cryptographic mechanisms, such as encryption and authentication as well as authorisation, require cryptographic keys to be distributed to the communicating parties prior to secure communications. The secure management of these keys is one of the most crucial aspects for the security of a system; it is

essential that that the right key is in the right place at the right time. In this paper, we describe the architectural options for the placement of KM functions in RINA architecture and discuss the pro/cons of these options.

Conference: TBD

This paper is a follow-up to the paper targeted for HotNets 2015. In this paper, we will evaluate RINA-ACC, RINA's congestion control, thoroughly under various network topologies and use cases. One of the main parameters affecting the performance RINA-ACC is the buffer size, i.e. RMT and EFCP queue sizes, in middle nodes. As RINA recursively adds layers to the network and each layer has its own buffers, it is of significant important to come up with an efficient buffer sizing solution to have high throughput and short queuing delay at the same time. The other issue we are going to address is scalability analysis of RINA-ACC under different load-balancing routing schemes; in other words, how well RINA-ACC scales if the underlying routing scheme is a multi-path routing approach with the capabilities of load-balancing and splitting flows into sub-flows. To this end, we will implement such a routing scheme in RINA.

Conference/Journal: TBD

Paper on the RINA approach to network management: monitor and repair, but not control. Explain how the Network Manager can design high-level strategies for different network operating conditions, associated to a set of policies to be configured to different layers. The NMS will detect when the network transitions from one operating scenario to another (from events received from the managed systems), triggering the required configuration changes. The paper will highlight how the commonality across RINA layers - reflected in a common base managed object model for all layers - facilitates multi-layer management, enabling larger-scale automated configuration changes with predictable results. The paper will be accompanied by a number of experiments with PRISTINE's DMS supporting the arguments of the authors.

Organisation of workshops

Workshops are key components of PRISTINE's dissemination strategy. The workshops planned, as reported in D7.2, have three main objectives: to disseminate the RINA theory, disseminate the project results and offer demonstrations of the work carried out. Three PRISTINE workshops have been held as of June 2015. The first one was successfully completed at the beginning of the project as reported in D7.2, the second one was a joint workshop with the IRINA GEANT3 project [irina], and in June 2015 a week long RINA module was hosted as part of an Irish Telecommunications Graduate Initiative [tgi]. Members of the consortium are exploring the possibility to hold a joint workshop with the NetIDE project. At the end of the project a last one will be organised.

- The second workshop was a joint workshop with the IRINA GEANT3 project [irina], held in Ghent on January 28th and 29th, 2015. The workshop allowed partners of both projects to expose their work and receive feedback from the audience. The workshop agenda and presentations are accessible online [rina-ws].
- In June 2015 a week long RINA module was hosted as part of an Irish Telecommunications Graduate Initiative [tgi], carried out by a consortium of leading Irish Universities and Institutes of Technology to enhance the experience of PhD students in Telecommunications and related topics. The PRISTINE project was invited to provide some lecture hours and lab sessions in relation to the project's activities for this RINA module.

Future workshop plans

- Joint NetIDE workshop: The RINA simulator developed in PRISTINE could be of interest for the NetIDE project. Both projects are discussing a potential joint workshop to take place in Ireland next September.
- Hackathon co-located with the PISA Internet festival [pisafest]. PRISTINE is in conversations with the PISA Internet festival organizing committee in order to organize a RINA hackathon as part of the event. The goal of the hackathon would be to port existing distributed applications to the RINA API, such as web browsers, servers, messaging applications, etc. The festival will take place from 8th - to 11th of October 2015.
- PRISTINE's third and final workshop, as reported in D7.2, will be held at the end of the project, during 2016. It is intended to put together the different targeted groups (industry, academia and the general public) and key stakeholders in networking (representatives of key initiatives, manufacturers, service providers) to present the project outcomes. The focus of the workshop will be on the exploitation of project's results.

Participation in target events

Serveral events in Networking and Future Internet, targeted in D7.2 as fundamental to achieve visibility and dissemination of PRISTINE's work, have been attended during the last period. The project has actively participated in and contributed to the Concertation activities organised at Future Internet Research and Experimentation (FIRE Conference and Workshops), Future Internet (FI Assembly) and ICT programme (ICT Conference) levels. The events, the results presented, the work carried out during the events, and any significant outcomes are described in the following sections:

EuCNC 2015 (June 2015)

Title Programmability of network functions within the Recursive InterNetwork Architecture (RINA)

Abstract The goal of this demonstration is to highlight in practice the benefits that are provided by the programmability capabilities of the RINA architecture, which goes beyond the state of the art of current SDN-based approach which basically is focused on the programmability of the forwarding tables in current Ethernet or IP networks. The demonstration will show that a flexible, adaptive and programmable architecture like RINA could support very well the requirements of 5G networks such as the adaptation to heterogeneous and wide set of application needs, end-user devices and radio interfaces. This demo will show how a software developer can develop new policies for the RINA implementation, load them in a running stack and configure the right components of the DIF (layer) with the new developed policies. It will also show how RINA network works in practice using developed policies managed via a multi-layer Network Management System that are designed by PRISTINE. A parallel demonstration will also be present the RINA Simulator as an ideal complement to the IRATI open implementation since it allows performing rapid provisioning of new policy ideas at scale.

Person Vladimir Vessely (FIT-BUT), Leonardo Bergesio, Bernat Gaston (Fundació i2CAT)

Notes PRISTINE was present at the latest EUCNC conference, via a booth where two of the project results were demonstrated. The project showed demonstrations of the IRATI RINA implementation with the SDK and policies developed by consortium partners, as well as of the RINA simulator. Conference attendees visited the PRISTINE booth and asked questions about RINA, details on the implementation and discussed appealing use cases for RINA adoption. Internet of Things (IoT) scenarios appear to be a good use case to exploit the simplicity, programmability and security properties enabled by the RINA architecture. Two posters were used to highlight the relevant details of the demonstration [eucnc]. Feedback on the simulator highlighted that RINASim was a great tool together with OMNeT++ built-in visualization features for educational purposes regarding RINA computer network simulation.

Infocomms Protocols. Accelerate a post 2020 connected world workshop (June 2015)

Title I Got Good News and Bad News

Abstract The presentation asserts that the TCP/IP model is fundamentally flawed, discussing why it has been flawed since the start (architecture, naming and addressing, protocol design, congestion control, security, network management). It then analyzies how it happened and why

is still TCP/IP dominant today, concluding with the bad news. Then, it is time for the good news, there's a scientific alternative to TCP/IP: RINA. RINA proposes a simple model in which networking is just Inter Process Communication, distributed applications forming one type of layer that repeats as many times as required by the network designers. The presentation analyzes the benefits of RINA, and concludes discussing how RINA can be deployed in today's networks.

Person John Day (BU, EAB) - presentation, discussion; Diego Lopez (Telefonica I+D) - discussion; Adam Chappell (Interoute, EAB) - discussion

Notes The Infocomms Protocols. Accelerate a post 2020 connected world workshop was part of the "The Future of Wireless International Conference 2015". The workshop's goal, organized by the British Standards Institution (BSI), was to discuss the potential future issues around IP, have input from various standards perspectives and determine a way forward. The event was organized as a set of presentations showing different perspectives (RINA amongst them), followed by an open discussion. RINA was positioned in the map as an alternative to IP, recognizing that its clean architecture has a lot of potential for the integration of different access technologies (wireless, wired, cellular, etc), core networks and distributed applications. RINA captured the interest of representatives of ETSI and IEEE, as it will be later discussed in the standardisation chapter of this document, as well as of mobile industry specialists (discussing 5G scenarios). PRISTINE partners and EAB members will follow up in order to further discuss RINA and its potential with the different stakeholders.

5G Joint Experts Group and Vision Group Workshop (June 2015)

Title RINA as a clean slate approach to software networks

Abstract The workshop objective was to identify disruptive technologies and clean-slate approaches for new, very advanced communication systems. Diego introduced how the RINA architecture can be used in a highly heterogeneous and mobile environment such as the one described by the 5G and beyond vision.

Person Diego Lopez (Telefonica I+D)

Notes On 29th June, 2015, the NetWorld2020 Joint Expert Group and Vision Group Workshop on "Looking Beyond 5G" was held in Paris. Diego Lopez (Telefonica I+D) exposed the views of the PRISTINE project during the workshop [beyond-5g]. The audience provided the following feedback/questions:

- They would like to see more details on how RINA could work in 5G environments, e.g in case of handover? (what specific policies for which components could be part of a mobile environment)

- What I need to do to port my app to RINA? Two approaches: faux-sockets API (don't touch your app, but it won't know it is running over RINA and won't be able to fully exploit the benefits); port it to the native RINA API.
- RINA is formally specified, draft specifications are available upon request.
- Need to evaluate how RINA can support existing business models and allow for the creation of new business models in the telecom and distributed computing arena.

TNC2015 (June 2015)

Session Title: Laying the groundwork for field trials of RINA in the EU.

Abstract: Some of the challenges faced by network service providers stem from early design and implementation decisions made at the infancy of data communications. Due to its groundbreaking potential, the Internet exploded from a small lab experiment to a full-scale production research network within a couple of years. Some opportunities for including key research results at crucial stages were abandoned in favor of fast global deployment. RINA, the Recursive InterNetwork Architecture, is an attempt at network design drawing from the experiences from 40 years of TCP/IP deployment, building on the premise that "Networking is IPC and IPC only". This session complements the keynote talk by John Day, providing updates on the research efforts funded by the European Commission through the final call in the Seventh Framework Programme (FP7) (IRATI and PRISTINE) and the GN3plus(IRINA) project.

People: Session chaired by Dimitri Staessens (iMinds). The session consisted in four talks:

- **IRATI: an open source RINA implementation for Linux/OS**, by *Eduard Grasa (i2CAT)*. IRATI [iratigh] is an open-source RINA implementation initially developed by the FP7 IRATI project, now being enhanced by the FP7 PRISTINE and IRINA projects. This RINA implementation targets the Linux/OS, allowing RINA DIFs to be deployed over VLANs, TCP or UDP. PRISTINE is developing an SDK to facilitate the programmability of the different networking functions (addressing, routing, flow control, retransmission control, forwarding, resource allocation, authentication, encryption or access control). This talk will explain the main goals of the IRATI implementation, discuss the major design decisions, provide a high-level overview of the different components and describe some of the validation experiments carried out by the FP7 IRATI and PRISTINE projects.
- **IRINA: RINA for NRENs**, by *Dimitri Staessens (iMinds)*. This presentation provides a summary of the activities and results obtained by the IRINA project in the GN3plus open calls. IRINA has investigated how RINA can be applied to NREN services. A state-of-the-art and analysis of network architecture proposals and associated research projects in a global context was performed to motivate the need for the project. A survey was conducted to align the scope of the project with the requirements and objectives of the NREN community. In

order to evaluate the use case, the rina-tgen tool was developed as part of the project and released as Open Source software. Experimental results from the project show that RINA has a lot of potential benefits in deploying services from a cloud environment.

- **PRISTINE: Programmability In RINA for Supreme Virtualised Networks**, by *Miguel Ponce de Leon (TSSG)*. Virtualization is a fundamental inherent attribute of the RINA architecture, and based on this aspect, the PRISTINE project has designed and is implementing programmable functions for: supporting QoS & congestion control in aggregated levels, facilitating more efficient topological routing, security of content & application processes, providing protection and resilience and unified multi-layer RINA stack management framework for handling network layer configuration, performance and security. This presentation shall give an overview of these programmable functions along with demonstrating the applicability and benefits of this approach and its built-in functions in two specific use-cases in the environments of a Distributed cloud and Datacenter networking.
- **When RINA meets NFV** by *Diego Lopez (TID)*. Network Functions Virtualization (NFV) requires an underlying networking infrastructure able to support the dynamic allocation of resources, flexible function composition, and implicit security. The RINA paradigm is especially well suited to these requirements, and this presentation will discuss how, and the findings the PRISTINE project has made about them.

Notes TNC is the largest and most prestigious European research networking conference, bringing together around 650 participants of the European research and education networking space, consisting in GEANT, National Research and Education Networks (NRENs), universities, research centres, equipment vendors and commercial operators. TNC 2015 took place in Porto, from 15 to 18 June 2015. PRISTINE's participation at the TNC consisted in a RINA session of four presentations [tnc15-session] and the opening keynote speech by PRISTINE's EAB member John Day [tnc15-plenary].

There were around 30-40 people in the RINA session audience. Some of the questions were around the implications of multiple namespaces, recursion as a tool for scalability (in particular for routing) or separation of mechanism and policy (RINA is an architecture not a building, different policies will be optimal in a variety of operational environments). There were questions on deployment issues as well, in particular by GEANT engineers who tried to understand what would be required to deploy the current IRATI implementation on the GEANT infrastructure.

RINA tutorial to EC officers (June 2015)

Title Reconstructing computer networking with RINA, how solid scientific foundations can allow Europe to become a world leader in internetworking

Abstract The Internet is just a prototype. Its core protocols and architecture were born as one of the first attempts to computer networking in the 70s. As it is not surprising for a first attempt, many of its concept definitions and design decisions were wrong. But in the last 40 years the academic and industrial community has just built on this weak foundation, patching and extending the basic protocols to reach the scale of our current Internet, without questioning or revisiting the core assumptions in that basic protocols, without trying to understand what is wrong and why. As a consequence, the world is progressively depending on a infrastructure that is very complex, brittle, insecure, inflexible and as a result, very expensive to operate.

RINA, the Recursive InterNetwork Architecture, is an innovative “back-to-basics” network architecture that solves current limitations and facilitates full integration between distributed computing and networking. What distinguishes RINA from other efforts is that RINA is the result of an effort that tries to work out the principles in computer networking that apply to everything. RINA is the specific architecture, implementation, testing platform and ultimately deployment of the theory.

This tutorial will start by deconstructing the current Internet, explaining what are their main design errors and their consequences. It will then introduce RINA, describing in a high-level the core fundamental principles and scientific results it is based on. After that the audience will be prepared to understand the implications and potential impact of developing and deploying such a technology, discussing the benefits of RINA adoption by different stakeholders in the computer networking value chain. It will end up discussing what the EC, specially FIRE, could do to accelerate the development of this disruptive technology.

Person Eduard Grasa, Sergi Figuerola (Fundació i2CAT)

Notes On June 25th PRISTINE had the opportunity to explain RINA, its motivation and its potential impact to a group of EC project officers [rina-ec-tutorial]. The event, organized by Mr. Mario Scillia, was very useful for both sides, with a lot of questions by the audience which hopefully left the tutorial with a better understanding of RINA, its potential impact and its deployment challenges. Real-time applications, secure networking environments, 5G or the Internet of Things were identified as potential communities were RINA could be initially adopted due to its features compared to the current Internet protocol suite.

Small Cell World Summit (June 2015)

Title RINA towards Mobile Edge Computing and Small Cell stakeholders

Abstract Discussions with regards to novel architectural solutions, such as RINA, to address the requirements of Small Cell networks.

Person Miguel Angel Puente (Atos)

Notes Small Cell networks, a key trend towards the consolidation of future Next Generation Mobile Network (NGMN) technologies, pose enabler characteristics towards the fulfilment of the tight capacity requirements of NGMNs, augmenting the Access Point density and providing higher allocated bandwidth for users and IoT devices. The high density level of Small Cell networks represent a challenge for the underlying network infrastructure, which must be highly flexible and adaptable to cope with the high dynamicity of the Small Cell aspects (e.g. high user mobility, changing conditions, etc.).

In this scenario, both the network infrastructure and the network management play a key role. Both must be tightly coupled to efficiently manage the allocation of resources to users and devices. In this regard, RINA may represent a novel and disruptive solution to address the requirements of Small Cell networks since it would allow overcoming the main challenges posed by current technologies. For example, localized congestion control, ad-hoc routing policies specifically tailored to address high mobility demands, an efficient and autonomous network management system to address the complexity of the multiple network management decisions, QoS-based resource allocation policies to cope with the high user density, etc.

This was discussed in a workshop session in the Small Cell World Summit focused on Mobile Edge Computing, as well as the expo floor with both hardware manufacturers and network operators. These stakeholders were not previously familiar with RINA technologies. Their primary feedback was that while they recognized the software transformation of networks and their access (both macro and small cells), an additional disruptive technology such as RINA would have to go through significant trials and proof of concepts via their use cases to gain industry traction. The datacenter use case was used as an example, where the larger discussion was on how the datacenter role will be adapted when decentralizing the network in a Mobile Edge Computing scenario. Similar stakeholder discussions will take place during the course of WP6 and WP7 as the project progresses with first integrated releases for testing and evaluation.

Net Futures (March 2015)

Title PRISTINE - Programability in RINA for European Supremacy in Virtualised Networks

Abstract Designing & implementing the internals of an innovative clean slate recursive inter network architecture (RINA) a solution developed by PRISTINE.

Person Miguel Ponce de Leon (WIT-TSSG)

Notes PRISTINE was one of 8 exemplary European projects showcased during the Net Futures 2015 Perfect Pitch Panel, and PRISTINE came away with the award for the cleanest pitch.

Net Futures is a European event which brings together a community involving companies, organisations and people, in Research & Innovation, Market Validation, Business Development, Entrepreneurship & Enterprise Strategy, to maximize competitiveness of the European technology industry. The perfect pitch panel was a great opportunity for the PRISTINE project to exhibit to a wide audience how it is designing and implementing the internals of an innovative clean slate recursive inter network architecture (RINA) a solution which is getting closer to being market ready. The pitch was presented by PRISTINE coordinator Miguel Ponce de Leon, who said, “the preparation for the panel was a little nerve racking, the goal of presenting such a deep networking project such as PRISTINE in a 3 minute window was a tough one, but with assistance from PRISTINE partners, the event organisers, an entertaining and informative pitch was put forth, highlighting the truly disruptive nature of the work being carried out by PRISTINE”. As the pitch was being presented an artist drew a live representation of the pitch. The Net Futures event was also an opportunity for the PRISTINE project to work and collaborate with EC projects and researchers in the same field, and there was lively discussion at the Future Internet cluster meeting, with SDN and NFV the hot topics of the day. Clearly there is a new market emerging in the networking space, by 2018 analysis shows that the SDN/NFV market will be a €1 billion market place, and PRISTINE are clearly creating innovate components for that market segment. A PRISTINE blog post [net-futures], covered the activity which was extensively shared on social networking communities.

RINA Tutorial @ IEEE Globecom 2014 (December 2014)

Mostly IRATI, but ideas on PRISTINE SDK also presented there

Title Tutorial T-5: Alternatives to TCP/IP

Abstract The goal of the tutorial is to provide the audience with an introduction to the concepts, motivation and state of the art of the Recursive InterNetwork Architecture (RINA), one of the most promising alternatives to TCP/IP. This tutorial is split into two parts: the first one will be dedicated to the theory and concepts behind RINA, while the second will explain real-world use cases that motivate its deployment and introduce the RINA stack under development by the FP7 IRATI and PRISTINE projects. To conclude the session a live demonstration of the IRATI prototype will be carried out.

The first part will start by exploring the lessons to be learned from the past. Most of the shortcomings of the Internet architecture stem from early design decisions that were made at the infancy of computer networking. The talk will briefly examine these decisions and their consequences for today’s Internet. The tutorial will proceed with an introduction to RINA, guiding the audience through the concepts and theoretical underpinnings of RINA. It will start with an overview of the architecture, explaining how recursion generalizes to all forms of

distributed computing. The talk will then analyze how RINA deals with naming and addressing, routing, data transfer, flow allocation, security and network management. The first part will conclude looking at other alternatives to TCP/IP and analyzing how they compare to RINA.

The second part will initially focus on RINA deployment considerations. The goal of this initial talk is to provide answers to the questions of “how can RINA be deployed?” by introducing a few scenarios that motivate RINA adoption. The lecture will also address some of the different ways in which RINA could be seamlessly deployed interoperating with the current systems and technologies. Having examined deployment scenarios, it will be time to concentrate on implementation strategies. RINA can be implemented in multiple ways for different target hardware platforms in a variety of operating environments. This tutorial will mainly focus on the RINA implementation of the IRATI project, currently also being extended by the PRISTINE project. It will give an overview of the software architecture and design decisions, glancing at the engineering problems and solutions applied to provide the first full-fledged RINA prototype. The last lecture will be devoted to presenting and explaining the various experiments that the IRATI project has been carrying out with the RINA prototype using the infrastructure provided by the OFELIA project.

People John Day, Lou Chitkushev (BU), Dimitri Staessens, Sander Vrijders (iMinds), Francesco Salvestrini (NXW), Eduard Grasa (i2CAT)

Notes The RINA tutorial at the IEEE Globecom 2014 conference was organized by the FP7 IRATI project with the collaboration of PRISTINE. The ideas and preliminary design of the PRISTINE Software Development Kit (SDK) were presented and discussed during the tutorial.

EU-Taiwan Workshop on 5G research (October 2014)

Title PRISTINE, Exploring programmability in RINA (the Recursive InterNetwork Architecture)

Abstract On October 24th PRISTINE was presented at discussed at the EU-Taiwan Workshop on 5G research in Brussels. During the workshop PRISTINE exposed the value proposition of RINA in the SDN/NFV/Softwarized Networks space: clean architecture, programmability and simplicity. The presentation also discussed the research and innovation activities that PRISTINE is carrying out in the context of RINA and SDN: Software Development Kits, RINA Simulator, congestion control, distributed resource allocation, topological routing, security and network management.

Person Tinku Rasheed (CREATE-NET)

Notes Some questions/comments were raised by the audience on a number of topics:

- Availability of RINA implementations. There are currently three prototype implementations under active development.
  # The C/C `implementation initiated by the FP7 IRATI project – basis of PRISTINE implementation work. Will be open-source (first release expected by mid-November), targets the Linux Operating System – with components both at user space (C)` and the kernel ©.
  # Boston University's one, called protoRINA. All user-space, open source, implemented in Java.
  # TRIA Network Systems implementation. Closed source, implemented in C/C++.
- Applicability of RINA to application scenarios / use cases different than the ones researched by PRISTINE. Below there are a couple of examples:
  # The IRATI [irati] and IRINA [irina] projects have written a number of reports on different use cases.
  # Paper on analysis of RINA in multi-homing and mobility scenarios, by Boston University.
- Discussion on the usefulness of PRISTINE/RINA on the NF chaining overlays use case

Interaction with other ICT projects

During this period, PRISTINE has pursued new collaboration opportunities with other FP7 projects, identifed in D7.2 as possible targets. In the following sections, the outcomes of these collaborations are described. In the next period, PRISTINE will continue devoting efforts to create synergies with other projects in the Future Networks Unit and other related areas such as FIRE.

FP7 IRATI[9] (2013-2014)

About IRATI. RINA is the best choice for the next generation networks due to its sound theory, simplicity and the features it enables. IRATI's goal is to achieve further exploration of this new architecture. IRATI will advance the state of the art of RINA towards an architecture reference model and speci#cations that are closer to enable implementations deployable in production scenarios. The design and implemention of a RINA prototype on top of Ethernet will permit the experimentation and evaluation of RINA in comparison to TCP/IP. IRATI will use the OFELIA testbed to carry on its experimental activities. Both projects will benefit from the collaboration.

[9] http://irati.eu

IRATI will gain access to a large-scale testbed with a controlled network while OFELIA will get a unique use-case to validate the facility: experimentation of a non-IP based Internet.

Collaboration. The dialogue between PRISTINE and IRATI project has provided PRISTINE with the required software baseline to build upon. The FP7 IRATI project setup the initial open source community for the RINA software implementation (called IRATI [iratios]), and transferred its management to PRISTINE before ending. IRATI also introduced RINA to the ISO SC6 WG7, a track that was followed up by PRISTINE resulting in the opportunity to initiate the standardisation procedure os some of the RINA core components within that group. PRISTINE and IRATI also collaborated to deliver a RINA tutorial at the IEEE Globecom 2014 conference.

IRINA[10] (2013-2015)

About IRINA. The prevalent TCP/IP network architecture has been applied in a variety of situations it was never designed for. A new architecture that better supports distributed computing and effectively exploits the raw transmission capacity of the physical media is required. IRINA shall compare RINA against current networking state of the art and relevant clean-slate architecture under research; perform a use-case study of how RINA could be better used in the NREN scenarios; and showcase a laboratory trial of the study.

Collaboration. IRINA and PRISTINE organized together the third international RINA workshop in Ghent, as well as the "Laying the groundwork for field trials of RINA at the EU" at the TNC 2015 conference.

FP7 NetIDE[11] (2013)

About NetIDE. Nowadays, while most of the programmable network apparatus vendors support OpenFlow, a number of fragmented control plane solutions exist for proprietary software-defined networks. Thus, network applications developers need to re-code their solutions every time they encounter a network infrastructure based on a different controller. Moreover, different network developers adopt different solutions as abstract control plane programming language (e.g. Frenetic, Nettle), leading to not reusable and shareable source code for network programs. So despite having OpenFlow as the candidate for a standard interface between the controller and the network infrastructure, interworking between different controllers and network devices is hindered and walled gardens are emerging. NetIDE will deliver a single integrated development environment to support the whole development lifecycle of network controller programs in a vendor-independent fashion.

[10] http://www.geant.net/opencall/Optical/Pages/IRINA.aspx
[11] http://www.netide.eu/

Collaboration. PRISTINE is analysing if it could use some of the NetIDE tools as a graphical configurator to specify a RINA network that then could be used as an input to the PRISTINE Manager. The Manager would inspect the output of the configurator, instantiated and configure as many IPC Processes at the relevant systems as required. Interactions between NetIDE tooling and the PRISTINE RINA simulator (RINAsim) are also under study. PRISTINE and NetIDE are organizing a joint workshop to discuss about the details of this potential collaboration.

PhD and MSc theses

PhD and MSc theses are important means for the dissemination of PRISTINE results in academia, with the potential to involve other academic institutions and the people working in them. In line with this, other universities and research centres that cooperate with the members of the consortium might be contacted with the ultimate goal of encouraging them to adopt RINA research topics and introduce them into the subjects taught in their institutions.

In the reporting period, the following PhD and MSc theses have been activated:

Table 2. PhD and/or MSc theses

Partner	Type	Duration	Topics
CREATE-NET	MSc	Q4 2015 - Q3 2016	Performance isolation in data-centres networks
FIT-BUT	PhD	Q3 2009 - Q3 2015	Internet alternative architectures and routing paradigms
iMinds	MSc	July 2014 - 2015	Comparing RINA and TCP/IP for latency-constrained applications
iMinds	PhD	Sep. 2012 - estd. Q4 2016	Routing and resiliency in the Recursive InterNetwork Architecture
WIT-TSSG	MSc	Oct. 2014 - Sept. 2015	Load balancing applications using RINA

Internal partner dissemination

PRISTINE partners have disseminated project results to other groups within their organisations. Internal dissemination has been achieved mainly through sharing of material, internal workshops and meetings.

The following table lists the internal dissemination activities carried out by PRISTINE partners so far.

Table 3. Internal dissemination

Partner	Date	Description
CREATE-NET	25/5/2015	The fundamental principles lying at the foundations of RINA have been presented to the students of the Wireless Networks course at the University of Trento (M.S. level, English speaking students). This was done as a 4 hour lecture where the general concept of recursion in network protocol was introduced, followed by the distinction of policy and mechanism in network management. Finally, RINA has been presented as the most promising architecture for future mobile applications where mobility and multi-homing shall play a key role.
ATOS	Q4 2014 / Q1 2015	Internal dissemination and liaison channels have been established in the company, where an initial presentation via the company's intranet has communicated the scope and objectives of the project beyond the R&D department. Particular attention has been given to the datacenter use case and the company's cloud operations centers. Synchronizing with Atos' exploitation roadmap, these channels will be re-approached at the end of the initial implementation cycle and first analysis of WP6 progress, presenting initial results in Q3/Q4 2015.
FIT-BUT	21/10/14	Project was briefly presented to research and PhD students at the Third Annual Conference of IT4Innovations National Supercomputing Center, http://www.it4i.cz/. FIT-BUT is a member of IT4I consortium
WIT-TSSG	5/8/14	Presentation about RINA and PRISTINE for research group members attending a Pecha Kucha session [wit-tssg-pecha-kucha]
FIT-BUT	6/3/14	Presentation about RINA principles for research group members meeting [fit-meeting]
FIT-BUT	20/2/14	Presentation about RINA principles for BSc and MSc students of CCNP courses [fit-ccnp-courses]

IMT-TSP	7/10/2014	Presentation of RINA at UCOOL Workshop. UCOOL is a STIC-AMSUD collaborative project between French and South American universities [imt-ucool]

External Advisory Board

PRISTINE has interacted with a number of organizations that have played the role of external advisors. These organizations have been presented the project's results and provided feedback that has influenced some of the research and development activities in the project. They have also participated in some of PRISTINE's dissemination and standardisation activities.

Active EAB members during the second period (M9-M18)

Boston University (USA)

Description of the Organization

Boston University (BU) —independent, coeducational, and non-sectarian—is an internationally recognized private institution of higher education and research. It is the third-largest independent institution of higher education in the United States. Through its fifteen Schools and Colleges, thirteen of which offer advanced degrees, the University serves the academic and research needs of nearly 30,000 students and over 2,800 faculty. Government and Industrial funding of research conducted at Boston University has exceeded $250M in FY'05. Boston University's student body represents all fifty states and more than 135 foreign countries.

The Computer Science (CS) Department at Boston University was established in 1983 as part of the College (and Graduate School) of Arts and Sciences. Today, it consists of 19 full-time faculty members (in addition to 10 joint and affiliated faculty members) who teach and conduct research in diverse areas of theoretical, experimental and applied computer science. The Department's student body consists of over 200 undergraduate students and over 80 graduate students, of which over 50 students (all supported) are pursuing PhD degrees. Over the last decade, the Computer Science Department at Boston University has had significant growth in areas of networking, databases, computer vision, security and applied cryptography, operating systems and real-time systems.

BU's representative for the PRISTINE EAB is Mr. John Day. PRISTINE has benefited from BU's vision on the theoretical aspects of the RINA architecture, as well as of his more than 40 years of experience in the computer networking field.

Interaction with PRISTINE

BU representatives (Mr. John Day and Mr. Lou Chitkushev) were present at the PRISTINE Kick off meeting and the second and third RINA international workshops - held in Dublin and Ghent, respectively. They participated in the discussions related to RINA research areas and actively discussed ideas and proposals with PRISTINE members. BU representatives are also active members in PRISTINE mailing lists, participating in discussions about technical details of the RINA architecture applied to the different PRISTINE research areas.

Mr. John Day has also participated in the following events related to the dissemination and standardisation of RINA and PRISTINE results:

- Opening plenary talk at the TNC 2015 conference.
- One of the keynotes at the *Expanding the issue* section of Infocomms protocol workshop.

Interoute (UK)

Description of the Organization

Interoute owns the largest Next Generation Network covering the European Union. Interoute provides a single platform for Information Technology services, which we call Unified ICT. Connectivity, Communication and Computing services are integrated on a single infrastructure that reduces cost and optimises security, performance and efficiency. As a result, Interoute is key to Europe’s digital supply chain, serving all the major incumbent operators as well as enabling for corporate customers more than €1 billion of e-Commerce transactions daily through our network. Consistently recognized as Europe’s leading provider of bandwidth and transmission services, Interoute is increasingly distinguished for enabling Cloud Computing across the European footprint. Interoute is Europe’s leading Cloud service provider; actively promoting our next generation secure Cloud solution to meet our customers business and community responsibilities. Our portfolio of advanced ICT services are designed to enable people to enjoy the benefits of the latest cloud technologies, promoting communications within companies and across the globe, while reducing carbon emissions that harm our planet.

Interoute’s representative for the PRISTINE EAB is Mr. Adam Chappell, Chief Network Engineer. Mr. Chappell brings in his experience designing and operating the largest network in Europe, offering all sorts of services such as Internet access, several flavors of corporate VPNs and customized cloud services.

Interaction with PRISTINE

Mr. Adam Chappell has attended the PRISTINE kick-off meeting and the second and third international RINA workshops. He has provided feedback to the project in how RINA can

be best applied in datacentre networking scenarios, as well as key RINA features that should be highlighted when presenting RINA to ISPs and/or datacentre operators. Mr Chappell also participated at the *'Expanding the issue' section of Infocomms protocol workshop*, complementing Mr. John Day and Mr. Diego Lopez in the discussion of the benefits of RINA as a long term networking solution.

Predictable Network Solutions (UK)

Description of the Organization

Predictable Network Solutions (PNSol) was founded in 2003 to provide consultancy on large and complex projects at the leading edge of feasibility, both technical and commercial. Coming from a strong scientific and engineering background we quickly found that the tools and techniques available were inadequate for the tasks we were being asked to perform. Our response was to construct both the mathematical basis and the practical tools that were needed to service our customers' needs. Since then we have continued to work at this leading edge, spanning the issues of: performance; quality of experience; design and operational risks/hazards; and total cost of ownership. We have taken those tools and techniques and industrialised them.

We have worked with: major system integrators; network operators, both fixed and mobile; industry regulators; international research centres; network equipment manufacturers; and public sector bodies. Our telecommunications customers include small ISPs, medium sized national service providers and also large global carriers.

PNSol’s representative for the PRISTINE EAB is Mr. Neil Davies, Chief Scientist and co-founder. Mr. Davies brings in more than 30 years of experience modeling, designing and building high-performance networked systems.

Interaction with PRISTINE

Mr. Davies is the author of the delta-q model for reasoning about quality attenuation in statistically-multiplexed packet networks. This approach provides a framework to differentially allocate loss and delay to the different flows in a packet network in a predictable way, even when the network works at 100% utilization. Mr. Davies has helped PRISTINE’s WP3 to understand how the delta-q approach can be applied in a DIF by designing a set of RMT multiplexing policies. Mr. Davies has also attended the second and third international RINA workshops, discussing the delta-q model and RINA. From M19 (July 2015) PNSol will join the PRISTINE consortium as an official partner, taking part of the tasks previously assigned to Juniper.

TRIA Network Systems (US)

Description of the Organization

TRIA Network Systems is a start-up company founded by networking industry veterans that is creating networking products based on a new approach to defining and managing computer networks and new and improved ways for applications to use them. TRIA will introduce software products for use in embedded networks, private networks, in public and private clouds, and in the public Internet. TRIA's technology provides new capabilities that are difficult or impossible with current Internet technology and protocols.

TRIA's representative for the IRATI EAB is Mr. Steve Bunch. IRATI has benefited from the vast experience designing and implementing complex networking software that TRIA members have accumulated over the years.

Interaction with PRISTINE

Mr. Steve Bunch has attended the PRISTINE kick-off meeting and the second and third international RINA workshops. He is also an active member of PRISTINE mailing lists, contributing to discussions about RINA implementation approaches, the RIB and RIB Daemon libraries, the CDAP specification and RINA security aspects.

Plans for the third period (M19-M30)

During the last stage of the project PRISTINE will continue collaborating closely with the aforementioned organizations (BU, TRIA, Interoute and PNSol - as a partner), but it will also try to raise the awareness of RINA and PRISTINE results within the other organizations that had showed interest in participating in the PRISTINE EAB. Those are Cisco Systems, Deutsche Telekom, Telecom Italia and Colt. The final workshop organized by PRISTINE - with a focus on RINA industrialization - should facilitate the interaction with these companies.

Standardisation

PRISTINE's standardisation strategy tries to achieve three goals. The first one is to contribute to the consolidation and enhancement of the experimental RINA specifications within the Pouzin Society (PSOC), the informal group that coordinates international RINA research and development activities. The second one is to engage with established Standard Development Organization (SDOs) such as ETSI or ISO in order to explore the possibilities for the standardisation of the RINA architecture at large.

The final goal is to expose some of the particular solutions developed within the project to established SDOs. Examples of these contributions will be the work on aggregate-based congestion control, which will be submitted to the IRTF Internet Congestion Control Research Group (ICCRG) or PRISTINE's view about Network Functions Virtualization (NFV), which will be brought to ETSI's NFV ISG. The following sections provide details of the PRISTINE' standardisation plans.

Pouzin Society (PSOC)

PRISTINE is committed to improving existing RINA specifications and contribute new ones in the areas of congestion control, resource allocation, routing, authentication, access control, encryption and management. All these enhanced and new specifications will be contributed to the Pouzin Society (PSOC) [psoc]. PSOC was founded to coordinate contributions to the draft RINA reference model and specifications, making sure that new knowledge is incorporated and inconsistencies are fixed. PSOC - as a small group of well-aligned people with common goals - has worked effectively on an informal basis. However, a growing number of contributors, resulting from the enhanced visibility created by FP7-funded projects IRATI [irati] and PRISTINE [pristine-homepage], BU's NSF grant, and the IRINA GEANT3 project [irina], has moved PSOC to transition to a more formal approach. A Memorandum of Understanding (MoU) defining PSOC protocols has to be signed by entities willing to become part of PSOC and gives access to the current RINA documentation and discussion channels. The specifications are stored in a github repository [psoc-github]. New and updated RINA specifications - in a variety of areas such as congestion control, resource allocation, routing, authentication, access control, encryption and management - resulting as public PRISTINE foreground will be contributed to PSOC, in order to be taken into consideration for their adoption in future official releases.

During the second part of the project, PRISTINE will contribute to further organize the specification editing process. In order to do so, it will assign editors to all the RINA specifications, and specify a lightweight procedure to maintain, revise and approve changes to the specification documents. PRISTINE will also help PSOC to increase its visibility by

designing a new website that provides a one-stop shop for the RINA online presence; with links to RINA research projects, introductions to RINA, case studies, presentations, videos and other dissemination material (the new PSOC website work has already started during the first phase of the project).

Standardisation of RINA at large

ETSI

The presentation of RINA at the "Infocomms protocols" workshop and the discussion that took place afterwards on what should be the way forward towards future networking standards captured the interest of the ETSI representatives that assisted at the event. The week after Dr. Hermann Brand, ETSI's Director of Innovation, talked to the PRISTINE representatives showcasing the project results at the EUCNC conference, expressing his interest in knowing more about the state of the art of RINA R&D activities, as well as of the community building activities to disseminate RINA to a wider audience.

During the first week of July Dr. Brand held a conference call with PRISTINE's technical manager. Dr. Brand showed his interest on "radical clean-slate approaches for future networks", and informed that interest on these topics is raising within ETSI. He showed his willingness on exploring whether there is sufficient interest among stakeholders including ETSI members to setup a new technology oriented pre-standardisation group within ETSI. Dr. Brand was informed about funded research projects working on RINA, open source software initiatives and community-building activities such as the RINA workshops organized in collaboration with the Pouzin Society. Dr. Brand proposed to follow up after the summer holidays, which is also a good timing to allow the PRISTINE consortium to discuss which partners would be interested in exploring this opportunity.

ISO

In D7.2, the International Standards Organization (ISO) WG 7 "Network, transport and future network" of SC 6 "Telecommunications and Information Exchange Between Systems" was identified as an interesting target for PRISTINE's standardisation efforts on two counts, timing and scope. The scope, the standardisation of an architecture that could cope with the requirements [iso29181] that WG7 is currently completing, suited perfectly the needs of PRISTINE and RINA.

In October 2014, the IRATI project sent representatives (iMinds, Nextworks, i2CAT) to the interim meeting in London. From the participation of that meeting emerged the possibility for the RINA community to start a New Project Proposal at ISO, should the community be interested

in that. PRISTINE has taken over the efforts with regards to ISO as the best opportunity to standardise RINA.

PRISTINE attended in the SC6 plenary meeting in Ghent, May 25-29 2015, jointly organised by iMinds and NBN (Belgian standards organisation), attending the WG7 meeting and further discussing with the WG7 convenor opportunities to bring RINA to this working group. A possible plan will be to initiate a New Project Proposal, something that any SC6 P-member National Body (NB) can do. At least five NB's are needed to proceed, and each must provide an expert name (someone that is registered on the SC6/WG7 member list). Belgium (with iMinds as its representative to SC6) and Spain (with UPC as its representative and presiding over SC6 and i2CAT as SC6 secretary) are already P-members. Experts from Korea and China would support the proposal, so reaching 5 should be possible. The NP ballot could be finalised at the WG7 interim meeting in October 2015. The ballot will close 3 months after, so it would be finished before the next SC6 plenary meeting (late February 2016). Then a Working Draft (WD) of any document deemed as ready for standardisation could be registered by March 2016. The standard itself would require some additional ballots: Committee Draft (CD) ballot, then Draft Internation Standard (DIS), Final DIS up to International Standard. An ISO DIS should be achievable within PRISTINE timeframe, by June 2016 (end of the project).

Standardisation of specific contributions

IETF/IRTF

The Internet Engineering Task Force (IETF) works on standards for the Internet. These standards are based on compatibility to the current Internet, and ways of gradually improving it - very often in very small steps. This is the opposite of what PRISTINE intends to achieve with RINA, and therefore it is hard if not impossible for this project to contribute its outputs to the IETF. However, since several PRISTINE partners attend IETF meetings on a regular basis, it will be easy to keep track of current activities and align developments in the project accordingly wherever this makes sense, i.e. take inputs from the IETF. Again, given the "baby step" nature of IETF developments, this will not always make sense, but there are exceptions. For example, Transport Services (TAPS), a new IETF Working Group that was created due to the effort of a PRISTINE partner, will define services that should be exposed to applications rather than transport protocols. It would make sense for RINA to directly exhibit a similar set of services rather than trying to map stream (TCP) vs. datagram (UDP) socket-based applications onto the RINA service model.

The Internet Research Task Force (IRTF) is more forward-looking and research-oriented than the IETF. Similar to the IETF's Working Groups, it is organised into Research Groups (RGs). The diversity of the topics that RGs focus on is broad, ranging from the somewhat close-

to-today's-network Internet Congestion Control RG (ICCRG) and Network Management RG (NMRG) to more drastic departures from today's common architectures such as Delay-Tolerant and Information-Centric Networking. It is therefore quite possible to contribute research results that PRISTINE has achieved in the context of RINA to some of these groups — e.g. congestion control results could be contributed to the ICCRG and network management results could be contributed to the NMRG. However, more visibility is achieved by the creation of a dedicated research group, and this possibility was therefore investigated.

PRISTINE has contacted the IRTF chair and learned the following regarding RG establishment:

- RGs are measured by activity. An RG needs people to be active on the mailing list and attend the meetings. Attending meetings normally requires some interest in the IETF, as IRTF RGs often meet at IETF meetings.
- Establishment happens during a 1-year phase, where a mailing list and meeting space at IETF meetings will be given to the organisers, and the activity level will be monitored. If, after this year, there is clearly enough activity, an RG will be created.

This option was internally discussed in PRISTINE. Options on the table included establishing a dedicated RINA-RG - which would probably not attract enough attention - and a more general "new architectures" RG - which would mean a lot of PRISTINE resources wasted for an activity that is only partially related to RINA. It was discussed to try nevertheless, if only for the benefit of the impact/visibility of initial activities, but then it seemed that it does not make sense to start an endeavor that we already expect to fail from the outset. There are examples of rather similar groups that have failed in the past, e.g. the Virtual Networks RG (VNRG), which essentially consisted of delegates from various research projects presenting their own work that did not fit together with any other work. Eventually, the VNRG had to close down.

Beyond these contacts, it is worth noting that the IRTF has recently launched a group on Network Functions Virtualization (NFVRG). The areas of interests of this NFVRG are well aligned with the PRISTINE goals in the NFV use case, so a report of the findings of this use case would contribute to the build awareness about the RINA applicability to complex problems like VNF (Virtualized Network Function) internal and external orchestration, and to a cross-validation of potential further contribution to the ETSI NFV ISG.

In conclusion, PRISTINE will make sure to stay up-to-date on developments in the IETF to get inputs, and contribute some of its outputs to subtopic-specific Research Groups in the IRTF.

NFV ISG

PRISTINE's Network Service Provider use case analyzes RINA as an essential component of the Network Functions Virtualization (NFV) concept within an operator network. The

application of RINA to the construction of VNFs and virtualized network services seems promising. Hence, standardisation activities related to NFV are highly relevant to PRISTINE.

The ETSI NFV Industry Specification Group (ISG) was created almost two years ago, promoted by a set of network operators already engaged in Network Function Virtualization technologies, with the goal of consolidating the NFV concept, building awareness among the industry and the academia, and produce pre-standardisation work aimed at the eventual production of standards related to NFV. The form of an ETSI ISG was selected because it guaranteed open participation to both members and non-members of ETSI. Since its creation, the ISG has grown to include almost 300 participating organisations and it is about to produce the first release of the NFV specifications (already available as stable drafts). Given these successful results, the NFV community is discussing a second phase for the ISG, with the goal of enhancing NFV specifications and continue to provide a common base for NFV standardisation activities.

The current structure of the ETSI NFV ISG considers three architectural Working Groups (Infrastructure, Software Architecture, Management and Orchestration) plus other three focused on non-functional requirements (Performance and Portability, Reliability, Security), and a framework for Proofs-of-Concept intended to demonstrate the applicability of NFV and help the group identify technology challenges and explore solutions.

Among the key challenges, the group is considering those related to the orchestration of the different components of a network service by means of VNFs (Virtualized Network Functions) and of each individual VNF into its components. Solving questions regarding scalability, manageability and security are essential for making NFV a feasible solution for real network problems.

PRISTINE (and RINA in general) is in the position of providing suitable solutions for these challenges, and the necessary decoupling between the supporting networking infrastructure and the services provided by the VNFs facilitate the adoption of RINA-based solutions among the network operator community.

Summary

In addition to the aforementioned initiatives towards SDOs, some PRISTINE partners have specific long-term presence in standardization which turns into potential benefits for the defining a concrete project standardization strategy.

UiO

UiO key person Michael Welzl chairs the IRTF Internet Congestion Control (ICCRG) Research Group. This facilitates having an overview of current congestion control developments, and

helps planning contributions to ICCRG from PRISTINE. UiO mainly works on aggregate congestion control and resource allocation. The results from evaluating aggregate congestion control are deemed to be of interest to ICCRG.

WIT-TSSG

WIT-TSSG have been members of the Telecommunications Management Forum (TMForum) for the past 7 years and have had many inputs towards the Information Framework as standardised by the TM Forum. WIT-TSSG can explore the new blueprint being devised within the TM Forum which is looking for end-to-end management with Zero-touch Orchestration, Operations and Management, as such called the TMForum ZOOM project [zoom-project]. WIT-TSSG will be investigating whether the PRISTINE' DMS can be applied to the TMForum ZOOM project.

i2CAT, NXW, IMT-TSP, iMinds

These partners identified the ISO SC6 Working Group 7 on Future Networks as a potential target for standardisation, since the PRISTINE architecture and more detailed topics such as resource allocation, routing, naming and addressing fall within its scope. Therefore, these partners can foster the adoption of PRISTINE' results in ISO.

i2CAT is also interested in exploring the possibility to setup a new technology oriented pre-standardisation group within ETSI about RINA. Probably other PRISTINE partners will also be willing to join this effort, which still has not been discussed project-wide.

TID

TID is mostly interested in contributing PRISTINE' results related to the NFV use case. TID aims at proposing seamless VNF and service construction to ETSI-NFV. TID also aims at supporting the possibility to setup a new technology oriented pre-standardisation group within ETSI about RINA.

Exploitation

The PRISTINE project's main goal is to bring RINA closer to real world deployment, by advancing the state of the art of the RINA specification and developing a prototype that is more tailored towards to real life industry use cases than what is currently available.

The development of the RINA technology has long-term commercial exploitation potential, since it can deliver key benefits to the IT market segments on future networks. However, as with any technology, RINA has to reach the degree of maturity that enables a viable exploitation path. PRISTINE is an important step towards the market deployment of RINA technology, as it will deliver a robust prototype upon which commercial products can be built in the future, without the need of starting an implementation from scratch.

Therefore PRISTINE's exploitation strategy is not focused on immediate commercialization of project results, as the market is not yet there. Instead, PRISTINE will be exploited to help bridge the RINA technology and market gap, helping to foster future products as the larger RINA roadmap matures. This will include the following type of activities:

- Continue R&D to mature the technology, improve the RINA specifications and extend industry use case software implementations; building on the results achieved by the project.
- Grow the community of actors in the RINA ecosystem and its larger roadmap, attracting more organizations interested in research, development and adoption of the technology.
- Engage with specific demonstration activities, use case studies and proof of concepts that can showcase the potential of the technology and bring it closer to the market.
- Encourage universities to incorporate master and PhD courses focused on the theory behind RINA.

The PRISTINE project provides a significant opportunity for cooperation among a wide range of partners from the industry, R&D institutions and academia. The impact of the project results will be realized in relatively wide and varying business and scientific landscapes represented by the consortium partners, affiliates and larger RINA community.

The following sections define the PRISTINE exploitation strategy, specifying the project's tangible results for exploitation (to be carried out with clear provisions for ownership of knowledge and IPR) and provide a detailed definition of actions to be pursued by the partner organisations with specified schedule and the expected impact on business and exploitation risks.

Joint exploitation plans

PRISTINE's joint exploitation strategy is defined along three main directions:

- Commercial exploitation. There is a general interest to have commercial exploitation of the results among the partners. However specific exploitation strategies differ for the industrial and academic partners, since different markets/segments are addressed. Academic partners will consider the creation of startups that, together with other industrial partners, can be key actors in the initial RINA ecosystem. Effective collaboration amongst them and the industrial partners is key to increase chances of success.
- Research exploitation. All the partners expect to increase their know-how and IPR on the project related technologies, and eventually through patents. The identification of unexplored research topics and other technological challenges after PRISTINE's project is another major exploitation goals.
- Academic exploitation. Research centres and academics within the PRISTINE consortium will exploit the know-how acquired through the project mainly through two avenues: by designing university or master-level courses that teach the principles of networking scoping in the topics of PRISTINE, and by supervising master or PhD students on areas related to PRISTINE research.

Specific PRISTINE outcomes exploitable from a commercial and research point of view are detailed in the following section. With reference to academic exploitation of PRISTINE research, the partners with direct interest in education services and programs have started RINA/PRISTINE seminars and classes at MSc programs, as well as MSc and PhDs theses on PRISTINE related subjects. The exploitable dimension of these academic activities consist in advancing those universities to the forefront of Future Internet, with a subsequent impact on the attractiveness towards students, funding and sponsorships.

Analysis of exploitable items

This section provides an analysis of the exploitable results of the project.

A standard template was created for the partners to structure their exploitation plans (see Table 1). In addition, to help scope the exploitation potential of the results during the first development cycle, business generation methodologies are being used, including Alexander Osterwalder's "Business Model Canvas", allowing the project to help define building blocks for exploitation scenarios, such as value proposition (benefit), key partnerships needed, customer segments and delivery channels. Such methodologies are usually applied for results closer to the market, but have still supported the elaboration of scenarios based on initial results. This will later influence

future iterations of the partner exploitation plans, in parallel to the maturation of initial technical results and the evaluation and analysis of the projects trials.

Also being developed in parallel to this deliverable is D6.2 “Proof of Concept Software for the Use Cases and Draft Report on the Use Cases Trials and Business Impact”. Upon the end of the first implementation cycle, it is addressing an initial impact analysis on the use cases based on defined experimentation, further evolved as the project progresses during it final year of development and additional designs are implemented, integrated and evaluated within the trials. This will serve as additional input for the exploitation development activities of the project in its final year.

Table 4. Exploitation result template

Exploitable results	A text label to be referenced in the text (e.g. PRISTINE-<number> or <partner>-<number>)
Exploitation type	Commercial, research or academic
Target segment for application	Who will be the customers, users, community that the result will be aimed at? Which stakeholder/s would promote your output? Are new business, collaboration, deployment models needed?
Major benefits and impact	What is the value proposition, or major customer benefit from adopting or utilising the asset? What are the socio economic impacts of the output on a larger scale for RINA? e.g., improved services, cost saving (OpEx), increased reliability, better QoS, ease of use, reduction of threats over current solution, better market positioning, access to new customer segments, etc.
Current status	Where are we now with the output?
Expected date of completion	Foreseen date of completion the work to be ready?
Time to market	How long after completion of the output do you estimate as the time that the solution or service would be able to be exploited and delivered to its target? (e.g. immediately, it takes time for market to realise the value of the product)
Further external collaboration	Will this product or service need collaboration outside of the consortium to be completed, perhaps the need for other know how or expertise not available within the consortium?

Cost to exploit	Will there be a need of further investment for the exploitation of this product and roughly how much will it be? What would be the cost of the needed further development and extension for realization of the scenario?
Protection required	What are the IPR and licensing requirements? For example, is certain licensing needed for protection, or to reach its success?
IPR issues	Has IPR management and licensing already been resolved? If yes, what are the details? If no, is there a specific reason, dependency or conflict that needs resolution?

Using the above template, the tables below provide brief overviews of the exploitation potential of key PRISTINE results, for use in reference to the more developed partner exploitation plans that follow, using the same criteria and format.

Exploitable results

Table 5. PRISTINE-1: RINA Software Development Kit (SDK)

Exploitable result id	PRISTINE-1.
Exploitable result name	RINA Software Development Kit (SDK).
Exploitation type	Commercial, Research
Work package	WP2 (T2.3).
Lead partner	Nextworks.
Other contributing partners	WIT-TSSG, I2CAT, BISDN, Atos, iMinds.
Type of exploitable result/output	Software.
Core function of output	Enable the programmability of the RINA implementation initially started by the IRATI project and enhanced by PRISTINE. Through a well-defined API, the RINA SDK will allow developers to i) design and implement policies for the IPC Process components (delimiting, data transfer, flow control, retransmission control, relaying, multiplexing, addressing, routing, authentication, access control, encryption, etc) and ii) manage the lifecycle of these policies (loading, instantiation, destruction,

	versioning) in the systems running the RINA implementation.
Target segment for application	Users of DIFs that want to develop particular policies to be used "in-house", such as (distributed) cloud providers, distributed application platform providers or network service providers, organizations interested in researching and experimenting with RINA. Companies specialised in developing and maintaining highly-sophisticated and specialised policies for specific environments. The first segment for adoption is the current RINA researcher community, empowering them with quicker development and experimentation. As RINA matures and gains further industry interest and traction, the SDK can be aimed at wider adoption with the same value proposition towards accelerated testing and deployment.
Major benefits and impact	Enable the customization of the RINA implementation without having to understand all the stack implementation and without having to rewrite the base source code. This significantly reduces the barrier of entry and alleviates the learning curve for new adopters of RINA technology. By accelerating the larger RINA roadmap, the facilitated development and experimentation via the SDK presents an overall gain in community growth, higher adoption rate and time-to-market.
Exploitation potential from 1 (very high) to 5 (very low)	2 (high).
Current status	Proof of concept delivered by D2.3 to WPs 3-5 and WP6.
Expected date of completion	PRISTINE’s final version expected by November 2015 (D2.5).

Time to market	3-5 years
Further external collaboration	Under evaluation
Cost to exploit	Under evaluation
Protection required	SDK is GPL/LGPL in order to give more importance to software traceability and protection than faciliting the creation of commercial products. This defensive approach is driven by the immaturity of the current software and specification. When the RINA ecosystem becomes more stable and mature, a re-licensing will be possible to allow commercial exploitation.
IPR issues	None

Table 6. PRISTINE-2: RINA Simulator

Exploitable result id	PRISTINE-2.
Exploitable result name	RINA Simulator.
Exploitation type	Research
Work package	WP2 (T2.4).
Lead partner	FIT-BUT.
Other contributing partners	Nexedi, IMT-TSP, CREATE-NET.
Type of exploitable result/output	Software.
Core function of output	Enable the simulation of several aspects of the behavior of the RINA architecture as a whole and specific parts of it, in a single computing platform. This allows researchers interested in the RINA architecture to simulate the behavior of various components and policies before actually implementing them.
Target segment for application	Organizations interested in researching and experimenting with RINA; organizations interested in teaching the RINA model and principles (such as universities). As RINA advances its own adoption roadmap, IT organizations that are providing related

	solutions will be a target for simulator uptake, as well.
Major benefits and impact	Allows the simulation of the behavior of various policies at scale, as well as how different policies will interact with each other, etc. It also provides a very good tool for teaching, since students can understand step by step how RINA works, design RINA networks or simulate different configurations. The simulator represents a testing tool that will be a key component to any proof of concepts towards industry acceptance, lowering the cost of trials and offering more predictable implementations and deployments.
Exploitation potential from 1 (very high) to 5 (very low)	2 (high).
Current status	Initial proof of concept internally delivered to WPs 3-5 (MS6).
Expected date of completion	First draft version is expected by January 2015 (D2.4); PRISTINE's final version expected by November 2015 (D2.5).
Time to market	3-5 years
Further external collaboration	Under evaluation
Cost to exploit	Under evaluation
Protection required	The software is released under the terms of MIT license.
IPR issues	None.

Table 7. PRISTINE-3: Management System for RINA networks

Exploitable result id	PRISTINE-3.
Exploitable result name	Management System for RINA networks.
Exploitation type	Commercial
Work package	WP5.
Lead partner	LMI, WIT-TSSG, BISDN.

Other contributing partners	i2CAT, TID, NXW, CREATE-NET, Atos, TRT.
Type of exploitable result/output	Software.
Core function of output	Manage the configuration, performance and security of a RINA network - a set of DIFs distributed among a number of computer systems.
Target segment for application	Organizations wishing to setup and operate RINA networks (data centres, network service providers, distributed application providers), researchers interested in RINA network management. A systems integrator could also package the system as a solution. A comparison can be made to the market for cloud management/monitoring systems and initial SDN/NFV solutions, where the exploitation potential raises with the underlying technology adoption, in this case RINA uptake.
Major benefits and impact	Allows the configuration and monitoring of a series of DIFs distributed between a number of computer systems. Different front-ends (GUIs, Domain-Specific Languages, etc) can be built to the management system, allowing the development of different products. As software-driven networks gain traction, configuration, management and monitoring solutions bring gains in increased resource optimization, higher performance/QoS, lower OpEx (operational costs), and lower CapEx (re-use of hardware, less need to invest more capital). PRISTINE’s impact on RINA architecture would bring similar benefits through a shared value proposition.
Exploitation potential from 1 (very high) to 5 (very low)	2 (high).

Current status	First version of specification of common elements and information model (D5.1), initial proof of concept implementation of common elements (D5.2) and first draft version (D5.3) are ready.
Expected date of completion	PRISTINE's final version expected by April 2016 (D5.4).
Time to market	3-5 years
Further external collaboration	Under evaluation
Cost to exploit	Under evaluation
Protection required	The software is released under the terms of MIT license.
IPR issues	None.

Table 8. PRISTINE-4: RINA Policy specifications

Exploitable result id	PRISTINE-4.
Exploitable result name	RINA Policy specifications
Exploitation type	Research
Work package	WP3, WP4, WP5
Lead partner	congestion control: UiO, security: FIT-BUT, resiliency: iMinds
Other contributing partners	Athos, TRT, i2CAT, NXW
Type of exploitable result/output	Technical specification(s).
Core function of output	Description of policies that are used to tailor DIFs to specific use case requirements
Target segment for application	Telecom and datacenter operators
Major benefits and impact	Policies can be implemented according to these specification by different parties. The modular design of PRISTINE could allow tailor-made solutions based on the adopter's needs. Increase the research impact of PRISTINE by addressing important operating environment, like Data Centres and Internet Service Providers, that require

	specific policies in order to optimise/improve their functioning.
Exploitation potential from 1 (very high) to 5 (very low)	4
Current status	Different policies have been specified, in their initial version: Aggregate Congestion Control, LFA for Resilient routing, QoS-aware Multipath Routing, Cherish/Urgency Multiplexing, Congestion control in datacenter-use-case, Multi-level Security.
Expected date of completion	At the end of the second iteration of the project (May 2016), the final version of PRISTINE policies will be available.
Time to market	3-5 years
Further external collaboration	Under evaluation
Cost to exploit	Under evaluation
Protection required	Specifications are available in public deliverables.
IPR issues	None

Table 9. PRISTINE-5: Integrated RINA PoC for the distributed cloud use case

Exploitable result id	PRISTINE-5.
Exploitable result name	Proof of concept of the distributed cloud use case.
Exploitation type	Commercial
Work package	All WPs.
Lead partner	i2CAT, Nexedi.
Other contributing partners	FIT-BUT, Nextworks, iMINDS.
Type of exploitable result/output	Software and scenario configuration.
Core function of output	RINA stack and policies for the distributed cloud use case, implementing a cloud networking infrastructure consisting in two levels of DIFs (cloud DIF and backbone DIF), supporting different tenant DIFs for different customers. Policies in the cloud

	provide authentication, encryption, scalable routing, congestion control and differentiated traffic treatment for both delay and loss.
Target segment for application	Decentralized cloud services. Cloud computing.
Major benefits and impact	Customizable, dedicated networking environment running over a decentralized cloud infrastructure designed to provide enhanced resiliency and privacy compared to traditional cloud offerings. The parallel deliverable D6.2 addresses an initial impact assessment of the three use cases.
Exploitation potential from 1 (very high) to 5 (very low)	1 (very high).
Current status	Authentication and encryption policies ready. Delay/loss multiplexing policies ready. Initial congestion avoidance policies ready. Second iteration will target more advanced routing policies that minimize latency and improve the congestion avoidance policies. NMS strategies tailored to the distributed cloud scenario will also be part of the second iteration work.
Expected date of completion	First release: July 2015. Final release: June 2016.
Time to market	3-5 years
Further external collaboration	Under evaluation
Cost to exploit	Under evaluation
Protection required	Software bundle composed by the IRATI implementation (GPL, LGPL) and policies for the use case (GPL, MIT).
IPR issues	None.

Table 10. PRISTINE-6: Integrated RINA PoC for the datacentre networking use case

Exploitable result id	PRISTINE-6.

Exploitable result name	Integrated PoC for the datacentre networking use case.
Exploitation type	Commercial
Work package	All WPs.
Lead partner	CREATE-NET, ATOS.
Other contributing partners	NXW.
Type of exploitable result/output	Software and scenario configuration.
Core function of output	An integrated sofware package to be deployed in a datacenter scenario. The RINA architecture can have a technical impact on the cloud services in terms of efficiency and costs, as well as a business impact that deployment may have in terms of new business opportunities and new added-value services on top of the network.
Target segment for application	Data Center and Virtual Data Center applications.
Major benefits and impact	The integration of RINA with existing hypervisors could simplify and speed up the configuration, administration and tear down of virtual networks while lowering the RINA adoption barrier in the current DC/ VDC scenarios. Resource optimization and performance gains would lower OpEx and increase QoS. This offers an opportunity to both datacenter operators (direct adoption) and systems integrators to offer as a solution for that customer segment. The parallel deliverable D6.2 addresses an initial impact assessment of the three use cases.
Exploitation potential from 1 (very high) to 5 (very low)	1 (very high).
Current status	Testing scenario under preparation.
Expected date of completion	First version of the PoC expected by Q3-2015. Final iteration is at the project’s end (June 2016).

Time to market	3-5 years
Further external collaboration	Under evaluation
Cost to exploit	Under evaluation
Protection required	Software bundle composed by the IRATI implementation (GPL, LGPL) and policies for the use case (GPL, MIT).
IPR issues	None

Table 11. PRISTINE-7: Integrated RINA PoC for the network service provider use case

Exploitable result id	PRISTINE-7.
Exploitable result name	Integrated demonstrator of RINA for ISPs.
Exploitation type	Commercial
Work package	All WPs.
Lead partner	Telefonica, iMinds
Other contributing partners	
Type of exploitable result/output	Software and scenario configuration.
Core function of output	Demonstrate PRISTINE concepts to stakeholders interested in new architectures for Internet Service Provider. The same outcome is also intended to be used for research and education purposes.
Target segment for application	Telecom providers.
Major benefits and impact	See PRISTINE in action, assess potential. The parallel deliverable D6.2 addresses an initial impact assessment of the three use cases.
Exploitation potential from 1 (very high) to 5 (very low)	1 (very high).
Current status	in progress
Expected date of completion	June 2016
Time to market	3-5 years
Further external collaboration	Under evaluation
Cost to exploit	Under evaluation

Protection required	Software bundle composed by the IRATI implementation (GPL, LGPL) and policies for the use case (GPL, MIT).
IPR issues	None

Table 12. PRISTINE-8: Boundary Protection Component for Multi-Level Security

Exploitable result id	PRISTINE-8.
Exploitable result name	Boundary Protection Component for Multi-Level Security.
Exploitation type	Commercial, Research
Work package	WP4.
Lead partner	TRT-UK.
Other contributing partners	-
Type of exploitable result/output	Software Component
Core function of output	This exploitable function enables data to be sent between classification levels in a carefully controlled and secure way to prevent accidental or deliberate release of sensitive data. It integrates the functionality of a Boundary Protection Component (BPC) into a RINA-based network to achieve the above. The intended use of this is to allow a controlled flow of data between security levels in a RINA network, while ensuring that data transferred the sending system is at a suitable classification level for the receiving system.
Target segment for application	Service and Network Providers
Major benefits and impact	The needs for MLS have emerged as organisations have had to deal with securing and protecting separate networking environments having different security classifications. This model no longer supports the needs for real-time communication, situational awareness and rapid response to crisis in the modern

	communications era. With MLS-BPC, it is possible to provide cross-domain information sharing across multi-domain security environments where each domain is managed by a separate administration authority.
Exploitation potential from 1 (very high) to 5 (very low)	2
Current status	Specified and being implemented.
Expected date of completion	Sept. 2015. (A laboratory component will be available).
Time to market	3-5 years
Further external collaboration	Under evaluation
Cost to exploit	Under evaluation
Protection required	Is being timestamped and protected. The licensing issue is under discussion internally.
IPR issues	None.

The same tables have been used in the per-partner exploitation plans reported in the following sections, in order to ease the analysis of the inputs as well as grouping the results towards defining the first iteration of the PRISTINE' exploitation plans.

IPR and Licensing

The main PRISTINE exploitable items described in the previous section have been also analised for the aspects related to Intellectual Property rights, in order to define mechanisms and frameworks that could allow the widest distribution, usage and adoption of RINA in various implementations, while guaranteeing - at the same time - appropriate authorship rights.

A balance between protection and adoption potential is being analyzed in the project in regards to licensing. (e.g. GPL, while ensuring that modifications of the open source code are made public, also could be problematic for integrating into industry-aimed solutions). Likewise, as this iteration of the exploitation strategy is prepared during the first development cycle, several of licensing decisions are temporary, for example, to protect the code while it is being matured during the second cycle.

The outcome of this analysis pertains mostly the PRISTINE software products. IPRs and licenses attached to PRISTINE’s software and specifications have been discussed within the

consortium and as a result of the partners' analysis the different software assets have been classified in three areas:

1. Extensions (e.g. SDK, Management Agent) or improvements (e.g. bug fixing, hardending, refactoring) of OpenIRATI software.
2. Custom (non default) plugins to implement PRISTINE policies and related specifications.
3. Other software modules outside OpenIRATI, e.g. the Network Manager (WP5) or RINA simulator.

Current status of licenses and IPRs

The following table reports a list of the licensed items and for each of them it is specified:

- Software module: Name of the software module to be licensed
- Component: RINA components involved in the software module
- Research area: Research area involved in the software module
- License: License currently associated with the software module
- Copyright holder: Partner that holds the software rights
- Dependencies & Licenses of the dependencies: libraries and binaries that the software module depends on, and their corresponding licenses

Table 13. Table of Licenses

Software Module	Component	Research area	License	Copyright holder	Dependencies & Licenses of the dependencies
librina (part of OpenIrati/ SDK)	ALL	ALL	LGPL	NXW, i2CAT, iMinds	
rinad (part of OpenIrati/ SDK)	ALL	ALL	GPL	NXW, i2CAT, iMinds, BISDN	
OpenIrati/ SDK kernel support	ALL	ALL	GPL	NXW, i2CAT, iMinds	
rina-tools (part of	ALL	ALL	GPL	NXW, i2CAT,	

Software Module	**Component**	**Research area**	**License**	**Copyright holder**	**Dependencies & Licenses of the dependencies**
OpenIrati/ SDK)				iMinds, BISDN	
Aggregate Congestion Control	RMT, DTCP	Congestion control	GPL	UiO, i2CAT	None
LFA for Resilient routing	RMT, RA, Routing	Routing, Security coordination	GPL	NXW, iMinds	None
QoS-aware Multipath Routing	RMT, RA, Routing	Routing	LGPL (temporary)	ATOS	None
Cherish/ Urgency Multiplexing	RMT	Resource allocation	GPL	UPC, i2CAT	None
Congestion control in datacenter-use-case	RMT, DTCP	Congestion Control	GPL	CREATE-NET	None
Multi-level Security	Security Manager (BPC)	Security coordination	Under internal discussion at TRT (Proprietary)	TRT	To be specified
Secure channel implementation Mechanisms and Policies	SDU Protection	Security	GPL	FIT-BUT	Linux Crypto API - GPL
Authentication policies	CACEP, Security coordination	Authentication, security coordination	LGPL	i2CAT	librina, LGPL

Software Module	Component	Research area	License	Copyright holder	Dependencies & Licenses of the dependencies
RINASim	simulator	simulation	MIT	FIT-BUT	OMNeT++ license http://www.omnetpp.org/intro/license
Network Manager	Manager of RINA-enabled systems	Network Management	Open source License (to be decided)	Ericsson, others?	None
Management Agent	Management Agent for the IRATI RINA implementation	Network Management	GPL	BISDN, i2CAT, Nextworks	rinad - GPL; librina - LGPL
Traffic Generator	Research tool for experimentation	Integration	GEANT outward Software License	iMinds, NXW	none, links with BOOST C++ libraries

Strategy and plans for licensing

The current status of licenses for the OpenIRATI software reflects the status of that software as released at the end of the IRATI project (March 2015). The introduction of PRISTINE SDK - and other PRISTINE developments - requires some change in the license strategy. Since all the IRATI partners that hold authorship on the software are also PRISTINE's partners, re-licensing is actually possible. In particular, two changes have been agreed:

- rinad will migrate to LGPL or ASL license in place of GPL, to allow other PRISTINE's partners and third parties to develop closed-source user-space plugins. In fact, PRISTINE SDK allows for custom policies to be plugged into the daemon processes contained in rinad (the IPC Process user-space implementation, the IPC Manager and the Management Agent). Since plugins are linked against rinad, the current rinad license (GPL) forces the plugins to be GPL. This is in contrast with PRISTINE commercial exploitation plans, that is foresees future commercialization of custom policies (to be distributed through plugins).
- rina-tools will have BSD license in place of GPL. The rina-tools package contains small utilities (rina-echo-time, rina-cdap-echo) that are used to debug/test the OpenIRATI

software. On one end utilities are not particularly important or central to PRISTINE, and therefore switching towards a more permissive license is not required in theory. On the other end it is reasonable to foresee that PRISTINE's partners and third parties (e.g. future projects) will use these small application as a starting point for developing their native RINA applications. For this reason, having these small pieces of software as BSD code will possibly avoid future licensing problems.

- the traffic generator (rina-tgen) was developed in the GN3+ IRINA project and was released under the GÉANT Standard Open Source Software Outward Licence, which is permissive (on par with Apache 2.0 and three-clause BSD). PRISTINE further updates and extends this tool to meet requirements for WP6 experimentation.

As reported in D5.3, the Management Agent is implemented as an add-on component of the IPC manager, and therefore it follows the same license of rinad.

For the other software not included in OpenIRATI, other licenses have been chosen:

- Ericsson has decided to open-source their Network Manager implementation.
- RINASim simulator is based on the OMNeT `framework, and has been therefore licensed with the OMNeT` license.
- Custom plugins choose their commercial-permissive license, because of the agreed changes reported at the beginning of this subsection.

Individual exploitation plans

The following paragraphs present the individual partner exploitation plans. Each section contains a short description of the partner and its interest, as well as the opportunities the partner sees for exploiting results developed within PRISTINE.

Analysis and information is provided in the tabular format introduced in Analysis of exploitable items.

Atos

As a large IT provider, Atos invests in research objectives of various timelines and levels of ambition. For example, several projects are aimed at readying an advanced prototype or proof of concept with an initial market potential within a few years after initial development. Others are more far reaching strategic objectives of several years, sometimes applying to a market transition that have not yet taken form. PRISTNE is of the latter.

Atos recognizes the potential of PRISTINE, and its extension of the RINA architecture, as a potential long-term disruptive technology for the core evolution of networks. The company's

exploitation development for the project involves highlighted scenarios of varying timelines and dependencies, also syncing with its larger 5G-related R&D roadmap.

The first scenario, Cloud / Data Center Management, relates to a more local application of the architecture (i.e. LAN, between company sites, or between company and customer), while the latter two scenarios are further reaching, meeting a potential wider impact of RINA across external networks. The multiple timelines are taken to compensate for various RINA adoption challenges:

- The Recursive Internet (RINA) concept is very disruptive, while TCP/IP is a very well established, requiring a longer term strategy to facilitate adoption.
- Technology readiness is below TLR 6. There are currently no production deployments of RINA yet and projects like PRISTINE are still studying practical solutions for unexplored aspects related to the fragmentation of processes that RINA proposes.
- Industrial involvement is at an early stage, and requires a more pragmatic demonstration of RINA potential through viable pilots; such as the project's SDK and use cases are designed to help achieve.

Scenario #1: Network Improvement of Cloud Computing Portfolios and Data Center Management

- Estimated Timeline: 2 to 5 years starting with proof of concept towards company's data centers. Atos has an established and growing Cloud computing portfolio that has become a core priority for the company.

The Canopy brand, originating from a joint venture between Atos, VMware and EMC, includes Infrastructure, Platform and Software as a Service (IaaS, PaaS and SaaS), as well as leadership in large enterprise consulting. The recent acquisition of Bull has brought even more resources to the Cloud focus of the group.

The company focuses on end-to-end service lines for its Cloud computing offerings. For example, this could begin with consulting, leading to implementation of a private Cloud integrated at the customer, and expanded into a hybrid solutions (private/public) at Atos data centers, or full managed operations of the deployment. The combinations are numerous, with several IaaS and PaaS offerings of different tenancy options, of local, hybrid and fully managed variations.

As the Cloud offerings mature in flexibility, resulting in the interlinking of several infrastructures or platforms between data centers, the network requirements become

increasingly complex. PRISTINE includes two use cases examining this area: Distributed Cloud and Datacenter Networking, bringing substantial improvements to routing and distributed resource allocation for more cost-effective operation and QoS for hosted customer applications, in addition to increased security as these scenarios become more and more distributed. For example, the Datacenter Networking use case recognizes IP bottlenecks in relations to management and mobility of VMs between sites, congestion issues, multi-tenancy complexity, etc.

These scenarios represent an area that Atos can exploit PRISTINE without the larger dependencies of a wider adoption and disruption, where such qualities can be implemented exclusively between company sites.

Next Steps:

1. Atos exploitation of PRISTINE towards these scenarios begins with its close collaboration in WP2 use cases and WP6 evaluation scenarios in the context of business impact.
2. In parallel, as initial demos become available, Atos will continue dialog with its counterparts in datacenter management, Cloud portfolios (Canopy, Bull) and managed operations, leveraging the impact analysis of WP6 and identifying the building blocks for a potential proof of concept.
3. As the project matures in its final development phase, as well as the supporting evaluation activities in WP6 on integrated, mature results, these internal next steps will present a roadmap for further trial and potential adoption of the technology.

Table 14. Exploitation entry

Exploitable results number	For management between datacenter sites: * PRISTINE-3: Management System for RINA Networks * PRISTINE-4: RINA Policy Specifications For programmability and testing of network: * PRISTINE-1: RINA Software Development Kit (SDK) * PRISTINE-2: RINA Simulator For general requirements, PoC, know-how, etc.

	* PRISTINE-5: Integrated RINA PoC for the Distributed Cloud Use Case * PRISTINE-6: Integrated RINA PoC for the Datacenter Networking Use Case
Target segment for application	This scenario is aimed at improving Cloud computing offerings at Atos, aimed at a variety of customer profiles in industry verticals (e.g. finance, transport, health, retail, manufacturing, etc.). It would not be disruptive to existing IaaS and PaaS business models, but instead improve the performance, OpEx and overall competitiveness of the offerings.
Major benefits and impact	The socio economic impact of the scenario is initially targeted at the company's operations: cost savings (decreased OpEx), reliability (interlinking data center network), security, etc. Benefits would then be delivered to the customer through improved IaaS and PaaS offerings, following the Cloud computing value chain. Customers of Atos' Cloud computing offerings would benefit from improved performance and QoS of applications and services deployed and federated between Atos data centers' distributed infrastructure.
Current status	Currently in development of primary PRISTINE assets and awaiting project PoC trials.
Expected date of completion	2 to 5 years additional development, simulation and proof of concept of architecture concepts for company's data centers.
Time to market	As mentioned above, in a 2 to 5 year timeline that includes internal proof of concepts, aspects of certain PRISTINE / RINA architecture could be used internally

	at data center operations. As technology receives more traction, “Time to Market” in this case refers to when existing offerings would be upgraded with project assets as an alternative, rather than a standalone service line.
Further external collaboration	Continued participation with RINA-related working groups and initiatives would be key. As PRISTINE is Atos' first experience with RINA, this continued collaboration is on the critical path for any exploitation scenario.
Cost to exploit	Internal follow-up PoC and related integration costs would be a company project, independent of additional funding. However, participation in continued research initiatives would be approached in Atos’ R&D department, as RINA implementation is still much in the research domain, as opposed to a high TRL prototype closer to production use.
Protection required	Open source with a commercial-friendly license (e.g. Apache) would be the preferred path. A protective proprietary or copyleft open source strategy (e.g. GPL) would limit integration potential.
IPR issues	Atos has been suggesting to the consortium to avoid GPL licensing for its final results in order to be more viable for the industry. Initial licensing (presented in this deliverable) also takes into account protection of the developing foreground, where certain components may be re-licensed once further matured.

Scenario #2: Telecom Sector Consulting and System Integration

- Estimated Timeline: 3-7 years of long-term technology forecast/consulting and later more tangible opportunities in potential systems integration.

Under the Atos Consulting brand, the company focuses on internal technology and knowledge transfer of such projects to support clients in commercializing innovative products and services. In the telecom sector in particular, the arena has expanded with new technologies that have permeated the market. Network Function Virtualization (NFV), for example, is readying an increased role for IT providers, such as Atos, in a 4-8 year span in increased adoption from telecom customers, leveraging experience in virtualization from its Cloud service provision as network providers break their dependence on hardware-centric solutions and move towards a more agile software-driven strategy.

PRISTINE offers a longer-term consulting and systems integration opportunity that can be dovetailed in its increased role in software-driven networks and 5G vision.

This scenario has a wide range in timeline, as the company's consulting also deals with longer-term disruptive technology when advising its customer base. As PRISTINE and RINA's influence increases over time, more hands-on services can be coupled with its other network technologies of more short and mid term time-to-market projections, such as NFV.

Next Steps:

1. Increase dissemination internally to the company, hosting presentations of PRISTINE's potentially disruptive impact.
2. Further industry-level dissemination in 5G-PPP arena to help close technology gap.
3. Collaboration with consulting teams as PRISTINE / RINA aspects further permeate networks.

Table 15. Exploitation entry

Exploitable results number	For experience and know-how of PRISTINE/ RINA-based network solutions: * PRISTINE-1: RINA Software Development Kit (SDK) * PRISTINE-2: RINA Simulator * PRISTINE-3: Management System for RINA Networks * PRISTINE-4: RINA Policy Specifications For best practices, general requirements of PRISTINE/RINA implementation:

	* PRISTINE-5: Integrated RINA PoC for the Distributed Cloud Use Case * PRISTINE-6: Integrated RINA PoC for the Datacenter Networking Use Case
Target segment for application	This scenario is aimed at the Telecom Sector through Atos consulting and systems integration services.
Major benefits and impact	As recursive networks break through the research domain and gains market traction, Telecom Sector customers, such as network operators, would benefit from consulting services by companies with context gained during related research initiatives and PoCs. The socio economic impact of the scenario is focused on consultancy and ease-of-integration of recursive networks, suggesting the ability to make better educated business decisions (refined requirements, scope of integration, etc.) and lower cost of entry (ease of integration by experts of the technology, etc.), respectively.
Current status	This is a farther off exploitation goal, when PRISTINE/RINA research experience can be translated to business consultancy and systems integration, which depends highly on the long-term maturation and adoption rate of RINA.
Expected date of completion	3-7 years, a wide estimation that depends on long-term adoption of RINA.
Time to market	Such services would be ideal to introduce immediately to first-movers from the Telecom Sector, as consultancy of the emerging technologies would be rare service due to its incubation in the research domain.

Further external collaboration	Continued participation with RINA-related working groups and initiatives would be key for any such scenario.
Cost to exploit	The costs of delivering consultancy or integration services is difficult to quantify given the distance to actual market introduction of PRISTINE/RINA. As many such services, this would depend heavily on the individual requirements and scope of each telco customer.
Protection required	(repeated from previous scenario, universal for all exploitation paths) Open source with a commercial-friendly license (e.g. Apache) would be the preferred path. A protective proprietary or copyleft open source strategy (e.g. GPL) would limit integration potential.
IPR issues	(repeated from previous scenario, universal for all exploitation paths) Atos has been suggesting to the consortium to avoid GPL licensing for its final results in order to be more viable for the industry. Initial licensing (presented in this deliverable) also takes into account protection of the developing foreground, where certain components may be re-licensed once further matured.

Scenario #3: Strategic Positioning in Disruptive Technologies

- Estimated Timeline: 3-10+ years, beginning with SDK and growing in relevance in parallel to larger PRISTINE / RINA adoption and disruption.

Atos remains competitive by a proactive approach towards new technologies, hence its large investment in research and innovation, and links with longer term IT business opportunities, such as 5G-related R&D.

PRISTINE’s fully realized impact is ambitious, helping to evolve the internet to foresee the industry and society’s future requirements. A standardization roadmap is developing in the project, and will help support the architecture’s larger advancement and adoption path.

Atos longest-term goal in the project is to support this effort with consistent dissemination and education of the PRISTINE's results. The SDK, in particular, can be recognized as a building block towards this end, allowing the creation of more advanced use cases to realize its potential, and bring the technology from an academic domain to more pragmatic, concrete trial scenarios. This a circular impact, where increased experimentation of the SDK will lead to a stronger business case for supporting the wider disruptive path of the architecture, and vice versa.

Atos will leverage the SDK towards future R&D, positioning the company in a supporting role of RINA's concepts. The ROI of this strategic support will be a competitive positioning as the architecture's adoption increases.

Next Steps:

1. Support of PRISTINE'S SDK development and dissemination during the project's timeline.
2. Exploitation of the SDK within the company's R&D department for further use cases and trials based on PRSTINE's extension of RINA architecture.
3. Continues dissemination of SDK and project's results to both internal (company) and external (IT sector, 5G-PPP and related initiatives) to maintain Atos growth in long-term network technologies.

Table 16. Exploitation entry

Exploitable results number	For additional experimentation for research: * PRISTINE-1: RINA Software Development Kit (SDK) * PRISTINE-2: RINA Simulator For base components for continued extension: * PRISTINE-3: Management System for RINA Networks * PRISTINE-4: RINA Policy Specifications For existing use cases and baselines to create new PoC's * PRISTINE-5: Integrated RINA PoC for the Distributed Cloud Use Case

	* PRISTINE-6: Integrated RINA PoC for the Datacenter Networking Use Case
Target segment for application	This scenario is aimed at strategic positioning around a potentially disruptive technology, beginning with the extension of research using the SDK, possibly leading to additional PoCs. Given the wide impact of potential longer-term, RINA-related adoption, this could eventually apply to a variety of sectors, gaining traction with further support from network providers and stakeholders in the Telecom sector. For now this is still limited to the growing RINA community, and the larger industry awaits further trials and validation, which PRISTINE is helping to move forward.
Major benefits and impact	This is a cumulative and longer-term collection of benefits from the other scenarios, whereas Atos would be able to position itself strategically for a potential widespread adoption of RINA architecture in networks. This would focus on a Telecom sector customer base and other verticals that would need consultancy, integration, service deployment, etc., on their RINA-enhanced networks, or, depending on adoption potential, the larger internet. The socio economic impact of the scenario is more focused on the research domain given its timeline and distance from its most disruptive adoption scenarios. Support for a larger PRISTINE / RINA roadmap, through extension of the core architecture, experimentation with the SDK and additional PoCs, would at its fullest help realize its vision of improving network technology in terms of QoS, efficiency, security, growth, etc.

Current status	This is a farther off research, experimentation and leadership goal, awaiting external dependencies such as PRISTINE / RINA adoption on a more standardization-related roadmap. Although this longer-term roadmap depends greatly on the larger RINA community, additional research and trials through this scenario can help speed its progress.
Expected date of completion	3-10+ years, a wide estimation that depends on long-term adoption of RINA.
Time to market	Time to market is a far off objective, where this scenario focuses on the potential of widespread adoption / overhaul of networks via an iteration of RINA architecture.
Further external collaboration	Continued participation with RINA-related working groups and initiatives would be key for any such scenario. Additional collaborative PoCs would avoid risk of silos, given that RINA success depends largely on a community effort.
Cost to exploit	In this case, the cost would be a combination of company-invested research and additional funded research.
Protection required	(repeated from previous scenario, universal for all exploitation paths) Open source with a commercial-friendly license (e.g. Apache) would be the preferred path. A protective proprietary or copyleft open source strategy (e.g. GPL) would limit integration potential.
IPR issues	(repeated from previous scenario, universal for all exploitation paths) Atos has been suggesting to the consortium to avoid GPL licensing for its final results in order to be more viable for the industry. Initial licensing (presented in this deliverable) also takes into account protection of the developing

	foreground, where certain components may be re-licensed once further matured.

BISDN

BISDN role in PRISTINE is primarily focused on the network management aspect of PRISTINE (WP5) and the authentication and authorization policies in the context of WP2. It is also involved in the general software stack development, which is a cross-WP activity.

BISDN will explore the feasibility to design and develop two different solutions:

Table 17. Exploitation entry 1

Exploitable results number	BISDN-1
Exploitable result name	Software accelerated RINA router
Exploitation type	Commercial
Work package	All WPs
Type of exploitable result/output	Software or software and hardware
Target segment for application	Data Centres and Service Providers
Major benefits and impact	Increased performance for RINA routers, that can benefit from the advantages/ flexibilites of RINA.
Exploitation potential	2
Current status	Under discussion
Time to market	2-5 years, depending on RINA adoption.
Further external collaboration	None forseen yet
Cost to exploit	Under evaluation
Protection required	To be defined
IPR issues	None.

Table 18. Exploitation entry 2

Exploitable results number	BISDN-2
Exploitable result name	RINA-based ISP transport solution
Exploitation type	Commercial
Work package	WP2, WP5
Type of exploitable result/output	Software

Core function of output	A more manageable and robust ISP access network transport solution
Target segment for application	ISP and access networks
Major benefits and impact	Improved manageability, reduced operational costs and CAPEX. Improvement of user's quality of experience.
Exploitation potential	2
Current status	Under discussion
Time to market	+5 years
Further external collaboration	To be defined
Cost to exploit	Under evaluation
Protection required	To be defined
IPR issues	None

CREATE-NET

CREATE-NET's exploitation plan is structured along two dimensions: (i) industrial exploitation, and (ii) academic exploitation. With the former, CREATE-NET plans to leverage on the competences and IPRs generated during the PRISTINE project in future industry projects. Regarding the latter (academic exploitation) Furthermore, CREATE-NET looks forward to integrate the fundamental RINA concept in curriculum of the Wireless Networks course (M.S.). This will be done within the invited seminars and guests lecturers that are regularly given by CREATE-NET researchers in the aforementioned course. Finally, CREATE-NET also plan to offer at least one M.S. level thesis focused on RINA concept and leveraging on the RINAsim.

Academic exploitation

Table 19. Exploitation entry

Exploitable results label	CREATE-NET-1
Exploitable result name	M.Sc. Course
Exploitation type	Academic
Type of exploitable result/output	M.Sc. course material
Target segment for application	Academy
Major benefits and impact	Introduce students to RINA, filling the current gap in M.Sc. level courses on recursive internet architectures. Educating

	students to RINA concepts will help fostering wider adoption.
Exploitation potential	3
Current status	A four hours seminar on RINA was given to the students of the Wireless Networks Course (M.Sc., University of Trento)
Expected date of completion	June 2015
Time to market	N/A
Further external collaboration	None
Cost to exploit	N/A
Protection required	No
IPR issues	None

Table 20. Exploitation entry

Exploitable results label	CREATE-NET-2
Exploitable result name	M.Sc. Thesis
Exploitation type	Academic
Type of exploitable result/output	M.Sc. Dissertation/Scientific Publication
Core function of output	Investigate performance isolation issues in data-centres
Target segment for application	Academy
Major benefits and impact	Developing student experitise on practical data-centres networking issues on RINA. Educating students to RINA concepts will help fostering wider adoption.
Exploitation potential	2
Current status	New students are expected to begin their M.Sc. thesis by the end of 2015
Expected date of completion	June 2016
Time to market	N/A
Further external collaboration	None
Cost to exploit	N/A
Protection required	No

IPR issues	None

Ericsson

The objectives of PRISTINE and the projects output will directly contribute to one of four strategic areas of Ericsson OSS/BSS. Policy management and Software-defined radio products have been announced by Ericsson at the 2013 MWC in Barcelona. Our primary goal for exploitation is to use PRISTINE results directly to improve our product line as well as to demonstrates new features for future releases. This will secure jobs in Europe and positively impact our competitiveness. The primary goal for dissemination is to channel innovation into existing standardisation projects, which we will realise in close cooperation with Ericsson Research.

Teaching

LMI is accepting research internship for advanced master and PhD tudents. The internship is based on a 3-6 months placement in the LMI Network Management Lab (NM-Lab). The interns are fully integrated in one of the Lab's research group and work on specific tasks.

Table 21. PhD and/or MSc Research Interns

Type [a]	Starting	Ending	Topics
Phd	01/10/2014	01/01/2015	Traffic classification and congestion detection using pack inspection of user-plane GTP traffic over UDP in mobile core networks" Paper in preparation for NOMS 2016
MSc	01/06/2015	31/08/2015	SDN support for switching for virtual network probes to perform deep analysis of high-volume user-plane traffic in mobile core networks

[a] Phd or MSc

Table 22. LMI Teaching Exploitation entry

Exploitable results	LMI-01
Exploitation type	Academic
Target segment for application	Education

Major benefits and Impact	Enable advanced students to work on real-world problems and use cases.
Current status	1 internship has been realised in 2014, 1 internship is active in 2015
Q2 2016	Time to market
Q3 2016	Further external collaboration
n/a	Cost to exploit
The costs of the internship is covered by LMI	Copyright
IPR issues	No

Scientific Communities - Workshops

Publication is an extremely important part of the LMI NM-Lab research. Peer-reviewed publications at top-class journals and conferences demonstrate LMI technology leadership and quite often start dicussions and projects with customers on advanced topics.

LMI is targeting the CNOM community in the IEEE with their main conferences IFIP / IEEE Integrated Network Management (IM), IEEE Conference on Network and Service Management (CNSM) and IEEE Network Operations and Management Symposium (NOMS) and jounrals Journal on Network and Systems Management (JNSM), and IEEE Transactions on Network and Service Management (TNSM), and the network management special issues in IEEE Communication Magazin.

LMI NM-Lab researchers are key scientific members are in the program committee of the following international conferences and workshops:

- Network Operations and Management Symposium (NOMS)
- Conference on Network and Service Management (CNSM)
- Integrated Network and Service Management (IM)
- Cognitive Network and Service Management (COgMan)

The LMI plan to actively participate in PRISTINE workshops during the project. The main objective for the LMI will be to promote the work on configuration management and performance management in RINA. Furthermor, LMI is promoting RINA and PRISTINE in various foras and with customers.

Table 23. LMI Scientific Exploitation entry

Exploitable results	LMI-02

Exploitation type	Research
Target segment for application	Scientific Community
Major benefits and Impact	A number of scientific publications based on PRISTINE work, where high-level data sets are made available through appropriate archives, and tools are developed for the advanced research of RINA. This activity is expected to add value to existing activities on European and international levels, and enhance and broaden research partnerships. It will help to increase the innovation, harmonisation and technological develop of RINA, which will increase its possible take up by industrial research centres.
Current status	Research papers are currently being drafted. RINA is promoted in various activities such as use case descriptions in related papers.
Expected date of completion	Q1 2016
Time to market	It will take up to Q2 2017 to fully disseminate the research finds and material.
Further external collaboration	Further external collaboration is expected.
Cost to exploit	While there is a disseminate budget available with in the PRISTINE project, it is foreseen that additional funding will need to be raised to help continue the dissemination of the research results into 2017 and beyond.
Protection required	Copyright
IPR issues	None

Commercial exploitation

Our commercial exploitation is focused mainly on the Pristine Manager and the DIF (or Distributed) Management System (DMS). Once the DMS is developed and documented, we plan to open source it and contribute it to various industry foras as a management option. Potential target foras are ONOS and ON.Lab. This requires that a cloud and SDN use case with a RINA network can be delivered along with the DMS to demonstrate the advantages of using RINA for cloud deployments and SDN networks, and to show the competitive features of the DMS.

Second, we are promoting RINA in discussions and projects with customers focusing on 5G networks in the horizon of 2020. For instance, we participated in the 1st IEEE 5G Summit in May in Princeton, NJ. The workshop was organised by Princeton University and the AT&T CSO. Our presentation at the workshop focused on autonomic control for 5G networks, very much driven by development realised in Pristine WP5.

Table 24. LMI Commercial Exploitation entry

Exploitable results	PRISTINE-3: Management System for RINA networks
Exploitation type	Commercial
Target segment for application	Network management system vendors in the telecommunications network operator space and enterprise data centre network operation space
Major benefits and Impact	Benefit from a reference implementation kept up-to-date with the RINA specifications. The same reference implementation would also be the base for consulting activities towards these vendors. There is the potential for a technology being developed here to be either licensed by a tier 1 network management systems vendor, and the investigation of a start-up company taking this product to market will be investigated.
Current status	PRISTINE phase I software base about to be released (M20 of PRISTINE)
Expected date of completion	Q2 2016
Time to market	Initial investigation on this topic appears to point towards Q4 of 2017.
Further external collaboration	This product will require external collaboration
Cost to exploit	There will be a need to raise new funding for the exploitation of this product.
Protection required	Patents
IPR issues	None to date

Further Research Projects

LMI will also actively participate in the activities organised at the EC programme level relating to the ICT Future Networks area.

FIT-BUT

FIT-BUT mostly focus their exploitation plans along academic initiatives, with a number of actions just started and reported in the following table.

Table 25. Academic exploitation

Partner	Type [a]	Starting date [b]	Ending date [c]	Topics
FIT-BUT	PhD	Q3 2013	Q1 2017	Data transfer in Recursive Network Architectures
FIT-BUT	PhD	Q3 2014	Q4 2017	Secure channel and data transfer
FIT-BUT	Bc	Q3 2014	May 2015	RMT and RA simulation modules
FIT-BUT	Bc	Q3 2014	May 2015	Enrollment and authentication process

[a] Phd or MSc

[b] Expected starting date

[c] Expected ending date

The main actives of FIT-BUT aim at research and evaluation of the PRISTINE concepts using simulation techniques the exploitation consists of RINA simulator tool being developed in the project.

Table 26. Exploitation entry

Exploitable results number	PRISTINE-2
Exploitable result name	RINA Simulation tool
Exploitation type	Research
Work package	WP2
Lead partner	FIT-BUT
Other contributing partners	IMT-TSP, CREATE-NET
Type of exploitable result/output	Software
Core function of output	RINA simulation model for OMNet++ simulator in form of a collection of RINA

	component models and predefined RINA nodes and a set of scenarios. It is possible to simulate RINA networks in order to demonstrate functionality and perform experiment with different policies and under various settings and constraints.
Target segment for application	Academy
Major benefits and impact	To better understand networking architectures based on RINA and analyse the properties of the different communication mechanisms within RINA. The simulation environment may be used for obtaining results to support research and also as a demonstration environment in education.
Exploitation potential	3
Current status	Alfa version of RINA Simulation tool is already available.
Expected date of completion	30.11.2015
Time to market	Because of the character of the output and target segment, this output can be successfully used even before it is completed.
Further external collaboration	Possible, depending on the interest of RINA community.
Cost to exploit	No
Protection required	This output will be available under public domain, and distributed under MIT license.
IPR issues	None

Table 27. Exploitation entry

Exploitable results number	FIT-BUT-1
Exploitable result name	PhD Project
Exploitation type	Academic
Work package	WP4
Lead partner	TRT

Other contributing partners	
Type of exploitable result/output	PhD Thesis
Core function of output	Except new theoretical results the output will consists of a set of methods and policies of RINA security accompanied with implementation. New results on security mechanisms that include authentication, access control and encryption in IPC-based network architecture.
Target segment for application	Academy
Major benefits and impact	New research results in the area of security in IPC environment.
Exploitation potential	2
Current status	PhD project started in September 2014, thus it is at the very early phase.
Expected date of completion	PhD Thesis completed and defended in year 2017.
Time to market	N/A
Further external collaboration	The PhD project will continue after completing PRISTINE project. External collaboration is possible.
Cost to exploit	N/A
Protection required	No
IPR issues	None

Table 28. Exploitation entry

Exploitable results number	FIT-BUT-2
Exploitable result name	MSc course
Exploitation type	Academic
Work package	WP3, WP4, WP5
Lead partner	TRT
Other contributing partners	
Type of exploitable result/output	MSc course material
Target segment for application	Academy

Major benefits and impact	To teach students current state in networking, identify challenges and possible solutions. To learn about current state in networking, challenges and possible outcomes.
Exploitation potential	2
Current status	Gathering information and compiling course materials.
Expected date of completion	End of 2015 (course prepared and taught during year 2015)
Time to market	N/A
Further external collaboration	Under evaluation
Cost to exploit	N/A
Protection required	No
IPR issues	None

i2CAT

i2CAT is the PRISTINE technical project coordinator and WP2 co-leader, leveraging its 3 years of experience participating in the international RINA effort. i2CAT periodically presents project outcomes among its board members, composed by a variety of Internet stakeholders: manufacturers - Cisco, Juniper, Alcatel, Fujitsu -, operators - Vodafone, Orange, Abertis – and content providers - Mediapro, Cromosoma. In these review events, the i2CAT RINA team tries to promote the involvement of the board members in RINA initiatives, pushing for the creation of a spin-off company specialised on RINA products and services.

As such this general exploitation strategy can be broken down into the following more detailed items.

Table 29. i2CAT exploitable result 1

Exploitable results	PRISTINE-1: RINA Software Development Kit (SDK)
Exploitation type	Research, training and consulting activities (commercial)
Target segment for application	Competitive research funding calls for proposals; organizations desiring to acquire RINA knowledge

Major benefits and impact	Customizable RINA reference implementation, allowing for quick prototyping of policies and setting up RINA demos/trials
Current status	RINA implementation with base SDK ready, being augmented with more capabilities. Expecting a moderately robust solution by the end of the project.
Expected date of completion	0-6 months after the project ends
Time to market	Immediate for competitive research calls for proposals; 6 months to 2 years for the consulting activities
Further external collaboration	Depending on the needs of the competitive research call or the customers, collaboration with partners that have RINA knowledge (such as the ones in the PRISTINE consortium) is foreseen
Cost to exploit	Can be exploited right away as a tool to be used in RINA research proposals; cost to exploit for consulting activities under analysis.
Protection required	Software has open source licenses as described in the Licensing section
IPR issues	No issues identified

Table 30. i2CAT exploitable result 2

Exploitable results	RINA product based on any of the three PoCs
Exploitation type	Commercial
Target segment for application	Datacentre operators, telecom operators wishing to implement service function chaining, distributed IT infrastructure providers
Major benefits and impact	Flexible, customizable networking solution with specific security, multiplexing, data-

	transfer and routing policies that satisfy the needs of particular scenarios
Current status	Initial version of datacentre networking and distributed cloud PoCs ready for phase 1 experimentation activities, integration with the Network Manager ongoing
Expected date of completion	1-2 years after the project ends
Time to market	1-3 years, depending on the target customer
Further external collaboration	Partnerships with other partners wishing to exploit similar solutions could be evaluated
Cost to exploit	Cost to exploit would depend on the specific needs of each customer
Protection required	Base software protected by the licenses described in section 3
IPR issues	No issues foreseen

iMinds

There are two important routes towards exploitation of the results. On the one hand, iMinds is an independent research institute that is working closely with industry. The knowledge and IPR gained in this project will be exploited in future projects with industry, where industry will directly benefit from iMinds knowledge but industry may also take over some of the IPR for further commercialization. iMinds is also exploiting its knowledge by establishing spin-off companies. More information: www.iminds.be/en/entrepreneurship. In addition, the research is fully embedded in the different Flemish universities allowing a very efficient exploitation of knowledge by embedding this in the more advanced master courses in engineering and related high-quality PhD programs. In this specific project, the research group IBCN (Internet Based Communication Networks and Services), part of Ghent University, is involved. Apart from transferring knowledge gained in the project through integrating this knowledge in courses of scientific papers, iMinds is participating in the development activities. The software contributed by iMinds is an integral part of the Open Source PRISTINE prototype, which is used as the basis for master thesis projects and as hands-on material for lectures on RINA.

Exploitation entries

Table 31. Academic exploitation

Partner	Type [a]	Starting date [b]	Ending date [c]	Topics
iMinds	PhD	Q1 2013	Q4 2016	Routing aspects of the Recursive InternetNetwork Architectures
iMinds	MSc	Q4 2014	Q2-Q3 2015	Comparing RINA and TCP for latency-constrained applications.

[a] Phd or MSc

[b] Expected starting date

[c] Expected ending date

Table 32. Exploitation entry

Exploitable results number	IMINDS-1: RINA Traffic Generator
Exploitation type	Academic, Research
Lead partner	iMinds
Other contributing partners	Nextworks
Type of exploitable result/output	Software
Core function of output	Generate RINA traffic according to well-defined statistical properties.
Target segment for application	Research and teaching activities.
Major benefits and impact	Enable RINA tseting, experimentation and performance measurement activities.
Current status	Under development
Expected date of completion	Prototype ready for research purposes for the experimentation phase of PRISTINE (Early 2016).
Time to market	N/A
Further external collaboration	Possible future research projects, under evaluation
Cost to exploit	N/A

Protection required	GEANT outward software license is in place.
IPR issues	Joint copyright iMinds and Nextworks, License in place.

IMT

IMT-TSP exploitation plan in the scope of PRISTINE concerns basically proposing a MSc/ PhD lecture that will introduce RINA architecture to the IMT-TSP students. IMT-TSP is also investigating the possibility to set up national research projects to develop RINA-based IoT platform. IMT-TSP intends also to publish PRISTINE research results in conferences and journals.

Table 33. Exploitation entry

Exploitable results number	TSP-IMT-1
Exploitable result name	MSc & PhD introductory RINA course
Exploitation type	Academic
Work package	WP3, WP4
Other contributing partners	
Type of exploitable result/output	Course lecture notes
Target segment for application	Academy
Major benefits and impact	Allow students to learn a new promising clean slate network architecture, integrating the course to one of our master programs or PhD programs.
Exploitation potential	3
Current status	Initial steps of the course preparation
Expected date of completion	2016
Time to market	N/A
Further external collaboration	None foreseen yet.
Cost to exploit	N/A
Protection required	No
IPR issues	None

Table 34. Exploitation entry

Exploitable results number	TSP-IMT-2

Exploitable result name	National Project set up tentative
Exploitation type	Research
Work package	All WPs
Other contributing partners	
Type of exploitable result/output	Advance on Research/development of RINA and exploration of the possibility of using RINA in sensor networks and IoT
Final output and its applicability	RINA-based IoT architecture: benefit of RINA naming and addressing strategies
Target segment for application	Academy/Industry
Major benefits and impact	Being a very resource-constrained environment, IoT can benefit from the flexibility of RINA architecture. In particular, naming and addressing strategies and security can be beneficial to the rising IoT architecture. Therefore, the impact of PRISTINE can be to provide efficient services in IoT for smart cities.
Exploitation potential	3
Current status	None
Expected date of completion	2016
Time to market	3-5 years
Further external collaboration	Industrial/academic partners (under evaluation)
Cost to exploit	Under evaluation
Protection required	None.
IPR issues	None

Juniper has decided to withdraw from the PRISTINE project as of 1st July 2015 for internal re-allocation of priorities and resources. The know-how on RINA gathered during their participation will be possibly used to support entrepreneurship initiatives in research centers they participate in, as for example reported in i2CAT section.

Nexedi

Nexedi is the largest European open source software publisher with 10 different software products and 10,000,000 lines of self developed code. Through the RINA project, Nexedi will be able to improve two of its software products: SlapOS and re6stnet. At the end of the project, SlapOS will provide initial support through the integration of IRATI and faux socket. re6stnet will support a form of scalability inspired by the recursive design of RINA. without losing its resilient nature.

Nexedi currently uses IPv6 across its worldwide infrastructure and has obtained access in China to a license to interconnect business applications without government interference. Thanks to re6stnet, Nexedi is able to provide resilient connectivity between business applications. Failure of a router, of BGP configuration or government filtering has virtually no effect on applications interconnected through re6stnet. However, the current model of re6stnet is not scalable and can be broken either through DPI or through intrusion. Solving those problems was the key reason for Nexedi to join the PRISTINE project with the distributed cloud use case as application use case.

All developments done by Nexedi are already based on SlapOS. Our goal is that RINA will become one of the standard protocols offered by SlapOS in addition to IPv6 and IPv4. The progress of IRATI will make this possible very soon. In order to make RINA usable by legacy application, Nexedi has contributed to "Faux Socket" library that provides an API similar to sockets and thus simplifies porting code to RINA. The ability to patch and build at the core of SlapOS simplified the release of RINA compatible profiles. Our goal at the end of the project is to demonstrate the use of standard python to connect two services on the same LAN through RINA. We may also try if time permits to achieve the same results for two processes interconnected through RINA by IRATI over a Layer2 openvpn tunnel generated by re6stnet.

In parallel, discussions with other project members as well as the influence of the recursive RINA design have lead us to find a solution for the scalability problem in re6stnet. re6stnet is actually a tunnel mesh generator which is network protocol independent. We will first extend it to support a recursive random mesh so that we gain scalability. We will then design a generic API that compares metrics provided by routing and metrics monitored by tunnels. We expect that through the comparison of both metrics, we can implement fair routing and anti-DPI protection.

The exploitation through SlapOS service provide by Nexedi’s fully owned subsidiary "VIFIB" will provide a cloud testbed to all RINA based projects and increase the awareness of RINA. With "Faux Socket", it will be easier for developers to adopt RINA.

The exploitation through re6stnet of the ideas developed as part of PRISTINE in the area of scalability and fair routing will provide exploitation of project results using other protocols (IPv4, IPv6) and later using RINA protocol. We expect that IRATI over re6stnet will be the first step towards a worldwide RINA network.

Nexedi does not expect to generate any significant revenue through RINA itself. However, the ideas brought by the PRISTINE project will increase the competitiveness of Nexedi services based on SlapOS and re6stnet. Moreover, thanks to IRATI, Nexedi will benefit from an alternative path to IPv6 which may prove to be useful if IPv6 collapses as some do predict. RINA is thus an insurance policy for Nexedi.

Exploitation entries

Table 35. Exploitation entry

Exploitable results number	* NEXEDI-1: SlapOS RINA base image
Exploitation type	Commercial
Target segment for application	Cloud computing and experimental deployment
Major benefits and impact	Provide deployment RINA support for Cloud applications. This results in the ability to work on advanced R&D outside a large company that primarily focuses on stockholders rather than on innovation or economic utility.
Current status	Development of initial release
Expected date of completion	2 to 5 years after initial release, based on progress of IRATI
Time to market	2 to 5 years after initial release, based on progress of IRATI
Further external collaboration	NXW consulting is required to support users
Cost to exploit	Under evaluation
Protection required	GPL/LGPL has our preference because it protects us the growing theft of staff and effort conducted by large companies which do not contribute to Free Software through non copyleft licenses

IPR issues	we use employment contracts that prevent theft of staff

Table 36. Exploitation entry

Exploitable results number	* NEXEDI-2: recursive re6stnet
Exploitation type	Commercial
Target segment for application	Application delivery networks
Major benefits and impact	Provide resilient Internet connectivity worldwide (including in China) for business applications. Ability to work on advanced R&D outside a large company that primarily focuses on stockholders rather than on innovation or economic utility
Current status	Commercial, but non scalable and no fair routing
Expected date of completion	1 year after end of project for scalability, 3 years after end of project for fair routing and 5 years after end of project for pure RINA implementation
Time to market	1 year after end of project
Further external collaboration	N/A
Cost to exploit	N/A
Protection required	GPL/LGPL has our preference because it protects us the growing theft of staff and effort conducted by large companies which do not contribute to Free Software through non copyleft licenses
IPR issues	we use employment contracts that prevent theft of staff

Nextworks

Nextworks has a consolidated portfolio of consulting activities in the TLC sector, in which it works as a complete solution provider for its customers (i.e. major TLC vendors and international Network Operators and NRENs). The company business in this market is supported by the ever-growing know-how of its personnel, which, in turn, is continuously renewed and widened through the participation in advanced R&D projects. Nextworks

participation in PRISTINE has the strategic objective of advancing the company expertise on emerging networking architectures, by continuing the work started with IRATI. Nextworks is convinced that the research on RINA, also augmented with the prototype and testbed activities planned in the project, can definitely contribute to the realization of the Future Internet vision. The company also expects that RINA research can primarily impact the market of the small-medium size (regional) network operators and campus networks, as these actors are commonly more inclined to deploy innovative networking solutions in shorter terms. In this market niche, the role of Nextworks as an SME could be decisive to engineer custom, flexible and advanced solutions tailored to the customer needs. Nextworks expects to pursue RINA R&D with a 5-8 years prospect to turn into market products. In this view, the outcomes from the PRISTINE project (PRISTINE SDK, RINA Management System, Integrated PoCs for PRISTINE usecases) will represent a key starting point towards new commercial products. Nextworks will also take advantage of the industrial and scientific dimension of the project, made of outstanding and renowned network vendors, R&D architects and performers. The company also expects to increase its market visibility to the wider research community active on the Future Internet through the dissemination activities in PRISTINE. Due to its nature and business opportunities, Nextworks has a strong interest in the PRISTINE SDK. The company actively participates in design, development and integration activities in order to foster and exploit all the prototype potentials, focusing on the applications to small operators and DCs. The company participation and roles in the project reflect these strategic plans.

Nextworks has covered a key designer and implementer role for the PRISTINE SDK, and has particularly focused in the project' first iteration on the implementation of the Rina Plugin Interface (RPI), which extends the final prototype released by IRATI to allow for programmability - e.g. policy deployment.

Nextworks strategy for exploiting the great amount of work behind these tangible PRISTINE foreground has been just applied during first iteration along three major drivers:

1. Producing high-impact and visibility through the contribution to the dissemination actions (papers, workshops and tutorial reported in this document)
2. Participating to the standardization work (both ISO and PSOC activities)
3. Leading the integration and mainteinance of code and infrastructure of OpenIRATI as open source via GitHub.

All these actions have aimed at building the Nextworks position as RINA expert and implementer in the international research and industrial community, which has been successfully accomplished with the numerous activities reported for first iteration.

However, Nextworks interest in RINA is part of broader research strategy the company has undertaken from some years on network architectures beyond TCP/IP. The ultimate goal for Nextworks is to find innovative (and disruptive) network control tools/solutions that can make more efficient the internetworking in virtualized data centers and geographically distributed and virtualized services. Nextworks expectation is that innovative network product lines may come from this type of research work and possibly turn into new profitable business opportunities for the company.

To implement this strategy Nextworks partecipates in PRISTINE with the role of key designer and implementer of the PRISTINE SDK, and has also been a key partner in the two other EC-funded companion projects, IRATI and IRINA.

Based on the deep knowledge of the RINA architecture matured during the IRATI, IRINA and PRISTINE projects and the current functionalities of the OpenIRATI stack, Nextworks sees the potential consolidation of this foreground (both know-how and software assets) in commercial RINA products to occur not earlier than 1-2 years (medium/long-term) from now, i.e. once the developments of PRISTINE will be completed and – in parallel – the RINA market assessment will be structured in terms of identification of customer interests and definition of sustainable business plans.

The more re-usable PRISTINE result in a short term (1 year) is currently the RINA know-how, which Nextworks intends to exploit along two directions:

- improve the expertise of Nextworks consultants involved in the design of specific network + cloud solutions and offer to its customers highly experienced network and software architects capable of extremely new and innovative solution design
- offer specialized training and tutoring on network technologies and RINA to interested customers (e.g. network/cloud providers, vendors, etc.).

The possibility to realize this short-term PRISTINE exploitation strategy is further increased by some strategic partnerships Nextworks has been working on from Q3-2014 with big consulting firms (info on partners not-disclosable) exactly on the themes of Future Internet and the training.

Exploitation entries

Table 37. Exploitation entry

Exploitable results number	* PRISTINE-1: RINA Software Development Kit (SDK)
Exploitation type	Commercial
Target segment for application	Consulting activities and research

Major benefits and impact	NXW customers would benefit from a reference implementation kept up-to-date with the specifications. The same reference implementation would also be the base for consulting activities on innovative network management solutions.
Current status	First iteration prototype released
Expected date of completion	2 to 5 years additional development, proof of concept and adoption of architecture concepts.
Time to market	2 to 5 year timeline, including internal proof of concepts.
Further external collaboration	Given the size of the code-base and its readiness level, continuous integration, updates and debugging are required. NXW foresee that enlarging the user-base and enforcing the Open Source related activities are key steps.
Cost to exploit	Under evaluation
Protection required	Open source with a commercial-friendly license would be the right path once adoption starts widening. However, given the status of the current code, NXW prefers a defensive strategy (GPL/LGPL), that allows to keep track of third parties modifications.
IPR issues	None

Table 38. Exploitation entry

Exploitable results number	* PRISTINE-5: Integrated RINA PoC for the Distributed Cloud Use Case * PRISTINE-6: Integrated RINA PoC for the Datacenter Networking Use Case
Exploitation type	Commercial
Target segment for application	Small-medium sized DC and campus networks

Major benefits and impact	Customer would benefit from flexibility that RINA provides in terms of resource allocation, ease of network virtualization (DIF as a basic block), built-in QoS and security mechanisms.
Current status	Currently in development of primary PRISTINE assets and awaiting project PoC trials.
Expected date of completion	2 to 5 years additional development, proof of concept and adoption of architecture concepts in company's data centers.
Time to market	2 to 5 years
Further external collaboration	Under evaluation
Cost to exploit	Under evaluation
Protection required	The PoC packages are based on OpenIRATI, which is currently licensed with GPL/ LGPL. In the next 2-5 years, however, we expect to relicense the software with a more commercial-friendly license, in order to allow to build products based on the PoCs.
IPR issues	None

TID

As the R&D branch of Telefonica, TID will use its privileged communication path with network operations and business units to identify where and how the opportunities RINA offers can be considered for integration in its network. Though the very nature of the RINA proposal makes it difficult to consolidate it in the extremely cautious environment of network operations, we are confident there are clear opportunities to start building the case for a clean-slate approach to network architecture. In particular, in what relates to the use case TID is focused on: the support to NFV deployment and operation. In this particular aspect, TID will be able to demonstrate to the Telefonica Group how the results of PRISTINE can be applied in the design and deployment of its future vPoPs (virtualized Points of Presence), and to incorporate some results even in its current commercial networks.

TID foresees the exploitation potential of PRISTINE in this new architecture for vPoPs and plans to demonstrate this through the use case developed in the project, aiming at building a proof of concept according to the NFV PoC Framework (http://www.etsi.org/

technologies-clusters/technologies/nfv/nfv-poc). We plan to use this NFV PoC as the keystone for showcasing RINA within the Telefonica Group and very likely among the NFV community at large. The PRISTINE NFV showcase could also be suitable to be applied to the technology showcases of projects like UNICA (http://saladeprensa.telefonica.com/documentos/UNICA__20140224.pdf), a NaaS (Network as a Service) infrastructure that will host critical network services.

TRT

TRT (UK) involvement in PRISTINE is mainly focused on security aspects in WP4. There has been special attention on the security functions and controls that can be exploited. Below we give the outline of an exploitable result, which have arisen to date. Detailed information on the results will be given in the appropriate deliverables (D4.2 and D4.3).

Multi-Level Security (MLS) refers to access control mechanisms for protecting data or “objects” that can be classified at various sensitivity levels, from processes or “subjects” who may be cleared at various levels of trust. However, to make an MLS system practical it is generally necessary to allow for at least some capability to send data from a high system to a low system, e.g. to allow higher cleared users to send emails to lower cleared users. This capability cannot be achieved using SDU protection and needs to be carefully controlled to prevent accidental or deliberate release of sensitive information by users or malicious code. This exploitable result integrates the functionality of a Boundary Protection Component (BPC) into a RINA-based network. The RINA BPC is used to control flows data between security levels, to ensure that data transferred from the high system is actually at a suitable classification level for the low system. As RINA can sit and operate on top of any networking environment depending on the support of an appropriate shim DIF, the MLS solution can be used as an overlay RINA-based service function over any networking technology.

Table 39. Exploitation entry

Exploitable results number	* PRISTINE-8:
Exploitation type	Commercial
Target segment for application	Network and Service Providers - There are many initiatives and application areas in various domains that require MLS solutions in order to provide easy sanitization and secure data sharing on a common infrastructure. These application areas includes data sharing in protecting Critical National Infrastructure (CNI), in multi-

	agency, multi-national coalition working environment and in business-to-business settings.
Major benefits and impact	Resilient, secure and highly-available networking is paramount to Thales and other organisations. MLS makes RINA as programmable secure networking for data sharing between systems and applications at different classifications. It allows cross-domain secure information sharing across multi-domain environments.
Current status	TRL-2/3. Designed, specified and being implemented for Proof of Concept (PoC)
Expected date of completion	A laboratory component will be available for PoC Sept. 2015.
Time to market	2-5 years, needs further development, verification, and Engineering design
Further external collaboration	Not yet.
Cost to exploit	To be specified.
Protection required	Yes. MLS solution in PRISTINE is dictated by policies and these policies and their security perimeters need to be highly protected.
IPR issues	Is being time-stamped and protected. The licensing issue is under discussion internally.

UiO

The foundational lecture on Computer Networks taught at UiO, INF3190, contains a unit on problems with the current Internet and possible future directions for its evolution. How RINA addresses some of these basic problems is already being taught there, and PRISTINE results will accordingly be incorporated in this lecture unit as they become available. Further planned exploitation at UiO includes national project proposals that can propose research based on the Simulator and the SDK.

Table 40. Exploitation entry

Exploitable results label	UiO-1

Exploitable result name	MSc course
Exploitation type	Academic
Type of exploitable result/output	MSc course material
Target segment for application	Academy
Majors benefits and impact	Teaching students (future ICT professionals) the current state in the Internet and networking, and possible future directions with an introduction to RINA and
Current status	Gathering information and compiling course materials.
Expected date of completion	End of 2015
Time to market	N/A
Further external collaboration	Under evaluation
Cost to exploit	N/A
Protection required	No
IPR issues	None

Table 41. Exploitation entry

Exploitable results number	For future national research proposals: * PRISTINE-1: RINA Software Development Kit (SDK) * PRISTINE-2: RINA Simulator
Exploitation type	Academic
Target segment for application	Academy
Major benefits and impact	It enables the exploitation of PRISTINE results, and enhancing its developed basic functionalities in the SDK and the simulator. Conducting research which can lead to better and safer networking.
Current status	A national research proposals based on RINA has been submited.
Expected date of completion	5 years after its start.

Further external collaboration	It provides the opportunity to collaborate with other external research centers.
Cost to exploit	N/A
Protection required	No
IPR issues	None

WIT-TSSG

The overall objective of the dissemination and exploitation plan for the TSSG is to promote the research activities for the institute along with raising awareness of RINA and the PRISTINE project and its results among a target community, including: researchers, software developers, companies, standardisation organisations, students and end-users.

Teaching

There are fellowship schemes in operation at the Waterford Institute of Technology (TSSG) which offer opportunities for suitably qualified women and men to pursue a Masters or Doctorate level postgraduate degree by research. During the period of the PRISTINE project, the TSSG will open up this offer in the technological area of RINA, and the policy-based configuration and autonomous operation of the DIF management system.

The institute also runs a one year taught Masters programme, and it is envisaged that as the project runs in the academic year of 2014-2015, there will be a new dissertation which relates to the research themes of PRISTINE.

Table 42. PhD and/or MSc theses

Type [a]	Starting date [b]	Ending date [c]	Topics
Phd	01/09/14	31/08/2017	Investigating Self-orchestration behaviour in Recursive Network Architectures
MSc	01/10/2014	30/09/2015	Load balancing applications using RINA

[a] Phd or MSc

[b] Expected starting date

[c] Expected ending date

There is one member of the TSSG team that is a full time lecturer at the Waterford Institute of Technology and he will work on full-time academic courses where several distinct modules will have their content created or updated, based on involvement in the PRISTINE project.

- BSc in Applied Computing.
  - # Internetworking
  - # Distributed Systems
- BSc in Multimedia.
  - # Network Systems and Concepts
- BSc in Information Technology
  - # Network Fundamentals
  - # Internetworking
  - # Network Technologies
  - # Cloud Infrastructure
- MSc in Computing (Communications Software).
  - # Communications Infrastructure & Security
  - # Communications Services Management

Table 43. WIT-TSSG Teaching Exploitation entry

Exploitable results	WIT-TSSG-01
Exploitation type	Academic
Target segment for application	Education
Major benefits and Impact	New networking teaching material at the Post-graduate and under-graduate levels. New graduates will leave the academic institute with a new perspective on networking and will bring to their new employers a revived sense of what a new network can bring to Internet applications. This has the potential to delivery an innovation cycle in networking which hasn't been seen in 30 years.
Current status	Post-graduate programmes have started, and an investigation is on going in regards to including PRISTINE/RINA related material into undergraduate programmes.
Expected date of completion	Q2 2016
Time to market	Q3 2016

Further external collaboration	It is not foreseen that external collaboration will be needed to initiate this teaching material, however it may be needed when it comes to sharing out and disseminating the material.
Cost to exploit	As this material will be infused into the Post-graduate and under-graduate programmes, the cost will be bore internally to the college.
Protection required	Copyright
IPR issues	No

Scientific Communities - Workshops

Publication is an extremely important part of TSSG research. The peer review process safeguards the credibility and scholarly merit of our work, and publication ensures that our results, findings and conclusions are disseminated to the research community.

As a research paper will be considered a formal academic paper only if it undergoes a process of peer review by one or more referees then the TSSG will only plan to target conferences and journals with a suitable review/publication policy. Therefore the TSSG plan to target high impact journals such as the Journal on Network and Systems Management (JNSM), and IEEE Transactions on Network and Service Management (TNSM), and conferences such as IFIP / IEEE Integrated Network Management (IM), IEEE Conference on Network and Service Management (CNSM) and IEEE Network Operations and Management Symposium (NOMS).

The TSSG are key scientific members are in the program committee of the following international conferences and workshops:

- Network Operations and Management Symposium (NOMS)
- Black Sea Conference on Communications and Networking (BlackSeaCom)
- Future Internet of Things and Cloud (FiCLOUD)
- Conference on Network and Service Management (CNSM)
- Local Computer Networks (LCN)
- Information Technology & Telecommunications (IT&T)
- Wireless Days (WD)
- Integrated Network and Service Management (IM)
- International Conference on Communications (ICC)
- Advanced Networks and Telecommunications Systems (ANTS)

- Cloud Networking (CLOUDNET)
- Mobile Cloud Computing, Services, and Engineering (MobileCloud)
- Cognitive Network and Service Management (COgMan)

The TSSG plan to actively participate in PRISTINE workshops during the project. The main objective for the TSSG will be to promote the work on configuration management, performance management & security management in RINA and to raise awareness among the RINA and wider communities that can contribute towards this research work. The TSSG want to create a vibrant and active community that will utilise the code, innovation and technical artefacts developed in PRISTINE and that can *out live* the PRISTINE research project.

Table 44. WIT-TSSG Scientific Exploitation entry

Exploitable results	WIT-TSSG-02
Exploitation type	Research
Target segment for application	Scientific Community
Major benefits and Impact	A number of scientific publications based on PRISTINE work, where high-level data sets are made available through appropriate archives, and tools are developed for the advanced research of RINA. This activity is expected to add value to existing activities on European and international levels, and enhance and broaden research partnerships. It will help to increase the innovation, harmonisation and technological develop of RINA, which will increase its possible take up by industrial research centres.
Current status	Research papers are currently being drafted.
Expected date of completion	Q1 2016
Time to market	It will take up to Q2 2017 to fully disseminate the research finds and material.
Further external collaboration	Further external collaboration is expected.
Cost to exploit	While there is a disseminate budget available with in the PRISTINE project, it is foreseen that additional funding will need to be raised to help continue the dissemination of the research results into 2017 and beyond.

Protection required	Copyright
IPR issues	None

Commercial exploitation

The TSSG is quite active in start-up companies, and in 2014 had a spin-out company acquired by Red Hat. Based on initial results of PRISTINE the TSSG has initial investigations underway on the possible market opportunities for the RINA DMS in certain application areas however it is at a very early stage and additional market research needs to be undertaken. Towards this end the TSSG plan to actively participate and present in at least 2 commercially focused industrial expos in the live time of the PRISTINE project.

Table 45. WIT-TSSG Commercial Exploitation entry

Exploitable results	PRISTINE-1 : RINA Software Development Kit (SDK), PRISTINE-3: Management System for RINA networks
Exploitation type	Commercial
Target segment for application	Network management system vendors in the telecommunications network operator space and enterprise data centre network operation space
Major benefits and Impact	Benefit from a reference implementation kept up-to-date with the RINA specifications. The same reference implementation would also be the base for consulting activities towards these vendors. There is the potential for a technology being developed here to be either licensed by a tier 1 network management systems vendor, and the investigation of a start-up company taking this product to market will be investigated.
Current status	PRISTINE phase I software base about to be released (M20 of PRISTINE)
Expected date of completion	Q2 2016
Time to market	Initial investigation on this topic appears to point towards Q4 of 2017.
Further external collaboration	This product will require external collaboration
Cost to exploit	There will be a need to raise new funding for the exploitation of this product.

Protection required	Patents
IPR issues	None to date

Further Research Projects

As coordinators of the project, the TSSG will also actively participate in the activities organised at the EC programme level relating to the ICT Future Networks area. The TSSG will provide input towards common activities and gather feedback (e.g. from FI clusters and coordination groups), offer advice & guidance and digest information relating to EC ICT programme implementation, standards, policy and regulatory activities. Such activities will include participation in concertation meetings twice a year, in Brussels and the European Conference on Networks and Communications. Other events and related relevant activities will identified during the ptojects life time.

The TSSG research team lead WP5 and through T5.1 have participated in identifying the common needs for configuring each component or set of components with a policy or set of policies that are desired for the overall PRISTINE framework. The TSSG also lead T5.3 and the investigation on how to effectively monitor and organise the large number of events happening in a multi-layer management framework. This research work has a clear lineage to TSSGs' research roots in communication software services encompassing emerging architectures for the management of complex communications and Internet systems. Given the success of the previous ICT AutoI, and ICT EFIPSANS projects, the TSSG envisage follow on research work that leverages the new insights gained from developing the DIF Management System (DMS) of RINA.

Given that the TSSG lead the PRISTINE project, and and have participated in research projects such as 4WARD, PERIMETER, PanLab and OpenLab the TSSG can leverage these projects and its connections to widen the TSSG#s industrial collaboration of PRISTINE research topics and possible follow on research projects and industrial technology transfer.

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