European Commission

PRISTINE main achievements and exploitation prospects

PRISTINE is designing & implementing the innovative internals of the RINA clean-slate architecture. This includes the programmable functions for: supporting congestion control, providing protection / resilience, facilitating more efficient topological routing, and multi-layer management for handling configuration, performance and security.

At A Glance: PRISTINE

Programmability In RINA for European Supremacy of Virtualised Networks

Pristine

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Main Objectives

The Internet as the global communications infrastructure has been successful in shaping the modern world by the way we access and exchange information. The Internet architecture designed in the 1960's has been supporting a variety of applications till now but emerging applications demand better quality, programmability, resilience and protection. Any alterations to the Internet architecture have become restricted to simple incremental updates and plug-ins instead of radical changes by introducing new solutions.

PRISTINE will take a major step forward in the integration of networking and distributed computing, by focusing on an IPC approach

RINA is an emerging clean-slate programmable networking approach, centring on Inter-Process Communication (IPC) paradigm, which will support high scalability, multi-homing, built-in security, seamless access to real-time information and operation in dynamic environments. The heart of this networking structure is naturally formed and organised by blocks of containers called "Distributed Information Facilities - DIFs" where each block has programmable functions to be attributed to as they require. A DIF is seen as an organizing structure, grouping together application processes that provide IPC services and are configured under the same policies.

PRISTINE will use RINA to develop practical, demonstrable, and commercially exploitable solutions to address existing networking limitations. The project results will showcase the relevance of RINA as the architecture that can best support the distributed computing infrastructure of the coming years, providing theoretical and experimental evidence of its superiority compared to other alternatives and showing potential exploitation paths of the technology in different areas of the market: datacentre networking, distributed cloud overlays, and network service providers.

Challenges and Technical Approach

Virtualization is a fundamental inherent attribute of the RINA architecture, and based on this aspect, the PRISTINE project shall:

- Design and implement 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
- Demonstrate the applicability and benefits of this approach and its built-in functions in three use-cases in the environments of a Distributed cloud, Datacenter networking and Network service provider.

In order to prepare the baseline designs, implemented functions and demonstrators, the consortium shall define PRISTINE's reference framework, identifying in advance the interactions between the different components programmed in each use case. This will assist in the development of a Software Development Kit to make the baseline RINA implementation, initially developed by the IRATI project (www.irati.eu), programmable. The SDK will be used to program their solutions into the prototypes. PRISTINE shall also implement a set of simulators, which will be used to understand the behaviour of their proposed solutions at scale.

Key results

In the last few years "Software Defined Networking'" (SDN) has come to the fore, with its proposed total decoupling between the decisions about where the traffic is sent (the Control plane) and the underlying system that forwards the traffic to its selected destination (the Data plane).

By targeting different realistic deployments, interoperating with some of the current computer networking technologies, PRISTINE implements real SDN concepts by focusing on the programmability aspects of the RINA model.

Network service providers have also been exploring different ways to bring the advantages of virtualized infrastructures (abstraction, resiliency, cost efficiency, re-usability) into network operations. This is to address the high cost of networks in terms of CAPEX and OPEX (including energy consumption) to achieve a certain level of performance.

As a result of this, the industry has gathered around NFV (Network Function Virtualization) to define a common model for achieving this virtualization. PRISTINE will be able to provide a RINA approach to NFV, facilitating a mapping between virtual network functions and DIFs, and supporting a richer and more flexible means to model NFV-aware infrastructures.

During the first year of the project, PRISTINE has achieved the following results. It has specified the common elements of a Multi-layer management framework, describing the object models for managing the common aspects of all types of DIFs. It has also drafted a design for the Manager and Management Agent, setting the base for the implementation of a RINA Management system [1].

PRISTINE has published the initial analysis of the RINA security aspects tackled by the project [2]. It has produced a detailed threat analysis of the RINA architecture, and investigated the design of policies for: authentication & access control, authorization, encryption, coordination of security functions, credential management and multi-level security.

Another important result of the first year has been the initial investigation on policies for congestion control, resource allocation, routing and addressing defined in [3]. This work leverages the RINA structure with its capabilities to support the instantiation of multiple layers, each of which having the ability to run a different configuration of those functions.

Finally, the first version of the RINA simulator has been released [4]. RINASim, which is publicly available, will facilitate exploring the behaviour of the RINA policies developed by PRISTINE at scale, before implementing them for real in the IRATI open source RINA prototype.

During the second year of the project PRISTINE will focus on the full specification of policies in the different research areas, the simulation of those policies, its implementation in the RINA prototype and a number of experimentation activities in order to evaluate the behaviour of the implementation.

Exploitation prospects

PRISTINE is returning to the foundational essence of networking, a revolutionary approach, as we believe that the current re-engineering approach is maintaining the inherent limitations of the current Internet. In taking the revolutionary approach PRISTINE takes up the challenge of a forward looking network architecture as it integrates communication, computing and storage resources in order to support cloud computing, networked data processing and limited resources of smart client devices.

The PRISTINE project will apply its approach to the SDN market segments of ”types of solutions” and ”end-user” markets, thus giving the project the potential for commercial and exploitation success via a number of different avenues. The solutions’ segment comprises of network infrastructure (switching, controllers), cloud virtualisation & control layer, and network virtualisation services; whilst the end-user markets include network service providers, cloud service providers, and enterprise data centers

How the 5G programme can build on the results of the project

PRISTINE does not directly address 5G wireless access networks, but instead proposes a broader evolution of network architecture that can also encompass its mobile counterpart. The hardest challenges of the future 5G standard are not in addressing specific radio access technologies, but on defining an adaptive network architecture that is capable of supporting a wide range of device capabilities, multiple connectivity models and heterogeneous application areas with their specific requirements. RINA fits very well this role since each DIF in the architecture can be fully customized to the capabilities of the different devices and/or the requirements of different application areas (such as e-health, self-driving cars, consumer electronics, home automation, content distribution, ad-hoc mobile networks, etc.)

5G Challenge - Reducing the average service creation time cycle from 90 hours to 90 minutes:

The IPC model offers the same unified API at all the network layers, so new applications can be quickly integrated (at any logical network layer). In addition, the network stack is highly configurable (via policies), to better suit specialist application demands. One can change as much or as little as needed (e.g. amount of logical layers, security, addressing, etc.) to suit the scenario.

5G Challenge - Creating a secure, reliable and dependable Internet with a “zero perceived” downtime for services provision:

RINA provides integrated security, configurable addressing, and routing resiliency. Mobility and multi-homing are built in, distributed within each layer and without a single point of failure. Add the inbuilt QoS support, and applications perceive a more predicable network with seamless dependability.

5G Challenge - Facilitating very dense deployments of wireless communication links to connect over 7 trillion wireless devices serving over 7 billion people:

The flat nature of IP (v4 and v6) addressing means routing tables have to grow to accommodate accessible devices (and the people operating them). Given devices can roam, they can have multiple points of attachment to one or more networks. Mobile IP is not efficient to manage this, and provides a single point of failure. RINA offers a recursive layer model, resulting in smaller layer routing tables, where mobility is just an update of a lower layer address. The result provides an improved scaling solution to meet 5G estimations.

Significant portions of the 5G infrastructure will be targeted at providing “workarounds” for the shortcomings of IP. RINA recursive layering can act as an inspiration for re-thinking how mobility, resiliency, multi-homing and routing are managed in an elegant, efficient, predictable and comprehensive way.

Next generation wireless networks will rely heavily on Network Function Virtualization (NFV) and Software Defined Networking (SDN). PRISTINE’s results provide a RINA approach to NFV and also addresses network architecture from a SDN viewpoint.

In contrast to the incremental evolutions seen for 4G and previous wireless standards, the 5G network architecture will present a new, clean-slate approach. To that extent, RINA presents a clean-slate architectural concept that can be leveraged for the 5G’s backhaul, fronthaul and Radio Access Network.

Network heterogeneity is also a key aspect to be addressed by 5G, since extreme density and heterogeneous networks are foreseen to account for the expected 5G data rate increase (roughly 1000× with respect to 4G). In this regard, RINA’s recursive approach addresses the management of heterogeneous networks (HetNets) in an efficient way.

References

[1] D5.2 Specification of the common elements of the Management Framework. Available online at http://ict-pristine.eu/?page_id=37

[2] D4.1. Draft conceptual and high-level engineering design of innovative security and reliability enablers. Available online at http://ict-pristine.eu/?page_id=37

[3] D3.1 Draft specification of techniques to enhance performance and resource utilization in networks. Available online at http://ict-pristine.eu/?page_id=37

[4] D2.4. RINA Simulator: basic functionality. Available online at http://ict-pristine.eu/?page_id=37