

INRIA, Evaluation of Theme Distributed Systems and Services

Team LogNet

Period considered : From 1/08 to 10/12

LogNet : Logical Networks “Self-organizing Overlay Networks and Programmable Overlay Computing Systems”

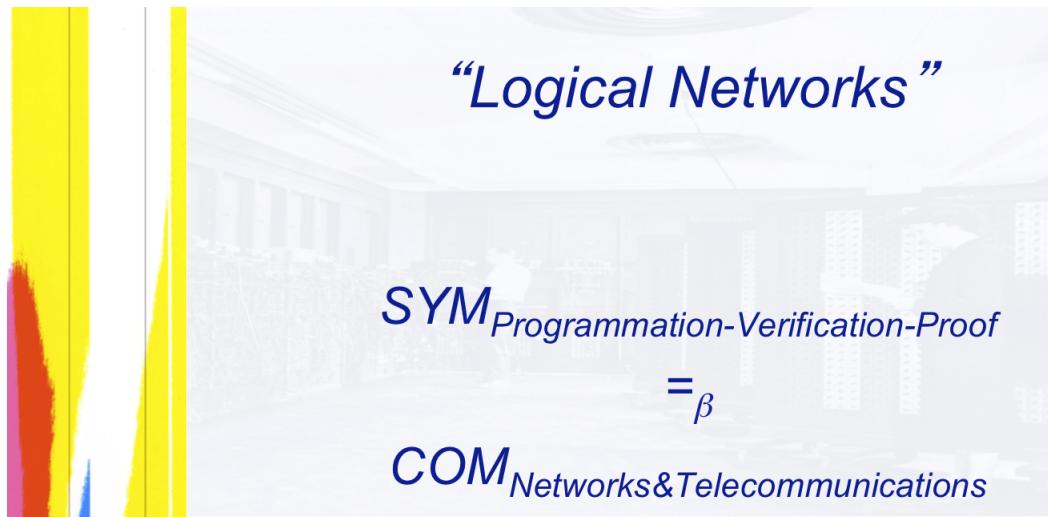


Figure 1: “The computer is moving on the edge of the Internet”

Scientific leader: Luigi Liquori, DR2 INRIA

Research center: INRIA Sophia Antipolis - Méditerranée

1 Personnel

Personnel (Period considered : From 1/10 to 3/13)

	Misc.	INRIA	CNRS	University	Total
DR (1) / Professors		1			1
CR (2) / Assistant Professors					
Permanent Engineers					
Temporary Engineers		7			7
PhD Students				5	5
Post-Doc.		1			
Support (secretary)					
Total		9		5	14
External Collaborators		5			5
Visitors (> 1 month)				2	2

Changes in staff

CR1	Misc.	INRIA	CNRS	University	Total
Arrival					
Leaving		2			2

Comment: The two CR1 researchers have left the team after only a few months in 2008, due to scientific divergences in the challenges and ambitions of the project-team proposal.

Current composition of the project-team (10/12):

- Luigi Liquori, DR2 INRIA, Team Leader, HDR, PhD University of Turin, HDR Ecole des Mines Nancy, INPL
- Laurent Vanni, Chief Expert Engineer INRIA, founded by the myMed Interreg Alcotra project, since 2009
- Milo Casagrande, Senior Expert Engineer INRIA, founded by the myMed Interreg Alcotra project, since 2010
- Cyril Auburtin, Junior Expert Engineer INRIA, founded by the myMed Interreg Alcotra project, since 2011
- Benia Stapor, Junior Expert Engineer INRIA, founded by the myMed Interreg Alcotra project, since 2012
- Romain Fritz, Junior Expert engineer INRIA, founded by the myMed Interreg Alcotra project, since 2012
- David da Silva, Extra-Junior Expert engineer (status of “auto-entrepreneur”), founded by the myMed Interreg Alcotra project, since 2012
- Valeria Mendolia, EU coordinator engineer INRIA, founded by the myMed Interreg Alcotra project, since 2011
- Vincenzo Ciancaglini, Italy, Ph.D. 2010-2012, Recipient of a French National Grant
- Petar Maksimovic, Serbia, Ph.D. 2010-2012, Recipient of EU DEUKS project funding and an EU BASILEUS Mobility Grant (see External Funding Grants)

- Thao Nguyen, Vietnam, Ph.D. 2011-2013, Recipient of an UNice University grant managed by the Rector (“bourse du president”)
- Giang Ngo Hoang, Vietnam, Ph.D. 2012-2014, Recipient of a Grant of the French Embassy at Hanoi
- Riccardo Loti, Italy, Ph.D. 2011-2013, Recipient of an Italian National Grant

Current position of former project-team members (including PhD students during the evaluation period):

- Bernard Serpette, CR1 INRIA, Permanent Member in 2008, now EPI Indes team member
- Didier Parigot, CR1 INRIA, Permanent Member in 2008, now EPI Zenith team member
- Cedrid Tedeschi, Post doc in 2009, now Maitre de Conference at University of Rennes, EPI Myriads
- Francesco Bongiovanni, Ph.D. in 2009, now ?

Visitors, students et al. ≥ 1 month

- Luc Maroungiu [IUT, from April 10th 2009 to June 12th 2009] ?
- Alexis Paoleschi [IUT, from April 10th 2009 to June 12th 2009] ?
- Marthe Bonamy, [ENS Lyon], from Avril 2009 to August 2009, now Ph.D. ENS Lyon
- Prof. Giuseppe Persiano, [University of Salerno, July 2010]
- Rossella Fortuna [Politecnico di Bari, Ph.D visitor, from 18th March 2010 to 10th October 2010], now Amadeus employee
- Bojan Marinkovic [Mathematical Institute of the Serbian Academy of Sciences and Arts (RS), 3 month Ph.D.]
- Salvatore Spoto [Università di Torino, from 1st October 2010 to 20th December 2010], Ph.D. visitor, now working as a software engineer at the University of Torino
- Fofack Nicaise [Master Ubinet, from 1st March 2010 to 31th August 2010], now Ph.D. EPI Maestro
- Alvinice Kodjio [Master Ubinet, from 1st March 2010 to 31th August 2010], now Ph.D. EPI Mascotte
- Ali Makke [Master Ubinet, from 1st March 2010 to 31th August 2010], now Ph.D. INRIA Rennes
- Michael Perez [Master Ubinet, from 1st March 2010 to 31th August 2010] + 3 months hired as an expert engineer on the myMed project, now working in Bordeaux in a SME
- Nicolas Goles [INRIA internship, from January 6th 2010 to 1st March 2010], now “auto-entrepreneur” @ SME located in Silicon Valley and in Chile
- Kevin Jedy [IUT, from April 10th 2010 to June 12th 2010] now Master SI IFI
- Bastien Blanchard [Si5, from 1st March 2011 to 31th August 2011] now employee SS2I in Paris
- Lydie Elias, [Master socio ergonomie, from 1st March 2011 to 31th August 2011] ?
- Emanuela Gambino [Master SEDI, from 1st March 2011 to 31th August 2011], now Master to become a Lawyer

- Prof. Erol Gelenbe, [Imperial college, july 2011]
- Elisa Pellicciari, [Master Langues et Affaires Internationales Relations franco-italienne Unice from april 2012 to october 2012]
- Francesca Guglielmino, [Master Langues et Affaires Internationales Relations franco-italienne, Unice from april 2012 to october 2012]
- Romain Fritz [Master 2 IFI, PFE + STAGE from Nov 2011 to September 2012] now employee chez LogNet.
- Sébastien Dupont [Master 2 IFI, PFE from Nov 2011 to March 2012]

Last INRIA enlistments

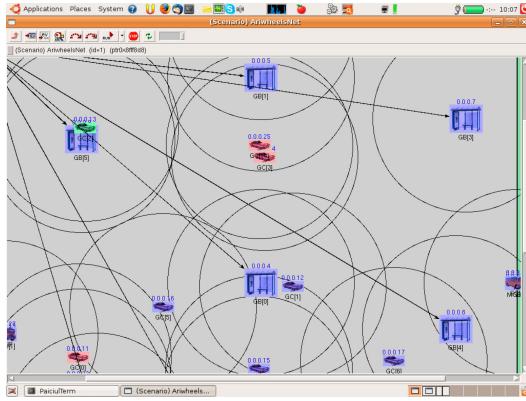
In order to increase the cardinality of permanent members, the team presented Vincenzo Mancuso as a CR2 candidate in 2011 (now junior researcher at IMDEA Network) and also presented a proposition of Team bi-localisation with the Politecnico di Torino, with the inclusion of two senior members, namely prof. Claudio Casetti and prof. Carla Fabiana Chiasseroni (with whom I have enjoyed 10yy of previous scientific collaborations). Both attempts were unfulfilled because of INRIA Sophia Méditerranée Local Policy. After these “re-bootstrapping failures”, to save time and focus on research and European contracts of R&D, we stopped proposing CR2/CR1 candidates or suggesting new fusions with other EPIS, and concentrated, to the best of our ability, on our scientific objectives and European contracts, leaving unsolved the problem of finding a critical mass. In 2010, the INRIA Sophia management had also left us with no administrative staff, a position which I took in pectore for 2 years, until mid 2012 (see Fig 2), where after multiple requests a “cloud” service of assistants was allocated to us. This was one of the hardest periods of my 20yy of professional life, due to the size of the team, and the fact that at that time LogNet had gotten a European project (1.4MEur/3yy), being the team leader.



Figure 2: My duties *in pectore* of *de facto* being the LogNet secretary

1.1 LogNet Genesis and Highlights

The LogNet project is a spin-off of the project-team Mascotte, 2006-2008. <http://www-sop.inria.fr/sloop/>.



EUROPEAN COMMISSION
Information Society and Media Directorate-General
Emerging Technologies and Infrastructures
Future & Emerging Technologies (FET) - Proactive

Brussels, 25 NOV. 2008
INFSO/F1/JLF/st/ D(2008) 948860

Subject: IST Project AEOLUS (015964) - Report of the third review held on 5 and 6 November 2008 covering period from 01/09/2007 to 31/08/2008 and update to the Final Implementation Plan.

Dear Professor Kaklamani,

The outreach to industry and practitioners still needs to be strengthened. Promising activities around the Arigatoni and Pub-Web projects, as well as on sensor networks, could lead to success stories.

nets. The interesting cooperation with Arigatoni and Arriwheels will continue and give experiences on how overlay computing strategies will perform in a real wireless environment. Still missing is a description of the outputs from SP2 that will be integrated into the AEOLUS testbed.

Figure 3: The Ariwheels simulator and the European Commission point of view.

2007-2008. In 2007, the Evaluation Committee of Mascotte wrote of us :

“The activity on overlay network is a hot topic, which started within the project in a prototypical way and will require more resources to grow.”

2008. The Arigatoni overlay network (developed in the Team) and the Ariwheels mobile overlay network projects (Developed with the Politecnico of Torino, see below) have been highlighted in the third year report of the IST Project AEOLUS, covering the period from 01/09/2007 to 31/08/2008 (Figure 3).

2009. The Ariwheels overlay network is being proposed as a publish & subscribe protocol in the vehicular platform under development in the VICSUM project (2MEur, founded by the Regione Piemonte) led by the Politecnico di Torino and involving the Centro Ricerche Fiat (CRF) and the Centro Supercalcolo Piemonte. The outputs of this project will be suitable for integration in the new Bluetooth system device Blue&MeTM by Fiat&Microsoft. The project will exploit the availability of existing urban infrastructure and public transportation vehicles (pledged by GTT – Gruppo Torinese Trasporti, the Torino’s public bus and metro). In the simulator, the semantics of the colors is:

- BLUE = Car already logged to a Broker (Bus Stop).
- PINK = Car that has lost WIFI connection with the Broker (Bus Stop).
- GREEN = Car that is looking for a Broker (Bus Stop).

2010-2011. The Interreg Alcotra office has funded the three-years project *myMed : un réseau informatique transfrontalier pour l'échange de contenus dans un environnement fixe et mobile*. LogNet will head the project; other partners are Vulog PME, GIR Maralpin, Politecnico di Torino, Uni. Torino, Uni. Piemonte Orientale and since january 2011 University of Nice Sophia Antipolis. The total budget amount of 1380KEur (796KEur granted for LogNet activities) - the external founding is 932KEur (526KEur for LogNet activities). The funding comes from the UE, PACA, CG06, PREF06, and INRIA, see <http://www-sop.inria.fr/mymed>.

First Term 2013. Official launch of the first mobile application of the myMed social network (Figure 4).

2 Work Progress

2.1 Keywords

Peer-to-peer networks - in particular Structured Overlay Networks à la Chord, Kademlia - and unstructured one like Gnutella, Meta-protocols for Interconnecting Heterogeneous Overlays Net-



Figure 4: The myRiviera article on Nice Matin

works, NoSql Databases (like Cassandra, MongoBD,...), running on cloud geographically distributed hardware architectures instead of classical data-centers (see myMed backbone solutions, see <http://mymed2.sophia.inria.fr/developers/>), Meta-Social Networks platform to build and interconnect existing social networks (see myMed EU project <http://www-sop.inria.fr/teams/lognet/MYMED/>), Video streaming over P2P networks, Trust and Reputation systems for Social Networks, enforcing a member's unique identity.

In addition to the following topics, the head of the Team, Luigi Liquori is still active in Theoretical Computer Science, in particular: Semantics of Programming Languages, Logics and Type Theory, Lambda-calculi and its variants, object-oriented calculi and its mobile versions, other programming paradigms such as the Rule-based one, Term Rewriting Systems, new models of computations, see publication list and “Thèse d’Habilitation, Ecole des Mines de Nancy, INPL”, see Fig 5.

2.2 LogNet Team Objectives

This paragraph represents the Team’s “Manifesto”.

We propose foundations for generic overlay networks and overlay computing systems.

Such overlays are built over a large number of distributed computational agents, virtually organized in colonies, and ruled by a leader (broker) who is elected democratically (*vox populi, vox dei*) or imposed by system administrators (*primus inter pares*). Every agent asks the broker to log into the colony by declaring the resources that can be offered (with variable guarantees). Once logged in, an agent can ask the broker for other resources. Colonies can recursively be considered as evolved agents who can log into an outermost colony governed by another super-leader. Communications and routing intra-colonies goes through a broker-2-broker PKI-based negotiation. Every broker routes intra- and inter- service requests by filtering its resource routing table, and then forwarding the request firstly inside its colony, and secondly outside, via the proper super-leader (thus applying an endogenous-first-estrogen-last strategy). Theoretically, queries are formulas in first-order logic equipped with a small program used to orchestrate and synchronize atomic formulas (atomic services). When the client agent receives notification of all of (or part of) the requested resources, then the real resource exchange is performed directly by the server(s) agents, without any further mediation of the broker, in a pure peer-to-peer fashion. The proposed overlay promotes an intermittent participation in

Peter, le langage qui n'existe pas...

Peter, the language that does not exist...

Habilitation à diriger les recherches / Habilitation thesis

Institut Polytechnique de Lorraine (INPL), LORIA Nancy, July 6, 2007.

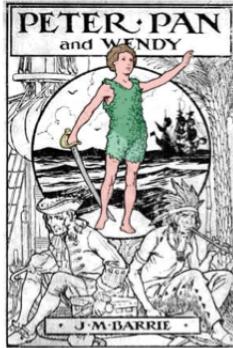


Figure 5: The “Habilitation à diriger les recherches” of Luigi Liquori

the colony, since peers can appear, disappear, and organize themselves dynamically. This implies that the routing process may lead to failures, because some agents have quit or are temporarily unavailable, or they were logged out manu militari by the broker due to their poor performance or greediness. We aim to design, validate through simulation, and implement these foundations in a generic overlay network computer system.

Therefore, the general objectives of LogNet can be summarized as follows:

- to provide adequate notions and definitions of a generic overlay computer: logic, communications, implementations, applications, hardware;
- on the basis of the above definitions, to propose a precise architecture of an overlay computer with related execution model and implement it;
- on the basis of the above definitions, to implement useful applications suitable to help the logical and software assembling of an overlay computer and experiment it at large scale;
- putting our savoir-faire in logics, type theory, formal systems, object-oriented, functional programming to the service of telecommunications and the so-called Internet of the future.

2.3 Objective 1: Backward-Compatible Protocols for Inter-routing over Heterogeneous Overlay Networks

An overlay network, simply speaking, would be a computer network running on the top of other computer networks. Nowadays, many distributed applications, such as those involving cloud computing, peer-to-peer networks, and VOIP applications are, in fact, built on top of an overlay network, and each application differs substantially from the underlying overlay network which is based on. Overlay networks differ from each other in many aspects. Concerning graph topologies and routing algorithms, some overlays such as Chord, Kademia, and CAN are based on structured topologies with routing algorithms of $O(\log n)$ complexity, while some other overlays, like Gnutella or Freenet are based on unstructured topologies, with a flooding routing scheme and a TTL. Overlay networks can use different types of querying, such as simple, wildcard, or range querying. The algorithms for encoding messages are also different across different overlays. These differences

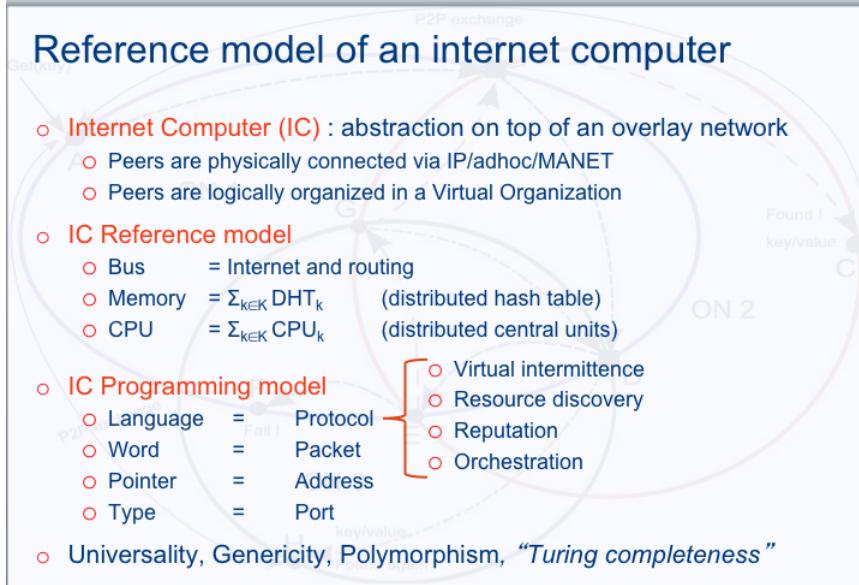


Figure 6: Reference model of an “Internet Computer”

result in an overall inter-incompatibility between overlay networks. As for motivation, there exist clear advantages of having different overlay networks co-operate: increased search space, easily achievable content redundancy, backward compatibility of different and sometimes old protocol standards, and many more. We can mention some examples of increased search space, such as: users from one of the overlays can reach resources which do not exist in their own overlay, but exist in other overlays; peers from one of the overlays can share location information with peers from other overlays in location-aware systems; the sharing of information regarding monitoring or maintenance can made possible, and so on. In summary, the main contribution of this objective is the introduction of new protocols for efficient inter-overlay co-operation as well as the implementation of efficient algorithms for the underlying unicast, broadcast, and multicast routing schemes.

2.3.1 Personnel

Liquori, Ciancaglini, Vanni, Marinkovic, Hoang, Maksimovic, old members and external collaborators.

2.3.2 Project-team positioning

Efficient cooperation between heterogeneous overlays has served as an inspiration to a number of research efforts. The co-operation proposals follow several approaches: co-operation via gateways, via super-overlay, via co-located nodes and via the merging of overlays.

2.3.3 Scientific achievements

We have designed two protocols, namely Synapse and OGP that are able to interconnect structured and unstructured overlay networks, with minimal overhead. We have made experiments involving our protocols via simulation and deployment on the Grid 5000 platform.

2.3.4 Collaborations

This objective was essentially developed inside the team. We have had the opportunity to profit from the fruitful advice of prof. Biersack (Eurecom) and prof. Meo (Politecnico di Torino).

2.3.5 External support

We have recently gotten some external support, by signing a contract with SRL Quantaflow, Paris.

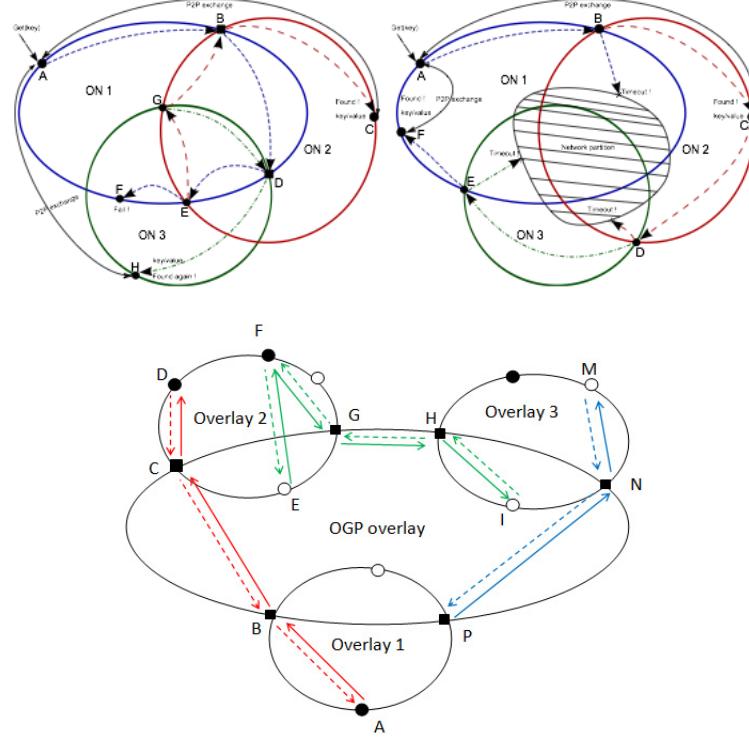


Figure 7: The Synapse and the ODP Protocols made in LogNet

2.3.6 Self assessment

Interconnecting heterogeneous networks is a topic which is truly worth studying, and that will put the computer at the edge of the Internet. The weak point is the number of permanent researchers involved (1 DR2).

2.4 Objective 2 : Arigatoni : a content-based overlay routing mechanism

An overlay network is a logical network which is built on top of another physical network. Overlay networks can be constructed in order to permit routing messages to destinations not specified by an IP address. In what follows, we briefly describe the main entities underneath our vision of an overlay network and an overlay computer. Agents. An agent in the overlay is the basic computational entity of the overlay: it is typically a device, like a PDA, a laptop, a PC, or smaller devices, connected through IP or other ad hoc communication protocols in different fashions (wired, wireless). Agents in the overlay can be thought of as being connected by virtual or logical links, each of which corresponds to a path, through many physical links, in the underlying network. For example, many peer-to-peer networks are overlay networks because they run on top of the Internet.

Colonies and colony leaders. Agents in the overlay are regrouped in Colonies. A colony is a simple virtual organization composed by exactly one leader, offering some broker-like services, and some set of agents. The leader, being also an agent, can be an agent of a colony different of the one it manages. Thus, agents are simple computers (think it as an amoeba), or sub-colonies (think it as a protozoa). Every colony has exactly one leader and at least one agent (the leader itself). Logically an agent can be seen as a collapsed colony, or a leader managing itself. The leader is the only one who knows all agents of its colony. One of the tasks of the leader is to manage (un)subscriptions to its colony.

Resource discovery. By adhering a colony, an agent can expose resources it has and/or ask for resources it needs. Another task of a leader is to manage the resources available in its colony.

Thus, when an agent of the overlay needs a specific resource, it makes a request to its leader. A leader is devoted to contacting and negotiating with potential servers, to authenticating clients and servers, and to route requests. The rationale ensuring scalability is that every request is handled first inside its colony, and then forwarded through the proper super-leader (thus applying an endogenous-first-exogenous-last strategy).

Orchestration. When an agent receives an acknowledgment of a service request from the direct leader, then the agent is served directly by the server(s) agents, i.e. without a further mediation of the leader, in a pure P2P fashion. Thus, the “main” program will be run on the agent computer machine that launched the service request and received the resources availability: it will orchestrate and coordinate data and program resources executed on others agent computers.

2.4.1 Personnel

Liquori, Cosnard, old team members and external collaborators Casetti (Politech TO), Chiasseroni (Politech TO).

2.4.2 Project-team positioning

Virtual organizations, social networks and (recently) content-centric networks using publish-subscribe paradigm are topics that can be naturally fit into the Arigatoni Overlay Network: in some cases concepts of Arigatoni comes at the same time if not earlier of the more famous concepts of e.g. CCN.

2.4.3 Scientific achievements

The Arigatoni overlay network computer, developed since 2006 in the Mascotte Project Team by Luigi Liquori and Michel Cosnard, and then in the LogNet team, is a structured multi-layer overlay network which provides resource discovery with variable guarantees in a virtual organization where peers can appear, disappear, and self-organize themselves dynamically. Arigatoni is universal in the sense of Turing machines, or generic as the von Neumann computer architecture is. Every agent asks the broker to log in the colony by declaring the resources that it provides (with variable guarantees). Once logged in, an agent can ask the broker for other resources. Colonies can recursively be considered as evolved agents who can log in an outermost colony governed by another super-leader. Communications and routing intra-colonies go through a broker-2-broker PKI-based negotiation. Every broker routes intra- and inter- service requests by filtering its resource routing table, and then forwarding the request first inside its colony, and second outside, via the proper super-leader (thus applying an endogenous-first- estrogen-last strategy). Theoretically, queries are formulas in first-order logic. When the client agent receives notification of all (or part of) the requested resources, then the real resource exchange is performed directly by the server(s) agents, without any further mediation of the broker, in a pure peer-to-peer fashion. The proposed overlay promotes an intermittent participation in the colony. Therefore, the routing process may lead to failures, because some agents have quit, or are temporarily unavailable, or they were logged out by the broker due to their poor performance or greediness. Arigatoni features essentially two protocols: the resource discovery protocol dealing with the process of an agent broker to find and negotiate resources to serve an agent request in its own colony, and the virtual intermittent protocol dealing with (un)registrations of agents to colonies.

2.4.4 Collaborations

This objective is developed inside the team. Several papers were done with external collaborators from the Politecnico di Torino.

2.4.5 External support

We have received a COLOR INRIA local funding in of 9Keur in 2006, to work with our collaborators from the Politecnico di Torino.

“Arigatoni” content-based routing

- Agents and Brokers
- Content-based routing
 - Based on rule-based pattern-matching
- Tree-based hierarchy topology
 - Inspired by inheritance in OOL
- 1.Resource discovery protocol
 - Inspired by dynamic lookup in OOL
- 2.Virtual intermittent protocol
 - Update routing tables in brokers
 - Formal SOS

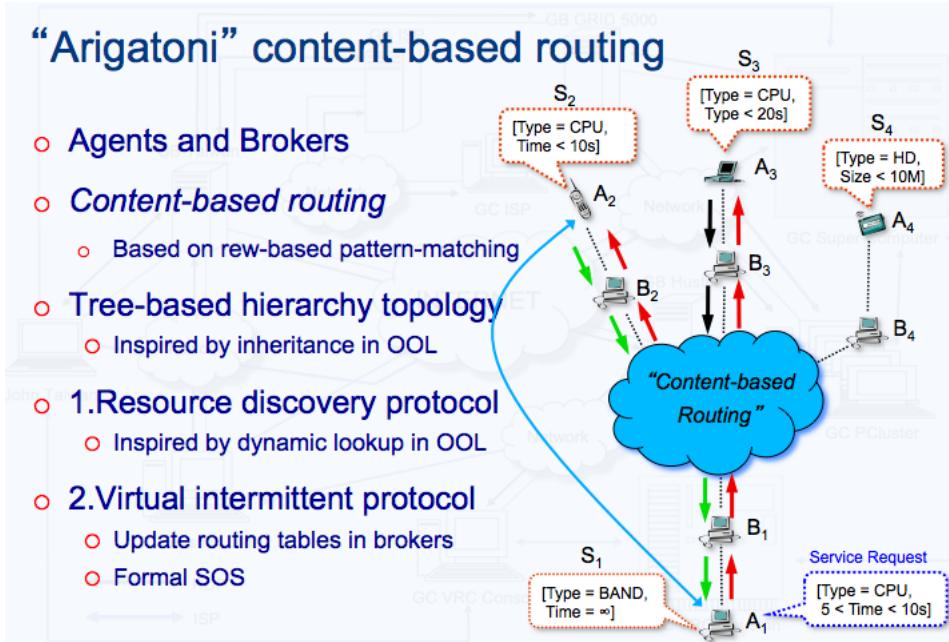


Figure 8: The Arigatoni protocols

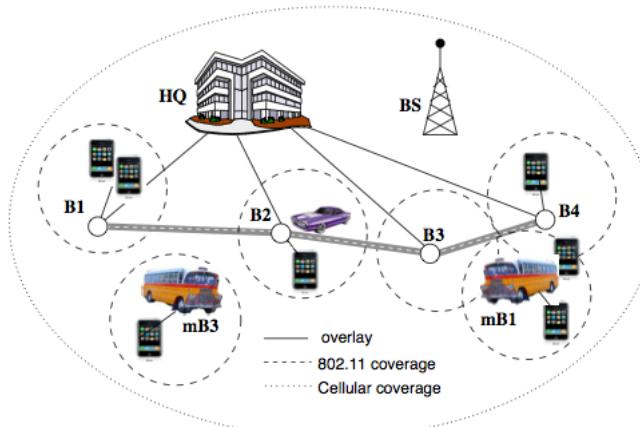


Figure 9: Ariwheels, a mobile ad hoc protocol using Arigatoni information-centric network protocol

2.4.6 Self assessment

The weak point is the number of permanent researchers involved (1 DR2).

2.5 Objective 3 (NEW): Towards a Trust and Reputation Framework for Social Web Platforms and @-economy

Trust and Reputation Systems (TRSs) represent a significant trend in decision support for Internet-based interactions. They help users to decide whom to trust and how much to trust a transaction. They are also an effective mechanism to encourage honesty and cooperation among users, resulting in healthy on-line markets or communities. The basic idea is to let parties rate each other so that new public knowledge can be created from personal experiences. The major difficulty in designing a reputation system is making it robust against malicious attacks. Our contribution in this paper is twofold. Firstly, we combine multiple research agendas into a holistic approach to building a robust

TRS. Secondly, we focus on one TRS component which is the reputation computing engine and provide a novel investigation into an implementation of various engines proposed in the literature. Our reputation systems can be also adopted to @-commerce applications.

2.5.1 Personnel

Liquori, Nguyen, Martin (University of Nice) and some external collaborators.

2.5.2 Project-team positioning

Trust and Reputation system are widely used in social networks and in @-economy. They are studied essentially starting from a mathematical approach and sometime disregarding the strong network component of such protocols. The novelty of our approach is to put reputations and trust at work on a real testbed, thanks to our European project Interreg myMed and to go even further implementing some social networks @-business oriented. We always try to take a “polymorphic approach” in the sense that our protocols could be customizable to different case studies with the addition of suitable parameters and network topology. We are building a “generic simulator” (or various libraries for well-known network simulators) and “generic patterns” to apply trust and reputation to a wide variety of topics.

2.5.3 Scientific achievements

From a functional point of view, a TRS can be split into three components. The first component gathers feedback on participants' past behavior from the transactions that they were involved in. This component includes storing feedback from users after each transaction they take part in. The second component computes reputation scores for participants through a Reputation Computing Engine (RCE), based on the gathered information. The third component processes the reputation scores, implementing appropriate reward and punishment policies if needed, and representing reputation scores in a way which gives as much support as possible to users' decision-making. A TRS can be centralized or distributed. In centralized TRSs, there is a central authority responsible for collecting ratings and computing reputation scores for users. Most of the TRSs currently on the Internet are centralized, for example the feedback system on eBay and customer reviews on Amazon. On the other hand, a distributed TRS has no central authority. Each user has to collect ratings and compute reputation scores for other users himself. Almost all proposed TRSs in the literature are distributed. Our aim to build on these studies and systematize the process of designing a TRS in general as in Fig. 1. First, we characterize the application system into which we want to integrate a TRS, and find and identify new elements of information which substitute for traditional signs of trust and reputation in the physical world. Second, based on the characteristics of the application, we find suitable working mechanisms and processes for each component of the TRS, as already introduced in Sect. 1. This step should answer the following questions: “What kind of information do we need to collect and how?”, “How should the reputation scores be computed using the collected information?”, and “How should they be represented and processed to lead users to a correct decision?”. Third, we study the tentative design obtained after the second step in the presence of selfish behaviors. During the third step, we can repeatedly return to Step 2 whenever appropriate until the system reaches a desired performance. The fourth step will refine the TRS and make it more robust against malicious attacks, some of which are listed in Sect. 1. If a modification is made, we should return to Step 2 and check all the conditions in steps 2 and 3 before accepting the modification (see Fig 10).

2.5.4 Collaborations

We currently have a collaboration on trust and reputations systems with Prof. Bruno Martin, University of Nice Sophia Antipolis.

2.5.5 External support

We have obtained external support by the University of Nice, which has offered a full Ph.D. grant to fund this research.

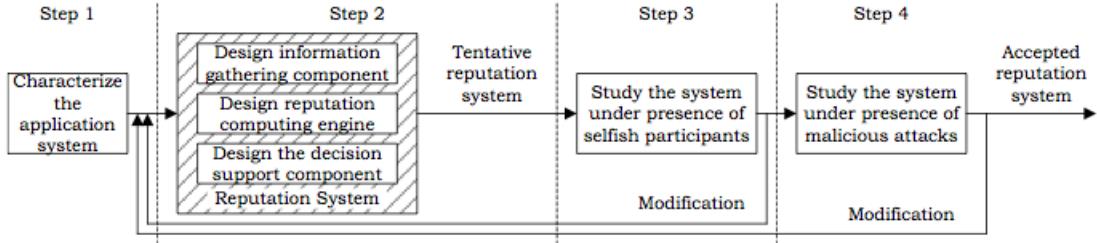


Figure 10: Process of designing a robust trust and reputation system

2.5.6 Self assessment

Trust and reputation systems are also protocols that are on the edge of the current virtual life in social networks and are the core of many @-commerce software. We expect that this topic will increase also with the advent of new Internet standard like the one of e.g. Content Centric Networks (CCN). The weak point is the number of permanent researchers involved (1 DR2).

2.6 Objective 4 (mainstream): Theoretical Computer Science

During the past decade, we have tried to study a “General Logical Framework”, called GLF, for defining Logical Frameworks, based on dependent types, in the style of the well known Edinburgh Logical Framework LF. The framework GLF features a generalized form of lambda abstraction where β -reductions fire provided the argument satisfies a logical predicate and may produce an n-ary substitution. The type system keeps track of which reductions have yet to fire. The framework GLF subsumes, by simple instantiation, LF as well as a large class of generalized constrained-based lambda calculi, ranging from well known restricted lambda calculi, such as Plotkin’s call-by-value lambda calculus, to lambda calculi with patterns. But it suggests also a wide spectrum of new calculi which have intriguing potential as Logical Frameworks (see Fig 11).

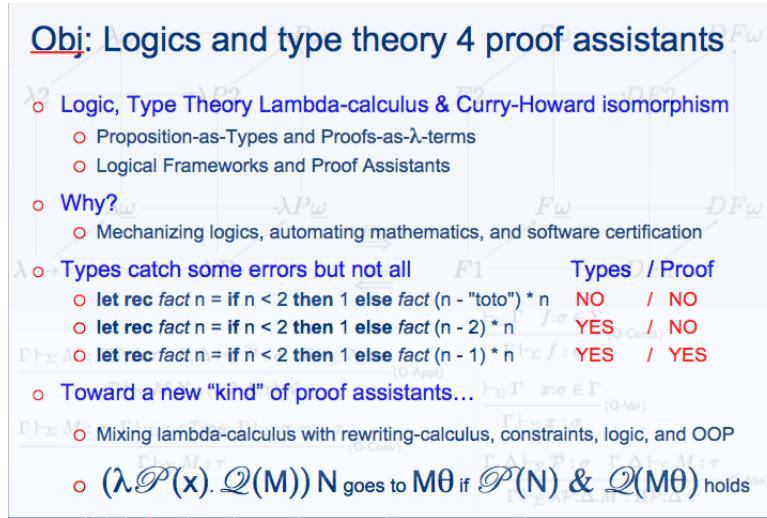


Figure 11: Logics and Type Theory for Proof Assistants

2.6.1 Project-team positioning

Improving the metalanguage underpinning proof assistants has been a subject of study for at least two decades. Interconnecting different proof assistants with external predicates implies that

predicates need only to be specified in the proof engine, while their verification can be delegated to an external proof engine, in the style of the Poincaré Principle. The most important publications of the team (appeared to the Plotkin feistscript in 2008) was the only French contribution in the volume, together with the one of P.L.Curien.

2.6.2 Scientific achievements

We investigate the meta-theoretical properties of the calculus underpinning GLF and illustrate its expressive power. In particular, we focus on two interesting instantiations of GLF. The first is the Pattern Logical Framework (PLF), where applications fire via pattern-matching in the style of Cirstea, Kirchner, and Liquori. The second is the Closed Logical Framework (CLF) which features, besides standard β -reduction, also a reduction which fires only if the argument is a closed term. For both these instantiations of GLF we discuss standard meta-properties, such as subject reduction, confluence and strong normalization. The GLF framework is particularly suitable, as a metalanguage, for encoding rewriting logics and logical systems, where rules require proof terms to have special syntactic constraints, e.g. logics with rules of proof, in addition to rules of derivations, such as, e.g., modal logic, and call-by-value lambda calculus (see Fig 12)

$$\begin{array}{c}
 \frac{}{\vdash_{CBV} M = M} (\text{refl}) \\
 \frac{\vdash_{CBV} N = M \quad \vdash_{CBV} M = N}{\vdash_{CBV} N = M} (\text{symm}) \\
 \frac{\vdash_{CBV} M = N \quad \vdash_{CBV} N = P}{\vdash_{CBV} M = P} (\text{trans}) \\
 \frac{\vdash_{CBV} M = N \quad \vdash_{CBV} M' = N'}{\vdash_{CBV} MM' = NN'} (\text{app}) \\
 \frac{v \text{ is a value}}{\vdash_{CBV} (\lambda x.M)v = M[v/x]} (\beta_v) \\
 \frac{\vdash_{CBV} M = N}{\vdash_{CBV} \lambda x.M = \lambda x.N} (\xi_v)
 \end{array}
 \qquad
 \begin{array}{l}
 \text{triple : Type} \\
 \langle _, _, _ \rangle : \text{term} \rightarrow \text{term}^2 \rightarrow \text{term}^2 \rightarrow \text{triple} \\
 \text{eq} : \text{term} \rightarrow \text{term} \rightarrow \text{Type} \\
 \text{refl} : \Pi M:\text{term}. (\text{eq } M M) \\
 \text{symm} : \Pi M:\text{term}. \Pi N:\text{term}. (\text{eq } N M) \rightarrow (\text{eq } M N) \\
 \text{trans} : \Pi M:\text{term}. \Pi N:\text{term}. \Pi P:\text{term}. \\
 \quad (\text{eq } M N) \rightarrow (\text{eq } N P) \rightarrow (\text{eq } M P) \\
 \text{eq_app} : \Pi M,N,M',N':\text{term}. \\
 \quad (\text{eq } M N) \rightarrow (\text{eq } M' N') \rightarrow \\
 \quad (\text{eq } (\text{app } M M') (\text{app } N N')) \\
 \text{betav} : \Pi M:\text{term}^2. \Pi N:\text{term}. \mathcal{L}_N^{\text{Val}} [\text{eq } (\text{app } (\text{lam } M) N) (M N)] \\
 \text{csiv} : \Pi M,N:\text{term}^2. \Pi x:\text{term}. \\
 \quad \mathcal{L}_{(x,M,N)}^\xi [(\text{eq } (M x)(N x)) \rightarrow (\text{eq } (\text{lam } M)(\text{lam } N))]
 \end{array}$$

Figure 12: Call-by-value and their encoding in GLF

2.6.3 Collaborations

Liquori, Maksimovic, and external collaborators like Kirchner, Cirstea (INRIA), Honsell, Lenisa, Scagnetto (University of Udine), and Dougherty (WPI (USA)).

2.6.4 External support

None.

2.6.5 Self assessment

The weak point is the number of permanent researchers involved (1 DR2).

3 Knowledge dissemination

3.1 Publications

	2008	2009	2010	2011-2012
PhD Thesis				2
H.D.R (*)	1			
Journal	5			1
Conference proceedings (**)	3	1	5	4
Book chapter	1			
Patent			1	
Technical report/submitted	1		1	5
Teaching Material		1	1	
Deliverable			a lot (***)	a lot (***)

(*) HDR Habilitation à diriger des Recherches

(**) Conference with a program committee (***) Due to the myMed interreg Alcotra contract

Journals

1. JLC/IGLP, Oxford press, with Liquori, Maksimovic (INRIA) and Honsell, Lenisa, Scagnetto (University of Udine)
2. Book Chapter: Heterogeneous Wireless Access Networks: Architectures and Protocols, with Borsetti, Casetti, Chiasserini (Politecnico of Turin) and Liquori (LogNet)
3. TOPLAS, ACM press, with Liquori (LogNet) and Spiwack (Ecole Politechnique)
4. TCS, Elsevier, with Liquori (LogNet) and Spiwack (Ecole Politechnique)
5. Future Generation Computer Systems, Elsevier, with Chand, Cosnard, and Liquori (all LogNet at the time)
6. Mathematical Structures in Computer Science, Cambridge University Press, with Liquori and Serpette (all LogNet at the time)

Conferences

1. OTM, Springer-Verlag, with Nguyen, Liquori (LogNet) and Martin (Unice)
2. LFMTP, ACM Digital Library, with Liquori, Maksimovic (LogNet) and Honsell, Lenisa, Scagnetto (University of Udine)
3. Hets-Nets, LNCS, Springer with Ciancaglini, Liquori, Hoang, and Maksimovic (all LogNet)
4. IICS, LNI, with Chand, Liquori and Cosnard (all LogNet at the time)
5. Hot-Post, IEEE, with Ciancaglini, Liquori, Hoang (all LogNet)
6. TCG, LNCS, Springer, with Ciancaglini, Liquori, Vanni (all LogNet)
7. TCG, LNCS, Springer, with Liquori and Cosnard, (all LogNet at the time)
8. ISCC, IEEE Computer Society, with Liquori, Tedeschi and Bongiovanni (all LogNet)
9. ICT, LNCS, Springer, with Marinkovic, Liquori, Ciancaglini (LogNet) and Ognjanovic (MI SANU, Serbia)
10. IFIP Networking, LNCS Springer, with Liquori, Tedeschi, Vanni, Bongiovanni, Ciancaglini and Marinkovic (LogNet)
11. IFIP Networking, LNCS Springer, with Liquori (LogNet) and Borsetti, Casetti and Chiasserini (Politecnico di Torino)
12. LPAR, LNCS, Springer, with Liquori (LogNet) and Dougherty (WPI, USA)
13. LPAR, LNCS, Springer, with Liquori, Maksimovic (LogNet), and Honsell, Lenisa, Scagnetto (University of Udine)

3.2 Software

1. **Arisimulator, 2007.** We have implemented in C++ ($\sim 2.5K$ lines of code) the Resource Discovery Algorithm and the Virtual Intermittent Protocol of the Arigatoni Overlay Network. The simulator was used to measure the load when we issued n service requests at Global Computers chosen uniformly at random. Each request contained a certain number of instances of one service, also chosen uniformly at random. Each service request was then handled by the Resource Discovery mechanism of Arigatoni networks.

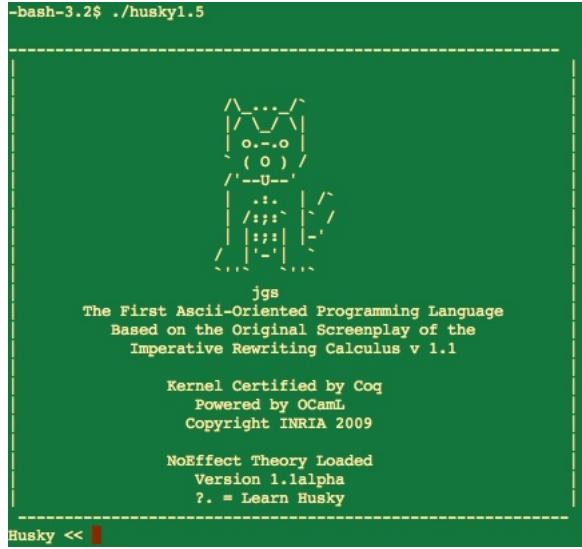


Figure 13: Launching the Husky interpreter

2. **The Husky Language, 2008-2009.** Husky is a variable-free language based on lambda calculus and term rewriting systems. Husky is based on the version 1.1 of another experiment of mixing lambda-calculus and term rewriting systems, called Snake. It was completely rewritten in CAML by Marthe Bonamy, ENSL (new parser, new syntactic constructions, like, eg, guards, anti-patterns, anti-expressions, exceptions and parametrized pattern matching). In Husky all the keywords of the language are ASCII-symbols. It could be useful in teaching basic algorithms and pattern-matching to children.
3. **Ariwheels, 2008.** is an info-mobility solution for urban environments, with access points deployed at both bus stops (forming thus a wired backbone) and inside the buses themselves. Such a network is meant to provide connectivity and services to the users of the public transport system, allowing them to exchange services, resources and information through their mobile devices. Ariwheels is both:

- a protocol, based on the proprietary protocol Arigatoni and the publish/subscribe paradigm;
- a set of applications, implementing the protocol on the different types of nodes;
- a simulator, written in OMNET++ and recently ported to the ns2 simulator.

See the web page <http://www-sop.inria.fr/members/Luigi.Liquori/ARIGATONI/Ariwheels.htm> and <http://arigtt.altervista.org>.

4. **myTransport, 2008.** myTransport is a GUI built on top of the Synapse protocol and network. Its purpose is to be a proof of concept of the future service of info-mobility to be available in the myMed social Network, see Figure 14. The GUI is written in Java and it is fully functional in the Nokia N800 Internet tablet devices. myTransport will be ported to the myMed social network.
5. **myDistributedCatalog for Digitized Cultural Heritage, 2009.** Peer-to-peer networks have emerged recently as a flexible decentralized solution to handle large amount of data

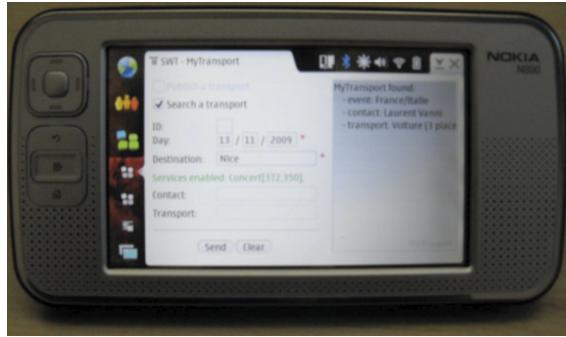


Figure 14: myTransport on the Nokia N800 Internet tablet

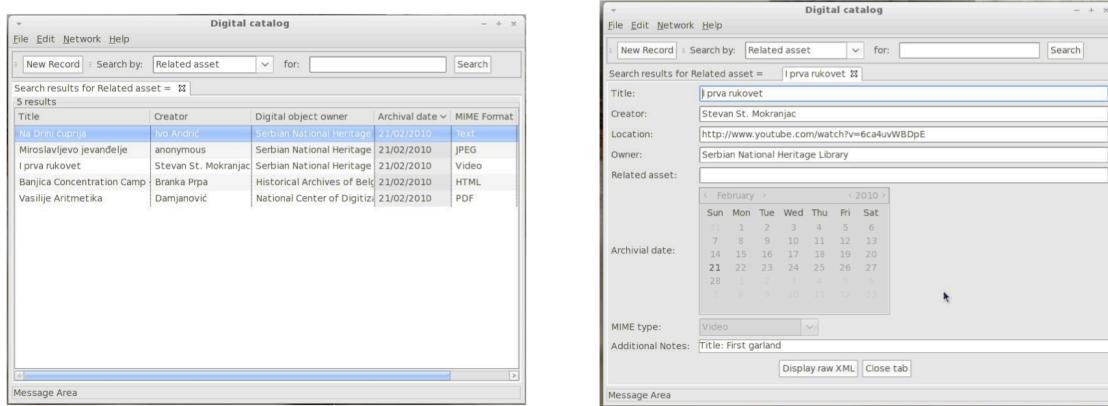


Figure 15: myDistributedCatalog

without the use of high-end servers. We have implemented a distributed catalog built up on an overlay network called “Synapse”. The Synapse protocol allows interconnection of different overlay networks each of them being an abstraction of a “community” of virtual providers. Data storage and data retrieval from different kind of content providers (i.e. libraries, archives, museums, universities, research centers, etc.) can be stored inside one catalog. We illustrate the concept based on the Synapse protocol: a catalog for digitized cultural heritage of Serbia, see Figure 15.

6. **JSynapse, 2009.** In order to test our Synapse inter-overlay P2P protocol on real platforms, we have initially developed JSynapse, a Java software prototype, which uses the Java RMI standard for communication between nodes, and whose purpose is to capture the very essence of our Synapse protocol. It is a flexible and ready-to-be-plugged library which can interconnect any type of overlay networks. In particular, JSynapse fully implements a Chord-based inter-overlay network. It was designed to be a lightweight and easy-to-extend software. We also provided some practical classes which help in automating the generation of the inter-overlay network and the testing of specific scenarios. We have experimented with JSynapse on the Grid’5000 platform connecting more than 20 clusters on 9 different sites. Again, Chord was used as the intra-overlay protocol. See, <http://www-sop.inria.fr/lognet/synapse/jSynapse/index.html>.
7. **OpenSynapse, 2009.** OpenSynapse is an open source implementation of the Synapse protocol. It is available for free under the GNU GPL. This implementation is based on Open Chord (v. 1.0.5) - an open source implementation of the Chord distributed hash table implementation by Distributed and Mobile Systems Group Lehrstuhl fuer Praktische Informatik Universitaet Bamberg, see <http://www-sop.inria.fr/lognet/synapse/open-synapse/index.html>.

OpenSynapse is implemented on top of an arbitrary number of overlay networks. Inter-networking can be built on top of Synapse in a very efficient way. Synapse is based on co-located nodes playing a role that is reminiscent of neural synapses. The current implementation of OpenSynapse in this precise case interconnects many Chord overlay networks. The new client currently can interconnect an arbitrary number of Chord networks.

8. **myStreaming P2P, 2010.** We have implemented in Python a fork of the Goalbit, see <http://goalbit.sourceforge.net>, an open source video streaming platform peer-to-peer software streaming platform capable of distributing high-bandwidth live video content to everyone preserving its quality. We have aligned with the classical gossip-based distribution protocol a DHT that distribute contents according to a content-based strategy.
9. **myMed Backbone, 2009-2012.** We have implemented a “backbone” for the myMed social network using a nosql database called Cassandra, see <http://cassandra.apache.org>, the latter used also by social networks like Facebook and Twitter. The backbone relies on 50 PC quad core HP400 equipped with 2Tb of hard drives each.

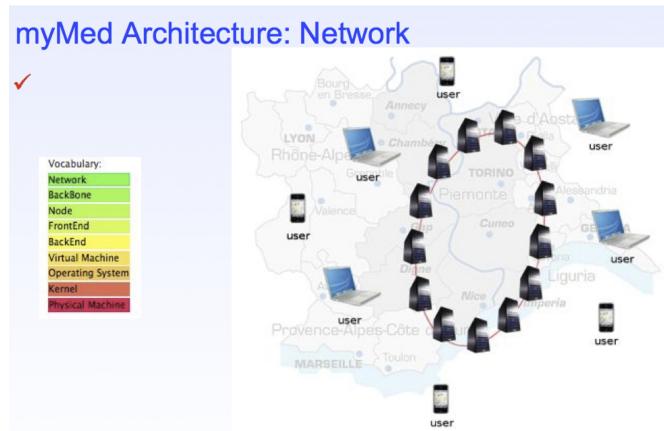


Figure 16: The myMed backbone

10. **myMed Front-End, 2010-2013.** We have launched an alpha-version of the myMed social network that can be freely tested starting from our myMed web page <http://mymed.fr>. Stay tuned with further releases in 2012 ad 2013.

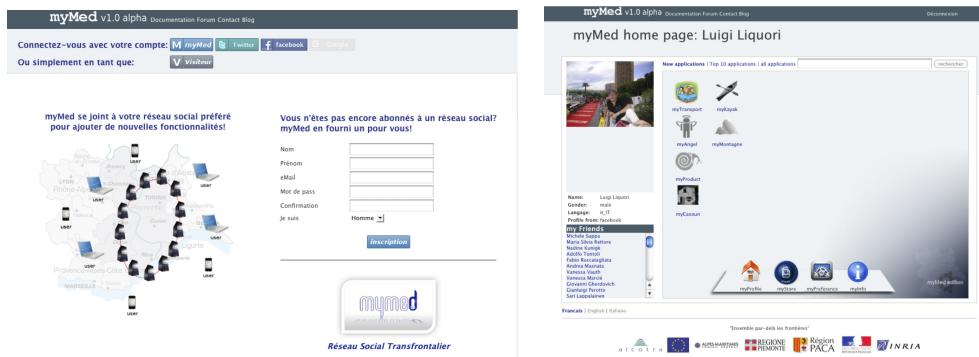


Figure 17: The myMed alpha client

3.2.1 Software assessment

We have licensed all of the produced software with open source licenses (varying from GPL V3 to Apache V2). With the notable exception of myMed (see www.mymed.fr), all of the software

can be considered as prototypes for validation of our ideas and papers. myMed (licensed with an ApacheV2 license) in addition to being a research prototype, will also be deployed, on a small-medium scale, in the territory of the “MedAlp Euroregion” (see <http://medalp.eu/>). To our knowledge, there are no direct competitors to our product. Because of the limited resources involved, in the immediate myMed will continue to evolve as a “validation software” in our team, while the myMed consortium is exploring other possibilities to create a company in which the product would achieve more maturity. To do this, we aim to be awarded another Interreg Alcotra funding: we would like to submit a “myMed2” project proposal, knowing that the interreg Alcotra call should be open in 2013. We have a strong feeling and clear external messages that we will have concrete possibilities to actually obtain this second round of funding. Unfortunately, the INRIA local management will officially forbid us the submission of this second-round proposal. This is a source of an unfortunate conflict between LogNet and the local management, since it will produce a big stop in the scientific research line of Research and Development (LogNet’s flagship is that of making research in a marked-pull fashion). Moreover, it will delay a potential chance to create a private company.

Worth noticing is that three french-based PMEs have already signed an NDA to use our kit, or obtain information on how to use it.

3.3 Valorization and technology transfer

Our skill in managing overlay networks has been recognized by a private company, Quantaflow (see www.quantaflow.com). Quantaflow covers more than 650,000 square meters of commercial premises and counts more than 185 million customers in France’s shops and stores every year. It offers the market’s most accurate solutions in all traffic and environmental conditions: a hi-tech counting system compliant with all market standards, simple software tailored to users’ needs (sales & marketing, security and operation), a team of professionals to advise and help the customer (layout, installation and methods for using the counting data). Their counting systems have been tested and validated by French and European inspection organizations. A *convention d’étude* has been signed between Quantaflow and LogNet, and a TechRep, protected by a NDA has been produced (see bibliography).

Additional 2 NDAs with 2 SMEs, for exploring the possibility to use our myMed SDK have been signed in 2012.

3.4 Teaching ≥ 2008

Intitulé	Année	Effectif	Public : 1er=Bac+3				Cours	TD	Conf.
			1er	2ème	3ème	DEA/M2			
Master UNSA SI5 IFI	12-13	??				×	21h		
Master UNSA SI5 IFI	11-12	12				×	21h		
Master UBINET P2P UNSA	10-11	30				×	24h		
Master MISMFISI P2P	09-10	30				×	20h		
Master UBINET P2P UNSA	09-10	20				×	9h		
FIT P2P Novi Sad	09	30				×	9h		
ENSL@Sophia OOP	08-09	15			×		24h		
Master RSD P2P UNSA	08-09	7				×	9h		

3.5 General Audience Actions

The interreg Alcotra myMed social network has been presented a dozen of times in different places, like e.g. “nuit des chercheurs”, “jeudi de l’europe” (organized by Gaston Franco, EU deputy), Chambers of commerce of Nice, Cuneo, Turin, and many local institutions (Conseil général, Région Paca et Piemonte, Préfecture de région, etc). The software is available via www.mymed.fr and very soon via the Apple Store and the Android Google Store. Many videos presenting the meta-social network myMed are also available on demand.

4 External Funding

(k euros)	year1	year2	year3	year4
European projects				
Interreg Alcotra myMed		150	150	226
EU TEMPUS DEUKS	~10	~5		
EU BASILEUS		~10		
Industrial contracts				
Quantaflow				15
Scholarships				
PhD (~60Keur/3YY)		2*60	2*60	1*60
Total	10	285	270	401

4.1 Interreg Alcotra

The LogNet team has been granted by the Interreg Alcotra office, the three-year project 2010-2013 Interreg Alcotra *myMed : un réseau social transfrontalier pour l'échange de contenus dans un environnement fixe et mobile*, see www.mymed.fr. LogNet will head the project; other partners are Vulog PME, GIR Maralpin, Politecnico di Torino, Uni. Torino, Uni. Piemonte Orientale. The total budget 1380Keur (796Keur for l'INRIA) - the external founding is 932Keur (526Keur for l'INRIA). The founders are UE, PACA, CG06, PREF06, and INRIA, see <http://www.mymed.fr> and <http://www.mymed.fr/?action=login#about>.

4.2 Quantaflow PME

The LogNet team has signed, in 2012, a “convention d’étude” with the PME Quantaflow, specialized in “design, implementation, and deployment of counting systems” in commercial centers such as Carrefour and Auchan. This equipment originally communicated using an ad hoc protocol. The contract deals with the design and analysis of a new, P2P-based protocol aimed at counting cars and visitors in commercial centers. This protocol is the evolution of the current protocol deployed by Quantaflow: this work is covered by an NDA.

4.3 TEMPUS DEUKS

TEMPUS DEUKS Doctoral School towards European Knowledge Society, see cms.uns.ac.rs/deuks/ : the main aim of this Project was to promote the current European landscape of doctoral programs in the Western Balkans, including Serbia. Particularly, the Project has developed and implemented a pilot Doctoral Program according to the European innovative recommendations, with comprehensive approach to information technologies, where foundational theories are fully integrated in a pragmatic engineering approach. The partners were the University of Udine (I), University of Novi Sad (RS), INRIA (F), Mathematical Institute of the Serbian Academy of Science and Arts (RS), The University of Novi Pazar (RS), and the Universidad Politecnica de Valencia (ES).

5 Objectives for the next four years

The LogNet team will close (by decision of the local director) on the 30th of June 2013, because the presence of only one permanent in the team does not suffice to bootstrap an EPI¹. We have tried intensively to increase the critical mass of LogNet during the last 3 years many times and in many forms, e.g. try to hire young, very high quality CR2, found international alliances to build an “équipe bi-localisé”, like the one with prof. Casetti and prof. Chiasserini of Politecnico di Torino (this proposal was rejected by the local direction).

At first glance, by looking at the research topics pursued in the INRIA SAM center, the successful research line opened, declared, maintained and pursued in the original LogNet manifesto

¹Even though a “singleton EPI” exists in situ (e.g. EPI ABS)

and later enriched with the addition of the studying and in vitro experimentation with distributed programmable social networks, a research-line granted by the huge founding of the Interreg Alcotra call seems difficult to pursue in a team composed of a single researcher, no secretary, and quite an important number or non-permanents. This will be subject of discussion with the direction and has been already subject of discussion with the National Human Resources. Submitting a LogNet project-team proposal again, without seriously considering the lack of a critical mass, essentially seems a “mission impossible”. The situation has been signaled to National Human Resources in mid 2012 using the COC = Conseil Orientation Chercheur.

6 Bibliography of the project-team

Note. All publications, unless not clearly marked, are published in international journals, conferences, and workshops, with an anonymous referee process. Almost all of my papers are available in Postscript/Pdf on

<http://www-sop.inria.fr/members/Luigi.Liquori/PAPERS/>

For every accepted paper and not published yet, we can provide an acceptance proof by editors.

(X%) = Taux d'acceptation (if available)

6.1 International Journals

1. **Invited** F. Honsell, M. Lenisa, L. Liquori, P. Maksimovic and I. Scagnetto. LFP : A Logical Framework with External Predicates. In *Special issue in Honour of Arnon Avron*, JLC/IGPL journal, Oxford press, to appear, 2012.
2. **Invited** D. Borsetti, C. Casetti, C. F. Chiasserini and L. Liquori. Content Discovery in Heterogeneous Mobile Networks. *Heterogeneous Wireless Access Networks: Architectures and Protocols*, E. Hossain editor, pages 419–441, Springer-Verlag, book chapter, 2008.
3. L. Liquori, A Spiwack. FeatherTrait: A Modest Extension of Featherweight Java. *ACM Transaction on Programming Languages and Systems*, 30(2), ACM Press, 2008.
4. **Invited** L. Liquori, A Spiwack. Extending FeatherTrait Java with Interfaces. In *Calculi, Types and Applications: Essays in honour of M. Coppo, M. Dezani-Ciancaglini and S. Ronchi Della Rocca. Theoretical Computer Science*, 398(1-3), pages 243–260, Elsevier, 2008.
5. **Selected** R. Chand, M. Cosnard, L. Liquori. Powerful Resource Discovery for Arigatoni Overlay Network. *Future Generation Computer Systems*, 24(1), pp 31–38, Elsevier, 2008.
6. L. Liquori, B. Serpette. iRho: An Imperative Rewriting-calculus. *Mathematical Structures in Computer Science*, 18, Cambridge University Press, 2008.

6.2 International Conferences / Workshops

7. T. Nguyen, L. Liquori, B. Martin and K. Hanks. Towards a Trust and Reputation Framework for Social Web Platforms. In Proc. of *OTM'12. OnTheMove Federated Conferences and Workshops*, Springer-Verlag, 2012, to appear.
8. F. Honsell, M. Lenisa, L. Liquori, P. Maksimovic and I. Scagnetto. LFP - A Logical Framework with External Predicates. In Proc. of *LFMTP'12. 7th International Workshop on Logical Frameworks and Meta-languages*, ACM Digital Library, 2012, to appear.
9. V. Ciancaglini, L. Liquori, G. Ngo Hoang, and P. Maksimovic. An Extension and Cooperation Mechanism for Heterogeneous Overlay Networks. In Proc. of *Hets-Nets'12. Future Heterogeneous Network : Lecture Notes in Computer Science* 7291, pages 10–18, Springer-Verlag, 2012.

10. V. Ciancaglini, L. Liquori, and G. Ngo Hoang. Towards a Common Architecture to Interconnect Heterogeneous Overlay Networks. In Proc of *HotPost'10. Hot Topics in Peer-to-Peer Computing and Online Social Networking* : IEEE, pages 817-822, 2010.
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13. V. Ciancaglini, L. Liquori and L. Vanni. CarPal : interconnecting overlay networks for a community-driven shared mobility, In Proc. of *TGC'10. International Symposium on Trustworthy Global Computing*, Munich, Germany. *Lecture Notes in Computer Science* 6084, pages 301–317, Springer-Verlag, 2010.
14. D. Dougherty and L. Liquori. Logic and computation in a lambda calculus with intersection and union types, In Proc. of *LPAR'10. Logic for Programming, Artificial Intelligence, and Reasoning*, Dakar, Senegal, *Lecture Notes in Computer Science*, 6355, pages –, Springer-Verlag, 2010.
15. L. Liquori, C. Tedeschi, L. Vanni, F. Bongiovanni, V. Ciancaglini and B. Marinković. Synapse: A Scalable Protocol for Interconnecting Heterogeneous Overlay Networks, In Proc. of *IFIP Networking'10. International Conferences on Networking.*, Chennai, India *Lecture Notes in Computer Science* 6091, pages 67–82, Springer-Verlag, 2010.
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17. 27% F. Honsell, M. Lenisa, and L. Liquori, and I. Scagnetto. A Conditional Logical Framework. In Proc. of *LPAR'08. Logic for Programming, Artificial Intelligence, and Reasoning*, Doha, Qatar, *Lecture Notes in Computer Science* 5330, pages 143–157, Springer-Verlag, 2008.
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19. 39% L. Liquori and M. Cosnard. Logical Networks: Towards Foundations of Programmable Overlay Networks and Overlay Computing Systems. In Proc. of *TGC'07. International Symposium on Trustworthy Global Computing*, Sophia-Antipolis, France. *Lecture Notes in Computer Science*, 4912, Springer-Verlag, 2008.

6.3 Research Reports not Published Elsewhere / Deliverables / Miscellaneous

20. L. Liquori. LogNet. Logical Networks: Self-organizing Overlay Networks and Generic Overlay Computing Systems. Proposition d'Equipe-Projet INRIA, V2, 2010.

6.4 Software and Reference Manuals

21. L. Liquori and the LogNet Team. myMed : an SDK to build social networks. https://gforge.inria.fr/scm/?group_id=2782, 2012.
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6.5 Submitted/Unpublished

25. V. Ciancaglini, G. Piro, R. Loti, L.A. Grieco and L. Liquori. CCN-TV a data centric approach to real time video services, Manuscript, submitted, 2012.
26. T. Gaeta, R. Loti, V. Ciancaglini and L. Liquori. Interconnexion of large scale unstructured P2P networks: modeling and analysis, Manuscript, submitted 2012.
27. G. Ngo Hoang, L. Liquori, H. Nguyen Chan and V. Ciancaglini. A Backward compatible protocol for inter-routing over heterogeneous overlay networks, Manuscript, submitted, 2012.
28. R. Fortuna, V. Ciancaglini, L. Liquori and A. Grieco. All peers for one, one peer for all: increasing cooperation by using DHT in P2P-TV systems, Manuscript, submitted, 2012.
29. P. Nain, C. Casetti, and L. Liquori. A Stochastic Model of an Arigatoni Overlay Computer, Manuscript, 2008.

6.6 Teaching Material / Course Notes

30. L. Liquori. Structured peer-to-peer overlay networks. Master en Ingenieria del Software, Metodos Formales y Sistemas de Informacion, Universidad Politecnica de Valencia, Espagne, 2010.
31. L. Liquori. Overlay and P2P networks. Summer Schools on Foundations of Information Technologies, FIT, DEUKS EU, Novi Sad, Serbia, 2009.