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Activity Report 2012

Team DANTE

Dynamic Networks : Temporal and Structural Capture Approach

IN COLLABORATION WITH: Laboratoire de l'Informatique du Parallélisme (LIP)

RESEARCH CENTER
Grenoble - Rhône-Alpes

THEME
Networks and Telecommunications

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Team DANTE

Keywords: Dynamic Networks, Graph Theory, Signal Processing, Stochastic Models, Social Networks, Sensor Networks, Wireless Networks, Distributed Algorithms

The Inria Team DANTE follows the Inria team DNET and the Inria project team RESO. DANTE was created in November 2012. The actual activity report will gather part of the DNET and RESO activities conducted by researchers now involved in DANTE.
The Inria team DANTE is located at the Computer Science Lab of ENS de Lyon (UMR CNRS - ENS Lyon - UCB Lyon 1 - Inria 5668) and hosted by IXXI (Rhône-Alpes Complex Systems Institute).

Creation of the Team: November 01, 2012 .

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2. Overall Objectives

2.1. Overall Objectives

The main goal of the DANTE team is to lay solid foundations to the characterization of dynamic networks, and to the field of dynamic processes occurring on large scale dynamic networks. Several kinds of real-world networks can be represented by graphs in which vertices represents entities like individuals in a social network, computers or routers for the Internet map, documents for the web, articles for citation networks, proteins or genes for biological networks, words or phonemes for linguistic networks, to mention only few examples. Interactions or relations between those entities are represented by edges. In order to develop tools of practical relevance in real-world settings, we propose to ground our methodological studies on real data sets obtained through large scale in situ experiments. Only recently it has become possible to study large scale interaction networks, such as collaboration networks, e-mail or phone call networks, sexual contacts networks, *etc.* This has prompted many research efforts in complex network science, mainly in two directions. First, attention has been paid to the network structure, considered as static graphs. Second, a large amount of work has focused on the study of spreading models in complex networks, which has highlighted the role of the network topology on the dynamics of the spreading. However, the dynamics of the networks, *i.e.*, topology changes, and in the networks, *e.g.*, spreading processes, are still generally studied separately. There is therefore an important need developing tools and methods for the joint analysis of both dynamics.

The DANTE project emphasizes the cross fertilization between these two research lines which should definitively lead to considerable advances. The DANTE project has the following fundamental goals:

1. To develop the study of dynamic interaction networks, through the design of specific tools combining graph theory and stochastic process targeted at characterizing and modeling their dynamic properties.
2. To infer from models, some statistical properties (dependencies, correlations) and some stochastic descriptions (transition law, large deviation) in order to characterize the dynamic behavior of the studied systems (non stationarity, burstiness, non-persistence).
3. To study dynamic processes occurring in dynamic networks, such as spreading processes, taking into account both the dynamics of and in the network structure.
4. To tune and control the network structure to optimize the global system performances.
5. To apply these theoretical tools to large scale experimental data sets.
6. To set up and foster multidisciplinary collaborations in order to study these interaction networks in their original context.

Most activity on complex networks has up to now focused on static networks, the characterization of their structure, and the understanding of how their structure influences dynamic processes such as spreading phenomenon. The important step that the DANTE project wants to undertake is to consider that the networks themselves are dynamic entities. Their topologies evolve and adapt in time, possibly driven by or in interaction with the dynamic process unfolding on top of it.

The DANTE project therefore addresses both very fundamental and very applied aspects that are tightly linked. On one hand, to develop knowledge in the networking field, in order to provide a better understanding of dynamic graphs. This fundamental work is grounded on real world large scale dynamic networks. On the other hand, to help develop a better understanding of the physical objects and networks that are studied. This point requires the joint study of both dynamics of the network and in the network, and requires a tied collaboration with the research disciplines where the objects come from.

The impact of the research developed in DANTE goes beyond the context of spreading process / epidemic diffusion, thanks to the inherent interdisciplinary of the complex networks research field. Dynamic processes on dynamic networks are indeed present in numerous fields, including rumor spreading in social networks, opinion formation, fashion phenomena, the innovation diffusion in a population, *etc.* The spread of computer viruses may take place through email networks or bluetooth connections, which are both dynamical. The

development of efficient algorithms for information spreading in wireless/P2P/DTN networks should also be improved by the understanding of the dynamics of these networks and their temporal properties. The study of all these processes should benefit from the tools developed in this project. It represents an important opportunity to study real-world dynamic processes occurring on interaction networks whose dynamics can be measured.

2.2. Highlights of the Year

2.2.1. Electronic Sensors to measure the exposition of Health care worker to Tuberculosis

Direct observation has been widely used to assess interactions between healthcare workers (HCWs) and patients but is time-consuming and feasible only over short periods. We used a wireless sensors (RFID like) system to automatically measure HCW-patient interactions. Methods: We equipped 50 patient rooms with fixed sensors and 111 HCW volunteers with mobile sensors in two clinical wards of two hospitals. For 3 months, we recorded all interactions between HCWs and 54 patients under airborne precautions for suspected ($n = 40$) or confirmed ($n = 14$) tuberculosis. Number and duration of HCW entries into patient rooms were collected daily. Concomitantly, we directly observed room entries and interviewed HCWs to evaluate their self-perception of the number and duration of contacts with tuberculosis patients. The RFID was well accepted by HCWs. This original technique holds promise for accurately and continuously measuring interactions between HCWs and patients, as a less resource-consuming substitute for direct observation. The results could be used to model the transmission of significant pathogens. HCW perceptions of interactions with patients accurately reflected reality. Results are published in PLoS ONE 7(5): e37893. doi:10.1371/journal.pone.0037893 (See[6])

2.2.2. Network science as a tool to study the Complex Systems Science field: Dreams of Universality, Reality of Interdisciplinarity...

Using a large database (more than 215 000 records) of relevant articles, we empirically study the "*complex systems*" field and its claims to find universal principles applying to systems in general. The study of references shared by the papers allows us to obtain a global point of view on the structure of this highly interdisciplinary field. We show that its overall coherence does not arise from a universal theory but instead from computational techniques and fruitful adaptations of the idea of self-organization to specific systems. We also find that communication between different disciplines goes through specific "*trading zones*, *i.e.*, sub-communities that create an interface around specific tools (a DNA microchip) or concepts (a network) [5].

2.2.3. Equipex FIT (Futur Internet of Things)

Within the FIT project, DANTE is leading the IoT-LAB workpackage and testbeds (Internet of Things Lab). Through its IoT-LAB testbeds, the FIT project will provide a very large-scale infrastructure suitable for testing heterogeneous embedded communicating objects of all sorts. Going beyond the existing SensLAB testbed, a pioneering testbed for small wireless sensor devices, the five ECO testbeds developed within FIT will encompass the following test environments:

- Internet
- wireless networks
- mobile networks
- sensor and actuator networks (SANETs)
- home gateways and access networks
- low-power and lossy networks (LLNs)

The testbeds will include a fleet of mobile robots which can be deployed to simulate a wide variety of different scenarios. The movement of each robot is controllable, and several smart objects can be embedded on each to simulate a Body Area Network. These mobile objects may act as an ad hoc network or use the fixed infrastructure that surrounds them to communicate via a real or emulated network. With full control of the network nodes and an access to the gateways these nodes are connected to, researchers are able to monitor their energy consumption as well as network-related metrics such as the end-to-end delay, throughput or overhead. DANTE leads the design of the software and hardware of all IoT-LAB nodes and a strong collaboration was set up with HiKoB company, created in 2011, an innovative startup in the field of sensor networking and embedded communicating measure.

2.2.4. Awards and honours

Classification of Content and Users in BitTorrent by Semi-supervised Learning Methods [21] was granted the best paper award at the 3rd International Workshop on Traffic Analysis and Classification (in conjunction with the 8th International Wireless Communications and Mobile Computing Conference, 2012). This result is part of M. Sokol PhD work, which is co-advised by Ph. Nain (Inria MAESTRO) and P. Gonçalves.
BEST PAPER AWARD :
[21] **Classification of Content and Users in BitTorrent by Semi-supervised Learning Methods in 8th International Wireless Communications and Mobile Computing Conference (3rd International Workshop on Traffic Analysis and Classification)**. K. AVRACHENKOV, P. GONCALVES, A. LEGOUT, M. SOKOL.

3. Scientific Foundations

3.1. Statistical Characterization of Complex Interaction Networks

Participants: Christophe Crespelle, Éric Fleury, Adrien Friggeri, Paulo Gonçalves, Qinna Wang, Lucie Martinet, Benjamin Girault.

Evolving networks can be regarded as "*out of equilibrium*" systems. Indeed, their dynamics is typically characterized by non standard and intricate statistical properties, such as non-stationarity, long range memory effects, intricate space and time correlations.

The dynamics of complex networks often exhibit no preferred time scale or equivalently involve a whole range of scales and are characterized by a scaling or scale invariance property. Another important aspect of network dynamics resides in the fact that the sensors measure information of different nature. For instance, in the MOSAR project, inter-individual contacts are registered, together with the health status of each individual, and the time evolution of the resistance to antibiotics of the various strains analyzed. Moreover, such information is collected with different and unsynchronized resolutions in both time and space. This property, referred to as multi-modality, is generic and central in most dynamical networks. With these main challenges in mind, we define the following objectives.

From "primitive" to "analyzable" data: Observables. The various and numerous modalities of information collected on the network generate a huge "*primitive*" data set. It has first to be processed to extract "*analyzable data*", which can be envisioned with different time and space resolutions: it can concern either local quantities, such as the number of contacts of each individual, pair-wise contact times and durations, or global measures, *e.g.*, the fluctuations of the average connectivity. The first research direction consists therefore in identifying, from the "primitive data", a set of "analyzable data " whose relevance and meaningfulness for the analysis of network dynamic and network diffusion phenomena will need to be assessed. Such " analyzable data " needs also to be extracted from large " primitive data " set with " reasonable " complexity, memory and computational loads.

Granularity and resolution. The corresponding data will take the form of time-series, "condensing" network dynamics description at various granularity levels, both in time and space. For instance, the existence of a contact between two individuals can be seen as a link in a network of contacts. Contact

networks corresponding to contact sequences aggregated at different analysis scales (potentially ranging from hours to days or weeks) can be built. However, it is so far unclear to which extent the choice of the analysis scale impacts the relevance of network dynamics description and analysis. An interesting and open issue lies in the understanding of the evolution of the network from a set of isolated contacts (when analyzed with low resolution) to a globally interconnected ensemble of individuals (at large analysis scale). In general, this raises the question of selecting the adequate level of granularity at which the dynamics should be analyzed. This difficult problem is further complicated by the multi-modality of the data, with potentially different time resolutions.

(non-)Stationarity. Stationarity of the data is another crucial issue. Usually, stationarity is understood as a time invariance of statistical properties. This very strong definition is difficult to assess in practice. Recent efforts have put forward a more operational concept of relative stationarity in which an observation scale is explicitly included. The present research project will take advantage of such methodologies and extend them to the network dynamics context.

The rationale is to compare local and global statistical properties at a given observation scale in time, a strategy that can be adapted to the various time series that can be extracted from the data graphs so as to capture their dynamics. This approach can be given a statistical significance via a test based on a data-driven characterization of the null hypothesis of stationarity.

Dependencies, correlations and causality. To analyze and understand network dynamics, it is essential that (statistical) dependencies, correlations and causalities can be assessed among the different components of the " analyzable data ". For instance, in the MOSAR framework, it is crucial to assess the form and nature of the dependencies and causalities between the time series reflecting e.g., the evolution along time of the strain resistance to antibiotics and the fluctuations at the inter-contact level. However, the multimodal nature of the collected information together with its complex statistical properties turns this issue into a challenging task. Therefore, Task1 will also address the design of statistical tools that specifically aim at measuring dependency strengths and causality directions amongst mutivariate signals presenting these difficulties. The objective is to provide elements of answers to natural yet key questions such as : Does a given property observed on different components of the data result from a same and single network mechanism controlling the ensemble or rather stem from different and independent causes? Do correlations observed on one instance of information (e.g., topological) command correlations for other modalities? Can directionality in correlations (causality) be inferred amongst the different components of multivariate data? These should also shed complementary lights on the difficulties and issues associated to the identification of " important " nodes or links...

3.2. Theory and Structural Dynamic Properties of dynamic Networks

Participants: Christophe Crespelle, Éric Fleury, Qinna Wang, Adrien Friggeri.

Characterization of the dynamics of complex networks. We need to focus on intrinsic properties of evolving/dynamic complex networks. New notions (as opposed to classical static graph properties) have to be introduced: rate of vertices or links appearances or disappearances, the duration of link presences or absences. Moreover, more specific properties related to the dynamics have to be defined and are somehow related to the way to model a dynamic graph.

To go further in the Classical graph notions like the definition of path, connected components and k-core have to be revisited in this context. Advanced properties need also to be defined in order to apprehend the intrinsic dynamic structural issues of such dynamic graphs. The notion of communities (dense group of nodes) is important in any social / interaction network context and may play an important role within an epidemic process. To transpose the static graph community concept into the dynamical graph framework is a challenging task and appears necessary in order to better understand how the structure of graphs evolves in time. In these context we define the following objectives:

Toward a dynamic graph model and theory. We want to design new notions, methods and models for the analysis of dynamic graphs. For the static case, graph theory has defined a vast and consistent set of notions and methods such as paths, flows, centrality measures. These notions and methods are completely lacking for the study of dynamic graphs. We aim at providing such notions in order to study the structure of graphs evolving in time and the phenomenon taking place on these dynamic graphs. Our approach relies on describing a dynamic graph by a series of graphs which are the snapshots of the state of the graph at different moments of its life. This object is often poorly used : most works focuss on the structure of each graph in the series. Doing so, one completely forget the relationships between the graphs of the series. We believe that these relationships encompass the essence of the structure of the dynamic and we place it at the very center of our approach. Thus, we put much effort on developping graph notions able to deal with a series of graphs instead of a dealing with a single graph. These notions must capture the temporal causality of the series and the non trivial relationships between its graphs. Our final goal is to provide a set of the notions and indicators to describe the dynamics of a network in a meaningful way, just like complex networks theory does for static complex networks.

Dynamic communities. The detection of dynamic communities is particularly appealing to describe dynamic networks. In order to extend the static case, one may apply existing community detection methods to successive snapshots of dynamic networks. This is however not totally satisfying for two main reasons: first, this would take a large amount of time (directly proportional to the data span); moreover, having a temporal succession of independent communities is not sufficient and we loose valuable information and dependencies. We also need to investigate the temporal links, study the time granularity and look for time periods that could be compressed within a single snapshot.

Tools for dynamic graph visualization. Designing generic and pure graph visualization tools is clearly out of the scope of the DANTE project. Efficient graph drawing tools or network analysis toolkit/software are now available (e.g., GUESS, TULIP, Sonivis, Network Workbench). However, the drawback of most softwares is that the dynamics is not taken into account. Since we will study the hierarchy of dynamics through the definition of communities we plan to extend graph drawing methods by using the communities' structures. We also plan to handle the time evolution in the network analysis toolkit. A tool like TULIP is well designed and could be improved by allowing operations (selection, grouping, sub graph computation...) to take place on the time dimension as well.

4. Application Domains

4.1. Life Science & Health

In parallel to the advances in modern medicine, health sciences and public health policy, epidemic models aided by computer simulations and information technologies offer an increasingly important tool for the understanding of transmission dynamics and of epidemic patterns. The increased computational power and use of Information and Communication Technologies makes feasible sophisticated modeling approaches augmented by detailed in vivo data sets, and allow to study a variety of possible scenarios and control strategies, helping and supporting the decision process at the scientific, medical and public health level. The research conducted in the DANTE project finds direct applications in the domain of LSH since modeling approaches crucially depend on our ability to describe the interactions of individuals in the population. In the MOSAR project we are collaborating with the team of Pr. Didier Guillemot (Inserm/Institut. Pasteur/Université de Versailles). Within the TUBEXPO and ARIBO projects, we are collaborating with Pr. Jean-Christopge Lucet (Professeur des université Paris VII ? Praticien hospitalier APHP).

4.2. Network Science / Complex networks

In the last ten years, the study of complex networks has received an important boost with large interdisciplinary efforts aimed at their analysis and characterization. Two main points explain this large activity: on the one hand, many systems coming from very different disciplines (from biology to computer science) have a convenient representation in terms of graphs; on the other hand, the ever-increasing availability of large data sets and computer power have allowed their storage and manipulation. Many maps have emerged, describing many networks of practical interest in social science, critical infrastructures, networking, and biology. The DANTE project targets the study of dynamically evolving networks, from the point both of their structure and of the dynamics of processes taking place on them.

5. Software

5.1. Sensor Network Tools: drivers, OS and more

Participants: Éric Fleury [correspondant], Sandrine Avakian.

As a outcomes of the ANR SensLAB project and the Inria ADT SensTOOLS and SensAS, several softwares (from low level drivers to OSes) were delivered and made available to the research community. The main goal is to lower the cost of developing/deploying a large scale wireless sensor network application. All software are gathered under the SensLAB web site: http://www.senslab.info/ web page where one can find:

- low C-level drivers to all hardware components;
- ports of the main OS, mainly TinyOS, FreeRTOS and Contiki;
- ports and development of higher level library like routing, localization.

5.2. http://queueing-systems.ens-lyon.fr

Participant: Thomas Begin [correspondant].

Queueing models, steady-state solution, online tool, web interface

This tool aims at providing a simple web based interface to promote the use of our proposed solutions to numerically solve classical queueing systems. In 2011, the tools merely implemented the solution to get the distribution for the number of customers along with customary performance parameters for a queue with multiple servers, general arrivals, exponential services and a possibly finite buffer, (i.e., $Ph/M/c/N$-like queue). The steady-state solution to this queue is based on a simple and stable recurrence [2] and was performed in collaboration with Pr. Brandwajn (UCSC). In 2012 we extended our tool so as to include the solution for a queue with a single server, Poisson arrivals, general services and a possibly finite buffer, (i.e., $M/Ph/1/N$-like queue). Our tool was presented at the conference [43] and attracts hundreds of visitors each month. Associated URL is: http://queueing-systems.ens-lyon.fr

6. New Results

6.1. Use of wireless sensor network for Assessing Interactions between Healthcare Workers and Patients under Airborne Precautions

Direct observation has been widely used to assess interactions between healthcare workers (HCWs) and patients but is time-consuming and feasible only over short periods. We used a Radio Frequency Identification Device (RFID) system to automatically measure HCW-patient interactions [14]. The RFID was well accepted by HCWs. This original technique holds promise for accurately and continuously measuring interactions between HCWs and patients, as a less resource-consuming substitute for direct observation. The results could be used to model the transmission of significant pathogens. HCW perceptions of interactions with patients accurately reflected reality.

6.2. Psychological Aspects of Social Communities

Social Network Analysis has often focused on the structure of the network without taking into account the characteristics of the individual involved. In this work [28], [8], we aim at identifying how individual differences in psychological traits affect the community structure of social networks. Instead of choosing to study only either structural or psychological properties of an individual, our aim is to exhibit in which way the psychological attributes of interacting individuals impacts the social network topology. Using psychological data from the myPersonality application and social data from Facebook, we confront the personality traits of the subjects to metrics obtained after applying the C3 community detection algorithm [41] to the social neighborhood of the subjects. We observe that introverts tend to have less communities and hide into large communities, whereas extroverts tend to act as bridges between more communities, which are on average smaller and of varying cohesion.

6.3. Community detection: dynamic, overlapping, fuzzy

Community, a notion transversal to all areas of Social Network Analysis, has drawn tremendous amount of attention across the sciences in the past decades. Numerous attempts to characterize both the sociological embodiment of the concept as well as its observable structural manifestation in the social network have to this date only converged in spirit. No formal consensus has been reached on the quantiffable aspects of community, despite it being deeply linked to topological and dynamic aspects of the underlying social network.

The DANTE team proceeded results on several aspects of community detection is large scale networks.

- Presenting a fresh approach to the evaluation of communities, we introduces and builds upon the cohesion [8], a novel metric which captures the intrinsic quality, as a community, of a set of nodes in a network. The cohesion, defined in terms of social triads, was found to be highly correlated to the subjective perception of communitiness through the use of a large-scale online experiment in which users were able to compute and rate the quality of their social groups on Facebook. The use of the cohesion proves invaluable in that it offers non- trivial insights on the network structure and its relation to the associated semantic. The use of the cohesion was use for example in order to study Agreement Groups in the United States Senate [35].
- Overlapping community detection is a popular topic in complex networks. As compared to disjoint community structure, overlapping community structure is more suitable to describe networks at a macroscopic level. Overlaps shared by communities play an important role in combining different communities. In this paper, two methods are proposed to detect overlapping community structure. One is called clique optimization, and the other is named fuzzy detection. Clique optimization aims at detecting granular overlaps. The clique optimization method is a fine grain scale approach. Each granular overlap is a node connected to distinct communities and it is highly connected to each community. Fuzzy detection is at a coarser grain scale and aims at identifying modular overlaps. Modular overlaps represent groups of nodes that have high community membership degrees with several communities. A modular overlap is itself a possible cluster/sub-community [7], [38].

6.4. Structure of Changes in Dynamic Contact Networks

We present a methodology to investigate the structure of dynamic networks in terms of concentration of changes in the network. We handle dynamic networks as series of graphs on a set of nodes and consider the changes occurring between two consecutive graphs in the series. We apply our methodology to various dynamic contact networks coming from different contexts and we show that changes in these networks exhibit a non-trivial structure: they are not spread all over the network but are instead concentrated around a small fraction of nodes. We compare our observations on real-world networks to three classical dynamic network models and show that they do not capture this key property [31].

6.5. Dynamic Resource Management in Clouds: A Probabilistic Approach

Dynamic resource management has become an active area of research in the Cloud Computing paradigm. Cost of resources varies significantly depending on configuration for using them. Hence efficient management of resources is of prime interest to both Cloud Providers and Cloud Users. In this work we suggest a probabilistic resource provisioning approach that can be exploited as the input of a dynamic resource management scheme. Using a Video on Demand use case to justify our claims, we propose an analytical model inspired from standard models developed for epidemiology spreading, to represent sudden and intense workload variations. We show that the resulting model verifies a Large Deviation Principle that statistically characterises extreme rare events, such as the ones produced by ?buzz/flash crowd effects? that may cause workload overflow in the VoD context. This analysis provides valuable insight on expectable abnormal behaviours of systems. We exploit the information obtained using the Large Deviation Principle for the proposed Video on Demand use-case for defining policies (Service Level Agreements). We believe these policies for elastic resource provisioning and usage may be of some interest to all stakeholders in the emerging context of cloud networking [4], [24].

6.6. Classification of Content and Users in BitTorrent by Semi-supervised Learning Methods

P2P downloads still represent a large portion of today?s Internet traffic. More than 100 million users operate BitTorrent and generate more than 30% of the total Internet traffic. Recently, a significant research effort has been done to develop tools for automatic classification of Internet traffic by application. The purpose of the present work is to provide a framework for sub-classification of P2P traffic generated by the BitTorrent protocol. The general intuition is that the users with similar interests download similar contents. This intuition can be rigorously formalised with the help of graph based semi- supervised learning approach. We have chosen to work with PageRank based semi-supervised learning method, which scales well with very large volumes of data. We provide recommendations for the choice of parameters in the PageRank based semi-supervised learning method. In particular, we show that it is advantageous to choose labelled points with large PageRank score.

This work was awarded best paper at the 3rd International Workshop on Traffic Analysis and Classification (in conjunction with the 8th International Wireless Communications and Mobile Computing Conference, 2012) [21] and led to a companion paper [22].

6.7. Large deviations estimates for the multiscale analysis of heart rate variability

In the realm of multiscale signal analysis, multifractal analysis provides with a natural and rich framework to measure the roughness of a time series. As such, it has drawn special attention of both mathematicians and practitioners, and led them to characterize relevant physiological factors impacting the heart rate variability. Notwithstanding these considerable progresses, multi- fractal analysis almost exclusively developed around the concept of Legendre singularity spectrum, for which efficient and elaborate estimators exist, but which are structurally blind to subtle features like non-concavity or, to a certain extent, non scaling of the distributions. Large deviations theory al- lows bypassing these limitations but it is only very recently that performing estimators were proposed to reliably compute the corresponding large devia- tions singularity spectrum. In this article, we illustrate the relevance of this approach, on both theoretical objects and on human heart rate signals from the Physionet public database. As conjectured, we verify that large devia- tions principles reveal significant information that otherwise remains hidden with classical approaches, and which can be reminiscent of some physiolog- ical characteristics. In particular we quantify the presence/absence of scale invariance of RR signals.

These results gather most achievements we carried out within the ANR project DMASC.

6.8. An Inexpensive Packet Capture Solution with Robust and Accurate Timestamping

The availability of inexpensive and reliable packet capture solutions is highly desirable for the management of future Internet infrastructures and practices. Currently, available solutions are either 1) based on GPS antennas and dedicated hardware and thus are expensive and difficult to deploy, or 2) based on commodity hardware and standard synchronization protocols and thus have inaccurate timestamps and cannot handle monitoring at high rate. In a series of ongoing works in collaboration with the Melbourne University (Australia), we proposed an architecture for a packet monitoring solution which combines inexpensive network cards capable of hardware timestamping, with RAD- clock, an open source software clock. In different papers, we presented the first implementation and evaluation of our approach, demonstrating a good compromise between affordability and accuracy [33], [36].

6.9. KBAC: Knowledge-Based Admission Control

Many methods have been proposed in the literature to perform admission control in order to provide a sufficient level of Quality of Service (QoS) to accepted flows. In this work, we introduce a novel data-driven method based on a timevarying model that we refer to as Knowledge-Based Admission Control solution (KBAC). Our KBAC solution consists of three main stages: (i) collect measurements on the on-going traffic over the communication link; (ii) maintain an up-to-date broad view of the link behavior, and feed it to a Knowledge Plane; (iii) model the observed link behavior by a mono-server queue whose parameters are set automatically and which predicts the expected QoS if a flow requesting admission were to be accepted. Our KBAC solution provides a probabilistic guarantee whose admission threshold is either expressed, as a bounded delay or as a bounded loss rate. We run extensive simulations to assess the behavior of our KBAC solution in the case of a delay threshold. The results show that our KBAC solution leads to a good trade-off between flow performance and resource utilization. This ability stems from the quick and automatic adjustment of its admission policy according to the actual variations on the traffic conditions [19].

6.10. Substitution Networks: Performance Collapse due to Overhead in Communication Times

A substitution network is a wireless solution whose purpose is to bring back connectivity or to provide additional bandwidth capacity to a network that just suffered a failure or a dramatic surge in its workload. We analyze the performance of the simplest possible multihop topology for a substitution network, i.e., the multihop chain subject to traffic transmitted in both directions. Clearly, the potential capacity of a substitution network, whose technology should be embedded in mobile routers, is very likely to be far much smaller than the prior base network. We investigate the actual performance attained by such a substitution network under various conditions of the chain length and the carrier sensing range. Our results show that the capacity, viz. its maximum attainable throughput, reaches a peak at a given workload and then, for larger values of workload, decreases towards an asymptote which value can be drastically lower than the peak value. We give insights into this performance collapse and show the need for a suitable admission control [18].

6.11. Characterisation and Application of Idle Period Durations in IEEE 802.11 DCF-based Multihop Wireless Networks

Multihop wireless networks are used to provide internet connectivity to the users and the level of performance and quality expected by these users are increasing. In order to meet these performance and quality requirements, wireless communications should be enhanced. Previous works from the literature show that the performance and quality provided by an IEEE 802.11-based multihop wireless network are far from optimal and that there exist different ways to increase the efficiency and the quality of service of such a network. Some studies show that using the medium state as a parameter to tune the behaviour of an IEEE 802.11-based multihop network is an appropriate way to proceed. A station in a IEEE 802.11-based multihop wireless network

senses the medium either busy or idle. The durations of idle periods and busy periods and their distributions have a clear impact on the network and nodes performance. The understanding of the relationship between these indicators, namely idle and busy periods, the network topology and the traffic, would give new insights to enhance the performance and quality of multihop wireless networks. Due to its multihop and distributed nature, the characterisation of idle period durations is difficult in such a network. This work explores the characterisation of idle period distribution by proposing a new analytical model and provides an application of this characterisation with the design of an adaptive backoff algorithm based on idle periods [30].

7. Bilateral Contracts and Grants with Industry

7.1. Bilateral Contracts with Industry

- A bilateral contract has been signed between the DANTE Inria team and ACT750 to formalize their collaboration in the context of churn prediction.
- A bilateral contract has been signed between the DANTE Inria team and KRDS to formalize their collaboration in the context of Facebook marketing / cascade analysis.
- A bilateral contract has been signed between the DANTE Inria team and HiKoB to formalize their collaboration in the context of the Equipex FIT (Futur Internet of Things) FIt is one of 52 winning projects in the Equipex research grant program. It will set up a competitive and innovative experimental facility that brings France to the forefront of Future Internet research. FIT benefits from 5.8 euros million grant from the French government Running from 22.02.11 – 31.12.2019. The main ambition is to create a first-class facility to promote experimentally driven research and to facilitate the emergence of the Internet of the future.

7.2. Inria Alcatel-Lucent Bell Labs joint laboratory

Participants: Isabelle Guérin-Lassous, Paulo Gonçalves, Thomas Begin, Éric Fleury, Doreid Ammar, Mohamad Jaber.

Traffic awareness, Flow analysis, Flow scheduling, Sampling, Flow-based routing

Former RESO team participated to the ADR (Action de Recherche/Research Action) “Semantic Networking" (SEM- NET), one of the three ADRs of the Inria ALCATEL-LUCENT BELL LABS joint laboratory. This ADR started on January 1st 2008 and formally ended in October 2012. I. Guérin Lassous and L. Noirie are the respective coordinator for Inria and for ALCATEL-LUCENT of the ADR SEMNET.

In 2013 the research axes of the Joint Lab will be renewed and a new one entitled "Network Science" will involve the participation of the research team DANTE.

8. Partnerships and Cooperations

8.1. Regional Initiatives

The ESPAD (Embedded Sport Performance Analysis Data) is bio-mechanics / physiology logging project funded by FEDER. The goal is to contributed to the design of a distributed multi-sensor architecture that can be worn by an individual and that records bio-mechanical, physiological and environmental data.

8.2. National Initiatives

8.2.1. ANR

- The purpose of the SensLAB project is to deploy a very large scale open wireless sensor network platform. SensLAB's main and most important goal is to offer an accurate and efficient scientific tool to help in the design, development, tuning, and experimentation of real large-scale sensor network applications. The sensLAB platform is distributed among 4 sites and is composed of 1,024 nodes. Each location hosts 256 sensor nodes with specific characteristics in order to offer a wide spectrum of possibilities and heterogeneity. The four test beds are however part of a common global testbed as several nodes will have global connectivity such that it will be possible to experiment a given application on all 1K sensors at the same time.
- Equipex FIT (Futur Internet of Things) FIt is one of 52 winning projects in the Equipex research grant program. It will set up a competitive and innovative experimental facility that brings France to the forefront of Future Internet research. FIT benefits from 5.8$\surd$¢¬Ç¬¨ million grant from the French government Running from 22.02.11 $\surd$¢¬Ä¬ì 31.12.2019. The main ambition is to create a first-class facility to promote experimentally driven research and to facilitate the emergence of the Internet of the future.
- As proposed by initiatives in Europe and worldwide, enabling an open, general-purpose, and sustainable large-scale shared experimental facility will foster the emergence of the Future Internet. There is an increasing demand among researchers and production system architects to federate testbed resources from multiple autonomous organizations into a seamless/ubiquitous resource pool, thereby giving users standard interfaces for accessing the widely distributed and diverse collection of resources they need to conduct their experiments. The F-Lab project builds on a leading prototype for such a facility: the OneLab federation of testbeds. OneLab pioneered the concept of testbed federation, providing a federation model that has been proven through a durable interconnection between its flagship testbed PlanetLab Europe (PLE) and the global PlanetLab infrastructure, mutualizing over five hundred sites around the world. One key objective of F-Lab is to further develop an understanding of what it means for autonomous organizations operating heterogeneous testbeds to federate their computation, storage and network resources, including defining terminology, establishing universal design principles, and identifying candidate federation strategies. On the operational side, F-Lab will enhance OneLab with the contribution of the unique sensor network testbeds from SensLAB, and LTE based cellular systems. In doing so, F-Lab continues the expansion of OneLab?s capabilities through federation with an established set of heterogeneous testbeds with high international visibility and value for users, developing the federation concept in the process, and playing a major role in the federation of national and international testbeds. F-Lab will also develop tools to conduct end-to-end experiments using the OneLab facility enriched with SensLAB and LTE.

  F-Lab is a unique opportunity for the French community to play a stronger role in the design of federation systems, a topic of growing interest; for the SensLAB testbed to reach an international visibility and use; and for pioneering testbeds on LTE technology.
- ANR RESCUE started in December 2010: Access and metropolitan networks are much more limited in capacity than core networks. While the latter operate in over-provisioning mode, access and metropolitan networks may experience high overload due to evolution of the traffic or failures. In wired networks, some failures (but not all) are handled by rerouting the traffic through a backup network already in place. In developed countries, backup networks are adopted wherever possible (note that this is generally not the case for the links between end users and their local DSLAM). Such a redundant strategy may not be possible in emerging countries because of cost issues. When dedicated backup networks are not available, some operators use their 3G infrastructure to recover some specific failures; although such an alternative helps avoid full network outage, it is a costly solution. Furthermore, availability of 3G coverage is still mainly concentrated in metropolitan zones. When no backup networks are available, it would be interesting to deploy, for a limited time

corresponding to the period of the problem (i.e., failure or traffic overload), a substitution network to help the base network keep providing services to users.

In the RESCUE project (2010-2013), we investigate both the underlying mechanisms and the deployment of a substitution network composed of a fleet of dirigible wireless mobile routers. Unlike many projects and other scientific works that consider mobility as a drawback, in RESCUE we use the controlled mobility of the substitution network to help the base network reduce contention or to create an alternative network in case of failure. The advantages of an on-the-fly substitution network are manifold: Reusability and cost reduction; Deployability; Adaptability.

The RESCUE project addresses both the theoretical and the practical aspects of the deployment of a substitution network. From a theoretical point of view, we will propose a two-tiered architecture including the base network and the substitution network. This architecture will describe the deployment procedures of the mobile routing devices, the communication stack, the protocols, and the services. The design of this architecture will take into account some constraints such as quality of service and energy consumption (since mobile devices are autonomous), as we want the substitution network to provide more than a best effort service. From a practical point of view, we will provide a proof of concept, the architecture linked to this concept, and the necessary tools (e.g., traffic monitoring, protocols) to validate the concept and mechanisms of on-the-fly substitution networks. At last but not least, we will validate the proposed system both in laboratory testbeds and in a real-usage scenario.
http://rescue.lille.inria.fr/

- ANR PETAFLOW (Appel Blanc International) started in march 2010 and will end in october 2013. It is a collaborative project between the GIPSA Lab (Grenoble), MOAIS (Inria Grenoble), RESO (Inria Grenoble), the University of Osaka (the Cybermedia Center and the Department of Information Networking) and the University of Kyoto (Visualization Laboratory).
We aim at proposing network solutions to guarantee the Quality of Service (in terms of reliability level and of transfer delay properties) of a high speed, long-distance connection used in an interactive, high performance computing application. Another specificity of this application is the peta-scale volume of the treated data corresponding to the upper airway flow modeling.
http://petaflow.gforge.inria.fr/

8.3. European Initiatives

8.3.1. Collaborations in European Programs, except FP7

Program: Life Science Health Priority of the Sixth Framework Program

Project acronym: MOSAR

Project title: Mastering hOSpital Antimicrobial Resistance and its spread into the community.

Duration: 06 2008 - 07 2012

Coordinator: INSERM

Other partners: University of Antwerp, National Medicines Institute (NMI), August Pi i Sunyer biomedical research Institute (IDIBAPS), University Medical Center Utrecht (UMCU), University of Geneva Hospitals (UNIGE), Tel Aviv Medical Center (TASMC), Health Protection Agency (HPA), Medical school of Paris 12 University (UPVM), Pasteur Institute, Inserm-Transfert, Ingen Biosciences, BiologischeAnalysensystemGmbH (BAG), AmpTec GmbH, Array-On GmbH, Inria

Abstract: MOSAR brings together internationally recognized experts to address the issue of antimicrobial resistance in a comprehensive manner. MOSAR consideres the major issue of antimicrobial resistance in the perspective of a complex system and not only through the prism of a single discipline.

To achieve its objectives MOSAR builds on advances generated by basic sciences, through dedicated and trans-disciplinary cooperation. This project integrates studies from epidemiology and basic laboratory sciences, clinical medicine, statistical sciences, behavioural sciences, and health economics. MOSAR network is structured into 10 interacting groups centered on the patients.

MOSAR focuses on major endemic and epidemic nosocomial pathogens such as Methicillin-resistant Staphylococcus aureus (MRSA), Vancomycin-resistant Enterococci (VRE), Extended-Spectrum Beta-Lactamases (ESBL) Enterobacteriaeceae, and Carbapenem-resistant Acinetobacter spp, and in interventional trials in high-risk areas (Intensive Care Units, Surgery and Rehabilitation centers) of countries with high-level of resistance.

8.3.2. FP7 Projects

8.3.2.1. GEYSERS

Title: Generalsed Architecture for dynamic infrastructure services

Type: COOPERATION (ICT)

Defi: The Network of the Future

Instrument: Integrated Project (IP)

Duration: January 2010 - march 2013

Coordinator: Interoute (Italy)

Others partners: Interoute (Italy), martel Martel GmbH (Switzerland), ADVA AG Optical Networking (Germany), SAP AG (Germany), Alcatel-Lucent Italia S.p.A. (Italy), Telefonica I+D (Spain), Telekomunikacja Polska S.A. (Poland), Instytut Chemii Bioorganicznej PAN, Poznan Supercomputing and Networking Centre (Poland), Nextworks s.r.l (Italy), Fundacio i2CAT, Internet i Innovacio Digital a Catalunya (Spain), Universiteit van Amsterdam (The Netherlands), University of Essex (UK), Research and Education Society in Information Technologies (Greece), Technical University of Braunschweig (Germany), Interdisciplinary Institute for BroadBand Technology VZW (belgium), Indian Institute of Technology (India), LYaTiss (France), ADVA Optica Networking Sp.zo.o. (Poland)

Abstract: GEYSERS's vision is to qualify optical infrastructure providers and network operators with a new architecture, to enhance their traditional business operations. Optical network infrastructure providers will compose logical infrastructures and rent them out to network operators; network operators will run cost-efficient, dynamic and mission-specific networks by means of integrated control and management techniques. GEYSERS's concept is that high-end IT resources at users' premises are fully integrated with the network services procedures, both at the infrastructure-planning and connection-provisioning phases. Following this vision, GEYSERS will specify and implement a novel optical-network architecture able to support 'Optical Network + Any-IT' resource provisioning seamlessly and efficiently. Energy-consumption metrics for the end-to-end service routing are part of this efficiency. GEYSERS proposes to:

- Specify and develop mechanisms that allow infrastructure providers to partition their resources (optical network and/or IT), compose specific logical infrastructures and offer them as a service to network operators. This will be done overcoming the current limitations of networks/domain segmentation, and will support dynamic and on-demand changes in the logical infrastructures
- Specify and develop a Network Control Plane for the optical infrastructure, by extending standard solutions (ASON/GMPLS and PCE), able to couple optical network connectivity and IT services automatically and efficiently, and provide them in 1 step, dynamically and on-demand, including infrastructure re-planning mechanisms.

These achievements will enable infrastructure providers, network operators and application providers to participate in new business scenarios where complex services with complex attributes and strict bandwidth requirements can be offered economically and efficiently to users and applications. GEYSERS's outcomes will be validated in an EU-wide optical network test-bed.

8.3.2.2. SAIL

Title: Scalable and Adaptive Internet Solutions

Type: COOPERATION (ICT)

Defi: The Network of the Future

Instrument: Integrated Project (IP)

Duration: August 2010 - January 2013

Coordinator: Ericsson (Sweden)

Others partners: Ericsson AB (Sweden), Alcatel-Lucent Deutschland (Germany), Nokia Siemens Networks OY(Finland), NEC Europe LTD (United Kingdom), France Telecom SA(France), Telef$\sqrt{}\geq$nica Investigacion y Desarrollo (Spain), Telecom Italia (Italy), Portugal Telecom Inovation (Portugal), Swedish institute of Computer science (Sweden), Instituto Superior Tecnico Address (Portugal), Universitaet Paderborn (Germany), Aalto-Korkeakoulus ti (Finland), Kungliga Tekniska Hogskolan (Sweden), Fraunhofer Gesellschaft zur Forderung der angewandten Forschung (Germany),Universitaet Bremen (Germany), Hewlett-Packard Limited (United Kingdom), Fundacion Tecnalia Research and Innovation (Spain), Institut Telecom (France), Technion? Israel Institute of Technology (Israel), DOCOMO Communication Laboratoties Europe (Germany), The Provost Fellows & Scholars of the College of the Holy and undivided Trinity of Queen Elizabeth (Ireland), National ICT Australia Limited (Australia), Universidad de Cantabria (Spain), Lyatiss (France)

See also: https://twiki.verkstad.net/bin/view/Main/WebHome

Abstract: SAIL? objective is the research and development of novel networking technologies using proof-of-concept prototypes to lead the way from current networks to the Network of the Future. SAIL leverages state of the art architectures and technologies, extends them as needed, and integrates them using experimentally-driven research, producing interoperable prototypes to demonstrate utility for a set of concrete use-cases. SAIL reduces costs for setting up, running, and combining networks, applications and services, increasing the efficiency of deployed resources (e.g., personnel, equipment and energy). SAIL improves application support via an information-centric paradigm, replacing the old host-centric one, and develops concrete mechanisms and protocols to realize the benefits of a Network of Information (NetInf). SAIL enables the co-existence of legacy and new networks via virtualization of resources and self-management, fully integrating networking with cloud computing to produce Cloud Networking (CloNe). SAIL embraces heterogeneous media from fibre backbones to wireless access networks, developing new signaling and control interfaces, able to control multiple technologies across multiple aggregation stages, implementing Open Connectivity Services (OConS). SAIL also specifically addresses cross-cutting themes and non-technical issues, such as socio-economics, inclusion, broad dissemination, standardization and network migration, driving new markets, business roles and models, and increasing opportunities for both competition and cooperation. SAIL gathers a strong industry-led consortium of leading operators, vendors, SME, universities and research centers, with a valuable experience acquired in previous FP7 projects, notably 4WARD. The impact will be a consensus among major European operators and vendors on a well-defined path to the Network of the Future together with the technologies required to follow that path.

8.4. International Initiatives

8.4.1. Participation In International Programs

Inria/FAPERJ Project CoDyN (Complex Dynamic Networks) between LNCC and DNET/Inria. The main goal of the CoDyN project is to lay solid foundations to the characterization of dynamically evolving networks, and to the field of dynamical processes occurring on large scale dynamic interaction networks.

PICS CNRS Combinatorial Structures for Complex Network Modeling DANTE is a member of a PICS project of the CNRS between the Academy of Science and Technology in Vietnam and the Laboratoire d'Informatique de Paris 6 (LIP6) and Université Claude Bernard Lyon 1 in France. The project started on january 2010 and will end in december 2012. Its goal is to design models of complex networks that are able to capture at the same time two of their most relevant properties : their heterogeneous degree distribution and their high local density. The goal is to provide very general models that do not make stronger assumptions on the structure of the graphs to be modeled. Our approach is based on the overlapping structure of cliques in complex networks and uses mainly tools coming from combinatorics, graph theory and statistics.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

- Phan Thi Ha Duong, Hanoï, Vietnam, May-June 2012.
- Renault Lambiotte, Namur, January 2012.
- Klaus Wehmuth, LNCC Brasil, April 2012.
- Prasan Kumar Sahoo, Chang Gung University, Taïwan, November 2012.

8.5.1.1. Internships

- Pranav Jindal, IIT Bombay, India, from May to July 2012

9. Dissemination

9.1. Scientific Animation

- Eric Fleury is President of the expert committee for the ANR INFRA call
- Eric Fleury is Co-chair of the Networking group ResCom of the CNRS GDR ASR. He is also a member of the scientific committee of the GDR ASR.
- Eric Fleury is in the in the steering committee of the IXXI – Rhône-Alpes Complex Systems Institute.
- Eric Fleury has been an expert for the Fund for Scientific Research - FNRS.
- Eric Fleury was PC member of ASE/IEEE International Conference on Social Computing (SocialCom)
- Eric Fleury was PC member of 3rd Workshop on Complex Networks
- Thomas Begin was PC member of ACM International Symposium on Performance Evaluation of Wireless Ad Hoc, Sensor, and Ubiquitous Networks (PE-WASUN 2012).
- Thomas Begin was PC member of Nouvelles Technologies de la Répartition / Colloque Francophone sur l'Ingénierie des Protocoles (NOTERE/CFIP 2012).
- Paulo Gonçalves is officer of the local liaison board of EURASIP
- Paulo Gonçalves was PC member of the 3rd Workshop on High Speed Network and Computing Environments (SAINT 2012)
- Paulo Gonçalves is organiser of the 4th Workshop on High Speed Network and Computing Environments (COMPSAC 2013, Kyoto)
- Christophe Crespelle was co-chair of the Discrete Mathematics Session of the SMF-VMS Joint Congress of Mathematics, August 2012, Huê, Vietnam.
- Christophe Crespelle was co-organiser of the 14èmes Rencontres Francophones sur les Aspects Algorithmiques des Télécommunications (AlgoTel 2012).

- Isabelle Guérin Lassous was vice-chair of the expert committee for the ANR Blanc call
- Isabelle Guérin Lassous is a member of the National Committee - Section 06 of the CNRS
- Isabelle Guérin Lassous was general chair of the 9th ACM International Symposium on Performance Evaluation of Wireless Ad Hoc, Sensor, and Ubiquitous Networks (PE-WASUN 2012).
- Isabelle Guérin Lassous is PC member of international conferences as ITC 2013, IWCMC 2013, ICC 2013, MedHocNet 2013, IPDPS 2013, ICC 2012, Globecom 2012.

9.2. Teaching - Supervision - Juries

9.2.1. Teaching

9.2.1.1. Teaching by Eric Fleury

Eric Fleury is a professor at ENS Lyon in the Computer Science Department since 2007. Since 2009 he is the head of the department of computer science. ENS de Lyon is one of the four Écoles normales supérieures in France.

Licence : "Introduction to Algorithm" (L3), ENS de Lyon, France

Licence : "Architecture, System and Networking" (L3), ENS de Lyon, France

9.2.1.2. Teaching by Thomas Begin

Thomas Begin is an Assistant Professor at Université Claude Bernard Lyon 1 in the Computer Science since 2009. He mostly lectures at the University, though he has a teaching activity at ENS Lyon as well.

Licence : "Networks" (L3), University Lyon 1, France

Master : "Networking" (M1), University Lyon 1, France

Master : "Advanced Networks" (M2), University Lyon 1, France

Master : "Performance Evaluation of Green Networks" (M2), ENS de Lyon, France

9.2.1.3. Teaching by Paulo Gonçalves

Master : Responsible for the teaching axis “Models and Optimization for Emergent Infrastructure". M1/M2 of the Department of Computer Sciences at ENS Lyon *(Informatique fondamentale)*

Eng. school : "Introduction to Compressive Sensing" (5th year), CPE Lyon, France

9.2.1.4. Teaching by Christophe Crespelle

Christophe Crespelle is an Assistant Professor at Université Claude Bernard Lyon 1 (UCBL) in the Computer Science department since 2010. He mostly lectures at UCBL, though he has a teaching activity at ENS Lyon as well.

Licence : "Programming" (L2), UCBL, France

Master : "Network Security Architecture" (M2), UCBL, France

Master : "Security" (M2), UCBL, France

Master : "Future Networks" (M2), UCBL, France

Master : "Complex Networks" (M2), ENS Lyon, France

9.2.1.5. Teaching by Isabelle Guérin Lassous

Isabelle Guérin Lassous is an Professor at Université Claude Bernard Lyon 1 in the Computer Science since 2006. She mostly lectures at the University, though she has a teaching activity at ENS Lyon as well. Isabelle Guérin Lassous also heads the Networking speciality of the Master in computer science of University Lyon 1.

Master : "QoS and multimedia networking applications" (M2), University Lyon 1, France

Master : "Networking" (M2), University Lyon 1, France

Master : "Wireless Networks" (M2), University Lyon 1, France

Master : "Ad Hoc Networks" (M1), University Lyon 1, France

Master : "Network Algorithms" (M1), ENS de Lyon, France

9.2.2. Supervision

PhD : Adrien Friggeri, A Quantitative Theory of Social Cohesion, ENS de Lyon, August 2012, Éric Fleury & Guillaume Chelius

PhD : Qinna Wang, Overlapping community detection in dynamic networks , ENS de Lyon, April 2012, Éric Fleury

PhD : Doreid Ammar, Knowledge Plane for Semantic Networks: Application to Admission Control, University Lyon 1, December 2012, Isabelle Guérin-Lassous & Thomas Begin

PhD : Van Nam Nguyen, Evaluation and improvment of the bandwidth use in 802.11-based multihop wireless networks, University Lyon 1, December 2012, Isabelle Guérin-Lassous & Victor Moraru (IFI, Vietnam)

PhD : Andreea Chis, Méthodes et outils pour la compilation et l'optimisation logicielles des systèmes embarqués sans fils dédiés à des applications, ENS de Lyon, January 2012, Éric Fleury & Antoine Fraboulet

PhD in progress : Lucie Martinet, iBird: Individual Based Investigation of Resistance Dissemination, September 2011, Éric Fleury & Christophe Crespelle

PhD in progress : Benjamin Girault, Ondelettes et graphe d'interactions dynamique : échelle temporelle et spatiale, September 2012, Éric Fleury & Paulo Gonçalves

PhD in progress : Thiago Abreu, Integration of Traffic Awareness in Substitution Networks, March 2011, Isabelle Guérin-Lassous & Thomas Begin

PhD in progress : Roy Shubhabrata, Measurements in the framework of Virtual Networks Development, October 2010, Paulo Gonçalves & Thomas Begin

PhD in progress: Marina Sokol, Clustering and learning techniques for traffic / users classification, October 2010, Philippe Nain (Inria MAESTRO) and Paulo Gonçalves. M. Sokol has interrupted her PhD and his currently on maternity leave (until October 2013).

PhD in progress: Elie Rotenberg, Complex Network Metrology, September 2010, Matthieu Latapy and Christophe Crespelle

PhD in progress: Anh Tuan GIANG, Modeling and Improving the Capacity of Vehicular Ad hoc network, April 2011, Anthony Busson (registered at University Paris XI).

PhD in progress: Sabrina Naimi, Mobility metrics in wireless mobile networks, September 2010, Véronique Vèque and Anthony Busson (registered at University Paris XI).

9.2.3. Juries

- Eric Fleury was president of the HDR jury of Emmanuel Baccelli (UPMC, France).
- Eric Fleury was president of the Ph. D. jury of Mikaila Toko Worou (Université de Nice - Inria Sophia Antipolis, France).
- Eric Fleury was member of the Ph.D. jury and reviewer of DIANA Rémi (Université de Toulouse, France).
- Eric Fleury was member of the Ph.D. jury of Afshin Moin (Université de Rennes, France).
- Eric Fleury was member of the Ph.D. jury of Fabio Rocha-Jimenez-Vieira (UPMC, France).
- Eric Fleury was member of the Ph.D. jury of Thomas Ferrandiz (ISAE, France).
- Thomas Begin was member of the Ph.D. jury of El Hachemi Bendahmane (University of Grenoble, France).n
- Paulo Gonçalves was member of the HDR jury of Sandrine Vaton (Telecom Bretagne, France).
- Paulo Gonçalves was member of the Ph.D. jury of Jerôme Van Zaen (EPFL, Switzerland).
- Christophe Crespelle was member of the Ph.D. jury of Massoud Seifi (UPMC, France).
- Isabelle Guérin Lassous was the member of the jury of the second competition of ENS Cachan.

- Isabelle Guérin Lassous was president of the HdR jury of Anne Fladenmuller (UPMC) and of the PhD juries of Bilel Romdhani (INSA Lyon) and Aruna Bianzino (Telecom ParisTech).
- Isabelle Guérin Lassous was reviewer of the PhD juries of Giorgio Corbellini (Grenoble), Mauricio Ituralde (Toulouse), Scott McKenzie Raynel (University of Waikato, New Zealand) and Bafing Sambou (Toulouse).

9.3. Popularization

Eric Fleury was the co-chair of the conference "Alan Turing's Heritage". This Turing Centenary Conference has been be held in Lyon on July 2-4, 2012. At this occasion, a short movie The Turing Machine Comes True was released on the "Real Turing Machine" built from a student team from the Computer Science Department of ENS de Lyon. We do not mean to simulate a Turing machine as it is indeed very easy to simulate a Turing machine on a modern computer. The challenge was really to build a purely mechanical Turing's machine y using only LEGO bricks, gear, rod, pneumatic jack...

10. Bibliography

Major publications by the team in recent years

[1] K. AVRACHENKOV, P. GONCALVES, A. LEGOUT, M. SOKOL. *Classification of Content and Users in BitTorrent by Semi-supervised Learning Methods*, in "8th International Wireless Communications and Mobile Computing Conference (3rd International Workshop on Traffic Analysis and Classification), Date-Added = 2012-04-16 17:03:44 +0200, Date-Modified = 2012-08-30 11:13:51 +0200", Cyprus, Cyprus, 2012, Best paper award [*DOI :* 10.1109/IWCMC.2012.6314276], http://hal.inria.fr/hal-00747641.

[2] A. BRANDWAJN, T. BEGIN. *A recurrent solution of Ph/M/c/N-like and Ph/M/c-like queues*, in "Journal of Applied Probability", 2012, vol. 49, n^{o} 1, p. 84-99, http://hal.inria.fr/hal-00746840.

[3] A. FRIGGERI, R. LAMBIOTTE, M. KOSINSKI, E. FLEURY. *Psychological Aspects of Social Communities*, in "IEEE International Conference on Social Computing (SocialCom)", Amsterdam, Netherlands, IEEE, September 2012, http://hal.inria.fr/hal-00768818.

[4] P. GONCALVES, S. ROY, T. BEGIN, P. LOISEAU. *Dynamic Resource Management in Clouds: A Probabilistic Approach*, in "IEICE Transactions on Communications, special session on Networking Technologies for Cloud Services", 2012, vol. E95-B, n^{o} 08, Invited paper [*DOI :* 10.1587/TRANSCOM.E95.B.2522], http://hal.inria.fr/hal-00747643.

[5] S. GRAUWIN, G. BESLON, E. FLEURY, S. FRANCESCHELLI, C. ROBARDET, J.-B. ROUQUIER, P. JENSEN. *Complex Systems Science: Dreams of Universality, Reality of Interdisciplinarity*, in "Journal of the American Society for Information Science and Technology", 2012, 10.1002/asi.22644 [*DOI :* 10.1002/ASI.22644], http://hal.inria.fr/hal-00706567.

[6] J.-C. LUCET, C. LAOUENAN, G. CHELIUS, N. VEZIRIS, D. LEPELLETIER, A. FRIGGERI, D. ABITEBOUL, E. BOUVET, F. MENTRÉ, E. FLEURY. *Electronic Sensors for Assessing Interactions between Healthcare Workers and Patients under Airborne Precautions*, in "PLoS ONE", May 2012, vol. 7, n^{o} 5 [*DOI :* 10.1371/JOURNAL.PONE.0037893], http://hal.inria.fr/hal-00706557.

[7] Q. WANG, E. FLEURY. *Fuzziness and Overlapping Communities in Large-Scale Networks*, in "J.UCS Journal of Universal Computer Science", 2012, vol. 18, n^{o} 4, http://hal.inria.fr/hal-00746133.

Publications of the year

Doctoral Dissertations and Habilitation Theses

[8] A. FRIGGERI. *A Quantitative Theory of Social Cohesion*, Ecole normale supérieure de lyon - ENS LYON, August 2012, http://hal.inria.fr/tel-00737199.

[9] Q. WANG. *Détection de communautés recouvrantes dans des réseaux de terrain dynamiques*, Ecole normale supérieure de lyon - ENS LYON, April 2012, http://hal.inria.fr/tel-00701217.

Articles in International Peer-Reviewed Journals

[10] A. BRANDWAJN, T. BEGIN. *A recurrent solution of Ph/M/c/N-like and Ph/M/c-like queues*, in "Journal of Applied Probability", 2012, vol. 49, n^{o} 1, p. 84-99, http://hal.inria.fr/hal-00746840.

[11] P. GONCALVES, S. ROY, T. BEGIN, P. LOISEAU. *Dynamic Resource Management in Clouds: A Probabilistic Approach*, in "IEICE Transactions on Communications, special session on Networking Technologies for Cloud Services", 2012, vol. E95-B, n^{o} 08, Invited paper [*DOI :* 10.1587/TRANSCOM.E95.B.2522], http://hal.inria.fr/hal-00747643.

[12] S. GRAUWIN, G. BESLON, E. FLEURY, S. FRANCESCHELLI, C. ROBARDET, J.-B. ROUQUIER, P. JENSEN. *Complex Systems Science: Dreams of Universality, Reality of Interdisciplinarity*, in "Journal of the American Society for Information Science and Technology", 2012, 10.1002/asi.22644 [*DOI :* 10.1002/ASI.22644], http://hal.inria.fr/hal-00706567.

[13] P. LOISEAU, C. MÉDIGUE, P. GONÇALVES, N. ATTIA, S. SEURET, F. COTTIN, D. CHEMLA, M. SORINE, J. BARRAL. *Large deviations estimates for the multiscale analysis of heart rate variability*, in "Physica A", June 2012, vol. 391, n^{o} 22, p. 5658-5671 [*DOI :* 10.1016/J.PHYSA.2012.05.069], http://hal.inria.fr/hal-00725380.

[14] J.-C. LUCET, C. LAOUENAN, G. CHELIUS, N. VEZIRIS, D. LEPELLETIER, A. FRIGGERI, D. ABITEBOUL, E. BOUVET, F. MENTRÉ, E. FLEURY. *Electronic Sensors for Assessing Interactions between Healthcare Workers and Patients under Airborne Precautions*, in "PLoS ONE", May 2012, vol. 7, n^{o} 5 [*DOI :* 10.1371/JOURNAL.PONE.0037893], http://hal.inria.fr/hal-00706557.

[15] A.-C. ORGERIE, L. LEFÈVRE, I. GUÉRIN-LASSOUS. *Energy-efficient bandwidth reservation for bulk data transfers in dedicated wired networks*, in "Journal of Supercomputing", 2012, p. 1139-1166 [*DOI :* 10.1007/S11227-011-0603-7], http://hal.inria.fr/hal-00770903.

[16] C. SARR, S. KHALFALLAH, I. GUÉRIN-LASSOUS. *Dynamic Bandwidth Management in IEEE 802.11-Based Multihop Wireless Networks*, in "Annals of Telecommunications", 2012, p. 191-202 [*DOI :* 10.1007/S12243-011-0263-X], http://hal.inria.fr/hal-00770894.

[17] Q. WANG, E. FLEURY. *Fuzziness and Overlapping Communities in Large-Scale Networks*, in "J.UCS Journal of Universal Computer Science", 2012, vol. 18, n^{o} 4, http://hal.inria.fr/hal-00746133.

Invited Conferences

[18] T. ABREU, N. NGUYEN, T. BEGIN, I. GUÉRIN-LASSOUS, B. BAYNAT. *Substitution Networks: Performance Collapse due to Overhead in Communication Times*, in "4th International Conference on Ad Hoc Networks", Paris, France, EAI - European Alliance for Innovation, October 2012, http://hal.inria.fr/hal-00763225.

International Conferences with Proceedings

[19] D. AMMAR, T. BEGIN, I. GUÉRIN-LASSOUS, L. NOIRIE. *KBAC: Knowledge-Based Admission Control*, in "IEEE LCN", États-Unis, 2012, 1111, http://hal.inria.fr/hal-00770910.

[20] D. AMMAR, T. BEGIN, I. GUÉRIN-LASSOUS, L. NOIRIE. *Contrôle d'Admission Basé sur un Plan de Connaissance*, in "14èmes Rencontres Francophones sur les Aspects Algorithmiques des Télécommunications (AlgoTel)", La Grande Motte, France, F. MATHIEU, N. HANUSSE (editors), 2012, p. 1-4, http://hal.inria.fr/hal-00690485.

[21] *Best Paper*
K. AVRACHENKOV, P. GONCALVES, A. LEGOUT, M. SOKOL. *Classification of Content and Users in BitTorrent by Semi-supervised Learning Methods*, in "8th International Wireless Communications and Mobile Computing Conference (3rd International Workshop on Traffic Analysis and Classification)", Cyprus, Cyprus, 2012, Best paper award [*DOI :* 10.1109/IWCMC.2012.6314276], http://hal.inria.fr/hal-00747641.

[22] K. AVRACHENKOV, P. GONCALVES, A. MISHENIN, M. SOKOL. *Generalized Optimization Framework for Graph-based Semi-supervised Learning*, in "SIAM Data Mining", Anaheim (CA), United States, 2012, http://hal.inria.fr/hal-00747649.

[23] A. BRANDWAJN, T. BEGIN. *An approximate solution for Ph/Ph/1 and Ph/Ph/1/N queues*, in "Proceedings of the 3rd ACM/SPEC International Conference on Performance Engineering, ICPE12", Boston, Massachusetts, United States, 2012, 6, http://hal.inria.fr/hal-00746838.

[24] J.-B. DELAVOIX, S. ROY, T. BEGIN, P. GONCALVES. *Demonstrating a Versatile Model for VoD Buzz Workload in Large Scale Distributed Network*, in "1st IEEE International Conference on Cloud Networking", Université Pierre et Marie Curie, Paris (France), France, 2012, http://hal.inria.fr/hal-00747638.

[25] I. DOGHRI, L. REYNAUD, I. GUÉRIN-LASSOUS. *On The Recovery Performance of Single- and Multipath OLSR in Wireless Multi-Hop Networks*, in "Third International ICST Conference on Ad Hoc Networks, ADHOCNETS 2011", Paris, France, ICST (editor), Springer, 2012, vol. 89, 239 [*DOI :* 10.1007/978-3-642-29096-1], http://hal.inria.fr/hal-00708684.

[26] R. DOMGA KOMGUEM, I. AMADOU, G. CHELIUS, F. VALOIS. *Routing Protocols: When to use it in terms of energy?*, in "IEEE Wireless Communications and Networking Conference (WCNC)", Paris, France, April 2012, http://hal.inria.fr/hal-00697717.

[27] A. FRIGGERI, E. FLEURY. *A Quantitative Theory of Social Cohesion*, in "Workshop on Information in Networks", new york, United States, September 2012, http://hal.inria.fr/hal-00768778.

[28] A. FRIGGERI, R. LAMBIOTTE, M. KOSINSKI, E. FLEURY. *Psychological Aspects of Social Communities*, in "IEEE International Conference on Social Computing (SocialCom)", Amsterdam, Netherlands, IEEE, September 2012, http://hal.inria.fr/hal-00768818.

[29] I. GUÉRIN-LASSOUS, C. TRIPP BARBA, M. AGUILAR IGARTUA, C. SARR. *Available Bandwidth-aware routing in urban Vehicular Ad-hoc Networks*, in "VTC-Fall", Quebec, Canada, 2012, http://hal.inria.fr/hal-00771269.

[30] N. V. NAM, I. GUÉRIN-LASSOUS, V. MORARU, T. RAZAFINDRALAMBO. *Characterisation and Application of Idle Period Durations in IEEE 802.11 DCF-based Multihop Wireless Networks*, in "ACM International Conference on Modeling, Analysis and Simulation of Wireless and Mobile Systems (MSWIM)", Paphos, Chypre, October 2012, http://hal.inria.fr/hal-00724969.

[31] V. NEIGER, C. CRESPELLE, E. FLEURY. *On the Structure of Changes in Dynamic Contact Networks*, in "Workshop on Complex Networks and their Applications", Sorrento, Italy, November 2012, http://hal.inria.fr/hal-00755251.

[32] V. N. NGUYEN, I. GUÉRIN-LASSOUS, T. RAZAFINDRALAMBO, V. MORARU. *Caractérisation des Périodes Libres dans les Réseaux 802.11 Multisauts*, in "14èmes Rencontres Francophones sur les Aspects Algorithmiques des Télécommunications (AlgoTel)", La Grande Motte, France, 2012, p. 1-4, http://hal.inria.fr/hal-00690957.

[33] A.-C. ORGERIE, P. GONCALVES, M. IMBERT, J. RIDOUX, D. VEITCH. *Survey of network metrology platforms*, in "12th IEEE/IPSJ International Symposium on 12th IEEE/IPSJ SAINT, 3rd Workshop on High Speed Network and Computing Environments", Izmir (Turkey), Turkey, 2012 [*DOI :* 10.1109/SAINT.2012.41], http://hal.inria.fr/hal-00747647.

Conferences without Proceedings

[34] C. CRESPELLE, P. GAMBETTE. *(Nearly-)Tight Bounds on the Linearity and Contiguity of Cographs*, in "Bordeaux Graph Workshop", France, LABRI (editor), November 2012, 2, http://hal.inria.fr/hal-00730247.

[35] A. FRIGGERI, E. FLEURY. *Agreement Groups in the United States Senate*, in "IOGDC - International Open Government Data Conference - 2012", Washington D.C., United States, June 2012, http://hal.inria.fr/hal-00705682.

[36] A.-C. ORGERIE, P. GONÇALVES, M. DAVIS, J. RIDOUX, D. VEITCH. *Distributed Simulation and Visualization of Unsteady Flows in a Transcontinental Context*, in "Supercomputing", Salt Lake City (US), Nov. 2012, Poster.

Scientific Books (or Scientific Book chapters)

[37] Q. WANG, E. FLEURY, T. AYNAUD, J.-L. GUILLAUME. *Communities in evolving networks: definitions, detection and analysis techniques*, in "Dynamics of Time Varying Networks", N. GANGULY, A. MUKHERJEE, B. MITRA, F. PERUANI, M. CHOUDHURY (editors), Springer, 2012, http://hal.inria.fr/hal-00746195.

[38] Q. WANG, E. FLEURY. *Fuzzy community structure and modular overlaps in complex networks*, in "Studies in Mining Social Networks and Security Informatics", Z. ERDEM, T. ÖZYER, S. KHOURY, J. ROKNE (editors), Springer, 2012, http://hal.inria.fr/hal-00746194.

Research Reports

[39] D. AMMAR, T. BEGIN, I. GUÉRIN-LASSOUS, L. NOIRIE. *Performance Evaluation of MBAC solutions*, Inria, September 2012, n^{o} RR-8080, http://hal.inria.fr/hal-00736695.

[40] D. AMMAR, T. BEGIN, I. GUÉRIN-LASSOUS, L. NOIRIE. *KBAC: Knowledge-Based Admission Control*, Inria, May 2012, n^{o} RR-7955, http://hal.inria.fr/hal-00695335.

[41] A. FRIGGERI, E. FLEURY. *Finding cohesive communities with CC^3*, Inria, April 2012, n^{o} RR-7947, http://hal.inria.fr/hal-00692548.

[42] S. ROY, T. BEGIN, P. LOISEAU, P. GONCALVES. *Un modèle de trafic adapté à la volatilité de charge d'un service de vidéo à la demande: Identification, validation et application à la gestion dynamique de ressources.*, Inria, September 2012, n^{o} RR-8072, http://hal.inria.fr/hal-00734295.

Patents and standards

[43] T. BEGIN, A. BRANDWAJN. *A Tool for solving Ph/M/c and Ph/M/c/N queues*, 2012, n^{o} xxx, http://hal.inria.fr/hal-00746841.

[44] L. NOIRIE, M. JABER, P. GONÇALVES. *A System And A Method For Detecting Cheating Applicaitons*, August 2012, Patent Alcatel Lucent, Inria No. 12305956.0.

Other Publications

[45] E. FLEURY, G. HARTER, F. SAINT-MARCEL, N. MITTON, J. VANDAËLE. *Tutorial : SensLAB/FIT - Very Large Scale Open Wireless Sensor Network Testbed*, November 2012, Tutorial of the FIT/SensLab platform, http://hal.inria.fr/hal-00740371.

[46] S. GRAUWIN, P. JENSEN. *Opinion groups formation and dynamics : structures that last from non lasting entities*, 2012, http://hal.inria.fr/hal-00704285.