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INSTITUT NATIONAL DE RECHERCHE EN INFORMATIQUE ET EN AUTOMATIQUE

Project-Team mascotte

Algorithms, simulation, combinatorics and optimization for telecommunications

Sophia Antipolis - Méditerranée

Theme : Networks and Telecommunications

Table of contents

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2. Overall Objectives

2.1. Introduction

MASCOTTE is a joint team between INRIA Sophia Antipolis Méditerranée and the laboratory I3S (Informatique Signaux et Systèmes de Sophia Antipolis) which itself belongs to CNRS (Centre National de la Recherche Scientifique) and UNS (University of Nice Sophia Antipolis). Its research fields are Algorithmics, Discrete Mathematics, Combinatorial Optimization and Simulation, with applications to telecommunication networks.

The objectives of the MASCOTTE project-team are to design networks and communication algorithms. In order to meet these objectives, the team studies various theoretical tools, such as Discrete Mathematics, Graph Theory, or Algorithmics and develops applied techniques and tools, especially for Combinatorial Optimization and Computer Simulation. In particular MASCOTTE used in the last year both these theoretical and applied tools for the design of various networks, such as WDM, wireless (radio), satellite, overlay, and peer-to-peer networks. This research has been done within various industrial and international collaborations.

This results also in the production of advanced softwares such as the MASCOPT library (MASCOTTE optimization), and ambitious software projects such as the OSA (Open Simulation Architecture) Computer Simulation Architecture.

2.2. Highlights

Honors: J-C. Bermond received two prizes: the prestigious French award (Grand Prix) from the French Academy of science *Prix de la Fondation d'entreprise EADS* (informatique) (http://www.academie-sciences.fr/prix/gpmp.htm) and the Prize for Innovation In Distributed Computing (http://www.sirocco2010.boun.edu.tr/invited.html).

HDR: Two members of MASCOTTE passed their HDR in March 2010: D. Coudert and S. Pérennes.

Last year Mascotte has strongly increased its international and industrial collaborations with:
European Collaborations: A STREP EULER (Experimental UpdateLess Evolutive Routing), part of FIRE (Future Internet Research and Experimentation) objective of FP7, started.
ANR: A new International ANR with Taiwan GRATEL (Graphs and Telecomunications) started.

3. Scientific Foundations

3.1. Scientific Foundations

The project develops tools and theory in the following domains: Discrete Mathematics (in particular Graph Theory), Algorithmics, Combinatorial Optimization and Simulation.

Typically, a telecommunication network (or an interconnection network) is modeled by a graph. A vertex may represent either a processor or a router or any of the following: a switch, a radio device, a site or a person. An edge (or arc) corresponds to a connection between the elements represented by the vertices (logical or physical connection). We can associate more information both to the vertices (for example what kind of switch is used, optical or not, number of ports, equipment cost) and to the edges (weights which might correspond to length, cost, bandwidth, capacity) or colors (modeling either wavelengths or frequencies or failures) etc. Depending on the application, various models can be defined and have to be specified. This modeling part is an important task. To solve the problems, we manage, when possible, to find polynomial algorithms. For example, a maximum set of disjoint paths between two given vertices is by Menger's theorem equal to the minimum cardinality of a cut. This problem can be solved in polynomial time using graph theoretic tools or flow theory or linear programming. On the contrary, determining whether in a directed graph there exists a pair of disjoint paths, one from s_1 to t_1 and the other from s_2 to t_2, is an NP-complete problem, and so are all the problems which aim at minimizing the cost of a network which can satisfy certain traffic requirements. In addition to deterministic hypothesis (for example if a connection fails it is considered as definitely down and not intermittently), the project started recently to consider probabilistic ones.

Graph coloring is an example of tool which appears in various contexts: WDM networks where colors represent wavelengths, radio networks where colors represent frequencies, fault tolerance where colors represent shared risk resource groups, and scheduling problems. Another tool concerns the development of new algorithmic aspects like parametrized algorithms.

Theoretical results are described after, with more emphasis on those of Graph Theory (Section 6.5) and Algorithmic Aspects (Section 6.6).

4. Application Domains

4.1. Application Domains

For the last year the main application domain of the project remained Telecommunications. Within this domain, we consider applications that follow the needs and interests of our industrial partners, in particular ORANGE LABS or Alcatel-Lucent Bell-Labs, but also SMEs' like UBISTORAGE or 3-ROAM.

MASCOTTE is mainly interested in the design of heterogeneous networks. The project has kept working on the design of backbone networks in particular optical ones (see Section 6.1) but also on wireless access networks (see Section 6.2) and on overlay (Peer to peer) networks (see Section 6.3).

Part of these research is done within the joint laboratory INRIA-Alcatel-Lucent Bell-Labs, (participation in the ADR HiMa on autonomous dynamic management of virtual topologies and within the ANR ECOSCells led by Alcatel-Lucent Bell-Labs). MASCOTTE has also a contract with Alcatel-Lucent Bell-Labs, on dynamic compact routing. This collaboration continues through the STREP EULER which started in October 2010. An emphasis is done on green networks with low power consumption financed with the ANR DIMAGREEN. We have also developed two cooperations with SMEs. The first one is on data storage in peer-to-peer networks with the SME UBISTORAGE within the ANR SPREADS (Safe P2P reliable Architecture for Data Storage). The second one is on backhaul networks with the SME 3-ROAM and AVISTO, and is funded by the *région PACA* project RAISOM (Wireless IP Service Deployment optimization and monitoring) and European fund FEDER.

5. Software

5.1. Dipergrafs

Participants: Luc Hogie, Aurélien Lancin, Issam Tahiri.

More than 11000 lines, developed in Java.

The Dipergrafs project proposes a Java framework for the manipulation of directed hypergraphs. Briefly, a directed hypergraph consists in a set of directed links, each link connecting a set of vertices to another set of vertices. Hypergraphs are used into the fields of network modeling, rational databases, semantic web, expert systems, route planning. In particular, Dipergrafs is designed in order to make it particularly useful in the context of network simulation.

The most important features of Dipergraphs are: it has a vertex-oriented design (in opposite to node-oriented design), that is the graph is seen as a collection of relations between nodes; it imposes no constraint on the type of nodes and vertices (in opposite to frameworks which oblige to follow a certain structure, leading to a lack of flexibility); it provides implementations for common graph operations : navigation (paths, connected components, shortest paths, hop-exploring, etc), graph queries, graph metrics (radius, density, degrees, distance/adjacency/incidence matrices, etc), distributions of vertex metrics; it is mostly usable through a small set of Java classes (in opposite to frameworks whose utilization requires the knowledge of numerous classes); it features graph input/output mechanisms, allowing persistence, serialization, etc; it does not feature any graph rendering tool. Instead bridges to external products dedicated to rendering are provided; it comes with a set of composeable topology generator allowing to quickly instantiate the desired topology.

Dipergrafs is extensively used in the DRMSim project, in which it enables the modeling and simulation of large backbone networks.

5.2. DRMSim

Participants: Luc Hogie, Aurélien Lancin, Issam Tahiri, David Coudert, Nicolas Nisse.

Around 30000 lines, developed in Java, collaboration between MASCOTTE and researchers in LaBRI (95 % MASCOTTE).

The expansion of the Internet results in a number of issues: BGP (Border Gateway Protocol) starts to show its limits in terms of the number of routing table entries it can manage. More efficient dynamic routing protocols are thus under investigation. However, because deploying under-development routing protocols on the Internet is not practicable at a large-scale, simulation is an unavoidable step to validate the properties of a newly proposed routing scheme. Unfortunately, the simulation of routing protocols over large networks poses real challenges due to the limited computational capabilities of computers. Existing simulation tools exhibit limitations in terms of the number of nodes they can handle and of the models they propose. This motivated us to conceive and develop DRMSim (Dynamic Routing Model simulator): a network simulator which addresses the specific problem of large-scale simulations of routing models.

DRMSim relies on a discrete-event simulation engine. It proposes a general routing model which accommodates any network configuration. Aside to this, it includes specific models for Generalized Linear Preference (GLP), and K-chordal network topologies, as well as implementations of routing protocols, including the routing protocol proposed in [89] and lightweight versions of BGP (Border Gateway Protocol).

DRMSim is developed in cooperation with LaBRI (Laboratoire Bordelais de Recherche en Informatique, Bordeaux, France).

See also the web page http://www-sop.inria.fr/mascotte/projets/DCR/.

5.3. Mascopt and openGVE

Participant: Michel Syska [correspondant].

Developed in Java.

MASCOPT [88] is a Java library distributed under the terms of the LGPL license which is dedicated to graph and network processing. MASCOPT includes a collection of Java interfaces and classes that implement fundamental data structures and algorithms. The forthcoming public distribution of MASCOPT will appear under the name of the OPENGVE project, MASCOPT being one implementation of the bridge graph interface [R. Correa, http://opengve.inria.fr/bridge-graph-interface/apidocs/fr/inria/opengve/bridge/interfaces/Graph.html). The objective is to allow easy integration of different implementations. The applications already written will not be affected. They will have different choices of internal implementation that may lead to better performances for specific issues such as large graphs processing.

The main objective of MASCOPT (MASCOTTE Optimization) project is to ease software development in the field of network optimization. Examples of problems include routing, grooming, survivability, and virtual network design. MASCOPT helps implementing a solution to such problems by providing a data model of the network and the demands, classes to handle data and ready to use implementations of existing algorithms or linear programs (e.g. shortest paths or integral multicommodity flow).

A key feature of MASCOPT is to provide a generic linear programming object interface which allows users to program the same way whether the target solver is IBM ILOG CPLEX, GLPK (GNU Linear Programming Kit) or CLP/CBC (accessed through JNI).

MASCOPT has intensively been used in the past within MASCOTTE industrial cooperation programs for experimentation and validation purposes as for example with Alcatel Space Technologies and Orange Labs. Today, the library is used within the framework of the ANR AGAPE to implement FPT algorithms (work done at LIFO).

See also the web page http://www-sop.inria.fr/mascotte/mascopt/.

5.4. Open Similation Architecture (OSA)

Participants: Olivier Dalle [correspondant], Judicaël Ribault.

Developed in Java (80%) and XML, AspectJ, etc. Represent the work of about 7 man/year during the last 5 years.

Component-based modeling has many well-known good properties. One of these properties is the ability to distribute the modeling effort amongst several experts, each having his/her own area of system expertise. Clearly, the less experts have to care about areas of expertise of others, the more efficient they are in modeling sub-systems in their own area. Furthermore, the process of studying complex systems using discrete-event computer simulations involves several areas of non-system expertise, such as discrete-event techniques or experiment planning.

The Open Simulation Architecture (OSA) [87] is designed to enforce a strong separation of the end-user roles and therefore, ensure a successful cooperation of all the experts involved in the process of simulating complex systems.

The OSA architecture is also intended to meet the expectations of a large part of the discrete-event simulation community: it provides an open platform intended to support researchers in a wide range of their simulation activities, and allows the reuse and sharing of system models in the simulation community by means of a flexible and generic component model (Fractal).

Many discrete-event simulators are developed concurrently, but with identical or similar purpose. Another goal of OSA is to favor the reuse and integration of simulation software components and models. To favor reuse, OSA uses a layered approach to combine the modeling, simulation, and related concerns, such as instrumentation or deployment. This ability is demonstrated by the successful integration and reuse of third-party components, such as Scave, the analysis module of Omnet++, or a large number of the James II plugins developed by the University of Rostock. OSA is both a testbed for experimenting new simulation techniques and a tool for real case studies.

OSA is Open Source (LGPL) and is available for download on the INRIA forge server http://osa.gforge.inria.fr/.

See also the web page http://osa.inria.fr/.

5.5. SageMath

Participant: Nathann Cohen [correspondant].

Developed in Python and Cython. N. Cohen wrote more than 140 patches and reviewed 75 others.

Sagemath is a free open-source mathematics software aiming at becoming an alternative to Maple and Matlab. Initially created by William Stein (Professor of mathematics at Washington University), Sagemath is currently developed by more than 180 contributors around the world (mostly researchers). It was initially of interest for Mascotte because of its large library in Combinatorics and Graph Theory. This year, impressive improvements have been made to this library. In particular, N. Cohen contributed a lot into the following: 1) implementation of a generic interface between Sage and existing (Mixed Integer) Linear Program solvers, 2) implementation of exact algorithms for common Polynomial/NP-Complete graph problems, often through the use of Linear Programs, and 3) improving Sage's documentation by participating to the writing of a French manual on the use of Sage with 10 other French scientists [66], [65].

Sage's Graph and Linear Programing libraries are currently used by Mascotte members to test algorithms or compare their performances, as well as to prove/disprove theoretical conjectures and for teaching purposes in the Master IFI, stream UBINET.

5.6. Utilities

5.6.1. EPR- Eclipse Project Releaser

Participant: Luc Hogie [correspondant].

More than 1000 lines, developed in Java.

EPR is a utility software aiming at providing a as-simple-as-possible tool for exporting an Eclipse Java project into a self-contained ZIP file, as well as updating the project website and SVN repository.

See also the web page http://www-sop.inria.fr/members/Luc.Hogie/epr/

5.6.2. Java4unix

Participant: Luc Hogie [correspondant].

More than 3000 lines, developed in Java.

Java4unix proposes a development framework which simplifies the use of Java for UNIX software programming/distribution. Until now, Java could hardly be used for the development UNIX applications because invoking Java applications from the UNIX shell must be done through an explicit call to the Java virtual machine and writing simple things in Java often requires long coding. Java4unix aims at filling those two gaps by providing a UNIX installer for java applications, turning them to standard UNIX application and a framework that UNIX programmers may use to manipulate files/text, etc.

The following applications/projects already make use of java4unix: java4unix itself, drmsim, dipergrafs, lmu, epr, mascsim, fff, etc.

See also the web page http://www-sop.inria.fr/members/Luc.Hogie/java4unix/.

5.6.3. Mascsim

Participants: Luc Hogie, Aurélien Lancin, Issam Tahiri.

Around 10000 lines, developed in Java.

Mascsim is a distributed discrete event simulator whose main target is to be easy to use.

Unlike most discrete-event simulators, the researcher who is using Mascsim is required to provide only the bare minimum material needed for the simulation: a model for the system, a set of events describing what is going on in the system, as well as a set of metrics of interest.

The simulation process is then entirely automatized, as concerns the distribution of the simulation campaign on the grid, the plot of result graphs or whatever other daunting task.

See also the web page http://www-sop.inria.fr/mascotte/software/mascsim/.

5.6.4. P2PVSim

Participant: Remigiusz Modrzejewski [correspondant].

Around 3000 lines, developed in Python.

P2PVSim is a simple discrete-event simulator created for analyzing theoretical properties of peer-to-peer live video streaming algorithms. Implemented in Python it was designed with clarity and extensibility in mind from the beginning. At the same time, a lot of work was put into the performance and scalability aspects of the software. Currently it is meant for simulating overlays of a few thousand peers running simple control protocols.

6. New Results

6.1. Backbone Networks

Participants: Jean-Claude Bermond, Nathann Cohen, David Coudert, Philippe Giabbanelli, Frédéric Giroire, Dorian Mazauric, Gianpiero Monaco, Joanna Moulierac, Napoleão Vieira Nepomuceno, Nicolas Nisse, Ronan Pardo Soares, Brice Onfroy, Issam Tahiri.

Network design is a very wide subject that concerns all kinds of networks. For telecommunications networks it can be either physical networks (backbone, access, wireless, ...) or virtual (logical) ones. The objective is to design a network able to route a (given, estimated, dynamic, ...) traffic under some constraints (e.g. capacity) and with some quality of service (QoS) requirements. Usually the traffic is expressed as a family of requests with parameters attached to them. In order to satisfy these requests, we need to find one (or many) path(s) between their end nodes. The set of paths is chosen according to the technology, the protocol or the QoS constraints. For instance, optical backbones use the WDM technology to take better advantage of the capacity of the optical fibers often already installed. This is achieved through the multiplexing of several wavelength channels onto the same fiber. In that case a resource allocation is an optical channel, which consists of a path and a wavelength assigned on each link along the path, and is called a *lightpath*. If wavelength translation is performed in optical switching, then to each channel may be assigned different wavelengths on each link along the path; otherwise the wavelength continuity constraint must be satisfied on all links along the path. Of course, two lightpaths sharing a link must use different wavelengths on that link. The design can be done at the conception of the network (i.e. when conceiving a virtual network in MPLS where we have to establish virtual paths) or to adapt the network to changes (failures, new link, updates of routers, variation of traffic, ...). Finally there are various optimization criteria which differ according to the point of view: for a network user they are related to his/her satisfaction (minimizing delays, increasing available bandwidth, ...), while for a network operator, economics criteria like minimizing deployment and operating costs are more important.

This very wide topic is considered by a lot of academic and industrial teams in the world. Our approach is to attack these problems with tools from Discrete Mathematics and to consider mainly telecommunications networks.

6.1.1. Traffic grooming

In a WDM network, routing a connection request consists in assigning a route in the physical network and a wavelength to this connection request. When each request uses at most $1/C$ of the bandwidth of the wavelength, we say that the grooming factor is C. That means that on a given edge of the network we can groom at most C requests on the same wavelength. With this constraint the objective can be either to minimize the number of wavelengths (related to the transmission cost) or minimize the number of Add/Drop Multiplexers (ADM) used in the network (related to the cost of the nodes). We addressed this problem in various WDM network topologies with the goal of minimizing the total number of ADMs required.

This year, we have provided optimal constructions in bidirectional WDM rings with All-to-All uniform unitary traffic when $C = 1, 2, 3$ and $k(k+1)/2$ ($k \geq 1$) for infinite congruence classes, and have proposed an approximate construction for $C = 2, 3$ [13]. We have also studied the all-to-all traffic grooming on unidirectional rings with grooming factor C and with the extra constraints that the traffic between a subset of vertices must be served with grooming factor C'. We provided optimal constructions for $C = 4$ and $C' = 1, 2, 3$ [10]. Finally, in [67], we have surveyed the main results obtained on traffic grooming, including complexity and hardness results, optimal constructions, approximation algorithms, ILP formulations and heuristic algorithms.

We have proposed a new framework, based on linear programming with column generation, for shared segment protection in WDM with grooming capability [50], [49]. The objective is to determine for every working path a set of protection segments(sub-paths) that are used to recover any node or link failure. The resources devoted to protection are shared among node and link disjoint working paths.

6.1.2. Routing reconfiguration and its link with graph searching

In production networks, traffic evolution, failures and maintenance operations force to adapt regularly the current configuration of the network (virtual topology, routing of connections). The routing reconfiguration problem in WDM networks is thus to schedule the *migration* of established lightpaths from current routing to a new pre-computed one while minimizing service disruptions. We have shown in the past the relations between this problem and the *graph searching problem* (see also Section 6.6.3).

This year, we have focussed on the tradeoffs between the total number and the number of simultaneous interruptions that occur during the reconfiguration process, proving in particular that the knowledge of one parameter does not help to optimize the other [39], [55].

6.1.3. Green-Networking

The minimization of ICT energy consumption has become a priority with the recent increase of energy cost and the new sensibility of public, governments and corporations towards energy consumption. ICT alone is responsible of 2% to 10% (depending on the estimations) of the world power consumption. For example, it is estimated that switches, hubs, routers account for 6 TWh per year in the US.

Several studies exhibit that the traffic load of the routers only has a small influence on their energy consumption. Hence, the power consumption in networks is strongly related to the number of active network elements, such as interfaces, line cards, base chassis,... In [43], [44], [81], we define and model formally the problem of finding a routing with the goal of minimizing the (weighted) number of active network elements. Then, we prove that this problem is not in APX, that is there is no polynomial-time constant-factor approximation algorithm. Thus, we propose a heuristic algorithm for this problem and we present a study on specific topologies, such as trees and complete graphs, that provide bounds and results useful for real topologies. Finally, we discuss the impact of energy efficient routing on the stretch factor and on fault tolerance.

[20] investigates the problem of determining feasible radio configurations in fixed broadband wireless networks, focusing on power efficiency.

6.1.4. Network Design

The transmission of an optical signal in a fiber causes small phase shifting and power loss forcing to regenerate the signal after a certain distance (e.g. 1000km). We have investigated the problem of minimizing the total number of locations to place the regenerators in a WDM network [26]. We established the complexity and inapproximability of the problem, and provided approximation algorithms and exact polynomial time algorithms whenever possible.

Motivated by the minimization of the number of wavelengths needed to route a set of requests in a WDM network, we studied the natural linear programming relaxation of the path coloring problem [16]. We prove constructively that finding an optimal fractional path coloring is Fixed Parameter Tractable (FPT), with the degree of the tree as parameter. We also show a $(1 + 5/3e) \approx 1.61$ approximation algorithm for the path coloring problem in bounded degree trees, improving on existing results.

We have also investigated the impact of topological properties, and in particular complex networks properties, on the routing in backbone networks [41]. We focussed in particular on the overall number of ports used in router nodes.

6.2. Wireless Access Networks

Participants: Jean-Claude Bermond, Bi Li, Dorian Mazauric, Napoleão Vieira Nepomuceno, Nicolas Nisse, Stéphane Pérennes.

MASCOTTE has conducted an intense research effort on wireless access networks. From the technological and architectural point of view, the field is broad, from mesh (or multi-hop cellular) networks to *ad-hoc* and sensor networks. Nevertheless, many questions and approaches are generic from an algorithmic and structural viewpoint.

In particular, we have studied three of the most prominent performance metrics for radio networks. Using combinatorial optimization and centralized algorithmic with a network design flavor, transport capacity and energy consumption of the networks have been studied. Using distributed algorithmic with a protocol flavor, fast data gathering and call scheduling are investigated. Our approach is complementary with those developed in other INRIA project-teams such as PLANETE, MAESTRO, SWING (ex ARES) or POPS. The complementarity has been exploited through a joint Ph.D. between MAESTRO and MASCOTTE and, recently, through an ANR VERSO project in which MAESTRO, MASCOTTE and SWING are involved.

At the international level, our researches cooperate with some groups in renowned research centers such as CTI of Patras in Greece, Universities of Roma or Salerno in Italy, the Technion Institute in Israël, SFU in Vancouver, Canada, UFC, Universidade Federal do Ceará, Fortaleza, Brazil, or the University of Sao Paulo in Brazil.

We studied a wide range of issues of wireless networks, from the design of efficient cross-layer medium access, call scheduling and routing techniques to energy efficient optimization. We developed theoretical tools for analyzing and evaluating dynamic networks. Some graph coloring problems motivated by channel assignment in wireless networks are detailed in Section 6.5 and the optimization techniques and wireless simulation tools that we have developed are also cited in Section 6.4.

6.2.1. Wireless Backhaul

We investigated network optimization problems related to the design and configuration of wireless microwave backhaul. We have proposed a chance-constrained programming approach to determine the optimal bandwidth assignment for the links of a microwave backhaul network under outage probability constraints [3]. Moreover, we have presented mathematical models to generate power-efficient radio configurations as a function of the network traffic [3], [20]. In addition, in collaboration with the SME 3Roam (see Section 7.3), we have developed an optimization tool, 3Link, for helping the design of microwave links [3].

6.2.2. Gathering

Several works of MASCOTTE have dealt with gathering (data collection) in wireless multi hop networks when interferences constraints are present.

In particular we consider interference constraint modeled by a fixed integer $d \geq 1$, which implies that nodes within distance d in the graph from one sender cannot receive messages from another node. We give optimal protocols for $d = 1$ when the network is a tree and the destination node is the root of the tree. In [14], we consider the case where buffering is allowed in intermediate nodes and in [11], the case where no buffering is allowed.

6.2.3. Call Scheduling

Distributed call scheduling in wireless networks is a challenging problem to tackle. Indeed, even when interferences are not considered, computing an optimal call scheduling with local information is still an open question. Due to interference constraints, incident links cannot be simultaneously activated, otherwise transmissions will fail. In [35], we design the first fully distributed local algorithm with the following properties: it works for any arbitrary binary interference model; it has a constant number of mini-slots of control (independent of the size of the network and the values of the queues); and it needs no knowledge. We also give sufficient conditions for stability under Markovian assumptions.

In [36], we have studied the stability of a localized algorithm for spreading a flow from a source to a destination, in presence of interferences.

Another way to deal with the distributed call scheduling problem is in terms of Round Weighting Problem (RWP). In [37], we develop the Cut Covering Problem (CCP) and prove that it is equivalent to RWP. We develop a primal/dual algorithm combining line and column generation to deal with the exponential number of variables and constraints of CCP.

6.3. Application/Overlay Networks: P2P Storage Systems

Participants: Frédéric Giroire, Dorian Mazauric, Remigiusz Modrzejewski, Julian Monteiro, Stéphane Pérennes.

Traditional means to store data are dedicated servers or magnetic tapes. These solutions are reliable but expensive. Recently, hard disks and bandwidth have become cheaper and widely available, allowing new forms of data storage on distributed, peer-to-peer (P2P) architectures. To achieve high durability, such P2P systems encode the user data in a set of redundant fragments and distribute them among the peers. These systems are cheap to operate, but their highly distributed nature raises questions about reliability, durability, availability, confidentiality, and routing of the data. An abundant literature exists on the topic of P2P storage systems. Several large-scale self-managing distributed systems have been proposed, including Intermemory, Ocean Store, Freenet, PASTRY, CFS, Total Recall. However, few analytical models have been proposed to estimate the behavior of the system (the data durability, resource usage) and understand the trade-offs between the system parameters.

We model a general storage system by using a Markov chain model in [45], [58]. This model allows us to take into account the effects of disk failures along with the time consumed by the self-repairing process. We confirm that a lazy repair strategy can be employed to amortize the repairing cost, mainly bandwidth. We then derive closed-form mathematical expressions that estimate the system average behavior. These formulas give a good intuition of the system dynamics. Our contribution is a guideline to system designers and administrators to choose the best set of parameters.

We study in [54], [38], [78] the impact of different data placement strategies on the system performance. This study is motivated by practical peer-to-peer storage systems that store data in logical neighbors. We use simulations and combinatorial models to show that, without resource constraints, the average system behaviour is the same no matter which placement policy is used. However, the variations in the use of bandwidth are much burstier under the local policies (in which the data are stored in logical neighbors). When the bandwidth is limited, these bursty variations induce longer maintenance time and henceforth a higher risk of data loss.

A good overview of the general approaches used for all these studies can be found in the Ph.D. thesis of J. Monteiro [2]. This thesis aims at providing tools to analyze and predict the performance of large scale data storage systems. Thus, different techniques are studied and applied. They range from formal analysis (using Markov chains and fluid models) to simulations and experimentation (using Grid5000 platform).

6.4. Simulation and Optimization Tools

Participants: Olivier Dalle, Afonso Ferreira, Luc Hogie, Aurélien Lancin, Juan-Carlos Maureira, Julian Monteiro, Philippe Mussi, Judicaël Ribault, Issam Tahiri.

The works related to simulation and optimization tools address two kinds of issues: issues related to the development of the tools and their associated methodology, and issues related to the use of these tools in order to investigate a particular problem or assess the performances or properties of a particular system.

6.4.1. Development of simulation tools and methodologies

Since 2005, MASCOTTE is developing a discrete event simulation architecture, named OSA, whose aim is to investigate how new software engineering techniques, such as component-based frameworks or Aspect Oriented Programming can help improving the simulation methodology [51], especially in terms of software reuse. However, an important issue to solve when considering the reuse problem, is that of standardization, hence our significant involvement in the current standardization efforts led around the DEVS formalism [69], [68]. Indeed, rigorous formalisms, such as the Discrete Event Systems Specification (DEVS) are necessary to express the behavior of the model to be simulated in a non-ambiguous and reusable way. In [21], we provide a comprehensive survey of various usages for the particular Cell-DEVS formalism. In a more general way, we also put efforts in federating the scientific community on such simulation issues, by organizing conferences and editing journals special issues, such as [71].

6.4.2. Simulation studies and application oriented developments

Our efforts on simulation development also apply to more specific, application oriented works, such a in [52], [85] in which we extend the Omnet++ network modeling Framework (INET) to support directional and asymmetrical wireless communications or in [48], in which we address the challenge of simulating routing

schemes in very large scale network topologies. In addition, in [25], we evaluate the performance of routing protocols in MANETs, in which the connectivity patterns are expressed using the concept of evolving graphs.

6.5. Graph Theory

Participants: Julio Araújo, Jean-Claude Bermond, Nathann Cohen, Philippe Giabbanelli, Frédéric Havet, Bi Li, Dorian Mazauric, Stéphane Pérennes, Leonardo Sampaio.

MASCOTTE principally investigates applications in telecommunications via Graph Theory (see other objectives). However it also studies a number of theoretical problems of general interest. Our research mainly focused on graph coloring and some other problems arising from networks'problems.

6.5.1. Graph Coloring

Coloring and edge-coloring are two central concepts in Graph Theory. There are many important and long-standing conjectures in these areas. We are trying to make advances towards such conjectures, in particular Hadwiger's conjecture, the List coloring Conjecture and the Acyclic Edge-coloring Conjecture.

We are also interested in coloring problems arising from some practical problems: improper coloring, $L(p,q)$-labeling and directed star arboricity. The first two are both motivated by channel assignment and the last one by problems arising in WDM networks. For many practical problems are posed in a dynamic setting, we study on-line coloring.

We also study some other variants of coloring like non-repetitive coloring or frugal coloring.

Edge-coloring: The most celebrated conjecture on edge-coloring is the List coloring Conjecture asserting that the chromatic index (minimum number of colors used in a proper coloring of the edges) is always equal to the list chromatic index. In list-coloring, each edge is assigned a list of colors. The list chromatic index is the smallest size of the tables, such that, for any assignment of colors in any table, each edge may choose a color in its own table to obtain a proper coloring of the graph (no two incident edges have the same color). Together with Vizing's Theorem it implies the following conjecture : For any graph G with maximum degree Δ, the list chromatic index is at most $\Delta + 1$. In [19], we give a short proof of a result of Borodin showing that this later conjecture holds for planar graphs of maximum degree at least 9.
Improper coloring: We studied a weighted improper coloring problem motivated by a frequency allocation problem. It consists of associating to each vertex a set of $p(v)$ (weight) distinct colors (frequencies), such that the set of vertices having a given color induces a graph of degree at most k (the case $k = 0$ corresponds to proper coloring). The objective is to minimize the number of colors. In [12], [76], we propose approximation algorithms to compute such a coloring for general graphs, and specific better approximation algorithms for grid and hexagonal graphs.
$L(p,q)$-labeling: An *$L(p,q)$-labeling of G* is an integer assignment f to the vertex set $V(G)$ such that $|f(u) - f(v)| \geq p$, if u and v are adjacent, and $|f(u) - f(v)| \geq q$, if u and v have a common neighbor. Such a concept is a modeling of a simple channel assignment, in which the separation between channels depends on the distance. The goal is to find an $L(p,q)$-labeling f of G with minimum *span* (i.e. $\max\{f(u) - f(v), u, v \in V(G)\}$). It is well known that for ll $k \geq 4$, deciding if a graph has an $L(p,1)$-labeling with minimum span k is NP-complete. We show that it remains NP-complete when restricted to planar graphs [22]. In [30], we present exact exponential time algorithms that are faster than existing ones.

In addition, $L(1,1)$-labeling of planar graphs is closely related to the notion of facial coloring which we study in [31].
Directed star arboricity: A *galaxy* is a vertex-disjoint union of stars. In [6], we show that the minimum number of galaxies needed to cover the arc-set of any digraph D with maximum degree $\Delta(D)$ is upper bounded by $2\Delta^-(D) + 1$ and is at most 3 in subcubic digraphs. We study the relationship of this problem with a more general problem modeling multicast in WDM networks.

On-line coloring: Several on-line algorithms producing colorings have been designed. The most basic and most widespread one is the greedy algorithm. The *Grundy number* of a graph G, denoted by $\Gamma(G)$, is the largest number of colors provided by the greedy algorithm according to some ordering of the vertices of G. It is easy to see that $\chi(G) \leq \Gamma(G) \leq \Delta(G) + 1$, where $\chi(G)$ is the chromatic number of G and $\Delta(G)$ its maximum degree. We prove that these to upper bounds are algorithmically useless: in [8], we show that for every fixed $c \geq 1$ it is CoNP-Complete to decide if $\Gamma(G) \leq c \times \chi(G)$ while in [47], we prove that for any positive integer k, it is NP-complete to decide if $\Gamma(G) \leq \Delta(G) + 1 - k$. On the other hand, we prove that it is FPT to decide if a graph on n vertices has a greedy coloring with at most $n - k$ colors. The first NP-completeness was obtained by considering the Grundy number of graph products, which we studied further in [77]. We also gave some complexity results on b-colorings, which is a manner of improving colorings on-line [83].
Other studies: In [29], we also study *non-repetitive coloring*. We prove that the edges of any planar graph may be colored using at most 8 colors such that the cycles corresponding to any faces contains no "repetitions" (roughly, no two consecutive and identical sequence of colors).

In the *Weighted Coloring Problem* (WCP), the weight of a proper coloring is the sum of the weights of its color classes, where the weight of a color class is the weight of a heaviest vertex belonging to it. Minimizing this weight is NP-hard in general. In [53], we study the WCP on P4-sparse graphs.

In [80], we study *frugal and linear colorings*, i.e., proper coloring such that any two colors induces disjoint paths and cycles, respectively, a forest of paths. Our work let us improve bounds on the 2-frugal choosability and linear choosability of graphs with small maximum average degree.

6.5.2. Distances and Subgraphs

Motivated by their importance when dealing with problems of network design, the team has been interested in the study of several graph metrics related to distances in graphs.
Wiener index: The Wiener index $W(G)$ of a graph G being defined as the sum of the distance between all pairs of vertices, it also represents the mean distance between vertices in the graph. It has also been used in chemistry whereit represents properties of molecules. In [17], we consider the relation between the Wiener index of a graph G and its line graph $L(G)$. We show that if G is of minimum degree at least two, then $W(G) \leq W(L(G))$ and that equality may be achieved whatever be the girth of G.
Wiener index of specific recursive graphs: In [42], [56], we are here considering a very specific network on which we are able to give a closed formula for the Wiener Index. The proof is of particular interests for other network models relying on similar recursive structures, as found in fractal models. In [42], we extend our approach to a stochastic version of ZRG in which layers of triangles are added with probability p.
Steiner tree: Given a graph with costs on edges, prizes at vertices and a target set, the Prize Collecting Steiner Tree (PCST) problem is to find a tree interconnecting vertices in the target set that has minimum total cost on edges and maximum total prize at vertices. In [32], we establish two risk models for the PCST problem with uncertain costs and prizes and propose polynomial-time algorithms for these problems on 2-trees, respectively. Our study shows that the risk models have advantages over the traditional robust optimization model.
Induced subdivision in digraphs: In [73], we consider the following problem for oriented graphs and digraphs: Given an oriented graph (digraph) G, does it contain an induced subdivision of a prescribed digraph D? The complexity of this problem depends on D and on whether H must be an oriented graph or is allowed to contain 2-cycles. We give a number of examples of polynomial instances as well as several NP-completeness proofs.

6.6. Algorithms

Participants: Janna Burman, Nathann Cohen, Philippe Giabbanelli, Nicolas Nisse, Ronan Pardo Soares, Stéphane Pérennes.

MASCOTTE is also interested in the algorithmic aspects of Graph Theory. In general we try to find the most efficient algorithms to solve various problems of Graph Theory and telecommunication networks.

This year we mainly investigated algorithmic problems arising in complex networks like the Internet or social networks. In this kind of networks, problems are becoming harder or impracticable because of the size and the dynamicity of these networks.

- One way to handle the dynamicity is to provide (distributed) fault tolerant algorithms. We considered self-stabilizing algoritms for the gathering problem, randomized algorithms for the routing (tolarating some fault in routing tables for the routing problems). Besides, the more an algorithm uses local information, the easier it is to update/correct the behaviour of the algorithm. In this direction, we investigated communication problems through game theory. We also studied the power of a communication model using only localized information, i.e., we study what can be computed using this communication model.
- Finally, large scale networks have some specific structural properties that may be usefully taken into account in the design of algorithms. We used graph theory to model the complex interactions between individuals in the spread of a disease. More generally, we study structural properties of networks through graph searching games.

Several of the works below take place in the project DCR (see Section 7.1) and the STREP EULER (see Section 8.3.4).

6.6.1. Fault Tolerant and Distributed Algorithms

We address dynamic large scale emerging networks, e.g., mobile sensor networks and we propose to extend the Population Protocols communication model suited for such networks with the notion of Cover Times [34]. Cover Times abstract the interaction characteristics of mobile agents and allow the design of fast converging protocols and the evaluation of their convergence time (this is impossible in the original model). In the new model we study a basic problem in sensor networks - the problem of information gathering. We show a lower bound for any protocol to solve this problem and we propose an optimal solution. To achieve fault-tolerance in the protocols designed in the new model, a generic self-stabilizing transformer is developed [9]. This is an automatic technique to convert a protocol to its self-stabilizing version. As a further extension and as another basic tool, a self-stabilizing phase-clock algorithm is developed [33]. This is a synchronization tool that simulates logical time in an asynchronous system. It enables a protocol designer to organize a protocol execution into phases and thus, simplifies his task.

Due to the dynamicity of large scale networks like the Internet, routing tables are not resilient and it is important for the QoS to design fault tolerant routing algorithms. We designed efficient routing probabilistic algorithms supporting a bounded number of faults in some particular topologies [57], [82].

In highly distributed systems, it might be often unrealistic to assume that the resources of the system are directly accessible and controllable by a centralized authority. Therefore, we consider communication problems arising in networks with autonomous or non-cooperative users. In such a scenario, users pursue their own selfish strategies and the system evolves as a consequence of the interactions among them. The scenario is thus characterized by the conflicting needs of the users aiming to maximize their personal profit and of the system wishing to compute a socially efficient solution [15], [64]. In particular, we study the performances of Nash equilibria in isolation games [15].

In [75], we proposed a distributed model of computation, related to the complexity of communication, and investigated which questions can be answered in this model. In our model, each node has only access to very few information about its neighborhood and a central authority receiving one small message from each node must decide a local or global structural property of the graph.

6.6.2. Spreading in Complex networks

We have also used graph theory to model the complex interactions between individuals in the spread of a disease. While our focus was on infectious diseases such as HIV [23], it was recently suggested that chronic diseases may also have a spreading component through the adoption of behavioral norms. This was shown with a new model of obesity [40], in which individuals exchange food and physical activity behaviours in a network, which results in weight changes.

6.6.3. Graph Searching, Cops and Robber Games

Pursuit-evasion encompasses a wide variety of combinatorial problems related to the capture of a fugitive residing in a network by a team of searchers. The goal consists in minimizing the number of searchers required to capture the fugitive in a network and in computing the corresponding capture strategy. We investigated the two main variants of these games.

Graph searching, where the fuggitive is arbitrary fast and moves simultaneously to the searchers, has been widely studied for its close relationship with graph decompositions [74].

The "Cops and Robber Games" are turn-by-turn games. We investigated two generalizations of the game introduced by Quilliot, Nowakoski and Winkler in 1983. We proved complexity results, we gave algorithmic lower bounds on the number of cops needed when the robber is fast [27] and we provided structural characterization of graphs where one cop is sufficient to capture a fast fugitive able to hide [59], [79].

6.6.4. Miscellaneous

We continue our study of Fixed Parameter Tractable algorithms. An out-tree T is an oriented tree with exactly one vertex of in-degree zero and a vertex x of T is called internal if its out-degree is positive. In [18] , we design randomized and deterministic algorithms for deciding whether an input digraph contains a subgraph isomorphic to a given out-tree with k vertices.

A (p, λ, k)-network is valid if for any choice of λ inputs and k outputs, there exist p edge-disjoint paths from the inputs to the outputs. In [5], we wish to determine $N(p, \lambda, k)$, the minimum number of nodes in a valid (p, λ, k)-network. In many cases, we provide asymptotically tight bounds for $N(p, \lambda, k)$.

In [61], we transform the problem of maximizing the modularity function in a semidefinite programming problem (SDP) and we draw on the method of Geomans and Williamson used for the MaxCut problem to obtain a recursive cut of the graph.

In [63], we propose a very fast algorithm to compute an approximation of the fractional arboricity which is a measure of the density of subgraphs in a graph. Our algorithm uses the principle of pushing flow and helps us to extract properties of densest subgraphs in order to get good clustering of the graph.

7. Contracts and Grants with Industry

7.1. Contract with Alcatel-Lucent Bell-Labs (Antwerpen, Belgium), 12/2008 -12/2010

Participants: David Coudert, Luc Hogie, Aurélien Lancin, Nicolas Nisse, Stéphane Pérennes, Issam Tahiri.

Contract between Alcatel-Lucent Bel-Labs, INRIA and LaBRI (Bordeaux) on Dynamic Compact Routing Schemes.

(http://www-sop.inria.fr/mascotte/projets/DCR/)

7.2. ADR HiMa, joint laboratory INRIA / Alcatel-Lucent Bell-labs France, 10/2009 -12/2012

Participants: Jean-Claude Bermond, David Coudert, Philippe Giabbanelli, Frédéric Giroire, Joanna Moulierac.

MASCOTTE is part of the join laboratory INRIA / Alcatel-Lucent Bell-labs France within the ADR HiMa (research action on High Manageability) and works on autonomous dynamic management of virtual topologies (the ADR finances a Ph.D. student).

(http://inria.bell-labs.commonlab.homeip.net/index.php/High_Manageability)

7.3. Contract APRF (région PACA/FEDER) RAISOM with 3-Roam and AVISTO, 05/2009 - 04/2012

Participants: Jean-Claude Bermond, David Coudert, Napoleão Vieira Nepomuceno, Stéphane Pérennes, Issam Tahiri.

On Wireless IP Service Deployment optimization and monitoring.

(http://www-sop.inria.fr/mascotte/projets/raisom/)

7.4. Contract CIFRE with Orange Labs., 11/2009 - 11/2012

Participants: Jean-Claude Bermond, Mikaila Toko Worou.

"Convention de recherche encadrant une bourse CIFRE" on the topic *Outils algorithmiques pour la détection des communautés*.

8. Other Grants and Activities

8.1. Regional Initiatives

8.1.1. Grant 3-Roam Province PACA, 12/2007 - 11/2010

Participants: David Coudert, Napoleão Vieira Nepomuceno.

Grant for a Ph.D. student (N. Vieira Nepomuceno) cofinanced by the SME 3-Roam and the *région PACA* on optimization and dynamic routing in wireless backhaul networks.

8.2. National Initiatives

8.2.1. ANR Jeunes Chercheurs DIMAGREEN 09/2009-08/2012

Participants: David Coudert, Frédéric Giroire, Dorian Mazauric, Joanna Moulierac, Napoleão Vieira Nepomuceno, Brice Onfroy.

The objectives of the project DIMAGREEN (DesIgn and MAnagement of GREEN networks with low power consumption) are to introduce and analyze energy-aware network designs and managements in order to increase the life-span of telecommunication hardware and to reduce the energy consumption together with the electricity bill.

(http://www-sop.inria.fr/teams/mascotte/Contrats/DIMAGREEN/index.php)

8.2.2. ANR Blanc AGAPE 10/2009-09/2013

Participants: Nathann Cohen, David Coudert, Frédéric Havet, Nicolas Nisse, Stéphane Pérennes, Michel Syska.

The project AGAPE (Parametrized and exact graph algorithms) is led by MASCOTTE and implies also LIRMM (Montpellier) and LIFO (Orléans). The aim of AGAPE is to develop new techniques to solve exactly NP-hard problems on graphs. To do so, we envisage two approaches which are closely related ways to reduce the combinatorial explosion of NP-hard problems through exponential exact algorithms and fixed-parameter tractability.

(http://www-sop.inria.fr/mascotte/Contrats/Agape.php)

8.2.3. ANR SPREADS 12/2007-11/2010

Participants: Olivier Dalle, Frédéric Giroire, Julian Monteiro, Philippe Mussi, Stéphane Pérennes, Judicaël Ribault, Michel Syska.

The project SPREADS (Safe P2p-based REliable Architecture for Data Storage) is led by the SME UBISTORAGE; other partners are the INRIA teams MASCOTTE and REGAL in Rocquencourt and Eurecom and LACL Paris XII. It concerns the evaluation and optimization of a peer-to-peer based reliable storage system for which simulations of very large peer-to-peer systems will be done using OSA. It has got the approbation and label of the "pôle de compétitivité" SCS.

(http://www-sop.inria.fr/mascotte/Contrats/spreads)

8.2.4. ANR VERSO ECOSCells 11/2009-12/2012

Participants: Jean-Claude Bermond, David Coudert.

The ECOSCells (Efficient Cooperating Small Cells) project aims at developing the algorithms and solutions required to allow Small Cells Network (SCN) deployment. The consortium gathers industrial groups, together with 3 SMEs and 6 research institutes: Alcatel-Lucent Bell Labs (leader), Orange Labs, 3ROAM, Sequans, Siradel, INRIA teams MAESTRO, MASCOTTE and SWING, Université d'Avignon et des Pays de Vaucluse, Laboratoire des Signaux et Systèmes / Supelec, LAAS and Eurecom.

(http://perso.citi.insa-lyon.fr/hrivano/contrats/ecoscells.php)

8.2.5. ANR USS-SimGrid 12/2008-12/2011

Participant: Olivier Dalle.

The USS-SimGrid project aims at Ultra Scalable Simulations with SimGrid. This tool is leader in the simulation of HPC settings, and the main goal of this project is to allow its use in the simulation of desktop grids and peer-to-peer settings.

(http://uss-simgrid.gforge.inria.fr/)

8.2.6. Action ResCom, ongoing (since 2006)

Réseaux de communications, working group of GDR ASR, CNRS. (http://citi.insa-lyon.fr/rescom/)

8.2.7. Action Graphes, ongoing (since 2006)

Action Graphes, working group of GDR IM, CNRS. (http://www.labri.fr/perso/raspaud/pmwiki/pmwiki.php)

8.3. European Initiatives

8.3.1. European project IST AEOLUS, Integrated Project IST-015964, 09/2005-02/2010

Participants: Jean-Claude Bermond, David Coudert, Frédéric Giroire, Frédéric Havet, Stéphane Pérennes.

On Algorithmic Principles for Building Efficient Overlay Computers (AEOLUS), in collaboration with 21 European universities and coordinated by University of Patras, Greece.

The goal of AEOLUS is to investigate the principles of and develop algorithmic methods for building an overlay computer that enables efficient and transparent access to the resources of an Internet-based global computer.

MASCOTTE is the leader of Sub-Project 2 on resource management.

The work within this subproject focuses on the study of fundamental issues for accessing and managing communication resources in an overlay computer. Our research addresses novel and challenging algorithmic issues for efficient resource discovery and querying like construction of overlay networks, query routing and execution, and for sharing critical resources like bandwidth.

(http://www.ceid.upatras.gr/aeolus/)

8.3.2. PHC Proteus (with Ljubljana) 01/2009-12/2010

Participants: Nathann Cohen, Frédéric Havet.

On Graph coloring: theoretical and algorithmic aspects.

8.3.3. PICS CNRS (with Charles University, Prague) 01/2009-12/2012

Participants: Nathann Cohen, Frédéric Havet, Leonardo Sampaio.

On Graph coloring: theoretical and algorithmic aspects.

8.3.4. STREP EULER, part of FIRE objective of FP7, 10/2010 -10/2013

Participants: David Coudert, Luc Hogie, Aurélien Lancin, Nicolas Nisse, Stéphane Pérennes, Issam Tahiri.

STREP EULER (Experimental UpdateLess Evolutive Routing) is part of FIRE (Future Internet Research and Experimentation) objective of FP7. It aims at finding new paradigms to design, develop, and validate experimentally a distributed and dynamic routing scheme suitable for the future Internet and its evolution. The STREP EULER gathers 7 partners: Alcatel-Lucent Bell (leader) (Antwerp, Belgique), IBBT (Ghent, Belgium), UCL (Louvain, Belgium), RACTI (Patras, Grece), UPC (Barcelona, Spain), UPMC (ComplexNetworks, Paris 6), INRIA (MASCOTTE, GANG, CEPAGE). MASCOTTE is the leader of WP3 on Topology Modelling and Routing scheme experimental analysis.

(http://www.euler-fire-project.eu/)

8.4. International Initiatives

8.4.1. Join team "EWIN", 01/2009-12/2011

Participants: Julio Araújo, Frédéric Havet, Napoleão Vieira Nepomuceno, Nicolas Nisse, Ronan Pardo Soares, Leonardo Sampaio.

Joint team EWIN (Efficient algorithms in WIreless Networks) with the Departamento de Computação of Universidade Federal do Ceará of Fortaleza (Brazil).

(http://www-sop.inria.fr/teams/mascotte/equipeassociee/ewin/)

8.4.2. ANR International Taiwan GRATEL, 01/2010 – 12/2013

Participants: Jean-Claude Bermond, Nathann Cohen, Frédéric Havet, Leonardo Sampaio.

GRATEL (Graphs and Telecomunications) has been started in collaboration with LABRI Bordeaux, UJF Grenoble and three partners in Taiwan: Sun Yat-sen University, the National Taiwan University and Academia Sinica.

(https://gratel.labri.fr/pmwiki.php?n=Main.HomePage)

8.5. Visitors

Jørgen Bang-Jensen: University of Southern Denmark, Odensee, Denmark, February 23-June 18, 2010 (4 months);

Manoel Campêlo: Universidade Federal do Ceara, Fortaleza, Brazil, December 11-18, 2010 (1 week);

Victor Campos: Universidade Federal do Ceara, Fortaleza, Brazil, December 2-19, 2010 (2 weeks);

Grit Classen: Lehrstuhl II fur Mathematik, RWTH Aachen - Aachen, Germany, December 13-17, 2010 (1 week);

Ricardo Correa: Universidade Federal do Ceara, Fortaleza, Brazil, December 10-January 4, 2010 (3 weeks);

Luisa Gargano: Dipartimento di Informatica ed Applicazioni "Renato M. Capocelli" of the Università di Salerno, Salerno, Italy, July 15-August 31, 2010 (1 month 1/2);

Arie Koster: Lehrstuhl II fur Mathematik, RWTH Aachen - Aachen, Germany, February 12- March 15 2010 and December 13-17, 2010 (1 month 1/2);

Mathieu Liedloff: LIFO, Université d'Orléans, Orléans, France, July 26-30, 2010 (1 week);

Claudia Linhares Sales: Universidade Federal do Ceara, Fortaleza, Brazil, December 03-12, 2010 (1 week);

Karol Suchan: Universidad Adolfo Ibañez, Santiago, Chile, February 1-7 and July 26-August 6, 2010 (3 weeks);

Ugo Vaccaro: Dipartimento di Informatica ed Applicazioni "Renato M. Capocelli" of the Università di Salerno, Salerno, Italy, July 15-August 31, 2010 (1 month 1/2);

Joseph Yu: S.F.U. Vancouver, Canada, january 26- April 16, 2010 (3 months).

8.6. Visits of Mascotte members to other research institutions

J. Araujo: Visit to Universidade Federal do Ceará, Fortaleza, Brazil, (from July 23 to August 24, 2010 and from December 22, 2010 to January 15, 2011);

N. Cohen: Visit to McGill University, Montreal, Canada (May 1-31, 2010); Visit to National Sun Yat-sen University, Kaohsiung, Taiwan (July 11-31, 2010); Visit to National Taiwan University, Taipei, Taiwan (August 1-15, 2010);

D. Coudert: Visit to Alcatel-Lucent Bell labs, Antwerpeen, Belgium, (March 11, 2010); Visit to CITI laboratory, Lyon, France (May 27-28, 2010); Visit to LIRMM, Montpellier, France (November 4-5, 2010);

O. Dalle: Visit to Carleton University, Ottawa, Canada (July 16-August 20, 2010);

A. Ferreira: Visit to Shenzhen Institute of Applied Technology, Shenzhen, China (May 2010); Tencent Inc., Shenzhen, China (May 2010); LIAMA, Beijing, China (May 2010); Ministry of Education, Beijing, China (May 2010); Chinese Academy of Sciences, Beijing, China (May 2010); CreateNet, Trento, Italy (June 2010); University of Buenos Aires, Buenos Aires, Argentina (November 2010); University of Sao Paulo, Sao Paulo, Brazil (November 2010); Ministry of Culture, Brasilia, Brazil (November 2010); Ministry of Science and Technology, Brasilia, Brazil (November 2010); CNPq, Brasilia, Brazil (November 2010); PUC Rio, Rio de Janeiro, Brazil (November 2010); Federal University of Rio de Janeiro (UFRJ), Rio de Janeiro, Brazil (November 2010); State Secretary for Science and Technology, Rio de Janeiro, Brazil (November 2010);

F. Havet: Visit to Zheijang Normal University, Jinhua, China, (October 28-November 6, 2010); Visit to LIAFA, University Paris 7, (January 20-22, March 08-11, 2010); Visit to LIRMM, University Montpellier 2, (May 17-20, 2010) Visit to LABRI, University of Bordeaux 1, (June 21-24 2010); Visit to G-SCOP, University Joseph Fourier, Grenoble (November 24-26, 2010);

A. Lancin: Visit to Univ. Catholique de Louvain, Louvain-La-Neuve (December, 7-10, 2010);

J-C. Maureira: Visit to the Communication Networks Institute, Dortmund University of Technology, (September 29, 2010);

N. Vieira Nepomuceno: Visit to RWTH Aachen University, Aachen, Germany (May 16-29, 2010); Visit to Universidade Federal do Ceará, Fortaleza, Brazil, (September 25 - October 5, 2010);

N. Nisse: Visit to Universidade Federal do Ceará, Fortaleza, Brazil, (April 1-10, 2010); Visit to McGill University, Montreal, Canada (May 1-31, 2010);

J. Ribault: Visit to University of Rostock, Rostock, Germany (May 25 - June 25, 2010);

L. Sampaio: Visit to Universidade Federal do Ceará, Fortaleza, Brazil, (April 1-30 2010); Visit to National Sun Yat-sen University, Kaohsiung, Taiwan (July 11-31, 2010); Visit to National Taiwan University, Taipei, Taiwan (August 1-15, 2010); Visit to LIRMM, Montpellier, France (October 25-November 5, 2010).

9. Dissemination

9.1. Animation of the scientific community

9.1.1. Participation in Committees

J-C. Bermond: expert for DRTT, and various projects outside France (Canada,Qatar, ...); member of the comité de sélection of *61me section of UNS*; responsible of the *Pôle ComRed* of I3S; member of the Ph.D. committee of the University of Marseille, member of the *comité de sélection des ATER*;

D. Coudert: expert for the National Sciences and Engineering Research Council of Canada (NSERC) and the ANR (ARPEGE, JC-JC, SIMI); Member of the *comité du suivi doctoral* of INRIA Sophia Antipolis (since January 2009); Member of *comité de sélection* 27e section for UCBL, Lyon, 2010;

O. Dalle: member of the *comité de sélection Maitre de Conférences*, University of Marseille 1, Marseille, May 2010;

A. Ferreira: expert with the European Commission; expert for the distribution of European Structural Funds with the Czech Ministry of Research and decision panel member; member of expert panel of EC PARADISO project; member of scientific committee of the STIC AmSud programme; member of the selection committee of several CNRS programmes (eg PICS, conventions, LIAs, GDRIs...); member of Working Group for the preparation of FP 8, Ministry of Research, France; member of the National Working Group for the monitoring of FP7, Ministry of Research, France;

F. Giroire: member of I3S laboratory committee;

F. Havet: member of the *comité de sélection Maitre de Conférences*, University of Nice Sophia-Antipolis, April-May 2010; member of the I3S laboratory committee; member of the *conseil de l'ecole doctorale I2S*, Montpellier;

J. Moulierac: responsible of a new international master of science at University of Nice Sophia Antipolis, stream UBINET of the master IFI (http://ubinet.inria.fr) since 2009; Member of the CDL (Commission for software development) at INRIA Sophia Antipolis since 2009; Member of the *Conseil de Département* (Department Committee) of IUT Nice since 2007.

M. Syska: member of the *comité de sélection des ATER* and of the *comité de sélection du poste MCF27* IUT.

9.1.2. Editorial Boards

J-C. Bermond: Combinatorics Probability and Computing, Computer Science Reviews, Discrete Mathematics, Discrete Applied Mathematics, Journal of Graph Theory, Journal Of Interconnection Networks (Advisory Board), Mathématiques et Sciences Humaines, Networks, Parallel Processing Letters the SIAM book series on Discrete Mathematics, Transactions on Network Optimization and Control , Discrete Mathematics, Algorithms and Applications;

D. Coudert: Discrete Applied Mathematics (since September 2010);

A. Ferreira: Journal of Parallel and Distributed Computing (Academic Press), Parallel Processing Letters (World Scientific), Journal of Interconnection Networks (World Scientific), Wireless Networks (Springer).

9.1.3. Steering Committees

D. Coudert: Pôle ResCom du GDR ASR du CNRS (since 2005); *Rencontres francophones sur les aspects algorithmiques des télécommunications* (AlgoTel);

O. Dalle: *ICST Intl. Conf. on Simualtion Tools and Techniques* (SIMUTools);

A. Ferreira: Chair of the *Strategic Forum of the European Alliance for Innovation*;

F. Havet: *Journées Combinatoire et Algorithmes du Littoral Méditerranéen* (JCALM); *Journées Graphes et Algorithmes* (JGA).

9.1.4. Conference organization

JDIR'10: *11es Journées Doctorales en Informatique et Réseaux*, Sophia Antipolis, France, March 24-26, 2010; Chairs: F. Giroire and D. Mazauric.

9.1.5. Workshop organization

3rd CSFGC *3rd Czech-Sloveno-French Workshop on Graph coloring*, Puyloubier, France, August 30-September 3, 2010; Organizer: F. Havet;

OMNeT++.: *4th International Workshop on OMNeT++*. Co-located with Simutools 2011. Barcelona. Spain. March, 21, 2011. Organizer: J-C. Maureira;

TERA-NET'10, *1st edition of the International workshop "Toward Evolutive Routing Algorithms for scale-free/internet-like NETworks "* (TERA-NET 2010) that was held in conjonction with ICALP 2010 - Bordeaux, France - July 5th, 2010; Organizer: N. Nisse.

9.1.6. Participation in program committees

J-C. Bermond: *5th International Conference on FUN with Algorithms* (FUN'10), Ischia Island, Italy (June 2-4, 2010), *8th French Combinatorial Conference* (8FCC), Orsay, France (June 28th - July 2nd, 2010);

D. Coudert: *9th International Symposium on Experimental Algorithms* (SEA'10), Ischia Island (Napoli), Italy (May 20-22, 2010);

O. Dalle: *1st IEEE International Workshop on Collaborative Modeling & Simulation* (CoMetS?10), TEI of Larissa, Greece (June 28- 30, 2010); *International Conference on High Performance Computing & Simulation* (HPCS'10), Caen, France (June 28 - July 2, 2010); *Symposium On Theory of Modeling and Simulation DEVS Integrative M&S Symposium* (DEVS'10), Orlando, FL, USA (April 11-15, 2010);

F. Giroire: *11es Journées Doctorales en Informatique et Réseaux* (JDIR'10), Sophia Antipolis, France (March 24-26, 2010). (co-chair);

F. Havet: *36th International Workshop on Graph Theoretic Concepts in Computer Science* (WG'10), Zarós, Crete, Greece (June 28 - 30, 2010), *12th Journées Graphes et Algorithmes* (JGA'10), Marseille, France (November 8-10, 2010);

J-C. Maureira: *3rd international workshop on OMNeT++*, Malaga, Spain (March, 15-19, 2010) (co-chair);

D. Mazauric: JDIR'10 (co-chair), *MAnifestation des JEunes Chercheurs en Sciences et Technologies de l'Information et de la Communication* (MajecSTIC'10), Bordeaux, France (October 13-15, 2010);

J. Moulierac: *12th rencontres francophones sur les aspects algorithmiques des télécommunications* (AlgoTel'10), Belle Dune, France (June 16-19, 2010), JDIR'10;

N. Nisse: JDIR'10, MajecSTIC'10.

9.2. Participation in conferences and workshops

9.2.1. Invited Talks

J-C. Bermond: Bordeaux graph Workshop, Bordeaux , France (November 18-20, 2010); SMAI Cérémonie des Grand Prix, Paris, France (November 25, 2010);

D. Coudert: Graph searching track of the 24th European Conference on Operational Research (EURO'10), Lisbon, Portugal (July 11-14, 2010); LIRMM seminar, Montpellier, France (November 4, 2010);

O. Dalle Invited talk at the VSIM Seminar (Carleton University)

A. Ferreira: Workshop on Future Internet, Mannheim, Germany (March 2010); European Forum for Innovation, Trento, Italy, June 2010; Workshop PARADISO, Brussels, Belgium (November 2010); Workshop on New ways of doing research which address societal challenges, Brussels, Belgium (November 2010);

F. Giroire: Workshop Green Networking, Seminar of the INRIA-Alcatel Lucent Bell common lab, Villarceau, France (March 19, 2010); Panel Session Energy-aware, Power-aware, and Green Computing for Large Distributed Systems and Applications, International Conference on High Performance Computing & Simulation (HPCS'10), Caen, France (June 28-July 2, 2010);

F. Havet: International Conference on Graph Theory, Combinatorics and Applications (ICGTCA), Zhejiang Normal University, Jinhua, China (Oct. 29 - Nov. 2, 2010); Centenary of Celina + Frederic (C+C=100), University Joseph Fourier, Grenoble (September 16-17, 2010);

J. Moulierac: Presentation for the Seminar on sustainable development at INRIA Sophia Antipolis, in videoconference for 7 INRIA sites (March 22, 2010);

N. Nisse: Graph searching track of the 24th European Conference on Operational Research (EURO'10), Lisbon, Portugal (July 11-14, 2010).

9.2.2. Participation in scientific meetings

AEOLUS: IST FET AEOLUS meeting, Athens, Greece (January 20-21, 2010).
Attended by J-C. Bermond and D. Coudert;

AEOLUS: IST FET AEOLUS final meeting, München, Germany (February 22-24, 2010).
Attended by J-C. Bermond and F. Giroire;

AGAPE'10 Kick off meeting of ANR Blanc AGAPE, LIFO, Orléans (January 7-8, 2010).
Attended by N. Cohen (speaker), D. Coudert, F. Havet (speaker), D. Mazauric, N. Nisse, L. Sampaio, M. Syska (speaker);

Alcatel-Lucent/INRIA Joint lab: Plenary meeting of Alcatel-Lucent/INRIA Joint lab, Villarceaux, France (March 18-19, 2010). Attended by D. Coudert, P. Giabbanelli, F. Giroire;

COMRED: *Journée du pôle COMRED*, Sophia Antipolis, France (March 1st, 2010).
Attended by most of the Mascotte members (speakers: F. Havet, J. Ribault);

3rd CSFGC 3rd Czech-Sloveno-French Workshop on Graph coloring, Puyloubier, France (August 30-September 3, 2010). Attended by N. Cohen, F. Havet, L. Sampaio;

DCR: Workshop on dynamic compact routing, Alcatel-Lucent Bell labs, Antwerpeen, Belgium (May 5-6, 2010). Attended by D. Coudert, L. Hogie, A. Lancin;

DCR: Closing meeting of the DCR project, Paris, France (December 6, 2010).
Attended by D. Coudert, L. Hogie, A. Lancin, N. Nisse;

ECOSCELLS/SP4: Meeting of sub-project 4 of ANR Verso ECOSCELLS, Sophia Antipolis, France (January 15, 2010). Attended by D. Coudert, N. Vieira Nepomuceno, I. Tahiri;

EULER: Kick-off meeting of the FP7 STREP EULER project, Antwerp, Belgium (October 6-8, 2010).
Attended by D. Coudert, A. Lancin, N. Nisse;

FET: Workshop on FET Flagships, Brussels, Belgium (June 2010).
Attended by A. Ferreira;

FIRE week: FIRE week: future internet research and innovation, Barcelona, Spain (June 30, July 1, 2010).
Attended by D. Coudert;

GRATEL 1st *GRATEL meeting*, Paris, France (January 20, 2010).
Attended by N. Cohen, F. Havet, L. Sampaio;

HiMa: Meeting of AdR HiMa, Alcatel-Lucent/INRIA Joint lab, Villarceaux, France (March 17, 2010).
Attended by D. Coudert, P. Giabbanelli, F. Giroire;

ICT'10: Information and Communication Technologies: Digitally driven (ICT 2010), Brussels, Belgium (September 27-29, 2010). Attended by D. Coudert; A. Ferreira;

Mascotte Days: Mascotte project annual seminar, Rocquebrune Cap-Martin, France (May 3-4, 2010).
Attended by most of the MASCOTTE members;

ResCom: 9th *Journées du Pôle ResCom du GDR ASR*, Lyon, France (November 25-26, 2010).
Attended by D. Coudert, A. Lancin, N. Vieira Nepomuceno (speaker), I. Tahiri;

SPREADS: Final meeting of ANR SPREADS, Université Paris 6, Paris, France (December 13th, 2010).
Attended By O. Dalle, F. Giroire;

Towards a Future Internet: Interrelation between Technological, Social and Economic Trends, Brussels, Belgium (June 2010), and final workshop, Brussels, Belgium (November 2010).
Attended by A. Ferreira.

9.2.3. Participation in conferences

8FCC: *8th French Combinatorial Conference*, Orsay, France (June 28th - July 2nd, 2010).
Attended by J. Araújo, J-C. Bermond, N. Nisse (speaker), L. Sampaio;

AlgoTel'10: *12th rencontres francophones sur les aspects algorithmiques des télécommunications*, Belle Dune, France (June 16-19, 2010).
Attended by J. Araújo, D. Coudert, A. Ferreira, P. Giabbanelli (speaker), F. Giroire, N. Vieira Nepomuceno, J. Monteiro (speaker), J. Moulierac, N. Nisse (speaker) and I. Tahiri;

BGW10: *Bordeaux Graph workshop*, Bordeaux, France (November 18-20, 2010).
Attended by J-C Bermond, F.Havet;

CCNet'10: *Workshop on Complex and Communication Networks*, Miami, USA (December 6-10, 2010).
Attended by Philippe Giabbanelli (speaker);

CompleNet'10: *2nd Workshop on Complex Networks*, Rio de Janeiro, Brazil (October 13-15, 2010).
Attended by Philippe Giabbanelli (speaker);

EURO'10: *24th European Conference on Operational Research* (EURO XXIV), Lisbon, Portugal (July 11-14, 2010).
Attended by D. Coudert (speaker), N. Nisse (speaker);

European Forum for Innovation: Trento, Italy (June 2010).
Attended by A. Ferreira;

FUN'10: *5th International Conference on FUN with Algorithms*, Ischia Island, Italy (June 2-4, 2010).
Attended by D. Mazauric (speaker);

Globe'10: *3rd International Conference on Data Management in Grid and P2P Systems*, Bilbao, Spain (September 1-2, 2010).
Attended by J. Monteiro (speaker);

GLOBECOM'10: *IEEE GLOBal COMmunications Conference*, Miami, United States, (December 6-10, 2010).
Attended by F. Giroire (speaker);

ICALP'10: *37th International Colloquium on Automata, Languages and Programming*, Bordeaux, France (July 5-12, 2010).
Attended by D. Coudert, N. Nisse;

JDIR'10: *11es Journées Doctorales en Informatique et Réseaux*, Sophia Antipolis, France (March 24-26, 2010).
Attended by most of the members of MASCOTTE;

JGA'10: *12th Journées Graphes et Algorithmes*, Marseille, France (November 8-10, 2010).
Attended by J. Araújo (speaker), J-C. Bermond, N. Cohen (speaker), D. Coudert, F. Havet, A. Lancin, D. Mazauric (speaker), J. Moulierac, N. Nisse and L. Sampaio (speaker);

JIIP: Symposium "The future of sectoral innovation", Brussels, Belgium (April 2010).
Attended by A. Ferreira;

ODSA'10: *4th conference on Optimal Discrete Structures and Algorithms*, Rostock, Germany (September 13-15, 2010).
Attended by M. Toko Worou (speaker);

OMNeT++: *3d international workshop on OMNeT++*, Malaga, Spain (March, 15-19, 2010).
Attended by O. Dalle, J-C. Maureira (speaker and publicity chair), J. Ribault;

PODC10: *29th Annual ACM Symposium on Principles of Distributed Computing*, Zurich, Switzerland (July 25-28, 2010).
Attended by J. Burman (speaker);

RISE: Workshop on Ehtics and Digital Sciences, Brussels, Belgium (September 2010).
Attended by A. Ferreira;

SIGMETRICS'10: New York, USA (June 14-18, 2010).
Attended by D. Mazauric (speaker);

Simutools'10: 3rd International ICST Conference on *Simulation Tools and Techniques*, Malaga, Spain (March 15-19, 2010).
Attended by O. Dalle, J-C. Maureira, J. Ribault (speaker);

TERA-NET'10: *1st workshop Toward Evolutive Routing Algorithms for scale-free/internet-like NETworks*, co-located with ICALP'10, Bordeaux, France (July 5, 2010).
Attended by D. Coudert, N. Nisse (organizer);

Workshop: Algorithmique, combinatoire du texte et applications en bio-informatique, Montpellier, France (January 25-26, 2010).
Attended by M. Toko Worou (speaker).

9.2.4. Participation in schools

ELAVIO: XV *Escuela Latino Americana de Verano en Investigatión Operativa*, Pacoti, Brazil (August 2-6, 2010). Attended by J. Araujo;

JCALM'10: 7th *Journées Combinatoire et Algorithmes du Littoral Méditerranéen*, Montpellier, France (June 25, 2010). Attended by J. Araujo, L. Sampaio, N. Cohen, J. Dousse, H. Hsu, A. K. Maia de Oliveira and I. Tahiri;

RESCOM: *École ResCom 2010*, Giens, France (June 13-18, 2010).
Attended by J-C. Maureira;

SSGT: *First Montreal Spring School in Graph Theory*, Montreal, Canada (May 2010).
Attended by N. Cohen and N. Nisse.

9.2.5. Popularization

Fête de la Science: F. Havet presented the stand "A quoi servent les mathématiques" at Rians, France (October 21-24, 2010);

Journées Méditerranéennes du Logiciel Libre: Michel Syska has presented "MASCOPT une boite à outils de manipulation de graphe", Polytech?Nice-Sophia (November 26, 2010) http://jm2l.linux-azur.org/conference/mascopt-une-boite-à-outils-de-manipulation-de-graphe;

Sience et culture au Lycée: J-C. Bermond and D. Mazauric have presented "les métiers de la recherche" at the Conferences 2GT and 1S STI STL in the Lycée de La rouvière Toulon (April 29, 2010);

Soirée scientifique: F. Havet gave the lecture: "Les problèmes mathématiques à travers les âges", Rians, France (December 10, 2010).

9.3. HdR, Thesis, Internships

9.3.1. HdR

9.3.1.1. Habilitations defended in 2010

D. Coudert: *Algorithmique et optimisation dans les réseaux de télécommunications*, March 2010;

S. Pérennes: *Contribution à l'algorithmique des réseaux de télécommunications*, March 2010;

9.3.2. Thesis

9.3.2.1. Thesis defended in 2010

J. Monteiro: *Modeling and Analysis of Reliable Peer-to-Peer Storage Systems*, November 16 2010;

N. Vieira Nepomuceno: *Network optimization for wireless microwave backhaul*, December 17 2010;

9.3.2.2. Thesis in preparation

J. Araujo: *Dynamic network routing*, since December 2009.

N. Cohen: *Allocation de fréquences et coloration des L-graphes*, since October 2008;

J-C. Maureira: *Internet on Rails*, since February 2008, defense planned January 21, 2011;

D. Mazauric: *Conception et analyse d'algorithmes distribués d'ordonnancement dans les réseaux sans-fil*, since October 2008;

R. Modrzejewski: *Systèmes pair-à-pair de partage de données*, since November 2010;

R. Pardo Soares: *Routing reconfiguration in WDM networks*, since November 2010;

J. Ribault: *Modélisation et simulation à événements discrets à base de composants Fractal*, since January 2008;

L. Sampaio: *Algorithmic aspects of graph colorings*, since November 2009;

I. Tahiri: *Optimisation dans les réseaux de collecte IP sans fils*, since November 2009;

M. Toko Worou: *Outils algorithmiques pour la détection des communautés*, since November 2009.

9.3.3. Participation in thesis Committees

D. Coudert: Ph.D. committee of Fen Zhou (IRISA, Rennes, France, Sepember 6, 2010), and Napoleão Vieira Nepomuceno (UNS, Nice, France, December 17, 2010);

O. Dalle, S. Perennes and F. Giroire: Ph.D. committee of Julian Monteiro, (UNS, Nice, France, November 16, 2010) "Modeling and Analysis of Reliable Peer-to-Peer Storage Systems", (O. Dalle and S. Perennes co-directors);

F. Havet: PhD M. Chen, University of Bordeaux 1, November 17, 2010, (external referee); HDR M. Montassier, University of Bordeaux 1, November 17, 2010, (external referee); PhD A. Silva, University Joseph Fourier, Grenoble, November 24, 2010, (external referee).

9.3.4. Internships

D. Coudert and N. Nisse: supervised the internship of Henry Wei Cheng Hsu (École Polytechnique, Paris, France) on the pathwidth of outerplanar graphs, April-August 2010 (4 months 1/2).

D. Coudert and N. Nisse: supervised the internship of Sonia Belhareth (ENIT Tunis, Tunisia) on Routing reconfiguration in WDM networks, February-May 2010 (4 months).

O. Dalle: supervised the internship of Inza Bamba (UBINET), March-August 2010 (6 months).

F. Havet: supervised the internship of Ana Karolina Maia de Oliveira (Universidade Federal do Ceará, Fortaleza, Brazil), April-June 2010 (3 months).

F. Havet and D. Mazauric: supervised the internship of Jehanne Dousse (ENS Lyon), April-June 2010 (3 months).

F. Giroire and S. Pérennes: supervised the internship of Remigiusz Modrzejewski (UBINET), March-August 2010 (6 months).

P. Mussi and M. Syska: supervisor of Yoann Bertrand, Apprenti en Licence Professionnelle Systèmes Informatiques et Logiciels (IUT of Nice - Côte d'azur) on Administration du Réseau Expérimental du Projet MASCOTTE (September 2009-August 2010, 1 year).

9.4. Teaching

MASCOTTE has widely contributed to the launching and success of the stram UBINET of the master IFI: a new international master of science at University of Nice Sophia Antipolis (http://ubinet.inria.fr), launched in october 2009. J. Moulierac is in charge of this master and J-C. Bermond is a member of the managing committee. Several members of MASCOTTE are involved in teaching in this Master of Science in Ubiquitous Networking and Computing.

At the graduate level, members of MASCOTTE are also involved in teaching in other Masters like the master MDFI of University of Marseille or in the 3rd year of engineering schools.

The members of MASCOTTE are heavily involved in teaching activities at undergraduate levels (Licence, IUT, Master 1, ENS program, Engineering Schools like Polytech'Nice). Some members are also involved in administrative duties related to teaching. For example, M. Syska is director of the Licence LP SIL degree at IUT. The teaching is carried out by members of the University as part of their teaching duties, and for INRIA CNRS or Ph.D.'s as extra work.

Altogether that represents more than 1000 hours per year.

The members of MASCOTTE also supervise several student projects and internships at all levels (Master 1 and 2, Engineering Schools).

10. Bibliography

Publications of the year

Doctoral Dissertations and Habilitation Theses

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[2] J. MONTEIRO. *Modeling and Analysis of Reliable Peer-to-Peer Storage Systems*, Université de Nice Sophia-Antipolis, November 2010.

[3] N. NEPOMUCENO. *Network optimization for wireless microwave backhaul*, Université de Nice Sophia-Antipolis et Universidade Federal do Ceará, December 2010.

[4] S. PÉRENNES. *Contribution à l'algorithmique des réseaux de télécommunications*, Université de Nice Sophia-Antipolis, March 2010, Habilitation à Diriger des Recherches.

Articles in International Peer-Reviewed Journal

[5] O. AMINI, F. GIROIRE, F. HUC, S. PÉRENNES. *Minimal selectors and fault tolerant networks*, in "Networks", 2010, vol. 55, n^{o} 4, p. 326-340, http://hal.inria.fr/inria-00485848.

[6] O. AMINI, F. HAVET, F. HUC, S. THOMASSÉ. *WDM and Directed Star Arboricity*, in "Combinatorics Probability & Computing", 2010, vol. 19, p. 161-182, http://hal.inria.fr/lirmm-00512776.

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[12] J.-C. BERMOND, F. HAVET, F. HUC, C. LINHARES SALES. *Improper colouring of weighted grid and hexagonal graphs*, in "Discrete Mathematics, Algorithms and Applications (DMAA)", 2010, vol. 2, n^o 3, p. 395–411, http://hal.inria.fr/inria-00526530.

[13] J.-C. BERMOND, X. MUÑOZ, I. SAU. *Traffic grooming in bidirectional WDM ring networks*, in "Networks", 2010, to appear,.

[14] J.-C. BERMOND, M.-L. YU. *Optimal gathering algorithms in multi-hop radio tree networks with interferences*, in "Ad Hoc and Sensor Wireless Networks", 2010, vol. 9, n^o 1-2, p. 109-128, http://hal.inria.fr/inria-00505517.

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