INSTITUT NATIONAL DE RECHERCHE EN INFORMATIQUE ET EN AUTOMATIQUE

Project-Team MAESTRO

Models for Performance Analysis and Control of Networks

Sophia Antipolis - Méditerranée

Theme : Networks and Telecommunications

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2. Overall Objectives

2.1. Presentation of MAESTRO

MAESTRO is an INRIA project-team whose members are located in Sophia Antipolis (S. Alouf, K. Avrachenkov, P. Nain, G. Neglia), at LIA in Avignon (E. Altman) and at LIRMM in Montpellier (A.-E. Baert and A. Jean-Marie). MAESTRO is concerned with the modeling, performance evaluation, optimization and control of stochastic Discrete-Event Dynamical Systems (DEDS), with a particular emphasis on networks and their applications. The scientific contributions are both theoretical, with the development of new modeling formalisms, and applied, with the development of software tools for the performance evaluation of DEDS.

2.2. Highlights of the year

- Patent with ALCATEL-LUCENT BELL LABS on a method for estimating the round-trip time of a packet flow [132];
- E. Altman has been nominated *IEEE Fellow* "for contributions to analysis, optimization, and control of telecommunication networks";
- A. Azad, S. Alouf and E. Altman received the *Best Paper Award* of the IFIP Wireless Days 2009 (Paris, 15-17 December 2009) [58];
- A new ANR VERSO called ECOSCELLS (Efficient Cooperating Small Cells) has been accepted for three years (http://perso.citi.insa-lyon.fr/hrivano/contrats/ecoscells.php). This project aims at developing algorithms and solutions which will enable the deployment of small cell networks (see Section 8.3.1).

3. Scientific Foundations

3.1. Scientific Foundations

The main mathematical tools and formalisms used in MAESTRO include:

- theory of stochastic processes: Markov process, point process, Palm measure, large deviations;
- theory of dynamical discrete-event systems: queues, fluid approximation, network calculus;
- theory of control and scheduling: dynamic programming, Markov decision process, game theory, deterministic and stochastic scheduling, pathwise comparison;
- theory of singular perturbations;
- random matrix theory.

4. Application Domains

4.1. Application Domains

MAESTRO's main application area is networking and in particular, modeling, performance evaluation, optimization and control of protocols and network architectures. It includes:

- Internet infrastructure: TCP, high speed congestion control, voice over IP, service differentiation, quality of service;
- Internet applications: multicast, content distribution systems, peer-to-peer systems, overlay networks, multimedia traffic;
- Wireless (cellular, ad hoc, sensor) networks: WLAN, WiMAX, UMTS, LTE, HSPA, delay tolerant networks (DTN), power control, medium access control, transmission rate control, redundancy in source coding, mobility models, coverage, routing, green base stations.

5. Software

5.1. Web Graph Analyzer

Participants: Konstantin Avrachenkov [correspondant], Danil Nemirovsky, Marina Sokol.

K. Avrachenkov, D. Nemirovsky and M. Sokol have continued to develop the software "Web Graph Analyzer" for the investigation of Web graph properties. With the help of the Web Graph Analyzer, one can study the local graph characteristics such as numbers and sets of incoming/outgoing links to/from a given page, the page level relative to a given root page, the global graph characteristics such as PageRank, Giant Strongly Connected Component and the number of dangling nodes. In 2009, the clustering module has been improved.

6. New Results

6.1. Congestion control and IP traffic characterization

Participants: Sara Alouf, Konstantin Avrachenkov, Alberto Blanc, Abdulhalim Dandoush, Alain Jean-Marie, Philippe Nain, Giovanni Neglia.

6.1.1. Evaluation of new TCP versions

Participants: Konstantin Avrachenkov, Alberto Blanc, Giovanni Neglia.

Compound TCP is one of the many new versions of TCP for high speed networks. In [64], [115] A. Blanc, K. Avrachenkov and D. Collange (ORANGE LABS) use a fluid model to analyze the behavior of an isolated Compound TCP connection.

In [63], [116], K. Avrachenkov, A. Blanc and G. Neglia, together with D. Collange (ORANGE LABS) study the performance of Compound TCP under random losses. Markovian and deterministic models are used to derive the steady state distribution of the window along with synthetic performance metrics like average throughput and coefficient of variation of the window for an immediate comparison with TCP Reno.

In [62] A. Blanc, K. Avrachenkov and D. Collange (ORANGE LABS) use a Markovian model to compare the performance of different TCP versions (Compound TCP, Cubic, HighSpeed, and Reno) under Bernoulli losses, computing the average window size (response function), the Coefficient of Variation (CoV) of the window and the average throughput.

6.1.2. Estimating the round-trip time of long-lived TCP sessions

Participants: Sara Alouf, Konstantin Avrachenkov, Alberto Blanc, Philippe Nain.

The Round-Trip Time (RTT) of a TCP connection represents an important characteristic whose knowledge is useful when controlling a long-lived flow at a router. In [132], K. Avrachenkov, S. Alouf, and P. Nain, in collaboration with D. Carra (UNIVERSITY OF VERONA, Italy) and G. Post (ALCATEL-LUCENT BELL LABS), propose a passive, online RTT estimation methodology based on the traffic observed in one direction. The method uses spectral analysis along with a pattern-matching technique for the extraction of the fundamental frequency. Since the proposed solution estimates in real-time the RTT using one-way traffic, it represents a candidate for a possible implementation in routers.

Together with A. Blanc, the authors have validated the methodology through measurements in a controlled testbed and on the Internet. The results can be found in [117].

This research is carried out within ADR "Semantic Networking" (see Section 7.1.1).

6.1.3. *Flow-aware traffic management*

Participants: Sara Alouf, Konstantin Avrachenkov, Alberto Blanc.

The congestion control mechanism of TCP, while simple and scalable, has several well-known limitations: 1) often different flows experience synchronized losses leading to lower link utilization, and 2) when flows with different Round-Trip Times (RTT) share the same bottleneck link, flows with a smaller RTT receive a larger share of the capacity.

In [103], A. Blanc, K. Avrachenkov, and S. Alouf, in collaboration with G. Post (ALCATEL-LUCENT BELL LABS), propose a new flow-aware traffic management mechanism that aims at addressing the two aforementioned limitations, while being self-configuring and supporting different fairness criteria. The core idea of the proposed mechanism can be described as a two step process: 1) decide a target rate for each flow; 2) control each TCP flow in order to minimize the oscillations around the chosen target rate.

This research is carried out within ADR "Semantic Networking" (see Section 7.1.1).

6.1.4. *Remote active queue management*

Participant: Eitan Altman.

In [75] E. Altman, in collaboration with M. Ibrahim and P. Vicat-Blanc Primet (INRIA project-team RESO), G. Carofiglio and G. Post (ALCATEL-LUCENT BELL LABS), has proposed an Active Queue Management (AQM) scheme that is able to detect congestion in other nodes. By reacting to that congestion in its own node, it is able to reduce the congestion in the other nodes. The detection of congestion is obtained through the identification of a change in the rate of increase of the congestion window of TCP connections. The authors study through simulations the accuracy of this way to detect congestion.

6.1.5. *Flow-level simulation of parallel downloads*

Participants: Abdulhalim Dandoush, Alain Jean-Marie.

Parallelism in the download process of large files is an efficient mechanism for distributed systems. In such systems, some peers (clients) exploit the power of parallelism to download blocks of data stored in a distributed way over some other peers (servers). Parallel downloading with capacity constraints on both the client downloads and server uploads has not been well analyzed. In particular, a basic problem is to predict the instantaneous shares of the bandwidths of each client/server devoted to each data transfer flow. A. Dandoush and A. Jean-Marie have proposed and analyzed a simple algorithm that works at the flow-level and uses the concept of "Water-Filling" (or min-max fairness). The response times of parallel downloading have been analyzed (both distributions and averages) using the algorithm by flow level simulations. The results have been compared to those of packet-level simulations after implementing the same process in Network Simulator ns-2.

6.2. Wireless communications

Participants: Utku Acer, Sara Alouf, Eitan Altman, Konstantin Avrachenkov, Amar Azad, Anne-Elisabeth Baert, Veeraruna Kavitha, Vincenzo Mancuso, Dorian Mazauric, Philippe Nain, Giovanni Neglia, Sreenath Ramanath, Giuseppe Reina, Leonardo Rocha, Alonso Silva, Saed Tarapiah.

6.2.1. Mesh networks

Participants: Vincenzo Mancuso, Dorian Mazauric, Philippe Nain.

6.2.1.1. Spatially biased mesh networks

In [26] and [135], V. Mancuso, in collaboration with O. Gurewitz (BEN GURION UNIVERSITY, Israel), J. Shi and E.W. Knightly (RICE UNIVERSITY, USA), tackles the problem of throughput unfairness for IEEE 802.11-based wireless mesh nodes. This unfairness is shown to be strongly correlated with the spatial distribution of the wireless nodes. The work in [26] gives experimental evidence of the problem, provides an analytical model that allows one to understand the origin of the protocol unfairness, and proposes a MAC-based solution to unfairness. In [135], the spatial unfairness is tackled via elastic rate limiting strategies to be implemented in a few selected network nodes.

6.2.1.2. Distributed call scheduling

D. Mazauric and P. Nain, in collaboration with J-C. Bermond (INRIA project-team MASCOTTE) and V. Misra (UNIVERSITY OF COLUMBIA, USA), have investigated the problem of distributed transmission scheduling in wireless networks. Due to interference constraints, "neighboring links" cannot be simultaneously activated, otherwise transmissions will fail. In [114], [133], they consider any binary model of interference. Traffic is assumed to be single-hop, time is slotted and calls arrive randomly on each link during a time slot. They design a fully distributed local algorithm which works for any arbitrary binary interference model and with a constant overhead (w.r.t. the network size and the backlog in the queues). Furthermore, as opposed to other existing algorithms, their algorithm performs without knowing the queue backlogs at the "neighboring links", an information which is typically difficult to collect in a wireless network with interference. Sufficient conditions for stability under Markovian assumptions are derived. The performance of the proposed algorithm (throughput, stability) is investigated via simulations. The results show that its performance favorably compares to that of previously proposed schemes.

6.2.2. Power save mechanisms

Participants: Sara Alouf, Eitan Altman, Amar Azad.

Power save/sleep mode operation is the key point for energy-efficient usage of mobile devices driven by limited battery lifetime. Recent advances in wireless radio technology facilitate the implementation of various possible sleep policies. In [58], [111], S. Alouf, E. Altman, A. Azad, in collaboration with V. Borkar (Tata Institute of Fundamental Research, India) and G. Paschos (CERTH, Greece), address the issue "which policy performs best under a certain condition?" They show that the constant duration policy is optimal for Poisson inactivity periods, but not for hyper-exponentially distributed inactivity periods. In the policy where vacations are i.i.d. exponential random variables, the optimal control is derived analytically as a function of the expected inactivity period. This result holds for general inactivity periods.

In [57], [110], the same problem is formulated as a control problem in which systems with inactivity periods of unknown duration are considered. The same authors study the question of scheduling "waking up" instants at which a server can check whether the inactivity period is over. They show that periodic fixed vacation durations are optimal and derive the optimal period. This structure does not hold for other inactivity distributions, but the authors manage to obtain some suboptimal solutions which perform strictly better than the periodic ones, and derive structural properties for optimal policies for the case of arbitrary distribution of inactivity periods.

This research is carried out within ANR grant WINEM (see Section 8.3.2) and the INRIA Associate Team DAWN (see Section 8.1.1).

6.2.3. Delay and disruption-tolerant networks (DTNs)

Participants: Utku Acer, Sara Alouf, Eitan Altman, Philippe Nain, Giovanni Neglia, Giuseppe Reina, Leonardo Rocha, Saed Tarapiah.

This research has been partially supported by the IST FET grant BIONETS(see Section 8.2.2).

6.2.3.1. Optimal control of DTNs

In collaboration with T. Başar (UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN, USA) and F. De Pellegrini (CREATE-NET, Italy), E. Altman has pursued and intensified his research on the optimal control of DTNs. Two main frameworks have been used: (i) the monotone framework, where it is assumed that the number of mobiles having a packet is a non-decreasing function of time, together with trajectorial pathwise arguments, give rise to optimal threshold type policies [20], and (ii) the linear quadratic framework, where when two-hop routing is enforced then the system's dynamic is often linear in the state and control. If the costs functions to be minimized can be expressed as quadratic functions of the state and/or of the control then optimal control policies can be obtained explicitly using the theory of linear quadratic regulator. This approach was carried out in [55].

The paper [52] by E. Altman and P. Nain, in collaboration with J.-C. Bermond (INRIA project-team MASCOTTE), has appeared in the proceedings of Infocom 2009. It concerned yet other aspects of optimization related to optimal forwarding and thus of storage of evolving files. The interested reader is referred to Maestro 2008 activity report for more details.

Other issues related to distributed optimal control and to learning in case of unknown parameters have appeared in [53]. These results by E. Altman and G. Neglia, together with F. De Pellegrini and D. Miorandi (CREATE-NET, Italy) have already been described in Maestro 2008 activity report.

6.2.3.2. Two-hop forwarding policies in DTNs

The particular structure of two-hop routing is useful for getting explicit expressions for the dynamics and for the optimal control not only in the linear quadratic control context but also in the case of competition between mobile nodes. In [37], E. Altman considers the stochastic framework with finite number of mobiles and obtains simple new closed-form expressions for the performance measures as a function of the controls. After studying both cooperative and competitive scenarios (through a team and a non-cooperative game formulations), the convergence to a mean field limit is established. This is extended to the more granular chunk level modeling of the system.

The ability of DTNs to deliver packets from a source to a destination comes at a cost of resources needed for storage of many copies of the packets in mobile (relay) nodes. An efficient way of coding the packet can substantially increase the diversity and have a significant impact on the system's capacity. This is illustrated in [43] where E. Altman, together with F. De Pellegrini (CREATE-NET, Italy) study the impact of various coding mechanisms on the system performance in terms of tradeoff between throughput and energy.

Various models of DTNs with two-hop routing can be described and analyzed using branching processes. In [32], E. Altman and D. Fiems (UNIVERSITY OF GENT, Belgium) identify such examples in which a file is dessiminated in the network. They study the performance measures under varying Markov environment. They obtain the first two order-moments of the number mobiles in the system that possess a copy of the file.

6.2.3.3. Adaptive epidemic routing in DTNs

In [85], [126], G. Neglia, G. Reina, and S. Alouf address the problem of designing adaptive epidemic-style forwarding mechanisms for message delivery in DTNs. The approach is based on a new analytical framework for multi-agent optimization through distributed subgradient methods. They investigate how this framework can be adapted to the considered networking problem and perform a preliminary evaluation, which shows promising results in terms of convergence speed.

This research has been partially supported by the IST FET grant BIONETS (see Section 8.2.2) and the NOE EURONF (see Section 8.2.3).

6.2.3.4. Routing in quasi-deterministic networks

U. Acer, G. Neglia, L. Rocha, together with P. Giaccone, D. Hay, and S. Tarapiah (Politecnico di Torino, Italy) have opened a new research direction by investigating routing in DTNs where the underlying node mobility is known in advance but can be modified by random effects. They have called these networks "quasi-deterministic" DTNs. This research direction has been the object of the COLOR project CRASQUIDEM (see

Section 8.3.5) and is described in [33]. In June 2009 the Torino public transportation society has started being involved in this research.

6.2.3.5. Virus attacks

In [34] E. Altman, in collaboration with M. Khouzani and S. Sarkar (UNIVERSITY OF PENNSYLVANY, USA), considers a defense strategy in a DTN networks under a virus attack. The authors study a policy that quarantines nodes that are not vaccinated against the virus by reducing the communication range. This countermeasure involves a trade-off: reducing the communication range suppresses the spread of the malware, however, it also negatively affects the performance of the network as the end-to-end communication delay increases. The authors model the propagation of the malware as a deterministic epidemic. Using an optimal control framework, they select the optimal communication range that captures the above trade-off by minimizing a global cost function. Using Pontryagin's Maximum Principle, the authors derive structural characteristics of the optimal communication range as a function of time for two different cost functions.

6.2.4. Sensor networks

Participants: Eitan Altman, Anne-Elisabeth Baert, Veeraruna Kavitha.

6.2.4.1. Sensor networks served by a message ferry

In [80], V. Kavitha and E. Altman study the concept of Ferry based Wireless Local Area Network (FWLAN), in which a number of isolated nodes are scattered over some area and where communication between a node and the outer world, or communication between the nodes, are made possible via a message ferry. The ferry has a predetermined cyclic path; it collects messages from a node and delivers messages to it when it is in the vicinity of the node. They use the mathematical theory of polling systems to study the performance of the FWLAN. They consider three different architectures and each one of them is mapped into an appropriate polling system. The polling disciplines that are needed for modeling the FWLAN involve non-standard variants of the so-called gating disciplines. The goal is to design the routes of the ferry as well as the points where it should stop to distribute and collect messages. This mathematical modeling brings another dimension to the classical related vehicle routing problem due to the radio channel: the cyclic path of the ferry need not touch every node. The distance between the node and the ferry at the point when communication occurs determines the transmission rate and hence the service time and thus the system capacity.

6.2.4.2. Energy-aware protocol engineering for sensor networks

A key criterion used to measure communication protocol efficiency in Wireless Sensor Networks (WSNs) is the energy consumption and the lifetime of these networks. In collaboration with J. Champ, C. Saad and V. Boudet (UNIVERSITY OF MONTPELLIER II, CNRS), A.-E. Baert has pursued her work on energy-aware protocol engineering for sensor networks. Existing criteria to measure network lifetime in WSNs have been surveyed and two new criteria (Average Node Percentage and Monitored Interest Point Percentage) have been introduced in [66].

In [65] these authors have proposed the *Dynamic Localized Broadcast Incremental Power Protocol* (DLBIP), a new localized broadcast protocol whose principle is to use dynamic broadcast trees to improve lifetime. The study is based on the best known localized algorithm, namely LBIP, which is based on a centralized one, BIP, whose principle consists in constructing a broadcast tree rooted at the source node, taking into account the specificities of wireless networks. DLBIP can guarantee the reception of broadcast messages in the network in the sense that over 90% of the sensors receive the broadcast messages.

6.2.5. Analysis of wireless access protocols

Participant: Eitan Altman.

The Fountain Code based Transport (FCT) protocol relies on a different paradigm than the ubiquitous TCP. It abolishes the need for a reverse feedback mechanism usually essential to provide reliability in packet data transmission. Absence of a reverse feedback mechanism can substantially improve the performance of networks with half-duplex wireless channels (such as 802.11 WLANs), where collisions between forward and reverse MAC frame transmissions contribute greatly to performance degradation. In [81] E. Altman, in cooperation with D. Kumar (IBM Yorktown Heights, USA) and T. Chahed (TELECOM SUDPARIS), proposes a Markovian stochastic framework to model the performance of a simple FCT protocol in an IEEE 802.11 WLAN setting. The model allows the WLAN Access Point to employ a generic rate control algorithm for MAC frame transmissions on the downlink. Using renewal theory the authors provide explicit expressions for the average downlink throughput and transfer time of a file in such a WLAN cell. ns-2 simulations are used to validate the model and the analytically obtained metrics. A detailed performance analysis study is then carried out to provide insights into the choice of various system parameters that may lead to optimal network performance. Finally, the performance of FCT and TCP are briefly compared through simulations.

6.2.6. Power control

Participants: Eitan Altman, Konstantin Avrachenkov.

In [15] E. Altman, K. Avrachenkov, I. Menache (MIT, USA), B. Miller (MOSCOW AVIATION INSTITUTE, Russia), B. Prabhu (LAAS-CNRS) and A. Shwartz (TECHNION, Israel) consider an uplink power control problem where each mobile wishes to maximize its throughput (which depends on the transmission powers of all mobiles) but has a constraint on the average power consumption. A finite number of power levels are available to each mobile. The decision of a mobile to select a particular power level may depend on its channel state. The authors consider two frameworks concerning the state information of the channels of other mobiles: i) the case of full state information and ii) the case of local state information. For each framework the authors consider both cooperative and non-cooperative power control. Both analytical and numerical results on the structure of the optimal policies are obtained.

In [38] E. Altman and K. Avrachenkov, in collaboration with L. Cottatellucci and A. Suarez (INSTITUT EURECOM), M. Debbah (SUPELEC) and G. He (MOTOROLA), study the selection of the rate allocation in Multiple Access Channels (MAC). They consider MACs with different rate regions, including polytope rate regions, convex non-polytope rate regions, and non-convex rate regions. Different operating points of the rate region possess different properties in terms of efficiency, fairness, stability, etc. The goal of this work is to provide guidelines for the choice of an operating point using the above-mentioned criteria. The authors use two methodological approaches: fairness function approach leading to an optimal system operation point and game theoretic approach leading to an equilibrium point.

6.2.7. Ad hoc networks

Participants: Eitan Altman, Alonso Silva.

6.2.7.1. Power and hop size control in ad hoc networks

E. Altman, in collaboration with A. Kumar and V. Ramaiyan (IISC, Bangalore, India), considers in [29] a dense, ad hoc wireless network, confined to a small region. The wireless network is operated as a single cell, namely only one successful transmission is supported at a time. Data packets are sent between source destination pairs by multihop relaying. It is assumed that nodes self-organize into a multihop network such that all hops are of length d meters, where d is a design parameter. There is a contention based multi-access scheme, and it is assumed that every node always has data to send, either originated from it or a transit packet (saturation assumption). In this scenario, the authors seek to maximize a measure of the transport capacity of the network (measured in bit-meters per second) over power controls (in a fading environment) and over the hop distance d, subject to an average power constraint. The authors first argue that for a dense collection of nodes confined to a small region, single cell operation is efficient for single user decoding transceivers. Then, operating the dense ad hoc wireless network (described above) as a single cell, the authors study the hop length and power control that maximizes the transport capacity for a given network power constraint.

6.2.7.2. Routing in massively dense ad hoc networks

E. Altman and A. Silva have pursued their line of research started on 2007 and dedicated to studying the routing in very dense static ad hoc. Their results obtained since 2007, and described in the activity reports of the last two years, have been summarized in a journal paper that has now appeared [18].

6.2.8. Cellular networks

Participants: Sara Alouf, Eitan Altman, Veeraruna Kavitha, Vincenzo Mancuso, Sreenath Ramanath.

6.2.8.1. Green strategies in cellular networks

In the context of the ANR grant WINEM (see Section 8.3.2), V. Mancuso and S. Alouf have surveyed the strategies adopted by base station manufacturers and operators on the road towards a low-cost and environment-friendly wireless networking. Most of the current green best practices concern the rationalization of (i) capital expenditures, by optimizing the base station site architecture and the distribution of the sites over the targeted coverage area, and (ii) operational expenditures, by minimizing the energy consumption of electronic devices and reducing the need for cooling systems. In addition, new software-based management tools have been coming into play, which try to enforce a sleep mode on those equipments that are expected to handle low or no traffic during the off-peak hours.

6.2.8.2. Optimizing cell size in pico-cell networks

E. Altman and S. Ramanath have been working within the ADR SELFNET as part of the joint INRIA Alcatel-Lucent Bell Labs (see Section 7.1.2).

In [35] S. Ramanath and E. Altman, in collaboration with V. Kumar (ALCATEL-LUCENT BELL LABS) and M. Debbah (INSTITUT EURECOM), present a systematic study of the uplink capacity and coverage of pico-cell wireless networks. Both the one dimensional and the two dimensional cases are investigated. The goal is to compute the size of pico-cells that maximizes the spatial throughput density. To achieve this goal, the authors consider fluid models that allow them to obtain explicit expressions for the interference and the total received power at a base station. They also study the impact of various parameters on the performance: the path loss factor, the spatial reuse factor and the receiver structure (matched filter or multiuser detector). Finally, the authors relate the performance of the fluid models to that of the original discrete system, and show that the fluid model provides a bound for the discrete one.

6.2.8.3. Fair assignment of base stations in cellular networks

In [88], S. Ramanath, E. Altman and V. Kavitha, in collaboration with V. Kumar and L. Thomas (ALCATEL-LUCENT BELL LABS), address the problem of fair assignment of base station locations in a cellular network. The authors use the generalized α-fairness criterion, which encompasses a contimuum set of fair assignments parametrized by a real number α. The set includes that of global, proportional, harmonic or max-min fairness in the study. They derive explicit expression for α-fair base station locations under large population limits in the case of simple one dimensional models. They show analytically that as α increases asymptotically, the optimal location for a single base station converges to the center of the cell. The authors validate the analysis via numerical examples. They further study throughput achievable as a function of α-fair base-station placement, path-loss factor and noise variance via numerical examples. They also address the problem of optimal placement of two base stations and obtain similar conclusions.

6.3. Information systems

Participants: Sara Alouf, Eitan Altman, Konstantin Avrachenkov, Anne-Elisabeth Baert, Abdulhalim Dandoush, Alain Jean-Marie, Philippe Nain, Giovanni Neglia, Danil Nemirovsky, Marina Sokol, Sulan Wong.

6.3.1. Interplay between legislation, Economics and information technology

Participants: Eitan Altman, Sulan Wong.

The internet allows access to a huge amount of multimedia content (music, films, etc.) and to copyrighted books and journals. This access brings large gain to Internauts at the cost of depriving the creators and the copyright owners from their rights. Two types of legislations have been debated, the first attempting to fight against the unauthorized offer and demand to copyrighted creation available through the Internet, and the other aiming at benefiting from this demand through taxation. Researchers who specialize in performance analysis and in development of protocols for file sharing systems are well placed to analyze each if the above options along with the efficiency of measures proposed to enforce complience with the law. Furthermore, an economic analysis may be used to propose yet other directions for the evolution of file sharing systems and for Internet access.

In 2009 E. Altman has been working on the above issues in collaboration with S. Wong (UNIVERSITY OF A CORUNA, Spain) who is a jurist specialized in copyrights and intellectual property. In collaboration with M. Ibrahim (INRIA project-team RESO) they analyze in [98] the role and interests of each economic actor as well as the interactions between the actors. The authors further evaluate the impact of measures taken by service or content providers to diminish the upload or download rate of a file on its availability in a file sharing system. In [54], E. Altman and S. Wong develop an economic model in collaboration with J. Rojas (UNIVERSITY OF AVIGNON) and explore the added value that wide access to the Internet can bring to content providers if pricing mecanisms such as Shapley value are adopted.

6.3.2. Storage in distributed/peer-to-peer systems

Participants: Sara Alouf, Anne-Elisabeth Baert, Abdulhalim Dandoush, Alain Jean-Marie, Philippe Nain.

Distributed systems using a network of peers has become an alternative solution for storing data. A. Dandoush, S. Alouf, and P. Nain study the performance of peer-to-peer storage systems in terms of data lifetime and availability. Prior efforts assumed data recovery process to follow an exponential distribution. To understand how the recovery process could be better modeled, they have implemented this process in the ns-2 network simulator (cf. [31]) and have performed an intensive simulation analysis of it in [69], [118].

Building on the findings in [69], [118], A. Dandoush, S. Alouf and P. Nain develop in [68] Markovian models assuming that the *fragment* download/upload time is exponentially distributed so that the recovery time follows a hypo-exponential distribution with many distinct phases. They find in particular that a distributed recovery scheme is a good implementation choice only in large networks where peers have a good availability.

The question of optimal data replication and placement on distributed storage systems has been completed within the VOODDO project (funded by the "Multimedia" Program of the ANR), jointly with V. Boudet and X. Roche from LIRMM, CNRS/UNIVERSITY OF MONTPELLIER II (see Section 8.3.3). The algorithmic problems of determining how much to replicate and where to replicate are difficult. The experimental evaluation of heuristics for both problems has been done in [24], [60], [23]. The study was completed by theoretical results including: the proof optimality of certain configurations (case of two replicates, Steiner systems), and the analysis (mean and variance) of certain random algorithms [125].

6.3.3. Document ranking and clustering on the Web

Participants: Konstantin Avrachenkov, Danil Nemirovsky.

In [22] K. Avrachenkov, N. Litvak (UNIVERSITY OF TWENTE, The Netherlands) and K. S. Pham (ST. PETERSBURG STATE UNIVERSITY, Russia) study the PageRank mass of principal components in a bow-tie web graph as a function of the damping factor c. It is known that the web graph can be divided into three principal components: the giant Strongly Connected Component (SCC), the in-component (IN) and the out-component (OUT). The giant SCC contains a large group of pages having a hyperlink path connecting them. The pages in the IN (OUT) component have a path to (from) the SCC, but not back. Using a singular perturbation approach, the authors show that the PageRank share of the IN and SCC components remains high even for very large values of the damping factor, in spite of the fact that it drops to zero when c tends to one. However, a detailed study of the OUT component reveals the presence of "dead ends" (small groups of pages linking only to each other) that receive an unfairly high ranking when c is close to 1. The authors argue that this problem can be mitigated by choosing c as small as $1/2$.

6.4. Game theory applied to networking

Participants: Eitan Altman, Konstantin Avrachenkov, Veeraruna Kavitha, Giovanni Neglia, Sreenath Ramanath.

6.4.1. Wireline networks

Participants: Eitan Altman, Giovanni Neglia.

6.4.1.1. Fairness based on Nash equilibria

In [77], E. Altman, jointly with H. Kameda (UNIVERSITY OF TSUKUBA, Japan), C. Touati and A. Legrand (INRIA project-team MESCAL), has proposed a new fairness concept for resource sharing among users. The starting point is that a Nash equilibrium is often considered to be fair since it is by definition an outcome of a competition with no collusions. On the other hand, a Nash equilibrium can be non-efficient since it can be dominated by other policies. The authors establish the existence of efficient policies that are on the one hand Pareto optimal and on the other hand proportional to a Nash equilibrium. These properties are used to define a new fairness criterion.

6.4.1.2. Size-based differentiation

In [92], E. Altman, S. Soudan, D. Divakaran and P. Primet (INRIA project-team RESO) study competitive situations that occur as a result of the differentiation between short and long flows. A long session can be presented as a number of short sessions in order to avoid being recognized and treated as a long session. The authors characterize the equilibrium.

6.4.1.3. File sharing systems

In [84] G. Neglia, together with D. Menasche, D. Towsley and S. Zilberstein (UNIVERSITY OF MASSACHUSETTS AT AMHERST, USA) study the problem of how to combine files into bundles in swarming systems. In particular, they analyze the case of a monopoly where a single publisher decides how to aggregate its files so as to satisfy user demands while mitigating its serving costs. They establish conditions for the existence and uniqueness of an equilibrium and have shown how the publisher's bundling strategy affects its profit. Moreover, they also consider the competitive case where bundling decisions of one publisher affect the outcome of other publishers. Using normal form games they analyze the impact of different system parameters on the Nash equilibrium.

6.4.2. Wireless networks

Participants: Eitan Altman, Konstantin Avrachenkov, Giovanni Neglia.

6.4.2.1. Jamming in wireless networks

The problem of jamming plays an important role in ensuring the quality and security of wireless communications, especially at nowadays when wireless networks are quickly becoming ubiquitous. Jamming is a form of a denial of service attack in which an adversary can degrade the quality of the reception by creating interference. One can study jamming both in the purpose of protecting a wireless network against such attack or, on the contrary, in order to efficiently disrupt the communications of some adversary. In both cases jamming is part of a conflict for which game theory is an appropriate tool. In a series of papers [41], [40], [39] E. Altman, K. Avrachenkov and A. Garnaev (ST. PETERSBURG STATE UNIVERSITY, Russia) analyze the jamming in wireless networks with partial information available. In particular, in [41] they study the scenario where users do not know how jamming efforts are distributed among sub-carriers and also do not know the fading channels gains with certainty. In [40] the authors consider the scenario when a user either does not have a complete information about the total energy available to the jammer or the user is not sure if the jammer is present in the environment. In [39] the same scenarios as in [40] are considered but with a more general utility function, the α-fairness utility function. Finally, in [42] the case of several jammers is investigated.

6.4.2.2. Jamming the signaling channel

In collaboration with S. Sarkar (UNIVERSITY OF PENNSYLVANIA, USA), R. El-Azouzi and Y. Hayel (UNIVERSITY OF AVIGNON), E. Altman investigates in [34] a game in which n channels are available to a mobile. The authors consider some adversarial node that can prevent the mobile to obtain the information on the state of k out of the n channels. Using a zero-sum Bayesian game model, they answer the questions of which state-dependent jamming policy is the most harmful and what is the best way for the other mobile to react.

6.4.2.3. WiFi networks

In WiFi networks, mobile nodes compete for accessing the shared channel by means of a random access protocol called Distributed Coordination Function (DCF), which is long term fair. Selfish nodes could benefit from violating the protocol and increasing their transmission probability. In [74], [73], [96], G. Neglia, I. Tinnirello and L. Giarre (UNIVERSITY OF PALERMO, Italy) study the interaction of selfish nodes in two different scenarios. In the first, one mobile stations are simply interested to maximize their upload rate to a single Access Point (AP); in the second one, they are also interested in their downlink rate. The work highlights the poor performance in presence of selfish behaviors and study the role of the AP in WiFi networks in infrastructure mode. Simple changes to AP functionalities can be introduced to design the game in order to achieve optimal global performance at Nash equilibrium. This work has also been presented to a larger community of researchers through the signal processing magazine [25].

6.4.2.4. Survey papers

In [28] S. Lasaulce, M. Debbah (SUPELEC) and E. Altman present an overview of foundations and tools of game theory that are relevant to wireless communications. Both finite as well as infinite populations of players are considered and various solution concepts (equilibria) are overviewed. Another survey paper by E. Altman in collaboration with R. El-Azouzi, Y. Hayel and H. Tembine (UNIVERSITY OF AVIGNON) focuses on evolutionary games and their applications to wireless networks (see [30]).

6.4.3. Competition in cellular networks

Participants: Eitan Altman, Veeraruna Kavitha, Sreenath Ramanath.

6.4.3.1. Opportunistic scheduling in the presence of noncooperative mobiles

In collaboration with R. El-Azouzi (UNIVERSITY OF AVIGNON) and R. Sundaresan (IISC, Bangalore, India), V. Kavitha and E. Altman study in [79] a centralized dynamic scheduling decision that has to be made by a base station to fair share the resources, based on the current channel gains signaled by the mobiles. Mobiles can be non-cooperative in the sense that they may erroneously signal to improve their own utilities. The authors formulate this non cooperative scheduling problem by using a signaling game, where (1) mobiles (lead players) signal the base station of their channel value, (2) base station (follower) makes a scheduling decision using the signals, (3) scheduling decision determines the payoff for all mobiles, base station. It is shown that this signaling game admits only babbling equilibria: mobile's strategy is to signal regardless of its channel. The base station's strategy is to ignore the signals from mobiles. Various approaches are then proposed so as to enforce truthful signaling of the radio channel conditions including a distributed stochastic approximation approach that combines estimation and control.

6.4.3.2. Location games applied to base station placement

In [49], E. Altman with A. Kumar, C. Singh and R. Sundaresan (IISC, Bangalore, India) consider the question of determining locations of base stations (BSs) that may belong to the same or to competing service providers, taking into account the impact of these decisions on the behavior of intelligent mobile terminals who can connect to the base station that offers the best utility. They first study the Signal to Interference and Noise Ratio (SINR) association-game: the authors determine the cells corresponding to each base station, namely, the locations at which mobile terminals prefer to connect to a given base station than to others. SINR is used as the quantity that determines the association. They make some surprising observations: (i) displacing a base station a little in one direction may result in a displacement of the boundary of the corresponding cell to the opposite direction, and (ii) a cell corresponding to a BS may be the union of disconnected sub-cells. They

further study the Stackelberg equilibrium in the combined BS location and mobile association problem: they determine where to locate the BSs so as to maximize the revenues obtained at the induced SINR mobile association game. They consider the cases of single frequency band and two frequency bands of operation. Finally, they study Stackelberg equilibria in two frequency systems with successive interference cancellations.

6.4.3.3. A hierarchical base station location game with differentiated services

In [78] E. Altman, jointly with G. Kasbekar and S. Sarkar (UNIVERSITY OF PENNSYLVANIA, USA), considers a scenario in which a regulator owns the spectrum in a certain region. A number of service providers lease spectrum from the regulator. Each service provider sets up a base station to serve mobile subscribers in the region. This gives rise to a hierarchical game with players at three levels: the mobile subscribers (level 1), the service providers (level 2) and the regulator (level 3). In the game at level 3, the regulator chooses the price at which to lease the spectrum. In the game at level 2, each service provider chooses the quantity of spectrum to lease from the regulator and the rate at which to charge the mobile subscribers. The authors consider the situation in which each service provider has two kinds of mobile subscribers: primary users, who receive high-priority service and secondary users who receive low-priority service. In the game at level 1, each mobile subscriber chooses a service provider to join and whether to become a primary or secondary user. Using game theoretic tools the authors compute the equilibrium strategies at all three levels.

6.4.3.4. Uplink competitive resource allocation problem

In [48], E. Altman, A. Kumar (IISC, Bangalore, India) and Y. Hayel (UNIVERSITY OF AVIGNON) consider a resource allocation problem in a multichannel wireless access system being shared by several users for uplink transfer of elastic traffic. Each user can allocate its resources (e.g., radios, antennas or power) to one or more of the carriers. The authors consider a problem of noncooperative allocation of resources by the users, each user's objective being to maximize its own utility. The theory of potential games is used to solve this problem by transforming it into an equivalent global optimization one. Structural properties of the equilibrium policies are obtained using tools from Schur concave stochastic order. Finally, a distributed algorithm is introduced and is shown to converge to a Nash equilibrium of the system.

6.4.3.5. Distributed resource allocation algorithms in a slotted aloha system

In collaboration with E. Sabir, R. El-Azouzi, Y. Hayel (UNIVERSITY AVIGNON) and E.-H. Bouyakhf (UNIVERSITY OF MOHAMMED V, Morocco), V. Kavitha considers in [90] finite number of users, with infinite buffer storage, sharing a single channel using the Aloha medium access protocol. They investigate the uplink case of a cellular system where each user will select a desired throughput. The users then participate in a non cooperative game wherein they adjust their transmit rate to attain their desired throughput. In contrast to the saturated case, the authors show that the game either has no Nash equilibrium or has infinitely many Nash Equilibria (NE). They further show that the region of NE coincides with an appropriate "stability region". The authors discuss the efficiency of the equilibria in term of energy consumption and congestion rate. Next, they propose two learning algorithms using a stochastic iterative procedure that converges to the best Nash equilibrium. They approximate the control iterations by an equivalent ordinary differential equation in order to prove that the proposed stochastic learning algorithm converges to a Nash equilibrium even in the absence of any coordination or extra information. Extensive numerical examples and simulations are provided to validate the results.

6.4.4. Evolutionary games

Participant: Eitan Altman.

In [16] E. Altman studies in cooperation with H. Tembine, Y. Hayel and R. El-Azouzi (UNIVERSITY OF AVIGNON) the evolution of competing flow control protocols. In this work models of population dynamics (such as the replicator dynamics) are considered to understand under what conditions can one expect different variants of TCP protocols to coexist, and what fraction of users should be using each type. A shorter version of this work has been described in the last year MAESTRO activity report.

6.5. Stochastic processes, queueing, control theory and game theory

Participants: Eitan Altman, Konstantin Avrachenkov, Alain Jean-Marie, Vijay Kamble, Danil Nemirovsky, Natalia Osipova, Alonso Silva.

6.5.1. Boostrap techniques for simulating the M/M/1 queue

Participant: Eitan Altman.

In [89], E. Altman, J. Rojas-Mora and T. Jimenez (UNIVERSITY OF AVIGNON) present several conclusions on how to simulate faster and with higher accuracy. Having chosen the M/M/1 queue, the authors are able to make use of a rich knowhow in the simulation theory as a reference, as well as of simple known formulas for the performance measures of the queue. The authors present both generic simulation aspects that would probably be useful for any implementation, as well as some aspects that are specific to the simulations in ns-2. They illustrate how bootstrap techniques can improve performance in the sense of reducing the number of simulations and of increasing the accuracy.

6.5.2. Tensor approach to mixed high-order moments of absorbing Markov chains

Participant: Danil Nemirovsky.

In absorbing Markov chains first moments and non-mixed second moments are determined in matrix form. Mixed moments of higher orders cannot be represented in a matrix form and have not been calculated so far. In [127], D. Nemirovsky succeeds in computing them in closed-form by using a tensor approach.

6.5.3. Advances in game theory

Participants: Eitan Altman, Konstantin Avrachenkov, Vijay Kamble, Alonso Silva.

6.5.3.1. Foundations of evolutionary Games

In evolutionary games, various populations have an impact on each other through a large number of local interactions each involving a small number of players. Each such interaction defines a fitness that depends on the actions of each player involved. In [17], E. Altman, Y. Hayel, H. Tembine and R. El-Azouzi (UNIVERSITY OF AVIGNON) add a notion of individual state to these games and consider the situation in which an action of a player determines not only its immediate fitness in given stage but also the transition probabilities to the next state. The player no longer maximizes her/his immediate fitness but rather maximizes the expected average cummulated fitness over time. The authors define an appropriate notion of equilibrium and propose a way to compute it. Applications to energy management problems are described by [134].

6.5.3.2. Foundations of population Games

Population games are similar to evolutionary games with the difference that interactions are not any more local but involve a continuum of players. In [97], P. Wiecek (UNIVERSITY OF WROCLAW, Poland), E. Altman and Y. Hayel (UNIVERSITY OF AVIGNON) study a dynamic version of such games where each player has some individual state, and the actions of the player determine the transitions between the states. They use this formalism to solve a power control problem in a CDMA system (where all mobiles use the same spectrum of frequencies at the same time). To do so, they adapt the theory of anonymous sequential games by Jovanovic & Rosenthal, J Math. Econ, 1988.

6.5.3.3. Stochastic games with delay sharing information pattern

Non-cooperative game theory has gained much interest as a paradigm for decentralized control in communication networks. It allows one to get rid of the need for a centralized controller. Decentralizing the decision making may result in situations where agents (decision makers) do not have the same view of the network. The global view of the network state cannot be available to an agent as fast as the information on its local state. Incorporating into the decentralized control paradigm this information asymmetry renders it applicable to a much wider class of situations. In [47], E. Altman, V. Kamble and A. Silva model the above information asymmetry using the one-step delay sharing information pattern from team theory and generalize it to the context of non-cooperative games. They study its properties and apply it to a distributed power control problem.

6.5.4. Branching processes with queueing applications

Participant: Eitan Altman.

In the last several years, E. Altman has been developing the theory of branching processes with non-Markovian immigration process, and has been applying it to a large number of queueing problems: polling with correlated vacations, the infinite server with correlated arrivals and more. Branching processes can be written in the form $X_{n+1} = A_n(X_n) + B_n$ where B_n is the immigration and A_n is a subordinator (non-decreasing Lévy process) with the following central properties: (i) it is infinitely divisible and (ii) it has independent increments. In [13], E. Altman extends this class of processes by dropping the requirement of independent increments in the process $\{A_n\}_n$. The equations that define this new class are called "semi-linear stochastic difference equations". Explicit expressions for the first order-moments of X_n in steady-state under the weak assumption that the process $\{B_n\}$ is stationary and ergodic are derived.

6.5.5. Advances in queueing theory

Participant: Alain Jean-Marie.

In conjunction with A. Ben Tahar (UNIVERSITY HASSAN I, Settat, Morocco), A. Jean-Marie has completed the analysis of the fluid limits in the Multiclass Processor Sharing queue, extending it to the Discriminatory Processor Sharing service discipline. An analysis of the accuracy of fluid approximations has been added to the work [61], [113].

6.5.6. Stochastic scheduling

Participants: Konstantin Avrachenkov, Alain Jean-Marie, Natalia Osipova.

The problem of optimal service scheduling in queues with impatience has been considered by A. Jean-Marie and E. Hyon (UNIVERSITY OF PARIS X). The problem has been solved in [124] for a single-server, discrete-time queue with geometrically-distributed impatience. For this simple system, the optimal policy is "always serve" or "never serve", depending on a simple criterion on costs, the impatience probability and the discount factor.

In [21] K. Avrachenkov, P. Brown and N. Osipova (FRANCE TELECOM R&D) analyze the Two Level Processor Sharing (TLPS) scheduling discipline with the hyper-exponential job size distribution and with the Poisson arrival process. TLPS is a convenient model to study the benefit of the file size based differentiation in TCP/IP networks. In the case of the hyper-exponential job size distribution with two phases, the authors find a closed form analytic expression for the expected sojourn time and an approximation for the optimal value of the threshold that minimizes the expected sojourn time. In the case of the hyper-exponential job size distribution with more than two phases, the authors derive a tight upper bound for the expected sojourn time conditioned on the job size. It is shown that when the variance of the job size distribution increases, the gain in system performance increases and the sensitivity to the choice of the threshold near its optimal value decreases.

In [87] N. Osipova (FRANCE TELECOM R&D), U. Ayesta (LAAS-CNRS) and K. Avrachenkov apply the Gittins optimality result to characterize the optimal scheduling discipline in a multi-class M/G/1 queue. The authors apply the general result to several cases of practical interest where the service time distributions belong to the set of decreasing hazard rate distributions, like Pareto or hyper-exponential. When there is only one class it is known that the Least Attained Service (LAS) policy is optimal. The authors show that in the multi-class case the optimal policy is a priority discipline, where jobs of the various classes depending on their attained service are classified into several priority levels. The authors find that the Gittins policy can outperform by nearly 10% the LAS policy.

6.5.7. Singular perturbation theory

Participant: Konstantin Avrachenkov.

In [27] K. Avrachenkov, in cooperation with V. Ejov, P. Howlett (UNIVERSITY OF SOUTH AUSTRALIA, Australia) and C. Pearce (UNIVERSITY OF ADELAIDE, Australia), considers a bounded not necessarily compact linear operator $A(z)$ between Hilbert spaces which depends analytically on a perturbation parameter z. If $A(0)$ is singular the authors find conditions under which $A^{-1}(z)$ is well defined on some region $0 < |z| < b$ by a convergent Laurent series with a finite order pole at the origin. Under certain conditions the results can be extended to Banach spaces. The results can be applied to singularly perturbed Markov chains with continuous state space.

7. Contracts and Grants with Industry

7.1. ADR "Semantic Networking" and "Self Optimization in Wireless Networks" of INRIA Alcatel-Lucent Bell Labs. joint laboratory (2008–2011)

MAESTRO participates in the ADR (Action de Recherche/Research Action) "Semantic Networking" (SEMNET) and "Self Optimization in Wireless Networks" (SELFNET), two of the three ADRs of the INRIA ALCATEL-LUCENT BELL LABS joint laboratory. These ADRs started on Jan. 1st 2008 and will last for four years.

Pascale Vicat-Blanc Primet, head of INRIA project-team RESO, is the coordinator for INRIA of the ADR SEMNET and Bruno Gaujal, head of INRIA project-team MESCAL, is the coordinator for INRIA of the ADR SELFNET. ALTCATEL-LUCENT coordinators of ADRs SEMNET and SELFNET are Ludovic Noirie and Laurent Thomas, respectively.

http://inria.bell-labs.commonlab.homeip.net/.

7.1.1. ADR "Semantic Networking"

Participants: Sara Alouf, Eitan Altman, Konstantin Avrachenkov, Alberto Blanc, Philippe Nain.

The new paradigm of "semantic networking" for the networks of the future brings together "flow-based networking", "traffic-awareness" and "self-management" concepts to get "plug-and-play" networks. The natural traffic granularity is the flow. MAESTRO's task is to elaborate on the scheduling of flows in routers having in mind the fairness among flows with different round-trip times. A joint INRIA ACATEL-LUCENT patent has been filed in 2009 (inventors for INRIA: S. Alouf, K. Avrachenkov, D. Carra, P. Nain).

E. Altman participates with P. Vicat-Blanc Primet (INRIA project-team RESO) in the supervision of the Ph. D. thesis of Dinil Mon Divakaran (INRIA project-team RESO), which aims at evaluating the advantages of introducing very large packets that would coexist with other packets whose size will not change.

7.1.2. ADR "Self Optimizing Wireless Networks"

Participants: Eitan Altman, Sreenath Ramanath.

E. Altman is responsible for INRIA of the work package on the "Design of Pico Cell Networks" whose objective is to increase the capacity with lower energy requirements.

8. Other Grants and Activities

8.1. International initiatives

8.1.1. INRIA Associate Team DAWN - Distributed Algorithms for Wireless Networks (2008-2011)

Participants: Sara Alouf, Eitan Altman, Konstantin Avrachenkov, Amar Azad.

MAESTRO has privileged collaborations with the Indian Institute of Science at Bangalore, the Tata Institute of Fundamental Research at Mumbai, and the University of Pennsylvania, through the INRIA Associate Team "DAWN" (an INRIA program). DAWN stands for "Distributed Algorithms for Wireless Networks". It was launched on Jan. 1st, 2008.

DAWN involves three INRIA project-teams teams (MAESTRO, the coordinator, MESCAL and TREC) and three foreign teams. The main foreign team is the IISC (Bangalore, India) with Prof. A. Kumar (coordinator), Prof. R. Sundaresan, Prof. V. Sharma and Prof. A Chokalingam. Two other foreign teams are TIFR Mumbay with Prof. V. Borkar and the University of Pennsylvania with Prof. S. Sarkar.

DAWN focuses on "Emerging Strategies for Wireless Communication Networks". More specifically, the project objectives are to model, analyze, optimize and invent protocols for both cellular as well as ad hoc wireless network.

DAWN was created in the perspective of creating a joint laboratory between INRIA and IISC at Bangalore (see "Inedit" magazine No. 63. Bangalore: Managing connections on wireless networks).

http://www-sop.inria.fr/maestro/Equipe-Associee.html.

8.1.2. Australian Research Council Discovery Grant (2007-2009)

Participant: Konstantin Avrachenkov.

This is a bilateral collaboration between MAESTRO team and the School of Mathematics and Statistics of the University of South Australia. The topic of this collaboration is the development of new perturbation methods for solving singular operator equations with applications to Statistics and Complex System Analysis. K. Avrachenkov is the coordinator of this project.

8.2. European initiatives

8.2.1. ICT STREP ECODE (2008-2011)

Participants: Sara Alouf, Konstantin Avrachenkov, Giovanni Neglia, Natalia Osipova.

MAESTRO is a partner of the ICT European STREP Project ECODE on "Experimental COgnitive Distributed Engine". K. Avrachenkov is the coordinator for MAESTRO.

ECODE is a 3-year STREP project (running from Sept. 2008 to Aug. 2011) co-funded by the European Commission under the Framework Programme 7 (FP7), addressing the Strategic Objective ICT-2007-1.6 "New paradigms and experimental facilities". There are seven partners involved and MAESTRO, together with INRIA project-team PLANETE, is one of them.

The goal of the ECODE project is to develop, implement, and validate experimentally a cognitive routing system that can meet the challenges experienced by the Internet in terms of manageability and security, availability and accountability, as well as routing system scalability and quality. By combining both networking and machine learning research fields, the resulting cognitive routing system fundamentally revisits the capabilities of the Internet networking layer so as to address these challenges altogether. MAESTRO's task is to design and evaluate flow management schemes that can deal with potentially sampled traffic information.

http://www.ecode-project.eu/.

8.2.2. IST FET IP BIONETS (2006-2009)

Participants: Sara Alouf, Eitan Altman, Konstantin Avrachenkov, Philippe Nain, Giovanni Neglia, Danil Nemirovsky, Giuseppe Reina, Alonso Silva.

MAESTRO is a partner of the IST FET European Integrated Project BIONETSon "BIOlogically-inspired autonomic NETworks and Services". E. Altman is the coordinator of the work package on "Paradigm Collection and Foundations".

BIONETS is a project belonging to the IST FET Proactive Initiative Program on "Situated and Autonomic Communication". There are sixteen partners involved and MAESTRO, together with INRIA project-team OASIS and colleagues from INSTITUT EURECOM, is one of them. BIONETSis planned for four years and started on Jan. 1st 2006.

BIONETSspecializes on the design of protocols that will allow evolution of services over a self-organizing wireless network that contains a huge amount of cheap sensors, as well as a limited number of intelligent terminals. The project proposes an inter-disciplinary strategy for designing such networks (called bionets) by using methods and tools from biology, physics, economics. MAESTRO's task is to collect such tools and to adapt them to BIONETS.

http://www.bionets.eu/.

8.2.3. Network of Excellence: Euro-NF (2008-2009)

Participants: Eitan Altman, Konstantin Avrachenkov, Philippe Nain, Giovanni Neglia.

MAESTRO is a member of the Network of Excellence (NoE) EUROFGI/NF which is a continuation of the EURONGI Network of Excellence on "Design and Engineering of the Next Generation Internet, Towards Convergent Multi-Service Networks" (see 2004-2007 MAESTRO activity reports).

http://euronf.enst.fr/.

8.2.4. EGIDE ECO-NET Project "Game theory for Wireless Networks" (2008–2009)

Participants: Konstantin Avrachenkov, Giovanni Neglia.

In this EGIDE ECO-NET project, MAESTRO collaborates with St. Petersburg State University and Erevan State University on the application of game theory methods to wireless networks. A number of exchange visits have taken place among the three institutions. K. Avrachenkov is the coordinator of this project.

8.3. National initiatives

8.3.1. ANR Verso ECOSCELLS (11/2009–10/2012)

Participants: Eitan Altman, Konstantin Avrachenkov, Philippe Nain.

ANR VERSO ECOSCELLS (Efficient Cooperating Small Cells) aims at developing algorithms and solutions which will be required for the deployment of small cell networks. The theoretical studies will define and solve the models needed to understand the behavior of radio channels, and will design the algorithms which will allow the exploitation of the diversity (user, spatial, interference, etc.) in these networks. The consortium gathers two main industrial groups in the telecommunication domain (ALCATEL-LUCENT BELL LABS (leader) and ORANGE LABS.), together with three leading SMEs (3ROAM, SEQUANS and SIRADEL) and six academic partners (UNIVERSITY OF AVIGNON, INRIA through its project-teams MAESTRO, MASCOTTE and SWING, INSTITUT EURECOM, LAAS-CNRS and LABORATOIRE DES SIGNAUX ET SYSTÈMES/SUPELEC).

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

8.3.2. ANR Télécommunications WINEM (2007–2010)

Participants: Sara Alouf, Eitan Altman, Amar Azad, Vincenzo Mancuso.

This project, called WINEM, for "WiMAX Network Engineering and Multihoming," started on Dec. 1st, 2006. Initially planned for three years, the project has been granted an extension until May 31st, 2010. After the withdrawal of Motorola from the project and the increased interest for LTE (Long-Term Evolution), the objectives of the project have been updated. The focus will be on: evaluating the coverage and capacity when relaying is possible, optimal joint radio resource management, evaluating energy saving mechanisms, and integrating the WiMAX simulators SimulX and Odyssée. The project's current partners are: FRANCE TELECOM R&D, INSTITUT TELECOM (ENST Bretagne and INT), INRIA (INRIA project-teams DYONISOS and MAESTRO), INSTITUT EURECOM, and LIA (University of Avignon).

S. Alouf is the coordinator for INRIA.

http://www.lia.univ-avignon.fr/index.php?id=502.

8.3.3. ANR Multimedia VOODDO (2008–2010)

Participants: Anne-Elisabeth Baert, Alain Jean-Marie.

Members of MAESTRO participate in this research project, coordinated by the VODDNET company, and involving researchers of the LIRMM (University of Montpellier II and CNRS). The global objective of this project is the development of an innovative visualization interface for video contents, based on a safe, reliable and optimized storage and transport infrastructure. The architecture of this infrastructure, named "Grid Delivery Network" has been defined by VODDNET. Challenging problems of data distribution and real-time control of the platform are at the heart of this project.

8.3.4. INRIA Cooperative Research Initiative (ARC) POPEYE (2008-2010)

Participants: Eitan Altman, Konstantin Avrachenkov, Alain Jean-Marie.

The ARC POPEYE focuses on the behavior of large complex systems that involve interactions among one or more populations. "Population" refers to a large set of individuals, that may be modeled as individual agents, but that will be often modeled as a continuum of non-atomic agents. The project brings together researchers from different disciplines: computer science and network engineering, applied mathematics, economics and biology. This interdisciplinary collaborative research aims at developing new theoretical tools as well as at their applications to dynamic and spatial aspects of populations that arise in various disciplines, with a particular focus on biology and networking.

There are three INRIA project-teams participating in this project (MAESTRO, MESCAL and TOSCA), three INRA groups (Biostatistics and Spatial Processes group in Avignon, Ecology of Insect Pararasitoids group in Sophia-Antipolis, LAMETA group in Montpellier) and three groups from universities (Combinatorics and Optimization group from the University of Pierre and Marie Curie in Paris, LIA from University of Avignon, and I3S from University of Nice Sophia Antipolis).

E. Altman and A. Jean-Marie coordinate the ARC POPEYE.

http://www-sop.inria.fr/maestro/POPEYE/home.html.

8.3.5. INRIA Sophia Antipolis - Méditerranée Local Cooperative Initiative (COLOR) CRASQUIDEM (2009)

Participants: Utku Acer, Giovanni Neglia, Leonardo Rocha.

In Delay Tolerant Networks (DTNs) information delivery is based on the store-carry-forward paradigm: a mobile node first stores the routing message from the source, carries it from a physical location to another and then forwards it to another intermediate node or to the destination. Most of the research on routing in DTNs has focused on two extreme cases, when 1) contacts among nodes are deterministic and known in advance, or 2) when they cannot be predicted and are supposed to obey some generic random mobility model. Many interesting scenarios do not fall in any of these two cases because the underlying node mobility is known in advance but can be modified by random effects. We refer to such networks as "quasi-deterministic" DTNs. The project CRASQUIDEM (Communication, Routing And Scheduling under QUasI DEterministic Mobility) aims at addressing the problem of message routing and scheduling in quasi-deterministic DTNs, bringing together two research teams – MAESTRO and Telecommunication Networks Group of Politecnico di Torino – with complementary competences on routing for DTNs under classical random mobility models and known deterministic contact times, respectively.

http://www-sop.inria.fr/maestro/crasquidem/

8.4. Invited scientists

Europe:

Samuli Aalto (TKK Helsinki University, Finland, 03/23/09-03/28/09),
Francesco De Pellegrini (CREATE-NET, Trentino, Italy 03/22/09-03/28/09),
Jocelyne Elias (Polytechnic school of Milano, Italy, 07/01/09–11/15/09),
Andrey Garnaev (St. Petersburg State University, Russia, 05/20/09–06/03/09 and 11/15/09–11/21/09),
Paolo Giaccone (Polytechnic school of Torino, Italy, 03/26/09–03/27/09),
David Hay (Polytechnic school of Torino, Italy, 03/26/09–03/27/09, 06/09/09–06/14/09 and 07/14/09–07/19/09),
Fabio Martignon (Faculty of Engineering of the University of Bergamo, Italy, 07/01/09–11/15/09),
Marco Mellia (Polytechnic school of Torino, Italy, 03/26/09–03/27/09),
Boris Miller (Russian Academy of Sciences, Moscow, Russia, 11/03/09–11/06/09),
Evsey Morozov (Russian Academy of Sciences, Russia, 11/08/09–11/15/09),
Leon Petrosyan (St. Petersburg State University, Russia, 07/27/09–08/07/09),
Alexei Piunovskiy (University of Liverpool, UK, 06/10/09–06/16/09),
Piotr Wiecek (Wroclaw University of Techonology, Poland, 03/09/09–06/30/09).

America:

Tamer Başar (University of Illinois at Urbana-Champaign, USA, 03/19/09– 03/29/09),
George Kesidis (The Pennsylvania State University, USA, 12/03/09–12/15/09),
Vishal Misra (Columbia University, New York, USA, 02/02/09–04/30/09),
Don Towsley (University of Massachusetts, USA, 01/25/09–02/01/09).

Maghreb, Middle-East:

Nahum Shimkin (Technion, Haifa, Israel, 09/10/09–09/19/09),
Vahan Avetisyan (Yerevan State University, Armenia, 07/27/09–08/03/09),
Adam Shwartz (Technion, Haifa, Israel, 11/14/09–12/31/09).

Asia:

Vivek Borkar (TATA Institute of Fundamental Research, Bumbai, India, 12/05/09-12/14/09).

Oceania:

Vladimir Ejov (University of South Australia, Adelaide, Australia, 04/22/09-05/01/09),
Jerzy Filar (University of South Australia, Adelaide, Australia, 06/28/09–07/05/09).

8.5. Visits of Maestro staff to other research institutions

E. Altman within the Associate Team DAWN, visited IISC and TIFR (collaboration with A. Kumar, V. Sharma, V. Borkar, R. Sundaresan, 01/25/09–07/02/09, Bangalore and Mumbay, India)

K. Avrachenkov visited A. Piunovskiy at the University of Liverpool in the context of EGIDE "Alliance" programme (one week in January 2009), U. Ayesta at LAAS(few days in Februrary and in December), N. Litvak at the University of Twente (one week in May 2009 and one week in November 2009), and the School of Mathematics and Statistics at the University of South Australia (one month in October 2009).

A. P. Azad within the Associate Team DAWN, visited TIFR (V. Borkar, 30/01/09–20/02/09, Mumbay, India). T. Başar at the University of Illinois at Urbana-Champaign (UIUC) (04/13/09 – 05/05/09) within collaboration program with UIUC and CREATE-NET(Italy, on October 12, 2009) within the BIONETSeuropean project.

A. Jean-Marie visited the Department of Economics of the University of Valladolid, Spain (November 23–27, 2009).

V. Kavitha within the Associate Team DAWN, visited IISC(collaboration with V. Sharma and R. Sundaresan, 18/12/09–17/01/10, Bangalore, India)

G. Neglia visited the Telecommunication Networks Group of the Politecnico di Torino, Italy, from 29 June until 3 July 2009.

D. Nemirovsky visited V. Dobrynin at St. Petersburg State University, St. Petersburg, Russia (Dec. 15, 2008 – June 6, 2009) and N. Litvak at the University of Twente, Enschede, the Netherlands (11/30/09 – 12/03/09).

S. Ramanath within the Associate Team DAWN, visited IISC (collaboration with V. Sharma and R. Sundaresan, 18/12/09–17/01/10, Bangalore, India)

A. Silva visited C. Jimenez at the "Laboratoire de Mathématique de l'Université de Bretagne Occidentale", France (09/28/09–09/29/09), O. Ryan in the Center of Mathematics for Applications at the University of Oslo, Norway (11/23-09–11/27/09) and P. Thiran at the School of Computer and Communication Sciences of EPFL, Switzerland (12/10/09–12/11/09).

9. Dissemination

9.1. Leadership within scientific community

9.1.1. Editorial activities

E. Altman is the Editor-in-Chief of *ICST Transactions on Network Optimization and Control* and an Associate Editor of *Journal of Economics, Dynamics and Control* (JEDC), *ACM/Kluwer Wireless Networks* (WINET) and of *Journal of Discrete Event Dynamic Systems* (JDEDS), and *Computer Communications* (COMCOM) Elsevier.

K. Avrachenkov is an Editor of *Performance Evaluation* and an Invited Editor of *LNCS no.5427: Algorithms and Models for the Web-Graph* [107].

A. Jean-Marie is an Associate Editor for *RAIRO Operations Research*.

P. Nain is the Editor-in-Chief of *Performance Evaluation* and an Associate Editor of *Operations Research Letters*.

9.1.2. Participation in technical program committees

S. Alouf was a program committee member of the following conferences:

- ACM SIGMETRICS/Performance 2009 (June 15–19, 2009, Seattle, Washington, USA).
- 7th Intl. Symposium on Modeling and Optimization in Mobile, Ad Hoc, and Wireless Networks (WiOpt 2009) (June 23–25, 2009, Seoul, Korea).
- 16th International Conference on Analytical and Stochastic Modelling Techniques and Applications (ASMTA 2009) (June 9–12, 2009, Madrid, Spain).
- 18th International Conference on Computer Communications and Networks (ICCCN 2009) track on Network Algorithms and Performance Evaluation (NAPE) (August 3–6, 2009, San Francisco, California, USA).

E. Altman was a program committee member of the following conferences:

- International Teletraffic Conference, Paris, 15-18 Sept, 2009
- 6th International Workshop on Internet Charging and QoS Technologies ICQT 2009, Aachen, Germany on the 15th of May 2009
- Workshop on The Economics of Networks, Systems, and Computation (NetEcon'09)
- The Sixth International Conference on Wireless On-demand Network Systems and Services, WONS 2009, February 2-4, 2009. Snowbird, Utah, USA

- 2nd Euro-NF Workshop and Future Internet Cluster meeting 9nd June 2009, Santander, Spain.
- International Workshop on Network Simulation Tools, (NStools) 2009, 19 October - Pisa, Italy.
- RAWNET/WNC3 2009, The 5th workshop on Resource Allocation, Cooperation and Competition in Wireless Networks, 27 June 2009, Seoul, Korea

K. Avrachenkov was a program committee member of the following conferences:

- The ICST 4th International Conference on Performance Evaluation Methodologies and Tools (ValueTools 2009), 22-23 October, Pisa, Italy;
- The The 3rd International Workshop on Game Theory in Communication Networks (GameComm 2009), 23 October, Pisa, Italy;
- The 2nd International Workshop on Multiple Access Communications (MACOM 2009), 14 June, Dresden, Germany;
- Euro-NF International Conference on Network Control and Optimization (NET-COOP 2009), 23-25 November, Eindhoven, The Netherlands;
- The 9th International Conference on Next Generation Wired/Wireless Networking (NEW2AN 2009), 15-18 September, St. Petersburg, Russia;
- The 1st International Conference on Advances in Future Internet (AFIN 2009), June 18-23, Athens/Glyfada, Greece.

A. Jean-Marie was a program committee member of the following conferences:

- 11th Workshop on Mathematical performance Modeling and Analysis (MAMA 2009) (June 15, 2009 - Seattle, WA, USA).
- 2nd Network Simulation Tools Workshop in conjunction VALUETOOLS'09 (October 19, 2009 - Pisa, Italy).

P. Nain was a program committee member of

- 11th Workshop on Mathematical performance Modeling and Analysis (MAMA 2009) (June 15, 2009 - Seattle, WA, USA).

G. Neglia was a program committee member of the following conferences:

- IEEE INFOCOM 2010 main conference and INFOCOM 2010 Work In Progress Track (March 15–19, 2010, San Diego, CA, USA).
- IEEE ICCCN 2009 (August 2–9, 2009, San Francisco, CA, USA).
- ICST WiOpt 2009 (June 23–25, 2009, Seoul, Korea)

9.1.3. Conferences, meetings and tutorial organization

S. Alouf was the Publicity Chair of ACM SIGMETRICS 2010 (June 14-18, 2010, Columbia University, New York, USA).

E. Altman participated in the Steering Committee of the following conferences:

- *8th International Symposium on Modeling and Optimization in Mobile, Ad Hoc, and Wireless Networks* (WiOpt 2009), Seoul, South Korea,
- *4th International Conference on Performance Evaluation Methodologies and Tools* (VALUETOOLS 2009), Pisa, Italy.
- *3rd Euro-NF Workshop on Network Control and Optimization* (NET-COOP 2009) Eindhoven, The Netherlands, 23-25 November 2009.

He was the general chair of Bionetics 2009, Dec. 9-11, 2009, Avignon, France.

K. Avrachenkov was the Co-Chair of the 6th Workshop on Algorithms and Models for the Web Graph (WAW2009) and the 5th workshop on Resource Allocation, Cooperation and Competition in Wireless Networks (RAWNET/WNC3 2009). He was also a co-organizer of the invited session "Stochastic-Deterministic Vinculum" at the 53rd Australian Mathematical Society Conference (AustMS 2009).

9.1.4. Participation in thesis committees

E. Altman was a member of the thesis committee of Ali Ibrahim (October 6, 2009, Orange-Lab, Issy Les Moulineaux).

K. Avrachenkov participated in the Ph. D. thesis committees of Hamidou Tembine (September 18, 2009, University of Avignon).

P. Nain was a reviewer of the Ph. D. thesis of Alessandro Duminuco (October 20, 2009, INSTITUT EURECOM).

9.1.5. Ph. D. theses

The following Ph. D. thesis was defended in 2009:

Natalia Osipova, Ph. D. Thesis from the University of Nice Sophia Antipolis: "Improving Resource Sharing in Computer Networks with Stochastic Scheduling". Graduation on March 27, 2009. Advisor: K. Avrachenkov.

9.1.6. Research administration

S. Alouf is a member of the Doctoral Committee of INRIA Sophia Antipolis.

A.-E. Baert

- is a member of the Recruiting Committee in Computer Science at the University of Montpellier II.
- was in charge of the Master in Combinatorics, Algorithms, Security and Administration of Networks at the University of Montpellier II.

A. Jean-Marie

- is the scientific coordinator of INRIA activities in Montpellier.
- heads the Local Research Collaborations Committee (COLOR) of INRIA Sophia Antipolis - Méditerranée.
- is co-head of the APR (Algorithms and Performance of Networks) project-team of the LIRMM Laboratory, a joint research unit of CNRS and the University of Montpellier II.
- was a member of the Recruiting Committee in Computer Science at the University of Avignon.
- is a member of the Steering Committee of the GDR RO, a national research initiative on Operations Research sponsored by the CNRS.

P. Nain

- is the Scientific Deputy of the Research Center of INRIA Sophia Antipolis - Méditerranée and the Chair of its Project-team Committee (since Sept. 1st, 2007).
- is Head of project-team MAESTRO.
- is a member of the management of the Research Center of INRIA Sophia Antipolis - Méditerranée.
- is a member of the Evaluation Committee of INRIA.

- was a member of the Recruiting Committee ofINRIA junior research scientists (CR2 and CR1) at INRIASophia Antipolis - Méditerranée and a member of the Recruiting Committee of a teaching assistant (maître de conférence) at the University of Nice - Sophia Antipolis (INRIA/UNS/JAD chair in "Médecine Numérique).

9.1.7. Miscellaneous (nominations, awards, etc.)

- E. Altman has been nominated *IEEE Fellow* "for contributions to analysis, optimization, and control of telecommunication networks".
- A. Azad, S. Alouf and E. Altman received the *Best Paper Award* of the IFIP Wireless Days 2009 (Paris, 15-17 December 2009) ([58]).
- E. Altman, A. Jean-Marie and P. Nain are (elected) members of IFIP WG7.3 on "Computer System Modeling".
- E. Altman is the chairman of the steering committee of WiOpt.
- P. Nain is the Vice-Chair of the IFIP WG7.3 working group on "Computer System Modeling" and a Member of the Board of Directors of SIGMETRICS (elected for the period June 30, 2007 – July 1, 2009).

9.2. Teaching

S. Alouf was in charge of the course on "Probability and Statistics" in the Engineering Program in the Polytech'Nice Sophia Antipolis School (11hrs of lecture, 28hrs of assignments). She also delivered 3hrs of lecture at Leonard de Vinci High School during the event "La fête de la Science."

A. Dandoush participated as a "moniteur" in the course on "Networking and System Architecture" in the Bachelor Program on "Computer Science" at the IUT of Nice Sophia Antipolis (66hrs).

A. Jean-Marie taught a course on "Evaluation of Performance" (15hrs), and one on "Metrology and Quality of Service for Networks" (25hrs), both in the Master in Computer Science of the University of Montpellier II.

P. Nain taught a course on "Performance Evaluation of Networks" (Master IFI, specialty Ubinet, PolytechNice-Sophia, 21hrs).

G. Neglia taught courses in "Probability and Statistics" (PolytechNice-Sophia, 2hrs of lectures, 24hrs of assignments) and in "Performance Evaluation of Networks" (Master IFI, specialty Ubinet, PolytechNice-Sophia, 6hrs). He also taught the course "Overlay and P2P networks", refresher course for researchers and technicians of the Sicilian Electronic Research Center in the framework of Smartlab, a project supported by the Italian ministry for Research and University (16th March – 15th April, 30hrs).

D. Nemirovsky taught the course on "Mathematical Modeling in Networks" at St. Petersburg State University (15hrs of lecture, 2hrs of homework).

9.3. Participation in scientific events

9.3.1. Technical program commitee meetings

ACM SIGMETRICS 2009, Jan. 29–30, 2009, New York City, New York, USA: attended by A. Jean-Marie.

IEEE INFOCOM 2010, Nov. 14, 2009, Los Angeles, California, USA: attended by G. Neglia.

9.3.2. Conferences and workshops

S. Alouf gave a presentation at IFIP Wireless Days 2009 (December 15–17, 2009, Paris, France).

E. Altman gave presentations at the *Conference on Electronic Commerce* (NAEC 2009, October 8–11, 2009, Riva de Garda, Italy), the *4th International Conference on Bio-Inspired Models of Network, Information, and Computing Systems* (Bionetics 2009, December 9–11, 2009, Avignon, France), the *International Conference on Game Theory for Networks* (GameNets 2009, March 13–15, 2009, Istanbul, Turkey), the *Workshop in Honor of O.J. Boxma* (June 3–4, Haifa, Israel) and the *Third Workshop on Network Control and Optimization* (NET-COOP 2009, November 23–25, 2009, Eindhoven, The Netherlands). He also presented papers at the French Pre-Infocom 2009 meeting (April 2009, Paris).

K. Avrachenkov gave presentations at WAW 2009 (12-13 February, Barcelona), GameNets 2009 (13–15 May, Istanbul), AustMath 2009 (28 September–1 October) and NET-COOP 2009 (November 23–25).

A. P. Azad gave presentations at the *Conference on Electronic Commerce* (NAEC 2009) (October 8–11, 2009, Riva de Garda, Italy) and at the *48th IEEE Conference on Decision and Control* (CDC 2009) (December 16–18, 2009, Shanghai, CHina).

A. Blanc gave presentations at the IFIP/TC6 NETWORKING 2009 (May 11–15, 2009, Aachen, Germany), the *International Workshop on Protocols for Future, Large-Scale and Diverse Network Transports* (PFLDNeT 2009, May 21–22, Tokyo, Japan) and the *EuroNF Workshop on Traffic Management and Traffic Engineering for the Future Internet* (EuroNFTraf09, December 7–8, Paris, France) and attended the *2nd INRIA - Bell Labs Workshop on the Fundamentals of Communications and Networking* (October 22-23, Rocquencourt, France).

A. Dandoush gave presentations at the IFIP/TC6 NETWORKING 2009 (May 11–15, 2009, Aachen, Germany), the *21th International Teletraffic Congress* (ITC 2009, September 19–21, Paris, France) and the *2nd International Workshop on Network Simulation Tools* (NsTools 2009, October 19, Pisa, Italy) held in conjunction with the *4th International Conference on Performance Evaluation Methodologies and Tools* (VALUETOOLS 2009).

A. Jean-Marie gave a presentation at the *Fourth International Conference on Performance Evaluation Methodologies and Tools* (VALUETOOLS 2009, Oct. 20–22, 2009, Pisa, Italy). He attended the *2nd Workshop on Dynamic Games in Management Science*, Valladolid, Jun. 29–30, 2009, Valladolid, Spain).

V. Kavitha gave a presentation at the *21th International Teletraffic Congress* (ITC 2009, September 19–21, 2009, Paris, France).

P. Nain gave in invited lecture at the BELL LABS – INRIA Workshop (June 1-2, Murray Hill, NJ, USA) on "Fundamentals of Communications and Networking". While attending the ACM Sigmetrics 2009 conference (Seattle, WA, USA, June 15-19) he participated in the ACM Sigmetrics Executive Committee meeting.

G. Neglia gave presentations at the Italian Networking Research workshop (Jan. 14–16, 2009, Cortina d'Ampezzo, Italy), at INFOCOM 2009 (Apr. 19–25, 2009, Rio de Janeiro, Brazil), at the INRIA-NICTA workshop (Dec. 8–10 2009, Sophia Antipolis, France), at BIONETICS 2009 (Dec. 9–11, 2009, Avignon, France), at Wireless Days 2009 (Dec. 15–17, 2009, Paris, France).

N. Osipova gave a presentation at the *21th International Teletraffic Congress* (ITC 2009, September 19–21, Paris, France)

S. Ramanath gave a presentation at the *22nd World wireless Research Forum* (May 5–7 2009, Paris, France).

A. Silva gave a presentation at the *International Conference on Game Theory for Networks* (GameNets 2009, March 13–15, 2009, Istanbul, Turkey).

9.3.3. Invited talks

E. Altman was an invited speaker at the *Third Workshop on Network Control and Optimization* (NET-COOP 2009) (November 23–25, 2009, Eindhoven, The Netherlands), the *Workshop in Honor of O.J. Boxma* (June 3–4, Haifa, Israel) and at the *4th International Conference on Bio-Inspired Models of Network, Information, and Computing Systems* (Bionetics 2009) (December 9-11, 2009, Avignon, France).

S. Alouf was an invited speaker at "Les Doctoriales" seminar organized by the DGA, Polytechnic School and ParisTech (September 24, 2009, Fréjus, France).

K. Avrachenkov gave invited talks on "Monte Carlo Methods for PageRank Computation" at BCAM (Basque Center for Applied Mathematics, September 8, 2009) and on "Monte Carlo Methods for Personalized PageRank" at PageRank Matrix Days (December 11, 2009, Toulouse).

A. Blanc gave presentations at INSA Lyon (April 20, Lyon, France) and at ENS Lyon (May 27, 2009, Lyon, France).

P. Nain gave in invited lecture at the BELL LABS – INRIA Workshop (June 1-2, Murray Hill, NJ, USA) on "Fundamentals of Communications and Networking".

G. Neglia gave a presentation at the Telecommunication Networks Group of Politecnico di Torino (June 29, 2009, Turin, Italy).

9.3.4. Seminars and meetings related to projects

Second seminar of the INRIA ACATEL-LUCENT joint laboratory, January 15–16, 2009, Paris, France: attended by S. Alouf, E. Altman, K. Avrachenkov, A. Blanc, and S. Ramanath. Presentation by S. Ramanath.

Plenary meeting of ECODE, February 9–11, 2009, Toulouse, France: attended by K. Avrachenkov.

ARC POPEYE seminar, meeting on game theory. February 10, 2009. Avignon, France: attended by and presentations by E. Altman and A. Jean-Marie.

Third review of BIONETS, March 2–4, 2009, Venice, Italy: attended by E. Altman.

ARC POPEYE seminar, meeting on population models and game theory. April 9, 2009, Avignon, France: attended by and presentations by E. Altman, A. Azad, and A. Jean-Marie,

Seventh BIONETSJoint Workpackage Meeting, May 12–15, 2009, Budapest, Hungary: attended by A. P. Azad.

Meeting of ANR WINEM, May 17–18, 2009, Rennes, France: attended by S. Alouf.

Bell Labs Open Days, June 2–5, 2009, Villarceaux, France: attended by and presentations by S. Alouf, K. Avrachenkov, and A. Blanc.

Third seminar of the INRIA ACATEL-LUCENT joint laboratory, October 20–21, 2009, Rocquencourt, France: attended by S. Alouf, E. Altman, A. Blanc, and M. Sokol. Presentations by A. Blanc and E. Altman.

ANR WINEM seminar, October 29–30, 2009, Avignon, France: attended by S. Alouf, E. Altman, A. P. Azad, and V. Mancuso. Presentation by E. Altman.

ANRECOSCELLS kickoff meeting, November 9, 2009, Avignon, France: attended by E. Altman and K. Avrachenkov.

Eighth BIONETSJoint Workpackage Meeting, December 5–6, 2009, Avignon, France: attended by E. Altman and A. P. Azad.

9.3.5. Schools and students workshops

Euro-NF Ph. D. Course (20H, 3 ECTS), April 16–22, 2009, Vienna, Austria: attended by A. Dandoush, D. Nemirovsky. Course title "Stochastic Simulation for Performace Evaluation of Telecommunication Networks."

Euro-NF Ph. D. Course (26H, 4 ECTS), October 6–9, 2009, Milan, Italy: attended by D. Nemirovsky. Course title “Advances in Sensor Networks.”

10. Bibliography

Major publications by the team in recent years

[1] S. ALOUF, E. ALTMAN, J. GALTIER, J.-F. LALANDE, C. TOUATI. *Quasi-Optimal Resource Allocation in Multi-Spot MFTDMA Satellite Networks*, in "Combinatorial Optimization in Communication Networks", M. X. CHENG, Y. LI, D.-Z. DU (editors), chap. 12, Kluwer Academic Publishers, 2006, p. 325–366, http://www.springer.com/computer/communications/book/978-0-387-29025-6.

[2] E. ALTMAN. *Constrained Markov Decision Processes*, Chapman and Hall/CRC, 30 March 1999, http://www.crcpress.com/product/isbn/9780849303821.

[3] E. ALTMAN, D. FIEMS. *Expected Waiting Time in Symmetric Polling Systems with Correlated Vacations*, in "Queueing Systems – Theory and Applications", vol. 56, n^{o} 3-4, August 2007, p. 241–253, http://www.springerlink.com/content/r06m431pt3xv6159/.

[4] K. AVRACHENKOV, U. AYESTA, P. BROWN, R. NÚÑEZ QUEIJA. *Discriminatory Processor Sharing Revisited*, in "Proc. of IEEE Infocom 2005, Miami, FL, USA", vol. 2, 13-17 March 2005, p. 784–795, http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=1498310.

[5] K. AVRACHENKOV, D. LEBEDEV. *PageRank of Scale Free Growing Networks*, in "Internet Mathematics", vol. 3, n^{o} 2, 2006, p. 243–267, http://akpeters.metapress.com/content/57710046386m7jx0/.

[6] F. CLÉVENOT, P. NAIN, K. W. ROSS. *Stochastic Fluid Models for Cache Clusters*, in "Performance Evaluation", vol. 59, n^{o} 1, January 2005, p. 1–18, http://linkinghub.elsevier.com/retrieve/pii/S0166531604000549.

[7] C. FIGUIÈRES, A. JEAN-MARIE, N. QUÉROU, M. TIDBALL. *Theory of Conjectural Variations*, World Scientific Publishing, February 2004, http://hal-lirmm.ccsd.cnrs.fr/lirmm-00109155.

[8] R. GROENEVELT, P. NAIN, G. KOOLE. *Message Delay in Mobile Ad Hoc Networks*, in "Performance Evaluation", vol. 62, n^{o} 1-4, 2005, p. 210–228, http://linkinghub.elsevier.com/retrieve/pii/S0166531605000970, Proc. of Performance 2005, Juan-les-Pins, France, 3-7 October 2005.

[9] A. KUMAR, E. ALTMAN, D. MIORANDI, M. GOYAL. *New Insights From a Fixed-Point Analysis of Single Cell IEEE 802.11 WLANs*, in "IEEE/ACM Transactions on Networking", vol. 15, n^{o} 3, June 2007, p. 588–601, http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=4237146.

[10] P. NAIN, D. TOWSLEY, B. LIU, Z. LIU. *Properties of Random Direction Models*, in "Proc. of IEEE Infocom 2005, Miami, FL, USA", vol. 3, 13-17 March 2005, p. 1897–1907, http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=1498468.

[11] X. ZHANG, G. NEGLIA, J. KUROSE, D. TOWSLEY. *Performance Modeling of Epidemic Routing*, in "Elsevier Computer Networks", vol. 51, n^{o} 10, July 2007, p. 2867–2891, http://dx.doi.org/10.1016/j.comnet.2006.11.028US.

Year Publications

Doctoral Dissertations and Habilitation Theses

[12] N. OSIPOVA. *Improving Resource Sharing in Computer Networks with Stochastic Scheduling*, University of Nice Sophia Antipolis, 27 March 2009, https://sites.google.com/site/osipovanb/Home/publications/Osipova_thesis.pdf?attredirects=0, Ph. D. Thesis.

Articles in International Peer-Reviewed Journal

[13] E. ALTMAN. *Semi-Linear Stochastic Difference Equations*, in "Discrete Event Dynamic Systems", vol. 19, n^{o} 1, March 2009, p. 115–136, http://www.springerlink.com/content/74J1648808K67841/.

[14] E. ALTMAN, K. AVRACHENKOV, A. GARNAEV. *Fair Resource Allocation in Wireless Networks in the Presence of a Jammer*, in "Performance Evaluation", vol. In Press, Corrected Proof, Available online 11 August 2009, 2009, http://linkinghub.elsevier.com/retrieve/pii/S0166531609001035 RU .

[15] E. ALTMAN, K. AVRACHENKOV, I. MENACHE, G. MILLER, B. PRABHU, A. SHWARTZ. *Dynamic Discrete Power Control in Cellular Networks*, in "IEEE Transactions on Automatic Control", vol. 54, n^{o} 10, October 2009, p. 2328–2340, http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=5247012 IL RU US .

[16] E. ALTMAN, R. EL-AZOUZI, Y. HAYEL, H. TEMBINE. *The Evolution of Transport Protocols: An Evolutionary Game Perspective*, in "Computer Networks", vol. 53, n^{o} 10, 14 July 2009, p. 1751–1759, http://linkinghub.elsevier.com/retrieve/pii/S1389128608004337, Special Issue on Autonomic and Self-Organizing Systems.

[17] E. ALTMAN, Y. HAYEL, H. TEMBINE, R. EL-AZOUZI. *Markov Decision Evolutionary Games with Expected Average Fitness*, in "Evolutionary Ecology Research", vol. 11, n^{o} 4, May 2009, Special Issue in Honor of Tom Vincent.

[18] E. ALTMAN, A. SILVA, P. BERNHARD, M. DEBBAH. *Continuum Equilibria for Routing in Dense Static Ad-hoc Networks*, in "Computer Networks", vol. In Press, Corrected Proof, Available online 1 November 2009, 2009, http://www.sciencedirect.com/science/article/B6VRG-4XKHDF8-2/2/3982b7360ee14695d91b625c4e066c84, Special Issue on Interdisciplinary Paradigms for Networking.

[19] E. ALTMAN, E. SOLAN. *Constrained games: The Impact of the Attitude to Adversary's Constraints*, in "IEEE Transactions on Automatic Control", vol. 54, n^{o} 10, October 2009, p. 2435–2440, http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=5256135 IL .

[20] E. ALTMAN, T. BAŞAR, F. DE PELLEGRINI. *Optimal Monotone Forwarding Policies in Delay Tolerant Mobile Ad Hoc Networks*, in "Performance Evaluation", vol. In Press, Corrected Proof, Available online 16 September 2009, 2009, http://linkinghub.elsevier.com/retrieve/pii/S0166531609001187 US IT .

[21] K. AVRACHENKOV, P. BROWN, N. OSIPOVA. *Optimal Choice of Threshold in Two Level Processor Sharing*, in "Annals of Operations Research", vol. 170, n^{o} 1, September 2009, p. 21–39, http://www.springerlink.com/content/w67p672720048921/.

[22] K. AVRACHENKOV, N. LITVAK, S. K. PHAM. *A Singular Perturbation Approach for Choosing the PageRank Damping Factor*, in "Internet Mathematics", vol. 5, n^{o} 1–2, September 2009, p. 47–69, http://akpeters.metapress.com/content/8725rn8r73716773/ RU NL .

[23] A.-E. BAERT, V. BOUDET, A. JEAN-MARIE. *Data Replication Optimisation in Grid Delivery Network*, in "International Journal of Grid and Utility Computing", vol. 1, n^{o} 4, October 2009, p. 287–295, http://hal-lirmm.ccsd.cnrs.fr/lirmm-00303672/en/.

[24] A.-E. BAERT, V. BOUDET, X. ROCHE, A. JEAN-MARIE. *Minimization of Variance Download Times in a Distributed VOD System*, in "Scalable Computing: Practice and Experience (SCPE)", vol. 10, n^{o} 1, March 2009, p. 75–86, http://hal-lirmm.ccsd.cnrs.fr/lirmm-00338810/en/, Special Issue on Simulation in Emergent Computational Systems.

[25] L. GIARRÉ, G. NEGLIA, I. TINNIRELLO. *Medium access in WiFi Networks: Strategies of Selfish Nodes*, in "IEEE Signal Processing Magazine", vol. 26, n^{o} 5, September 2009, p. 124–128, http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=5230851, Special Issue on Game Theory IT .

[26] O. GUREWITZ, V. MANCUSO, J. SHI, E. W. KNIGHTLY. *Measurement and Modeling of the Origins of Starvation of Congestion-Controlled Flows in Wireless Mesh Networks*, in "IEEE/ACM Transaction on Networking", vol. Available online 14 July 2009, 2009, http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=5164899 IL IT US .

[27] P. HOWLETT, K. AVRACHENKOV, C. PEARCE, V. EJOV. *Inversion of Analytically Perturbed Linear Operators that are Singular at the Origin*, in "Journal of Mathematical Analysis and Applications", vol. 353, n^{o} 1, May 2009, p. 68–84, http://linkinghub.elsevier.com/retrieve/pii/S0022247X08011682 AU .

[28] S. LASAULCE, M. DEBBAH, E. ALTMAN. *Methodologies for Analyzing Equilibria in Wireless Games*, in "IEEE Signal Processing Magazine", vol. 26, n^{o} 5, September 2009, p. 41–52, http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=5230845, Special Issue on Game Theory.

[29] V. RAMAIYAN, E. ALTMAN, A. KUMAR. *Delay Optimal Scheduling in a Two-Hop Vehicular Relay Network*, in "ACM/Springer Mobile Networks and Applications", vol. Published online: 26 May 2009, 2009, http://www.springerlink.com/content/v01lr1491xj68u88/, Special Issue on Advances and Applications in Vehicular Ad Hoc Networks IN .

[30] H. TEMBINE, E. ALTMAN, R. EL-AZOUZI, Y. HAYEL. *Evolutionary Games in Wireless Networks*, in "IEEE Transactions on Systems, Man, and Cybernetics, Part B: Cybernetics", vol. Available online 4 December 2009, 2009, http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=5345810, Special Issue on Game Theory.

Invited Conferences

[31] A. DANDOUSH, S. ALOUF, P. NAIN. *A Realistic Simulation Model for Peer-to-Peer Storage Systems*, in "Proc. of International Workshop on Network Simulation Tools (NSTOOLS 2009), Pisa, Italy", 19 October 2009.

[32] D. FIEMS, E. ALTMAN. *Applying Branching Processes to Delay-Tolerant Networks*, in "Proc. of 4th International Conference on Bio-Inspired Models of Network, Information, and Computing Systems (BIONETICS 2009), Avignon, France", 9-11 December 2009 BE .

[33] P. GIACCONE, D. HAY, G. NEGLIA, L. ROCHA. *Routing in Quasi-Deterministic Intermittently Connected Networks*, in "Proc. of 4th International Conference on Bio-Inspired Models of Network, Information, and Computing Systems (BIONETICS 2009), Avignon, France", 9-11 December 2009 IT .

[34] M.H.R. KHOUZANI, E. ALTMAN, S. SARKAR. *Optimal Quarantining of Wireless Malware Through Power Control*, in "Proc. of the 4th Symposium on Information Theory and Applications, San Diego, California", 9-14 February 2009, p. 435–440, http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=5044961 US .

[35] S. RAMANATH, E. ALTMAN, V. KUMAR, M. DEBBAH. *Optimizing Cell Size in Pico-cell Networks*, in "Proc. of the 5th Workshop on Resource Allocation, Cooperation and Competition in Wireless Networks (RAWNET/WNC3 2009), Seoul, Korea", 27 June 2009, http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=5291586.

International Peer-Reviewed Conference/Proceedings

[36] S. AKBARZADEH, L. COTTATELLUCCI, E. ALTMAN, C. BONNET. *Distributed Communication Control Mechanisms for Ad Hoc Networks*, in "Proc. of the IEEE International Conference on Communications (ICC 2009), Dresden, Germany", 14-18 June 2009, http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=5198923.

[37] E. ALTMAN. *Competition and Cooperation Between Nodes in Delay Tolerant Networks with Two Hop Routing*, in "Proc. of the 3rd Workshop on Network Control and Optimization (NET-COOP 2009), Eindhoven, The Netherlands", LNCS, vol. 5894, Springer, 23-25 November 2009, p. 264–278, http://www.springerlink.com/content/v23k9872456n5854/.

[38] E. ALTMAN, K. AVRACHENKOV, L. COTTATELLUCCI, M. DEBBAH, G. HE, A. SUAREZ. *Operating Point Selection in Multiple Access Rate Regions*, in "Proc. of 21st International Teletraffic Congress (ITC), Paris, France", 15-17 September 2009, http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=5300242.

[39] E. ALTMAN, K. AVRACHENKOV, A. GARNAEV. *Alpha-Fair Resource Allocation under Incomplete Information and Presence of a Jammer*, in "Proc. of the 3rd Workshop on Network Control and Optimization (NET-COOP 2009), Eindhoven, The Netherlands", LNCS, vol. 5894, Springer, 23-25 November 2009, p. 219–233, http://www.springerlink.com/content/uu634341r26891k2/ RU .

[40] E. ALTMAN, K. AVRACHENKOV, A. GARNAEV. *Jamming Game with Incomplete Information about the Jammer*, in "Proc. of the 3rd ICST/ACM International Workshop on Game Theory in Communication Networks (GameComm 2009), Pisa, Italy", 23 October 2009 RU .

[41] E. ALTMAN, K. AVRACHENKOV, A. GARNAEV. *Jamming in Wireless Networks under Uncertainty*, in "Proc. of the 7th International Symposium on Modeling and Optimization in Mobile, Ad Hoc, and Wireless Networks (WiOpt 2009), Seoul, Korea", 23-25 June 2009, http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=5291638 RU .

[42] E. ALTMAN, K. AVRACHENKOV, A. GARNAEV. *Jamming in Wireless Networks: The Case of Several Jammers*, in "Proc. of the International Conference on Game Theory for Networks (GameNets 2009), Istanbul, Turkey", 13-15 May 2009, p. 585–592, http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=5137448 RU .

[43] E. ALTMAN, F. DE PELLEGRINI. *Forward Correction and Fountain codes in Delay Tolerant Networks*, in "Proc. of IEEE INFOCOM 2009, Rio de Janeiro, Brazil", 19-25 April 2009, p. 1899–1907, http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=5062111 IT .

[44] E. ALTMAN, J. ELIAS, F. MARTIGNON. *A Game Theoretic Framework for joint Routing and Pricing in Networks with Elastic Demands*, in "Proc. of the 4th International Conference on Performance Evaluation Methodologies and Tools (VALUETOOLS 2009), Pisa, Italy", 20-22 October 2009 IT .

[45] E. ALTMAN, M. HAVIV. *Broadcasting Forever*, in "Proc. of the International Conference on Game Theory for Networks (GameNets 2009), Istanbul, Turkey", 13-15 May 2009, p. 484–487, http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=5137436 IL .

[46] E. ALTMAN, V. KAMBLE, V. BORKAR. *Convergence of Population Dynamics in Symmetric Routing Games with a Finite Number of Players*, in "Proc. of the International Conference on Game Theory for Networks (GameNets 2009), Istanbul, Turkey", 13-15 May 2009, p. 668–672, http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=5137459 IN .

[47] E. ALTMAN, V. KAMBLE, A. SILVA. *Stochastic Games with One Step Delay Sharing Information Pattern with Application to Power Control*, in "Proc. of the International Conference on Game Theory for Networks (GameNets 2009), Istanbul, Turkey", 13-15 May 2009, p. 124–129, http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=5137393 IN .

[48] E. ALTMAN, A. KUMAR, Y. HAYEL. *A Potential Game Approach for Uplink Resource Allocation in a Multichannel Wireless Access Network*, in "Proc. of the 3rd ICST/ACM International Workshop on Game Theory in Communication Networks (GameComm 2009), Pisa, Italy", 23 October 2009 IN .

[49] E. ALTMAN, A. KUMAR, C. SINGH, R. SUNDARESAN. *Spatial SINR Games Combining Base Station Placement and Mobile Association*, in "Proc. of IEEE INFOCOM 2009, Rio de Janeiro, Brazil", 19-25 April 2009, p. 1629–1637, http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=5062081 IN .

[50] E. ALTMAN, I. MENACHE, A. OZDAGLAR. *Noncooperative Load Balancing in the Continuum Limit of a Dense Network*, in "Proc. of IEEE INFOCOM 2009, Rio de Janeiro, Brazil", 19-25 April 2009, p. 2636–2640, http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=5062202 US .

[51] E. ALTMAN, I. MENACHE, A. SUAREZ. *Team and Noncooperative Solutions to Access Control with Priorities*, in "Proc. of IEEE INFOCOM 2009, Rio de Janeiro, Brazil", 19-25 April 2009, p. 1611–1619, http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=5062079 US .

[52] E. ALTMAN, P. NAIN, J.-C. BERMOND. *Distributed Storage Management of Evolving Files in Delay Tolerant Ad Hoc Networks*, in "Proc. of IEEE INFOCOM 2009, Rio de Janeiro, Brazil", 19-25 April 2009, p. 1431–1439, http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=5062059.

[53] E. ALTMAN, G. NEGLIA, F. DE PELLEGRINI, D. MIORANDI. *Decentralized Stochastic Control of Delay Tolerant Networks*, in "Proc. of IEEE INFOCOM 2009, Rio de Janeiro, Brazil", 19-25 April 2009, p. 1134–1142, http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=5062026 IT .

[54] E. ALTMAN, S. WONG, J. ROJAS-MORA. *P2P Business and Legal Models for Increasing Accessibility to Popular Culture*, in "Proc. of the International Conference on Digital Business (DIGIBIZ 2009), London, United Kingdom", 17-19 June 2009.

[55] E. ALTMAN, T. BAŞAR, F. DE PELLEGRINI. *Optimal Control in Two-Hop Relay Routing*, in "Proc. of 48th IEEE Conference on Decision and Control (CDC 2009), Shanghai, China", 16-18 December 2009 US IT .

[56] E. ALTMAN, T. BAŞAR, I. MENACHE, H. TEMBINE. *A Dynamic Random Access Game with Energy Constraints*, in "Proc. of the 7th International Symposium on Modeling and Optimization in Mobile, Ad Hoc, and Wireless Networks (WiOpt 2009), Seoul, Korea", 23-25 June 2009, http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=5291611 US .

[57] A. P. AZAD, S. ALOUF, E. ALTMAN, V. BORKAR, G. PASCHOS. *Optimal Sampling for State Change Detection with Application to the Control of Sleep Mode*, in "Proc. of 48th IEEE Conference on Decision and Control (CDC 2009), Shanghai, China", 16-18 December 2009 IN GR .

[58] A. P. AZAD, S. ALOUF, E. ALTMAN, V. BORKAR, G. PASCHOS. *Vacation Policy Optimization with Application to IEEE 802.16e Power Saving Mechanism*, in "Proc. of 2nd IFIP Wireless Days 2009, Paris, France", 15-17 December 2009, BEST PAPER AWARD IN GR .

[59] A. P. AZAD, E. ALTMAN, R. EL-AZOUZI. *From Altruism to Non-Cooperation in Routing Games*, in "Proc. of Networking and Electronic Commerce Research Conference (NAEC), Riva del Garda, Italy", 8-11 October 2009.

[60] A.-E. BAERT, V. BOUDET, A. JEAN-MARIE. *Guaranteed Download time in a Distributed Video on Demand System*, in "Proc. of the 3rd International Conference on Complex, Intelligent and Software Intensive Systems (CISIS 2009), Fukuoka, Japan", 16-19 March 2009, p. 421–426, http://hal-lirmm.ccsd.cnrs.fr/lirmm-00347956/en/.

[61] A. BEN TAHAR, A. JEAN-MARIE. *Population Effects in Multiclass Processor Sharing Queues*, in "Proc. of the 4th International Conference on Performance Evaluation Methodologies and Tools (VALUETOOLS 2009), Pisa, Italy", 20-22 October 2009.

[62] A. BLANC, K. AVRACHENKOV, D. COLLANGE. *Comparing Some High Speed TCP Versions under Bernoulli Losses*, in "Proc. of the International Workshop on Protocols for Future, Large-Scale and Diverse Network Transports (PFLDNeT 2009), Tokyo, Japan", 21-22 May 2009, p. 435–440, http://www.hpcc.jp/pfldnet2009/Program_files/1569197811.pdf.

[63] A. BLANC, K. AVRACHENKOV, D. COLLANGE, G. NEGLIA. *Compound TCP with Random Losses*, in "Proc. of IFIP/TC6 Networking 2009, Aachen, Germany", LNCS, vol. 5550, Springer, 11-15 May 2009, p. 482–494, http://www.springerlink.com/content/tt81383w258277v2/.

[64] A. BLANC, D. COLLANGE, K. AVRACHENKOV. *Modelling an Isolated Compound TCP Connection*, in "Proc. of the 5th Advanced International Conference on Telecommunications (AICT 2009), Venice/Mestre, Italy", 24-28 May 2009, p. 435–440, http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=5072471.

[65] J. CHAMP, V. BOUDET, A.-E. BAERT. *Dynamic Localized Broadcast Incremental Power Protocol and Lifetime in Wireless Ad Hoc and Sensor Networks*, in "Proc. of the 2nd Joint IFIP Wireless and Mobile Networking Conference (WMNC 2009), Gdańsk, Poland", 9-11 September 2009, p. 286–296, http://hal-lirmm.ccsd.cnrs.fr/lirmm-00385340/en/.

[66] J. CHAMP, C. SAAD, A.-E. BAERT. *Lifetime in Wireless Sensor Networks*, in "Proc. of the 3rd International Conference on Complex, Intelligent and Software Intensive Systems (CISIS 2009), Fukuoka, Japan", 16-19 March 2009, http://hal-lirmm.ccsd.cnrs.fr/lirmm-00354195/en/.

[67] O. CZERNIAK, E. ALTMAN, U. YECHIALI. *Analysis of a TCP System under Polling-Type Reduction-Signal Procedures*, in "Proc. of the 4th International Conference on Performance Evaluation Methodologies and Tools (VALUETOOLS 2009), Pisa, Italy", 20-22 October 2009 IL .

[68] A. DANDOUSH, S. ALOUF, P. NAIN. *Performance Analysis of Centralized versus Distributed Recovery Schemes in P2P Storage Systems*, in "Proc. of IFIP/TC6 Networking 2009, Aachen, Germany", LNCS, vol. 5550, Springer, 11-15 May 2009, p. 676–689, http://www.springerlink.com/content/e8qh585177388676/.

[69] A. DANDOUSH, S. ALOUF, P. NAIN. *Simulation Analysis of Download and Recovery Processes in P2P Storage Systems*, in "Proc. of 21st International Teletraffic Congress (ITC), Paris, France", 15-17 September 2009, http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=5300232.

[70] D. M. DIVAKARAN, E. ALTMAN, G. POST, L. NOIRIE, P. VICAT-BLANC PRIMET. *Analysis of the Effects of XLFrames in a Network*, in "Proc. of IFIP/TC6 Networking 2009, Aachen, Germany", LNCS, vol. 5550, Springer, 11-15 May 2009, p. 364–377, http://www.springerlink.com/content/9107653164ng8541/.

[71] D. M. DIVAKARAN, E. ALTMAN, G. POST, L. NOIRIE, P. VICAT-BLANC PRIMET. *From Packets to XL-Frames: Sand and Rocks for Transfer of Mice and Elephants*, in "Proc. of IEEE INFOCOM Workshops 2009, Rio de Janeiro, Brazil", 19-25 April 2009, http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=5072149.

[72] R. EL-AZOUZI, H. SIDI, J. ROJAS-MORA, A. P. AZAD. *Game Theory and Learning Algorithm in Delay Tolerant Network*, in "Proc. of 4th International Conference on Bio-Inspired Models of Network, Information, and Computing Systems (BIONETICS 2009), Avignon, France", 9-11 December 2009, Work-in-progress track.

[73] L. GIARRÉ, G. NEGLIA, I. TINNIRELLO. *Performance Analysis of Selfish Access Strategies on WiFi Infrastructure Networks*, in "Proc. of the 52nd IEEE Global Communications Conference (GLOBECOM 2009), Honolulu, HI, USA", 30 November - 4 December 2009 IT .

[74] L. GIARRÉ, I. TINNIRELLO, G. NEGLIA. *A Game Theoretic Approach to Control Resource Repartitions in WiFi Infrastructure Networks*, in "Proc. of 48th IEEE Conference on Decision and Control (CDC 2009), Shanghai, China", 16-18 December 2009 IT .

[75] M. IBRAHIM, E. ALTMAN, P. VICAT-BLANC PRIMET, G. CAROFIGLIO, G. POST. *A Simulation Study of Passive Inference of TCP Rate and Detection of Congestion*, in "Proc. of International Workshop on Network Simulation Tools (NSTOOLS 2009), Pisa, Italy", 19 October 2009.

[76] M. IBRAHIM, P. NAIN, I. CARRERAS. *Analysis of Relay Protocols for Throwbox-equipped DTNs*, in "Proc. of the 7th International Symposium on Modeling and Optimization in Mobile, Ad Hoc, and Wireless Networks (WiOpt 2009), Seoul, Korea", 23-25 June 2009, http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=5291625 IT .

[77] H. KAMEDA, E. ALTMAN, C. TOUATI, A. LEGRAND. *Nash Equilibrium Based Fairness*, in "Proc. of the International Conference on Game Theory for Networks (GameNets 2009), Istanbul, Turkey", 13-15 May 2009, p. 533–539, http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=5137442 JP .

[78] G. KASBEKAR, E. ALTMAN, S. SARKAR. *A Hierarchical Spatial Game over Licensed Resources*, in "Proc. of the International Conference on Game Theory for Networks (GameNets 2009), Istanbul, Turkey", 13-15 May 2009, p. 70–79, http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=5137385 US .

[79] V. KAVITHA, E. ALTMAN, R. EL-AZOUZI, R. SUNDARESAN. *Opportunistic Scheduling in Cellular Systems in the Presence of Non-Cooperative Mobiles*, in "Proc. of 48th IEEE Conference on Decision and Control (CDC 2009), Shanghai, China", 16-18 December 2009 IN .

[80] V. KAVITHA, E. ALTMAN. *Queueing in Space: Design of Message Ferry Routes in Static Ad Hoc Networks*, in "Proc. of 21st International Teletraffic Congress (ITC), Paris, France", 15-17 September 2009, http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=5300246.

[81] D. KUMAR, T. CHAHED, E. ALTMAN. *Analysis of a Fountain Codes Based Transport in an 802.11 WLAN Cell*, in "Proc. of 21st International Teletraffic Congress (ITC), Paris, France", 15-17 September 2009, http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=5300267 US .

[82] I. MABROUKI, Y. HAYEL, R. EL-AZOUZI. *An Ant-Based Model for Contact Time Analysis in Delay-Tolerant Networks*, in "Proc. of 4th International Conference on Bio-Inspired Models of Network, Information, and Computing Systems (BIONETICS 2009), Avignon, France", 9-11 December 2009, Work-in-progress track.

[83] I. MABROUKI, X. LAGRANGE. *From Rosenstock Model to Random Walk Based Routing in Wireless Sensor Networks*, in "Proc. of 1st International Workshop on Performance Methodologies and Tools for Wireless Sensor Networks (WSNPerf 2009), Pisa, Italy", 23 October 2009.

[84] D. S. MENASCHE, G. NEGLIA, D. TOWSLEY, S. ZILBERSTEIN. *Strategic Reasoning about Bundling in Swarming Systems*, in "Proc. of the International Conference on Game Theory for Networks (GameNets 2009), Istanbul, Turkey", 13-15 May 2009, p. 611–620, http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=5137451 US .

[85] G. NEGLIA, G. REINA, S. ALOUF. *Distributed Gradient Optimization for Epidemic Routing: a Preliminary Evaluation*, in "Proc. of 2nd IFIP Wireless Days 2009, Paris, France", 15-17 December 2009.

[86] D. NEMIROVSKY, K. AVRACHENKOV. *Weighted PageRank: Cluster-Related Weights*, in "Proc. of the 17th Text Retrieval Conference (TREC 2008)", February 2009, http://trec.nist.gov/pubs/trec17/papers/inria.ent.rev.pdf.

[87] N. OSIPOVA, U. AYESTA, K. AVRACHENKOV. *Optimal Policy for Multi-Class Scheduling in a Single Server Queue*, in "Proc. of 21st International Teletraffic Congress (ITC), Paris, France", 15-17 September 2009, http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=5300261.

[88] S. RAMANATH, E. ALTMAN, V. KUMAR, V. KAVITHA, L. THOMAS. *Fair Assignment of Base Stations in Cellular Networks*, in "22nd World Wireless Research Forum Meeting (WWRF), Paris, France", 5-7 May 2009.

[89] J. ROJAS-MORA, E. ALTMAN, T. JIMÉNEZ. *Some Considerations in Simulating an M/M/1 queue*, in "Proc. of International Workshop on Network Simulation Tools (NSTOOLS 2009), Pisa, Italy", 19 October 2009.

[90] E. SABIR, R. EL-AZOUZI, V. KAVITHA, Y. HAYEL, E.-H. BOUYAKHF. *Stochastic Learning Solution for Constrained Nash Equilibrium Throughput in Non Saturated Wireless Collision Channels*, in "Proc. of the 3rd ICST/ACM International Workshop on Game Theory in Communication Networks (GameComm 2009), Pisa, Italy", 23 October 2009 MA .

[91] A. SILVA, P. REYES, M. DEBBAH. *Congestion in Randomly Deployed Wireless Ad-Hoc and Sensor Networks*, in "Proc. of the International Conference on Ultra Modern Telecommunications, St-Petersburg, Russia", 12-14 October 2009, http://hal.inria.fr/inria-00417774/.

[92] S. SOUDAN, D. M. DIVAKARAN, E. ALTMAN, P. VICAT-BLANC PRIMET. *Equilibrium in Size-Based Scheduling Systems*, in "Proc. of the 16th International Conference on Analytical and Stochastic Modeling Techniques and Applications (ASMTA 2009), Madrid, Spain", LNCS, vol. 5513, Springer, 9-12 June 2009, p. 234–248, http://www.springerlink.com/content/91p4h00206n40415/.

[93] H. TEMBINE, E. ALTMAN, R. EL-AZOUZI, Y. HAYEL. *Correlated Evolutionarily Stable Strategies in Random Medium Access Control*, in "Proc. of the International Conference on Game Theory for Networks (GameNets 2009), Istanbul, Turkey", 13-15 May 2009, p. 212–221, http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=5137404.

[94] H. TEMBINE, J.-Y. LE BOUDEC, R. EL-AZOUZI, E. ALTMAN. *From Mean Field Interactions to Evolutionary Game Dynamics*, in "Proc. of the 2nd Workshop on Physics-Inspired Paradigms in Wireless Communications and Networks (PHYSCOMNET 2009), Seoul, Korea", 27 June 2009, http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=5291592 CH .

[95] H. TEMBINE, J.-Y. LE BOUDEC, R. EL-AZOUZI, E. ALTMAN. *Mean Field Asymptotics of Markov Decision Evolutionary Games and Teams*, in "Proc. of the International Conference on Game Theory for Networks (GameNets 2009), Istanbul, Turkey", 13-15 May 2009, p. 140–150, http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=5137395 CH .

[96] I. TINNIRELLO, L. GIARRÉ, G. NEGLIA. *The Role of the Access Point in Wi-Fi Networks with Selfish Nodes*, in "Proc. of the International Conference on Game Theory for Networks (GameNets 2009), Istanbul, Turkey", 13-15 May 2009, p. 631–637, http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=5137453 IT .

[97] P. WIECEK, E. ALTMAN, Y. HAYEL. *An Anonymous Sequential Game Approach for Battery State Dependent Power Control*, in "Proc. of the 3rd Workshop on Network Control and Optimization (NET-COOP 2009), Eindhoven, The Netherlands", LNCS, vol. 5894, Springer, 23-25 November 2009, p. 121–136, http://www.springerlink.com/content/122l4374748574p5/ RU .

[98] S. WONG, E. ALTMAN, M. IBRAHIM. *P2P Networks: The Interplay Between Legislation and Information Technology*, in "Proc. of Networking and Electronic Commerce Research Conference (NAEC), Riva del Garda, Italy", 8-11 October 2009.

National Peer-Reviewed Conference/Proceedings

[99] E. HYON, A. JEAN-MARIE. *Politiques à Seuil dans un Système Stochastique Discret avec Pertes et Set-Up*, in "Proc. of 10th congress of the French Society for Operations Research and Decision (ROADEF 2009), Nancy, France", 10-12 February 2009, p. 214–215, http://roadef2009.loria.fr/programme/Resumes.pdf.

[100] G. SIMONIN, A.-E. BAERT, A. JEAN-MARIE, R. GIROUDEAU. *Problème d'Acquisition de Données par une Torpille*, in "Proc. of 10th congress of the French Society for Operations Research and Decision (ROADEF 2009), Nancy, France", 10-12 February 2009, p. 161–162, http://hal-lirmm.ccsd.cnrs.fr/lirmm-00354634/en/.

Workshops without Proceedings

[101] K. AVRACHENKOV. *Quasi-Stationary Distributions as Centrality Measures for the Giant Strongly Connected Component of a Reducible Graph*, in "15th INFORMS Applied Probability Society Conference, Ithaca, NY, USA", 12-15 July 2009, http://appliedprob.society.informs.org/apsconf09/Abstracts.pdf.

[102] J.-C. BERMOND, D. MAZAURIC, P. NAIN. *Algorithmes Distribués d'Ordonnancement dans les Réseaux sans-fil*, in "10èmes Journées Doctorales en Informatique et Réseaux (JDIR 2009), Belfort, France", 2-4 February 2009, http://jdir.utbm.fr/presentations/mazauric.pdf.

[103] A. BLANC, K. AVRACHENKOV, S. ALOUF, G. POST. *Flow Aware Traffic Management*, in "EuroNF Workshop on Traffic Management and Traffic Engineering for the Future Internet, Paris, France", 7-8 December 2009.

[104] U. YECHIALI, K. AVRACHENKOV. *On Tandem Blocking Queues with a Common Retrial Queue*, in "15th INFORMS Applied Probability Society Conference, Ithaca, NY, USA", 12-15 July 2009, http://appliedprob.society.informs.org/apsconf09/Abstracts.pdf IL .

Scientific Books (or Scientific Book chapters)

[105] S. ALOUF, I. CARRERAS, A. FIALHO, D. MIORANDI, G. NEGLIA. *Autonomic Information Diffusion in Intermittently Connected Networks*, in "Autonomic Computing and Networking", M. K. DENKO, L. T. YANG, Y. ZHANG (editors), chap. 17, Springer, June 2009, p. 411–433, http://www.springerlink.com/content/t83l874p04j53545/ IT .

Books or Proceedings Editing

[106] E. ALTMAN, A. CHAINTREAU (editors). *Second Euro-NF Workshop, NET-COOP 2008 Paris, France, September 8-10, 2008. Revised Selected Papers*, LNCS, vol. 5425, February 2009, http://www.springerlink.com/content/n836556266p3/.

[107] K. AVRACHENKOV, D. DONATO, N. LITVAK (editors). *Algorithms and Models for the Web-Graph. 6th International Workshop, WAW 2009 Barcelona, Spain, February 12-13, 2009, Proceedings*, LNCS, vol. 5427, February 2009, http://www.springerlink.com/content/p48u22x260t5/.

Research Reports

[108] E. ALTMAN. *Competition and cooperation between nodes in Delay Tolerant Networks with Two Hop Routing*, n^{o} RR-6904, INRIA, May 2009, http://hal.inria.fr/inria-00381030/, Research Report.

[109] E. ALTMAN, J. ROJAS-MORA, T. JIMÉNEZ. *Simulating Bandwidth Sharing with Pareto distributed File Sizes*, n^{o} RR-6926, INRIA, May 2009, http://hal.inria.fr/inria-00383079/, Research Report.

[110] A. P. AZAD, S. ALOUF, E. ALTMAN, V. BORKAR, G. PASCHOS. *Optimal Sampling for State Change Detection with Application to the Control of Sleep Mode*, n^{o} RR-7026, INRIA, September 2009, http://hal.inria.fr/inria-00420542/, Research ReportINGR.

[111] A. P. AZAD, S. ALOUF, E. ALTMAN, V. BORKAR, G. PASCHOS. *Vacation Policy Optimization with Application to IEEE 802.16e Power Saving Mechanism*, n^{o} RR-7017, INRIA, August 2009, http://hal.inria.fr/inria-00410117/, Research ReportINGR.

[112] A. P. AZAD, E. ALTMAN, R. EL-AZOUZI. *Routing Games : From Egoism to Altruism*, n^{o} RR-7059, INRIA, October 2009, http://hal.inria.fr/inria-00423475/, Research Report.

[113] A. BEN TAHAR, A. JEAN-MARIE. *The Fluid Limit of the Multiclass Processor Sharing Queue*, n^{o} RR-6867, INRIA, April 2009, http://hal.inria.fr/inria-00368246/, Research Report.

[114] J.-C. BERMOND, D. MAZAURIC, V. MISRA, P. NAIN. *Distributed Call Scheduling in Wireless Networks*, n^o RR-6763, INRIA, October 2009, http://hal.inria.fr/docs/00/43/42/51/PDF/RR-6763.pdf, version 3, Research Report.

[115] A. BLANC, K. AVRACHENKOV, D. COLLANGE. *Modelling an Isolated Compound TCP Connection*, n^o RR-6778, INRIA, January 2009, http://hal.inria.fr/inria-00349845/, Research Report.

[116] A. BLANC, K. AVRACHENKOV, D. COLLANGE, G. NEGLIA. *Compound TCP with Random Losses*, n^o RR-6736, INRIA, January 2009, http://hal.inria.fr/inria-00346050/, Research Report.

[117] D. CARRA, K. AVRACHENKOV, S. ALOUF, A. BLANC, P. NAIN, G. POST. *Passive Online RTT Estimation for Flow-Aware Routers using One-Way Traffic*, n^o RR-7124, INRIA, November 2009, http://hal.inria.fr/inria-00436444/, Research ReportIT.

[118] A. DANDOUSH, S. ALOUF, P. NAIN. *Simulation Analysis of Download and Recovery Processes in P2P Storage Systems*, n^o RR-6858, INRIA, February 2009, http://hal.inria.fr/inria-00363966/, Research Report.

[119] D. M. DIVAKARAN, G. CAROFIGLIO, E. ALTMAN, P. PRIMET. *A Flow Scheduler Architecture*, n^o RR-7133, INRIA, December 2009, http://hal.inria.fr/inria-00438594/, Research Report.

[120] D. M. DIVAKARAN, S. SOUDAN, P. PRIMET, E. ALTMAN. *A Survey on Core Switch Designs and Algorithms*, n^o RR-6942, INRIA, May 2009, http://hal.inria.fr/inria-00388943/, Research Report.

[121] J. ELIAS, F. MARTIGNON, K. AVRACHENKOV, G. NEGLIA. *Passive Online RTT Estimation for Flow-Aware Routers using One-Way Traffic*, n^o RR-7141, INRIA, December 2009, http://hal.inria.fr/inria-00439687/, Research ReportIT.

[122] D. FIEMS, E. ALTMAN. *Markov-Modulated Stochastic Recursive Equations with Applications to Delay-Tolerant Networks*, n^o RR-6872, INRIA, March 2009, http://hal.inria.fr/inria-00366541/, Research ReportBE.

[123] L. GIARRÉ, G. NEGLIA, I. TINNIRELLO. *The Role of the Access Point in Wi-Fi Networks with Selfish Nodes*, n^o RR-6737, INRIA, January 2009, http://hal.inria.fr/inria-00350047/, Research ReportIT.

[124] A. JEAN-MARIE, E. HYON. *Scheduling in a Queuing System with Impatience and Setup Costs*, n^o RR-6881, INRIA, March 2009, http://hal.inria.fr/inria-00369382/, Research Report.

[125] A. JEAN-MARIE, X. ROCHE, V. BOUDET, A.-E. BAERT. *Combinatorial Designs and Availability*, n^o RR-7119, INRIA, November 2009, Research Report.

[126] G. NEGLIA, G. REINA, S. ALOUF. *Distributed Gradient Optimization for Epidemic Routing: A preliminary Evaluation*, n^o RR-7016, INRIA, November 2009, http://hal.inria.fr/inria-00435184/, Research Report.

[127] D. NEMIROVSKY. *Tensor Approach to Mixed High-Order Moments of Absorbing Markov Chains*, n^o RR-7072, INRIA, November 2009, http://hal.inria.fr/inria-00426763/, Research Report.

[128] A. SILVA, P. REYES, M. DEBBAH. *Congestion in Randomly Deployed Wireless Ad-Hoc and Sensor Networks*, n^o RR-6854, INRIA, February 2009, http://hal.inria.fr/inria-00364370/, Research Report.

[129] S. SOUDAN, D. M. DIVAKARAN, E. ALTMAN, P. PRIMET. *Extending Routing Games to Flows over Time*, n^{o} RR-6931, INRIA, May 2009, http://hal.inria.fr/inria-00383573/, Research Report.

[130] S. SOUDAN, D. M. DIVAKARAN, E. ALTMAN, P. VICAT-BLANC PRIMET. *Equilibrium in Size-Based Scheduling Systems*, n^{o} RR-6888, INRIA, March 2009, http://hal.inria.fr/inria-00371391/, Research Report.

[131] S. WONG, E. ALTMAN, M. IBRAHIM. *P2P Networks: The Interplay Between Legislation and Information Technology*, n^{o} RR-6889, INRIA, June 2009, http://hal.inria.fr/inria-00371507/, Research Report.

Patents and standards

[132] D. CARRA, K. AVRACHENKOV, S. ALOUF, P. NAIN, G. POST. *Method for Estimating a Round Trip Time of a Packet Flow*, March 2009, Patent No. 2416, Filing No. 09305207.4, Filing date March 3, 2009.

References in notes

[133] J.-C. BERMOND, D. MAZAURIC, V. MISRA, P. NAIN. *A Distributed Scheduling Algorithm for Wireless Networks with Constant Overhead and Arbitrary Binary Interference*, Submitted to ACM Sigmetrics 2010.

[134] Y. HAYEL, H. TEMBINE, E. ALTMAN, R. EL-AZOUZI. *A Markov Decision Evolutionary Game for Individual Energy Management*, in "Annals of the International Society of Dynamic Games", vol. 11, 2010, to appear.

[135] V. MANCUSO, O. GUREWITZ, A. KHATTAB, E. W. KNIGHTLY. *Elastic Rate Limiting for Spatially Biased Wireless Mesh Networks*, in "Proc. of IEEE INFOCOM 2010", 15-19 March 2010, to appear IL US .