
IN PARTNERSHIP WITH:
**Université des sciences et techniques du Languedoc (Montpellier 2)**

Activity Report 2011

# Project-Team MAESTRO

## Models for the performance analysis and the control of networks

IN COLLABORATION WITH: Laboratoire d'informatique, de robotique et de microélectronique de Montpellier (LIRMM)

RESEARCH CENTER
**Sophia Antipolis - Méditerranée**

THEME
**Networks and Telecommunications**

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# Project-Team MAESTRO

**Keywords:** Discrete Event Systems, Markovian Model, Game Theory, Wireless Networks, Wireline Network, Control Theory, Delay Tolerant Networks, Cellular Networks, Peer-to-Peer, Sensor Networks

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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. 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

- Patent with ALCATEL-LUCENT BELL LABS on "Stacking cells for seamless mobility management of high speed users in small cells networks" [87].
- One new grant from Orange Labs on "Quality of Service and Quality of Experience" (July 2010 – June 2011) (see Section 6.3).
- A research contract with the Flowxy startup on the joint optimization of compression and transmission activities of a data backup system (September 2010 – September 2011) (see Section 6.5).
- The Institute of Electrical and Electronics Engineers (IEEE) awarded Eitan Altman the title of IEEE Fellow (Class of 2010) for contributions to analysis, optimization, and control of telecommunication networks.

BEST PAPER AWARD :
[52] **7th International Conference on Network and Service Management (CNSM 2011)**. R. COMBES, Z. ALTMAN, E. ALTMAN.

# 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, branching process, mean-field approximation;
- theory of dynamical discrete-event systems: queues, fluid approximation;
- 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. New Results

## 5.1. IP networks

**Participants:** Eitan Altman, Konstantin Avrachenkov.

### *5.1.1. Interdisciplinary study of the Internet access and of network neutrality*

In our previous research we have identified large inefficiencies that occur when one allows one type of provider (e.g. access provider) to impose costs on another type of provider (e.g. content provider). This part in which E. Altman collaborated with P. Bernhard (INRIA project-team BIOCORE), S. Caron and G. Kesidis (both from Pennsylvania State Univ., USA), J. Rojas-Mora (Univ. of Barcelona, Spain), and S. Wong (Univ. of A Coruña, Spain) has now appeared in [96].

This investigation has been pursued in various directions. In [42], E. Altman, A. Legout (INRIA project-team PLANETE) and Y. Xu (Univ. Avignon/LIA) have studied a hierarchical structure of ISPs, the economic impact of some cashing placement policies, and more complex demand functions (the demands of users for content). In [33], E. Altman and the law specialist S. Wong (Univ. of A Coruña, Spain) analyze in cooperation with the economist J. Rojas-Mora (Univ. of Barcelona, Spain) the impact of legislation related to network neutrality on the quality of service for the end users.

### *5.1.2. Adaptive monitoring system for IP networks*

The remarkable growth of the Internet infrastructure and the increasing heterogeneity of applications and users' behavior make more complex the manageability and monitoring of ISP networks and raises the cost of any new deployment. The main consequence of this trend is an inherent disagreement between existing monitoring solutions and the increasing needs of management applications. In this context, in [62] K. Avrachenkov, I. Lassoued, A. Krifa and C. Barakat (all three from INRIA project-team PLANETE) present the design of an adaptive centralized architecture that provides visibility over the entire network through a network-wide cognitive monitoring system. Practically, given a measurement task and a constraint on the volume of collected information, the proposed architecture drives the sampling rates on the interface of network routers to achieve the maximum possible accuracy, while adapting itself to any change in network traffic conditions. The authors tune the system parameters with the help of FAST sensitivity test.

### 5.1.3. Size based scheduling

Size-based scheduling is a promising solution to improve the response time of small flows (mice) that have to share bandwidth with large flows (elephants). To do this, one important task is to track the size of the ongoing flows at the router. However, most of the proposed size-based schedulers either employ the trivial way of tracking the size information of all flows, or require changes at end-hosts. Hence, either they are not scalable or they increase complexity. In [55], E. Altman, D. Mon Divakaran (IIT Mandi, India) and P. Vicat-Blanc Primet (Lyatiss, France) have proposed a new way of performing size-based scheduling in a practical and scalable fashion, by identifying and 'de-prioritizing' elephants only at times of high load. They exploit TCP's behavior by using a mechanism that detects a window of packets - called spikes - when the buffer length exceeds a certain threshold. This spike-detection is used to identify elephant flows and thereafter de-prioritize them. Two-level processor-sharing (TLPS) scheduling is employed to schedule flows in two queues, one with the high-priority flows, and the other with the de-prioritized flows. They show that the proposed mechanism not only improves the response time of mice flows in a scalable way, but also gives better response times to other flows by treating them preferentially as long as they do not overload the high-priority queue.

### 5.1.4. Accuracy of fluid models for bandwidth-sharing networks

Optimal control of stochastic bandwidth-sharing networks is typically difficult. In order to facilitate the analysis, deterministic analogues of stochastic bandwidth-sharing networks, the so-called fluid models, are often chosen for analysis, as their optimal control can be found more easily. The tracking policy translates the fluid optimal control policy back into a control policy for the stochastic model, so that the fluid optimality can be achieved asymptotically when the stochastic model is scaled properly. In [20] K. Avrachenkov, A. Piunovsky and Y. Zhang (both from the University of Liverpool, UK) study the efficiency of the tracking policy, that is, how fast the fluid optimality can be achieved in the stochastic model with respect to the scaling parameter. In particular, the result of [20] shows that, under certain conditions, the tracking policy can be as efficient as feedback policies.

### 5.1.5. Bootstrap method for simulating bandwidth sharing

In [71], E. Altman, T. Jimenez and J. Rojas-Mora (both from Univ. Avignon/LIA) identify difficulties in evaluating through simulations the expected transfer time of a file when several TCP connections share a common bottleneck buffer. The main difficulties are due to the fact that the file size over the Internet has been reported to have a Pareto distribution with parameter smaller than 1.5. This implies that the number of ongoing connections as well as the sojourn times have infinite variance. This has two implications: one cannot estimate the confidence intervals for simulation based on the CLT (central Limit Theory approach), and the duration of the simulations needed to get to steady state is very long. The authors show how to solve both problems by the use of the bootstrap approach.

## 5.2. Wireless communications

**Participants:** Sara Alouf, Eitan Altman, Konstantin Avrachenkov, Nicaise Choungmo Fofack, Mahmoud El Chamie, Majed Haddad, Manjesh Kumar Hanawal, Philippe Nain, Giovanni Neglia, Manoj Panda, Sreenath Ramanath.

### 5.2.1. Green networking

Green networking is a new trend in network design that is more aware of the impact of technology on the environment and on humans. Reducing energy has been so far the main concern in that approach, and much of the research has been devoted to understanding the tradeoffs between reducing energy and other performance measures such as coverage and delay.

For several years we have been contributing to this research effort, many of which have been summarized in the survey [67] by E. Altman in collaboration with G. S. Paschos (Center for Research and Technology, Hellas, Greece), P. Mannersalo (VTT, Finland), S. Stanczak (HH-Fraunchofer, Berlin, Germany) and L. Tassiulas (Univ. of Thessaly, Greece). In particular, much of the work involving members of MAESTRO that had appeared in previous years in conferences concerning energy saving in WiMax has now appeared in a journal publication [21] by A. P. Azad, S. Alouf, E. Altman, in cooperation with V. Borkar (TATA Inst. of Fundamental Research, Mumbai, India) and G. S. Paschos (Center for Research and Technology, Hellas, Greece).

In 2011 we started investigating policies for switching off base stations using two new tools: multimodularity and stochastic geometry. The latter has been used by E. Altman and M. K. Hanawal (also with Univ. Avignon/LIA), in cooperation with R. El-Azouzi (Univ. Avignon/LIA) and S. Shamai (Technion, Israel) in [98] to study the tradeoffs related to the uplink, and by E. Altman in cooperation with C. Hasan and J. M. Gorce (both from INSA-Lyon and INRIA project-team SWING) in [89] for the downlink. Optimal policies were obtained within the class of policies that switch off base stations with some fixed probability but independently of each other. To relax this restriction of independence and thus obtain even better policies, S. Ramanath and E. Altman, in collaboration with V. Kavitha (Univ. Avignon/LIA), have used in [69] the theory of multimodularity, which is the discrete counterpart of convexity. Among the most striking points in this research has been the observation in [98] that the conventional energy saving approach can have the opposite effect on the humans in the uplink: when the base station closest to a mobile phone is switched off (for energy saving) then the mobile phone has to transmit with a larger power so as to reach a more remote base station. It turns out that the main source of radiation to the human brain is indeed the uplink transmission, which implies that switching off base stations could cause more exposure to radiation. This is of particular concern in view of the announcement by the World Health Organization (May 31, 2011) that cell phones cause cancer.

### *5.2.2. Cellular networks with continuous connectivity*

In [65], S. Alouf and V. Mancuso (Institute IMDEA Networks, Madrid, Spain) analyze the power save and its impact on web traffic performance when customers adopt the continuous connectivity paradigm. Considering realistic http traffic, they evaluate the user access delay, the download time and the expected economy of energy in the cell. The model, validated through packet-level simulations, shows that dramatic energy save can be achieved by both mobile users and base stations. In case of Poisson arrivals, the aggregate behavior of a base station's users is studied by means of a processor-shared queueing system [105]. The model can be used to maximize the base station energy savings under a given set of QoS performance constraints. With the participation of N. Choungmo Fofack, the work in [65] has been complemented with a sensitivity analysis [95]. The impact of model parameters on the performance and cost metrics is thoroughly assessed.

### *5.2.3. Power allocation in multicell networks*

Power allocation to satisfy user demands in the presence of large number of interferers in a multicellular network is a challenging task. Further, power to be allocated depends upon the system architecture, for example, upon components like coding, modulation, transmit precoder, rate allocation algorithms, available knowledge of the interfering channels, etc. This calls for an algorithm via which each base station in the network can simultaneously allocate power to their respective users so as to meet their demands (when they are within the achievable limits), using whatever information regarding the other users is available. In [70], S. Ramanath, V. Kavitha (Univ. Avignon/LIA) and M. Debbah (SUPELEC) devise such an algorithm which is in fact universal: the proposed algorithm works from a fully cooperative setting to almost no cooperation and or for any configuration of modulation, rate allocation, etc. schemes. The algorithm asymptotically satisfies the user demands, running simultaneously and independently within a given total power budget at each base station. Further, it requires minimal information to achieve this: every base station needs to know its own users demands, its total power constraint and the transmission rates allocated to its users in every time slot. The authors formulate the power allocation problem in a system specific game theoretic setting, define system specific capacity region and analyze the proposed algorithm using ordinary differential equation (ODE) framework. Simulations confirm the effectiveness of the proposed algorithm.

### 5.2.4. Small cell networks

In [28], S. Ramanath and E. Altman, in collaboration with V. Kavitha (Univ. Avignon/LIA), characterize the performance of Picocell networks in the presence of moving users. They model various traffic types between base-stations and mobiles as different types of queues. They derive explicit expressions for the expected waiting time, service time and drop/block probabilities for both fixed and random velocity of mobiles. They obtain (approximate) closed-form expressions for optimal cell size when the velocity variations of the mobiles is small for both non-elastic and elastic traffic. They conclude from the study that, if the expected call duration is long enough, the optimal cell size depends mainly on the velocity profile of the mobiles, its mean and variance. It is independent of the traffic type or duration of the calls. Further, for any fixed power of transmission, there exists a maximum velocity beyond which successful communication is not possible. This maximum possible velocity increases with the power of transmission. Also, for any given power, the optimal cell size increases when either the mean or the variance of the mobile velocity increases.

### 5.2.5. New concepts in fair resource allocation

Fair resource allocation is usually studied in a static context, in which a fixed amount of resources is to be shared. In dynamic resource allocation one usually tries to assign resources instantaneously so that the average share of each user is split fairly. The exact definition of the average share may depend on the application, as different applications may require averaging over different time periods or time scales. Our main contribution is to introduce new refined definitions of fairness that take into account the time over which one averages the performance measures. In [39] E. Altman, K. Avrachenkov and S. Ramanath examine how the constraints on the averaging durations impact the amount of resources that each user gets. The authors apply this new concept in [68] to spectrum allocation and indoor-outdoor femtocells.

### 5.2.6. Self organization in cellular networks

Time-slots and frequencies are contended in cellular networks and their allocation is determined by base stations. For scalability purposes the resource allocation is decentralized, so that base stations do not share their information with each other. Actions are often taken based on partial information on the system. In particular, the statistics of the channels are often not available. Scheduling decisions of a base station concerning mobiles in its cell cause interference in other cells and there is thus a need to dynamically adjust to interference and to converge to a satisfactory operation point. This has motivated a large amount of work on self-organization in cellular networks based on OFDMA. E. Altman, Z. Altman, R. Combes (both from Orange Labs, Issy les Moulineaux) and M. Haddad have written a series of papers on self-organization. In [53] and [51] self-organization in interference coordination is studied. In [50], R. Combes, Z. Altman and E. Altman, further propose and analyze a self-optimization method for coverage-capacity optimization in OFDMA networks with MIMO. Moreover, they study in [52] self-organization when adding relays so as to increase coverage. Static and dynamic resource sharing mechanisms are investigated. In the static case they use a queuing model to calculate the optimal resource sharing strategy and the maximal capacity of the network analytically. The influence of relay planning and number of deployed relays is investigated, and gains resulting from good planning are evaluated analytically. Self-optimizing dynamic resource allocation is tackled using a Markov Decision Process (MDP) model.

[52] received the **Best Paper Award** of the *7th International Conference on Network and Service Management*, Paris, Oct. 24-28, 2011.

Self-organization has also been used in the past to obtain opportunistic scheduling in a way that achieves proportional fair resource sharing. In [23], R. Combes, Z. Altman (both from Orange Labs, Issy les Moulineaux) and E. Altman, have extended this to the general $\alpha$-fair concept. A dynamic choice of the factor $\alpha$ is proposed, which has the interpretation of trading optimality with fairness in a dynamic way.

### 5.2.7. Dynamic networks

In source routing, a complete path is chosen for a packet to travel from source to destination. While computing the time to traverse such a path may be straightforward in a fixed, static graph, doing so becomes much more challenging in dynamic graphs, in which the state of an edge in one timeslot (i.e., its presence or absence) is

random, and may depend on its state in the previous time step. The traversal time is due to both time spent waiting for edges to appear and time spent crossing them once they become available. In [99], P. Nain in collaboration with A. Bar-Noy (City University of New York), P. Basu (Raytheon BBN Technologies), M. P. Johnson (Pennsylvania State University), F. Yu (City University of New York) and D. Towsley (University of Massachusetts at Amherst) computes the expected traversal time (ETT) for a routing path in a number of special cases of stochastic edge dynamics models, and for three edge failure models, culminating in a surprisingly challenging yet realistic setting in which the initial configuration of edge states for the entire path is known. We show that the ETT for this "initial configuration" setting can be computed in quadratic time, by an algorithm based on probability generating functions. The authors also give several linear-time upper and lower bounds on the ETT.

### *5.2.8. Sensor networks*

In many application scenarios sensors need to calculate the average of some local values, e.g. of local measurements. A possible solution is to rely on consensus algorithms. In this case each sensor maintains a local estimate of the global average, and keeps improving it by performing a weighted sum of the estimates of all its neighbors. The number of iterations needed to reach an accurate estimate depends on the weights used at each sensor. K. Avrachenkov, G. Neglia and M. El Chamie have proposed a new average consensus algorithm, where each sensor selects its own weights on the basis of some local information about its neighborhood [45]. In realistic sensor network topologies, the algorithm shows faster convergence than other existing consensus protocols.

### *5.2.9. Delay and disruption-tolerant networks (DTNs)*

#### *5.2.9.1. Applying risk sensitive control to delay tolerant networks*

When controlling the propagation of a message in DTNs, the objective is often to maximize the successful delivery probability of a message within a given deadline. It takes often the form of the expectation of the exponent of some integral cost. So far, models involving such costs have been solved by interchanging the order of expectation and the exponential function. While reducing the problem to a standard optimal control problem, this interchange is only tight in the mean-field limit obtained as the population tends to infinity. In [41] E. Altman, V. Kavitha (Univ. Avignon/LIA), F. De Pellegrini (Create-Net, Trento, Italy), V. Kamble (UC Berkeley, CA, USA) and V. Borkar (TATA Inst., Mumbai, India), identify a general framework from optimal control in finance, known as risk sensitive control, which allows handling the original (multiplicative) cost and obtaining solutions to several novel control problems in DTNs. New optimal control problems which consider the effect of wireless propagation path loss factor and the power constraints at the source and or the destination are proposed for DTNs within this framework. Optimal policies of non-threshold type are found.

#### *5.2.9.2. Multiple destinations*

In [73], C. Singh, A. Kumar and R. Sundaresan (all three from IISc Bangalore, India) in collaboration with E. Altman, use Markov Decision Processes to study optimal policies for propagation of contents in DTNs to multiple destinations. They obtain structural properties for a discretized system which allows them to derive the structure of optimal policies to the original problem.

#### *5.2.9.3. Reliable unicast and multicast*

In case the DTN does not deliver a packet within some time $T$, it has to be retransmitted. In [36] E. Altman and M. Panda, in collaboration with T. Chahed and A. Ali, (both from Telecom SudParis) and L. Sassatelli (Univ. Nice Sophia Antipolis/I3S), propose protocols for unicast and for multicast that render the connection reliable. These protocols include ACKs and retransmissions. The authors compute the value of $T$ that optimizes the throughput and address energy consumptions aspects.

#### *5.2.9.4. Network coding*

In [18], E. Altman studies, in cooperation with F. De Pellegrini (Create-Net, Trento, Italy), how to improve the performance of DTNs by adding network coding. The latter has the effect of efficiently adding spatial redundancy to the network. They identify the structure of optimal policies, which are shown not always to be of a threshold type.

G. Neglia, in collaboration with X. Zhang (Fordham University, New York) and J. Kurose (University of Massachusetts at Amherst), has published a survey on the application of network coding to DTNs [78].

*5.2.9.5. Ferry based local area networks*

Polling systems are used to model the Ferry assisted Wireless LANs and thereby to obtain the stationary workload performance. Not much theory is available for calculating the stationary workload of polling systems with arrivals in a continuum. In [103], V. Kavitha (Univ. Avignon/LIA) and E. Altman propose a discretization approach, by which the so-called "pseudo conservation law" of the discrete polling systems is utilized to derive the stationary performance of continuous polling systems. The continuous polling results are used in deriving optimal ferry routes.

*5.2.9.6. Adaptive epidemic routing in DTNs*

G. Neglia and R. Masiero (University of Padua, Italy) have explored a recently proposed optimization framework that relies on local sub-gradient methods and consensus algorithms. The research is described in MAESTRO 2010 activity report and has appeared in [66].

*5.2.9.7. Routing in quasi-deterministic networks*

G. Neglia, U. Acer (Bell labs Antwerp), P. Giaccone and S. Tarapiah (both from Politecnico di Torino, Italy) and D. Hay (Hebrew University of Jerusalem), have investigated routing in DTNs where the underlying node mobility is known in advance but can be modified by random effects. The research is described in MAESTRO 2010 activity report and has appeared in [35] and [94].

## 5.3. Information systems

**Participants:** Eitan Altman, Konstantin Avrachenkov, Nicaise Choungmo Fofack, Majed Haddad, Alain Jean-Marie, Dorian Mazauric, Philippe Nain, Marina Sokol.

### *5.3.1. Web crawler optimization*

A typical web search engine consists of three principal parts: crawling engine, indexing engine, and searching engine. The work [19] by K. Avrachenkov and P. Nain, together with A. Dudin, V. Klimenok, and O. Semenova (all three from Belarussian State University, Belarus), aims to optimize the performance of the crawling engine. The crawling engine finds new web pages and updates existing web pages in the database of the web search engine. The crawling engine has several robots collecting information from the Internet. The authors first calculate various performance measures of the system (e.g., probability of arbitrary page loss due to the buffer overflow, probability of starvation of the system, average time waiting in the buffer). Intuitively, one would like to avoid system starvation and at the same time to minimize the information loss. The authors formulate the problem as a multi-criteria optimization problem and solve it in the class of threshold policies. The authors consider a very general web page arrival process modeled by Batch Marked Markov Arrival Process and a very general service time modeled by Phase-type distribution. The model has been applied to the performance evaluation and optimization of the crawler designed by INRIA MAESTRO team in the framework of the RIAM INRIA-Canon research project (see MAESTRO 2006 and 2007 activity reports).

### *5.3.2. PageRank node centrality*

In [48] K. Avrachenkov and M. Sokol, together with D. Nemirovsky (former MAESTRO team member), E. Smirnova (INRIA project-team AXIS) and N. Litvak (University of Twente, The Netherlands), study a problem of quick detection of top-k Personalized PageRank (PPR) lists. This problem has a number of important applications such as finding local cuts in large graphs, estimation of similarity distance and person name disambiguation. The authors suggest that two observations are important when finding top-k PPR lists. Firstly, it is crucial that one detects fast the top-k most important neighbors of a node, while the exact order in the top-k list and the exact values of PPR are by far not so crucial. Secondly, by allowing a small number of "wrong" elements in top-k lists, one achieves great computational savings, in fact, without degrading the quality of the results. Based on these ideas, the authors propose Monte Carlo methods for quick detection of top-k PPR lists. We demonstrate the effectiveness of these methods on the Web and Wikipedia graphs, provide performance evaluation and supply stopping criteria.

### *5.3.3. Analysis of YouTube*

E. Altman and M. Haddad, in collaboration with S.-E. Elayoubi (Orange Labs, Issy les Moulineaux), R. El-Azouzi, T. Jimenez and Y. Xu (all three from Univ. Avignon/LIA) have been investigating streaming protocols similar to the one used by YouTube. After preparing a survey on the state-of-the-art in [57], they used Ballot theorems in [106] in order to compute the starvation probabilities (these are the probability that the queue empties before completing to send a streaming application).

This work is carried out in the framework of the Grant with Orange Labs (see Section 6.3) on "Quality of Service and Quality of Experience".

### *5.3.4. Peer-to-peer networks*

#### *5.3.4.1. Real-time control of contents download*

In the course of the VOODDO project, the question of assessing the theoretical limits of prefetching information in real-time arose. Given a network bandwidth and a graph of documents, is it possible to download documents in advance, so that the document surfer is never blocked because of missing information? The problem is modeled using a "cops-and-robbers" game and some of its algorithmic properties are derived. This work of A. Jean-Marie and D. Mazauric is joint with F. Fomin (Univ. Bergen) and F. Giroire and N. Nisse (both from INRIA project-team MASCOTTE) [86].

#### *5.3.4.2. P2P traffic classification*

P2P downloads still represent a large portion of today's Internet traffic. More than 100 million users operate BitTorrent and generate more than 30% of the total Internet traffic. According to the Wikipedia article about BitTorrent, the traffic generated by BitTorrent is greater than the traffic generated by Netflix and Hulu combined. Recently, a significant research effort has been done to develop tools for automatic classification of Internet traffic by application. The purpose of the work [47] by K. Avrachenkov and M. Sokol, together with A. Legout (INRIA project-team PLANETE) and P. Gonçalves (INRIA project-team RESO), is to provide a framework for subclassification of P2P traffic generated by the BitTorrent protocol. The general intuition is that users with similar interests download similar contents. This intuition can be rigorously formalized with the help of graph based semi-supervised learning approach. In particular, the authors propose to work with PageRank based semi-supervised learning method, which scales well with very large volumes of data.

#### *5.3.4.3. BitTyrant*

The success of BitTorrent has fostered the development of variants to its basic components. Some of the variants adopt greedy approaches aiming at exploiting the intrinsic altruism of the original version of BitTorrent in order to maximize the benefit of participating to a torrent. G. Neglia, D. Carra (University of Verona, Italy), P. Michiardi and F. Albanese (both from INSTITUT EURECOM) have studied BitTyrant, a recently proposed strategic client. The research is described in MAESTRO 2008 activity report. Results have been extended and supported by PlanetLab experiments in [22].

### *5.3.5. Content-centric networks*

In [100] N. Choungmo Fofack, P. Nain and G. Neglia, together with D. Towsley (University of Massachusetts at Amherst), provide building blocks for the performance evaluation of Content Centric-like Networks (CCNs). In CCNs if a cache receives a request for a content it does not store, it forwards the request to a higher-level cache, if any, or to the server. When located, the document is routed on the reverse-path and a copy is placed in each cache along the path. In this work the authors consider a cache replacement policy based on Time-to-Lives (TTLs) like in a DNS network. A local TTL is set when the content is first stored at the cache and is renewed every time the cache can satisfy a request for this content (at each hit). The content is removed when the TTL expires. Under the assumption that requests follow a renewal process and the TTLs are exponential random variables, we determine exact formulas for the performance metrics of interest (average cache occupancy, hit and miss probabilities/rates) for some specific architectures (a linear network and a tree network with one root node and $N$ leaf nodes). For more general topologies and general TTL distributions, an approximate solution is proposed. Numerical results show the approximations to be accurate, with relative errors smaller than $10^{-3}$ and $10^{-2}$ respectively for exponentially distributed and constant TTLs.

This work is carried out in the framework of the Grant with Orange Labs on "Content-centric networks" (Section 6.2).

## 5.4. Game theory applied to networking

**Participants:** Eitan Altman, Konstantin Avrachenkov, Majed Haddad, Manoj Panda, Giovanni Neglia.

### *5.4.1. Resource allocation in wireless networks*

*5.4.1.1. Power control*

In [14] E. Altman, K. Avrachenkov and A. Garnaev (St. Petersburg State University, Russia), study power control for Gaussian interference channel in optimization and game frameworks. In the optimization framework there is a single decision maker who assigns network resources and in the game framework users share the network resources according to Nash equilibrium. The authors enhance the water-filling technique with explicit analytic solutions. The authors also provide an alternative simple proof of the convergence of the Iterative Water Filling Algorithm. Finally, the authors compare the non-cooperative approach with the cooperative approach and show that the non-cooperative approach results in a more fair resource distribution.

There has been a debate between those proposing protocols based on a centralized controller and those favoring decentralized protocols based on non-cooperative game theory. In [26] E. Altman and M. Haddad, together with S.-E. Elayoubi and Z. Altman (both from Orange Labs, Issy les Moulineaux), consider a situation where a base station lets mobiles take power control decisions in some system states and imposes actions in other states. The authors study how best to choose what information to make available and how mobiles should react.

*5.4.1.2. Joint power and rate allocation*

In [63] X. Lei and L. Cottatellucci (both from INSTITUT EURECOM) and K. Avrachenkov consider a block fading interference channels with partial channel state information and address the issue of joint power and rate allocation in a game theoretic framework. Resource allocation algorithms based on Bayesian games are proposed. The existence, uniqueness, and some stability properties of Nash equilibria are analyzed. For some asymptotic setting, closed-form expressions of Nash equilibria are also provided.

*5.4.1.3. Jamming in wireless networks*

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 [15] E. Altman, K. Avrachenkov and A. Garnaev (St. Petersburg State University), investigate the effect of partially available information in which the user does not even know whether or not the jammer is indeed present. The problem is formulated as a zero-sum game. The authors find the equilibrium strategies in closed-form and specify the range of sub-carriers where the user can expect the jamming attack.

*5.4.1.4. Channel access*

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. G. Neglia, I. Tinnirello and L. Giarré (University of Palermo, Italy) have been studying the interaction of selfish nodes in the last two years (the research activity is described in MAESTRO 2009 and MAESTRO 2010 activity reports). [31], [74] further extend the results to a heterogeneous scenario, where nodes have different requirements in terms of uplink/downlink ratios.

### *5.4.2. Network formation games*

The continued growth of computer networks such as the Internet has raised the interest in understanding how networks get formed. The design of such networks is generally carried out by a large number of self-interested actors (users, Internet Service Providers ...), all of whom seek to optimize the quality and cost of their own operation. Previous works have addressed the "Network Formation" problem considering almost exclusively networks designed by selfish users, which can be consistently suboptimal. In [46] K. Avrachenkov and G. Neglia, together with J. Elias (University Paris Descartes), F. Martignon (University Paris-Sud 11), and L. Petrosyan (St. Petersburg State University, Russia), address the network formation issue using cooperative game theory, which permits to study ways to enforce and sustain cooperation among agents. Both the Nash bargaining solution and the Shapley value are investigated. After the comparison of these two approaches, the authors conclude that the Nash bargaining solution is more suitable to enforce cooperation in the network formation game in terms of cost allocation to users and computation time to get the solution.

#### *5.4.2.1. Network design with socially-aware users*

In many scenarios network design is not enforced by a central authority, but arises from the interactions of several self-interested agents. This is the case of the Internet itself. K. Avrachenkov and G. Neglia, in collaboration with J. Elias (University Paris Descartes) and F. Martignon (University Paris-Sud 11), have proposed two novel socially-aware network design games. The research has been described in MAESTRO 2010 activity reports. [24] extends the results for the case when users' utility functions incorporate a socially-aware component.

#### *5.4.2.2. Stochastic games for cooperative network routing*

In [64] K. Avrachenkov, L. Maggi and L. Cottatellucci (both from INSTITUT EURECOM) consider a system where several providers share the same network and control the routing in disjoint sets of nodes. They provide connection toward a unique server (destination) to their customers. The objective is to facilitate the design of the available network links and their costs such that all network providers are interested in cooperating and none of them withdraw from the coalition. More specifically, the authors establish the framework of a coalition game by providing an algorithm to compute the transferable coalition values. As by-product, the authors apply the proposed algorithm to two-player games both in networks subject to hacker attacks and in epidemic networks.

#### *5.4.2.3. Association games*

Using tools from coalition game theory, E. Altman, in cooperation with C. Singh (IISc Bangalore, India), considers in [72] a wireless framework in which several mobile terminals can receive and decode the same signal of the base station, and where the cost for broadcasting is taken to be the transmission power. They begin by proposing various schemes to share the cost and study their properties. Then, they study the association with partial information: an arriving user knowing its location has to decide without knowledge of the location of the other users and their number whether to join the multicast tree and pay according to a given cost sharing scheme, or to have a unicast connection at a given cost. The unicast alternative that each mobile has, results in a limitation on the coverage (area covered by the multicast session) and on the capacity (number of mobiles connected to the multicast session). The authors derive the expected capacity and coverage as a function of the cost sharing policy. This work is extended in [58] to the case of several base stations by E. Altman in collaboration with C. Hasan and J. M. Gorce (both from INSA Lyon and INRIA project-team SWING).

### *5.4.3. Routing games*

In [40], E. Altman, M. Panda and A. Estanisla (Master student at UPMC) study ring networks extensively used in both road traffic and telecommunications (in local area networks) in which each source with a given origin and destination on the ring, can split its traffic and send some part in one direction of the ring and some other part in the other direction. They compute the equilibria and find out that due to non-cooperation, much traffic is sent at equibrium along long paths.

In [16], E. Altman, O. Pourtallier (INRIA project-team COPRIN), T. Jimenez (Univ. Avignon/LIA) and H. Kameda (Univ. Tsukuba, Japan) study a load balancing processor sharing problem. The classical framework of routing games turned out not to apply here. Indeed, it had been used to model situations where the flow from each class of users is split among paths without any information on the realization of the sizes of each packet. In contrast, in this paper, each individual knows its size. The authors have succeeded in computing the equilibrium within the new setting.

Collusion is the situation where several players decide to cooperate and to choose their actions as if they were a single player - each player maximizes the sum of utilities of that group instead of only its own utility. In [90], E. Altman in collaboration with Y. Hayel (Univ. Avignon/LIA) and H. Kameda (Univ. Tsukuba, Japan), has proposed various concepts that evaluate the impact of collusions. The authors have further studied collusions in routing games and identified situations where collusions are bad for all players: both those that collide loose in performance as well as those who remain independent.

## 5.5. Stochastic processes, queueing, control theory and game theory

**Participants:** Eitan Altman, Julien Gaillard, Majed Haddad, Alain Jean-Marie.

### *5.5.1. Convergence of rolling horizon control*

In collaboration with E. Della Vecchia and S. Di Marco (both from National Univ. Rosario, Argentina), A. Jean-Marie has investigated the performance (convergence and error bounds) of the Rolling Horizon heuristic for optimal stochastic control and stochastic games in different modeling situations.

In the case of the long-term average expected gain, they have shown [85] that convergence occurs whenever the value iteration algorithm converges. They have then considered zero-sum semi-Markov games with discounted payoff [54], [76], for which they have proved geometric convergence under the usual assumptions of the literature.

### *5.5.2. Impulse control versus continuous control*

Impulse control is a modeling framework of optimal control theory, in which the control actions can provoke instantaneous changes in the value of the state. For modelers, it has the features of both continuous-time and discrete-time models, and it can help understand which one to choose in a given optimization situation. A. Jean-Marie has studied the question in conjunction with K. Erdlenbruch (CEMAGREF), M. Tidball (INRA) and M. Moreaux (Univ. Toulouse 1). In a quite generic single-dimensional model, they show that the optimality of impulse policies with respect to "smooth" control policies is strongly related to a submodularity property of the instantaneous cost function [101].

### *5.5.3. Routing games*

Several fundamental results have been obtained in routing games that model finite number of sources of traffic (players) who decide how to split the traffic among various paths. When the number of players is large, the Wardrop equilibrium concept is often used, where the problem is modeled as one with a continuum of decision makers where each has a negligible impact (non atomic game) on other's performance. E. Altman and his co-workers have studied the question of whether Wardrop equilibrium is a good approximation for a problem with finitely many players for which the Nash equilibrium is the solution concept. In [38], E. Altman, in collaboration with Z. Altman, R. Combes (both from Orange Labs, Issy les Moulineaux) and S. Sorin (Univ. Pierre and Marie Curie (UPMC)) establishes the convergence under mild convexity assumptions on the link costs (or delays). The proof is based on yet another fundamental result derived in that reference and that was later extended in [44] by E. Altman in collaboration with O. Pourtallier (INRIA project-team COPRIN), T. Jimenez (Univ. Avignon/LIA) and H. Kameda (Univ. Tsukuba, Japan), that states that if there is some symmetry in a network then any Nash equilibrium will inherit the symmetric properties (for example, if two users have the same source and destination and the same demand then at equilibrium, they will send the same amount of traffic over each link).

In all the above work there is an assumption that the link cost (or delay) per packet is class independent (it depends on the flows through the link only through their sum). In the case of Wardrop equilibrium this assumption implies that the game has an equivalent global optimization problem whose solution coincides with the equilibrium. The link cost evaluated at some $x$ in the equivalent problem is the integral of the original link cost (from 0 to $x$) and is in fact a potential. In the case of class dependent cost, that is, when the cost depends in other ways on the traffic of each class then the result of the integration may depend on the path and one cannot transform the problem to an equivalent optimization one. H. Kameda and J. Li (both from Univ. Tsukuba, Japan) in collaboration with E. Altman, identify in [27] other class-dependent cost that have the property of a field, that is, it can be expressed as the gradient of a potential. They obtain the Wardrop equilibrium and study its properties.

Another difficulty occurs in rouging games when the paths available are not the same for all users. This is the case, in particular, when there are priorities. This problem is addressed in [25] by J. Elias (University Paris Descartes), F. Martignon (University Paris-Sud 11), A. Capone (Politecnico di Milano, Italy) and E. Altman within an application to non-cooperative spectrum access in cognitive radio networks.

### *5.5.4. Bio-inspired paradigms*

*5.5.4.1. Epidemiology*

For several years now, E. Altman has been developing techniques for dynamic optimal control and games in cooperation with with S. Sarkar's group from the University of Pennsylvania (which used to be part of the DAWN associated team with MAESTRO). This year this collaboration has resulted in three additional publications co-authored by M.H.R. Khouzani and S. Sarkar (both from Univ. of Pennsylvania, PA, USA) and E. Altman [61], [60], [104]. All three papers use the Pontriagin maximal principle to derive the structure of optimal policies applied to a mean-field approximation of the problem. The first two papers do that in a context of optimal control theory while the third one does it in the context of a dynamic game.

*5.5.4.2. Sequential anonymous games (SAG)*

Sequential Anonymous Games (SAG) can be viewed as an extension of Markov Decision evolutionary games. In both formalisms there are many players modeled as a continuum number of players. A Markov chain is associated with each player. There are several types of players. The fraction of players in each class is called a global state and the state of the Markov chain of an individual is called the individual state. An individual chooses at some sequential decision opportunities actions. It earns some immediate reward (fitness) at each slot and moves with some probability to another individual state. In SAG, both the transition probabilities and the immediate fitness of an individual depend on its current state and action as well as on the current global system state. The latter evolves according to some function averaged over the fitness of the individuals in each class (the fraction of individuals in a class grows if they do better than those in the other classes). In [75] E. Altman investigates, in collaboration with P. Wiecek (Wroclaw Univ. of Technology, Poland), the case where the objective of an individual is to maximize either its total expected fitness during its life time or its expected average fitness. The authors establish the existence of equilibria and study its properties. Applications to power control have appeared in [32] by E. Altman, in collaboration with P. Wiecek (Wroclaw Univ. of Technology, Poland) and Y. Hayel (Univ. Avignon/LIA).

*5.5.4.3. Markov decision evolutionary games (MDEGs)*

Since his 2004 Infocom paper, E. Altman has been working on this novel paradigm. The model is similar to that of the previous paragraph (SAG) except that in MDEG both immediate fitness and transition probabilities depend linearly on the global state. This reflects a scenario where the interaction between a player and the rest of the population occurs through pairwise interactions: each player encounters from time to time a randomly chosen other player and it finds itself playing a matrix game with that player. The entries of the matrix corresponding to each player as well as the transition probabilities for each player depend on the individual states of the players. E. Altman has applied this model to the dynamic Hawk and Dove game, in which individuals have to choose the degree of aggressiveness in their behavior as a function of their energy state.

Below are three publications both with biological applications and applications to wireless communications (where depending on one's remaining battery energy, one has to decide at what power to transmit). The first publication in [30], by E. Altman, H. Tembine (SUPELEC), R. El-Azouzi and Y. Hayel (both from Univ. Avignon/LIA), lays the foundations of MDEGs and presents the application to power control in which the individual state is the battery level of energy. The second publication in [59], by Y. Hayel (Univ. Avignon/LIA), E. V. Belmega (SUPELEC) and E. Altman, studies theoretical aspects that arise in case that the global state cannot represent the fractions of different populations but rather their actual size. The third publication in [97] by E. Altman, J. Gaillard, M. Haddad and P. Wiecek (Wroclaw Univ. of Technology, Poland) again studies MDEGs (as in the first paper), but restricts to policies that use static policies: the same mixed strategy is taken by a player at each state. The authors manage to compute explicitly the equilibrium in this game within this class of policies.

*5.5.4.4. Delayed evolutionary games*

Evolutionary game theory includes much theory on the description of the global system state as a function of the fitness of individuals. The models are often described through differential equations (e.g. the "replicator dynamics"). In many scenarios it is realistic to consider delays between the moment that one receives a given fitness till this is translated to a change in the population size. For example, if the lifetime of a computer is three years then an application that performs better with one computer may take more than a year till it is adopted by other users who do not have the same computer. In [30], H. Tembine (SUPELEC), E. Altman, R. El-Azouzi and Y. Hayel (both from Univ. Avignon/LIA) investigate instability phenomena that are introduced by the delay and derive necessary stability conditions.

# 6. Contracts and Grants with Industry

## 6.1. ADR "Semantic Networking" and "Self Optimizing 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 January 1st 2008 and will last for four years.

Isabelle Guérin Lassous (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 Roullet, respectively.

### *6.1.1. ADR "Semantic Networking"*

**Participants:** Sara Alouf, Eitan Altman, Konstantin Avrachenkov, Philippe Nain, Marina Sokol.

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. Three joint INRIA ACATEL-LUCENT patents have been filed already, one in 2009 (inventors for INRIA: S. Alouf, K. Avrachenkov, D. Carra, P. Nain) and two in 2010 (inventors for INRIA: S. Alouf, K. Avrachenkov, A. Blanc).

### *6.1.2. ADR "Self Optimizing Wireless Networks"*

**Participants:** Eitan Altman, Manjesh Kumar Hanawal, 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. One joint INRIA ACATEL-LUCENT patent has been filed [87] and two were submitted in 2011 (inventors for INRIA: E. Altman and S. Ramanath).

## 6.2. Grant from Orange Labs on "Content-Centric Networking" (October 2010 – September 2012)

**Participants:** Sara Alouf, Konstantin Avrachenkov, Nicaise Choungmo Fofack, Philippe Nain, Giovanni Neglia.

The objective of this grant (CRE) is to develop mathematical models for the analysis of Content-Centric Networks (CCN). This research focuses on routing and caching policies.

P. Nain is responsible for INRIA. This work is done in collaboration with C. Barakat (PLANETE, INRIA).

## 6.3. Grant from Orange Labs on "Quality of Service and Quality of Experience" (July 2010 – June 2011)

**Participants:** Eitan Altman, Majed Haddad.

The objective of this grant (CRE) is to study the performance and to optimize protocols related to new applications over the Internet such as YouTube. E. Altman is responsible for INRIA.

## 6.4. Grant from Orange Labs on "Self Optimization in Networks" (October 2009 – September 2012)

**Participant:** Eitan Altman.

This is a joint contract with University Pierre and Marie Curie (UPMC) and Orange Labs, signed on June 2011 (retroactively), related to a Cifre thesis of R. Combes, whose advisors are E. Altman, S. Sorin (UPMC) and Z. Altman (Orange Labs).

## 6.5. Research Contract with the Flowxy startup (September 2010 – September 2011)

**Participant:** Alain Jean-Marie.

The aim of this research action was to optimize the joint compression/transmission activities of the data backup system developed by the Flowxy company. This work was done in collaboration with A.-E. Baert, V. Boudet, M. Chaumont and W. Puech of the University of Montpellier 2.

# 7. Partnerships and Cooperations

## 7.1. International Initiatives

### *7.1.1. INRIA International Partners*

*7.1.1.1. St. Petersburg State University*

**Participant:** Konstantin Avrachenkov.

MAESTRO has a continuing collaboration with St. Petersburg State University. St. Petersburg State University is a partner in INRIA Internship International programme. In particular, MAESTRO hosts every year several intern students from St. Petersburg State University. The collaboration with L. Petrosyan and A. Garnaev is on the application of game theory to resource allocation in networks. The collaboration with V. Dobrynin is on data clustering.

### *7.1.2. Visits of International Scientists*

*7.1.2.1. Professors*

Augustin Chaintreau (from November 4, 2011 until November 9, 2011)

Institution: Columbia University, New York (USA)

Andrey Garnaev (from May 8, 2011 until May 13, 2011)

Institution: St. Petersburg State University (Russian Federation)

Richard Gibbens (from April 4, 2011 until April 10, 2011)

Institution: University of Cambridge (United Kingdom)

Evsey Morozov (from March 23, 2011 until March 28, 2011)

Institution: Russian Academy of Sciences (Russian Federation)

Charles Pearce (from September 25, 2011 until September 30, 2011)

Institution: University of Adelaide (Australia)

Karl Sigman (from March 25, 2011 until March 26, 2011)

Institution: Columbia University, New York (USA)

Don Towsley (from March 28, 2011 until June 27, 2011)

Institution: University of Massachusetts at Amherst (USA)

Uri Yechiali (from March 27, 2011 until April 4, 2011)

Institution: Tel Aviv University (Israel)

*7.1.2.2. Post-doctoral fellows*

Josu Doncel (from July 9, 2011 until July 16, 2011)

Subject: Multiarmed Bandit Problems
Institution: Basque Center for Applied Mathematics (BCAM), Derio (Spain)

Nicolas Gast (from October 23, 2011 until October 25, 2011)

Institution: École Polytechnique Fédérale de Lausanne (Switzerland)

Jasper Goseling (from November 14, 2011 until November 18, 2011)

Institution: University of Twente (The Netherlands)

Peter Jacko (from July 9, 2011 until July 16, 2011)

Subject: Multiarmed Bandit Problems
Institution: Basque Center for Applied Mathematics (BCAM), Derio (Spain)

*7.1.2.3. Ph.D. students*

Eugenio Martin Della Vecchia (from July 11, 2011 until July 19, 2011)

Subject: Rolling Horizon stochastic control
Institution: National University of Rosario (Argentina)

Ana Maria Galindo (from September 15, 2011 until December 15, 2011)

Institution: Centre Tecnològic de Telecomunicacions de Catalunya (CTTC) (Spain)

Naveen K. P. (from October 11, 2011 until October 20, 2011)

Subject: Self Organization in Wireless Networks
Institution: Indian Institute of Science, Bangalore (India)

Sulan Wong (from May 2, 2010 until July 31, 2011)

Subject: Intellectual property and human rights : Patent law interference in the exercise of the scientific research freedom, the right to life and the right to health
Institution: University of A Coruña (Spain)

*7.1.2.4. Graduate students*

Tejas Bodas (from October 17, 2011 until October 20, 2011)

Institution: Indian Institute of Technology Bombay (India)

*7.1.2.5. Internships*

Adam Abeshouse (from June 1, 2011 until July 21, 2011)

Subject: Simulator for visualization of evolutionary games
Institution: Brown University (USA)

Bogdan Augustin Benga (from April 1, 2011 until September 30, 2011)

Subject: Monte Carlo Methods for Centrality Measures in Online Social Networks
Institution: West Timisoara University (Romania)

John Boreiko (from June 1, 2011 until July 21, 2011)

Subject: Simulator for visualization of replicator dynamics in evolutionary games
Institution: Brown University (USA)

Vladimir Fux (from March 17, 2011 until June 15, 2011)

Subject: Framework for crawling and analyzing web and social networking graphs
Institution: St. Petersburg State University (Russia (Russian Federation))

Alexey Mishenin (from February 23, 2011 until March 25, 2011)

Subject: Random walks based clustering techniques
Institution: St. Petersburg State University (Russia (Russian Federation))

Harshil Mittal (from May 30, 2011 until August 26, 2011)

Subject: Study of network capacity sharing in contents distribution networks
Institution: LNM Institute of Information Technology (India)

Larissa Spinelli (from April 18, 2011 until July 15, 2011)

Subject: Consensus algorithms in complex networks
Institution: Universidade Federal do Rio de Janeiro (Brazil)

### *7.1.3. Participation in International Programs*

*7.1.3.1. STIC Tunisie*

**Participants:** Eitan Altman, Majed Haddad.

E. Altman and M. Haddad have been collaborating with I. Mabrouki (Institut Supérieur d'Informatique et des Techniques de Communication, Tunisia) on intelligent jamming in wireless networks, i.e. jamming in which the jammer is aware of the protocol used by the network.

*7.1.3.2. Indo-French Centre for the Promotion of Advanced Research (IFCPAR)*

**Participants:** Eitan Altman, Manjesh Kumar Hanawal.

Within project 4000-IT on "Emerging Strategies for Wireless Communication Networks," E. Altman and M. K. Hanawal (also with Univ. Avignon/LIA) have been collaborating with V. Kavitha (Univ. Avignon/LIA), R. Sundaresan and C. Singh (Indian Institute of Science, India) on evaluating and optimization issues in wireless networks. They also worked on network neutrality issues.

## 7.2. European Initiatives

### *7.2.1. FP7 Projects*

*7.2.1.1. ECODE*

**Participant:** Konstantin Avrachenkov.

Title: Experimental COgnitive Distributed Engine (ECODE)

Type: COOPERATION (ICT)

Challenge: New paradigms and experimental facilities

Instrument: Specific Targeted Research Project (STREP)

Duration: September 2008 – August 2011

Coordinator: Alcatel Lucent (Belgium)

Other partners:

- Universite Catholique de Louvain (UCL), IP Networking Lab (INL) (Belgium)
- Universite de Liege (ULg), Research Unit in Networking (Belgium)
- Interdisciplinair instituut voor BreedBand Technologie (IBBT), iLab.t (Belgium)
- Lancaster University (ULANC), Computing Department (United Kingdom)
- Centre National de la Recherche Scientifique (CNRS), Laboratory for Analysis and Architecture of Systems (LAAS) (France)

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

Abstract: As part of the Future Internet Research and Experimentation (FIRE) initiative, the ECODE FP7 project designs and experiments machine learning-based control functionality. For this purpose, the project designs, develops, and experiments a distributed machine learning component that augments the capability and functionality of the routing and the forwarding engine of current routers. To evaluate the executability and the performance of the developed machine learning based control functionality, several experiments are conducted at the iLab.t experimental facility, located at IBBT in Ghent, Belgium.

MAESTRO's task is to design and evaluate flow management schemes that can deal with potentially sampled traffic information. K. Avrachenkov is the coordinator for MAESTRO.

## 7.3. National Initiatives

### *7.3.1. 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

### *7.3.2. ANR Syscom MODECOL (01/2009–12/2011)*

**Participants:** Eitan Altman, Alain Jean-Marie.

ANR VERSO MODECOL (Using mathematical MODeling to improve ECOLogical services of prairial ecosystems) is integrated in the framework of the urgent need for solutions for compensating human deterioration of the environment. New environmental policies point out natural ecosystems as key elements for providing ecological services such as water purification, soil detoxification, climate regulation and advocate for the creation of new ecosystems (as surrogates for the degraded natural systems) for increasing their positive effect on the environment. The design of such new ecosystems needs to be optimized for providing the best ecological services. The project MODECOL aims at developing a hybrid model, sufficiently realistic, that will simulate a prairial ecosystem (modelled through IBM) correlated through feedbacks to environmental conditions (modelled through PDEs). This approach aims to provide a virtual laboratory for testing ecological hypothesis on complex ecological systems.

The participants are: UMR Ecobio (CNRS/Univ. Rennes 1), University of Houston (USA), University of Berkeley (USA), University of La Rochelle, and INRIA through its projects and project-teams MAESTRO, MODEMIC and TOSCA.

http://ecobio.univ-rennes1.fr/modecol/gb/index.php

### *7.3.3. ANR Multimedia VOODDO (2008-2011)*

**Participant:** Alain Jean-Marie.

The aim of this research project, now terminated, was the development of an innovative visualization interface for video contents, based on a safe, reliable and optimized storage and transport infrastructure. It was coordinated by the VodDnet company, and involved researchers of the LIRMM (University of Montpellier 2 and CNRS). The last results obtained were on the optimal placement of data [84] and the problem of prefetching data so that users never experience blocking [86].

### *7.3.4. INRIA Cooperative Research Initiative (ARC) OCOQS (2011-2013)*

**Participant:** Alain Jean-Marie.

The ARC OCOQS (Optimal threshold policies in COntrolled Queuing Systems) is devoted to the structural analysis of Markov Decision Processes, with the objective to improve the set of formal techniques available to prove that optimal control policies have a particular structure (typically, threshold-type). One of the benchmarks for this project is the extension of the model solved in [102]. This project also involves A. Busic (INRIA project-team TREC), E. Hyon (LIP6 and Univ. Paris 10) and I. Vliegen (Univ. Twente).

http://www.di.ens.fr/~busic/OCOQS/

## 7.4. Visits of Maestro staff to other research institutions

K. Avrachenkov visited the Basque Center for Applied Mathematics (BCAM) (Derio, Spain) in the period January 10–15, 2011, the University of Liverpool (United Kingdom) in the period March 7–11, 2011, and the University of Twente in the period May 23, 2011 – June 24, 2011.

A. Jean-Marie visited the Groupe d'études et de recherche en analyse des décisions (GERAD) (Montréal, Canada), in the periods May 2–27, 2011, and November 21–30, 2011, as well as the Universidad Nacional de Rosario (Rosario, Argentina), in the period September 3–7, 2011.

G. Neglia visited the Electrical Engineering Department of the University of Palermo (Italy), in the period December 22–23, 2011.

# 8. Dissemination

## 8.1. Animation of the scientific community

### *8.1.1. Editorial activities*

E. Altman is an Associate Editor of *Journal of Economics, Dynamics and Control* (JEDC), *Dynamic Games and Applications* (DGAA) Springer, and *Computer Communications* (COMCOM) Elsevier.

K. Avrachenkov is an Associate Editor of *Performance Evaluation*.

A. Jean-Marie has been Associate Editor for *RAIRO Operations Research* until 2011.

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

### *8.1.2. Participation in technical program committees*

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

- 9th International Symposium on Modeling and Optimization in Mobile, Ad Hoc, and Wireless Networks (WiOpt 2011), Princeton, New Jersey, USA (May 9–13, 2011),
- 29th International Symposium on Computer Performance, Modeling, Measurements and Evaluation (IFIP Performance 2011), Amsterdam, The Netherlands (October 18–20, 2011),
- IEEE 75th Vehicular Technology Conference (VTC2012-Spring), Yokohama, Japan (May 6–9, 2012).

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

- 2nd International Conference on Game Theory for Networks (GameNets 2011), Shanghai, China (April 16–18, 2011),
- 5th International Conference on Game Theory and Management (GTM 2011), St. Petersburg, Russia (June 27–29, 2011),
- IEEE ICC Workshop on Game Theory and Resource Allocation for 4G (GeT-ReAl 2011), Kyoto, Japan (June 5, 2011).

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

- 11th International Conference on Next Generation Wired/Wireless Networking (NEW2AN 2011), St. Petersburg, Russia (August 23–35, 2011),
- 3rd International Conference on Advances in Future Internet (AFIN 2011), Nice/Saint Laurent du Var, France (August 21–27, 2011),
- 4th International Workshop on Multiple Access Communications (MACOM 2011), Trento, Italy (September 11–13, 2011),
- International Conference on NETwork Games, COntrol and OPtimization (NETGCOOP 2011), Paris, France (October 12–14, 2011),

– 2nd Conference on Decision and Game Theory for Security (GameSec 2011), College Park, Maryland, USA (November 14–15, 2011).

M. Haddad was a program committee member of the following conferences:

– International Conference on NETwork Games, COntrol and OPtimization (NETGCOOP 2011), Paris, France (October 12–14, 2011),

– 2nd Conference on Decision and Game Theory for Security (GameSec 2011), College Park, Maryland, USA (November 14–15, 2011).

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

– 13th Workshop on Mathematical Performance Modeling and Analysis (MAMA 2011), San Jose, California, USA (June 8, 2011),

– 26th International Symposium on Computer and Information Sciences (ISCIS 2011), London, UK (September 26–28, 2011).

P. Nain was a program committee member of the following conferences:

– 13th Workshop on Mathematical Performance Modeling and Analysis (MAMA 2011), San Jose, California, USA (June 8, 2011),

– 29th International Symposium on Computer Performance, Modeling, Measurements and Evaluation (IFIP Performance 2011), Amsterdam, The Netherlands (October 18–20, 2011).

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

– 46th IEEE International Conference on Communications – Next Generation Networking and Internet Symposium (IEEE ICC 2011 – NGNI), Tokyo, Japan (June 6–8, 2011),

– 5th International IEEE WoWMoM Workshop on Autonomic and Opportunistic Communications (IEEE AOC 2011), Lucca Italy (June 20, 2011),

– 20th International Conference on Computer Communications and Networks (ICCCN 2011), Maui, Hawaii, USA (July 31 – August 4, 2011),

– 6th International Conference on Broadband, Wireless Computing, Communication and Applications (BWCCA 2011), Barcelona, Spain (October 26–28, 2011),

– 31st Annual IEEE International Conference on Computer Communications (IEEE INFOCOM 2012), Orlando, Florida, USA (March 25–30, 2012).

M. Panda was a program committee member of the following conferences:

– International Conference on NETwork Games, COntrol and OPtimization (NETGCOOP 2011), Paris, France (October 12–14, 2011),

– 2nd Conference on Decision and Game Theory for Security (GameSec 2011), College Park, Maryland, USA (November 14–15, 2011).

### *8.1.3. Conferences, meetings and tutorial organization*

E. Altman was a TPC co-chair of the 2nd Conference on Decision and Game Theory for Security (GameSec 2011), College Park, Maryland, USA (November 14–15, 2011), and a co-chair of the 3rd International Workshop on Indoor and Outdoor Femto Cells (IOFC 2011), Princeton, New Jersey, USA (May 13, 2011). He has been the steering committee chair of the 9th International Symposium on Modeling and Optimization in Mobile, Ad Hoc, and Wireless Networks (WiOpt 2011), Princeton, New Jersey, USA (May 9–13, 2011) and the International Conference on NETwork Games, COntrol and OPtimization (NETGCOOP 2011), Paris, France (October 12–14, 2011).

K. Avrachenkov was chair and organizer of a special session on "Structured Markov Chains" at the 5th ICST International Conference on Performance Evaluation Methodologies and Tools (ValueTools 2011), Cachan, France (May 16–20, 2011).

### *8.1.4. Participation in thesis committees*

E. Altman participated in the Habilitation (HDR) thesis committee of Rachid El-Azouzi (December 13, 2011, University of Avignon), and the PhD thesis committees of

- Van Minh Nguyen (June 20, 2011, Telecom ParisTech),
- Semir Medina Perlaza (July 8, 2011, SUPELEC) as a reviewer,
- Gaurav S. Kasbekar (September 29, 2011, University of Pennsylvania, Philadelphia) as a reviewer,
- Sreenath Ramanath (October 6, 2011, University of Avignon) as co-advisor,
- Anis Jdidi (November 3, 2011, University Pierre and Marie Curie).

K. Avrachenkov participated in the PhD thesis committee of Elena Smirnova (December 15, 2011, INRIA).

A. Jean-Marie participated in the PhD thesis committees of

- Jean Daligault (July 5, 2011, University of Montpellier 2) as president,
- Dorian Mazauric (November 7, 2011, University of Nice-Sophia Antipolis) as president, and
- Dalila Goudia (December 6, 2011, University of Montpellier 2) as president.

P. Nain participated in the PhD thesis committees of

- Mohamad Jaber (October 6, 2011, University of Nice-Sophia Antipolis) as co-advisor.
- Tuan Minh Pham (December 14, 2011, University Pierre and Marie Curie) as a reviewer.
- Dorian Mazauric (November 7, 2011, University of Nice-Sophia Antipolis) as co-advisor.

### *8.1.5. Research administration*

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

E. Altman is co-responsible of one of the five themes of the SFR (Structure Fédérative de Recherche) AGORANTIC (in which INRIA is a founding member) entitled "Digital Culture and Virtual Societies."

K. Avrachenkov

- is a member of the Invited Researchers Committee of INRIA Sophia Antipolis - Méditerranée.
- is responsible for validation of activity reports of all teams at INRIA Sophia Antipolis - Méditerranée.

N. Choungmo Fofack is the PhD representative at the General Information Commission of INRIA Sophia Antipolis - Méditerranée.

A. Jean-Marie

- is the scientific coordinator of INRIA activities in Montpellier.
- is member of the managing sub-committee of the Project-Team Committee of the INRIA Sophia Antipolis - Méditerranée research center.
- was appointed expert for the Recruiting Committee for Professors (Commission d'Évaluation des Appellations) at Telecom ParisTech.

- 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 Head of project-team MAESTRO.
- is a member of the INRIA steering group (13 people including 6 researchers) in charge of producing the first version of the INRIA 2013-2017 strategic plan.

### *8.1.6. Miscellaneous (nominations, awards, etc.)*

- E. Altman is a fellow member of IEEE.
- E. Altman, A. Jean-Marie and P. Nain are (elected) members of IFIP WG7.3 on "Computer System Modeling".
- 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, 2011). This year he has been promoted at the rank of "directeur de recherche de classe exceptionnelle" (DRCE).

### *8.1.7. Scientific popularization*

S. Alouf gave conferences at the Albert Camus Library, Antibes, France (May 20, 2011), at the International High School of Manosque, France (November 7, 2011) and at the Jean Cocteau High School of Miramas, France (November 24, 2011).

## 8.2. Teaching and supervision

### *8.2.1. Teaching activities*

E. Altman

Master : "Network Engineering Games", 15H (22.5H ETD), M2, University Pierre and Marie Curie (UPMC), France.

K. Avrachenkov

Master : "Linear Algebra and Numerical Methods", 12H (18H ETD), M1 EuroAquae, University of Nice Sophia Antipolis (UNS), France.

Master : "Probability and Statistics", 18H (27H ETD), M1 EuroAquae, University of Nice Sophia Antipolis (UNS), France.

N. Choungmo Fofack

Licence : "Stochastic processes for Signal Processing", 64H (64H ETD), 1st year Electronic Engineering degree (L3), University of Nice Sophia Antipolis (UNS), France.

A. Jean-Marie

Master : Metrology and Quality of Service for Networks, 12H (18H ETD), M2, University of Montpellier 2, France.

Doctoral module : Advanced Markov Modeling, 18H (18H ETD), University of Montpellier 2, France.

D. Mazauric

Licence : "Algorithms and Complexity", 25H (29H ETD), Computer Science Program (L3), University of Nice Sophia Antipolis (UNS), France.

Licence : “Functional Programming (Scheme)”, 18H (18H ETD), Computer Science Program (L1), University of Nice Sophia Antipolis (UNS), France.

P. Nain

Master : “Performance Evaluation of Networks”, 21H (32.5H ETD), M2 IFI Ubinet, University of Nice Sophia Antipolis (UNS), France.

G. Neglia

Licence : “Probability and Statistics”, 35H (38.5H ETD), 1st year Applied Mathematics and Modeling Engineering degree (L3), University of Nice Sophia Antipolis (UNS), France.

Master : “Performance Evaluation of Networks”, 15H (22.5H ETD), M2 IFI Ubinet, University of Nice Sophia Antipolis (UNS), France.

Master : “Introduction to Fluid Models”, 6H (9H ETD), M2, University of Palermo, Italy.

Doctoral module : “Introduction to Game Theory”, 4H (6H ETD), PhD school, organized by the Italian Control Theory Society, Italy.

### *8.2.2. HDR and PhD theses*

PhD: Dorian Mazauric, “Discrete optimization in telecommunication networks: reconfiguration of the routing, energy efficient routing, link scheduling, and data placement” [12], University of Nice Sophia Antipolis, November 7 2011, advisors: Jean-Claude Bermond (INRIA project-team MASCOTTE) and Philippe Nain.

PhD: Sreenath Ramanath, “Cell design and resource allocation for small cell networks” [13], University of Avignon, October 6 2011, advisors: Eitan Altman and Merouane Debbah (SUPELEC).

PhD in progress: Nicaise Choungmo Fofack, “Analysis of green strategies in wireless cellular networks,” October 1 2010, advisors: Sara Alouf and Philippe Nain.

PhD in progress: Richard Combes, “Self-organizing functionalities in radio networks,” October 1 2009, advisors: Eitan Altman and Zwi Altman (France Telecom) and Sylvain Sorin (University Pierre and Marie Curie).

PhD in progress: Mahmoud El Chamie, “Belief propagation in complex networks,” October 1 2011, advisors: Konstantin Avrachenkov and Giovanni Neglia.

PhD in progress: Julien Gaillard, “Creation, simulation and multidiscipline evaluation of dynamic mobility models in complex systems,” October 1 2011, advisors: Eitan Altman, Marc El-Bèze (University of Avignon) and Emmanuel Ethis (University of Avignon).

PhD in progress: Manjesh Kumar Hanawal, “Resource allocation and learning algorithms in small cells wireless networks,” January 1 2010, advisors: Eitan Altman and Rachid El-Azouzi (University of Avignon).

PhD in progress: Cengis Hasan, “Optimization of resource allocation for small cells networks,” October 1 2010, advisors: Eitan Altman and Jean-Marie Gorce (INRIA project-team SWING).

PhD in progress: Lorenzo Maggi, “Game theory for wireless communications,” November 1 2009, advisors: Konstantin Avrachenkov and Laura Cottatellucci (INSTITUT EURECOM).

PhD in progress: Marina Sokol, “Clustering and learning tecnhiques for traffic/user classification,” October 1 2009, advisors: Paulo Gonçalves (INRIA project-team RESO) and Philippe Nain.

## 8.3. Participation in scientific events

### *8.3.1. Conferences and workshops*

S. Alouf attended the 29th International Symposium on Computer Performance, Modeling, Measurements and Evaluation (IFIP Performance 2011), Amsterdam, The Netherlands (October 18–20, 2011).

E. Altman gave presentations at:

- 10th International Conference on Networking (Networking 2011), Valencia, Spain (May 9–13, 2011),
- MENEUR Workshop, Paris, France (May 26, 2011),
- International Conference on NETwork Games, COntrol and OPtimization (NETGCOOP 2011), Paris, France (October 12–14, 2011),
- Bionetic workshop, York, United Kingdom, (December 5–6, 2011).

K. Avrachenkov gave presentations at:

- 5th ICST International Conference on Performance Evaluation Methodologies and Tools (ValueTools 2011), Cachan, France (May 16–20, 2011),
- 8th Workshop on Algorithms and Models for the Web Graph (WAW 2011), Atlanta, GA, USA (May 28, 2011),
- 4th International Conference on Markov and Semi Markov Processes and Related Fields (MSMPRF 2011), Sithonia, Greece (September 20–23, 2011).

M. Haddad gave a presentation at the 5th ICST International Conference on Performance Evaluation Methodologies and Tools (ValueTools 2011), Cachan, France (May 16–20, 2011).

M. K. Hanawal gave a presentation at:

- 2nd International Conference on Game Theory for Networks (GameNets 2011), Shanghai, China (April 16–18, 2011),
- MENEUR Workshop, Paris, France (May 26, 2011).

D. Mazauric gave a presentation at the 13th French Meeting on the Algorithmics of Telecommunications (AlgoTel'11), Agay, France (May 23–26, 2011).

G. Neglia gave a presentation at the 5th French-Japanese Symposium "Frontiers of Science", Tokyo, Japan (January 22, 2011).

M. Panda gave a presentation at the International Conference on NETwork Games, COntrol and OPtimization (NETGCOOP 2011), Paris, France (October 12–14, 2011).

S. Ramanath gave presentations at:

- 9th International Symposium on Modeling and Optimization in Mobile, Ad Hoc, and Wireless Networks (WiOpt 2011), Princeton, New Jersey, USA (May 9–13, 2011),
- 3rd International Workshop on Indoor and Outdoor Femto Cells (IOFC 2011), Princeton, New Jersey, USA (May 13, 2011),
- IEEE Winter School of Information Theory (WSIT), Barcelona, Spain (March 15–19, 2011).

### *8.3.2. Invited talks*

K. Avrachenkov gave invited talks at the STAR-seminar on Stochastic Networks at CWI, The Netherlands (May 24, 2011) and at the TW Colloquium at University of Twente, The Netherlands (May 26, 2011).

M. K. Hanawal gave an invited talk at the Workshop on Stochastic Geometry (GDR ISIS), Paris, France (December 9, 2011).

G. Neglia gave an invited talk at the Workshop on Algorithmic Game Theory: Dynamics and Convergence in Distributed Systems (AlgoGT), Grenoble, France (June 20, 2011).

### *8.3.3. Schools and students workshops*

Winter School in Computer Science (24H), ENS Lyon, France (January 10–14, 2011): attended by M. K. Hanawal, S. Ramanath. Course title “Stochastic Geometry for Wireless Networks”.

Tutorial on “Mean field stochastic games” (12H), SUPELEC, France (March 29 and April 1, 2011): attended by M. Panda.

# 9. Bibliography

## Major publications by the team in recent years

[1] S. ALOUF, G. NEGLIA, I. CARRERAS, D. MIORANDI, Á. FIALHO. *Fitting genetic algorithms to distributed on-line evolution of network protocols*, in "Computer Networks", December 2010, vol. 54, n° 18, p. 3402-3420 [*DOI :* 10.1016/J.COMNET.2010.06.015], http://hal.inria.fr/hal-00640798/en/.

[2] 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, April 19-25, 2009, p. 1431–1439, http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=5062059.

[3] E. ALTMAN, P. NAIN, A. SHWARTZ, Y. XU. *Predicting the Impact of Measures Against P2P Networks on the Transient Behaviors*, in "Proceedings of IEEE INFOCOM 2011", Shanghai, China, April 2011, p. 1440–1448, http://dx.doi.org/10.1109/INFCOM.2011.5934931.

[4] E. ALTMAN, T. BAŞAR, F. DE PELLEGRINI. *Optimal Control in Two-Hop Relay Routing*, in "IEEE Transactions on Automatic Control", March 2011, vol. 56, n° 3, p. 670–675, http://dx.doi.org/10.1109/TAC.2010.2095930.

[5] E. ALTMAN, F. DE PELLEGRINI. *Forward correction and fountain codes in delay-tolerant networks*, in "IEEE/ACM Transactions on Networking", February 2011, vol. 19, n° 1, p. 1-13, http://dx.doi.org/10.1109/TNET.2010.2091968.

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

[7] K. AVRACHENKOV, B. RIBEIRO, D. TOWSLEY. *Improving Random Walk Estimation Accuracy with Uniform Restarts*, in "Proc. of 7th Workshop on Algorithms and Models for the Web Graph (WAW 2010)", Stanford University, CA, USA, Lecture Notes in Computer Science, Springer Berlin / Heidelberg, December 13-14, 2010, vol. 6516, p. 98–109, http://dx.doi.org/10.1007/978-3-642-18009-5_10.

[8] 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.

[9] V. MANCUSO, S. ALOUF. *Power save analysis of cellular networks with continuous connectivity*, in "Proc. of 2011 IEEE International Symposium on a World of Wireless, Mobile and Multimedia Networks (WoWMoM 2011)", Lucca, Italy, June 2011 [*DOI :* 10.1109/WOWMOM.2011.5986202], http://hal.inria.fr/hal-00640894/en/.

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

[11] H. ZHANG, G. NEGLIA, D. TOWSLEY, G. LO PRESTI. *Stability and Efficiency of Unstructured File Sharing Networks*, in "IEEE Journal on Selected Areas in Communications", September 2008, vol. 26, n$^{o}$ 7, p. 1284–1294.

## Publications of the year

### Doctoral Dissertations and Habilitation Theses

[12] D. MAZAURIC. *Optimisation discrète dans les réseaux de télécommunication : reconfiguration du routage, routage efficace en énergie, ordonnancement de liens et placement de données*, University of Nice Sophia Antipolis, November 7, 2011, http://hal.inria.fr/tel-00643513/en.

[13] S. RAMANATH. *Cell design and resource allocation for small cell networks*, University of Avignon and the Vaucluse, October 6, 2011.

### Articles in International Peer-Reviewed Journal

[14] E. ALTMAN, K. AVRACHENKOV, A. GARNAEV. *Closed form solutions for water-filling problems in optimization and game frameworks*, in "Telecommunication Systems", June 2011, vol. 47, n$^{o}$ 1-2, p. 153–164, Special Issue on Game Theory in Communications Networks Dedicated to Papers from GameComm'08 and GameComm'07, http://dx.doi.org/10.1007/s11235-010-9308-0.

[15] E. ALTMAN, K. AVRACHENKOV, A. GARNAEV. *Jamming in Wireless Networks Under Uncertainty*, in "Mobile Networks and Applications", April 2011, vol. 16, p. 246–254, Special Issue: Ad-hoc Wireless Network Systems, http://dx.doi.org/10.1007/s11036-010-0272-4.

[16] E. ALTMAN, U. AYESTA, B. J. PRABHU. *Load balancing in processor sharing systems*, in "Telecommunication Systems", June 2011, vol. 47, n$^{o}$ 1-2, p. 35–48, Special Issue on Game Theory in Communications Networks Dedicated to Papers from GameComm'08 and GameComm'07, http://dx.doi.org/10.1007/s11235-010-9300-8.

[17] E. ALTMAN, T. BAŞAR, F. DE PELLEGRINI. *Optimal Control in Two-Hop Relay Routing*, in "IEEE Transactions on Automatic Control", March 2011, vol. 56, n$^{o}$ 3, p. 670–675, http://dx.doi.org/10.1109/TAC.2010.2095930.

[18] E. ALTMAN, F. DE PELLEGRINI. *Forward correction and fountain codes in delay-tolerant networks*, in "IEEE/ACM Transactions on Networking", February 2011, vol. 19, n$^{o}$ 1, p. 1–13, http://dx.doi.org/10.1109/TNET.2010.2091968.

[19] K. AVRACHENKOV, A. DUDIN, V. KLIMENOK, P. NAIN, O. SEMENOVA. *Optimal threshold control by the robots of web search engines with obsolescence of documents*, in "Computer Networks", June 2011, vol. 55, n$^{o}$ 8, p. 1880–1893, http://dx.doi.org/10.1016/j.comnet.2011.01.013.

[20] K. AVRACHENKOV, A. PIUNOVSKIY, Y. ZHANG. *Asymptotic fluid optimality and efficiency of the tracking policy for bandwidth-sharing networks*, in "Journal of Applied Probabilities", March 2011, vol. 48, p. 90–113, http://dx.doi.org/10.1239/jap/1300198138.

[21] A. P. AZAD, S. ALOUF, E. ALTMAN, V. BORKAR, G. S. PASCHOS. *Optimal Control of Sleep Periods for Wireless Terminals*, in "IEEE Journal on Selected Areas in Communications", September 2011, vol. 29, n$^{o}$ 8, p. 1605–1617 [*DOI :* 10.1109/JSAC.2011.110910], http://hal.inria.fr/hal-00640926/en.

[22] D. CARRA, G. NEGLIA, P. MICHIARDI, F. ALBANESE. *On the Robustness of BitTorrent Swarms to Greedy Peers*, in "IEEE Transactions on Parallel and Distributed Systems", December 2011, vol. 22, n$^{o}$ 12, p. 2071–2078 [*DOI :* 10.1109/TPDS.2011.94], http://hal.inria.fr/hal-00648127/en.

[23] R. COMBES, Z. ALTMAN, E. ALTMAN. *Scheduling gain for frequency-selective Rayleigh-fading channels with application to self-organizing packet scheduling*, in "Performance Evaluation", February 2011, vol. 68, n$^{o}$ 8, p. 690–709, Special Issue: Modeling and Optimization in Mobile, Ad hoc, and Wireless Networks: selected papers from WiOpt 2010, http://dx.doi.org/10.1016/j.peva.2011.01.009.

[24] J. ELIAS, F. MARTIGNON, K. AVRACHENKOV, G. NEGLIA. *A game theoretic analysis of network design with socially-aware users*, in "Computer Networks", January 2011, vol. 55, n$^{o}$ 1, p. 106–118 [*DOI :* 10.1016/J.COMNET.2010.07.014], http://hal.inria.fr/hal-00648161/en.

[25] J. ELIAS, F. MARTIGNON, A. CAPONE, E. ALTMAN. *Non-cooperative spectrum access in cognitive radio networks: A game theoretical model*, in "Computer Networks", December 2011, vol. 55, n$^{o}$ 17, p. 3832–3846 [*DOI :* 10.1016/J.COMNET.2011.07.022], http://www.sciencedirect.com/science/article/pii/S1389128611002829.

[26] M. HADDAD, S.-E. ELAYOUBI, E. ALTMAN, Z. ALTMAN. *A Hybrid Approach for Radio Resource Management in Heterogeneous Cognitive Networks*, in "IEEE Journal on Selected Areas in Communications", April 2011, vol. 29, n$^{o}$ 4, p. 831–842, http://dx.doi.org/10.1109/JSAC.2011.110414.

[27] H. KAMEDA, J. LI, E. ALTMAN. *Optimal Routing for Multiclass Networks*, in "Advances in Operations Research", 2011, vol. 2011, Article ID 645954, 21 pages, http://dx.doi.org/10.1155/2011/645954.

[28] V. KAVITHA, S. RAMANATH, E. ALTMAN. *Spatial queuing analysis for design and dimensioning of Picocell networks with mobile users*, in "Performance Evaluation", August 2011, vol. 68, n$^{o}$ 8, p. 710–727, Special Issue: Modeling and Optimization in Mobile, Ad hoc, and Wireless Networks: selected papers from WiOpt 2010, http://dx.doi.org/10.1016/j.peva.2011.03.002.

[29] V. MANCUSO, S. ALOUF. *Reducing costs and pollution in cellular networks*, in "IEEE Communications Magazine", August 2011, vol. 49, n$^{o}$ 8, p. 63–71 [*DOI :* 10.1109/MCOM.2011.5978417], http://hal.inria.fr/inria-00506758/en.

[30] H. TEMBINE, E. ALTMAN, R. EL-AZOUZI, Y. HAYEL. *Bio-inspired Delayed Evolutionary Game Dynamics with Networking Applications*, in "Telecommunication Systems", June 2011, vol. 47, n$^{o}$ 1-2, p. 137–152, Special Issue on Game Theory in Communications Networks Dedicated to Papers from GameComm'08 and GameComm'07 [*DOI :* 10.1007/s11235-010-9307-1], http://hal.inria.fr/hal-00632204/en.

[31] I. TINNIRELLO, L. GIARRÉ, G. NEGLIA. *MAC Design for WiFi Infrastructure Networks: A Game-Theoretic Approach*, in "IEEE Transactions on Wireless Communications", August 2011, vol. 10, n$^{o}$ 8, p. 2510–2522 [*DOI :* 10.1109/TWC.2011.062011.100193], http://hal.inria.fr/hal-00648152/en.

[32] P. WIECEK, Y. HAYEL, E. ALTMAN. *Stochastic State Dependent Population Games in Wireless Communication*, in "IEEE Transaction on Automatic Control", March 2011, vol. 56, n$^{o}$ 3, p. 492–505, http://dx.doi.org/10.1109/TAC.2010.2054810.

[33] S. WONG, E. ALTMAN, J. ROJAS-MORA. *Internet access: Where law, economy, culture and technology meet*, in "Computer Networks", February 2011, vol. 55, n$^{o}$ 2, p. 470–479, Special Issue: Wireless for the Future Internet, http://dx.doi.org/10.1016/j.comnet.2010.09.004.

### Invited Conferences

[34] E. ALTMAN, J. ROJAS-MORA, S. WONG, M. K. HANAWAL, Y. XU. *Net Neutrality and Quality of Service*, in "Proc. of 2nd International Conference on Game Theory for Networks (GameNets 2011)", Shanghai, China, April 2011, http://arxiv.org/abs/1105.0283.

### International Conferences with Proceedings

[35] U. ACER, P. GIACCONE, D. HAY, G. NEGLIA, S. TARAPIAH. *Timely Data Delivery in a Realistic Bus Network*, in "Proceedings of IEEE INFOCOM 2011", Shangai, China, April 2011, p. 446–450, Presented at the Mini-Conference [*DOI :* 10.1109/INFCOM.2011.5935201], http://hal.inria.fr/hal-00648204/en.

[36] A. ALI, E. ALTMAN, T. CHAHED, M. PANDA, L. SASSATELLI. *A New Reliable Transport Scheme in Delay Tolerant Networks Based on Acknowledgments and Random Linear Coding*, in "23rd International Teletraffic Congress (ITC 2011)", San Francisco, USA, September 2011, p. 214–221, http://dl.acm.org/citation.cfm?id=2043468.2043503.

[37] A. ALI, T. CHAHED, E. ALTMAN, M. PANDA, L. SASSATELLI. *A New Proposal for Reliable Unicast and Multicast Transport in Delay Tolerant Networks*, in "22nd IEEE Personal Indoor Mobile Radio Communications (PIMRC'11 - LPAN)", Toronto, Canada, September 2011, p. 1129–1134.

[38] E. ALTMAN, Z. ALTMAN, R. COMBES, S. SORIN. *Routing Games in the many players regime*, in "Proceedings of the International Workshop on Game Theory in Communication Networks (GAMECOMM)", Paris, France, May 16, 2011.

[39] E. ALTMAN, K. AVRACHENKOV, S. RAMANATH. *Multiscale Fairness and its Application to Resource Allocation in Wireless Networks*, in "IFIP/TC6 Networking 2011", Valencia, Spain, Lecture Notes in Computer Science, May 9-13, 2011, vol. 6641, p. 225–237, http://dx.doi.org/10.1007/978-3-642-20798-3_17.

[40] E. ALTMAN, A. ESTANISLAO, M. PANDA. *Routing Games on a Circle*, in "NetGCOOP 2011: International conference on NETwork Games, COntrol and OPtimization", Paris, France, October 2011, http://hal.inria.fr/hal-00644364/en.

[41] E. ALTMAN, V. KAVITHA, F. DE PELLEGRINI, V. KAMBLE, V. BORKAR. *Risk sensitive optimal control framework applied to delay tolerant networks*, in "Proceedings of IEEE INFOCOM 2011", Shanghai, China, April 2011, p. 3146–3154, http://dx.doi.org/10.1109/INFCOM.2011.5935161.

[42] E. ALTMAN, A. LEGOUT, Y. XU. *Network Non-Neutrality Debate: An Economic Analysis*, in "IFIP/TC6 Networking 2011", Valencia, Spain, Lecture Notes in Computer Science, May 9-13, 2011, vol. 6641, p. 68–81 [*DOI :* 10.1007/978-3-642-20798-3_6], http://hal.inria.fr/inria-00568922/en.

[43] E. ALTMAN, P. NAIN, A. SHWARTZ, Y. XU. *Predicting the Impact of Measures Against P2P Networks on the Transient Behaviors*, in "Proceedings of IEEE INFOCOM 2011", Shanghai, China, April 2011, p. 1440–1448, http://dx.doi.org/10.1109/INFCOM.2011.5934931.

[44] E. ALTMAN, O. POURTALLIER, T. JIMENEZ, H. KAMEDA. *Symmetric Games with networking applications*, in "NetGCOOP 2011: International conference on NETwork Games, COntrol and OPtimization", Paris, France, October 2011, http://hal.inria.fr/hal-00644106/en.

[45] K. AVRACHENKOV, M. EL CHAMIE, G. NEGLIA. *A Local Average Consensus Algorithm for Wireless Sensor Networks*, in "International Conference on Distributed Computing in Sensor Systems and Workshops (DCOSS 2011)", Barcelona, Spain, June 2011 [*DOI :* 10.1109/DCOSS.2011.5982199], http://hal.inria.fr/hal-00648185/en.

[46] K. AVRACHENKOV, J. ELIAS, F. MARTIGNON, G. NEGLIA, L. PETROSYAN. *A Nash bargaining solution for cooperative network formation games*, in "IFIP/TC6 Networking 2011", Valencia, Spain, Lecture Notes in Computer Science, May 9-13, 2011, vol. 6641, p. 307–318 [*DOI :* 10.1007/978-3-642-20757-0_24], http://hal.inria.fr/hal-00648190/en.

[47] K. AVRACHENKOV, A. LEGOUT, P. GONÇALVES, M. SOKOL. *Graph Based Classification of Content and Users in BitTorrent*, in "NIPS Big Learning Workshop 2011", Sierra Nevada, Spain, December 2011, http://biglearn.org/files/papers/biglearn2011_submission_14.pdf.

[48] K. AVRACHENKOV, N. LITVAK, D. NEMIROVSKY, E. SMIRNOVA, M. SOKOL. *Quick Detection of Top-k Personalized PageRank Lists*, in "Proc. of Algorithms and Models for the Web Graph – 8th International Workshop (WAW 2011)", Atlanta, GA, USA, Lecture Notes in Computer Science, May 27-29, 2011, vol. 6732, p. 50–61, http://dx.doi.org/10.1007/978-3-642-21286-4_5.

[49] A. CHATZIPAPAS, S. ALOUF, V. MANCUSO. *On the Minimization of Power Consumption in Base Stations using on/off Power Amplifiers*, in "2011 IEEE Online Conference on Green Communications", September 2011 [*DOI :* 10.1109/GREENCOM.2011.6082501], http://hal.inria.fr/hal-00640958/en.

[50] R. COMBES, Z. ALTMAN, E. ALTMAN. *A Self-Optimization Method for Coverage-Capacity Optimization in OFDMA networks with MIMO*, in "Proceedings of VALUETOOLS 2011 - 5th International ICST Conference on Performance Evaluation Methodologies and Tools", Paris, France, May 16-20, 2011.

[51] R. COMBES, Z. ALTMAN, E. ALTMAN. *Self-Organizing Fractional Power Control for Interference Coordination in OFDMA Networks*, in "IEEE International Conference on Communications Workshops (ICC 2011)", Kyoto, Japan, June 2011, http://dx.doi.org/10.1109/icc.2011.5963461.

[52] *Best Paper*
R. COMBES, Z. ALTMAN, E. ALTMAN. *Self-Organizing Relays in LTE networks: Queuing analysis and algorithms*, in "7th International Conference on Network and Service Management (CNSM 2011)", Paris, France, October 24-28, 2011, http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=6103951.

[53] R. COMBES, Z. ALTMAN, M. HADDAD, E. ALTMAN. *Self-Optimizing Strategies for Interference Coordination in OFDMA Networks*, in "IEEE International Conference on Communications Workshops (ICC 2011)", Kyoto, Japan, June 2011, http://dx.doi.org/10.1109/iccw.2011.5963595.

[54] E. DELLA VECCHIA, S. C. DI MARCO, A. JEAN-MARIE. *On the rolling horizon procedure applied to zero-sum semi-Markov games with discounted payoff*, in "Eighth International ISDG Workshop", Padova, Italy, July 2011.

[55] D. M. DIVAKARAN, E. ALTMAN, P. VICAT-BLANC PRIMET. *Size-Based Flow-Scheduling Using Spike-Detection*, in "18th International Conference on Analytical and Stochastic Modelling Techniques and Applications (ASMTA'11)", Venice, Italy, Lecture Notes in Computer Science, June 20-22, 2011, vol. 6751, p. 331–345, http://dx.doi.org/10.1007/978-3-642-21713-5_24.

[56] A. GARNAEV, K. AVRACHENKOV, Y. HAYEL, E. ALTMAN. *Pricing Throughput and QoS in Wireless Communication*, in "Proceedings of VALUETOOLS 2011 - 5th International ICST Conference on Performance Evaluation Methodologies and Tools", Paris, France, May 16-20, 2011.

[57] M. HADDAD, E. ALTMAN, R. EL-AZOUZI, T. JIMENEZ. *A Survey on YouTube Streaming Service*, in "Proceedings of VALUETOOLS 2011 - 5th International ICST Conference on Performance Evaluation Methodologies and Tools", Paris, France, May 16-20, 2011.

[58] C. HASAN, E. ALTMAN, J.-M. GORCE. *A Coalition Game Approach to the Association Problem of Mobiles in Broadcast Transmission*, in "Proceedings of the International Symposium on Modeling and Optimization in Mobile, Ad Hoc and Wireless Networks (WiOpt 2011)", Princeton, New Jersey, USA, May 2011, p. 236–240, http://dx.doi.org/10.1109/WIOPT.2011.5930021.

[59] Y. HAYEL, E. V. BELMEGA, E. ALTMAN. *Hawks and Doves in a Dynamic Framework*, in "NetGCOOP 2011: International conference on NETwork Games, COntrol and OPtimization", Paris, France, October 2011, http://hal.inria.fr/hal-00643719/en.

[60] M. KHOUZANI, S. SARKAR, E. ALTMAN. *A Dynamic Game Solution to Malware Attack*, in "Proceedings of IEEE INFOCOM 2011", Shanghai, China, April 2011, p. 2138–2146, http://dx.doi.org/10.1109/INFCOM.2011.5935025.

[61] M. KHOUZANI, S. SARKAR, E. ALTMAN. *Optimal Control of Epidemic Evolution*, in "Proceedings of IEEE INFOCOM 2011", Shanghai, China, April 2011, p. 1683–1691, http://dx.doi.org/10.1109/INFCOM.2011.5934963.

[62] I. LASSOUED, A. KRIFA, C. BARAKAT, K. AVRACHENKOV. *Network-wide monitoring through self-configuring adaptive system*, in "Proceedings of IEEE INFOCOM 2011", Shanghai, China, April 2011, p. 1826–1834, http://dx.doi.org/10.1109/INFCOM.2011.5934983.

[63] X. LEI, L. COTTATELLUCCI, K. AVRACHENKOV. *Equilibriums in slow fading interfering channels with partial knowledge of the channels*, in "Proceedings of IEEE INFOCOM 2011", Shanghai, China, April 2011, p. 481–485, Presented at the Mini-Conference, http://dx.doi.org/10.1109/INFCOM.2011.5935209.

[64] L. MAGGI, K. AVRACHENKOV, L. COTTATELLUCCI. *Stochastic Games for Cooperative Network Routing and Epidemic Spread*, in "IEEE International Conference on Communications Workshops (ICC 2011)", Kyoto, Japan, June 2011, http://dx.doi.org/10.1109/iccw.2011.5963532.

[65] V. MANCUSO, S. ALOUF. *Power save analysis of cellular networks with continuous connectivity*, in "2011 IEEE International Symposium on a World of Wireless, Mobile and Multimedia Networks (WoWMoM)", Lucca, Italy, June 2011 [*DOI :* 10.1109/WOWMOM.2011.5986202], http://hal.inria.fr/hal-00640894/en.

[66] R. MASIERO, G. NEGLIA. *Distributed subgradient methods for Delay Tolerant Networks*, in "Proceedings of IEEE INFOCOM 2011", Shangai, China, April 2011, p. 261–265, Presented at the Mini-Conference [*DOI :* 10.1109/INFCOM.2011.5935089], http://hal.inria.fr/hal-00648195/en.

[67] G. S. PASCHOS, P. MANNERSALO, S. STANCZAK, E. ALTMAN, L. TASSIULAS. *Energy Optimal Algorithms for mobile Internet: Stochastic modeling, performance analysis and optimal control*, in "7th Conference on Next Generation Internet (EURO-NGI 2011)", Kaiserslautern, Germany, June 27-29, 2011, p. 124–125, http://dx.doi.org/10.1109/NGI.2011.5985873.

[68] S. RAMANATH, E. ALTMAN, K. AVRACHENKOV. *A heterogeneous approach to fair resource allocation and its application in femtocell networks*, in "Indoor and Outdoor Femto Cells (IOFC'11)", Princeton, New Jersey, USA, May 13, 2011, p. 440–444, http://dx.doi.org/10.1109/WIOPT.2011.5930060.

[69] S. RAMANATH, V. KAVITHA, E. ALTMAN. *Open Loop Optimal Control of Base Station Activation for Green Networks*, in "Proceedings of the International Symposium on Modeling and Optimization in Mobile, Ad Hoc and Wireless Networks (WiOpt 2011)", Princeton, New Jersey, USA, May 2011, p. 161–166, http://dx.doi.org/10.1109/WIOPT.2011.5930009.

[70] S. RAMANATH, V. KAVITHA, M. DEBBAH. *Satisfying Demands in a Multicellular Network: A Universal Power Allocation Algorithm*, in "Proceedings of the International Symposium on Modeling and Optimization in Mobile, Ad Hoc and Wireless Networks (WiOpt 2011)", Princeton, New Jersey, USA, May 9-13, 2011, p. 175–182 [*DOI :* 10.1109/WIOPT.2011.5930011], http://hal.inria.fr/hal-00648524/en.

[71] J. ROJAS-MORA, T. JIMENEZ, E. ALTMAN. *Simulating Flow Level Bandwidth Sharing with Pareto distributed File Sizes*, in "Proceedings of VALUETOOLS 2011 - 5th International ICST Conference on Performance Evaluation Methodologies and Tools", Paris, France, May 16-20, 2011.

[72] C. K. SINGH, E. ALTMAN. *The wireless multicast coalition game and the non-cooperative association problem*, in "Proceedings of IEEE INFOCOM 2011", Shanghai, China, April 2011, p. 2705–2713, http://dx.doi.org/10.1109/INFCOM.2011.5935101.

[73] C. K. SINGH, A. KUMAR, R. SUNDARESAN, E. ALTMAN. *Optimal Forwarding in Delay Tolerant Networks with Multiple Destinations*, in "Proceedings of the International Symposium on Modeling and Optimization in Mobile, Ad Hoc and Wireless Networks (WiOpt 2011)", Princeton, New Jersey, USA, May 2011, p. 228–235, http://dx.doi.org/10.1109/WIOPT.2011.5930020.

[74] I. TINNIRELLO, L. GIARRÉ, G. NEGLIA. *Achieving Fair Bandwidth Distribution in WiFi Networks: A Game Theoretical Approach*, in "18th IFAC World Congress", Milano, Italy, August 28 – September 2, 2011, http://hal.inria.fr/hal-00648177/en.

[75] P. WIECEK, E. ALTMAN. *Stationary anonymous sequential games with undiscounted rewards*, in "NetGCOOP 2011: International conference on NETwork Games, COntrol and OPtimization", Paris, France, October 2011, http://hal.inria.fr/hal-00643737/en.

### Conferences without Proceedings

[76] E. DELLA VECCHIA, S. C. DI MARCO, A. JEAN-MARIE. *Rolling Horizon and State Space Truncation Approximations for Zero-Sum Semi-Markov Games with Discounted Payoff*, in "INFORMS Applied Probability Society Conference", Stockholm, Sweden, July 2011.

### Scientific Books (or Scientific Book chapters)

[77] Y. HAYEL, H. TEMBINE, E. ALTMAN, R. EL-AZOUZI. *A Markov Decision Evolutionary Game for Individual Energy Management*, Annals of the International Society of Dynamic Games, 2011, vol. 11, part 3, p. 313–335, http://dx.doi.org/10.1007/978-0-8176-8089-3_16.

[78] X. ZHANG, G. NEGLIA, J. KUROSE. *Network Coding in Disruption Tolerant Networks*, in "Network Coding: Fundamentals and Applications", M. MEDARD, A. SPRINTSON (editors), Elsevier Science, 2011, chap. 10, p. 267–308 [*DOI :* 10.1016/B978-0-12-380918-6.00010-X], http://hal.inria.fr/hal-00648207/en.

### Books or Proceedings Editing

[79] E. ALTMAN, S. K. DAS, L. LENZINI, A. WOLISZ (editors). *Wireless for the Future Internet*, Computer Networks, February 2011, vol. 55, Issue 2, p. 371–496, http://www.sciencedirect.com/science/journal/13891286/55/2.

[80] J. S. BARAS, J. KATZ, E. ALTMAN (editors). *Decision and Game Theory for Security – Second International Conference, GameSec 2011, College Park, MD, Maryland, USA, November 14-15, 2011. Proceedings*, Lecture Notes in Computer Science, 2011, vol. 7037, http://dx.doi.org/10.1007/978-3-642-25280-8.

### Research Reports

[81] K. AVRACHENKOV, L. COTTATELLUCCI, L. MAGGI. *Cooperative Markov decision processes : Time consistency, greedy players satisfaction, and cooperation maintenance*, Eurecom, June 2011, n$^{o}$ RR-11-248, http://www.eurecom.fr/util/popuppubli.en.htm?page=detail&id=3326.

[82] K. AVRACHENKOV, P. GONÇALVES, A. MISHENIN, M. SOKOL. *Generalized Optimization Framework for Graph-based Semi-supervised Learning*, INRIA, October 2011, n$^{o}$ RR-7774, http://hal.inria.fr/inria-00633818/en.

[83] A. P. AZAD, S. ALOUF, E. ALTMAN, V. BORKAR, G. S. PASCHOS. *Optimal control of sleep periods for wireless terminals*, INRIA, May 2011, http://hal.inria.fr/inria-00591761/en.

[84] J.-C. BERMOND, A. JEAN-MARIE, D. MAZAURIC, J. YU. *Well Balanced Designs for Data Placement*, INRIA, September 2011, n$^{o}$ RR-7725, http://hal.inria.fr/inria-00618656/en.

[85] E. DELLA VECCHIA, S. C. DI MARCO, A. JEAN-MARIE. *Illustrated review of convergence conditions of the value iteration algorithm and the rolling horizon procedure for average-cost MDPs*, INRIA, August 2011, n$^{o}$ RR-7710, http://hal.inria.fr/inria-00617271/en.

[86] F. FOMIN, F. GIROIRE, A. JEAN-MARIE, D. MAZAURIC, N. NISSE. *To Satisfy Impatient Web surfers is Hard*, INRIA, September 2011, n$^{o}$ RR-7740, http://hal.inria.fr/inria-00625703/en.

## Patents and standards

[87] V. CAPDEVILLE, S. RAMANATH, E. ALTMAN, L. ROULLET. *Stacking Cells for seamless mobility management of high speed users in Small Cells networks*, 2011, n$^{o}$ 809154-EP-EPA.

### Other Publications

[88] E. ALTMAN, R. EL-AZOUZI, D. S. MENASCHE, Y. XU. *Poster: aging control for smartphones in hybrid networks*, September 2011, vol. 39, n$^{o}$ 2, Special Issue on IFIP PERFORMANCE 2011- 29th International Symposium on Computer Performance, Modeling, Measurement and Evaluation, Poster, http://dx.doi.org/10.1145/2034832.2034852.

[89] E. ALTMAN, C. HASAN, J.-M. GORCE, L. ROULLET. *Green Networking: Downlink Considerations*, in "NetGCOOP 2011: International conference on NETwork Games, COntrol and OPtimization", Paris, France, October 2011, Poster, http://hal.inria.fr/hal-00644558/en.

[90] E. ALTMAN, H. KAMEDA, Y. HAYEL. *Revisiting Collusion in Routing Games: a Load Balancing Problem*, in "NetGCOOP 2011: International conference on NETwork Games, COntrol and OPtimization", Paris, France, October 2011, Poster, http://hal.inria.fr/hal-00644539/en.

[91] S. BELHARETH. *The effect of graph structure on Network Coding performance*, University of Nice Sophia-Antipolis, France, 2011, Master thesis.

[92] M. EL CHAMIE. *Average Consensus on Large Scale networks*, University of Nice Sophia-Antipolis, France, 2011, Master thesis.

[93] M. HADDAD, E. ALTMAN. *The Interplay Between Caching and Popularity*, in "NetGCOOP 2011: International conference on NETwork Games, COntrol and OPtimization", Paris, France, October 2011, Poster, http://hal.inria.fr/hal-00644545/en.

## References in notes

[94] U. ACER, P. GIACCONE, D. HAY, G. NEGLIA, S. TARAPIAH. *Timely Data Delivery in a Realistic Bus Network*, in "IEEE Transactions on Vehicular Technology", published online December 9, 2011, http://dx.doi.org/10.1109/TVT.2011.2179072.

[95] S. ALOUF, V. MANCUSO, N. CHOUNGMO FOFACK. *Analysis of power save and its impact on web traffic in cellular networks with continuous connectivity*, submitted to "Pervasive and Mobile Computing", Special Issue: selected papers from WoWMoM 2011.

[96] E. ALTMAN, P. BERNHARD, S. CARON, G. KESIDIS, J. ROJAS-MORA, S. WONG. *A model of network neutrality with usage-based prices*, in "Telecommunication Systems", published Online June 15, 2011, http://dx.doi.org/10.1007/s11235-011-9504-6.

[97] E. ALTMAN, J. GAILLARD, M. HADDAD, P. WIECEK. *Dynamic Hawk and Dove games within flocks of birds*, in "Proc. of 6th International Conference on Bio-Inspired Models of Network, Information, and Computing Systems (BIONETICS 2011), York, UK, December 5-6, 2011", LNICST, 2012, to appear.

[98] E. ALTMAN, M. K. HANAWAL, R. EL-AZOUZI, S. SHAMAI. *Tradeoffs in Green Cellular Networks*, in "ACM SIGMETRICS Performance Evaluation Review", March 2012, Special Issue on GreenMetrics 2011 Workshop, San Jose, CA, USA, June 7, 2011. To appear.

[99] A. BAR-NOY, P. BASU, MATTHEW P. JOHNSON, P. NAIN, D. TOWSLEY, F. YU. *Traversal Times on Markovian Paths*, submitted to ACM Sigmetrics - IFIP Performance 2012.

[100] N. CHOUNGMO FOFACK, P. NAIN, G. NEGLIA, D. TOWSLEY. *Analysis of TTL-based cache networks*, submitted to ACM Sigmetrics - IFIP Performance 2012.

[101] K. ERDLENBRUCH, A. JEAN-MARIE, M. MOREAUX, M. TIDBALL. *Optimality of impulse harvesting policies*, in "Economic Theory", published online June 24, 2011, p. 1–31, http://dx.doi.org/10.1007/s00199-011-0650-6.

[102] E. HYON, A. JEAN-MARIE. *Scheduling Services in a Queuing System with Impatience and Setup Costs*, in "The Computer Journal", published Online January 5, 2011 [*DOI :* 10.1093/COMJNL/BXQ096], http://comjnl.oxfordjournals.org/content/early/2011/01/05/comjnl.bxq096.abstract.

[103] V. KAVITHA, E. ALTMAN. *Continuous polling models and application to ferry assisted WLAN*, in "Annals of Operations Research", published online September 21, 2011, http://dx.doi.org/10.1007/s10479-011-0960-x.

[104] M. KHOUZANI, E. ALTMAN, S. SARKAR. *Optimal Quarantining of Wireless Malware Through Reception Gain Control*, in "IEEE Transactions on Automatic Control", January 2012, vol. 57, n$^{o}$ 1, p. 49–61, http://dx.doi.org/10.1109/TAC.2011.2150350.

[105] V. MANCUSO, S. ALOUF. *Analysis of power saving with continuous connectivity*, submitted to "Computer Networks", Special Issue: Green Communication Networks.

[106] Y. XU, E. ALTMAN, R. EL-AZOUZI, M. HADDAD, S.-E. ELAYOUBI, T. JIMENEZ. *Probabilistic Analysis of Buffer Starvation in Markovian Queues*, in "Proc. of IEEE INFOCOM 2012", Orlando, Florida, USA, March 2012, to appear.