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Booklet contents:

PROJET FINANCÉ PAR L'ANR - PROJECT FUNDED BY THE ANR

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Inria INVENTORS FOR THE DIGITAL WORLD

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Caption:

Tutorials:
SN: Competition over popularity of content in social networks
NE: Socio-economic and legal issues in the Internet: game theoretical models
MF: Introduction to mean field games and applications
DTN: Delay-Tolerant Networks

Tracks:
Worst-Case: Worst-case End-to-end Performance Evaluation
Econ: Economic Challenges in Telecommunication Systems
Games: Game Theory in Communication Networks
Mean Field: Mean Field and Control

Monday 8	Tuesday 9	Wednesday 10	Thursday 11	Friday 12
9 : 00 – 10 : 40 ***Tutorial***: SN - Part I	9 : 00 – 10 : 00 ***Plenary Talk***: L. Massoulié	9 : 00 – 10 : 00 ***Tutorial***: NE & DTN - Part II	9 : 00 – 10 : 00 ***Plenary Talk***: A. Ozdaglar	9 : 00 – 10 : 00 ***Plenary Talk***: S. Borst
11 : 00 – 12 : 25 ***Tutorial***: MF - Part I	10 : 20 – 12 : 25 ***Tech. Session***: Queuing	10 : 20 – 12 : 25 ***Tech. Session***: Networks and Random Systems	10 : 20 – 12 : 25 ***Track***: Worst-Case	10 : 20 – 12 : 25 ***Track***: Econ
Lunch Break	***Lunch Break***	***Lunch Break***	***Lunch Break***	***Lunch Break***
13 : 30 – 16 : 00 ***Tutorial***: MF - Part II	13 : 30 – 14 : 30 ***Tutorial***: NE Part I	14 : 00 – 18 : 35 ***Social Event***	14 : 30 – 16 : 35 ***Track***: Games I	14 : 30 – 16 : 35 ***Track***: Games II
16 : 20 – 18 : 35 ***Tutorial***: MF III & SN II	14 : 30 – 15 : 30 ***Tutorial***: DTN Part I		16 : 55 – 18 : 35 ***Poster Session***	16 : 55 – 18 : 35 ***Track***: Mean Field
	15 : 45 – 17 : 00 ***Tech. Session***: Software Tools			
	17 : 20 – 18 : 35 ***Tech. Session***: Wireless Networks			

Welcome Reception ***Conference Dinner***

VALUETOOLS
Performance Evaluation Methodologies and Tools

From 08: 30 : **Registration**

09 : 00 - 10 : 40 : ***Tutorial***: Competition over popularity of content in social networks - Part I
Speaker: E. Altman (Inria)
(description on Page 9).

10 : 40 - 11 : 00 : **Coffee Break**

11 : 00 - 12 : 25 : ***Tutorial***: Introduction to mean field games and applications - Part I
Speaker: Hamidou Tembiné (Supelec)
(description on Page 9).

12 : 25 - 13 : 30 : **Lunch Break**

13 : 30 - 16 : 00 : ***Tutorial***: Introduction to mean field games and applications - Part II

16 : 00 - 16 : 20 : **Coffee Break**

16 : 20 - 18 : 35 : ***Tutorial***: (parallel sessions)

- Competition over popularity of content in social networks - Part II
- Introduction to mean field games and applications - Part III

19 : 00 - 20 : 00 : **Welcome Reception and Opening Speech** (open to all participants)

The **registration desk** will be open from 8:30 for the participants of the tutorials and 18:30 for the conference technical sessions' participants.

The **welcome reception** is open to **all** ValueTools participants (tutorials and technical sessions) and will be held at the conference center's patio (weather permitting).

Do not miss the ***best paper and best student papers announcements*** during the welcome reception!

From 08: 30 : **Registration**

09: 00 - 10: 00 : ***Plenary Talk***: L. Massoulié (Technicolor)
The Price of Privacy in Untrusted Recommendation (abstract in Page 8)
Chair: Pete Harrison (Imperial Colege London)

10: 00 - 10: 20 : **Coffee Break**

10: 20 - 12: 25 : ***Technical Session***: ***Queuing*** (description in Page 11)
Chair: Anne Bouillard (Ecole Normale Supérieure)

- Nicaise Choungmo Fofack, Philippe Nain, Giovanni Neglia and Don Towsley. *Analysis of TTL-based Cache Networks.*
- Harsha Honnappa, Rahul Jain and Amy Ward. *A New Transitory Queueing Model and its Process Limits.*
- Jaron Sanders, Sem Borst and Johan van Leeuwaarden. *Online Optimization of Product-Form Networks.*
- Ricky Roet-Green and Refael Hassin. *Information cascades in a queueing system with parallel servers.*
- Koen De Turck, Eline De Cuypere, Sabine Wittevrongel and Dieter Fiems. *Algorithmic approach to series expansions around transient Markov chains with applications to paired queueing systems.*

12: 25 - 13: 30 : **Lunch Break**

13: 30 - 14: 30 : ***Tutorial***: Socio-economic and legal issues in the Internet: game theoretical models - Part I
Speaker: Eitan Altman (Inria) (description in Page 10)

14: 30 - 15: 30 : ***Tutorial***: Delay-Tolerant Networks - Part I (description in Page 10)
Speaker: Francesco De Pellegrini (Create-Net)

15: 30 - 15: 45 : **Coffee Break**

15: 45 - 17: 00 : ***Technical Session***: ***Software Tools*** (description in Page 12)
Chair: Peter Reichl (Université Européenne de Bretagne / Télécom Bretagne)

- Emanuel Heidinger, Stefan Burger, Stefan Schneele, Alexander Klein and Georg Carle. *DIMTOOL: A Platform for Determining Worst Case Latencies in Switched Queuing Networks.*
- Armin Zimmermann. *Modeling and Evaluation of Stochastic Petri Nets With TimeNET 4.1.*
- Enrico Barbierato, Mauro Iacono and Stefano Marrone. *PerfBPEL: a graph-based approach for the performance analysis of BPEL SOA applications.*

17: 00 - 17: 20 : **Coffee Break**

17: 20 - 18: 35 : ***Technical Session***: ***Wireless Networks*** (description in Page 12)
Chair: Marceau Coupechoux (Telecom ParisTech)

- Laurent Decreusefond, Eduardo Ferraz, Philippe Martins and Than Tung Vu. *Robust methods for LTE and WiMAX dimensioning.*
- Vineeth S. Varma, Salah E. Elayoubi, Samson Lasaulce and Merouane Debbah. *A Flow Level Perspective on Base Station Power Allocation in Green Networks.*
- Mohammed Raiss-El-Fenni, Rachid El-Azouzi, Daniel Menasché and Yuedong Xu. *Optimal Sensing Policies for Smartphones in Hybrid Networks: A POMDP Approach.*

19: 30 - 22: 00 : ***Conference Dinner***

The **conference dinner** will be held in the conference center cafeteria.

The **registration desk** will be open from 8:30 AM.

09: 00 - 10: 00 ***Tutorial***: (parallel sessions) (descriptions in Page 10)

- Socio-economic and legal Issues in the Internet: game theoretical models - Part II
- Delay-Tolerant Networks - Part II

10: 00 - 10: 20 **Coffee Break**

10: 20 - 12: 25 ***Technical Session***: ***Networks and Random Systems*** (description in Page 13)
Chair: George Stamoulis (Athens University of Economics and Business)

- Walid Ben-Ameur, Pascal Bianchi and Jérémie Jakubowicz. *Robust Average Consensus using Total Variation Gossip Algorithm.* (invited paper)
- Marceau Coupechoux. *A Bilevel Competitive Facility Location Problem for the Design of Cognitive Networks.* (invited talk)
- Andrea Marin and Peter G. Harrison. *Deriving the rate equations characterising product-form models and application to propagating synchronisations.*
- Alessandro Zocca, Sem C. Borst and Johan S. H. van Leeuwaarden. *Mixing Properties of CSMA Networks on Partite Graphs.*
- Karthyek Rajhaa Annaswamy Murthy and Sandeep Juneja. *State-independent Importance Sampling for estimating large deviation probabilities in heavy-tailed random walks.*

12: 25 - 14: 00 **Lunch Break**

14: 00 - 18: 00 ***Social event*** (open to all participants)

The **social event** is a 45 mins walk in the surroundings of the conference center and to/from the harbor (walking shoes are recommanded) and a 2h30 boat trip to the ***"Calanques de Piana"***.
The social event participation is complimentary to all tutorials and technical session participants.
For those ***NOT*** wishing to participate to the walk, a **car pooling service** will be organized. Interested participants are kindly requested to inform the registration desk as early as possible.
The social event is subject to the weather and sea conditions. In extreme cases, the conference organizer may have to postpone the social event to Thursday 11th. In that case, the technical sessions of Thursday afternoon will be moved to Wednesday 10th.

09: 00 - 10: 00 : ***Plenary Talk***: A. Ozdaglar (M.I.T.)
Systemic Risk in Economic and Financial Networks (abstract in Page 8)
Chair: Eitan Altman (Inria)

10: 00 - 10: 20 : **Coffee Break**

10: 20- 12: 25 : ***Track***: ***Worst-case End-to-end Performance Evaluation*** (description in Page 16)
Chair: Alain Jean-Marie (Inria, LIRMM)

- Anne Bouillard, Nadir Farhi and Bruno Gaujal. *Packetization and Packet Curves in Network Calculus.* (invited paper)
- Marc Boyer, Giovanni Stea and William Mangoua Sofack. *Deficit Round Robin with network calculus.*
- Michael Beck and Jens Schmitt. *On the Calculation of Sample-Path Backlog Bounds in Queueing Systems over Finite Time Horizons.*
- Anne Bouillard and Giovanni Stea. *Exact Worst-case Delay for FIFO-multiplexing Tandems.*
- Hao Wang, Florin Ciucu and Jens Schmitt. *A Leftover Service Curve Approach to Analyze Demultiplexing in Queueing Networks.*

12: 25 - 14: 30 : **Lunch Break**

14: 30 - 16: 35 : ***Track***: ***Game Theory in Communication Networks (I)*** (description in Page 17)
Chair: S. El Ayoubi (Orange Labs)

- Haddad Majed. *A Hierarchical Approach for the Association Problem with Misleading Partial Channel State Information.* (invited talk)
- Daniele Miorandi and Francesco De Pellegrini. *Demand-Side Management in Smart Grids: an Evolutionary Games Perspective.*
- Helene Le Cadre and Jean-Sebastien Bedo. *Distributed Learning in Hierarchical Networks.*
- Eitan Altman, Ana Galindo-Serrano and Lorenza Giupponi. *Equilibrium Selection in Interference Management Non-Cooperative Games in Femtocell Networks.*
- Ioanna Papafili, Sergios Soursos and George Stamoulis. *A Novel Game-Theoretic Framework for Modeling Interactions of ISPs Anticipating Users' Reactions.*

16: 35 - 16: 55 : **Coffee Break**

16: 55 - 18: 35 : ***Poster Session*** (description in Page 15)

- Sunitha Azad, Eitan Altman and Majed Haddad. *Jamming DoS in IEEE 802.11 WLANs.*
- Ilaria Brunetti, Eitan Altman and Majed Haddad. *Pricing Access to the Internet with Partial Information.*
- Marcel Christoph Guenther and Jeremy Bradley. *Mean field performance analysis of a hazard detection Wireless Sensor Network.*
- Elena Kornilina and Aleksandr Mikhailov. *A new approach to analysis the proximity of the political positions of participants of the group.*
- Gareth L. Jones, Peter G. Harrison, Uli Harder and Anthony J. Field. *Fluid Queue Models of Renewable Energy Storage.*
- Toshiyuki Miyachi, Razvan Beuran, Shinsuke Miwa, Yoshiki Makino, Satoshi Uda, Yasuo Tan and Yoichi Shinoda. *On Network System Evaluation under Various Failures.*

09: 00 - 10: 00 : ***Plenary Talk***: Sem Borst (Alcatel-Lucent Bell Labs and Eindhoven University of Technology)
Wireless Random-Access Networks: Fairness, Delay and Stability (abstract in Page 8)
Chair: Nahul Shimkin, Israel Institute of Technology

10: 00 - 10: 20 : **Coffee Break**

10: 20 - 12: 25 : ***Track***: ***Economic Challenges in Telecommunication Systems*** (description in Page 19)
Chair: J. Cohen (CNRS, PRiSM)

- Bruno Escoffier, Laurent Gourves, Jerome Monnot and Stefano Moretti. *Cost allocation protocols for network formation on connection situations.* (invited paper)
- Peter Reichl, Patrick Maillé, Patrick Zwickl, Andreas Sackl. *On the Fixpoint Problem of QoE-based Charging.* (invited paper)
- Mohamed Lamine Lamali, Hélia Pouyllau and Dominique Barth. *SLA negotiation: Experimental Observations on Learning Policies.*
- Daniel Funke, Fabian Brosig and Michael Faber. *Towards Truthful Resource Reservation in Cloud Computing.*
- Salah Elayoubi, Frédéric Morlot and Thomas Redon. *Risk-hedging using options for upgrading investments in mobile networks.*

12: 25 - 14: 30 : **Lunch Break**

14: 30 - 16: 35 : ***Track***: ***Game Theory in Communication Networks (II)*** (description in Page 17)
Chair: Francesco De Pellegrini (Create-Net)

- Lorenzo Maggi. *Cooperative Stochastic games with applications to multiaccess systems.* (invited talk)
- Eitan Altman. *A semi-dynamic model for competition over popularity and over advertisement space in social network.*
- Mohamed Baslam, Rachid El-Azouzi, Essaid Sabir and El Houssine Bouyakhf. *New Insights from a Bounded Rationality Analysis for Strategic Price-QoS War.*
- Francois Meriaux, Stefan Valentin, Samson Lasaulce and Michel Kieffer. *An Energy-Efficient Power Allocation Game with Selfish Channel State Feedback in Cellular Networks.*
- Yalemzewd Negash and Eduard Jorswieck. *Energy Efficient Topology Control for WLANS.*

16: 35 - 16: 55 : **Coffee Break**

16: 55 - 18: 35 : ***Track***: ***Mean Field and Control*** (description in Page 20)
Chair: H. Tembiné (Supélec)

- Raul Tempone and Pedro Vilanova. *On the indistingishability Assumtion in Mean Field Games.* (invited talk)
- Danilo Abbaldo, Marco Gribaudo and Daniele Manini. *Evaluation of different scheduling policies in IaaS applications by Mean Field analysis.*
- Sandeep Juneja, Tushar Raheja and Nahum Shimkin. *The Concert Queueing Game with Random Arrivals Volume.*
- Anil Aswani, Neal Master, Jay Taneja, Andrew Krioukov, David Culler and Claire Tomlin. *Quantitative Methods for Comparing Different HVAC Control Schemes.*

Alcatel-Lucent Bell Labs & Eindhoven University of Technology.

Backlog-based wireless access schemes are relatively simple and inherently distributed, yet provide a striking capability to match the optimal throughput performance of centralized scheduling mechanisms in a wide range of scenarios. Unfortunately, the specific type of activation rules for which throughput optimality has been established, may result in excessive backlogs and delays. The use of more aggressive/persistent access schemes can improve the delay performance, but does not offer any universal maximum-stability guarantees.

In order to gain qualitative insights and examine stability properties, we investigate fluid limits where the system dynamics are scaled in space and time. Several distinct types of fluid limits can arise, ranging from ones with smooth deterministic features, to others which exhibit random oscillatory characteristics, depending on the topology of the network, in conjunction with the form of the activation rules. As we will show, these qualitatively different regimes are closely related to short-term fairness properties and mixing times for random-access mechanisms with fixed activation rates. It turns out that more aggressive access schemes continue to provide maximum stability in some networks, e.g. complete interference graphs. In other topologies however such schemes can drive the system into inefficient states and thus cause instability.

Note: based on joint work with Niek Bouman (TU/e), Javad Ghaderi (UIUC), Johan van Leeuwaarden (TU/e), Alexandre Proutiere (KTH), Peter van de Ven (IBM), Phil Whiting (Alcatel-Lucent Bell Labs), Alessandro Zocca (TU/e)

Technicolor Research and Innovation Laboratory.

Online privacy concerns prompt the following question: can a recommendation engine be accurate if end-users do not entrust it with their private data? To provide an answer, we study the problem of learning user ratings for items under so-called local differential privacy, a formal notion of data privacy. We obtain lower bounds on learning complexity based on mutual information. These results highlight the role played by the amount of ratings performed by each user. In the information-rich regime (where each user rates at least a constant fraction of items), a spectral clustering approach is shown to achieve optimal sample complexity, as it matches our information-theoretic lower bounds. In contrast, the information-scarce regime (where each user only rates a vanishing fraction of the total item set) is found to require a different approach. We thus propose the so-called MaxSense algorithm, which achieves optimal sample complexity in the information-scarce regime.

This is based on joint work with Nidhi Hegde (Technicolor) and Siddhartha Banerjee (UT Austin).

MIT.

This work develops a theoretical model of investments in security in a network of interconnected agents. The network connections introduce the possibility of cascading failures depending on exogenous or endogenous attacks and the profile of security investments by the agents. The general presumption in the literature, based on intuitive arguments or analysis of symmetric networks, is that because security investments create positive externalities on other agents, there will be underinvestment in security. We show that this reasoning is incomplete because of a first-order economic force: security investments are also strategic substitutes. In a general (non-symmetric) network, this implies that underinvestment by some agents will encourage overinvestment by others. We demonstrate by means of examples that not only there will be overinvestment by some agents but also aggregate probabilities of infection can be lower in equilibrium than in the social optimum. We then provide sufficient conditions for underinvestment. This requires both sufficiently convex cost functions (just convexity is not enough) and networks that are either symmetric or locally tree-like (i.e., either trees or in the case of stochastic networks, without local cycles with high probability). We also characterize the impact of network structure on equilibrium and optimal investments. Finally, we show that when the attack location is endogenized (by assuming that the attacker chooses a probability distribution over the location of the attack in order to maximize damage), there is another reason for overinvestment: greater investment by an agent shifts the attack to other parts of the network.

This is joint work with Daron Acemoglu and Azarakhsh Malekian.

Monday, October 8th

Inria.

Highlights: The course covers the following topics: Models of propagation of content in networks: branching processes and epidemic models. Identification of various actors and actions that accelerate the propagation of content. Embedding, Sharing, Advertisement, the role of caching, publishers, recommendation graphs. Models for deciding in which type of content to specialize. The connections to congestion games and crowding games. Dynamic and semi-dynamic advertisement problems. Optimal control and stochastic game models. Taking into account information asymmetry. The case of full information, no-information and the case of private information. The case of linear utilities. Competing over advertisement space. Related problems in operations research. The case of linear utilities. Models for viewing content as a function of their popularity.

References: d1-d6 in http://www-sop.inria.fr/members/Eitan.Altman/dodescaden.html
(All six references are available for download.)

Short bio: Eitan Altman received the B.Sc. degree in electrical engineering (1984), the B.A. degree in physics (1984) and the Ph.D. degree in electrical engineering (1990), all from the Technion-Israel Institute, Haifa. In (1990) he further received his B.Mus. degree in music composition in Tel-Aviv university. Since 1990, Dr. Altman has been a researcher at INRIA (National research institute in computer science and control) in Sophia-Antipolis, France. He has been in the editorial boards of several scientific journals: Wireless Networks (WINET), Computer Networks (COMNET), Computer Communications (Comcom), J. Discrete Event Dynamic Systems (JDEDS), SIAM J. of Control and Optimisation (SICON), Stochastic Models, and Journal of Economy Dynamic and Control (JDC). He received the best paper award in the Networking 2006, in Globecom 2007, in IFIP Wireless Days 2009 and in CNSM 2011 (Paris) conferences. His areas of interest include Network Engineering Games, social networks and their control. He received in 2012 the Grand Prix de France Telecom from the French Academy of Sciences. More information can be found at www-sop.inria.fr/members/Eitan.Altman/.

Supélec.

Highlights: Recently there has been renewed interest in large-scale games in several research disciplines, with its uses in financial markets, biology, power grid and cloud networking. Classical work provides rich mathematical foundations and equilibrium concepts, but relatively little in the way of computational and representational insights that would allow game theory to scale up to large-scale systems. The rapidly emerging field of mean field games is addressing such behavioral and algorithmic issues, and this tutorial course will provide a survey of developments so far. The tutorial will be self-contained, assuming no prior knowledge of mean field systems.

Outline:

- ***A short history.*** (de Finetti 1931, Wardrop 1952, Hewitt Savage 1955, Aumann 1964, Schmeidler 1973, Jovanovic & Rosenthal 1988, Benamou & Brenier 2000).
- ***Static mean field games.*** Applications: public good provisioning, power grid and beauty contest in financial markets.
- ***Mean field learning.*** (partially distributed, fully distributed, no-feedback) Application: resource sharing in cloud networking.
- ***Dynamic mean field games.*** Applications: Access control, reaction to interference field in large-scale wireless networks.
- ***Risk-sensitive players.*** Applications: How to flatten peak periods in smart grid?
- ***Discussions,*** conclusions and future directions.

Short Bio: Hamidou Tembine is an assistant professor at Ecole Superieure d'Electricite (Supelec), France. His current research interests include evolutionary games, mean field stochastic games and applications. He was the recipient of many student grant awards, and best paper awards (ACM Valuetools 2007, IFIP Networking 2008, IEEE/ACM WiOpt 2009, IEEE Infocom Workshop 2011).

Tuesday, October 9th and Wednesday, October 10th

Inria.

Highlights: The talk focuses on modelling interactions between various actors in the telecommunication sector. This includes serevice providers, content providers, subscribers, the advertisement industry and the regulation organisms. We introduce definions of collusions along with the price of collusion. We use these to study horizontal and vertical monopolies in the telecommunication markets and their impact on the subscribers. We introduce various types of competition between the actors, and use cooperative game techniques to study potential impacts of regulation of the telecommunication industry on the various agents. The talk will include a background on network neutrality and on the current public consultation on that area launged last month by the European Union.

References: http://www-sop.inria.fr/members/Eitan.Altman/nn.html

Short bio: Eitan Altman received the B.Sc. degree in electrical engineering (1984), the B.A. degree in physics (1984) and the Ph.D. degree in electrical engineering (1990), all from the Technion-Israel Institute, Haifa. In (1990) he further received his B.Mus. degree in music composition in Tel-Aviv university. Since 1990, Dr. Altman has been a researcher at INRIA (National research institute in computer science and control) in Sophia-Antipolis, France. He has been in the editorial boards of several scientific journals: Wireless Networks (WINET), Computer Networks (COMNET), Computer Communications (Comcom), J. Discrete Event Dynamic Systems (JDEDS), SIAM J. of Control and Optimisation (SICON), Stochastic Models, and Journal of Economy Dynamic and Control (JDC). He received the best paper award in the Networking 2006, in Globecom 2007, in IFIP Wireless Days 2009 and in CNSM 2011 (Paris) conferences. His areas of interest include Network Engineering Games, social networks and their control. He received in 2012 the Grand Prix de France Telecom from the French Academy of Sciences. More information can be found at www-sop.inria.fr/members/Eitan.Altman/.

Create-Net.

Highlights: Delay-Tolerant Networks (DTN) have recently attracted the attention of the networking community because they work with no need of persistent connectivity. A message originated at a source node is delivered to the destination by means of intermediate relays. However, lack of connectivity is overcome at the expense of other resources, e.g., energy consumption of relay nodes. Furthermore, physical constraints related to the nodes' intermeeting patterns pose certain constraints on the delay of message delivery. This tutorial course will provide a survey of developments in the resources allocation for DTNs formulated as optimization problems.

Outline:

- Background on DTNs and relevant literature
- Forwarding control: homogeneous case
- Forwarding control: heterogeneous case
- Activation control
- Stochastic approximation and learning algorithms
- Risk-sensitive control
- Joint Forwarding and Coding
- Discussion on open issues and future directions

Short Bio: Francesco De Pellegrini is a senior researcher and Deputy Area Head of the iNspire group at CREATE-NET. His research interests are location detection in sensor networks, multirate systems, routing, wireless mesh networks, VoIP, Ad Hoc and Delay-Tolerant Networks. F. De Pellegrini has been a TPC member of IEEE Infocom and a reviewer for several international networking conferences and journals. He serves in the Steering Programm Commitee of Mobiquitous, and Complex Conferences. Francesco was the Vice-General chair for the first edition of Robocomm.

Session: Queuing (Tuesday 9th, 10 : 20 - 12 : 25)

Nicaise Choungmo Fofack, Philippe Nain, Giovanni Neglia and Don Towsley.
Analysis of TTL-based Cache Networks.
Many researchers have been working on the performance analysis of caching in Information-Centric Networks (ICNs) under various replacement policies like Least Recently Used (LRU), FIFO or Random (RND). However, no exact results are provided, and many approximate models do not scale even for the simple network of two caches connected in tandem. In this paper, we introduce a Time-To-Live based policy (TTL), that assigns a timer to each content stored in the cache and redraws the timer each time the content is requested (at each hit/miss). We show that our TTL policy is more general than LRU, FIFO or RND, since it is able to mimic their behavior under an appropriate choice of its parameters. Moreover, the analysis of networks of TTL-based caches appears simpler not only under the Independent Reference Model (IRM, on which many existing results rely) but also under the Renewal Model for requests. In particular, we determine exact formulas for the performance metrics of interest for a linear network and a tree network with one root cache and N leaf caches. For more general networks, we propose an approximate solution with the relative errors smaller than 10^{-3} and 10^{-2} for exponentially distributed and constant TTLs respectively.

Harsha Honnappa, Rahul Jain and Amy Ward.
A New Transitory Queueing Model and its Process Limits.
We introduce the $\Delta_{(i)}/G_I/1$ queue, a new queueing model. In this model, customers from a given population indepen- dently arrive according to some given distribution F . Thus, the arrival times are an ordered statistics, and the inter- arrival times are differences of consecutive ordered statis- tics. They are served by a single server which provides ser- vice according to a general distribution G, with independent service times. We develop fluid and diffusion limits for the various stochastic processes, and performance metrics. The fluid limit of the queue length is observed to be a reflected process while the diffusion limit is observed to be a func- tion of a Brownian motion and a Brownian bridge, reflected through a directional derivative of the usual Skorokhod re- flection map. We also observe what may be interpreted as a "transient" Little's law. Sample path analysis reveals various operating regimes where the diffusion limit switches between a free diffusion, a reflected diffusion process and the zero process, with possible discontinuities during regime switches.

Jaron Sanders, Sem Borst and Johan van Leeuwaarden.
Online Optimization of Product-Form Networks.
We develop an online gradient algorithm for optimizing the performance of product-form networks through online adjustment of control parameters. The use of standard algorithms for finding optimal parameter settings is hampered by the prohibitive computational burden of calculating the gradient in terms of the stationary probabilities. The proposed approach instead relies on measuring empirical frequencies of the various states through simulation or online operation so as to obtain estimates for the gradient. Besides the reduction in computational effort, a further benefit of the online operation lies in the natural adaptation to slow variations in ambient parameters as commonly occurring in dynamic environments. On the downside, the measurements result in inherently noisy and biased estimates. We exploit mixing time results in order to overcome the impact of the bias and establish sufficient conditions for convergence to a globally optimal solution.

Ricky Roet-Green and Refael Hassin.
Information cascades in a queueing system with parallel servers.
When a customer makes an appointment at the doctor, call the plumber or reserve flight tickets, he joins a queue. By making the reservation, the customer can learn his position in the service provider's queue. If the customer is unsatisfied with his position, he might consider calling an alternative service provider, hoping to get a better position. In our model, the service is provided by n parallel servers. Upon arrival to the system, each customer randomly chooses one server and inspects it. Then, he either joins it or inspects another queue. If he inspects another queue, he can join the shorter queue, or continue his search and inspect another queue. We assume that each inspection is associated with a fixed cost. The solution of this model is not straightforward even when $n = 2$, and is characterized by cascades. In equilibrium, there exist isolated queue lengths (holes) at which customers inspect the other queue. In other queue lengths customers join the first queue. In some cases, there exist queue lengths at which customers adopt a mixed strategy.

Koen De Turck, Eline De Cuypere, Sabine Wittevrongel and Dieter Fiems.
Algorithmic approach to series expansions around transient Markov chains with applications to paired queueing systems.
We propose an efficient numerical scheme for the evaluation of large-scale Markov chains, under the condition that their generator matrix reduces to a triangular matrix when a certain rate is sent to zero. A numerical algorithm is presented which calculates the first N coefficients of the MacLaurin series expansion of the steady-state probability vector with minimal overhead. We apply this numerical approach to paired queuing systems, which have a.o. applications in kitting processes in assembly systems. Pairing means that departures from the different buffers are synchronised and that service is interrupted if any of the buffers is empty. We also show a decoupling result that allows for closed-form expressions for lower-order expansions. Finally we illustrate our approach by some numerical examples.

Session: Software Tools (Tuesday 9th, 15 : 45 - 17 : 00)

Emanuel Heidinger, Stefan Burger, Stefan Schneele, Alexander Klein and Georg Carle.
DIMTOOL: A Platform for Determining Worst Case Latencies in Switched Queuing Networks.
Performance evaluation in computer networks requires consistent traffic and topology models to deliver comparable results. In this work we present our platform that provides a consistent interface by encapsulating standard parameters as scheduling strategy, link speed, processing delay, and propagation delay. In contrast to existing solutions, we provide several performance estimation techniques within a single toolbox making the identified performance results comparable. The functionality of our developed toolbox is demonstrated by employing it to real-world scenarios in avionics, which is the Ethernet based Cabin Management System and the communication network inside the cabin server.

Armin Zimmermann.
Modeling and Evaluation of Stochastic Petri Nets With TimeNET 4.1.
The paper presents a major update of the software tool TimeNET, a package for the modeling and performance evaluation of standard and colored stochastic Petri nets. Among its main characteristics are simulation and analysis modules for stationary and transient evaluation of Petri nets including non-exponentially distributed delays, as well as an efficient simulation module for complex colored models. An overview of the tool is given as well as a description of the new features, which are demonstrated using a manufacturing system application example. The tool is available free of charge for non-commercial use.

Enrico Barbierato, Mauro Iacono and Stefano Marrone.
PerfBPEL: a graph-based approach for the performance analysis of BPEL SOA applications.
Non-functional properties evaluation in Service Oriented Architecture (SOA) is still mostly an open challenge. Although this is a problem that has been already partially explored with some success, there is lack of consolidated results for more complex SOA applications based on services composition. This paper presents a contribution to performance evaluation of SOA-based applications integrated by BPEL. The evaluation technique is based on a performance-oriented reinterpretation of the BPEL specification as a performance modeling language within a multiformalism framework. The approach is based on automatic translation of PerfBPEL into Markov chains and it is implemented by means of SIMTHESys modeling and analysis framework to enable the interaction with other performance oriented formalisms.

Session: Wireless Networks (Tuesday 9th, 17 : 20 - 18 : 35)

Laurent Decreusefond, Eduardo Ferraz, Philippe Martins and Than Tung Vu.
Robust methods for LTE and WiMAX dimensioning.
This paper proposes an analytic model for dimensioning OFDMA based networks like WiMAX and LTE systems. In such a system, users require a number of subchannels which depends on their SNR, hence of their position and the shadowing they experience. The system is overloaded when the number of required subchannels is greater than the number of available subchannels. We give an exact though not closed expression of the loss probability and then give an algorithmic method to derive the number of subchannels which guarantees a loss probability less than a given threshold. We show that Gaussian approximation lead to optimistic values and are thus unusable. We then introduce Edgeworth expansions with error bounds and show that by choosing the right order of the expansion, one can have an approximate dimensioning value easy to compute but with guaranteed performance. As the values obtained are highly dependent from the parameters of the system, which turned to be rather undetermined, we provide a procedure based on concentration inequality for Poisson functionals, which yields to conservative dimensioning. This paper relies on recent results on concentration inequalities and establish new results on Edgeworth expansions.

Vineeth S. Varma, Salah E. Elayoubi, Samson Lasaulce and Merouane Debbah.
A Flow Level Perspective on Base Station Power Allocation in Green Networks.

In this work, we propose a novel power allocation mechanism which allows one to optimize the energy-efficiency of base stations operating in the downlink. The energy-efficiency refers to the amount of bits that can be transmitted by the base station per unit of energy consumed. This work studies the impact of flow-level dynamics on the energy efficiency of base stations, by considering user arrivals and departures. Our proposed power allocation scheme optimizes the energy-efficiency, accounting for the dynamic nature of users (referred to as the global energy-efficiency). We emphasize our numerical results that study the influence of the radio conditions, transmit power and the user traffic on the energy-efficiency in an LTE compliant framework. Finally, we show that the power allocation scheme that considers traffic dynamics, is significantly different from the power allocation scheme when the number of users is considered as constant, and that it has a better performance.

Mohammed Raiss-El-Fenni, Rachid El-Azouzi, Daniel Menasché and Yuedong Xu.
Optimal Sensing Policies for Smartphones in Hybrid Networks: A POMDP Approach.

The ubiquity of mobile devices is fostering a paradigm shift in the realm of Internet services. Consider, for instance, mobile users of social networks, that require frequent updates through small messages from their friends. If a user activates his mobile device and has a contact opportunity with an access point, an update can be received at the expense of monetary and energy costs. Thus, users face a tradeoff between such costs and the utilities of the messages received. The goal of this paper is to show how a user can cope with such a tradeoff, by deriving optimal sensing policies. A sensing policy consists of deciding, based on the age of the last message received and the belief about the future availability of a WiFi access point, whether to activate the mobile device or not. Alternatively, users may also decide to use 3G technology to receive updates, which provides broader coverage at the expense of higher monetary costs and lower bandwidth. To address the tradeo faced by the users, we propose an analytical model based on a Partially Observed Markov Decision Process (POMDP) with an average reward criterion. Using the proposed model, we show properties of the optimal sensing policy. The applicability of the model and of the derived policy is illustrated through numerical case studies.

Session: Network and Random Systems (Wednesday 10th, 10 : 20 - 12 : 25)

Walid Ben-Ameur, Pascal Bianchi and Jérémie Jakubowicz.
Robust AverageConsensus using Total Variation Gossip Algorithm.

Consider a connected network of N agents observing N arbitrary samples. We investigate distributed algorithms, also known as gossip algorithms, whose aim is to compute the sample average by means of local computations and nearby information sharing between agents. First, we analyze the convergence of some widespread gossip algorithms in the presence of misbehaving (stubborn) agents which permanently introduce some false value inside the distributed averaging process. We show that the network is driven to a state which exclusively depends on the stubborn agents. Second, we introduce a novel gossip algorithm called Total Variation Gossip Algorithm. We show that, provided that the sample vector satisfies some regularity condition, the final estimate of the network remains close to the sought consensus, and is unsensitive to large perturbations of stubborn agents. Numerical experiments complete our theoretical results.

Marceau Coupechoux.
A Bilevel Competitive Facility Location Problem for the Design of Cognitive Networks.

A Bilevel Competitive Facility Location Problem for the Design of Cognitive Networks Abstract: In this talk, we tackle the problem of strategic base stations placement in Cognitive Radio (CR) Networks. We consider a Primary User (PU), operating on the frequency channels of a primary network, and a CR operator (the leader) facing the competition of a second operator (the follower). CR operators are willing to exploit the unused downlink capacity of the primary network so as to maximize the profits derived from operating the installed Base Stations (BS) and serving Secondary Users (SU). The leader is aware of the future arrival of the follower, who is able to capture SUs by appropriately placing his own Cognitive Radio-Base Stations (CR-BS). He has also to limit the interference temperature at some measurement points defined by the PU. We formulate the problem as a bi-level facility location and design problem. We apply to the leader problem a hybrid probabilistic matheuristic algorithm and, at each step, we solve the mixed integer program (MIP) derived from the follower problem. We show that the latter is NP-hard and that the leader problem is Σ_2^P-hard. Our numerical experiments show the interest of anticipating competition when deploying a cognitive network.

Andrea Marin and Peter G. Harrison.
Deriving the rate equations characterising product-form models and application to propagating synchronisations.

Performance engineering often uses stochastic mod- elling as a powerful approach to the quantitative analysis of real systems. Product-form Markovian models have the property that the steady-state analysis can be carried out efficiently and without the need for solving the system of global balance equations. The Reversed Compound Agent Theorem (RCAT) gives sufficient conditions for the model to have a product-form solution. In this paper we show its application in the case of instantaneous synchronisations of more than two components at the same time. Although examples of this class of product-form models are already known, the results shown here are novel. We introduce the idea of Propagation of Instantaneous Transitions (PITs) to model multi-way synchronisations as successive pairwise ones in the case of product-form. An algorithm that derives the system of equations that must be solved to obtain the steady-state distribution is presented. Two examples of new product-form models are then derived as a consequence of these contributions. The first is a queueing network with finite capacity nodes, a skipping policy, and partial flushing as a congestion handling mechanism. The second is a queueing network with nodes that may have negative queue lengths, where an unbounded customer deletion mechanism is introduced.

Alessandro Zocca, Sem C. Borst and Johan S. H. van Leeuwaarden.
Mixing Properties of CSMA Networks on Partite Graphs.

We consider a stylized stochastic model for a wireless CSMA network. Experimental results in prior studies indicate that the model provides remarkably accurate throughput estimates for IEEE 802.11 systems. In particular, the model offers an explanation for the severe spatial unfairness in throughputs observed in such networks with asymmetric interference conditions. Even in symmetric scenarios, however, it may take a long time for the activity process to move between dominant states, giving rise to potential starvation issues. In order to gain insight in the transient throughput characteristics and associated starvation effects, we examine in the present paper the behavior of the transition time between dominant activity states. We focus on partite interference graphs, and establish how the magnitude of the transition time scales with the activation rate and the sizes of the various network components. We also prove that in several cases the scaled transition time has an asymptotically exponential distribution as the activation rate grows large, and point out interesting connections with related exponentiality results for rare events and meta-stability phenomena in statistical physics. In addition, we investigate the convergence rate to equilibrium of the activity process in terms of mixing times.

Karthyek Rajhaa Annaswamy Murthy and Sandeep Juneja.
State-independent Importance Sampling for estimating large deviation probabilities in heavy-tailed random walks.

Efficient simulation of rare events involving sums of heavy-tailed random variables has been an active research area in applied probability over the last fifteen years. These problems are viewed as challenging, since large deviations theory inspired and exponential twisting based importance sampling distributions that work well for rare events involving sums of light tailed random variables fail in these settings. Moreover, there exist negative results suggesting that state-independent importance sampling methods that work well in light-tailed settings fail for certain rare events involving sums of heavy-tailed random variables. This has led to the development of growing literature for efficiently simulating such events using more nuanced, and in many cases, computationally demanding state-dependent importance sampling methods. In this article we shed new light on this issue by observing that simpler state-independent exponential twisting based importance sampling methods, suitably adjusted in the tails, can provide strongly efficient algorithms to estimate such rare event probabilities. Specifically, we develop strongly efficient state-independent importance sampling algorithms for the classical large deviations probability that sums of independent, identically distributed random variables with regularly varying tails exceed an increasing threshold both in the case where the number of random variables increases to infinity and when it is fixed.

Sunitha Azad, Eitan Altman and Majed Haddad.
Jamming DoS in IEEE 802.11 WLANs.

In this paper, we consider an intelligent malicious mobile that can send signals which would cause interference to the users that communicate with an Access Point (AP). The attack is based on the well known anomaly of IEEE 802.11 in which a single connection with low signal to noise ratio causes the throughputs of all connections to decrease. The attacker tries to exploit this anomaly by jamming a single node in the cell. The rate of that particular node reduces and thus the throughput of all the hosts transmitting at higher rate is degraded below the level of the lower rate. The jammer tries to maximize the throughput degradation by driving the SINR below the SINR threshold reception and placing itself at its optimal position. We analyze the impact of jamming on the system throughput especially from the perspective of jammer's utility. Extensive simulations are conducted to analyze the performance of the jammer on 802.11 WLANs.

Ilaria Brunetti, Eitan Altman and Majed Haddad.
Pricing Access to the Internet with Partial Information.

We shall consider two competition problems between service providers with asymmetric information. The utility of each one of them depends on the demand it gets and in its price. The demand itself is also a function of the prices of the providers. In both problems there is one provider (super player or player 1) that has more information than the other (player 2) on the demand function. The more informed provider plays first, and then the second observes the move of the first provider and chooses accordingly its own action: it determines its price per unit demand. In the first problem that we consider, the first provider does not control its price (it has a fixed price known to the other provider which does not depend on the information that is unknown to provider 2). Before player 2 takes its action it receives a signal (or a recommendation) from the more informed player, i.e. from provider 1. The pure actions of provider 1 are thus the possible choices of what signal to send. The second problem that we consider is the same as the first one except that the actions of provider 1 is to choose its price. Since player 2 observes the choice of price of player 1 before it takes its own pricing decision, we can consider the choice of price by player 1 has also a role of signalling. We reduce each one of the problem to an equivalent four by four matrix game.

Marcel Christoph Guenther and Jeremy Bradley.
Mean field performance analysis of a hazard detection Wireless Sensor Network.

Wireless Sensor networks (WSNs) are often deployed to monitor emergencies such as forest fires or landslides. Naturally, such events can impact network performance by destroying sensors or otherwise limiting their transmission capabilities. Fail-safe WSN routing protocols can mitigate the effect by closing routing holes promptly. Our work presents a model of pheromone based, fail-safe WSN routing. In particular we use higher-order moment mean field techniques to study network behaviour during topology changes.

Gareth L. Jones, Peter G. Harrison, Uli Harder and Anthony J. Field.
Fluid Queue Models of Renewable Energy Storage.

In this work we introduce an approximation algorithm for the evaluation of networks of fluid queues. Such models can be used to describe the generation and storage of renewable energy. We discuss how our algorithm would be applied to an example where the approximation performs very well, and note a modification to the model which would result in a poorer result.

Elena Kornilina and Aleksandr Mikhailov.
A new approach to analysis the proximity of the political positions of participants of the group.

The study focuses on mathematical modeling proximity dynamics of positions of interacting individuals. The alternative method measuring the roximity of declared in texts olitical positions is suggested and tested on the example of pre-election programs of parties in Russian assembly (the State Duma) and social nets users' records. The method could be used to fulfill the model with data and to validate its quality.

Toshiyuki Miyachi, Razvan Beuran, Shinsuke Miwa, Yoshiki Makino, Satoshi Uda, Yasuo Tan and Yoichi Shinoda.
On Network System Evaluation under Various Failures.

We always have possibilities of being involved in various network troubles because of system misconfigurations and trouble by natural disasters, etc. So evaluations of network technologies under these situations are important. We are developing a framework for emulating environments with failures and evaluating technologies for recovering from them by utilizing our existing technologies for building large-scale network experimental environments. We successfully conducted several case studies using our technologies with various failure types.

Track: Worst-case End-to-end Performance Evaluation (Thursday 11th, 10 : 20 - 12 : 25)

Anne Bouillard, Nadir Farhi and Bruno Gaujal.
Packetization and Packet Curves in Network Calculus.

Arrival and service curves re core functions in the Network Calculus framework. Based on those curves, we present in this talk a new formalism for data packetization in Network Calculus, the packet curves. Indeed, a more precise knowledge of the packet characteristics can be efficiently exploited to get tighter performance bounds, for example for aggregation of flows, packet-based service policies and shared buffers. Finally, we will give a model for a wormhole switch and show how our results can be used to get efficient delay bounds.

Anne Bouillard and Giovanni Stea.
Exact Worst-case Delay for FIFO-multiplexing Tandems.

This paper computes the actual worst-case end-to-end delay for a flow in a tandem of FIFO multiplexing service curve nodes, where flows are shaped by concave, piecewise linear arrival curves, and service curves are convex and piecewise linear. Previous works only computed bounds on the above quantity, which are not always tight. We show that the solution entails taking the maximum among the optimal solution of a number of Linear Programming problems. However, the number and size of LP problems grows exponentially with the tandem length. Furthermore, we present approximate solution schemes to find both upper and lower delay bounds on the worst-case delay. Both of them only require to solve just one LP problem, and they produce bounds which are generally more accurate than those found in the previous work. Finally, we elaborate on how the worst-case scenario should be constructed.

Michael Beck and Jens Schmitt.
On the Calculation of Sample-Path Backlog Bounds in Queueing Systems over Finite Time Horizons.

The ability to calculate backlog bounds is of key importance for buffer sizing in packet-switched networks. In particular, it is critical to capture the statistical multiplexing gains which, in turn, calls for stochastic backlog bounds. The stochastic network calculus (SNC) is a promising methodology to compute such stochastic backlog bounds. So far in the literature SNC-based backlog bounds apply only to an arbitrary, but fixed single point in time. Yet, from the network engineering perspective, one would rather like to have a sample path backlog bound, i.e., a bound that applies (with a certain fixed violation probability) all of the time. While, in general, such bounds are hard to obtain we investigate in this paper how sample path backlog bounds can be computed over finite time horizons. In particular, we show how a simple extension of the known SNC results can lead to sub-optimal bounds by deriving an alternative methodology (based on extreme value theory) for bounding the backlog over finite time horizons. Interestingly, none of the two methods completely dominates the other. For the new method we also discuss how it can be evolved into a corresponding calculus for network analysis analogous to the existing SNC.

Marc Boyer, Giovanni Stea and William Mangoua Sofack.
Deficit Round Robin with network calculus.

Generalised Processor Sharing (GPS) is a well-known ideal service policy designed to share the capacity of a server among the input flows fairly: each backlogged flow receives a pre-defined fraction of the total server capacity, according to its weight. Several practical implementations of GPS have been proposed, among which Deficit Round Robin (DRR) is widely deployed since it can be implemented in a very efficient way. The worst-case performance of DRR has been studied by several papers, all of which assume that the shared server has a constant rate. This paper studies DRR using Network Calculus, under very general assumptions. Latency results that generalise all the previous works are derived, and a residual service is derived from DRR parameters. This residual service is shown to be as good as or even better than previous studies when restricting it to the same assumptions.

Hao Wang, Florin Ciucu and Jens Schmitt.
A Leftover Service Curve Approach to Analyze Demultiplexing in Queueing Networks.

Queueing networks are typically subject to demultiplexing operations, whereby network nodes split flows into multiple sub-flows. The demultiplexing operation captures relevant network aspects such as packet loss or multi-path routing. In this paper we propose a novel approach to analyze queueing networks with demultiplexing. The basic idea is to represent a network node implementing a demultiplexing operation on an output flow as an equivalent system for which the corresponding input flow is logically demultiplexed according to the demultiplexing operation at the output. In this way, the service given to one of the demultiplexed sub-flows at the output can be expressed in terms of a leftover service curve, and consequently performance bounds can be derived using the network calculus methodology. Using numerical illustrations, we show that the obtained bounds improve upon existing bounds, especially in the case of the rather small sub-flows.

Track: Game Theory in Communication Networks (Thursday 11th and Friday 12th, 14 : 30 - 16 : 35)

Eitan Altman.
A semi-dynamic model for competition over popularity and over advertisement space in social network.

Various tools are available for increasing the speed of content dissemination such as embeddinigs in some popular web pages, sharing in some other social networks, and advertisement. In particular, when individuals pass through a content provider to distribute contents, they can benefit from tools such as recommendation systems. The content provider can give a preferential treatment to individuals who pay for advertisement. In this paper we study competition between several contents, each characterized by some given potential popularity. We study competition through advertisements that are placed at the beginning of the dissemination of contents. We answer the question of when is it worthwhile to invest in advertisement as a function of the potential popularity of a content as well as its competing contents. The competition between similar contents (e.g. news channels) over a finite set of potential destinations. We then consider a second model in which there is also competition on advertisement space. We compute the equilibrium strategy and identify its structure and properties for each one of the situations.

Eitan Altman, Ana Galindo-Serrano and Lorenza Giupponi.
Equilibrium Selection in Interference Management Non-Cooperative Games in Femtocell Networks.

In this paper we apply a special class of n-person non-cooperative games, which we call Weakly Coupled Constrained Games (WCCG), in femtocell systems to manage the aggregated interference they may generate at macrocell associated users. WCCG have the following structure: the utility of a player depends only on its own assignment and interactions between players appear through extra constraints. Non-cooperative games with common constraints have infitely many equilibria, we focus on selecting one, the normalized Nash equilibrium, which has some desirable scalable properties related to pricing, establish its uniqueness and compute it in a closed form.

Mohamed Baslam, Rachid El-Azouzi, Essaid Sabir and El Houssine Bouyakhf.
New Insights from a Bounded Rationality Analysis for Strategic Price-QoS War.

We present a game theoretic framework for the dynamical behaviors of a duopoly game in telecommunications service providers' context. Competition between two Service Providers (SPs) is assumed to take place in terms of their pricing decisions and the Quality of Service (QoS) they offer. Moreover, we consider the general scheme with multilevel rationality. More precisely, we consider two schemes: 1) Both SPs are rational, and 2) One SP is rational and the second SP is boundedly rational. We describe the competitive interaction and analyze the resulting equilibria. Later, we compute explicitly the steady states of the dynamical system induced by bounded rationality, and establish a necessary and sufficient condition for stability of its Nash equilibria (NEs). We prove that there exists exactly one NE which is fair whereas remaining equilibria are unfair. A special feature is that the stability condition of the Nash equilibrium coincides with the instability condition of the boundary equilibria. Thus the system would never be absorbed by any of the unfair equilibria which solves the equilibrium selection issue! Moreover, we show that considering the delay case (i.e., assuming a market with memory) increases the stability of the system. Here, the size of the memory could be considered for multi-level rationality, which means that bounded rationality tends to rationality as the memory size increases. We finally show that boundedly rational SPs with delay have a higher chance of reaching the fair Nash equilibrium.

Helene Le Cadre and Jean-Sebastien Bedo.
Distributed Learning in Hierarchical Networks.

In this article, we propose distributed learning based approaches to study the evolution of a decentralized hierarchical system, an illustration of which is the smart grid. Smart grid management requires the control of non-renewable energy production and the integration of renewable energies which might be highly unpredictable. Indeed, their production levels rely on uncontrolable factors such as sunshine, wind strength, etc. First, we derive optimal control strategies on the non-renewable energy productions and compare competitive learning algorithms to forecast the energy needs of the end users. Second, we introduce an online learning algorithm based on regret minimization enabling the agents to forecast the production of renewable energies. Additionally, we define organizations of the market promoting collaborative learning which generate higher performance for the whole smart grid than full competition.

Lorenzo Maggi.
Cooperative Stochastic games with applications to multiaccess systems.

We deal with multi-agent Markov Decision Processes (MDP's) in which cooperation among players is allowed. We find a cooperative payoff distribution procedure (MDP-CPDP) that distributes in the course of the game the payoff that players would earn in the long-run game. We show under which conditions such a MDP-CPDP fulfills a time consistency property, contents greedy players, and strengthen the coalition cohesiveness throughout the game. We then apply these concepts to a wireless multiaccess system, in which the channel coefficients follow a quasi-static Markov process on a finite set of states. Since the

channel is dynamic, the users change their preference over the rates in the course of time. We allocate a transmission rate to each user, in each state of the channel process, according to some criteria of sum-rate optimality, dynamic stability, and fairness, which hold throughout the transmission.

Haddad Majed.
A Hierarchical Approach for the Association Problem with Misleading Partial Channel State Information

In this contribution, we develop a hierarchical Bayesian game framework where users compete to maximize their throughput by picking the best locally serving radio access network (RAN) with respect to their own measurement, their demand and a partial statistical channel state information (CSI) of other users. In particular, we investigate the properties of a Stackelberg game, in which the base station is a player on its own. We derive analytically the utilities related to the channel quality perceived by users to obtain the equilibria. We study the Price of Anarchy (PoA) of such system, where the PoA is the ratio of the social welfare attained when a network planner chooses policies to maximize social welfare versus the social welfare attained in Nash/Stackeleberg equilibrium when users choose their policies strategically. We show by means of a Stackelberg formulation, how the operator, by sending appropriate information about the state of the channel, can optimize its global utility while users maximize their individual utilities. The proposed hierarchical decision approach for wireless networks can reach a good trade-off between the global network performance at the equilibrium and the requested amount of signaling. Typically, it is shown that when the network goal is orthogonal to user's goal, this can lead the users to a misleading association problem.

Francois Meriaux, Stefan Valentin, Samson Lasaulce and Michel Kieffer.
An Energy-Efficient Power Allocation Game with Selfish Channel State Feedback in Cellular Networks.

With energy-efficient resource allocation, mobile users and base station have different objectives. While the base station strives for an energy-efficient operation of the complete cell, each user aims to maximize its own data rate. To obtain this individual benefit, users may selfishly adjust their Channel State Information (CSI) reports, reducing the cell's energy efficiency. To analyze this conflict of interest, we formalize energy-efficient power allocation as a utility maximization problem and present a simple algorithm that performs close to the optimum. By formulating selfish CSI reporting as a game, we prove the existence of an unique equilibrium and characterize energy efficiency with true and selfish CSI in closed form. Our numerical results show that, surprisingly, energy-efficient power allocation in small cells is more robust against selfish CSI than cells with large transmit powers. This and further design rules show that our paper provides valuable theoretical insight to energy-efficient networks when CSI reports cannot be trusted.

Daniele Miorandi and Francesco De Pellegrini.
Demand-Side Management in Smart Grids: an Evolutionary Games Perspective.

In the context of smart energy grids, demand-side management refers to the ability of dynamically controlling and scheduling energy-consuming tasks. In one potential deployment scenario, smart appliances are controlled by a local intelligent software agents, which implement a given optimization algorithm for scheduling such tasks. The higher the fraction of users adopting such technology, the higher the advantage for the energy operator, due to the ability to control load curve and smooth peaks. At the same time, single users may incur some penalties, related to the fact that energy-consuming tasks may be deferred, thereby causing inconveniences. In this paper we take a game-theoretical perspective at demandside management techniques. Tools and solution concepts from evolutionary games are employed: we are interested in the dynamics of the adoption of demand-side management schemes by intelligent software agents. We focus on distributed control schemes that can be enforced by the operator through pricing schemes. Agent-based numerical simulations are provided to validate our theoretical results.

Yalemzewd Negash and Eduard Jorswieck.
Energy Efficient Topology Control for WLANS.

Wireless LANs employing the IEEE 802.11a/b/g/n standard operate in the unlicensed frequency bands. Their deployment has seen an exponential growth since their introduction. It is very common to find a wireless LAN in most buildings and houses around the world. These infrastructure-based WLANs are deployed to meet certain connectivity requirements and are usually deployed randomly. This random deployment has made the networks to be collectively unmanaged leading to the existence of larger interference areas. Power is lost because the access points usually operate with their factory default configurations that use the maximum authorized power level. This leads the access points to cover an area beyond required leading to the formation of larger interference areas that affects the performance of the networks. In this paper we study the power control problem in these networks using computation geometry and coalition formation game theory. We first analyze a coalition formation game between two neighboring access points for transmit power optimization. Then we set the requirements for other access points to join the coalition and investigate if a stable coalition can be formed. We finally show that by forming a coalition of up to five access points an optimal radio range assignment scheme exists that minimizes the total transmit power in the network substantially while meeting the requirements of network coverage.

Ioanna Papafili, Sergios Soursos and George Stamoulis.
A Novel Game-Theoretic Framework for Modeling Interactions of ISPs Anticipating Users' Reactions.
Effective management of overlay traffic is crucial for ISPs, due to the high interconnection costs incurred. In this paper, we investigate the interactions among ISPs that manage effectively overlay traffic but also take into account users' reactions. We introduce an innovative game-theoretic framework that employs separately two metrics, quantifying the ISPs' interconnection costs and the effects of their actions to users' QoE with the permissible strategies at each state being "memory-based", i.e., depending on the payoffs of the previous states. We present the details of this framework and justify why it fits nicely our problem. Furthermore, we study two games that model the adoption of ISP-driven locality promotion and of ISP-owned caches that intervene in the overlay. We formulate these games and investigate their evolution and equilibria by means of numerical results of two theoretical models, one of which is introduced here for quantifying the effects of mechanisms promoting locality.

Track: Economic Challenges in Telecommunication Systems (Friday 12th, 10 : 20 - 12 : 25)

Salah Elayoubi, Frédéric Morlot and Thomas Redon.
Risk-hedging using options for upgrading investments in mobile networks.
In this paper, we illustrate how a mobile network operator can plan an upgrading investment to anticipate explosions of the traffic demand, taking into account the expected generated profit and the customers satisfaction. The former parameter grows with the demand, whereas the latter sinks if the demand is too high as individual Quality of Service (QoS) may collapse due to capacity saturation problems. In addition to that, as the equipment price decreases with time, it may be interesting to wait rather than to invest at once. Taking into account this trade off, we propose a real option strategy to hedge against the risk that the investment has to take place earlier than expected. At last, we price this option with a backward dynamic programming approach, using recent improvements based on least-squares estimations.

Bruno Escoffier, Laurent Gourves, Jerome Monnot and Stefano Moretti.
Cost allocation protocols for network formation on connection situations.
The issue of embedding cost-awareness in the design of communication network devices and protocols has been growing at a fast rate in last years. Under certain connection situations, however, network design is not enforced by a central authority. This is the case, for instance, of power control for wireless networks, where the cost of a link is a function of the power needed to send a message to a remote node, which increases with the distance. Here each player wishes to consume as few power as possible to send its request and the main question is how to avoid that players deviate from a socially optimal network. In this paper, we study strategic games based on connection situations with the objective to coordinate self-interested agents placed on the nodes of a graph to realize a more efficient communication network. We address the problem of the design of cost allocation protocols that may guarantee the convergence of the best response dynamic and we analyze the effects of cost monotonicity and other statedependent properties on the optimality of a protocol.

Daniel Funke, Fabian Brosig and Michael Faber.
Towards Truthful Resource Reservation in Cloud Computing.
Prudent capacity planning to meet their clients future computational needs is one of the major issues cloud computing providers face today. By offering resource reservations in advance, providers gain insight into the projected demand of their customers and can act accordingly. However, customers need to be given an incentive, e.g. discounts granted, to commit early to a provider and to honestly, i.e. truthfully, reserve their predicted future resource requirements. Customers may reserve capacity deviating from their truly predicted demand, in order to exploit the mechanism for their own benefit, thereby causing futile costs for the provider.

Mohamed Lamine Lamali, Hélia Pouyllau and Dominique Barth.
SLA negotiation: Experimental Observations on Learning Policies.
The Internet has moved to content broadcasting and one might anticipate future evolutions of the supported applications. Meanwhile, the Internet business model remains the same from the early-days. While, on the technological side, many discussions assess the ossification of the Internet, the Internet traded good is still reachability. Some authors argue that the technical ossification is a consequence of the economic one. But adopting a clean-slate economic model is as challenging as adopting a clean-slate architecture. The new system must meet requirements on profitability and stability while tackling complex issues. In this paper, we focus on the proposal of enriching Service Level Agreements (SLAs), which are contracts among Network Service Providers (NSPs) with Quality of Service (QoS) information. We propose a game model of the SLA negotiation among NSPs in order to study how some learning algorithms converge to stable conditions, which are mixed Nash Equilibria in this case. Computing a mixed Nash equilibrium is PPAD-complete; the corresponding algorithms are thus quite complex. In previous works, some authors studied the convergence of Reinforcement Learning techniques to pure and mixed Nash Equilibria. Learning mixed Nash Equilibria seems harder. Hence, we rather experimentally observe how such algorithms can, according to different policies, converge to mixed Nash Equilibria, and also how profitable they are for the NSPs.

Peter Reichl, Patrick Maillé, Patrick Zwickl, Andreas Sackl.
On the Fixpoint Problem of QoE-based Charging.
While with traditional QoS-based charging the pricing structure mainly reflects the delivered QoS in order to regulate the demand, the role of service prices in a Quality of Experience (QoE) context is more complex. Amongst others, the charged price may in addition have a direct impact on the user's quality perception. In this paper, we analyze the structure of the resulting fixpoint problem and discuss the corresponding equilibrium. Based on recent user trials, additional insight into the characteristics of the related feedback loops is provided, before we conclude with outlining some consequences for future QoE-based charging mechanisms.

Track: Mean Field and Control (Friday 12, 16 : 55 - 18 : 35)

Danilo Abbaldo, Marco Gribaudo and Daniele Manini.
Evaluation of different scheduling policies in IaaS applications by Mean Field analysis.
Cloud Computing is emerging today as a commercial infrastructure that through the use of virtualization aims to provide on demand computing resources. In particular, the Infrastructure as a Service (IaaS) is a cloud service that allows the user to perform and execute any OS and application in virtual environments. In this work we present an evaluation of different policies for the assignment of virtual machines that IaaS providers can adopt in order to both efficiently planning their infrastructures and guaranteeing the quality of service expected by customers. The study is based on the exploitation of a Mean Field Model, able to evaluate systems with a relevant number of interacting entities, that can provide interesting insights derived from the computation of different performance indexes such as the request loss rate, the mean number of executing/available resources, and the overall ratio of satisfied requests to mention a few.

Anil Aswani, Neal Master, Jay Taneja, Andrew Krioukov, David Culler and Claire Tomlin.
Quantitative Methods for Comparing Different HVAC Control Schemes.
Experimentally comparing the energy usage and comfort characteristics of different controllers in heating, ventilation, and air-conditioning (HVAC) systems is difficult because variations in weather and occupancy conditions preclude the possibility of establishing equivalent experimental conditions across the order of hours, days, and weeks. This paper is concerned with defining quantitative metrics of energy usage and occupant comfort, which can be computed and compared in a rigorous manner that is capable of determining whether differences between controllers are statistically significant in the presence of such environmental fluctuations. Experimental case studies are presented that compare two alternative controllers (a schedule controller and a hybrid system learning-based model predictive controller) to the default controller in a building-wide HVAC system. Lastly, we discuss how our proposed methodology may also be able to quantify the efficiency of other building automation systems.

Sandeep Juneja, Tushar Raheja and Nahum Shimkin.
The Concert Queueing Game with Random Arrivals Volume.
We consider the concert queueing game in the fluid framework, where the service facility opens at a specified time, the customers are particles in a fluid with homogeneous costs that are linear and additive in the waiting time and in the time to service completion, and wish to choose their own arrival times so as to minimize their cost. This problem has recently been analyzed under the assumption that the total volume of arriving customers is deterministic and known beforehand. We consider here the more plausible setting where this volume may be random, and only its probability distribution is known beforehand. In this setting, we identify the unique symmetric Nash equilibrium and show that under it the customer behavior significantly differs from the case where such uncertainties do not exist. While, in the latter case, the equilibrium profile is uniform, in the former case it is uniform up to a point and then it tapers off. We also solve the associated optimization problem to determine the socially optimal solution when the central planner is unaware of the actual amount of arrivals. Interestingly, the Price of Anarchy (ratio of the social cost of the equilibrium solution to that of the optimal one) for this model turns out to be two exactly, as in the deterministic case, despite the different form of the social and equilibrium arrival profiles.

Raul Tempone and Pedro Vilanova.
On the indistingishability Assumtion in Mean Field Games.
In a stochastic dynamical system, the independence assumption implies that the accumulation of observations does not provide any information about future events. This assumption is clearly inappropiate in a complex network context. The joint law of those random observables must contain some form of dependence among them. One form of dependence is to assume that the indices of the sequence of random variables are non informative. That is, all the marginal distributions of a finite number of random variables are identical. This implies that the joint distribution does not change when the order of the random variables are permuted. This concept can be also extended to the infinite case. In this talk we start with the classical representation theorems of de Finetti and Hewitt-Savage for 0,1 and [0-1] random variables, and then we discuss a general representation theorem. Then, we show its applications to games and mean field games in discrete and continuous time.