

The first Workshop on Pricing and Incentives in Networks (W-PIN 2012)

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Today's communication networks are highly complex and heterogeneous, and are often owned by multiple profit-making entities. For new technologies or infrastructure designs to be adopted, they must not be only based on sound engineering performance considerations but also present the right economic incentives. Recent changes in regulations of the telecommunication industry make such economic considerations even more urgent. For instance, new concerns such as network neutrality have a significant impact on the evolution of communication networks. On the other hand, communication networks support an ever growing economic activity based on applications and services such as cloud computing, social networks, peer-to-peer networks, etc. These applications pose new challenges such as the development of good pricing mechanisms taking into account the network characteristics. In relation to these applications, security and privacy also require consideration of economic aspects to be fully understood.

The aim of the first Workshop on Pricing and Incentives in Networks was to foster discussions on the application of economic and game-theoretic models and principles to address challenges in the development of networks and network-based applications and services. We received 24 submissions, all of which were reviewed by at least 3 members of the program committee (in most cases by 4 members). Based on the reviews, we selected 10 papers that were presented at the workshop. The presentations were organized in 4 sessions: Neutrality, Pricing and QoS, Transit and Peering, and Infrastructure and Network Formation.

In the Neutrality session, *Coucheney et al.* discuss the neutrality issue for search engines. They propose a simple model for a single keyword and perform numerical comparisons of the revenues in the neutral and non-neutral regimes. Their paper is among the first attempts to analyze quantitatively the effect of non-neutrality in search engines. *Hanawal et al.* analyze the incentive for a content provider (CP) and an ISP to collude by means of an exclusive contract in a simple model with one ISP and several CPs. They show that the collusion is beneficial to the colluding CP if its advertisement revenue is sufficiently high relative to that of other CPs.

In the Pricing and QoS session, *Yu and Kim* propose two subsidy schemes (price subsidy and QoS subsidy) to improve user welfare in a mobile network. They analyze the effect of each scheme on user welfare and on network service provider

and find that the best scheme depends on the level of spectrum scarcity. *Berry et al.* discuss the problem of capacity sharing in wireless networks. They model two providers who each invest in capacity ahead of time and can share capacity according to some sharing contract once their demand is revealed. They find that sharing can increase the expected revenue of both carriers. *Ma et al.* generalize Kelly's mechanism where users submit bids and are allocated resources in proportion of their bid. They include price differentiation and analyze the new mechanism. They show that it is more flexible and allows in particular to achieve social optimum at Nash equilibrium.

In the Transit and Peering session, *Ben Houidi and Pouyllau* present their position and analysis of recent tussles involving CPs and ISPs and discuss the role of transit ISPs as intermediary between access ISPs and CP. *Lodhi et al.* use an agent-based computational model to analyze equilibria in games where autonomous systems decide whether to peer openly, selectively with peers of comparable size, or restrictively. They find that the situation where autonomous systems peer openly is a risk dominant Nash equilibrium, which contributes to understanding the prominence of this strategy.

In the Infrastructure and Network Formation session, *Mastroeni and Naldi* propose the use of insurance against storage price increase in cloud computing. They use the Black-Scholes formula to compute the fair insurance premium. *Lee et al.* analyze the incentive for an ISP to deploy its own CDN service. They use a model with two competing ISPs. They find that the benefits (or loss) of deploying the CDN depends in a subtle way on the cache server cost and the interplay of two contrary effects: competition and delay reduction. *Gulyás et al.* propose a first attempt at combining greedy routing and network formation games. Their main result is that if the network is formed strategically, greedy-routable small-world networks do not emerge in equilibrium.

In addition to contributed sessions, the workshop had two keynote talks by Andrew Odlyzko and Tommaso Valletti. Odlyzko talked about "Economics, QoS, and charging in the next great telecom revolution." He discussed the expansion of the mobile communication business and argued that some of the pricing and QoS schemes developed by the research community for the Internet could become crucial in the wireless context. Valletti talked about "Unbundling the incumbent: Evidence from UK broadband." Using a very large dataset from UK broadband penetration, he showed that the "local loop unbundling" policy did not increase penetration but had a very strong positive impact on the

quality of service.

We thank all the PC members for their great help in writing thoughtful reviews within a very tight schedule: Eitan Altman, Jörn Altmann, Tamer Başar, Rainer Böhme, Costas Courcoubetis, Roch Guerin, Ekram Hossain, Jianwei Huang, Stratis Ioannidis, Rahul Jain, Ramesh Johari, Scott Jordan, Nikolaos Laoutaris, John C. S. Lui, Richard T.B. Ma, Patrick Maillé, Jeonghoon Mo, John Musacchio, Ariel Orda, Peter Reichl, Galina Schwartz, R. Srikant, Hamidou Tembine, Bruno Tuffin, Vishal Misra, Adam Wierman. We also thank the ACM PER editor Giuliano Casale and the ACM SIGMETRICS/Performance 2012 organizing committee (in particular Peter Harrison and Gareth Jones) for their help with the proceedings and with the local organization.

The workshop received financial support from EURECOM and Institut Mines-Télécom which is gratefully acknowledged.