

## SHORT TERM SCIENTIFIC MISSION (STSM) – SCIENTIFIC REPORT

The STSM applicant submits this report for approval to the STSM coordinator

**Action number: CA16228 - European Network for Game Theory**

**STSM title: Toulouse School of Economics Short Term Visit**

**STSM start and end date: 01/04/2018 to 30/04/2018**

**Grantee name: Otavio Barbosa da Silva Soares**

### PURPOSE OF THE STSM/

#### Scope

GAMENET, the European Network for Game Theory is offering an opportunity for early-stage researches engaged in research that is relevant to Game Theory to promote a short term scientific mission-STSM to an institution in a country another than its affiliated institution.

#### Objective

The broad objective of the program is to foster collaboration and diffusion of new techniques that can contribute to the investigation of complex networks such social, telecommunication and transportation networks.

#### Expected outcomes

Benefit from the discussion and exchange of ideas with leading scholars in Industrial Organization, Game Theory and Mechanism Design. Attend discussion, seminars and any other public debate that are open for external attendance.

Gain a substantial knowledge while learning from more experienced scholars how best to approach the problem of investigation.

#### Brief summary of the research interest:

Radiofrequency spectrum is an essential facility for innumerable modern applications, wireless communication, broadcasting, autonomous systems (drones, driverless cars), internet of things, satellite among others. Wireless spectrum is a valuable but limited resource.

As expected, some applications place higher value on spectrum than others, and some spectrum frequencies are more valuable than others. Common wisdom would suggest widespread transactions among service providers, applications and rights of use. Nevertheless, spectrum allocation market still is a territory of rigid rules that often stifle innovation.

Even though much progress has been observed since the adoption of auction mechanism in the early nineties, the loss of efficiency due the lack of flexible mechanism design has become evident for market

players. Spectrum management is lagging behind the rapid technological progress in devices, services and business models.

Flexible schemes of radio frequency spectrum allocation are still rare worldwide, policy makers are struggling to identify the right framework to provide Radio spectrum management with the proper design and incentives to allow spectrum users make timely decisions on how to use available spectrum, responding to market evolution and new technology opportunities. The proposal of the research is to investigate mechanisms that can improve the functions of market-settings through a number of rigorous economic tools, like two-sided spectrum auctions, dynamic allocation of property rights, dynamic auctions, secondary markets, among others. An institutional change that favors the use of economic reasoning.

One way envisioned to tackle the problem and improve spectrum allocation efficiency is through Dynamic Spectrum Sharing Networks-DSAN. A game theoretical approach favors richer models for investigating strategic network users (primary user: right owners and secondary users: leasing users). A general framework for DSAN consist in multi-objective optimization problem in a non-cooperative setup with incomplete information. Primary users aim sell idle spectrum and secondary users need to acquire spectrum rights for communicating purposes. Mechanism design might include a centralized control or flexible self-organized bargain process.

### **DESCRIPTION OF WORK CARRIED OUT DURING THE STSMS**

The grantee dedicate himself to pursue the stated objectives of the present short-term scientific mission, employing the necessary resources to strengthen his knowledge in Game Theory, while building important connections that might help in further stages of his research.

During the visit, the grantee was accommodated at the local Ph.D. student office, which posed as very convenient in the sense that it allowed to build relationships and also worked as an appropriate infrastructure to conduct his studies.

Throughout the period of visit, innumerable instances of interactions were possible given the vibrant agenda of discussions and events that took place in the host institution in that period and the welcome atmosphere from other Ph.D. candidates and the Scholars of TSE.

Over the course of the four weeks, the grantee was able to attend internal and external conferences with relevant topics of research. Among them, it should be highlighted:

- Internal Seminar of Senior TSE Scholars:
  - Discussion on modelling of games with parameter uncertainty; social media and the news: attention capture via content bundling; morality and the market; among other themes.
  - The seminar included a paper presentation from the winner of The Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel of 2014, Prof. Dr. Jean Tirole.
- Industry seminars:
  - Merger analysis of digital platforms (Presented by the French Competition Authority).
  - Challenges of the aviation industry (Presented by Airbus).
- Jambore Enter:
  - A 2-day conference where PhD students in Economics and faculty of the institutions forming the ENTER network<sup>1</sup> meet.
  - Innumerable paper presentations and discussions by PhD students and plenary sessions by senior scholars.

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<sup>1</sup> The EUROPEAN NETWORK FOR TRAINING IN ECONOMIC RESEARCH is a cooperative venture between eight leading European Economics Departments, located in Barcelona (Spain), Brussels (Belgium), London (United Kingdom), Madrid (Spain), Mannheim (Germany), Stockholm (Sweden), Tilburg (the Netherlands) and Toulouse (France).

Besides that formal events, it was possible to have parallel discussions with the Ph.D students from TSE and other institutions as well as Professors of the host institution and the visiting institutions who attended the Jambore Enter conference.

Finally, it should be mention the constant support that Professor Renato Gomes provided, not only in terms of being an intermediary to other scholars, but mainly with advices over the grantee research interest.

### **DESCRIPTION OF THE MAIN RESULTS OBTAINED**

The essence of the European Network is to facilitate interactions and collaborations between different groups of game theorists, to provide game theoretic expertise to industrial partners, and to establish a large and vibrant interconnected community of excellent scientists in these different fields. It should be stated that from the first day at Toulouse School of Economics-TSE up to the end of the proposed short-term scientific mission this aim was pursued.

Being exposed to too much rich and excellent work posed as specially helpful for the grantee to understanding the impact of powerful game theory techniques. The debates on his research topic and on researches of Ph.D. students and TSE Scholars encouraged further discussions and initiated plans for future collaborations.

Some aspects of the grantee research interest were debated and suggestions for improvement or ways to address the points were presented. It was emphasized that in terms of allocation mechanisms, a firm's valuation of the good depends on the allocation to others. This allocative externality must be taken in account when modelling strategic interactions between spectrum right holders (government or private companies) and secondary users. In fact, Moldovanu and Jehiel (2006)<sup>2</sup> investigates the effects of allocative and informational externalities in (multi-object) auctions and related mechanisms and this work might be a good starting point to study the matter.

From the point of view of a policy question it was suggested that Government's choices over spectrum allocation could be further explored in terms of empirical evidences of what scheme provided better outcomes in terms of performance, competition in prices and investment.

Finally, noteworthy, that the short-term scientific mission was a great opportunity to strengthen the collaboration between the Lisbon Institute of Economics and Management and the pioneering Toulouse School of Economics, what, definitely, could be translated in future collaborations.

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<sup>2</sup> Jehiel, P and Moldovanu, B. 2006. 'Allocative and Informational Externalities in Auctions and Related Mechanisms'. London, Centre for Economic Policy Research.