Chapter 5
Game Theory for Cooperation in Multi-Access Edge Computing

Jose Moura
Instituto Universitário de Lisboa, Portugal

Rui Neto Marinheiro
Instituto Universitário de Lisboa, Portugal

Joao Carlos Silva
Instituto Universitário de Lisboa, Portugal

ABSTRACT

Cooperative strategies amongst network players can improve network performance and spectrum utilization in future networking environments. Game Theory is very suitable for these emerging scenarios, since it models high-complex interactions among distributed decision makers. It also finds the more convenient management policies for the diverse players (e.g., content providers, cloud providers, edge providers, brokers, network providers, or users). These management policies optimize the performance of the overall network infrastructure with a fair utilization of their resources. This chapter discusses relevant theoretical models that enable cooperation amongst the players in distinct ways through, namely, pricing or reputation. In addition, the authors highlight open problems, such as the lack of proper models for dynamic and incomplete information scenarios. These upcoming scenarios are associated to computing and storage at the network edge, as well as, the deployment of large-scale IoT systems. The chapter finalizes by discussing a business model for future networks.

1. INTRODUCTION

Game Theory (GT) techniques have recently emerged in many engineering applications, notably in communications and networking. With the emergence of cooperation as a new communication paradigm, alongside the need for self-organizing, decentralized, and autonomic networks, it has become imperative to seek suitable GT tools to analyze and study the behavior and interactions of nodes in Future Networks (FNs). The final goal is to find low-complexity distributed algorithms that can efficiently manage the

DOI: 10.4018/978-1-5225-7570-2.ch005

Copyright © 2019, IGI Global. Copying or distributing in print or electronic forms without written permission of IGI Global is prohibited.

high-complexity future network environment formed by heterogeneous technologies, enhancing collaboration among players and punish selfish or misbehaving nodes. In addition, the new management solutions should reduce the unwanted effects of stale information (e.g. oscillation around a specific network status) by choosing the proper values, namely, for both sampling rate of network status and delay associated to the dissemination of status information amongst the network nodes. This chapter fills a hole in existing communications literature, by providing a comprehensive review about GT models/concepts that are highly relevant for enabling collaboration in FNs environments.

In FNs, distributed and intelligent management algorithms can manage (control) the network infrastructure. These algorithms create incentive mechanisms that force the players to cooperate instead of pursuing their own interest. This novel player's behavior enables the efficient usage of available (sometimes-constrained) network resources, satisfying the heterogeneous requirements of data flows. Broadly speaking, the current literature highlights two different ways to encourage cooperation (collaboration) among the players: one with a short-term control effect and the other with a long-term control effect. The first approach uses virtual payments (credit-based games) to relieve costs for relaying traffic, and the second approach enforces the creation of communities (or groups, clusters) to establish long-term relationships among the nodes (reputation-based games). The reputation-based games sustain cooperation among the players because defection against a specific node causes personal retaliation or sanction by others. In the limit, nodes that do not cooperate will not be able to use the network themselves. Effective corrective actions against cheating nodes are also required with either permanent or temporary measures. Other interesting perspective to investigate is the deployment of hybrid solutions combining credit-based and reputation-based methods to enhance collaboration amongst players.

There is a relatively new and a very interesting set of games designated by evolutionary coalitional games that can enable more intelligent, self-adjustable, and robust algorithms for the management of FNs. In addition, the social networks, like Facebook or Flickr, can rapidly disseminate the positive impact of collaborative actions among the users of FNs (Apicella, Marlowe, Fowler, & Christakis, 2012) (Bond et al., 2012). Furthermore, the deployment in large scale of vehicular and sensor networks supported by the convergent (Moura & Edwards, 2015) and heterogeneous (Moura & Edwards, 2016) wireless access can enable some collaborative behavior amongst players.

The current chapter reviews the literature to discuss the more promising GT proposals that can incentivize the collaboration among the diverse players, aiming to use more intelligently and efficiently the available resources of FNs. This chapter has the following structure. Section 2 introduces and discusses important GT aspects for FNs. Section 3 gives the background and highlights collaborative strategies in FNs. It also presents our vision about FNs. Then, section 4 describes how GT can enable and enhance collaboration in FNs. Section 5 offers a broad GT literature survey in wireless networking. Section 6 discusses some relevant research work about how GT addresses the more significant functional aspects we expect to be present in FN environments. In addition, Section 7 discusses the business perspective for FNs. Finally, Section 8 concludes with relevant GT open problems to support collaboration in FNs.

2. DISCUSSING GAME THEORY

The current section introduces and discusses relevant aspects of GT, which can be very useful to model the emergent network environments of FNs.

48 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the publisher's webpage:
www.igi-global.com/chapter/game-theory-for-cooperation-in-multi-access-edge-computing/219142

Related Content

Deep Learning and IoT: The Enabling Technologies Towards Smart Farming
Muhammad Suleman Memon, Pardeep Kumar, Azeem Ayaz Mirani, Mumtaz Qabulioand Irum Naz Sodhar (2020). *Industrial Internet of Things and Cyber-Physical Systems: Transforming the Conventional to Digital (pp. 47-60).*
www.irma-international.org/chapter/deep-learning-and-iot/257839

Receiver Diversity for Distributed Detection in Wireless Sensor Networks
Mohammad A. Al-Jarrahand Mohammad M. Al-Ibrahim (2012). *International Journal of Wireless Networks and Broadband Technologies (pp. 1-15).*
www.irma-international.org/article/receiver-diversity-distributed-detection-wireless/75524

Reinforcement Learning for Routing and Spectrum Management in Cognitive Wireless Mesh Network
Ayoub Alsarhan (2016). *International Journal of Wireless Networks and Broadband Technologies (pp. 59-72).*
www.irma-international.org/article/reinforcement-learning-for-routing-and-spectrum-management-in-cognitive-wireless-mesh-network/170429

Printing Techniques and Performance of Chipless Tag Design on Flexible Low-Cost Thin-Film Substrates
Rubayet-E-Azim Anee, Sushim Mukul Roy, Nemai Chandra Karmakar, Ramprakash Yerramilliand Gerhard F. Swiegers (2012). *Chipless and Conventional Radio Frequency Identification: Systems for Ubiquitous Tagging (pp. 175-195).*
www.irma-international.org/chapter/printing-techniques-performance-chipless-tag/65981

Data Gathering in Correlated Wireless Sensor Networks with Cooperative Transmission
Laxminarayana S. Pillutlaand Vikram Krishnamurthy (2010). *Cooperative Communications for Improved Wireless Network Transmission: Framework for Virtual Antenna Array Applications (pp. 471-496).*
www.irma-international.org/chapter/data-gathering-correlated-wireless-sensor/36560