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Josephina Antoniou

Game Theory, the Internet of Things and 5G Networks

Utilizing Game Theoretic Models
to Characterize Challenging Scenarios

Springer

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RESEARCH MEETS INNOVATION

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Preface

With the recent deployment of fourth generation technology (4G), the fifth generation of mobile communication technology (5G) is slowly emerging to support the Internet of Things (IoT), where millions of sensors and mobile devices will be deployed in order to provide data for smart homes, smart buildings and smart cities. 5G networks will have to handle data (collection, storage, mining, analysis, etc.) gathered from a very diverse set of sources like traffic, weather, security incidents, and crowds, and additional issues surfacing due to IoT deployment and the increasing use of wearable devices. Since any communication network, such as IoT, is a multi-entity system, decisions are taken by different system entities. All entities are motivated to make decisions that optimize their own potential benefit, whether this is experience, profit, resource usage or any other factor that may result in high utility measurements or high satisfaction for these entities.

The strengthening of the user role allows a user of the 5G communication network to decide whether or not to participate in a network and offer value to that network. For example, a user may select it to provide a requested service, its criterion being user satisfaction in terms of, for example, experience (e.g. service quality) and cost. Then user experience can be improved by the consideration of context information, i.e. location, device capabilities, environment, preferences, etc. Alternatively, the network operator may decide which of the users to admit, how to allocate available resources to the participating users and how to design certain mechanisms in order to maximize its capacity. All these decisions are driven mainly by the network's revenue maximization criterion.

In this book, we utilize Game Theory in order to model, analyse and finally propose solutions (in terms of strategies for the involved entities) for a number of representative types of interactions in 5G communication networks. The interacting entities are the mobile user devices, IoT nodes and vehicular nodes participating in the 5G network, on the one hand, and the actual network operators and service operators, on the other hand. Game Theory has been extensively used in networking research as a theoretical decision-making framework. Game Theory provides appropriate models and tools to handle multiple, interacting entities attempting to make a decision and seek a solution state that maximizes each entity's utility.

To this end, in this book four selected interactive situations have been analysed using existing game theoretical models, and theoretical conclusions are drawn for each interactive situation; the theoretical conclusions are further reinforced with appropriate numerical results in several cases. Summarizing the work presented, we begin with a scenario where multiple IoT nodes cooperate to achieve the adoption of a password generation mechanism to protect them against malware attacks. Next, we turn our attention to the offloading scenario where mobile nodes take on the role of content repeaters to provide an alternative communication path through the network, subsequently increasing the network coverage. Therefore, 5G communication service is enabled by data offloading from infrastructure transmission points onto the mobile users that act as content repeaters, for a monetary payoff. The third scenario explores the interaction between a receiving node and a sending node in a vehicular network, in order to motivate trust between them. The final scenario deals with the bargaining situation between two provider entities, namely a service provider and a cloud provider, attempting to partition a service payment optimally.

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