Schémas d'allocation de ressources distribués pour réseaux cognitifs

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Résumé du projet de recherche (Langue 1)

The proposed research consists in designing and evaluating the performances of distributed resource allocation algorithms for cognitive networks. The notion of cognitive radio comes from the observation that the radio spectrum is not efficiently utilized. There is indeed a high heterogeneity of its usage both in time and space. FCC measurements have shown that large parts of the spectrum remains unused although allocated, while in the same time, some spectrum bands are subject to congestion because of the increasing demand for wireless services. An important challenge for current research in the wireless networks community is to propose efficient algorithms to cope with this issue. This is facilitated by the rapid development of software radio, which allows radio equipments to be agile and flexible. They can indeed rapidly change frequency band, sense or scan several channels or even recon gure protocols. In this context, Mittola has developed the notion of cognitive radio, which is particularly adapted to the primary/secondary usage of the spectrum. In this model, a primary user (PU) is the license owner of a spectrum band, possibly divided into several frequency channels, and has a strict priority for using this resource for its own transmissions. It can be a TV broadcaster or a cellular network operator. This primary user is however not using radio resource at 100%, either because transmissions are sporadic in the time domain or because it leaves some geographical white spaces unused. This offers the opportunity for secondary users (SU), which are also cognitive radios (CR), to opportunistically access the spectrum and so make a better usage of it. A central constraint for SUs is to not disturb in anyway primary users transmissions. The way secondary users choose the best frequency channels, access to the medium and share the resource with other cognitive radios is related to radio resource allocation schemes. These schemes are by nature distributed thus should rely on learning mechanisms in order to evaluate the potentiality of scanned spectrum bands and observe the strategies of other secondary users. A natural framework for studying such algorithms is game theory.

Résumé du projet de recherche (Langue 2)

Several theoretical frameworks can be investigated to tackle the problem of secondary usage of the spectrum and many papers have already made use of them to solve resource allocation problems. We think however, that cognitive radios have speci c constraints that are insufficiently taken into account up to now. The main research goal is to design distributed resource allocation algorithms for cognitive networks and to evaluate their performances in realistic scenarios. In the line of our previous work [1, 2, 3], we intend to work in the framework of stochastic learning and game theory. Here are the specific constraints, we would like to address (and insufficiently taken into account in the literature from our point of view): 1) Medium Access Control (MAC) constraint: the MAC protocol is usually ignored from resource allocation studies and very simple and unrealistic models are assumed. In this study, we will better de fine the MAC protocol (assuming for example CSMA/CA) and optimize the resource allocation algorithm for speci c MAC protocols. 2) Switching cost constraint: switching from a frequency channel to another induces some disadvantages or cost for a CR in terms of reconfigurability and protocol overhead. The resource allocation algorithms will be aware of this constraint. 3) Imperfect sensing: although some papers are dealing with this issue, many assume a perfect sensing of the PU for the design of resource allocation schemes. Dealing with an imperfect sensing module may a fect the resource allocation decisions. 4) Network topology: studies on cognitive radios generally ignore network topology, SUs are indeed aware of all transmissions on the considered spectrum band. While taking into account network topology, radio propagation and interferences, hidden terminals may appear and alter the performances of radio resource allocation schemes. New algorithms are needed to deal with this aspect. 5) Network dynamic: the classical assumption for evaluating resource allocation schemes is to consider a fi xed number of SUs trying to access channels owned by PUs. This model neglects the possibility of new SUs arrivals or SUs departures. It also assumes backlogged SUs, while SUs may generate a more complex traffic (e.g. ON/OFF). 6) Quality of Service (QoS) diff erentiation: SUs may have di fferent QoS requirements, so that designing allocation schemes able to differentiate QoS is an important research area. All the proposed learning scheme will be analyzed using the Multi-Armed Bandit (MAB) theory for small populations (extended for cognitive networks) and the population and evolutionary game theory for large populations. As we want also to fi ll the gap between convergence analytical results and practical protocol implementation, we will also evaluate our resource allocation schemes using simulations.

Informations complémentaires (Langue 2)