Proposition de recherche doctorale

Planning and dimensioning C-RAN architectures under spatio-temporal traffic

Mots clés :

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- **Co-encadrant(s)** :
- **Unité de recherche** : Laboratoire d'informatique de Paris 6
- **Ecole doctorale** : École Doctorale Informatique, Télécommunications, Électronique de Paris
- **Domaine scientifique principal**: Divers

Résumé du projet de recherche (Langue 1)

The subject of the thesis is the analysis, planning and dimensioning of wireless networks under a Cloud-RAN architecture. Cloud-RAN considers the grouping of stations into clusters and the common management of their resources for performance improvement and better service of user traffic. In this thesis, the wireless nodes are deployed on the plane, and the system is investigated under dynamic space-time user arrivals and departures. Important questions to be treated are related to the optimal size of the C-RAN cluster head, the choice of stations to be grouped together, and the quantification of the performance benefits with respect to throughput, coverage, delay and energy efficiency. Another important issue is to determine the adaptability of C-RAN clusters to user mobility (intra- and inter- cluster), as well as variations of the traffic load both over space and time.

Résumé du projet de recherche (Langue 2)

The novelty of the thesis lies in the consideration of both temporal as well as spatial aspects of traffic in the evaluation of C-RAN architectures. Most queuing models take into account only temporal dynamics, leaving aside the influence of space. In our model, that will consider the SINR model for interference and service, the analysis is necessary to be done in three dimensions (2D and time). Hence, the users arrive at some point in time, having a specific planar position. Each user is associated to a server (say wireless station) under some rule (e.g. geographically closest). Since the rule will be related to distance geometry, the spatial distribution of users will influence the performance. We further consider that due to finite resources, not all users can be served instantaneously by the station. Hence, service-delay arises. The way stations participate in the service of a user should be done in a way that improves total performance. The service from the whole cluster will require a type of cooperation or resource coordination and different strategies will be evaluated. To achieve a joint space-time analysis and evaluation/optimization of C-RAN, the thesis will develop models that are based on both stochastic geometry for the spatial aspects, as well as queuing theory for temporal delay aspects. Combination of the models should provide a thorough evaluation of such architectures. We provide an illustrative case which highlights the necessity of C-RAN and of determining the appropriate coordination: Consider the simplest scenario of two stations and two active users, each user served (associated) by a different station. We can envision two very different placements for these users on the plane. i) If both users are close to each other and also found in between the two stations (say at almost equal distance from each station), then each user can sense the transmission of both stations. Since the interference will be almost as strong as the beneficial signal, the stations must coordinate in order to sequentially transmit to users one after the other, interference free. On the other extreme, ii) if the two users are far from each other and can only sense the transmission of their associated station, both stations can transmit simultaneously. Existing literature on queuing in cellular networks includes [1], [2], [3], whereas topics of mobility and cooperation are treated in [4] and [5] among other works. These works simply touch the problem of arrivals in space, without sufficient analysis. Related to the topic of stochastic geometry and cooperation, results can be found in [6], [7]. References: [1] T. Bonald, A. Proutière: Wireless downlink data channels: user performance and cell dimensioning. MobiCom 2003: 339-352 [2] T. Bonald, Sem C. Borst, Alexandre Proutière: Inter-cell coordination in wireless data networks. European Transactions on Telecommunications 17(3): 303-312 (2006) [3] Bartlomiej Blaszczyszyn, Miodrag Jovanovic, Mohamed Kadhem Karray: How user throughput depends on the traffic demand in large cellular networks. WiOpt 2014: 611-619 [4] B. Baynat, N. Nya: Performance Model for 4G/5G Networks Taking into Account Intra- and Inter-Cell Mobility of Users. IEEE Local Computer Networks (LCN) 2016: 212-215 [5] A. Khlass, T. Bonald, S.-Eddine Elayoubi: Performance evaluation of intra-site coordination schemes in cellular networks. Perform. Eval. 98: 1-18 (2016) [6] F. Baccelli, A. Giovanidis: A Stochastic Geometry Framework for Analyzing Pairwise-Cooperative Cellular Networks. IEEE Trans. Wireless Communications 14(2): 794-808 (2015) [7] L.D. Alvarez-Corrales, A. Giovanidis, P. Martins, L. Decreusefond: Analysis of Static Cellular Cooperation between Mutually Nearest Neighboring Nodes. ArXiv:1611.02614 (2016)

Informations complémentaires (Langue 2)

This thesis will be done in close collaboration with Bruno Baynat (UPMC-LIP6, NPA).