Message Passing Algorithms for distributed resource allocation in 5G and Beyond 5G

Mots clés :
- Directeur de thèse : Didier LE RUYET
- Co-encadrant(s) :
- Unité de recherche : Centre d’Étude et de Recherche en Informatique et Communications
- Ecole doctorale : École Doctorale Informatique, Télécommunications, Électronique de Paris
- Domaine scientifique principal: Divers

Résumé du projet de recherche (Langue 1)

Message Passing Algorithms (MPA) have been widely used in digital communications for decoding on codes showing sparsity properties such as Low Density Parity-Check Codes (LDPC) [LOE04, LOE07, KSC98]. MPA has also been used for distributed resource allocation in some recent work in 4G and 5G context [GUE13, GUE16]. The min-sum algorithm was used to solve beamforming allocation in MIMO and beam sweep in massive MIMO. MPA is suited for sparse factor-graph, which corresponds to few interfering users. In 5G and Beyond 5G (B5G) systems with large number users and large number of beams with massive MIMO, centralized resource allocation will be far too complex and distributed resource allocation must be performed. Moreover, in B5G with asynchronous transmissions, inter-channel interference may take place in multi-carrier transmissions. In this case, resource allocation cannot be separated per subcarrier and the interdependency between optimization variables become larger than in classical resource allocation problems. Theoretical convergence of the MPA is only insured for cycle-free graphs, but good practical convergence has been shown even with cycles and non-sparse factor-graphs in [GUE13, GUE16]. The main drawbacks of MPA for distributed resource allocation are its convergence delay, which should be within the coherence time and before users’ traffic changes; and the fact that it requires discrete optimization variables, which may not be practical for power allocation, for instance. This thesis will investigate MPA for resource allocation problems in 5G and B5G, including massive MIMO, mmWave communications, and device-to-device communications. The optimization variables will be the power, subcarriers and streams, and several optimization objectives will be investigated in different 5G and B5G contexts. The performance results obtained with MPA will be compared both theoretically and numerically with other distributed resource allocation techniques such as game theory, and with centralized allocation. The complexity and convergence delay issues will be taken into account, as well as the problem of non-cycle-free factor-graphs. The PhD student will propose new schemes to achieve lower connectivity and theoretically study the limits and improvements that can be brought to the MPA for resource allocation. [LOE04] H.-A. Loeliger, “An introduction to factor graphs,” Signal Processing Magazine, IEEE, vol. 21, no. 1, pp. 28–41, 2004. [LOE04] H.-A. Loeliger, J. Dauwels, J. Hu, S. Korl, L. Ping, and F. Kschischang, “The factor graph approach to model-based signal processing,” Proceedings of the IEEE, vol. 95, no. 6, pp. 1295–1322, 2007. [KSC08] F. Kschischang and B. Frey, “Iterative decoding of compound codes by probability propagation in graphical models,” IEEE Journal on Selected Areas in Communications, vol. 16, pp. 219–230, feb 1998. [GUE13] I. M. Guerreiro, D. Hui, and C. C. Cavalcante, “A distributed approach to precoder selection using factor graphs for wireless communication networks,” in EURASIP Journal on Advances in Signal Processing, vol. 2013, no. 1, 2013. [GUE16] I. M. Guerreiro, J. Axnäs, D. Hui and C. C. Cavalcante, “Graph-based power efficient beam sweep for initial synchronization,” in Proc. of 2016 IEEE 17th International Workshop on Signal Processing Advances in Wireless Communications (SPAWC), Edinburgh, United Kingdom, 2016.

Résumé du projet de recherche (Langue 2)

The purpose of this thesis is to investigate message passing algorithm for different distributed resource allocation problems in 5G and B5G, including massive MIMO, mmWave communications, and device-to-device communications

Informations complémentaires (Langue 1)

We will collaborate with other international research teams involved in the same field including UFC, Brazil, CTTC, Barcelona, Spain, ...

Informations complémentaires (Langue 2)

contacts : didier Le Ruyet (didier.le_ruyet@cnam.fr) Mylène Pischella (mylene.pischella@cnam.fr)