Spectral and energy efficiencies for 5G networks with variable load

Laboratory:
Institut d’électronique et de télécommunication de Rennes (IETR),

Start date: October 1st, 2018 – duration: 42 months

Topic

Stochastic geometry provided a mathematical framework to study large wireless communication networks by characterizing the distribution of interferences [1]. From this stochastic characterization, network performance metrics can be evaluated such as coverage probability and ergodic rate. Recent works have combined stochastic geometry and random matrix theory to evaluate the spectral-efficiency energy-efficiency (SE-EE) tradeoff of signal to leakage plus noise ratio (SLNR) compared to zero forcing (ZF) precoder [2]. Basically, the interest of spatial point processes in performance analysis is the possibility to express the main performance metrics with the Laplace transform of the interference which can be expressed in closed-form in some cases. However, same as the regular hexagonal grid model, the performance evaluation of wireless cellular networks with a fully stochastic spatial description strongly depends on the kind of process used, e.g. Ginibre, Matern, Poisson, and overall on hypothesis on the network (elastic flow, power constraint, Gaussian signals, etc) [1]. The challenge is to find a tradeoff between the relevance of the results and tractability. Still, stochastic geometry allows to evaluate, at a large scale, some new communication techniques known for performing well in a point-to-point scenario, such as large MIMO, digital and analog beamforming. A basic limitation of traditional stochastic geometry approach is that it does not catch the fact that users do not receive the same resources according to their location w.r.t. the base station. Hence the resources allocated to users are not related to the integration over the domain of the spatial process. A first challenge is to deal with different resource provisioning in the same time than averaging over the point process.

Moreover, heterogeneous data rate demand should be taken into account by introducing a transmit probability or a conditional thinning process [3]. In case of heterogeneous cells-loading, i.e. overloaded and underloaded cells, flow balancing between cells and its influence on delays should be carefully taken into account [4, 5].

The PhD thesis aims at designing tractable and constructive models based on stochastic geometry and random matrix theory to evaluate the key performance metrics, e.g. spectral and energy-efficiencies, of dense 5G networks. A rigorous state of the art study will be conducted first, including the cited references in particular, then theoretical model including heterogeneous resource allocations and variable load in the network will be proposed. The validation of theoretical findings will be done by comparing with large Monte-Carlo simulations.

References


Key skills

The candidate should have earned an MSc degree, or equivalent, in one of the following field: Signal processing, electrical engineering, applied mathematics. He should have a strong background in probabilities and in signal processing for wireless communications as well. The candidate should be familiar with Matlab and C/C++ languages.

Key words:

Stochastic geometry, Poisson point process, probabilities, resource allocations, random matrix theory, non-stationary point processes.
<table>
<thead>
<tr>
<th>Contacts:</th>
<th>e-mails: <a href="mailto:jean-yves.baudais@insa-rennes.fr">jean-yves.baudais@insa-rennes.fr</a> ; <a href="mailto:philippe.mary@insa-rennes.fr">philippe.mary@insa-rennes.fr</a></th>
</tr>
</thead>
</table>
| Dr. Jean-Yves Baudais  
CNRS, IETR UMR 6164  
20 Avenue des buttes de Côesmes, 35708 Rennes, France  
Dr. Philippe Mary  
INSA de Rennes, IETR UMR 6164  
20 Avenue des buttes de Côesmes, 35708 Rennes, France | Web sites:  
http://jeanyves.baudais.free.fr  

**Web sites:**  
http://jeanyves.baudais.free.fr  