UMR 7252

Thesis proposal (2025-2026)

Title : Implementation of a NOMA-based cross-layer 5G approach in an edge computing environment

Laboratory: XLIM, Poitiers-Futuroscope (France)

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Contexte

5G networks aim to support an increase in capacity while guaranteeing services with varied quality of service requirements (connected objects, autonomous cars, multimedia applications, etc.). To achieve these objectives, the network architecture has been radically transformed, with a reorganisation of cells, an improved backhaul network, and a redeployment of functionalities between the core and the edge of the network, thanks in particular to edge computing, which brings data processing closer to users for faster response times. Network architectures are now defined as adaptable software functions (Service Based Architectures), offering dynamic slicing capabilities for different types of services.

In this context, Non Orthogonal Multiple Access (NOMA) techniques can increase spectral efficiency by serving multiple users simultaneously in the same frequency band. However, in order to take full advantage of NOMA technologies for the 5G network, it is essential to develop more efficient approaches to meet the growing needs of connected objects and highly mobile users. While much work has explored these challenges, issues related to resource allocation, interference management and network dynamics are still open.

To further improve the flexibility and performance of 5G networks, this approach can be optimised through integration with edge computing and distributed optimisation solutions. These technologies enable data processing to be decentralised, offering reduced response times and greater adaptability of services, particularly in terms of Quality of Service and NOMA resource management.

Context and goals:

The thesis will aim to develop solutions that improve the performance of NOMA techniques, while optimising energy consumption and meeting the various quality of service requirements of users. Specific objectives include :

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1. **Develop optimised resource allocation strategies for NOMA in centralised mode:** On a point-to-point uplink, we will seek to define NOMA strategies that balance complexity and robustness. This will include the reduction of transmission power via PD-NOMA and CD-NOMA techniques, adapted to multi-user and multi-service contexts, based on work developed in the RUBIH research team.

2. **Proposing integrated cross-layer solutions in decentralised mode and in a multi-cellular context:** By combining NOMA and edge computing, the approach will aim to optimise performance by dynamically adapting resources to meet differentiated quality of service requirements while managing multi-cellular interference as effectively as possible.

3. **Extend the previous solutions towards distributed optimisation:** These technologies will facilitate an efficient distribution of tasks and will make it possible to adapt the NOMA allocation to the required Quality of Service according to the local network load, reducing latency and increasing the resilience of the network. The optimisation methods will be based on 'systems' mathematical approaches using distributed optimisation developed in another thesis by the RUBIH team.

4. **Validate the proposed solutions:** The impact of the solutions will be assessed through experiments (simulation, emulation, real environment) to demonstrate the relevance of integrating edge computing and distributed optimisation into the proposed cross-layer model.

Localisation :
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