Self-Optimisation of Vertical Sectorisation in 4G Mobile Networks

JOB DESCRIPTION

In mobile networks, the service area is segmented in so-called cells, each of which is served by an individual antenna. Typically, a given site location features three distinct directional antennas, each serving an associated cell\(^1\) in the horizontal plane as depicted in Figure 1 (left: ‘horizontal sectorisation’). With the technological developments of ‘active antenna systems’ it becomes possible in 4G networks to also deploy adaptive vertical sectorisation. When deploying sectorisation in the vertical plane, a given cell is segmented in an inner and an outer sector, as shown in Figure 1 (right), where both sectors make use of the same spectral resources, i.e. there is an increased spatial reuse of resources. The footprints of the inner and outer sectors are determined by the respective (electrical) downtilts, i.e. the vertical antenna direction, which is large for the inner compared to the outer sector. The available transmit power of the original sector is split into specific transmit powers available for the inner and outer sectors, respectively. The technological capabilities of active antenna systems allow the vertical sectorisation to be adaptively deployed, i.e. dynamically switch it on or off depending on e.g. traffic loading, and tune the downtilts and the power split accordingly.

![Horizontal and vertical sectorisation in a mobile network.](image)

Objective of the proposed graduation project is twofold:

(i) To perform a controllability study in order to assess the performance potential from vertical sectorisation in static scenarios w.r.t. for instance traffic load, spatial traffic distribution and propagation conditions, for different settings of downtilt and power split, and considering both idealized and realistic network environments. In particular, we are interested in determining the significance of the gain that comes from the denser reuse of spectral resources, the gain yielded by a reduction in inter-cell interference reduction and the loss that occurs due to the reduction of per-sector transmit powers, as well as the sensitivity of these gains/losses w.r.t. to scenario specifics.

(ii) To develop and assess a self-optimisation algorithm which adaptively (de)activates and parameterizes the vertical sectorisation in each cell, considering e.g. scenarios with time-varying spatial traffic distribution. As part of this study, a realistic mechanism is needed to estimate the traffic loads in the inner/outer sectors in case the cell is still unsectorised. The impact of self-optimised vertical sectorisation on call handover performance is to be assessed, and potential enhancements to this end should be developed, e.g. considering whether the inner or the outer sector should inherit the original

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\(^1\) Regarding terminology, we refer to ‘cells’ in case of horizontal sectorisation, while with vertical vectorisation, such cells and split into (inner and outer) ‘sectors’.
cell’s ID upon vertical sectorisation. As for (i) the developed solutions are to be assessed in both idealized and realistic network environments.

The graduation project is carried out as part of the international SEMAFOUR project, cooperating with partners such as Ericsson (Sweden) and Orange (France). You will learn about the broader context of the overall project and will learn the necessary technological knowledge about mobile telecommunications.

REQUIREMENTS
You are a graduate student pursuing a Master’s degree, preferably in the direction of Computer Science, Econometrics, Mathematics or Electrical Engineering. You have affinity with optimization, interest in mobile networks and programming experience. You have an enterprising, flexible and cooperative nature. You are also communicative, creative and innovative. Duration of the internship is seven to nine months.

ABOUT TNO
TNO is an independent research organisation whose expertise and research make an important contribution to the competitiveness of companies and organisations, to the economy and to the quality of society as a whole. Innovation with purpose is what TNO stands for. We develop knowledge not for its own sake but for practical application. To create new products that make life more pleasant and valuable and help companies innovate. To find creative answers to the questions posed by society. We work for a variety of customers: governments, the SME sector, large companies, service providers and non-governmental organisations. Working together on new knowledge, better products and clear recommendations for policy and processes. In everything we do, impact is the key. Our product and process innovations and recommendations are only worth something if our customers can use them to boost their competitiveness.

TERMS OF EMPLOYMENT
You want to work on the precursor of your career; a work placement gives you an opportunity to take a good look at your prospective future employer. TNO goes a step further. It’s not just looking that interests us; you and your knowledge are essential to our innovation. That’s why we attach a great deal of value to your personal and professional development. You will, of course, be properly supervised during your work placement and be given the scope for you to get the best out of yourself. Naturally, we provide suitable work placement compensation.

CONTACT US
Dr. Remco Litjens M.Sc., email remco.litjens@tno.nl, telephone 088 866 7184
Kostas Trichias M.Sc., email kostas.trichias@tno.nl, telephone 088 866 2963