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Real-world analysis of a network deployment in office scenario with a Software Defined Radio testbed

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The deployment of small cells in local-area scenarios is a key feature for improving channel capacity in next-generation wireless communication networks. Indoor residential and office scenarios constitute fundamental study-cases for the validation of beyond-4G systems enabling, for example, autonomous interference coordination and dynamic spectrum allocation. System-level performance studies are typically carried out by means of Monte-Carlo simulations. Standardization bodies, such as the 3GPP, identified reference building configurations and propagation models for comparable analysis of algorithms and solutions [1]. The employed propagation models are typically stochastic and the deployment scenarios are characterized by extremely regular and symmetric shaping. The extremely complex propagation characteristics of indoor environments however, suggests that testbed-based experimental experiences and on-site measurements campaigns should be complementary to simulation-based studies in the validation of novel communication techniques. The deployment of nodes in local-area environments (e.g. in residential areas) often does not allow a prior planning network frequency reuse, thus generating severe interference conditions for users in the cells. Distributed algorithms for dynamic spectrum management aim at mitigating such problem, enabling the access points to autonomously select the transmission frequency resources and avoid harmful interferers. The network-level performance evaluation of such algorithms is, however, difficult to evaluate because specific deployment and propagation characteristics greatly impact the inter-cell interference levels and thus the achievable channel capacity. In simulations large amount of network layouts are typically considered in order to statistically validate the network performance. In a real-world context, the previous approach is clearly unfeasible due to the difficulties in managing a large experimental network.
In this work a Software Defined Radio testbed has been designed, enabling the extensive analysis of the propagation characteristics of an indoor scenario and providing a large amount of on-field measurements about pathloss characteristics of a network deployment in the considered area. 14 testbed nodes, equipped with USRP boards and running the ASGARD software platform [2], have been mounted on movable trolleys and placed in several measuring positions which homogeneously cover the space of the first floor of an office building at the Aalborg University campus. The testbed

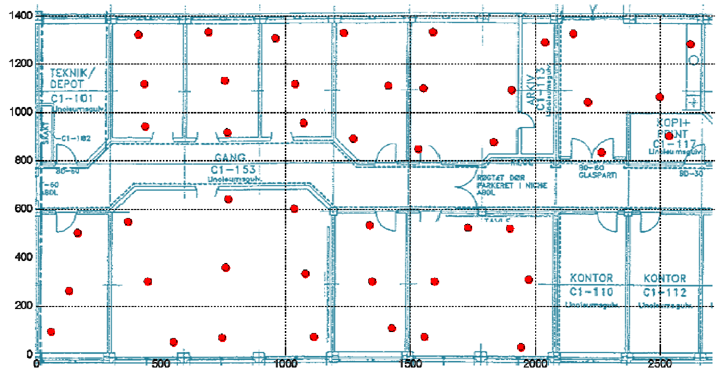
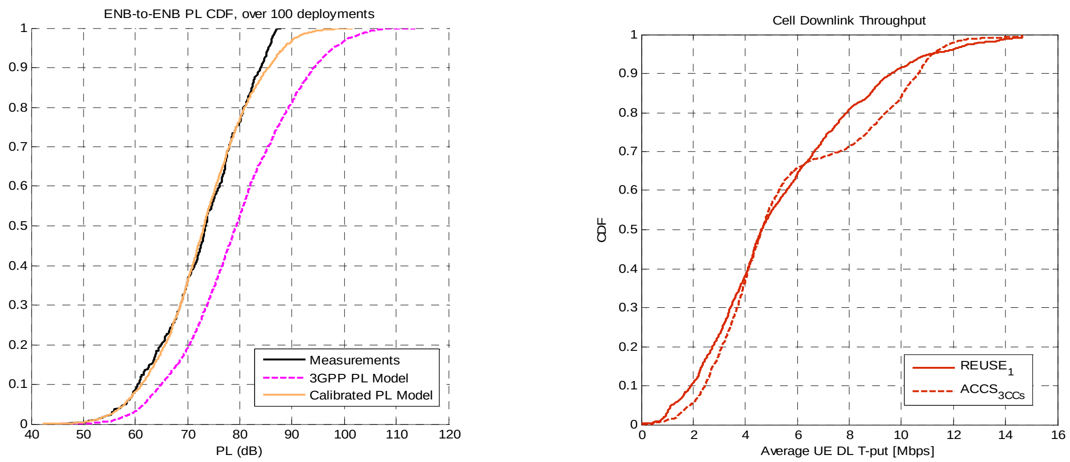


Figure 1 – Measured positions across the office premises at Aalborg University

setup allowed to measure the pathloss across 45 positions, thus providing information about 990 different radio links. In Figure 1 the location of the measured positions is given. Pathloss measurements have been performed in static environment conditions during night hours. 19 re-deployments of the testbed have been necessary to cover all possible link combinations. In order to remove the effect of multipath fading, every single pathloss value has been obtained by averaging across multiple measurements in frequency (from 4.91 to 5.89 GHz with a step of 20 MHz).

The obtained pathloss information has then been utilized for the analysis of the characteristics of a large network deployment. In Figure 2.a is shown the pathloss distribution of a network over 100 deployments. Each deployment assumes one access point and one user equipment to be present in each room. Measurement results are compared to the values obtained with a WINNER II pathloss model in the same deployment conditions. On-field pathloss measurements can be used to validate



a) b)

Figure 2 – Scenario pathloss analysis and downlink throughput results of the ACCS algorithm

the performance of a distributed network algorithm in realistic deployment conditions. In figure 2.b, downlink throughput results are provided for a network running the Autonomous Component Carrier Selection (ACCS) algorithm [3] for interference coordination purposes.

[1] Alcatel Lucent, "R4-091422, Simulation assumptions and parameters for FDD HeNB RF requirements," 3GPP, Seoul, Korea, 2009.

[2] L. G. U. Garcia, I. Z. Kovács, K. I. Pedersen, G. W. O. Costa and P. E. Mogensen, "Autonomous Component Carrier Selection for 4G Femtocells - A Fresh Look at an Old Problem," *IEEE Journal on Selected Areas in Communications,* vol. 30, no. 3, pp. 525-537, April 2012.

[3] The ASGARD software radio, *http://asgard.lab.es.aau.dk,* 2013.