ISSUE 10

PAINLESS

An innovative training network (ITN) on

Energy-autonomous portable access points for infrastructure-less networks

NEWSLETTER DATE
September 2021

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 812991

PAINLESS addresses many of the challenges through critical interdisciplinary collaborations.
The collaboration of the participating teams happen at two levels: training activities and research objectives.

PAINLESS participants have so far conducted many successful multilateral collaborations.

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PAINLESS RESEARCH PROJECTS' UPDATES

ESR 15 Igor Donevski (Aalborg University) received the Best Paper Award at ACM DroNet 2021

PAINLESS Research projects' Updates

Igor Donevski,
ESR#15
(Aalborg University)

Received the Best Paper Award at ACM DroNet 2021. (*DroNet '21: Proceedings of the 7th ACM Workshop on Micro Aerial Vehicle Networks, Systems, and Applications)*

An Experimental Analysis on Drone-Mounted Access Points for Improved Latency-Reliability

Authors: Igor Donevski, Christian Raffelsberger, Micha Sende, Aymen Fakhreddine, Jimmy Jessen Nielsen

The anticipated densification of contemporary communications infrastructure expects the use of drone small cells (DSCs). Thus, we experimentally evaluate the capability of providing local and personalized coverage with a drone mounted Wi-Fi access point that uses the nearby LTE infrastructure as a backhaul in areas with mixed line of sight (LoS) and Non-LoS (NLoS) links to the local cellular infrastructure. To assess the potential of DSCs for reliable and low latency communication of outdoor users, we measure the channel quality and the total round trip latency of the system. For a drone following the ground user, the DSC-provided network extends the coverage for an extra 6.4% when compared to the classical LTE-direct link. Moreover, the DSC setup provides latencies that are consistently smaller than 50 ms for 95% of the experiment. Within the coverage of the LTE-direct connection, we observed a latency ceiling of 120 ms for 95% reliability of the LTE-direct connection. The highest latency observed for the DSC system was 1200 ms, while the LTE-direct link never exceeded 500 ms. As such, DSC setups are not only essential in NLoS situations, but consistently improve the latency of users in outdoor scenarios.

The paper is available on:

https://dl.acm.org/doi/10.1145/3469259.3470489

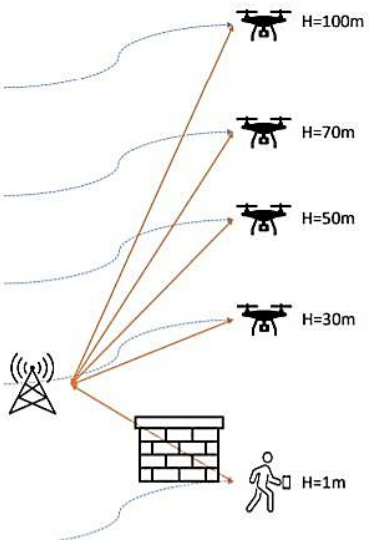

Figure 1. Testing LTE signal performance for four altitudes (30 m, 50 m, 70 m, 100 m) and the ground UE-BS link is likely to be NLoS.

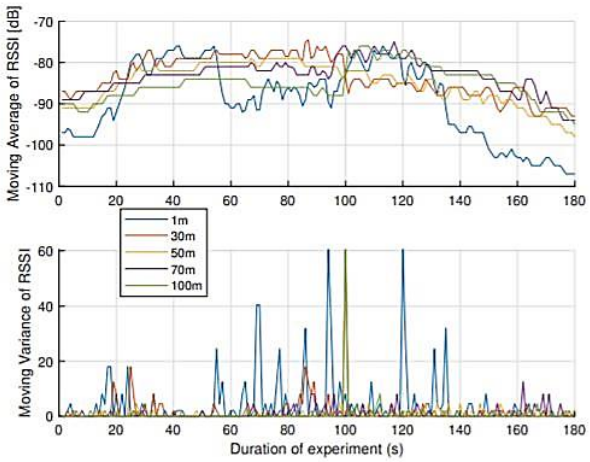

Figure 2. 2-point Moving Average and Moving Variance for RSSI values of all 5 experiments.

PAINLESS Research projects' Updates

Mahshid Javidsharifi
ESR #3
(Aalborg University)

Optimum Sizing of Photovoltaic and Energy Storage Systems for Powering Green Base Stations in Cellular Networks

This paper presents an optimal method for designing a photovoltaic (*PV*)-battery system to supply base stations in cellular networks. A systematic approach is proposed for determining the power rating of the photovoltaic generator and battery capacity from a technical and economical point of view in order to minimize investment cost as well as operational expenditure, while the power autonomy of the *PV*-battery system is maximized in a multi-objective optimization framework. The proposed method is applied to optimally size a photovoltaic-battery system for three cases with different availability of solar power to investigate the effect of environmental conditions. Problem-solving using the proposed approach leads to a set of solutions at different costs versus different levels of power autonomy. According to the importance of each criterion and the preference of decision-makers, one of the achieved solutions can be selected for the implementation of the photovoltaic-battery system to supply base stations in cellular networks.

https://www.mdpi.com/1996-1073/14/7/1895

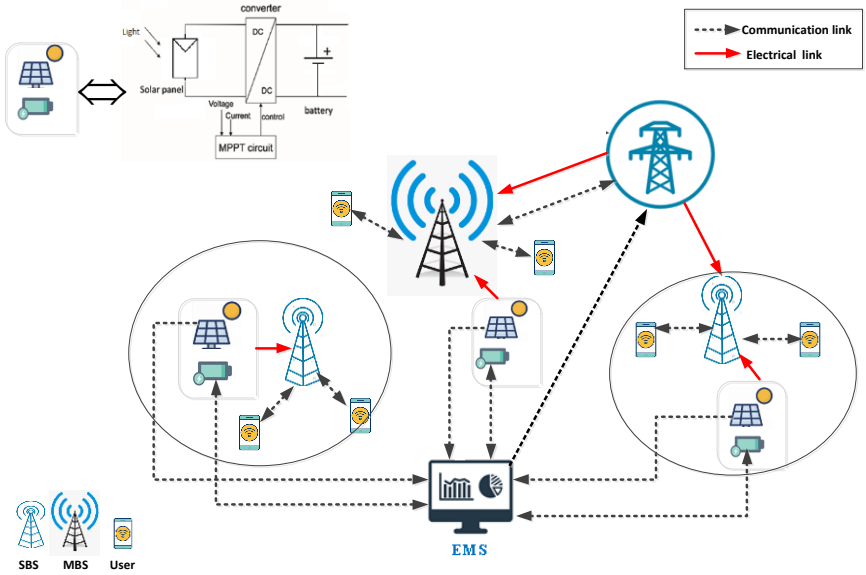

Figure 3. The configuration of next generation cellular telecommunication networks.

Marco Virgili
ESR #8
(Lyra Electronics)

A Multi-Objective Genetic Algorithm methodology for sizing and power electronics selection of standalone renewable energy systems

This work proposes a design methodology to optimize multiple design metrics of a stand-alone PV/battery system at the same time. The relevance of each objective can be adjusted by the designer and this paper explores the correlations among them. An application example is proposed, where the objectives are the minimization of investment and operational cost, with a boundary set on the system reliability. The variables are six and represent the size of the generation, storage, and power conversion elements, as well as the converters selection. The example design is repeated with two battery types, Lead-Acid and Li-Ion. The use of a genetic algorithm reduces the computational power, allowing the quick execution of several optimizations with different settings.

https://doi.org/10.36227/techrxiv.14837928.v1

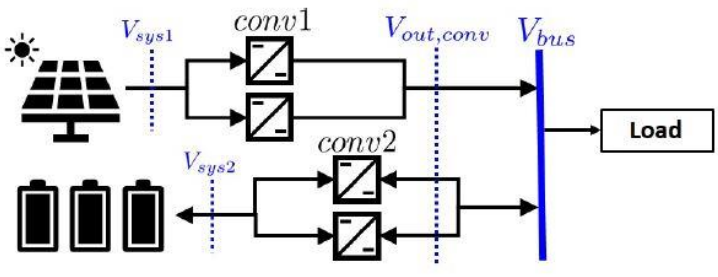

Figure 4. Schematic of the energy system.

PAINLESS Research projects' Updates

Mohammad Al-Jarrah
ESR#6
(University of Manchester)

Capacity Analysis of IRS-Based UAV Communications with Imperfect Phase Compensation

This letter presents the capacity analysis of unmanned aerial vehicles (UAVs) communications supported by flying intelligent reflecting surfaces (IRSs). In the considered system, some of the UAVs are equipped with an IRS panel that applies certain phase-shifts to the incident waves before being reflected to the receiving UAV. In contrast to existing work, this letter considers the effect of imperfect phase knowledge on the system capacity, where the phase error is modelled as a von Mises random variable with parameter κ . Analytical results, corroborated by Monte Carlo simulations, show that the achievable capacity is dependent on the phase error, however, the capacity loss becomes negligible at high signal-to-noise ratio (SNR) and when $\kappa \geq 6$.

https://ieeexplore.ieee.org/document/9395180

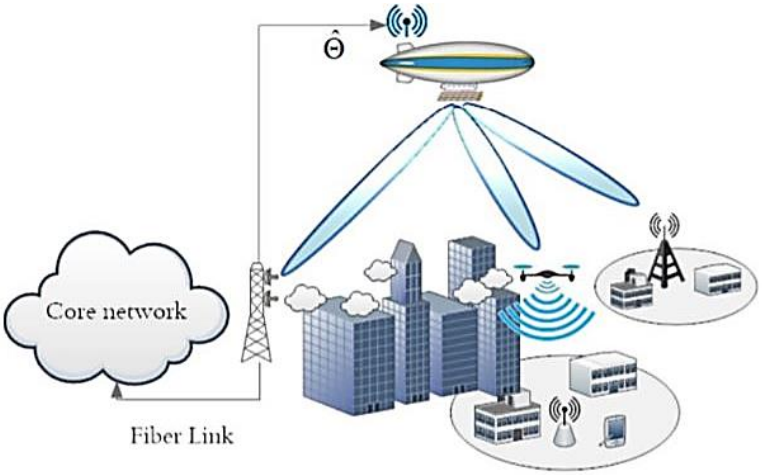

Figure 5. IRS assisted flying networks.

Mahmoud AlaaEldin
ESR #14
(University of Manchester)

Quantized vs. Analog Channel Feedback for FDD Massive MIMO Systems with Multiple-Antenna Users (*Accepted to IEEE PIMRC 2021*)

In this paper, the problem of channel feedback in massive multiple-input-multiple-output (MIMO) systems is considered. For the downlink scenario, we present a detailed comparison between the performance of the quantized and the analog channel feedback schemes for the case of having multiple antenna users. Both schemes' performance is evaluated by deriving an upper bound on the rate gap between the rate of the system with perfect channel state information (CSI) and with imperfect CSI for both feedback schemes. We compare the two schemes, namely, quantized channel feedback and analog channel feedback, under the same resources allocated for channel feedback for a fair comparison. Moreover, we consider two different downlink transmission schemes; the first one does not consider power allocation across the streams and the second one does power allocation (water-filling) across the streams. Our results show that the analog feedback scheme performs better in the low signal to noise (SNR) region when performing power allocation across the multiple data streams. However, the quantized channel feedback scheme performs better at the high SNR region, where the quantized CSI can provide a better approximation of the actual CSI. Finally, simulation results are presented to verify our theoretical analysis and demonstrate our conclusions.