Scientific Report

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Name of the *Host Organisation*	VTT Technical Research center of Finland
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Period of the fellowship	01/01/2020 to 31/03/2021

I – SCIENTIFIC ACTIVITY DURING YOUR FELLOWSHIP

During my fellowship, my research mainly focused on 5G and beyond 5G radio access design. Firstly, I was involved in one EU project to analysis the energy efficiency of eMBMS transmission for the educational surgery. We proposed to use the eMBMS approach instead of broadcasting to optimize the bandwidth and energy consumptions in such scenarios.

We also work on cloud radio access network (C-RAN) to provide a framework to support high spectral efficiency and low latency which are required to provide ubiquitous communication for the emerging applications in 5G wireless communication networks. We propose a novel framework that considers these requirements simultaneously by integrating the notion of effective capacity (EC) into orthogonal frequency division multiple access (OFDMA) cloud-radio access networks (C-RAN) where the users select the distributed radio remote heads (RRHs) based on their specific delay requirements to transmit over different subcarriers cooperatively. Consequently, an optimization problem is defined to maximize the EC under the average peak power constraint and the delay requirements. The problem is combinatorial and non-convex and an algorithm based on

the duality and alternating optimization algorithms is proposed, which is efficiently computed with good accuracy. Simulation and analytical results demonstrate that the proposed solution has a near-optimal performance and there is a trade-off between delay and spectral efficiency. Moreover, the cooperation between RRHs can considerably improve the system throughput.

Afterwards, we start to work on Open radio access network (ORAN) architecture. ORAN is an emerging idea that enables such a transformation using the concepts of virtualization, flexibility, openness and intelligence. The RAN Reference Architecture defined by the O-RAN alliance, is based on well-defined, open standardized interfaces and is designed to be intelligent and compliant with 3GPP standards and other industry standards organizations. Its main component the Near-Real Time (RT) RAN Intelligent Controller (Near-RT RIC) is a core element of the O-RAN Reference Architecture. Its functionality is to collect information from and manage the edge resources in real-time, while communicating with the Non-RT RIC operating in the cloud. It introduces embedded intelligence in every layer of the RAN architecture that improves the flexibility and agility of the network. It provides possibility of RAN automation, which reduces manual intervention, saving OPEX while avoiding human errors. Such automation provides the ability to offer efficient, optimized radio resource management (RRM) through closed-loop control, to enhance network-wide efficiency and users' Quality of Experience (QoE). We could propose a new architecture to integrate the ORAN architecture into the zero-touch system management (ZSM) and experiential networked intelligence (ENI) concepts.

II – PUBLICATION(S) DURING YOUR FELLOWSHIP

I have submitted two following papers:
-N. Moosavi, M. Sinaie, P. Azmi, P-H. Lin and E. Jorswieck, "Cross Layer Resource Allocation in H-CRAN with Spectrum and Energy Cooperation", Accepted in IEEE Transactions on mobile computing, 2021
- N. Moosavi, M. Sinaie, P. Azmi, J. Huusko," Delay Aware Resource Allocation in user-centric 5G C-RAN", Accepted in IEEE communication letters, 2021

III – ATTENDED SEMINARS, WORKHOPS, CONFERENCES

Because of the corona pandemic, most of the conferences and workshops were cancelled or held virtually. I attended several online seminars which was held by Aalto university, Nokia Bell labs, 3GPP and Ericsson. I was also TPC member of workshop "5G-enabled safety and support services for cooperative, connected and automated mobility" in VTC2021-spring.

IV – RESEARCH EXCHANGE PROGRAMME (REP)

I planned to visit RISE Research Institutes of Sweden AB (RISE) in Summer for doing research exchange program. However, I could not visit RISE due to the pandemic situation as you remember. However, we had two virtual meetings (one on 16 March 2021, and one on 19 March 2021) where we discussed about future 5G and beyond network architecture design and we discuss about future collaborations.