University of Victoria | Graduate Studies

Notice of the Final Oral Examination for the Degree of Master of Applied Science

of

WEIHENG NI

BEng (Beijing University of Posts and Telecommunications, 2013)

"Practical System Implementation for 5G Wireless Communication Systems"

Department of Electrical and Computer Engineering

Friday April 17, 2015
1:00 P.M.
Engineering Office Wing
Room 430

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Abstract

The fifth generation (5G) wireless communications technology will be a paradigm shift which does not only provide an explosive increment on the achievable data rate per cell, but also ideally decreases the costs and energy consumption per data link. The engineering requirements of 5G standard can be intuitively interpreted as highly enhanced spectral efficiency and energy efficiency. This thesis focuses on the practical implementation issues of the massive multiple-input multiple-output (MIMO) and energy harvesting systems. To begin with, massive MIMO, as one of the key technologies of 5G systems, can provide enormous enhancement in spectral efficiency. For a practical massive MIMO system, hybrid processing (precoding/combining), by restricting the number of RF chains to far less than the number of antenna elements, can significantly reduce the implementation cost compared to the full-complexity radio frequency (RF) chain configuration. This thesis designs the hybrid RF and baseband precoders/combiners for multi-stream transmission in the point-to-point (P2P) massive MIMO systems, by directly decomposing the pre-designed digital precoder/combiner of a large dimension. The performance of the matrix decomposition based hybrid processing (MD-HP) scheme is near-optimal compared to the singular value decomposition (SVD) based full-complexity processing.

In addition, the downlink communication of a massive multiuser MIMO (MUMIMO) system is also investigated, and a low-complexity hybrid block diagonalization (Hy-BD) scheme is developed to approach the performance of the traditional BD method. We aim to harvest the large array gain through the phase-only RF precoding and combining and then BD processing is performed on the equivalent baseband channel in the massive MU-MIMO scenario. The MD-HP and Hy-BD schemes are examined in both the large Rayleigh fading channels and millimeter wave channels.

On the other hand, energy harvesting is an increasingly attractive and renewable source of power for wireless communications devices, which contributes to the enhancement of the system energy efficiency. This thesis also designs the energy cooperation assisted energy harvesting communication between a practical transmitter and receiver, whose hardware circuits consume non-zero power when active. The energy cooperation save-then-transmit (EC-ST) scheme aims to obtain the optimal active time ratio and energy cooperation power for the maximum throughput under additive white Gaussian channels and the minimum outage probability under block Rayleigh fading channels.