論文 / 著書情報
Article / Book Information

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Category(English)	Doctoral Thesis
種別(和文)	論文要旨
Type(English)	Summary

Doctoral Program

論 文 要 旨

THESIS SUMMARY

専攻： Department of	国際開発工学　　専攻	申請学位（専攻分野）： Academic Degree Requested	博士 Doctor of　（　工学　）
学生氏名： Student's Name	小西　洋平	指導教員（主）： Academic Advisor(main)	高田　潤一
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要旨（英文 800 語程度）

Thesis Summary (approx.800 English Words)

The title of the thesis is "Development of Versatile Channel Sounder for Multi-link MIMO Channel Characterization at 11 GHz". The thesis consists of 6 chapters as follows.

Chapter 1, "Introduction", describes motivation and objective of this thesis. First, by overviewing future perspective of mobile communication systems, frequency shift towards higher microwave bands and multi-link MIMO communication were identified as key technologies to satisfy the increasing user demands. However in the existing studies, multi-link MIMO channel models and multi-link measurement systems are very limited, particularly for above 6 GHz frequency bands. The rack of multi-link measurement systems is due to the widely used switched array sounder architecture. The switched array sounder only has single radio front-end, and it is shared by antenna arrays via RF switches to measure complete elements of MIMO channel matrix. Therefore, it is advantageous in cost efficient hardware development and simple system calibration. On the other hand, a fully parallel MIMO architecture have not been used in channel sounders due to the need for complex system calibration, but advantageous in fast channel acquisition and flexibility of the system. These properties are particularly attractive for the evaluation of multi-link MIMO systems operating at higher frequency bands where the channel sounder have to be separable and the channel Doppler effect will be significant. Finally, the objective of this thesis is stated as the development of versatile MIMO channel sounder for the characterization of multi-link MIMO channel at 11 GHz with a bandwidth of 400 MHz.

Chapter 2, "Measurement Systems for MIMO Applications", first identify the implementation issues to realize multi-link fully parallel MIMO channel sounder. Based on a detailed review of existing measurement systems including MIMO system testbed, multi-dimensional MIMO channel sounders, and multi-link MIMO evaluation systems, design considerations for multi-link MIMO channel sounder to be developed are discussed in terms of hardware architecture and synchronization method. A scalable fully parallel MIMO sounder architecture and flexible synchronization method are proposed, then pros and cons of the proposed system architecture is discussed in this chapter.

Chapter 3, "System Implementation", presents main contributions of this thesis, realization of channel sounder for multi-link MIMO channel characterization. Implemented channel sounding methodology, realized hardware components and calibration methods are described together with the methodology for synchronized data acquisition among spatially distributed receivers. Since existing studies on the IQ imbalance compensation and back-to-back calibration were only limited to a single radio front-end case, novel calibration methods for parallel MIMO architecture have developed utilizing switching circuit. In this method, a total time for the system calibration can be drastically reduced, and easily conducted in the field environment. In addition to the calibration issues, hardware realization of 11 GHz channel sounder requires special care on the performance of frequency standard and local oscillator (LO). A frequency standard ensures the frequency synchronization between transmitter and receiver. A Cesium frequency standard is selected in this study which has about hundred times better frequency accuracy compared with widely used Rubidium oscillator. On the other hand, the LO supplies 11 GHz carrier signal, and its phase noise performance is critical for the directional estimation. The required performance of the LO is determined by means of a computer simulation in terms of estimation error of MIMO channel matrix, so that the influence of phase noise not to exceed the influence of compensated IQ imbalance.

Chapter 4, "Performance Evaluation", presents results of several performance evaluation tests. Influence of separated frequency references at Tx and Rx systems, phase noise stability and receiver sensitivity were evaluated. To verify the total system performance after applying several compensation techniques

for hardware imperfection and back-to-back calibration, measurement results were compared with the results measured by commercial vector network analyzer (VNA). The good agreement between the results obtained by the channel sounder and the VNA verified the performance of developed system.

Chapter 5, “Measurement Campaign”, presents results from indoor measurement campaign using the developed channel sounder. The measurement aimed at testing the developed system in practical measurement environment, and demonstrating the system capability. A ray-tracing simulation has also conducted to confirm the results of double directional estimation by using developed channel sounder. The results of channel sounding validated the developed channel sounder and its system calibration techniques, hence demonstrated the capability of the novel versatile MIMO channel sounder architecture for the characterization of multi-link MIMO propagation channel.

Chapter 6, “Conclusion”, summarizes the achievement and contributions of this work. Several considerations in the future research are also presented for the further utilization of the achievements in this thesis.