International Journal of Engineering Research & Management Technology
ISSN: 2348-4039
IJERMT
Email: editor@ijermt.org
November- 2014 Volume 1, Issue-6
www.ijermt.org

Design of Smart Antenna for Wireless Mobile Communication

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ABSTRACT:-
Design of antennas for wireless communication systems has attracted increasing interest during last year's. The main objective of this Thesis is to propose a general design procedure of antennas for wireless communications systems, which provides a physical insight into the design process. To accomplish this objective, a method based on a modal decomposition of the current on the surface of the conducting structure will be proposed. Modes have the advantage to provide physical insight into the radiating behavior of the antenna, as well as useful information for the optimization of the antenna geometry and the selection of the optimum feeding mechanism and its location.
Here we will discuss current and future antenna technology for wireless systems and the improvement that smart and adaptive antenna arrays can provide. We will describe standard cellular antennas, smart antennas using fixed beams, and adaptive antennas for base stations, as well as antenna technologies for handsets and other wireless devices.. We will show the potential improvement that these antennas can provide, including range extension, multipath diversity, interference suppression, and capacity increase.

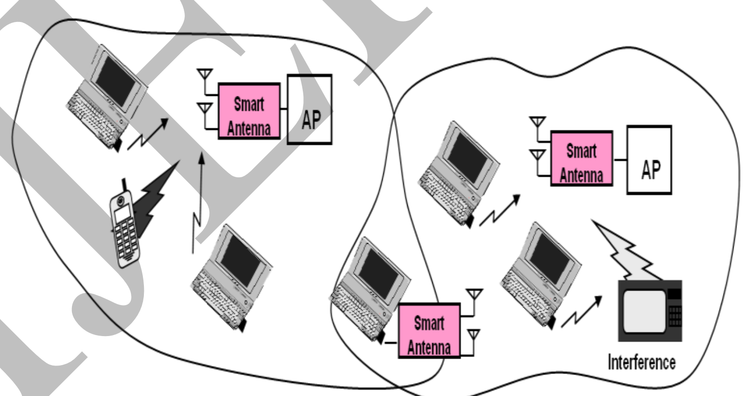
1. INTRODUCTION

Smart antennas have become an essential paradigm for the enhancement of capacity in cellular communications systems. In 2nd Generation Systems smart antennas were aiming at increasing capacity either by reuse within ceN (Space Division Multiple Access - SDMA) or by intercool interference reduction (Spatial Filtering for Interference Reduction - SFIR). Later in 3rd Generation UMTS UTRA (Universal Terrestrial Radio Access) smart antenna concepts evolved from pure beam forming techniques merely based on directional information of the radio channel to more general space- time processing concepts which exploit a variety of available processing gains and sources of diversity. As a natural consequence the adaptive antenna and smart antenna concepts in mobile communication systems have become a hot topic in the Technical Specification Groups for Radio Access at 3GPP (Third Generation Partnership Project) who shall prepare, approve and maintain the 3GPP Technical Specifications and Technical Reports. In this Special Issue of the European Transactions on Telecommunications journal, ainied at presenting original results in the field of Smart Antennas, contributions are collected, which emerged from a special session of the World Micro-Technologies Congress (Hannover, Germany, 2000) which has been incorporated within EXPO 2000. The presented selection of papers comprises almost all varieties of considering and deploying smart antenna concepts in mobile communication systems both in radio layer 1 and 2. The first three papers explicitly refer to applications of smart antennas for UTRA FDD and UTRA TDD. The first paper, by C. Brunner, W. Utschick, and J.A. Nossek, presents an overview of eigen beam foning concepts in the uplink and downlink techniques for

FDD; the focal point of the paper is the efficient use of short-term and long-term properties of the radio channel. In the second paper, A. Jarosch and D. Dahlhaus focus on the downlink in UTR4 FDD; simple linear demodulation schemes exploit- ing the space and time diversity of the mobile radic channel are derived. Smart Antennas for

UTRA TDD is the tenor of the paper by M. Haardt, C.F. Mecklenbr8ucker, M.Vollmer, and P. Slanina: here both uplink and downlink techniques are discussed; whereas in the uplink the emphasis is on joint detection techniques and its efficient implementation, the downlink again the efficient use of short-term and long-term properties of the radio channel is discussed. The next two contributions are devoted to more principal investigations of downlink processing. First, H. Troger, T. Weber, M. Meurer, and P. W. Baier present a performance survey of Joint Transmission, a novel downlink transmission scheme, by exemplary system assessments and comparisons. In the next paper, by H. Boche and M. Schubert, the problem of joint downlink beamforming and power control in wireless communication systems is addressed. The third selection of papers contains two prospective topics of smart antennas in wireless communications. In the first paper, R.S. Thoma, D. Hampicke, A. Richter, and G. Sommerkorn present a new real-time MIMO vector radio channel sounder; the proposed MIMO measurement principle can be exploited to estimate channel properties at both ends of the wireless link simultaneously, and thus, dramatically enhance overall resolution of the multi path parameters. Finally, very promising strategies for radio resource management using smart antenna cellular networks are discussed by C. Hartmann and J. EberspZicher, the focus is on adaptive strategies which combine spatial reuse within the cell with dynamic inter-cell channel allocation. We would like to take this room to thank the Editor-in-Chief of the European Transactions on Telecommunications for the opportunity of publishing this Special Issue, as well as the editorial staff at ETT for their assistance during the preparation of the issue and we are especially indebted to the reviewers for their critical comments and their constructive suggestions. We also wish to express our sincere appreciation to all the authors of this Issue, whose contributions made this work an important document of recent theoretical and practical advancement of smart antenna concepts.

2. Smart Antennas for WLANs



Smart Antennas can significantly improve the performance of WLANs

- TDD operation (only need smart antenna at access point or terminal for performance improvement in both directions)
- Higher antenna gain ⇒ Extend range/ Increase data rate/ Extend battery life
- Multipath diversity gain ⇒ Improve reliability
- Interference suppression ⇒ Improve system capacity and throughput
- – Supports aggressive frequency re-use for higher spectrum efficiency, robustness in the ISM band (microwave ovens, outdoor lights)
- Data rate increase ⇒ M-fold increase in data rate with M Tx and M Rx antennas (MIMO 802.11n).

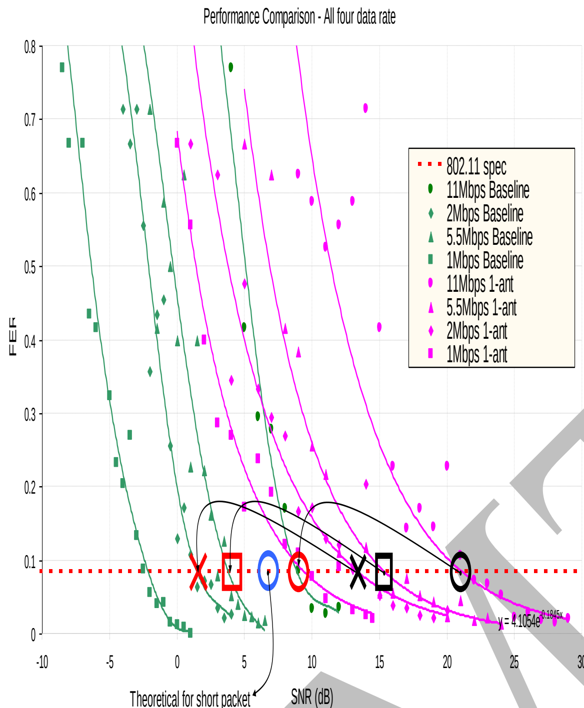
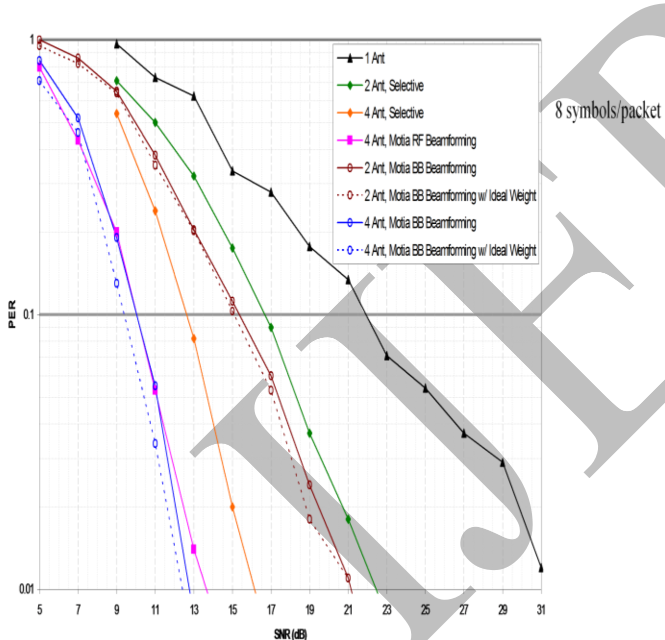


Figure 1 Performance Fade with increasing



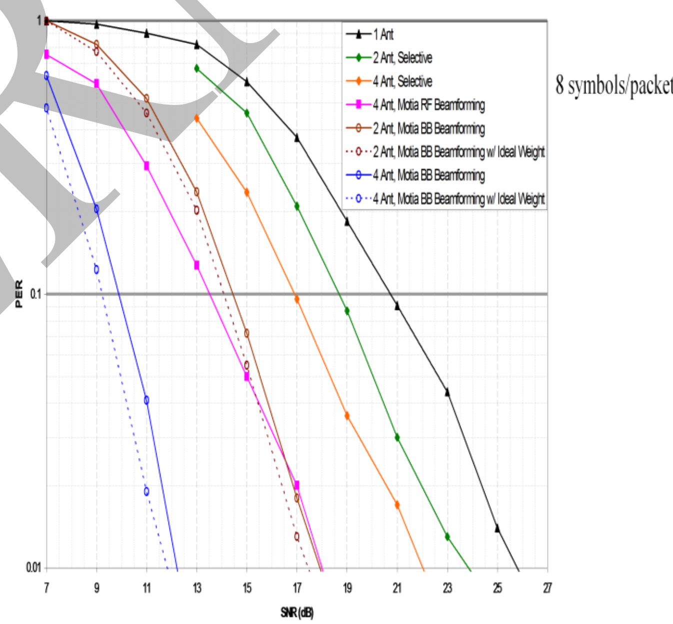


Figure 2 Flat Rayleigh Fading 24Mbps Short Packet

Figure 3 50ns Exp Decay Rayleigh Fading, 24Mbps, Short Packet

Beamforming Gain (dB) @ 10% PER							
	6 Mbps		24 Mbps		54 Mbps		Sum
	SP	LP	SP	LP	SP	LP	
Flat Rayleigh Fading	11	11	12	12	12	12	11 ~ 12
50ns Exp Decay Rayleigh Fading	8	10	7	7	8	9	7 ~ 10
100ns Exp Decay Rayleigh Fading	6	6	5	5	6	7	5 ~ 7
200ns Exp Decay Rayleigh Fading	4	9	5	6	Very High Error Floor		**4 ~ 9**

Table 4. Beamforming Performance Summary

In the above table 4 some short terms are used that are:-
SP- Short Packet, LP- Long Packet, Sum- Summary

- Requirements for 802.11n:
  - 100 Mbps in MAC
  - 3 bits/sec/Hz
  - Backward compatible with all 802.11 standards
- Requires MAC changes and may require MIMO:
  - 4X4 system

3. CONCLUSIONS

- Smart antennas can improve user experience and system capacity by reducing interference, extending range, increasing data rates, and improving quality
- Smart antennas can be implemented in the physical layer with little or no impact on standards
- Expertise and experience in the development and deployment of smart antennas for cellular can be applied to develop smart antennas for WLANs, and many other wireless applications

Thus this Thesis has been to provide a general method for the design of antennas for wireless communications systems, based on the modal analysis of open conducting structures. The utility of the proposed method has been fully demonstrated, providing several antenna designs that cover different applications. The proposed design procedure should start by performing a computation of the surface modal currents on the radiating structure. Once the properties of these modes have been analyzed, an appropriate feeding mechanism must be provided for a suitable excitation of modes and for a proper matching to the traditional 50 Ω feeding line.

4. REFERENCES

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