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Tutorial – 1

Wireless Transmission of Big Data: A Data Oriented Approach

Presented by:

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Abstract*—Wireless communication systems play an essential role in the generation and transmission of big data. The design and optimization of wireless transmission strategies for big data application are of critical current interest. In this proposed tutorial, we present a unique data-oriented approach for the design and analysis of wireless transmission strategies, specifically targeting at big data transmission. Novel data-oriented performance metrics are proposed and applied to the analysis of wireless transmission strategies in the information theoretical and practical transmission settings. We also develop analytical frameworks to accurately characterize the data transmission time in both cognitive and non-cognitive environments. Compared to conventional analytical approach, the data-oriented approach offers important new insights and leads to interesting new research directions. Through this tutorial, the attendees can obtain a brand new perspective to the analysis and optimization of wireless transmission technologies for big data applications.*

Tutorial Objectives

We are in an era of big data. Data are generated and collected at an accelerating rate. To efficiently support various big data applications, future wireless transmission systems should optimize their strategies for transmitting a huge amount of data. Most wireless transmission technologies are designed with the goal of enhancing or approaching the capacity of the wireless channel, usually characterized by ergodic capacity and outage capacity.

To further improve the efficiency of wireless transmission systems, we need to study them from a new perspective. We note that the traditional channel-oriented approach is ignorant of the specifics of individual transmission session, such as the channel state, the data property, and the network conditions, and apply the same transmission strategy for all transmission sessions over the same channel. Motivated by this observation, we propose a novel data-oriented approach for wireless transmission system design. Specifically, we consider the optimal design of transmission strategy for individual data transmission session according to the operating

environment. The rationale for this data oriented approach is that optimizing the transmission strategy of individual session will maximize the transmission efficiency of the overall system.

The objective of the tutorial is to bring new insights to the analysis and design of wireless transmission strategies, especially for big data applications. We adopt a unique data-oriented approach by targeting at the performance analysis of individual data transmission sessions. With novel data-oriented performance metrics, we can fully characterize the quality of individual data transmission session. We also develop analytical frameworks to investigate the transmission time performance of practical wireless transmission technologies in both non-cognitive and cognitive environments. Through this tutorial, the attendees can obtain a brand new perspective on the analysis and optimization of wireless transmission technologies for big data applications.

Tutorial Outline

- Big data transmission over fading channels
- Data oriented performance limits
    - Minimum transmission time
    - Maximum entropy rate
    - Application: rate adaptation only vs optimal power and rate adaptation
- Channel adaptive transmission of big data
    - Transmission time analysis for block fading channel
    - Transmission time analysis for Markov channel
    - Application: energy consumption analysis
- Cognitive transmission of big data
    - Characterization for temporal spectral opportunities
    - Extended delivery time analysis
    - Work-preserving vs non-work-preserving strategies
    - Effect of sensing imperfection
    - Application: secondary queuing performance analysis
- Conclusion and open research topics

Primary Audience

The tutorial coverage is sufficiently broad as to have strong appeal to MS and PhD students, instructors/lecturers, and researchers currently working in the field of wireless communications, as well as a large cross-section of practicing engineers who are responsible for the design, development, and performance evaluation of wireless communication systems for big data applications.

Novelty

Wireless communication systems play an essential role in the generation and transmission of big data. The design and optimization of wireless transmission strategies for big data application are of critical current interest. The data-oriented analytical approach will provide important new insights to the analysis and design of wireless transmission strategies. The tutorial will coherently cover the most recent research findings of the presenters that were accepted or published in IEEE journals within the past three years.

Biographies:

Professor Dr. Hong-Chuan Yang received the Ph.D. degree in electrical engineering from the University of Minnesota in 2003. He is a professor of the Department of Electrical and Computer Engineering at the University of Victoria, Canada. From 1995 to 1998, He was a Research Associate at the Science and Technology Information Center (STIC) of the Ministry of Posts & Telecomm. (MPT), Beijing, China. His current work mainly focuses on different aspects of wireless communications, with special emphasis on channel modeling, diversity techniques, system performance evaluation, cross-layer design, and energy efficient communications. He has published over 200 journal and conference papers. He is the author of the book Introduction to Digital Wireless Communications by IET press and the co-author of the book Order Statistics in Wireless Communications by Cambridge University Press.

Professor Dr. Mohamed-Slim Alouini (FIEEE) received the Ph.D. degree in electrical engineering from the California Institute of Technology (Caltech) in 1998. He also received the Habilitation degree from the Universite Pierre et Marie Curie in 2003. Dr. Alouini started his academic career at the University of Minnesota in 1998. In 2005, he joined Texas A&M University at Qatar, Doha, and in 2009, he was appointed as Professor of Electrical Engineering at KAUST, Thuwal, Mekkah Province, Saudi Arabia, where he is responsible for research and teaching in the areas of Communication Theory and Applied Probability. More specifically, his research interests include design and performance analysis of diversity combining techniques, MIMO techniques, multi-hop/cooperative communications systems, cognitive radio systems, and multi-resolution, hierarchical and adaptive modulation schemes. Dr. Alouini has published many papers on the above subjects, and he is co-author of the textbook Digital Communication over Fading Channels published by Wiley Interscience.

Dr. Alouini is a (i) Fellow of the Institute of Electrical and Electronics Engineers (IEEE), (ii) IEEE Distinguished Lecturer for the IEEE Communication Society and IEEE Vehicular Technology Society, (iii) member for several times in the annual Thomson ISI Web of Knowledge list of Highly Cited Researchers as well as the Shanghai Ranking/Elsevier list of Most Cited Researchers, and (iv) co-recipient of best paper awards in eleven IEEE conferences (including ICC, GLOBECOM, VTC, PIMRC, ISWCS, and DySPAN).