Wireless Mobile Communication and Transmission (WMCT) Lab.

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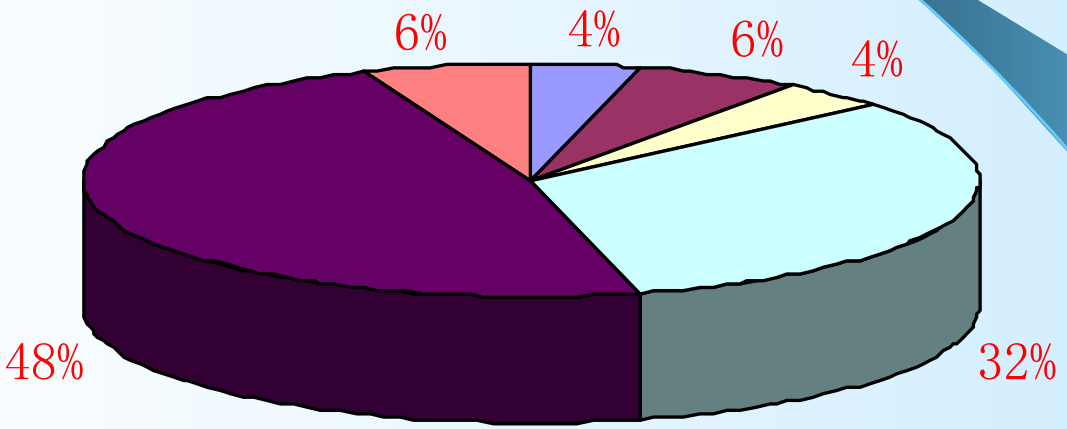
OUTLINE

- Group structure
  - Research Areas
  - Research and Industry projects

Group Structure

- Founded in 1988
- Affiliated to School of Information Science and Engineering, Shandong University
  - Financially supported by the 985 subject of the Ministry of Education in China
  - Key laboratory of wideband wireless communications of Shandong

Group Structure



- Professor (2)
- Associate Professors (3)
- Lecturer (2)
- Ph. D. Candidates (17)
- M.S. Candidates (26)
- Postdoctor(3)

OUTLINE

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- Research Areas
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Advanced Channel Coding and Modulation, Channel Modeling

Cognitive radio and Cooperative communications

Ultra Wideband Technology

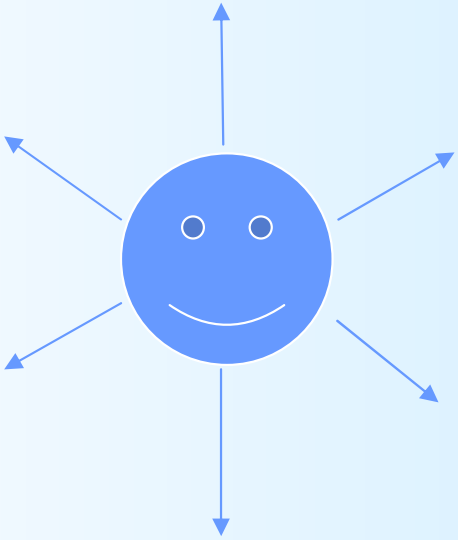
Physical Layer

IDMA/OFDMA

Multi-Carrier Techniques

MIMO Technology/ Precoding

Cross-Layer Design and Radio Resource Management



ASIC Design and Implementation

Cognitive Radio

Compressive Sensing

Sensor Networks

Advanced Channel Coding and Modulation

- Turbo Codes
- LDPC Codes
- Coded Modulation (CM)
  - TCM、MLC、BICM、OVCDM

Turbo Codes

- Propose a modified Code-Matched interleaver
  - Improve the code error performance at moderate to high SNR
  - Reduce the error floor in Rayleigh channel
- Investigate Turbo TCM scheme based on non-binary Turbo codes
  - Analyze the decoding algorithm of TTCM
  - Research on the effects of different set partitioning design

LDPC Codes

- Construct Rate-compatible LDPC codes based on sequential puncture
- Propose several improved decoding algorithms
  - Bit-Flipping algorithms, BP algorithm
  - Better tradeoff between performance and complexity can be achieved
- Simplified design of receiver for LDPC-BICM system
- Apply irregular LDPC codes to unequal error protection

OVxDM

- Propose two improved MAP detection algorithms
  - Based on LLR normalization to improve the decoder performance
  - Based on improved sphericity decoding algorithm to reduce the system complexity
- Performance verification for the proposal of OVxDM to IMT-A.

Channel Modeling, Estimation and Equalization

- Modern scenarios of communication
  - From mobility to wide bandwidth
  - From wide bandwidth to mobility
- Channel modeling for wideband communication
- Channel estimation and equalization
  - Channel estimation and equalization in MIMO-OFDM systems.
  - Pilot channel assisted channel estimation
  - Blind channel estimation

Channel Modeling

- Propose a method to exactly simulate multiple-path uncorrelated Rayleigh channel.
- Propose a channel model for frequency and time selective multiple-antenna channel based on one-ring theory.
  - The model can simulate the mobile wideband communication scenario well.
  - The model has no restriction on the number of antennas.

Turbo Equalization

- Turbo equalization based on precoding
  - Propose a turbo equalization scheme based on the characteristic of precoding and turbo iterative equalization.
  - System performance can be improved without increasing complexity.

- Turbo equalization based on Turbo Codes
  - Obtain the probability of input bits via iteration of two Turbo decoders.
  - With this probability, there is no need to assume independent identical distribution (IID) , and system performance can be greatly improved.

Multi-Carrier Techniques

- MCM、OFDM、OFDMA
  - OFDM: WOFDM（Wavelet OFDM）
  - COFDM (Turbo + OFDM/LDPC＋OFDM)
  - MIMO-OFDM
- Investigate two different orthogonal basis (Fourier and Wavelet) in MCM
- Study PAPRs in MCM system
  - Propose a novel threshold-based PAPR reduction scheme
- Provide the criteria of appropriate wavelet basis selection in difference scenarios

MIMO

- Performance analysis
  - Study the relation of BER and capacity in MIMO systems.
- System design and detection algorithm.
  - Space-Time Coding (STC);
  - Precoding
- Study the throughput in correlated MIMO channels with feedback error and delay
- Design the antenna selection criteria at transmitter and receiver sides.

Space-Time Coding

- Propose a new decoding scheme of Quasi-Orthogonal Space-Time Block Code based on array processing
  - Separate the signal transmitted from different antennas by using Null Space
  - Reduce the decoding complexity
- Find a set of subspaces of Grassmann manifold
  - Construct new space-time constellation with higher transmission rate or better BER performance
  - Obtain Quasi-Orthogonal Space-Time Block Code of rate 1

Precoding

- Study the theory of precoding based on channel covariance information.
  - Propose a MIMO multi-user theoretical model without user and receiver-antenna limitation theoretically.
  - Reduce the overhead of feedback channels and improve the efficiency of communication.

- Propose the concept of MIMO multi-user multi-stream transmission based on spatial decomposition.
  - Overcome the limitation that channel vectors of streams bound to the same user have the same covariance information.

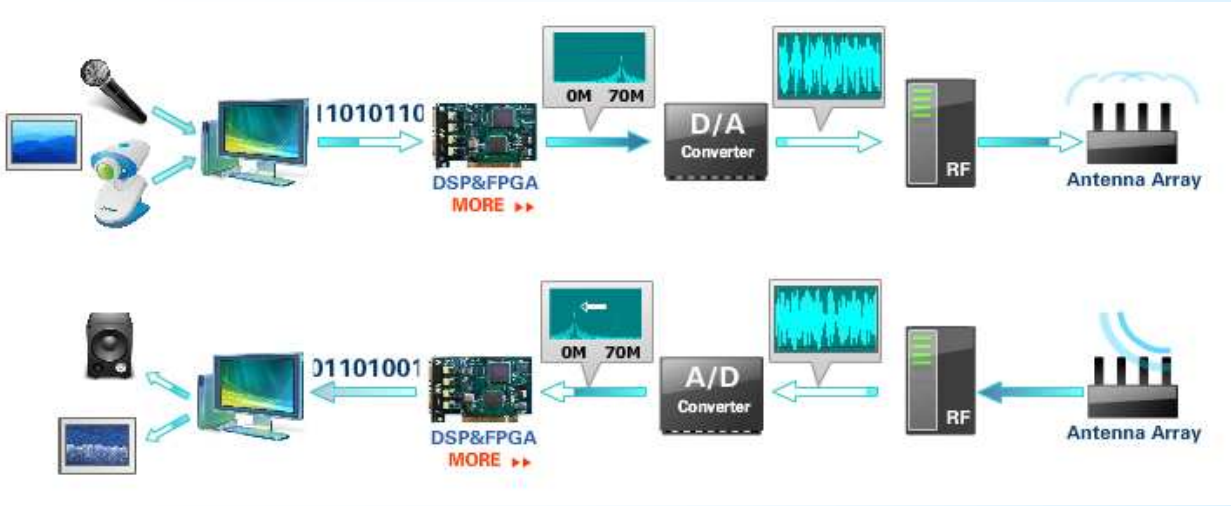
Ultra Wideband

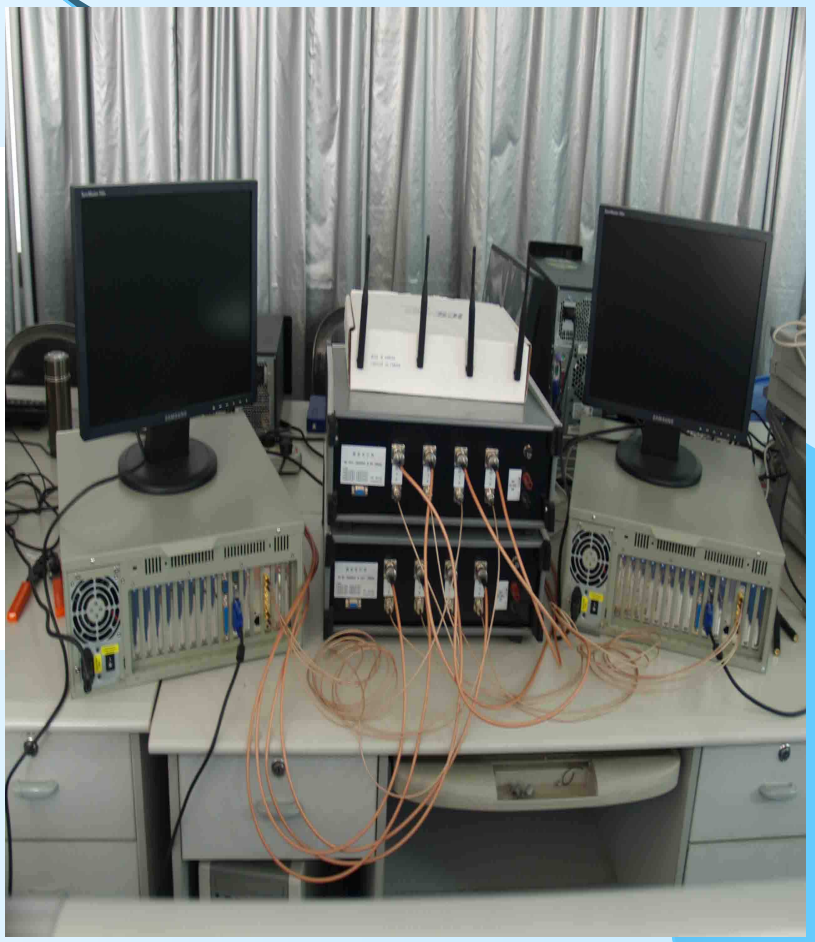
- Investigation of high efficient modulation schemes of UWB system
  - Propose an M-ary code-selected DS-UWB system
  - Improve the system performance and also the data rate
- Research on coginitve UWB system
  - Fouce on the pulse design and utilize the Chirp function
  - Realize the flexible pulse spectrum design
- Research on the combination of MIMO technology and Cooperative communication with UWB system.

MIMO Test-Bed

- Provide real MIMO wireless channel to overcome the limitation of computer simulation.
- Support prototype development and performance evaluation for standard system.
- MIMO non-real-time test-bed
  - MIMO antenna array
  - Mid-frequency processor：ADC/DAC &DUC&DDC
  - PC: base-band process, source signal generation, performance evaluation.
- MIMO real-time test-bed
  - MIMO antenna array
  - Mid-frequency processor：ADC/DAC &DUC&DDC
  - DSP base-band process
  - PC: source signal generation, performance evaluation.

MIMO Test-Bed





IDMA

- Interleaver Design in IDMA
  - Reduce the complexity of generation of interleaver
  - Improve the performance of IDMA
- OFDM-IDMA
  - Reduce the complexity of receiver
  - Achieve flexible rate control
- SCM (Superposition Coding Modulation)
  - High-speed transmission for single-user
  - Easily applied to different communication scenario, such as CR, Mesh.

Cross Layer Design and Radio Resource Management

- Link-based adaptive transmission technologies
  - CLD: PHY + MAC
  - RRM: improve spectrum efficiency
- End-to-end QoS guaranteed resource allocation
  - CLD: PHY + MAC + Transport
  - RRM: improve end-to-end QoS defined at Transport layer
- APP-aware RRM for multimedia communications
  - CLD: PHY + MAC + APP
  - RRM: improve end-to-end QoS defined at APP layer

Application-Aware QoS Guarantee

- Study fairness with game theory
  - Design the co-opetition strategies for multi-user multi-carrier multimedia system.
  - Co-opetition can guarantee satisfied QoS for more users.
  - Co-opetition can make improvement in QoS for unsatisfied users.

- System optimization with optimization theory
  - Joint sub-carrier and power allocation among multiple multimedia users, using Layering as decomposition optimization (LDO) method.
  - With given fairness criteria, resource efficiency can be maximized, providing a theoretical architecture for cross layer design.

Cognitive Radio

- Radio resource management based on CR
  - Spectrum sensing, spectrum management, spectrum share
  - Compressive Sensing
- RRM based CLD in cognitive and cooperative networks
  - Routing protocol design based on cooperative relay selection.
  - Fairness in multi-hop networks
  - RRM based on CLD

Compressive and Cooperative Sensing

- Two principles of compressive Sensing
  - Sparsity of the signal
  - Incoherence of the sensing system
- Application of Compressive Sensing
  - Image processing
  - Communication： channel estimation/spectrum analysis/sensor networks
- Investigate the cooperation gain in cooperative sensing
  - Study the factors that affects the cooperation gain using a new digital model
- Derive the detection probability and false-alarm probability in cooperative sensing with arbitrarily sample resolution

Wireless Sensor Networks

- Cross layer design to save energy in wireless sensor networks.
- Energy-efficiency analysis using error control techniques in WSN.
  - Prove that the energy efficiency of ARQ has nothing to do with retransmissioins.
  - Propose to use chase combining HARQ to implement adaptive error control

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Research Projects

- Ongoing Projects (6 in total)
  - Key Project Financed by National Natural Science Foundation of China (NSFC)
  - Project Financed by National Natural Science Foundation of China (NSFC)
  - Key Project Financed by Provincial Natural Science Foundation
  - ...
- Finished Projects (17 in total)
  - Projects Financed by Ministry of Education of China
  - China-Greece government cooperation project
  - Project Financed by Natural Science Foundation of Shandong province
  - Projects Financed by State Key Lab. on mobile communications Southeast Univ. in Nanjing, China
  - …

Projects from Industry

Hisense 海信

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WMCT

Beijing 2008

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Thank you !