Wireless Mobile Communication and Transmission (WMCT) Lab.

Director: Prof. Dongfeng Yuan

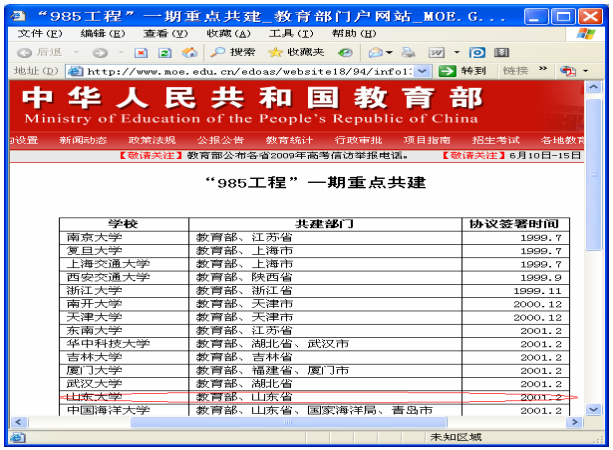
UK-China Science Bridges Project

OUTLINE

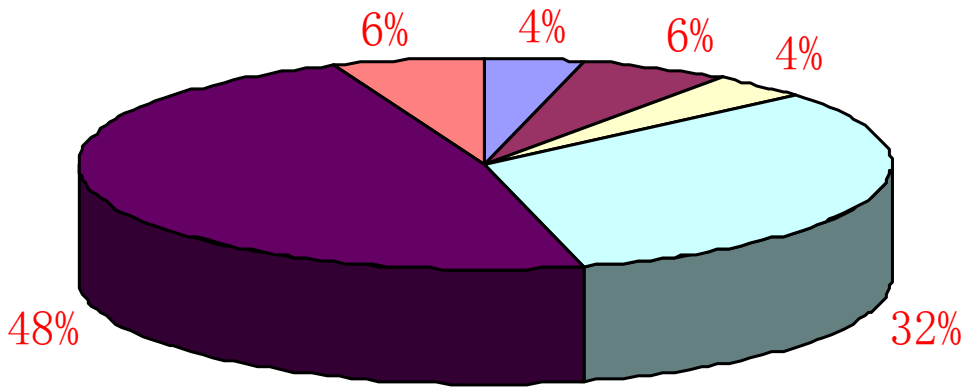
- General Introduction
- Research Areas
- Desired Research Topics
- Patentable Research Outcomes

WMCT

- 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 of WMCT



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

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Advanced Channel Coding and Modulation

Channel Modeling, Estimation and Equalization

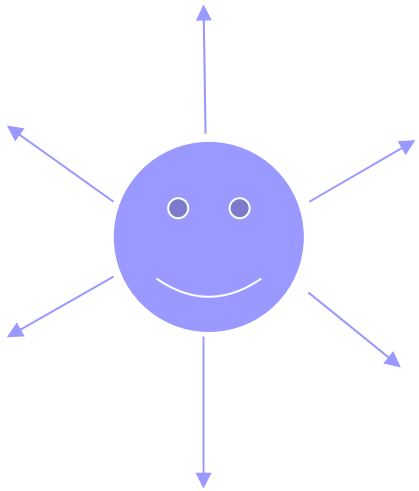
Multi-Carrier Techniques

Multiple-Antenna Techniques

Physical Layer Techniques

IDMA

Cross-Layer Design and Radio Resource Management



ASIC Design and Implementation

Cognitive Radio

Compressive Sensing

Sensor Networks

Achievements (from 2001)

Books published:

- Theory and Applications of LDPC Codes, 2008
- Principles and Applications of Coded Modulation Techniques, 2006
- Principles of Communications(Chinese version), 2004
- Advanced Channel Coding in Wideband Wireless Communication, 2004
- Cross Layer Design in Wireless Communications -- From Theory to Application,, in Press

Publications:

Over 200 technical publications till now. (SCI: 26, EI: 131)

Patents: 24 filed

Awards: (over 10 items totally)

- Natural science award of China education ministry (Level 2), 2005
- Natural science award of Shandong Province (Level 2), 2007
- Natural science award of Shandong Province (Level 2), 2003

Finished Projects

More than 20 finished projects:

- Research on Key Technologies for Error Correcting schemes at High Speed Transmission Based on OFDM, 2004.1 ~ 2006.12, supported by NSFC, China
  - Propose a frequency-selective multiple-antenna channel model based on the one-ring channel model
  - Propose an improved code-matched interleaver based on Turbo code weight analysis
  - Determining the criterion for selecting the optimal wavelet-basis in wavelet-based multicarrier system
  - Propose to reduce the PAPR in OFDM based on the discrete wavelet transform (DWT)
  - Won the Natural science award of Shandong Province in 2007
- Research on Optimal Coded Modulation Schemes in Mobile Digital and Image Transmission Systems, 1999.1 ~ 2003.1, supported by NSFC, China
- Error correction theory and technology based on space-time-frequency diversity technology, 2004.1~2006.12 , Supported by Key Project of Provincial Scientific Foundation of Shandong, China

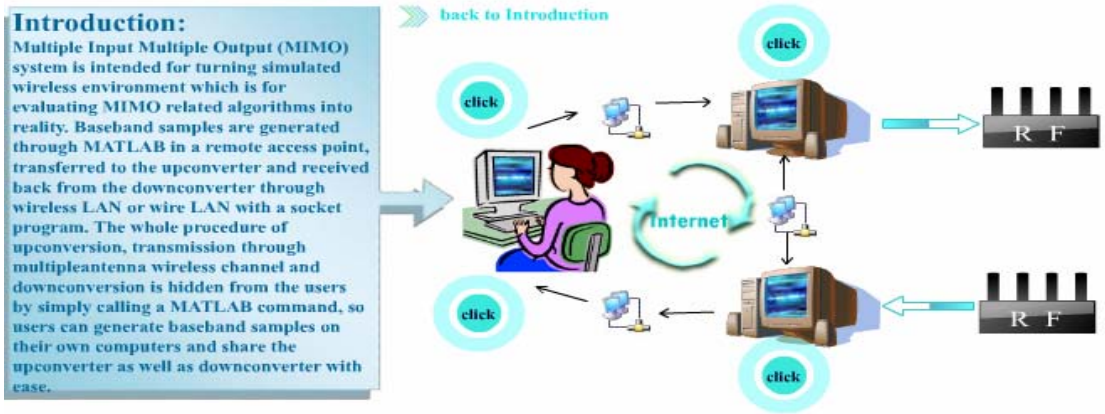
Ongoing Projects

More than 5 ongoing projects:

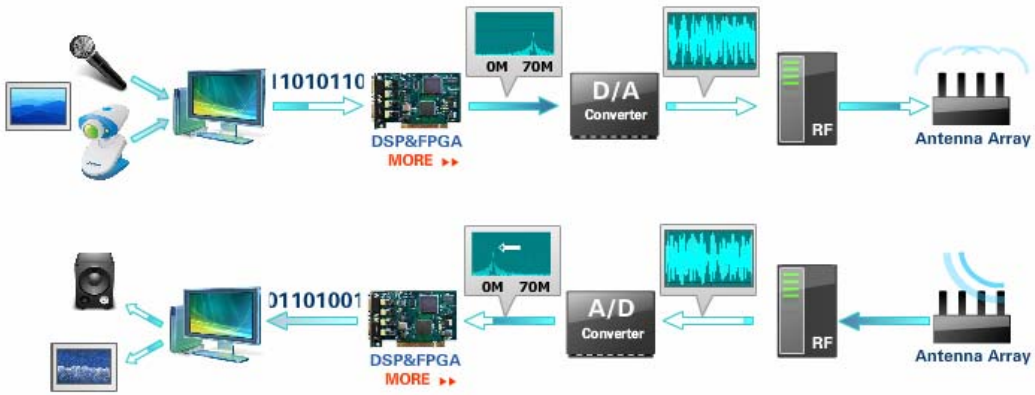
- Cross-Layer Design in Wideband Wireless Communication Network, 2007.01 ~ 2009.12, Supported by NSFC, China
  - Novel fairness in multiuser resource allocation based on game theory
  - Spectrum efficiency analysis based on effective bandwidth theory
  - Joint scheduling in wireless communications, e.g., WLAN, CR systems
  - Joint congestion control and MAC design
  - Joint routing scheme and cooperative transmission in WSN
  - Book: Cross-layer design in wireless communications: from theory to application, Science Press, 2009.9
- Research of Relaying and Cooperative Communication Based on Cognitive Radio, 2009.01 ~ 2012.12, Key Project of NSFC, China (cooperate with Tsinghua Univ., et al)
- Research of Multi-Access Technologies for IMT-A, National Significant Science and Technology Standard Project (cooperate with Daoben Li, et al)

Test-Beds

- **MIMO Test-Bed, Wireless Sensor Network Test-Bed, …**
- **MIMO non-real-time test-bed (finished)**
  - MIMO antenna array
  - Mid-frequency processor：ADC/DAC &DUC&DDC
  - PC：base-band process, source signal generation, performance evaluation.



- **MIMO real-time test-bed (ongoing)**
  - MIMO antenna array
  - Mid-frequency processor：ADC/DAC &DUC&DDC
  - DSP base-band process
  - PC：source signal generation, performance evaluation.



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Application of MIMO Test-Bed

- **MIMO Test-Bed**
  - Provide real MIMO wireless channel to overcome the limitation of simulation model.
  - Can be used for theory and algorithm verification, such as base-band algorithm, key technologies for software and hardware development.
  - Support prototype development and performance evaluation for standard system.

- **The test-bed applies to (not limited to)**
  - Source coding: H.264 MPEG-4
  - Channel coding: LDPC, Turbo
  - Synchronization: simple correlation, MML
  - Beaming forming: RRC filtering
  - MIMO technologies: Alamouti coding
  - Modulation: QPSK, M-QAM
  - Channel estimation: LS

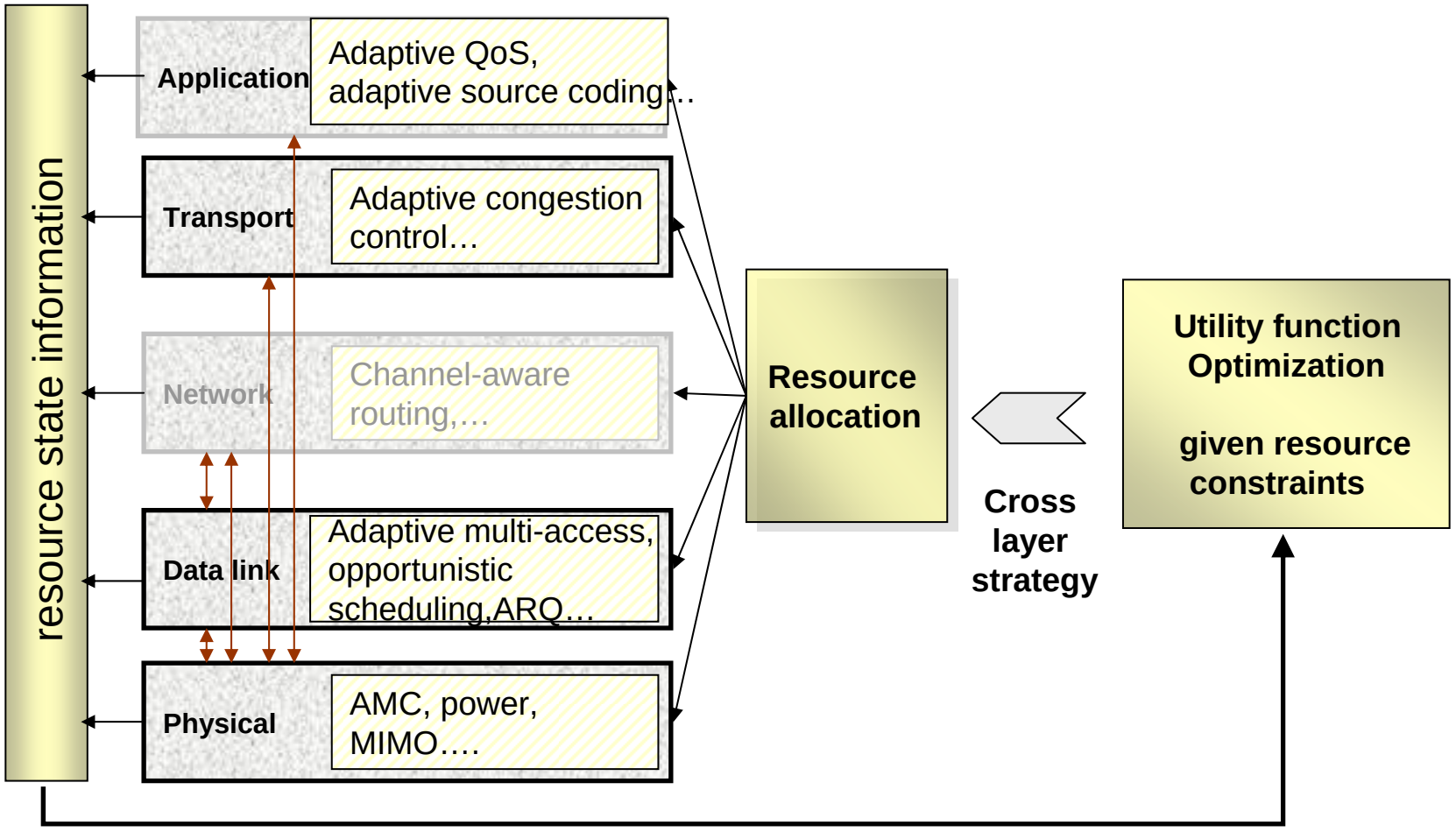
MIMO Non-Real-Time Test-Bed

Institute / Parameters	Bremen University, Germany	Universidade da Coruña, Spain	University of Texas, America	Shandong University, China
Num. of Antennas	8X8	4X4	4X4	4X4, **extendable**
RF	2.4GHZ	2.4 GHz	2.4 GHz and 5.2 GHz	2.4 GHz
IF	none	70MHZ	none	70MHZ/programmable (0-100MHZ)
Sampling Frequency	10MHZ, 40MHZ, 50MHZ, PLL and External Input	Unknown	105 MHz(TX), 20MHZ(RX)	200MHZ/(4xN) (TX), N=1 to 63; 100MHZ/ L (RX), L=16 to 8192;
Bandwidth	16MHZ	16MHZ	10MHz	10MHz
AD/DA	12bit	Unknown	14bit	14bit
FIFO	512K(TX),1024K(RX)	1024K(RX)	Unknown	One Channel : 128K(TX),128K(RX); Others: 128K(TX),32K(RX)
Architecture	Baseband Samples : MATLAB; TX/RX: Hardware;	Baseband Samples : MATLAB; TX/RX: Hardware;	Baseband Samples: MATLAB; TX/RX: Hardware;	Baseband Samples : MATLAB; TX/RX: Hardware;
Network Sharing	Not supported	Supported Details Unknown	Not supported	Supported**: (easy for use)** Matlab functions
Publications & IPR	A Multiple-Antenna System for ISM Band Transmission - Calibration Issues and Eigenbeam Measurements, InOWo 2008	A Distributed Multilayer Architecture enabling End-User Access to MIMO Testbeds, IEEE PIMRC2008	Rapid Prototyping of A Cost Effective and Flexible 4x4 MIMO Testbed, IEEE SAM2008	**Patent ID:** 200710114176.X Patent Name: Distributed MIMO Wireless Communication Testbed

MIMO Real-Time Test-Bed

Institute / Parameters	Brigham Young University, Britain	University of Queensland (UQ), Australia	University Duisburg-Essen, Germany	Shandong University, China
Num. of Antennas	4X4(scalable to 8X8)	2 X2	4X4	4X4,extendable
RF	2.4GHZ	2.4GHZ/5GHZ	2.4GHZ	2.4GHz
IF	8MHZ	Unknown	15~20MHZ	70MHZ,programmable (0-100MHZ)
Sampling Frequency	Maximum 200MS/s	Maximum 125MS/s	160MHZ(TX) 105MHZ(RX)	160 MHz – 400 MHz (TX) 125MHZ(RX)
Bandwidth	10MHZ	Unknown	15~20MHZ	20MHZ
AD/DA	12bit	14 bit	DA 16bit AD 14bit	DA 16bit AD 14bit
Architecture	Baseband Processing : TI TMS6203 fixed-point 300MHZ DSPs DUC:Pentek6229 DDC:Pentek6216	Baseband Samples : C++ TX/RX: Hardware：FPGA Altera;	Baseband Samples : TI TMS3206416 1.600MHz ; IF : FPGA Xilinx Virtex 2	Baseband Samples : TI TMS3206416T 1GHz ; IF : FPGA Xilinx Virtex 4
Publications & IPR	A real-time multiple antenna element testbed for MIMO algorithm development and assessment	2x2 MIMO Testbed for Dual 2.4GHz/5GHz Band,	MIMO Prototyping Using Sundance's Hardware and Software Products, Sundance Application Notes, www.sundance.com	

Cross Layer Design and Radio Resource Management



Cross Layer Design and Radio Resource Management (Cont.)

- 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

Supported by :
NFSC: Cross-Layer Design in Wideband Wireless Communication Network

Cognitive Radio (CR)

- 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

Supported by:

- Key Project of NFSC: Research of Relaying and Corporative Communication Based on Cognitive Radio (Partner: Tsinghua University, Prof. Zhigang Cao)
- Key Project of Provincial Scientific Foundation of Shandong: Research of Cross-Layer Optimization Theory in Multi-hop Cognitive Radio Networks

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Patentable Outcomes

- Real testbed of distributed MIMO communication system 200710114176.x;
- Adaptive Channel Estimation for MIMO Non-Realtime Testbed 200810157204.0
- A new-style synchronous training sequence for non-real-time MIMO testbed, 200810159284.3
- A joint time syschronization and channel estimation scheme for MIMO real time testbed, 200810158142.5
- A design scheme of high rate orthogonal STBC code with four transmitting antennas, 200810014483.5
- A low complexity decoding scheme for quasi-orthogonal space-time block code 200710113841.3

Patentable Outcomes (Cont.)

- Improved decoding algorithm of OVCDM 200810015370.7
- An improving sphere decoding algorithm using in OvCDM, 200810158049.4
- Packet scheduling algorithm based on backoff algorithm for IEEE 802.11 WLAN 200710113258.2
- Enhance system performance of WLAN 200810014876.6;
- Low complexity turbo equalization base on precoding 200810015787.3
- Adaptive Cooperative HARQ based on adaptive modulation and coding 200810016212.3
- A Design Method of Pulse Interpolation Shaping Filter 200810157205.5

Thanks for your attention!