

National Mobile Communications Research Laboratory

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UK-China Science Bridges: R & D on 4G Wireless Mobile Communications



- One of the oldest institutions of higher learning in China
 - Origin traced back to 1902
- Comprehensive university, with engineering as its focus
 - 34 schools/departments, 64 undergraduate majors
- 28,000 full-time students including over 10,000 graduates
- 6000 faculty/staff
- National lead in architecture, civil engineering, electronics, information technology, energy, power engineering, and transportation technology
 - 5 areas in nation's top 5
 - 11 areas in nation's top 10



- Five majors: Communications and Information Systems; Magnetic Field and Microwave; Signal and Information Processing; Circuits and Systems; Information Security
- 2 National Key Research Laboratories
- 208 faculty members: 1 academican Chinese Academy of Engineering, 41 professors (23 doctoral advisors), 36 associate professors, 15 postdocs
- 1200 undergraduates; 800 masters; 180 Ph.D.s
- 11 academicians Chinese Academy of Engineering as alumni

National Mobile Communications Research Lab (NCRL)



- China's only national key research lab on mobile comm.
- Lab director **Professor Xiaohu You**: ChangJiang Professor and young talent in Mobile Communications; Dean of School
- 51 researchers: 24 professors (16 doctoral advisors), 14 associate professors, 7 postdocs, 80 Ph.D., 265 Masters
- In 2008, 31 journal papers in International journals, 50 journal papers in Chinese journals
- Applying "National Research Lab on Mobile Communications"

- Research Areas:
 - Broadband wireless transmission & multiple access techniques
 - Modern signal processing & its applications in mobile comm.
 - Theory and applications in mobile networks
 - Short-distance wireless communications
 - Information theory and coding

- In the recent 10 years, the lab has been at the forefront of domestic mobile communications R & D:
 - 1996: took part in 1st domestic GSM experimental system
 - 1998: built the 1st domestic CDMA system
 - 2002: field tests of domestic 3G mobile comm. systems (lead unit)
 - 2003: designed 1st domestic CDMA2000 cellphone chipsets
 - 2005: designed 1st domestic WCDMA cellphone chipsets
 - 2005: developed 1st domestic UWB wireless transmission experimental system
 - 2006: designed the experimental system of the domestic 4G mobile communications (lead unit)

4G Mobile Communications Experimental System (1)



- 2 Basestations, 8 antennas each
- 3 UE, 4 antennas each
- Distributed antenna system and adaptive MIMO

4G Mobile Communications Experimental System (2)



- 20MHz bandwidth, 100Mbps transmission rate
- Downlink OFDM, Uplink Generalized Multi-carrier
- Iterative detection/decoding

- Related Publications:

- *The capacities of cooperative distributed antenna system*
 - D. Wang and X. You
 - IEEE Trans. on SP, 2008
 - IEEE Wireless Comm. Mag., to appear
- *Transmission over Jointly-Correlated MIMO Channels*
 - X. Gao, B. Jiang, X. Li, A. B. Gershman and M. R. McKay
 - IEEE Trans. on IT, 2009
- *Fast implementation the GMC filter banks through FFT*
 - X. Gao, X. You, B. Sheng and H. Hua
 - IEEE JSAC, 2006
- *Dual-Turbo Receiver Architecture*
 - W. Wang, X. Gao, X. Wu, X. You, C. Zhao
 - ICC 09
 - IEEE Trans. on Wireless Communications, to appear

Funding at NCRL in 2007

Project category	Project #		Amounts (RMB)	Percentage	
National "863" plan	6	27	32.9m	73.34 %	89.77 %
NSF China	6		1.59m	3.54%	
Other Gov. Fund.	11		3.15m	7.02%	
Provincial	4		2.63m	5.86 %	
International	7		1.19m	2.65 %	
Industrial	11		3.40m	7.58 %	
Total	45		44.86m	100 %	

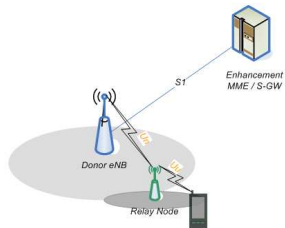
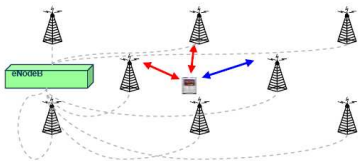
Current Projects at NCRL (1)

- The ministry of science and technology of China:
 - National major science & technology project: IMT-Advanced new wireless technology R & D, 2 years 24 million RMB, lead unit (of 11 units)
 - National major science & technology project supporting plan: research on IMT-Advanced specifications, 1 year 3 million RMB, lead unit (of 10 units)
- National Natural Science Foundation of China:
 - NSF China major project: theory and technology of future mobile communication systems, 4 years 2.1 million RMB
 - NSF China major project: design and optimization of 4G mobile communication systems, 4 years 0.9 million RMB
- National “863” plan:
 - R & D on Gbps wireless transmission key technology and experimental systems, 2 years 3.95 million RMB
 - Adaptive MIMO transmission technology in distributed wireless networks, 2 year 1 million RMB

Current Projects at NCRL (2)

- National “973” plan:
 - Theory of cooperative multi-domain broadband wireless communications—cooperative MIMO channel modeling, 5 year 1.6 million RMB
- International collaboration:
 - NOKIA-SEU Collaboration Project Plan on Standardization Research, 2.5 years 1.1 million RMB
 - Qualcomm: Broadband Wireless and Mobile Communications, 3 years 0.9 million RMB
 - Sweden government: technology of self-organizing networks in ad-hoc, sensor, mesh and cooperative networks, 3 year 0.85 million RMB
 - Korea ETRI: Key technology in next generation wireless networks, 9 months 0.8 million RMB

Desired collaboration: IMT-Advanced (1)



- Research on novel technologies related to IMT-Advanced mobile communication systems
 - Promote China's position in technology and standardization
 - Enable smooth evolution of TD-SCDMA and TD-LTE systems

*. Pictures from "LTE-Advanced", Ericsson Research and 3GPP R3-091194, "Protocol architecture of Relay", ZTE

Desired collaboration: IMT-Advanced (2)

- Six areas
 - Distributed antenna system:
 - Basestation connect to multiple antennas through fiber
 - Network topology, resource allocation, mobility management
 - Wireless relays:
 - Relays to increase capacity and to increase coverage
 - Capacity analysis, resource allocation, mobility management
 - Self-organization, self-configuration, self-optimization
 - Working between networks of different RAT:
 - Measurement, handover, selection of access network, resource allocation etc.
 - IMT-Advanced standardization:
 - Algorithms, protocols, simulations
 - IMT-Advanced trial system:
 - Evaluate, test and verify

Desired collaboration: SON

- Every entity in the network requires a huge amount of parameter configuration and optimization
- Complexity far surpass traditional mobile networks
- In order to reduce the cost of network construction, operation and maintenance
- Devices should negotiate, configure and optimize involved parameters in a distributed fashion by themselves
- Goal:
 - Reduce amount of human intervention
 - Increase network performance and quality
 - React to dynamic processes in the network

- Event triggering for UE, for example:

$$Mn + Ofn + Ocn - Hys > Ms + Ofs + Ocs + Off$$

- Self-configure many HO parameters of the system such that
 - Avoid too late HO, too early HO, wrong HO and ping-pong
- Detect problems in the network
 - Too late HO:
 - RLF at source cell
 - Reestablished connection at target cell
- Distributed algorithm that self-adjusts parameters to resolve problems
- Negotiation and protocol between eNBs

Desired collaboration: mobility load balancing (MLB)

- When one cell becomes overloaded, hand off load to another nearby cell without affecting QoS
- By self-optimizing HO parameters → delay or advance HO
- Algorithm
 - input: load information of cells
 - output: HO parameter change
- Protocol:
 - Load definition, especially inter-RAT
 - Load exchange procedure
 - Time-scale of MLB
- **Relationships:** MRO and MLB
 - Both MRO and MLB output HO parameter changes, inspected jointly
 - Which one has higher priority?
 - How do they affect each other?



- NCRL is a very strong lab on mobile communications
- Many projects on 4G communications
- IMT-Advanced project is our big focus
- Welcome collaboration on all aspects of IMT-Advanced project, including SON