



华中科技大学
Huazhong University Of Science & Technology

UK-China Science Bridge: R&D on 4G Wireless Mobile Communications at HUST

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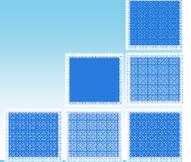
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Huazhong University of Science & Technology,
Wuhan, P.R.China



Contents



Introduction of HUST



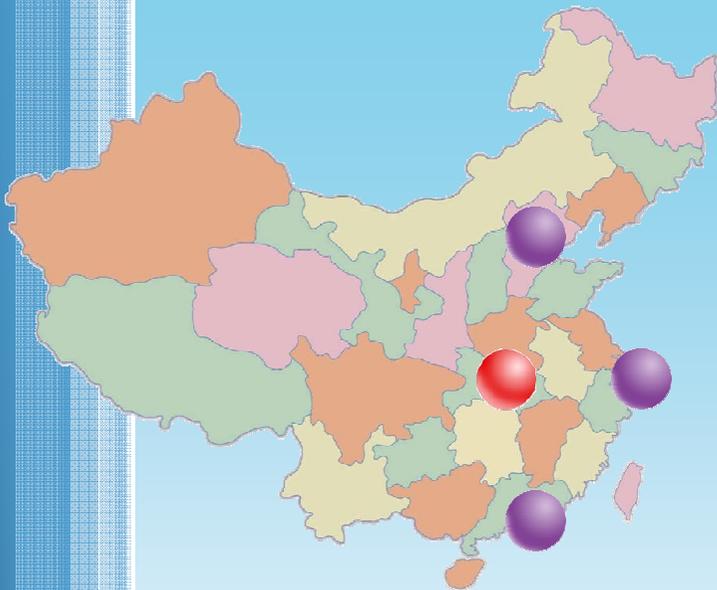
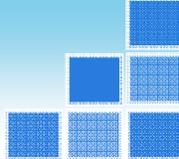
Research Basic



Desired research topics



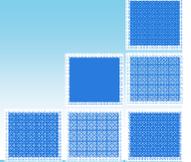
Research outcomes



HUST

Wuhan, China





National Grade A disciplines on doctor and master's degree

- Information and communication engineering
- Electronics science and technology

National Grade B disciplines on doctor

- Communication and information system
- Signal and information processing
- Electromagnetic field and microwave technology
- Circuits and system
- Space information technology
- Biological information technology

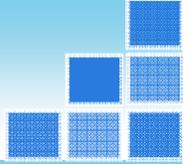
27 Professors

40 Associate Professors

100+ PhD Candidates

500+ MSc Students





- 12 full time Researchers;
- 1000 m² research floor;
- Two research directions: wireless communication & microwave detection

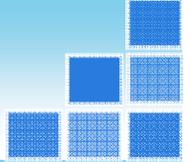
Wireless communication group

Head: A. Prof. Xiaohu Ge (Vice director of institute)

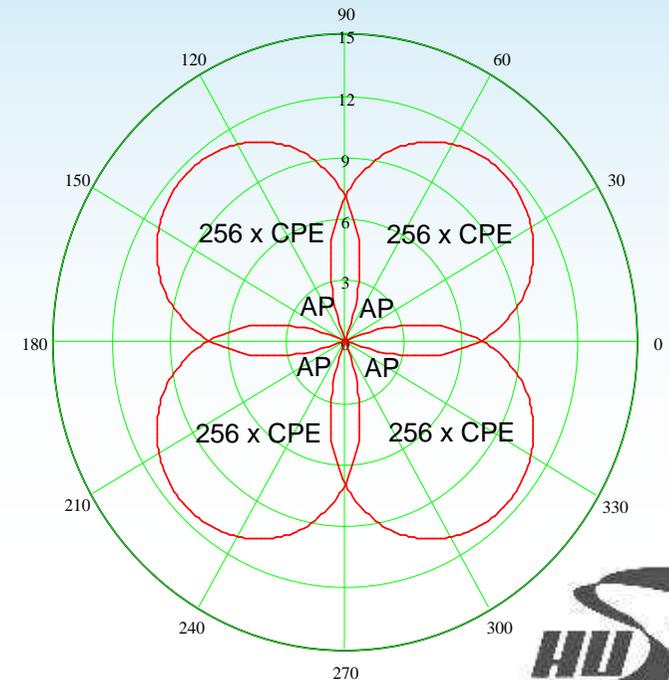
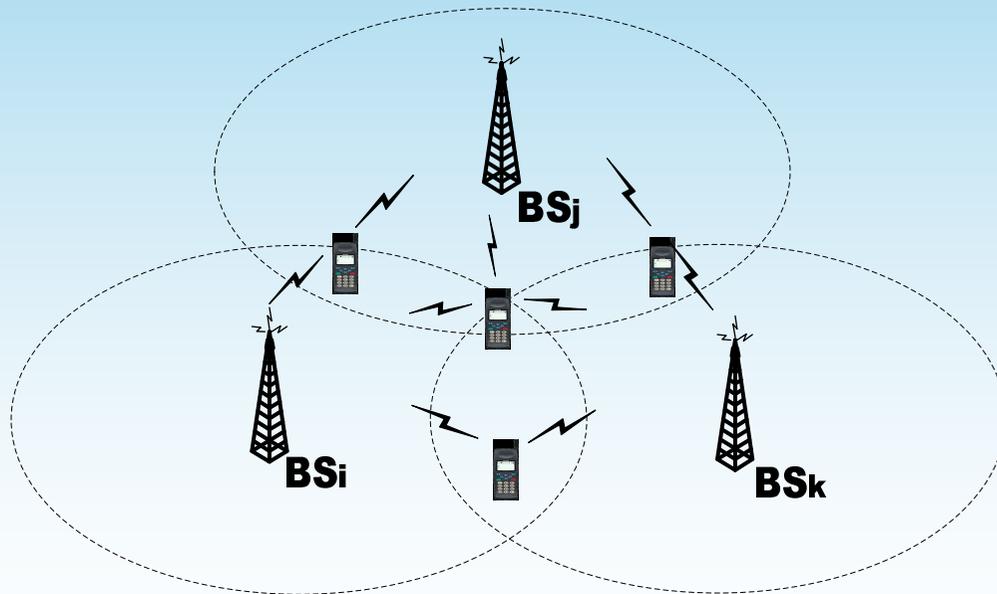
Member: 4 full time Researchers, 2 PhD candidates, 16 MSc students (include two foreign students)

**Research topics: (1) wireless communication in 4G
(2) wireless networks**

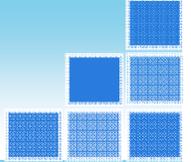
Research Topics---- wireless communication



As we know, the MIMO technology could greatly improve the transmission efficiency (rate) and this technology will be widely used in the 4G communication system, but in the high interference environment, the MIMO's gain will be obviously decreased, even approach to **ZERO**.



Research Topics---- wireless communication

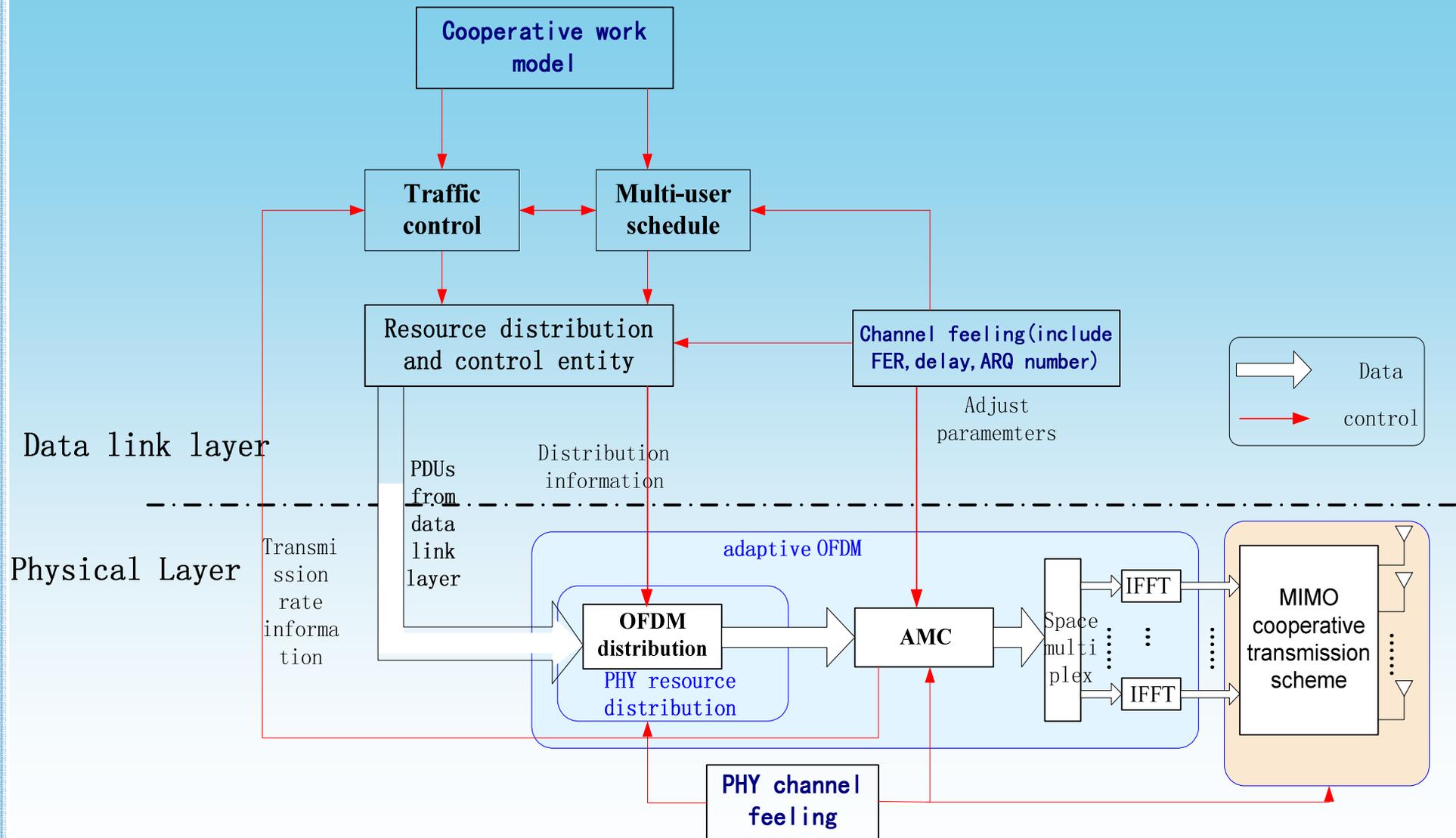
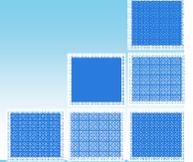


Aim: In this research, we try to overcome the inter-cell interference based on the cooperative communication idea. In the PHY layer, we try to design the new pre-code algorithm and power control scheme based on the multi-basestations cooperative idea under MIMO environment; in the data link layer, we will design the new user schedule, traffic control and resource distribution scheme based on the cooperative communication; and then, we try to improve the communication network efficiency by the cross-layer design technology. Based on all these technologies, a total solution should be proposed to improve the marginal user's QoS.

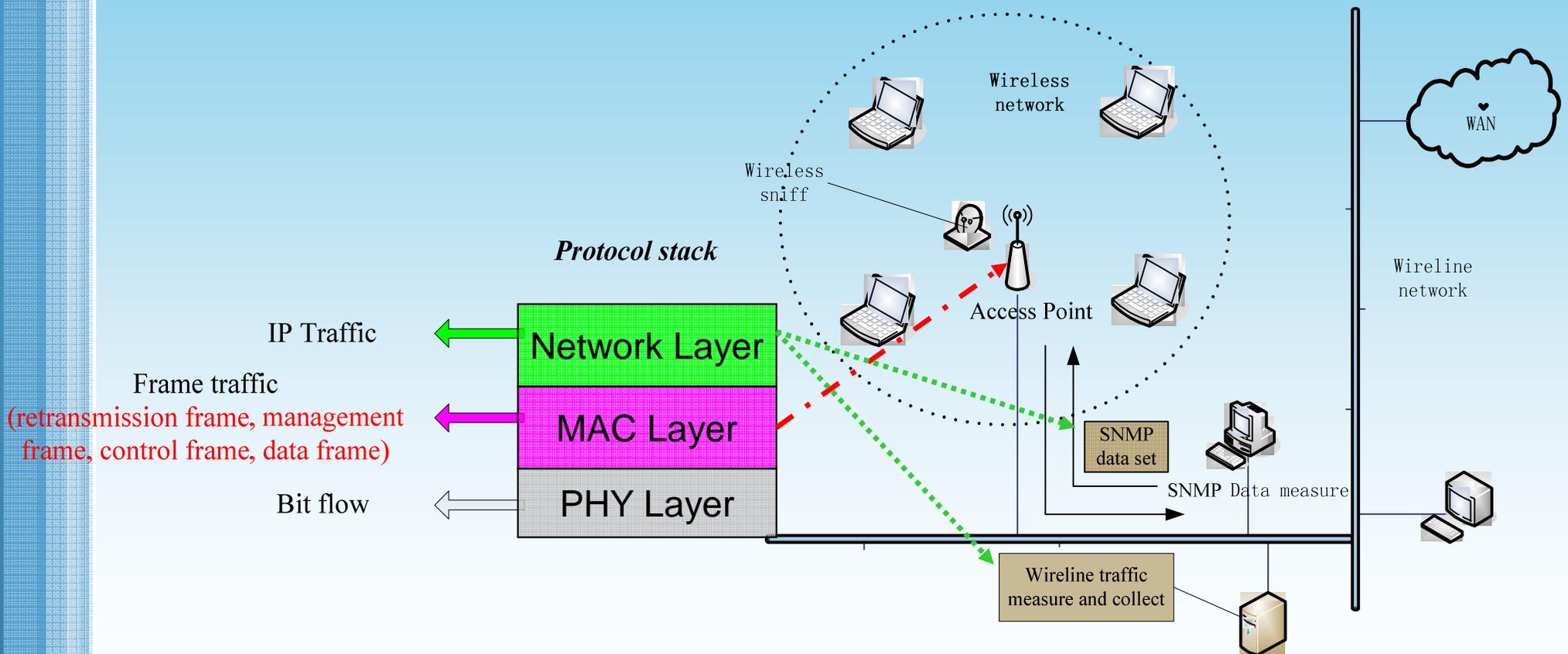
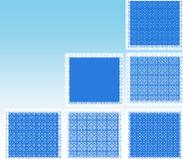
Research context:

- Pre-code algorithm and power control scheme under MIMO condition based on the cooperative communication;
- User schedule, traffic control and resource distribution scheme based on cooperative communication;
- Cross-layer design technologies in the cooperative communication network;
- Propose a total solution used for 4G mobile communication system.

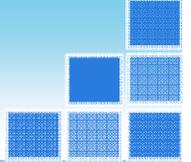
Research Topics---- wireless communication



Research Topics---- wireless network



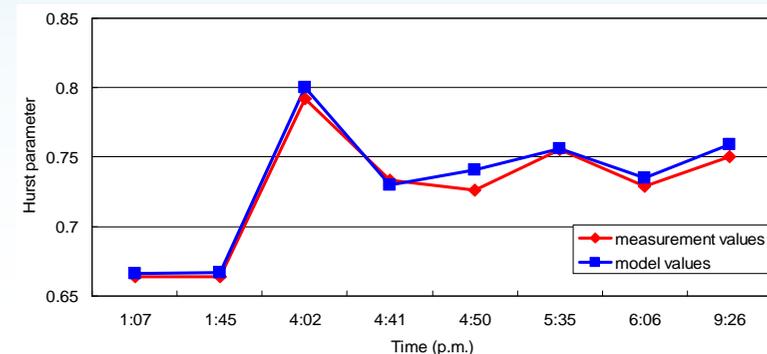
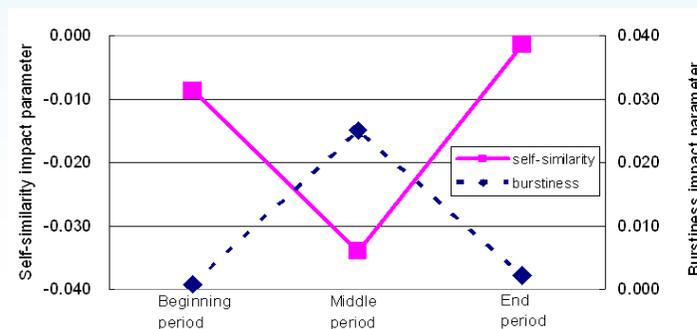
Research Topics---- wireless network



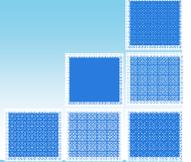
Aim: In this research, we try to explore the characteristics of frame traffic in wireless networks, modeling the frame traffic in wireless networks, and then design the new algorithm to improve the efficiency of MAC protocols.

Research context:

1. Measuring and analyzing characteristics of frame traffic in WLANs
 - Characteristics in time domain;
 - Characteristics in frequency domain;
2. Modeling of frame traffic in wireless networks
 - Frame traffic model
 - Prediction model of frame traffic
3. Algorithm design and performance analysis in wireless networks
 - Design the new back-off policy in MAC layer
 - Design the new traffic control algorithm in wireless networks
 - Derive the performance bounds of the new algorithms and schemes

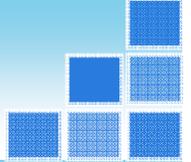


Previous/current research projects



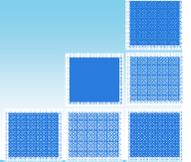
- “**UK-China Science Bridges: R&D on 4G Wireless Mobile Communications**”, UK research councils, 1 June 2009-31 May 2012.
- “Multi-users and Multi-cells Interference Coordination Technology Based on MIMO Environment” , Sponsor: National 863 High Technology Program, **Project Leader: Dr.Xiaohu Ge**, Research Period: 2009 ~ 2010,
- “Performance Analysis and Modeling of Frame Traffic in Wireless Networks”, Sponsor: NSFC (Natural Science Foundation of China), **Project Leader: Dr.Xiaohu Ge**, Research Period: 2009 ~ 2011,
- “Research on the Characteristics of Wireless Network Traffic”, Sponsor: NSFC, **Project Leader: Dr.Xiaohu Ge**, Research Period: Jan. ~ July 2007,
- “Performance Prediction Modelling for Multimedia Network Based on the Covariation Orthogonality and United Optimization”, Sponsor: NSFC, **core researcher: Dr.Xiaohu Ge**, Research Period: 2006 ~ 2008,
- “Key Technology in IMT-Advanced wireless networks”, Sponsor: Ministry of Industry and Information Technology, Research Period: 2008 ~ 2009,
- “Access Technology in Space-Sky Wireless Networks”, Sponsor: National High-Tech 863 Programme, **Project Leader: Dr.Xiaohu Ge**, Research Period: 2007 ~ 2008,
- “Protocol Structure Design in Space-Sky Wireless Networks”, Sponsor: National High-Tech 863 Programme, **Project Leader: Dr.Xiaohu Ge**, Research Period: 2006 ~ 2007,

Desired research topics



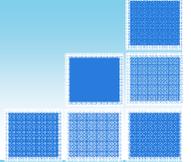
1. Interference modelling in MIMO environment;
 - research problem: In the multi-cells MIMO system, the capacity is limited by the interference. How to reflect the impacting of interference on the capacity is a key problem in the MIMO system.
 - possible solution: analyze how the capacity is impacted by the interference, and then propose the corresponding technologies to decrease the impact of interference and to improve the capacity .
 - preliminary results: interference modelling and corresponding technologies used to improve the capacity in the multi-cells MIMO system.

Desired research topics



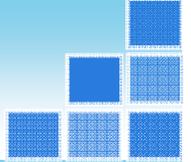
2. User schedule and resource management based on cooperative communication in 4G
 - research problem: Multi-basestations cooperative communication could improve the frequency efficiency and coverage area, however, this result should be supported by corresponding user scheduling and resource management. How to realize the joint multi-users scheduling and resource management in multi-basestations is a complex problem.
 - possible solution: build a scheduling model to describe the user's scheduling, and then distribute the resource in multi-basestations based on the user's scheduling.
 - preliminary results: user's scheduling model and corresponding technologies used for improving the efficiency of basestations in cooperative communication.

Desired research topics



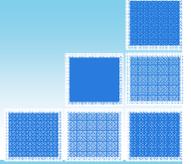
3. **Wireless traffic control and load balance in cooperative communication system;**
 - research problem: traditional traffic control scheme pursues the maximal of throughput at basestations, however, it could result in the decrease of marginal user's QoS and system stabilization. In this research, we are looking for the possible solution for protecting the marginal user's QoS and system stabilization.
 - possible solution: build the load balance model in multi-base stations, and then design the joint traffic control scheme based on the cooperative communication.
 - preliminary results: load balance model and traffic control scheme to maintain the stabilization of cooperative communication system.

Desired research topics



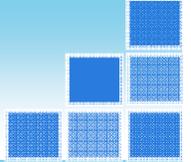
4. Wireless frame traffic characterizing and modelling and performance analysis.
 - research problem: traditional traffic characterizing is measured at gateways by IP traffic, however, it could not describe the characteristics of traffic in the air. Such as retransmission frames have not been included in the IP traffic.
 - possible solution: measure and analyze the frame traffic, and then build the corresponding frame traffic model, furthermore, derive the performance bounds of the frame traffic model.
 - preliminary results: the frame traffic model and performance bounds of the frame traffic model

Potential Industry Application



- ✓ A good interference model could provide the guideline for design power control algorithm and base station topology structure to improve the frequency efficiency in the MIMO system.
- ✓ User schedule and resource management based on cooperative communication could improve transmission efficiency in the 4G communication system.
- ✓ Wireless frame traffic characterizing and modelling could provide guideline for designing traffic control algorithm and improve the throughput of wireless networks.

Existing research outcomes



◆ Publications:

- **Xiaohu Ge, Yang Yang, Chengxiang Wang**, “Characteristics Analysis and Modeling of Frame Traffic in 802.11 Wireless Networks”, submitted to *Wireless Communications and Mobile Computing* (Wiley).
- **Xiaohu Ge**, Jianghua Liu, Yingzhuang Liu, “HSWA-TCP: A New Traffic Control algorithm for High-speed Satellite Communication Networks”, *Chinese Journal of Electronics*, accepted for publication.
- **Xiaohu Ge, Yang Yang**, Zhu Yaoting, “Performance Analysis of Capture Effect in High Speed Wireless Networks”, *Chinese Journal of Electronics*, Vol.17, No.1, pp165-169, 2008 Jan.
- **Yang Yang**, F. Huang, **Xiaohu Ge**, X. Gu, M. Guizani, and H. H. Chen, “Double Sense Multiple Access for Wireless Ad Hoc Networks”, *Elsevier Computer Networks*, Vol.51, No.14, pp3978-3988, 2007.
- **Xiaohu Ge**, Guangxi Zhu, Yaoting Zhu, “On the Testing for Alpha-Stable Distributions of Network Traffic”, *Computer Communication (Elsevier Science)*, Vol 27/5 pp 447-457, 2004.
- **Xiaohu Ge**, Guangxi Zhu, Yaoting Zhu, “An Improved Modeling of Network traffic based on Alpha-Stable Self-similar Processes”, *Chinese Journal of Electronics*, Vol.12, No.4, pp494-498, 2003, Oct.

◆ Patents:

- A User Schedule Algorithm for MIMO System, patent number: 200910062132.6
- A Time Synchronization Algorithm for Sensor networks, patent number: 200910062301.6
- A New Transition Control Algorithm used in Satellite networks, patent number: 200810075702.0



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Thank You !

