華中科技大學
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Impact of Interference on Energy Efficiency in Multi-cell Cellular Networks

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UK-China Science Bridge

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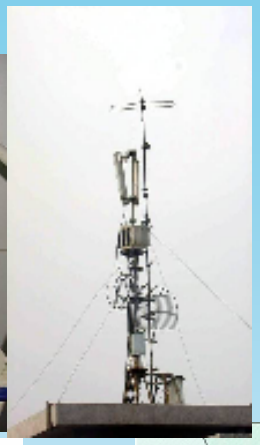
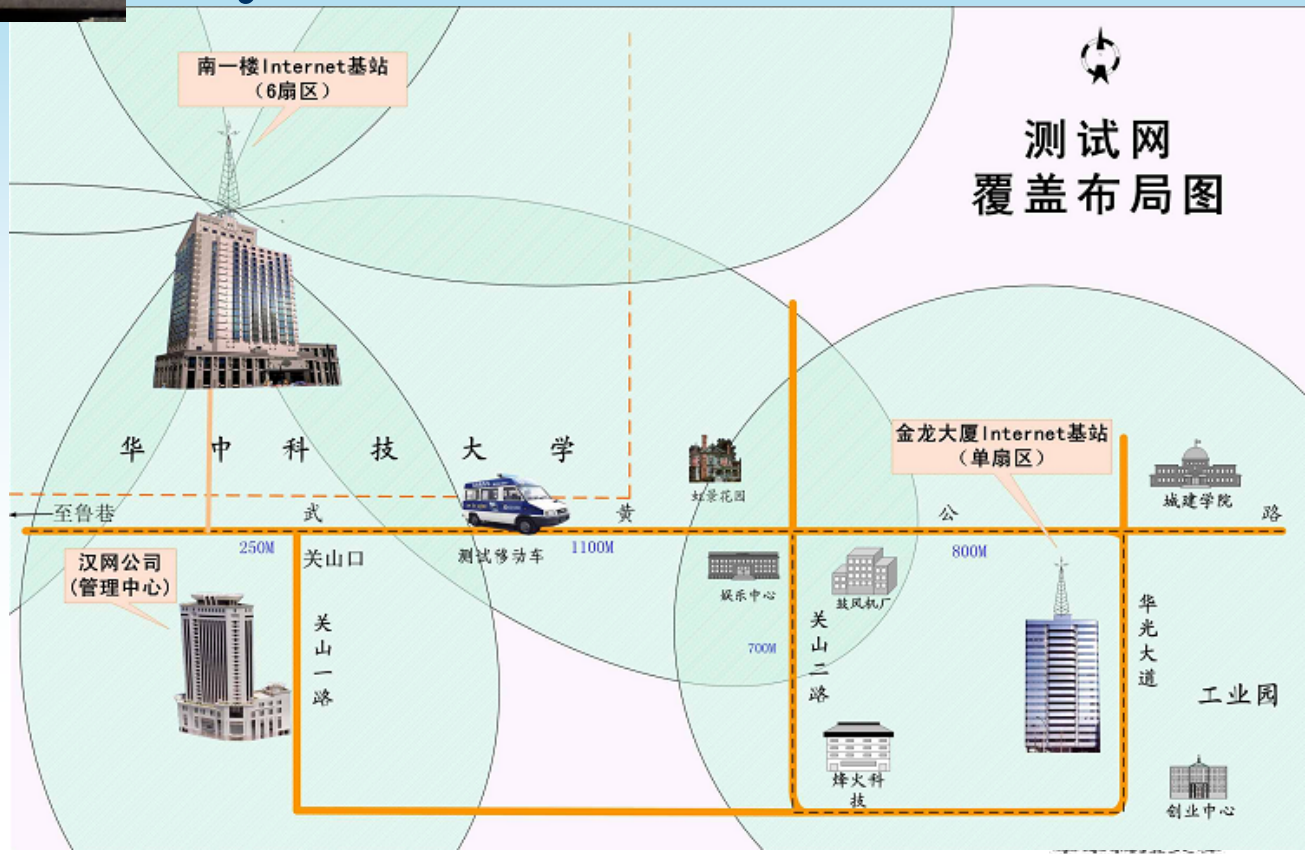


PDMA: @2Mbps
All-IP Cellular Mobile Communication Trial System by HUST in 2002



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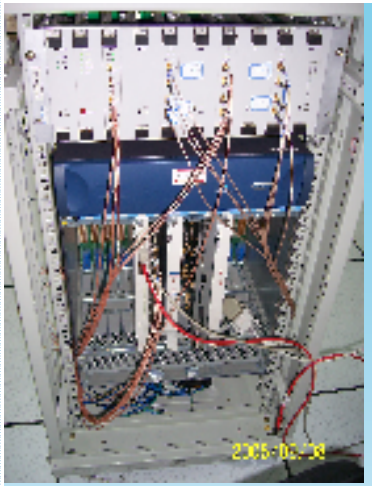
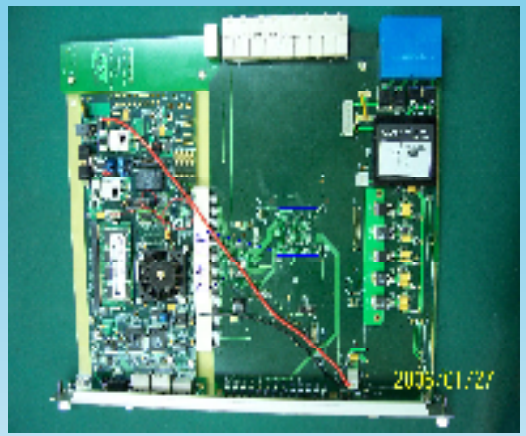
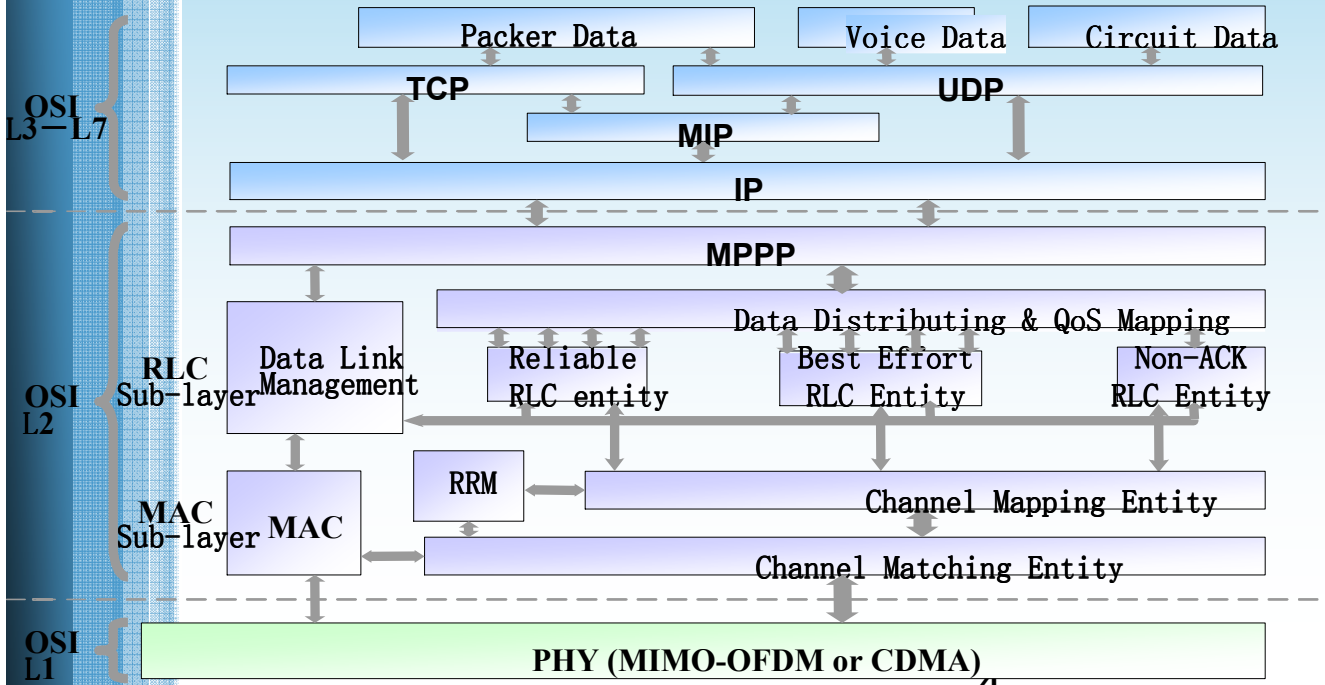


FuTURE/B3G Project





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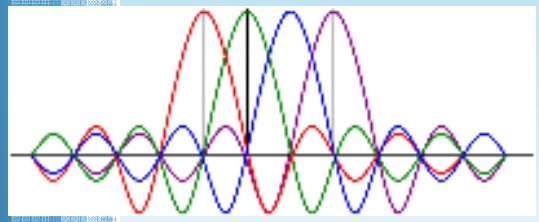
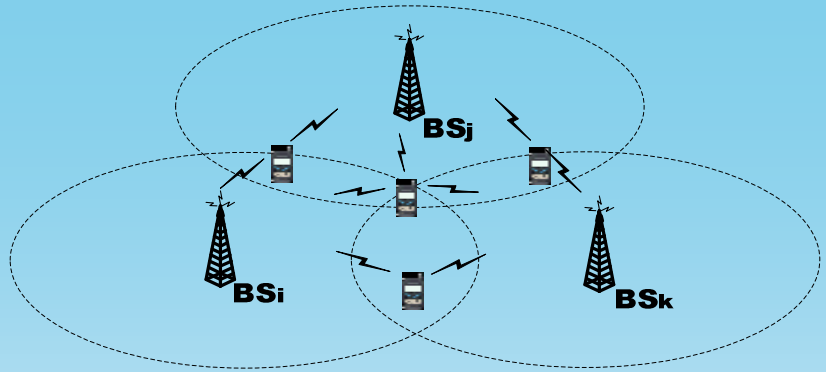
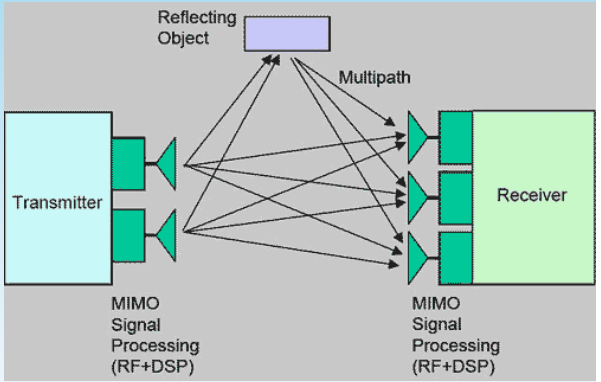
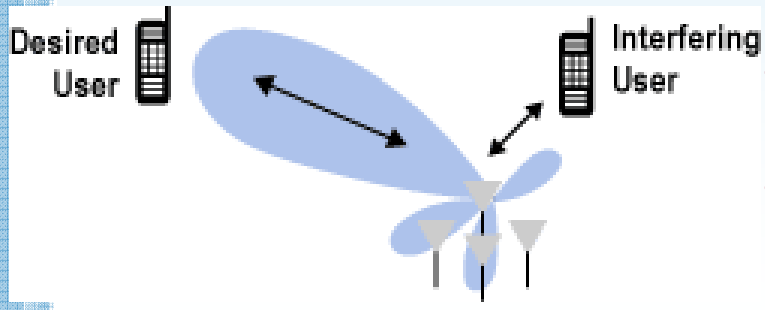
Orthogonal Frequency Division Multiplexing





Interference Coordination





Adaptive Antenna System

Multiple Input Multiple Output

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PDMA project

- China MOST Key 863 Programme “Broadband wireless IP technology”, 2000-2002;

FuTURE project

- China MOST Important 863 Programme “Research on wireless link technology for next generation cellular mobile communication system”, 200-2003;
- China MOST Important 863 Programme “Design and testbed of TDD system protocol, adaptive link and coding”, 200-2005;
- China NSFC Important Project “Adaptive air interface technology based on MIMO-OFDM”, 2004-2008;

Current projects

- China MOST 863 Porgramme “Research on interference coordination technology for multi-user multi-antenna cellular networks”, 2009-2010;
- China MOST international cooperative Programme “Cooperative communication technology in wireless networks”, 2010-2012.

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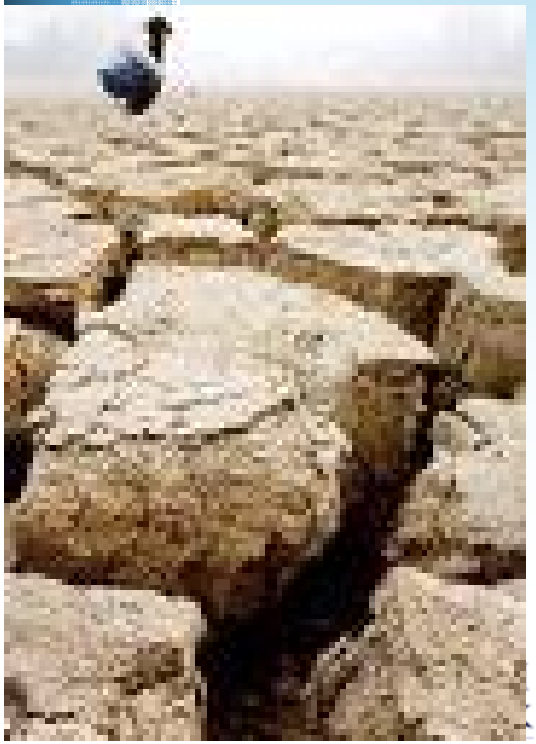
2.1 Background and Motivation-1

In China, the Telcom. Industry consumed **20** Billion kilowatt at 2008.



Until 2011, the China 3G mobile communication system will add 400,000 base stations. More base stations, more energy consumption?

2.1 Background and Motivation-2

- For the next generation mobile communication system, MIMO technology was widely accepted to improve the transmission rate and spectrum efficiency;
- Interference issue is one of the key problems to implement high energy efficiency in the multi-cell MIMO cellular networks.
- How to evaluate the interference on the energy efficiency in multi-cell cellular networks considering characteristics of wireless channels?

2.1 Background and Motivation-3

- Aim and objects:

  The aim of this research tries to explore and evaluate the impact of interference on the energy efficiency of multi-cell cellular networks based on the two-state Markovian wireless channels.

- The measurable objectives

(1) Build an energy efficiency model for a two-cell cellular network with co-channel interference;

(2) Investigate the impact of multi-antenna on the energy efficiency of two-cell cellular networks with co-channel interference;

(3) Investigate the impact of the cell number on the energy efficient of cellular networks with co-channel interference.

2.2 Research Programme - 1

Work Package 1 :Energy Efficiency of Two-cell Cellular Networks

- the two-cell cellular network energy efficiency model based on the maximum achievable capacity is proposed considering co-channel interference.
- Impact of transmission power and wireless channel on the energy efficiency and spectrum efficiency of two-cell cellular networks is evaluated.

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Work Package 2: Impact of Multi-antenna on Energy Efficiency of Cellular Networks

- the model of energy efficiency for MISO two-cell cellular networks with Markovian wireless channels is proposed.
- Impact of multi-antenna on energy efficiency of cellular networks is analyzed.

2.2 Research Programme - 3

Work Package 3: Impact of Multi-cell on Energy Efficiency of Cellular Networks

- A model of energy efficiency for multi-cell cellular networks is investigated.
- Impact of multi-cell on energy efficiency of cellular networks is evaluated.

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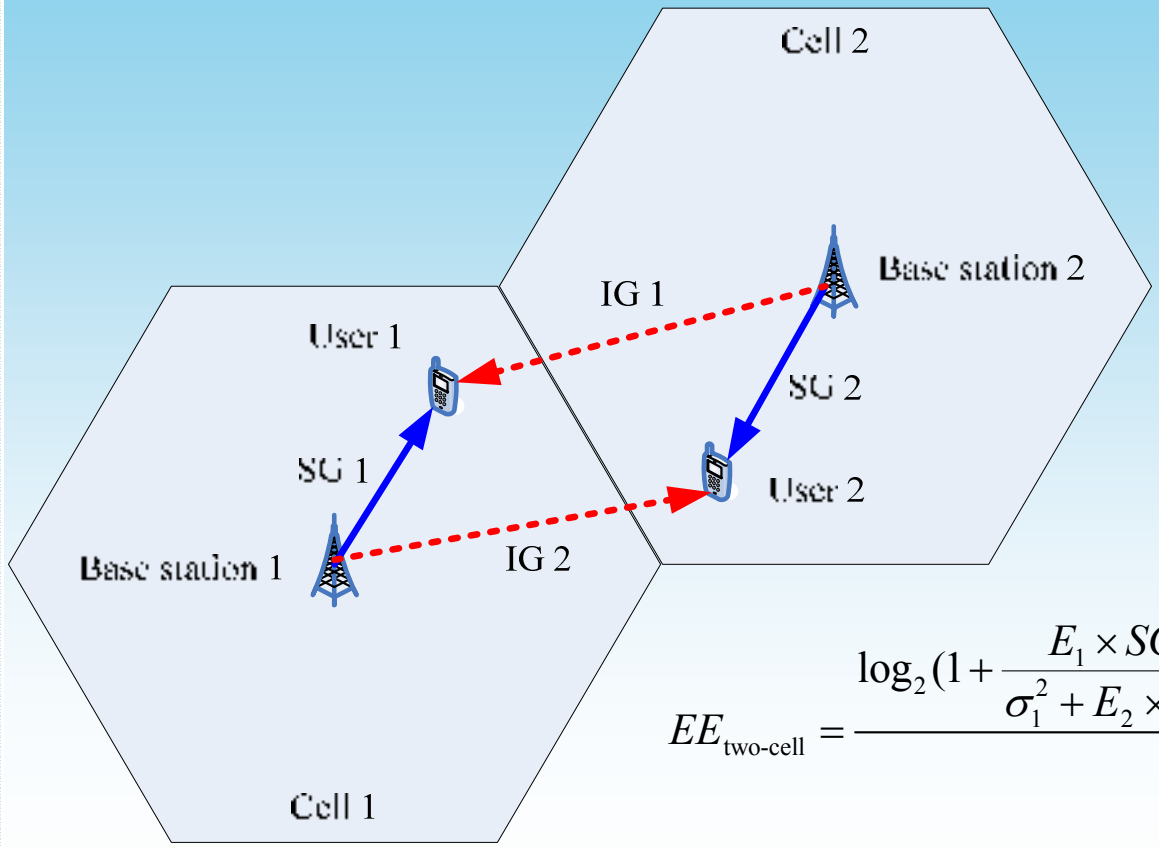
2.3 Research Results -1

Two-cell cellular network system model



$$EE_{\text{two-cell}} = \frac{\log_2(1+\frac{E_1 \times SG_1}{\sigma_1^2 + E_2 \times IG_1}) + \log_2(1+\frac{E_2 \times SG_2}{\sigma_2^2 + E_1 \times IG_2})}{E_1 + E_2}$$

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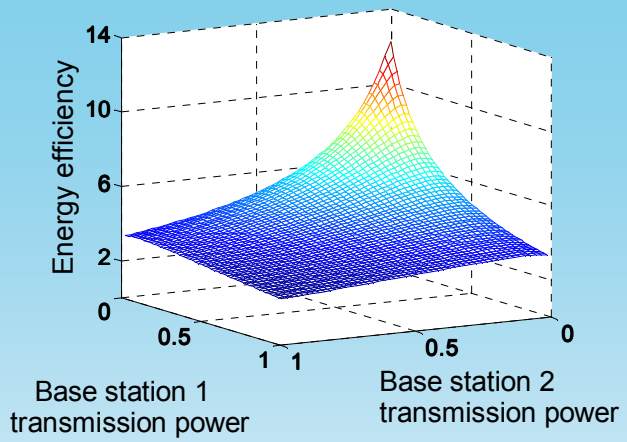
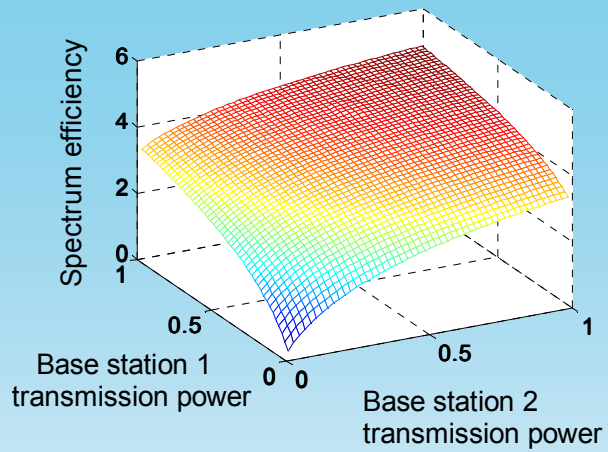
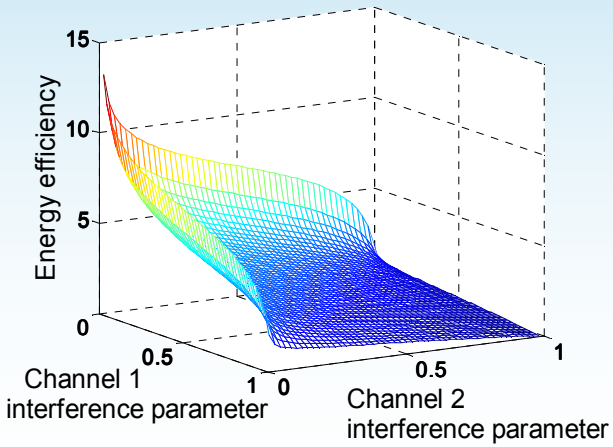
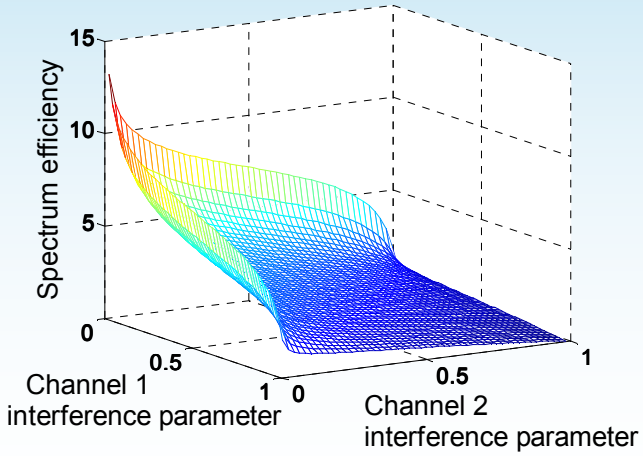
2.3 Research Results - 2









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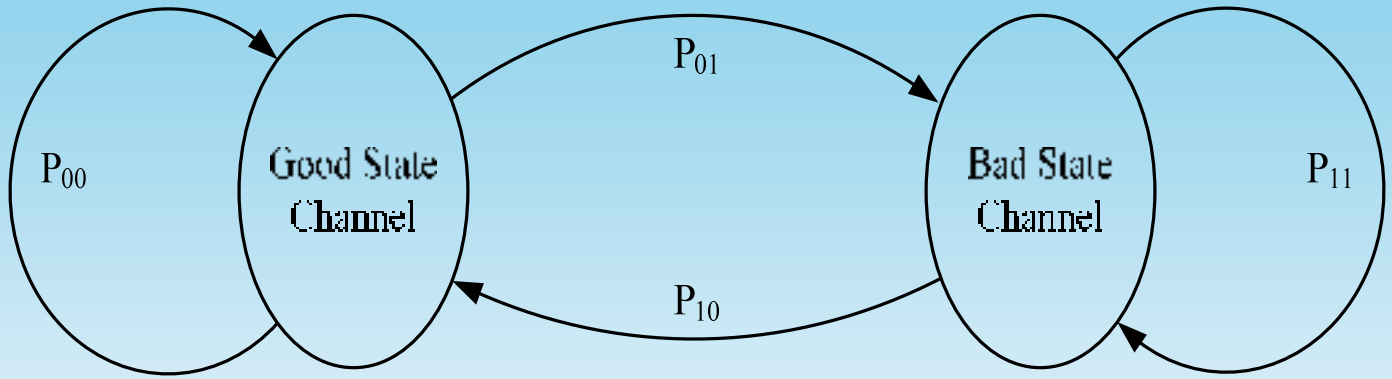
2.3 Research Results - 3



State transition diagram of two-state Markovian wireless channel

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2.3 Research Results - 4

$$C_{MISO\_two-cell} = P_{00}^{(n)} C_{\text{MISO\_cell\_1}} + P_{01}^{(n)} C_{\text{MISO\_cell\_1}} + P_{10}^{(n)} C_{\text{MISO\_cell\_2}} + P_{11}^{(n)} C_{\text{MISO\_cell\_2}}$$

$$= P_{00}^{(n)} \log_2\left(1 + \frac{E_1^{MISO} \times \left\| \mathbf{SG}_1^{good} \right\|_F^2}{\sigma_1^2 + E_2^{MISO} \times \left\| \mathbf{IG}_2^{good} \right\|_F^2}\right)$$

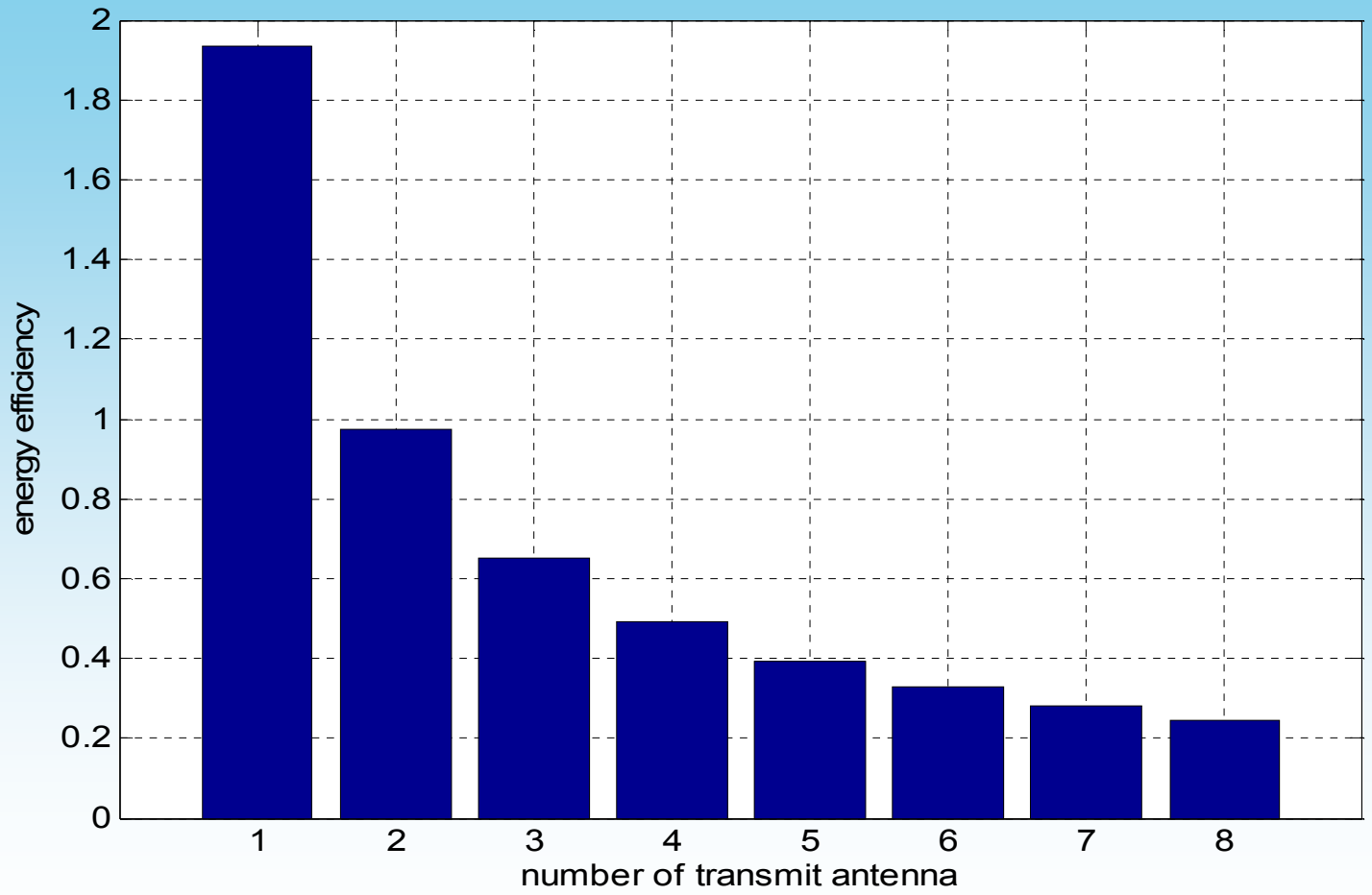
$$+ P_{01}^{(n)} \log_2\left(1 + \frac{E_1^{MISO} \times \left\| \mathbf{SG}_1^{bad} \right\|_F^2}{\sigma_1^2 + E_2^{MISO} \times \left\| \mathbf{IG}_2^{bad} \right\|_F^2}\right)$$

$$+ P_{10}^{(n)} \log_2\left(1 + \frac{E_2^{MISO} \times \left\| \mathbf{SG}_2^{good} \right\|_F^2}{\sigma_2^2 + E_1^{MISO} \times \left\| \mathbf{IG}_1^{good} \right\|_F^2}\right)$$

$$+ P_{11}^{(n)} \log_2\left(1 + \frac{E_2^{MISO} \times \left\| \mathbf{SG}_2^{bad} \right\|_F^2}{\sigma_2^2 + E_1^{MISO} \times \left\| \mathbf{IG}_1^{bad} \right\|_F^2}\right)$$

$$EE_{\text{MISO\_two-cell}} = \frac{C_{MISO\_two-cell}}{N_t(E_1 + E_2)}$$

2.3 Research Results - 5



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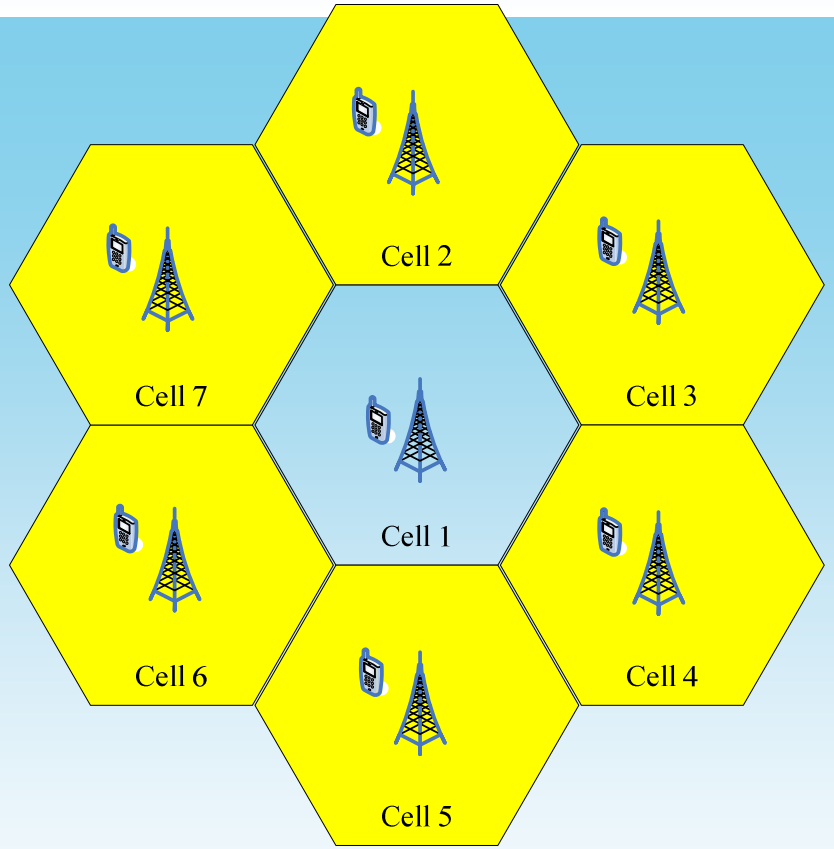
2.3 Research Results - 6



$$EE_{\text{multi-cell}} = \frac{\sum_{i=1}^{n}\left\{\log_2\left(1+\frac{E_i \times SG_i^{good}}{\sigma_i^2+\sum_{j=1,j\neq i}^{n} E_j \times IG_{ij}^{good}}\right)P_{00}^{(n)} + \log_2\left(1+\frac{E_i \times SG_i^{bad}}{\sigma_i^2+\sum_{j=1,j\neq i}^{n} E_j \times IG_{ij}^{bad}}\right)P_{01}^{(n)}\right\}}{\sum_{i=1}^{n} E_i}$$

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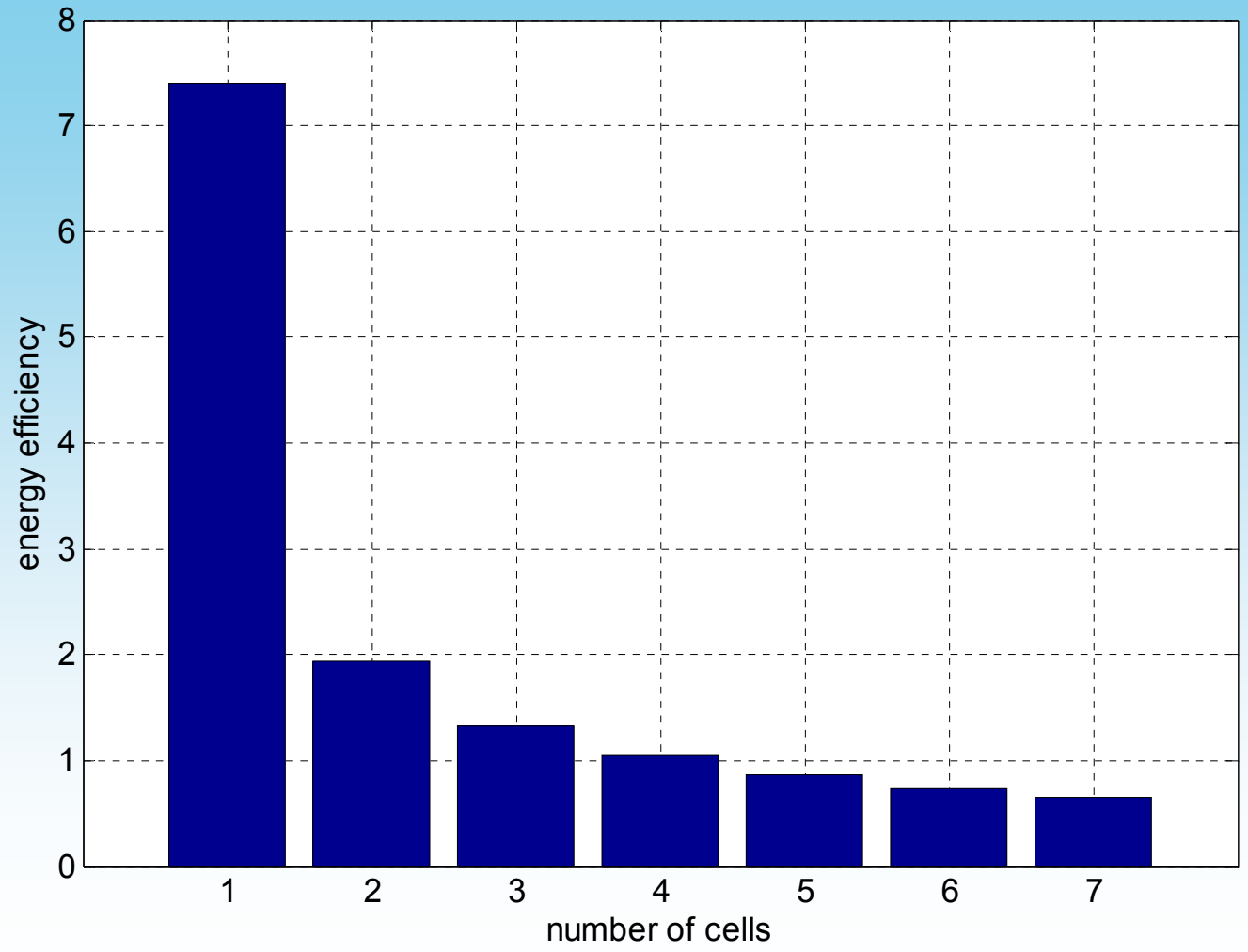
2.3 Research Results - 7



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2.3 Research Results - 8

[1] Xiaohu Ge, Chengqian Cao, Minho Jo, Min Chen, Jinzhong Hu and Iztok Humar, "Energy Efficiency Modelling and Analyzing Based on Multi-cell and Multi-antenna Cellular Networks ," *KSII Transactions on Internet and Information Systems*， vol. 4, no. 4, pp. 560-574 ;

Future research plan

- Based on this result, we plan to explore the impact of detailed wireless channel parameters on the energy efficiency of multi-cell cellular networks with co-channel interference;
- We are looking for potential exchanging researchers from UK and China, and carry out the possible joint research in the future.

Researcher Exchange

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Thank You !






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