北京郵電大學
BEIJING UNIVERSITY OF POSTS AND TELECOMMUNICATIONS

RESEARCH COUNCILS UK

UK-China Science Bridges

R&D on 4G Wireless Mobile Communications

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Beijing China

Outline

- Introduction of BUPT
- Introduction of Research Group
- Cooperative Frequency Reuse Scheme
- Suggested Research Topics
-

Beijing University of Posts and Telecommunications

- **BUPT is a research-oriented university with information and communication as its main features.**
- **BUPT enjoys a nationwide reputation for innovation and excellence in advanced research and learning in information and communication technology. It serves as one of the most important teaching and research bases for information technology and telecommunication industry in China.**
- **BUPT has fourteen schools, namely the School of information and communication Engineering, School of Computer Science and Technology, School of Automation, School of Economics and Management, School of Electronic Engineering**

Beijing University of Posts and Telecommunications

- There are over 230 professors and 426 associate professors out of the total of 1066 faculty members
- Currently, BUPT has over 16,200 full-time students and 12,000 long-distance and E-learning students, among full-time students there are 10,800 undergraduate students, 4650 master students and 805 doctoral students.
- BUPT's graduates boast the top employment rate among Chinese universities, about 98%, and most of them are employed by famous IT companies at home and abroad.

Key Laboratory of Universal Wireless Communications, Ministry of Education

Research team

64 research staffs:

2 academicians of CAE
15 professors
29 associate professors

Research Centers:

Mobile communication research center
Wireless ubiquitous networks architecture center
Short range wireless communication center

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Introduction of Research Group

Team members

- **Prof. Ping Zhang**
- **Prof. Xiaofeng Tao**
- **Prof. Hui Tian**
- **Prof. Baoling Liu**
- **Prof. Peizhi Liu**
- **8 Associate Professors**
- **8 Lecturers**
- **More than 50 master students and 20 doctoral students**

Research Directions

✓Mobile communication key techniques for TD-SCDMA/3GPP LTE-Advanced /IMT-Advanced systems
✓Wireless networking theory
✓Cognitive wireless networks
✓Wireless ubiquitous network architecture
✓Wireless sensor networks

Key Concepts and Technologies

- **All-IP Based Flat Architecture——Hi-Station**
  - Network Convergence, Flat architecture, Shorten Latency
- **Generalized Cellular Network——Group Cell and Slide Handover**
  - Breakthrough traditional cellular architecture
  - User always in cell center
- **Convergent Network Service——Mobile Ubiquitous Service Environment**
  - Providing Mobile Ubiquitous Services Supporting
- **Efficient Frequency Reuse Scheme——Soft Fractional Frequency Reuse**
  - Apply Extension/Fuzzy Set theory, Efficient Frequency Plan
- **Cell-edge user performance improving——Fast Cell Selection Scheme**
  - Proposal accepted by 3GPP LTE: *3GPP R1-050788*

Projects in Our Laboratory

Subjects	Classification
Theory and constructing method of generalized cellular communication networks	NSFC
Uplink design and implementation of TDD OFDM system and integration of TDD technology	863 project
Research of key technologies and implementation of Gbps wireless transmission system	863 project
Research of B3G Mobile Communications based on generalized distributed multi-antenna systems	New century excellent talent projects in Ministry of Education
Research of mobile management, control and routing for 4G and beyond communication system	International cooperation project

Achievements and Honors

- NSFC projects (key-size projects) 31 items (2 items)
- 973/863 projects (key-size projects) 1/16 items (2 items)
- Enterprise projects 67 items
- Paper (SCI/EI) 638 pieces
- Patents (authorized/applied) 29/164 items
- Honors 5 items
- Publications 33 books
- 35 proposals submitted to international standardization organizations, 10 proposals accepted by 3GPP, 3GPP2 and ITU.

4G-TDD Demo System

Multi-channel Services

- Multi-channel VOD
- Wireless FTP download
- Internet access
- VoIP

AP

Wireless environment

Link Performance:

- Uplink 4T X 8R，peak data rate 100Mbps
- Downlink 4T X 4R ， peak data rate 100Mbps
- BLER is less than 0.5%，BER is less than 1.0e-6

AMCS(4G) IPv4/6 based Services

VOD and FTP on Mobile

Exploring Internet on Mobile

Wireless Video phone on Open day

Wireless HDTV Transmission

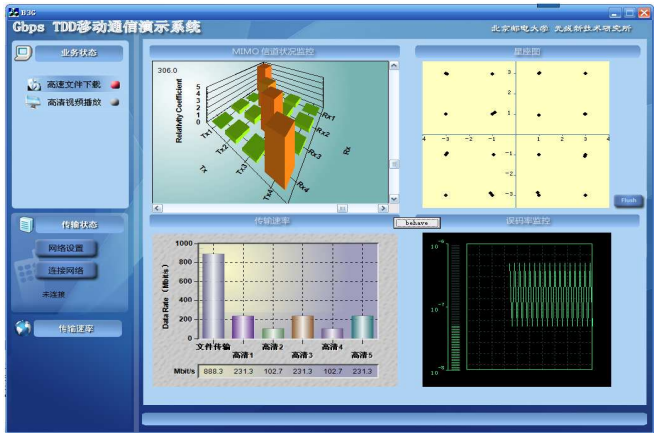
With almost wired quality and save power

Gbps Wireless Communication Demo Platform

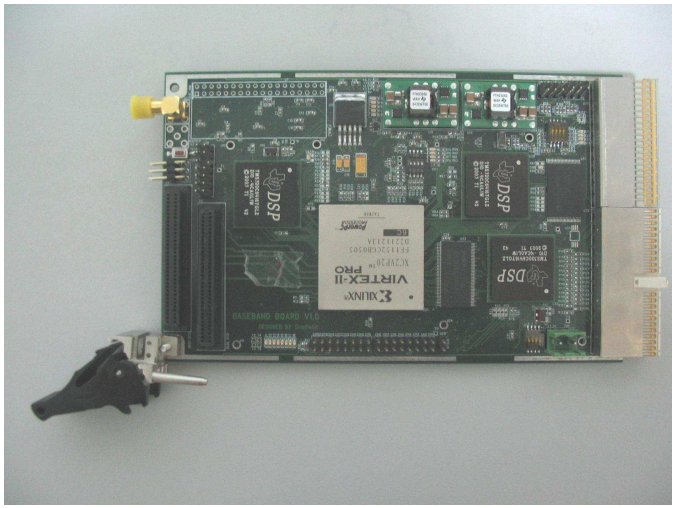
AP

MT

– **4T X 6R，peak data rate 1Gbps**



Industrialization



– The first commercial TD-SCDMA terminal test bed, bring in more than 60 million RMB

– In April, 2006, the first 4G CALL in China

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Background

✓ In order to improve the coverage of high data rates, the cell-edge throughput and/or to increase system throughput. Coordinated multi-point (CoMP) transmission/reception is considered as a key technology for LTE-Advanced.

✓ By aggregating the joint scheduling/processing of multiple eNodeBs, CoMP technology can handle inter-cell interference coordination (ICIC) and increase the throughputs on the cell-edge.

✓ Efficient frequency reuse scheme need to be designed to support joint resource management in L3.

Background

- **Classical Fractional Frequency Reuse/Soft frequency reuse**

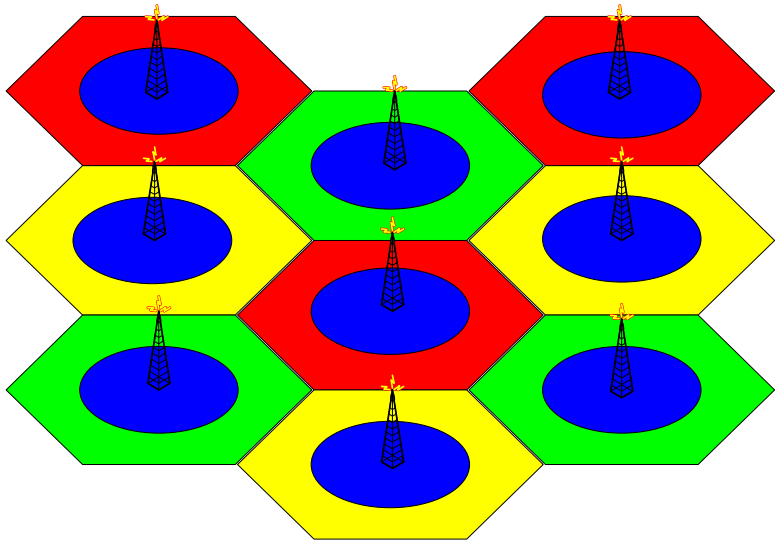


Fig.1 FFR/SFR cell deployment

- **Sub-carriers are divided into two groups**

major sub-carriers group: for cell_center users
minor sub-carriers group: for cell_edge users

- **Major subcarriers in neighboring cell are orthogonal**

can depress the inter-cell interference, however, can't support for CoMP joint transmission.

In this contribution, we propose a novel frequency reuse scheme for CoMP, called Cooperative Frequency Reuse (CFR).

System Model

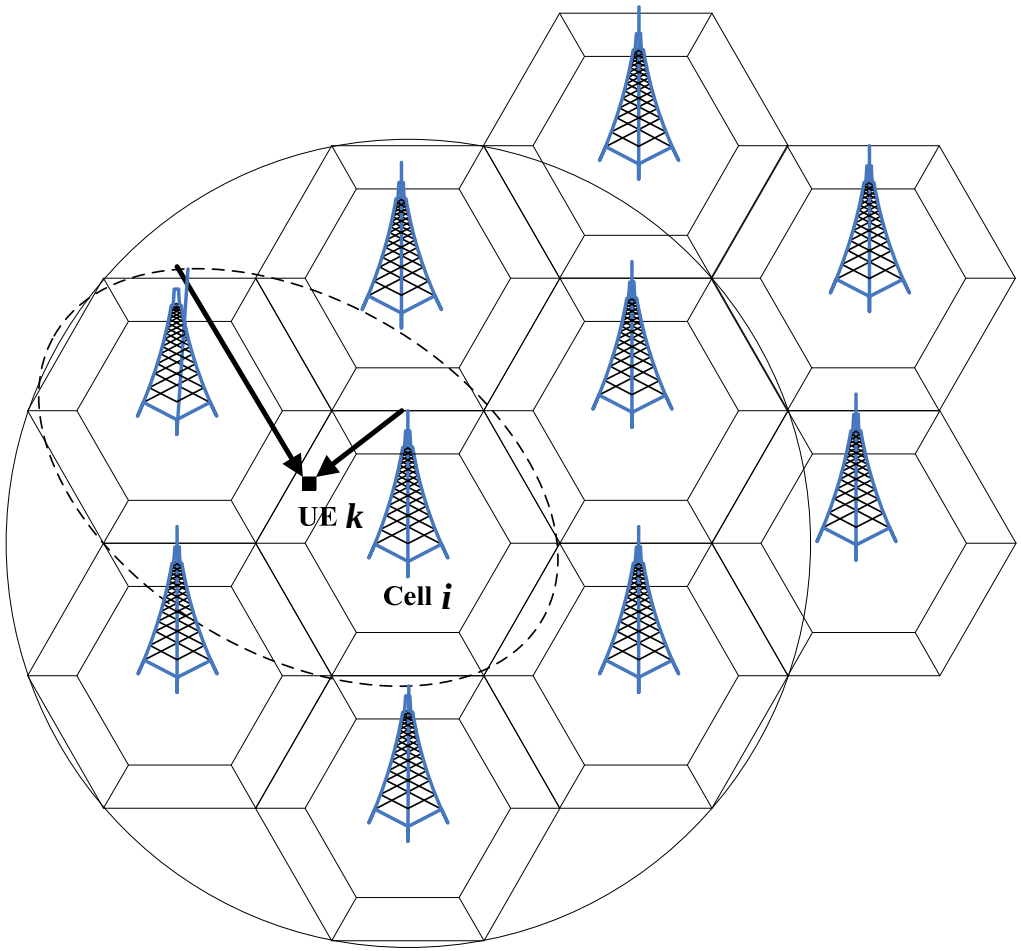


Fig.2 CoMP system model

UE categories:

- **Center_UE**
- **Edge_UE**
  - **CoMP_UE**
  - **no_CoMP_UE**

For CoMP_UE k:

- CoMP Cooperating Set (CCS)Φ : Severing cell and 6 neighboring cells
- CoMP Transmission Points(CTP) Ψ : Select form CCS according to the pilot signal Strength.

Cooperative Frequency Reuse Scheme

Pick up 3 neighboring cells as a cell cluster, then mark them using number {1,2,3}

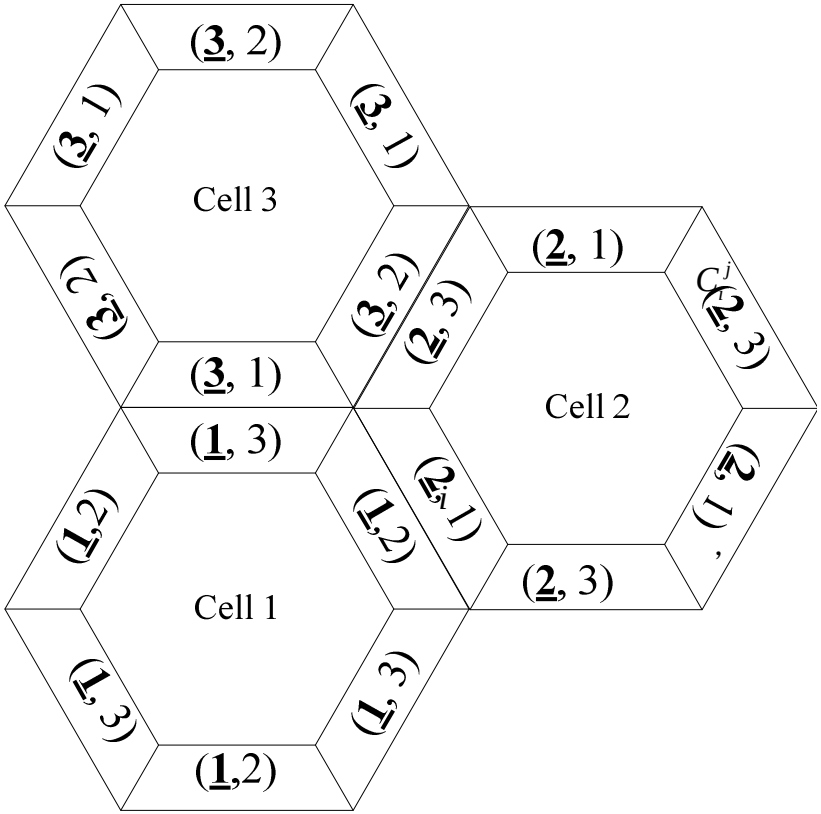


Fig.3 exterior zones division

- **Sub-carriers are divided into two groups**

  center sub-carriers group F_{center}

  edge sub-carriers group F_{edge}

- **Exterior cells' areas are divided into 6 zones**

  (i, j) Denotes the exterior zone in cell , in which the biggest interference comes from cell j

Cooperative Frequency Reuse Scheme

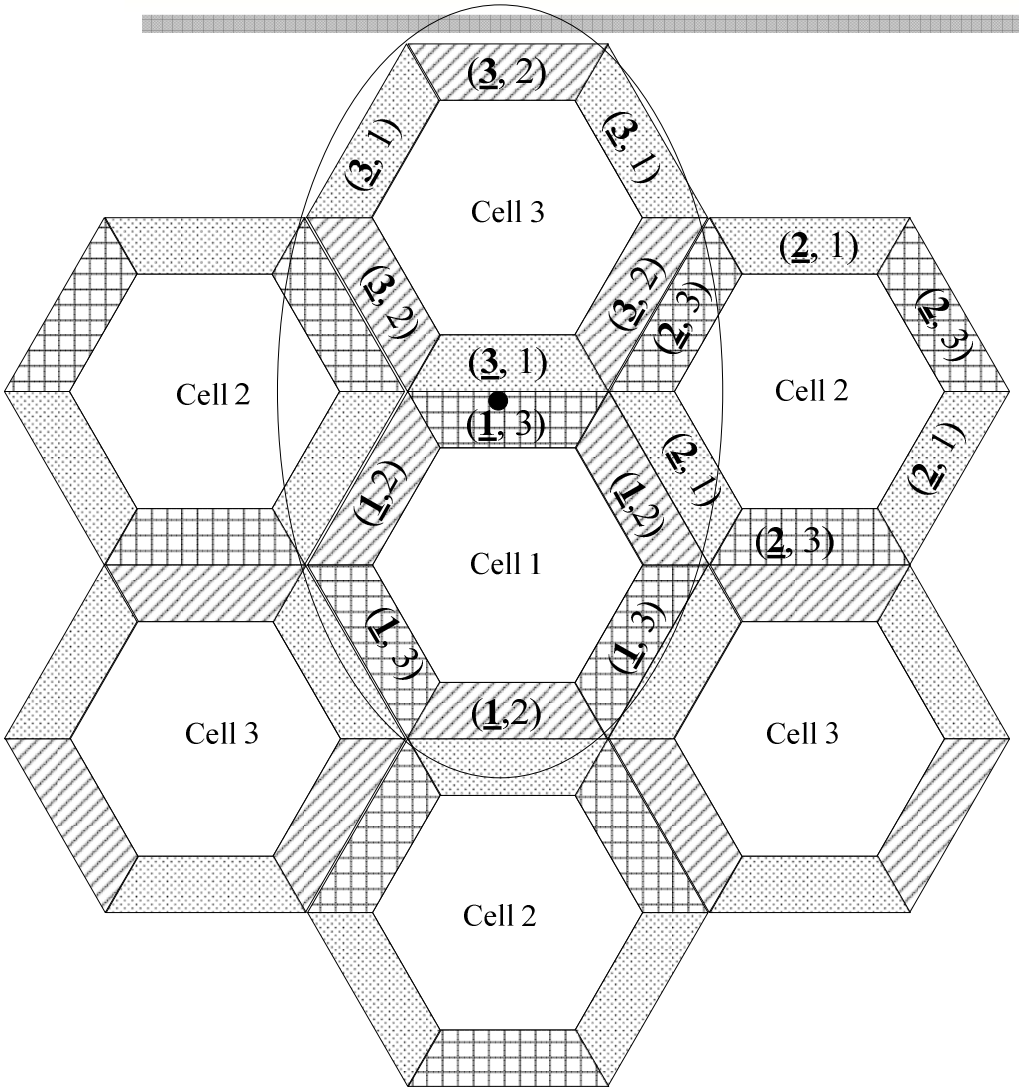


Fig.4 CFR frequency deployment

$$F_{edge} = \{ f_1, f_2, f_3 \}$$

① $f_i \cap f_j = \varnothing \quad (i \neq j)$

② $C_i^j = f_j \quad (i \neq j)$

③ $CF_i = f_i$

④ $\bigcup_{j=1}^{n} C_i^j \cup CF_i = F_{edge} (i \neq j)$

Cooperative Frequency Reuse Scheme

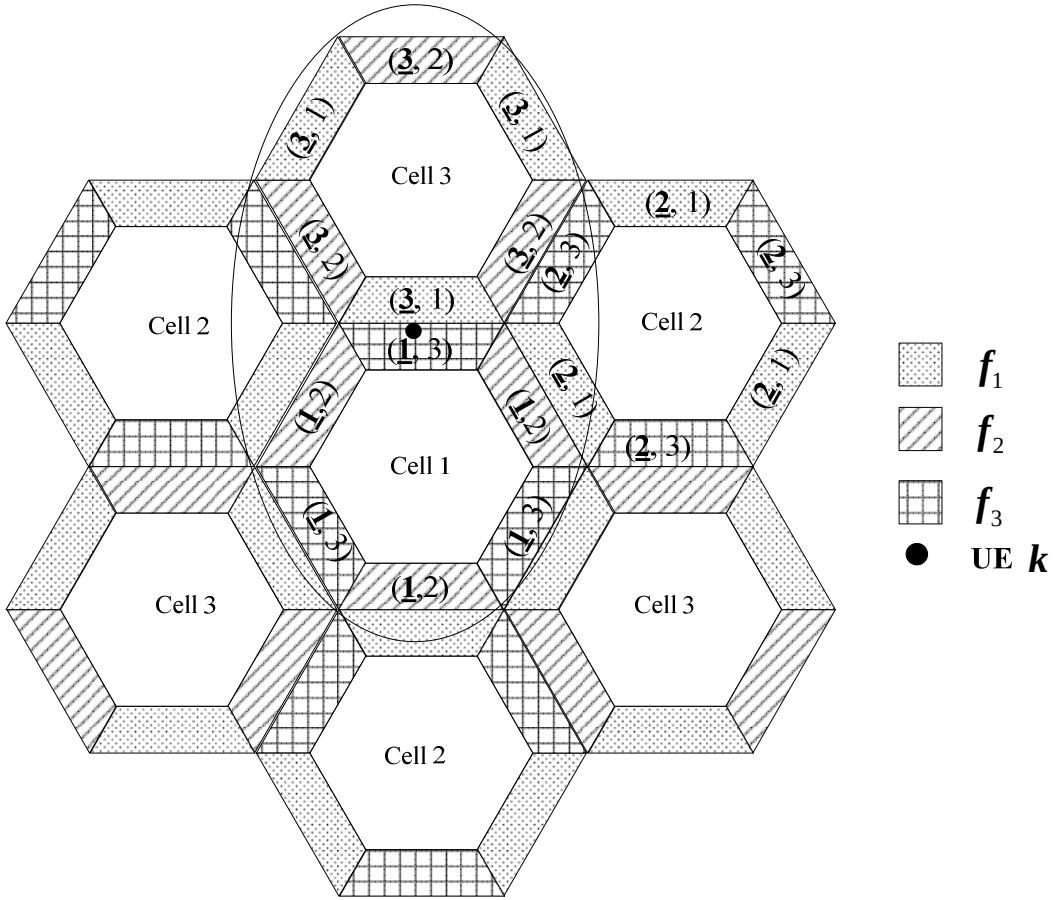


Fig.4 CFR frequency deployment

✓Reserve a cooperative frequency segment for each cell,

✓ Form an orthogonal frequency allocation among adjacent cells for exterior zones.

✓ Make the cooperative frequency segment for each cell the same with the adjacent exterior zones

Simulation Results and Discussion

Simulation results:

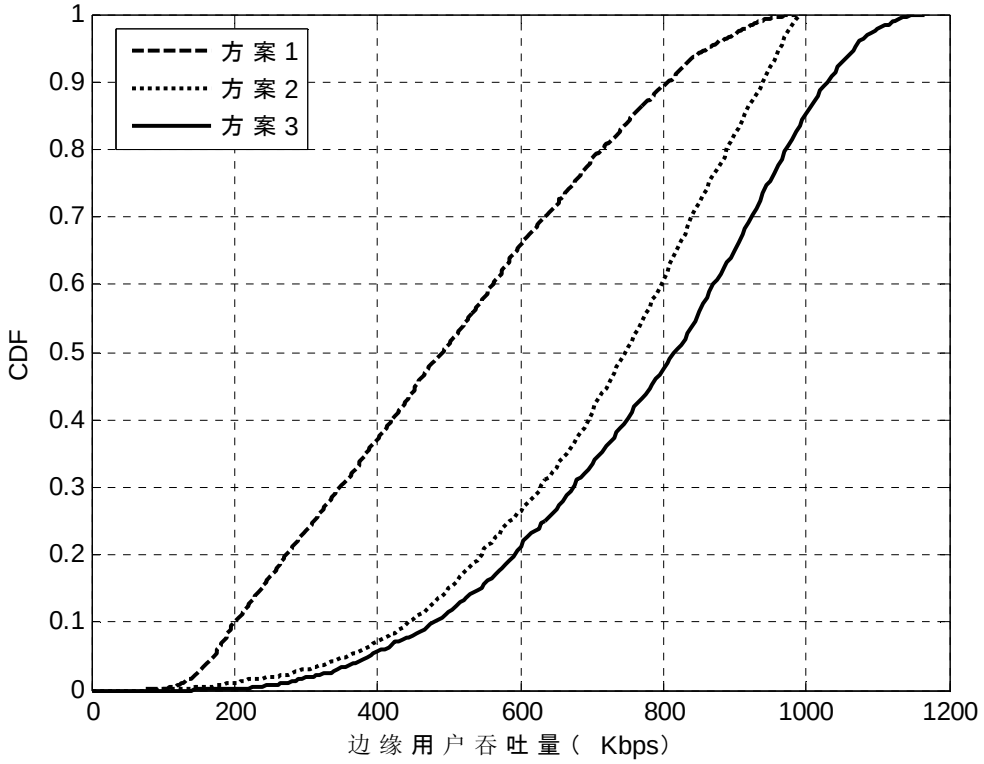


Fig. 5 CDF of cell-edge users' throughputs

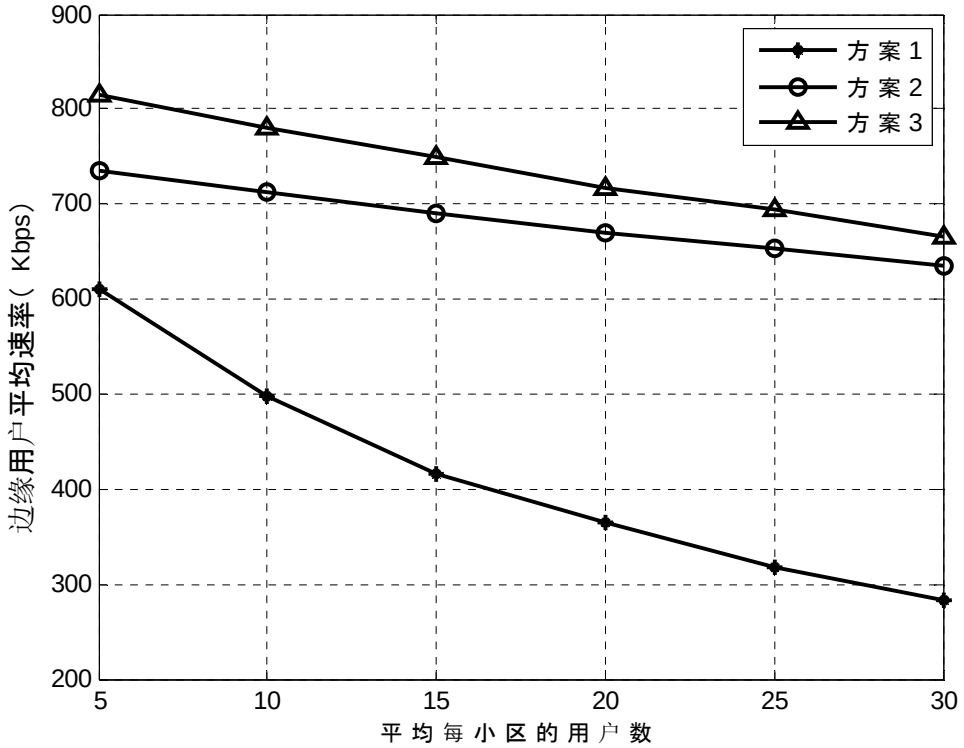
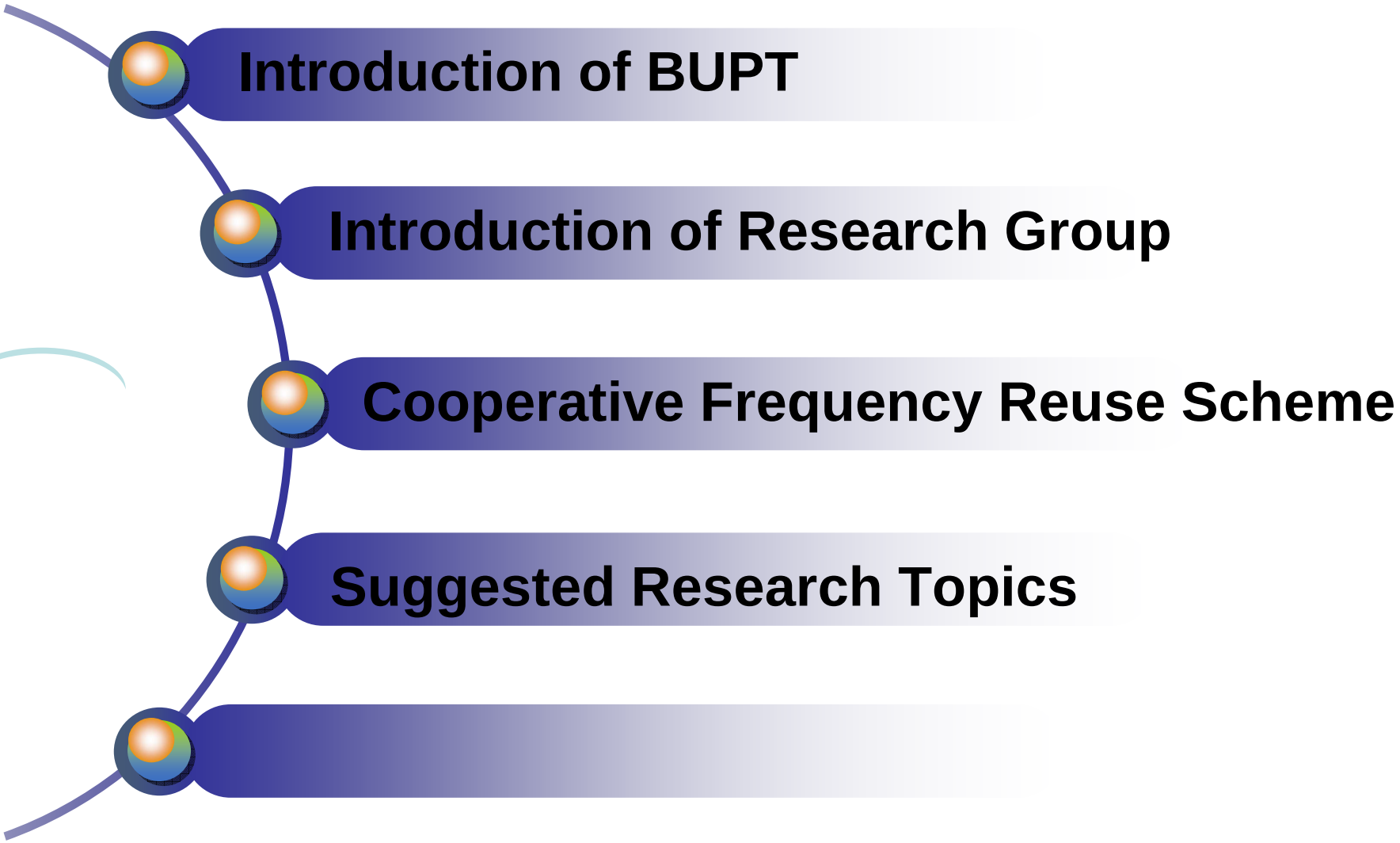


Fig. 6 cell-edge user average throughput

Outline


Introduction of BUPT
Introduction of Research Group
Cooperative Frequency Reuse Scheme
Suggested Research Topics

Suggested Research Topics

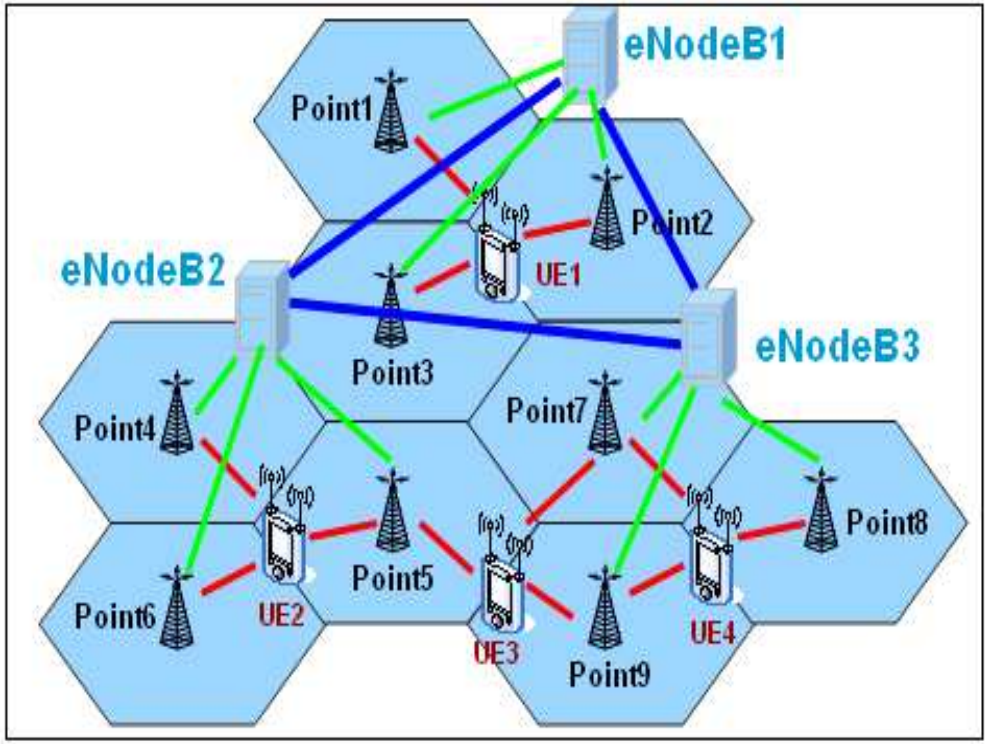
Research on Capacity analysis of future wireless network based on novel network architecture

1、Capacity analysis of Coordinated Multi-Point (CoMP) transmission network

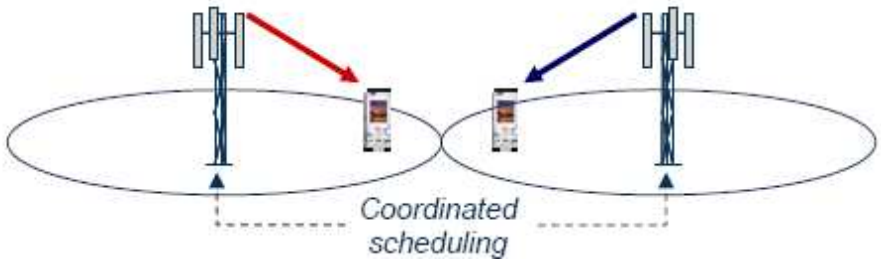
2、Capacity analysis of wireless Relay networks

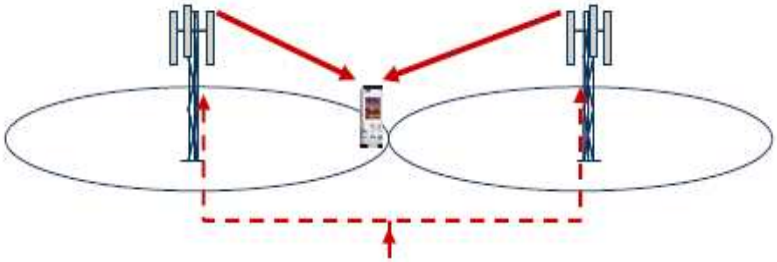
3、Capacity analysis of wireless networks for Special network environments ,for example ,emergency conditions, damaged networks

Capacity Analysis of CoMP Transmisson Network



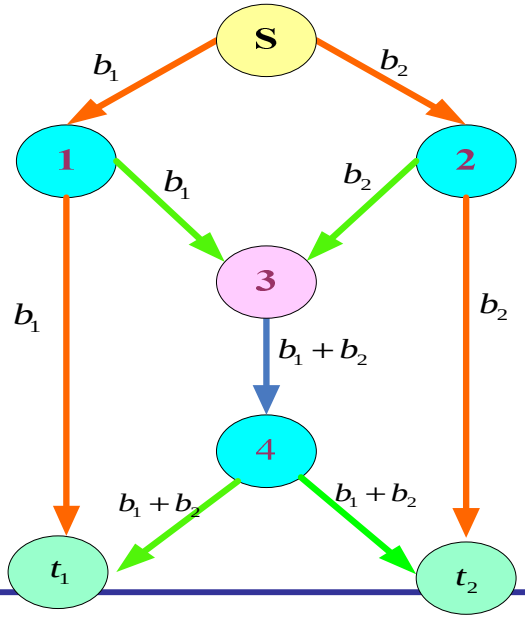
- **Capacity analysis of different CoMP scenarios**
  - **-UL Joint Procession/Coordinated scheduling CoMP**
  - **-DL CoMP SU-MIMO,MU-MIMO**
- **Consider multiple access techniques, time-frequency resource scheduling, and MIMO techniques under capacity analysis**

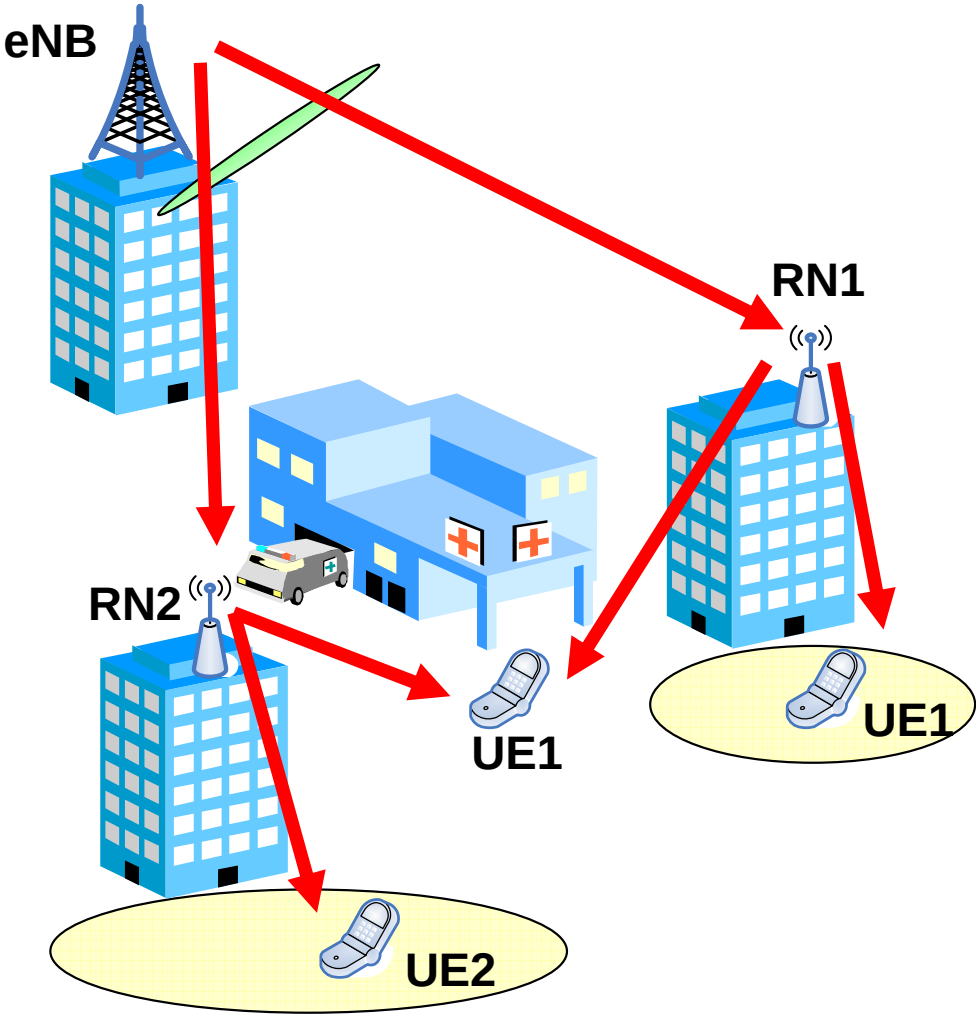




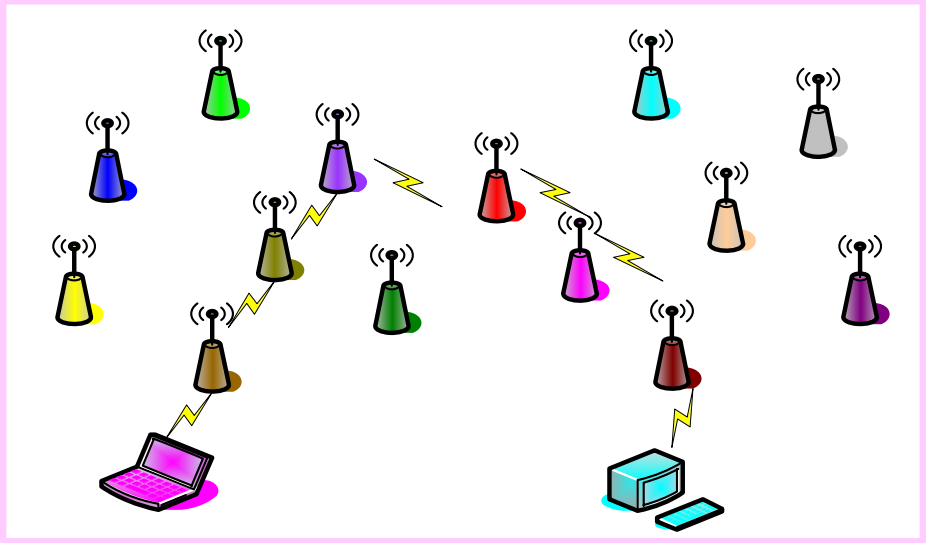
Capacity Analysis of Wireless Relay Networks

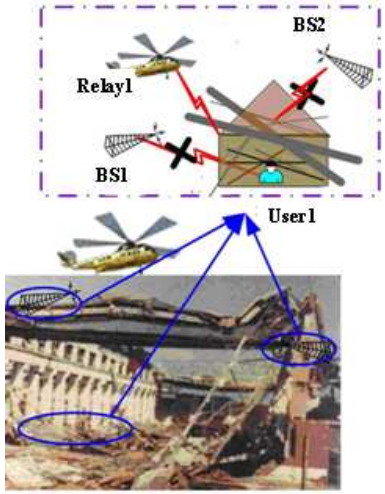
- Single resource –multiple relay - single destination
- Single resource –multiple relay- multiple destinations
- Network with cooperative untrusted relay stations

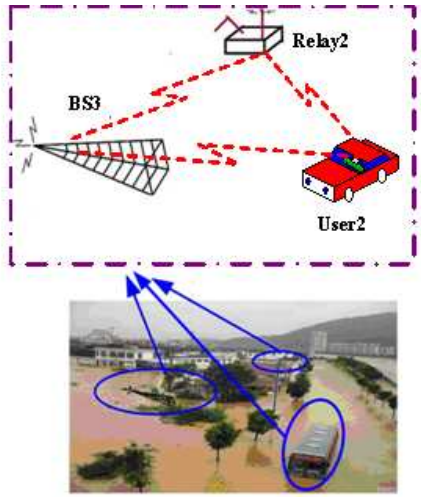




Capacity Analysis for Special Network Environments







How to compute the capacity in this situation?

In some environment, there is no fixed BS or the BS is damaged.

v=350km/h, traditional cellular network s not suitable, the cost is very high

Q and A!

We are Thinking ,
and Innovating

Thank you!