



FUTURE B3G/4G TDD MIMO OFDM System

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Outline

Vision of B3G/4G Wireless Communication System

Key Techniques and Testing of B3G-TDD System

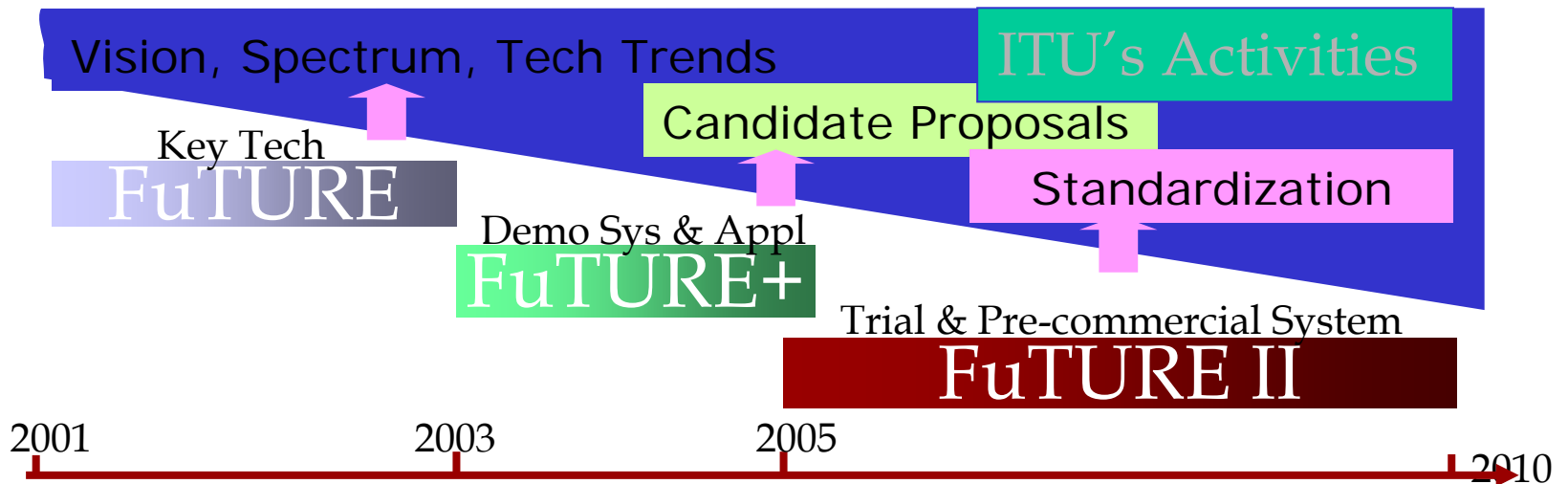
System and Demonstration

Conclusion



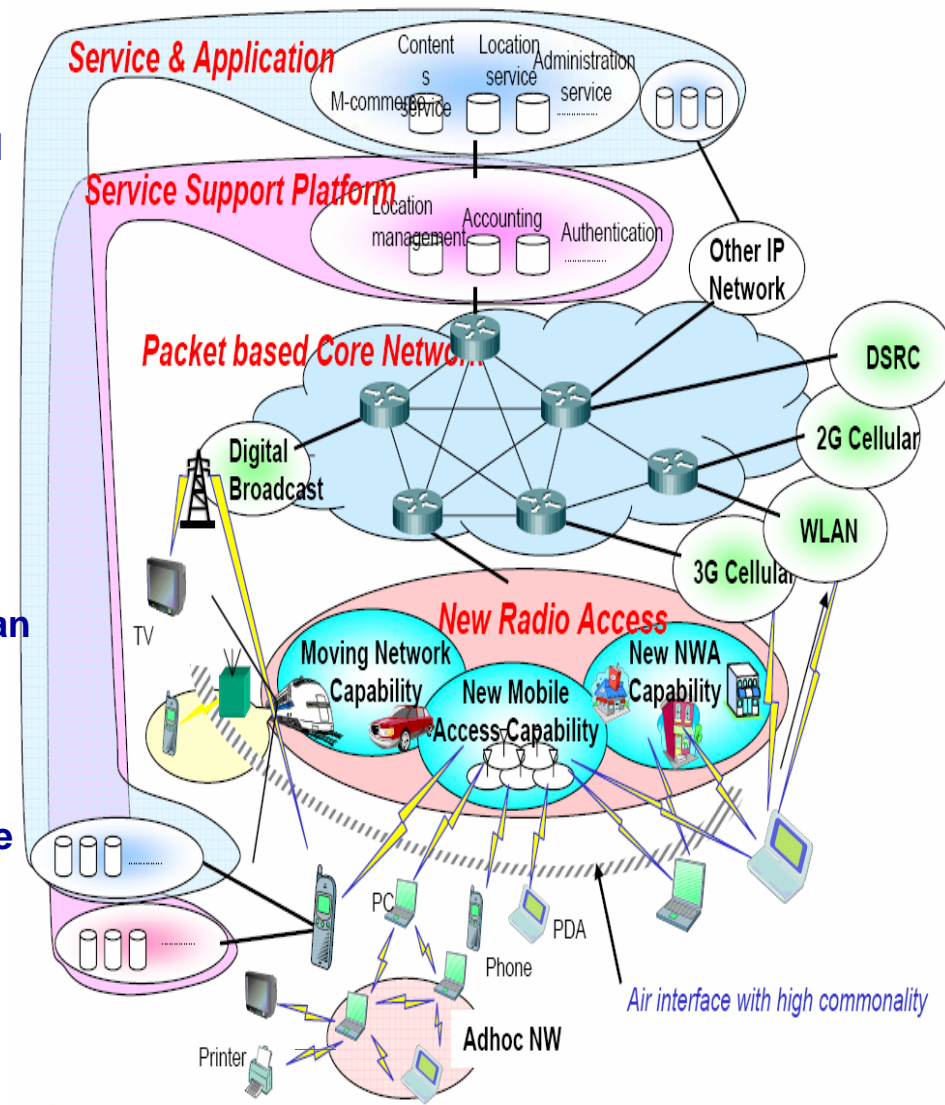
Background: AMCS & FuTURE Project

- **FuTURE – Future Technologies for Universal Radio Environment as a part of China High-Tech 863 program.**
- **Phase 1: Six universities cooperating with six companies developed six transmission schemes for AMCS(4G) mobile.**
- **Phase 2: Jointly develop AMCS(4G) experimental systems and networks supporting both FDD and TDD.**
- **Phase 3: Trial & Pre-commercial System will be developed.**



Vision of B3G Wireless Communication System

- **Higher Data Rate (100M~1Gbps)**
 - 3GPP TR 25.913 "Requirements for Evolved UTRA and Evolved UTRAN"
- **Higher Mobile Mobility (250km/h)**
 - ITU-R M.1645: "Framework and overall objectives of the future development of IMT-2000 and systems beyond IMT-2000"
- **All-IP Architecture, Function Split of Control Plane and User Plane**
 - ITU-T SG13 FGNGN
 - 3GPP TS 22.258 "Service requirements for an All-IP Network"
- **Ubiquitous Services, Convergence of different Network Architecture**
 - 3GPP TR 23.882 "3GPP system architecture evolution (SAE)"
- **Versatile Multimedia Packet Service**
 - WWRF (MUSE)



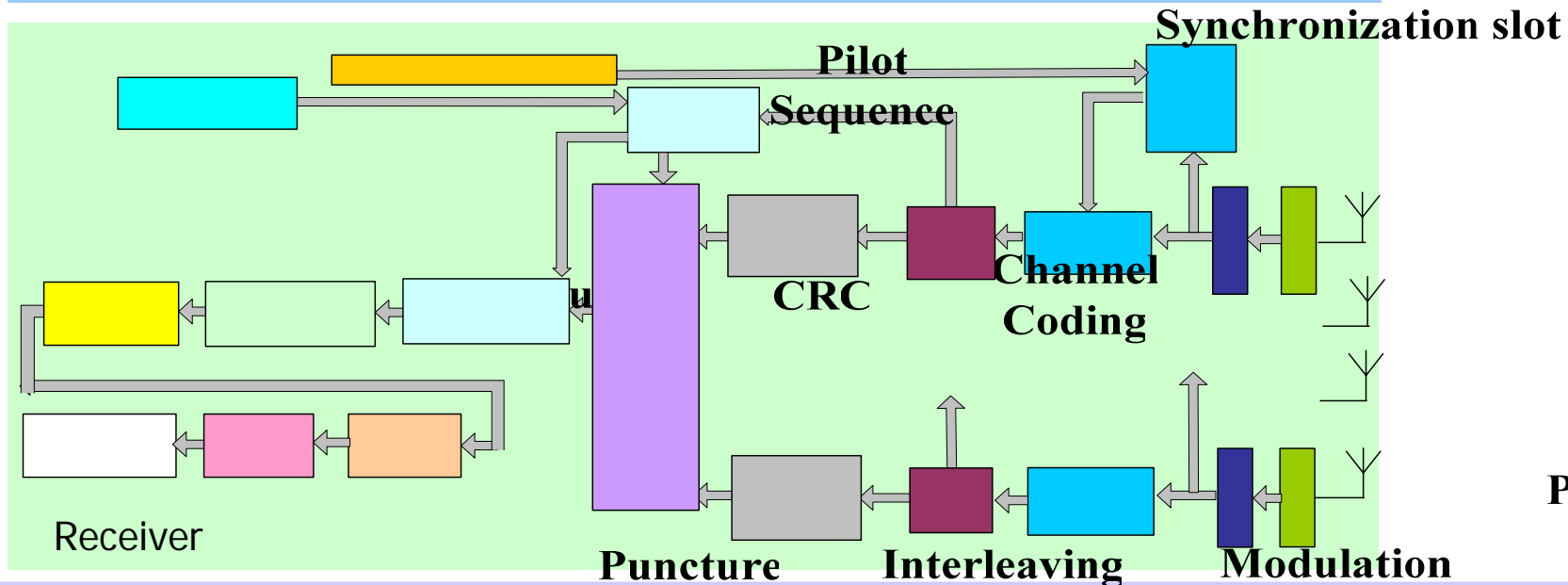
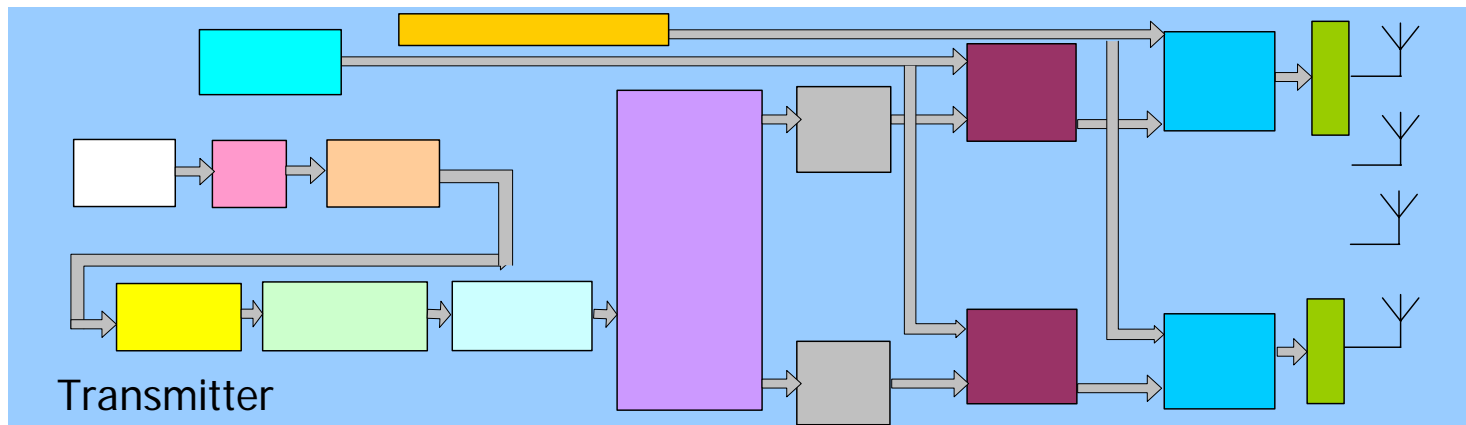


B3G-TDD System Characteristic

- ❑ Frame structure design——consider compatibility to TD-SCDMA
- ❑ Propose new architecture of cell network——group cell and group handover
- ❑ Propose soft fractional frequency reuse (SFFR)scheme to resist multi-cell interference effectively
- ❑ Bring forward fast cell group selection (FCGS) scheme to overcome performance degradation of users in cell edge
- ❑ Share asymmetrical spectrum for uplink and downlink, flexible resources allocation
- ❑ Block-building MIMO architecture
- ❑ Support multimedia, FTP, Internet and voice service simultaneously
- ❑ Adopt broadband OFDM MIMO techniques, peak data transmission rate up to 100Mbps
- ❑ Spectral efficiency is able to reach 5.9bit/s/Hz

B3G-TDD System Link Configuration

Link design of TDD system combined with advanced MIMO, OFDM techniques



Breakthrough of B3G Theory

—B3G TDD Network Architecture

□ Flat Radio Access Network

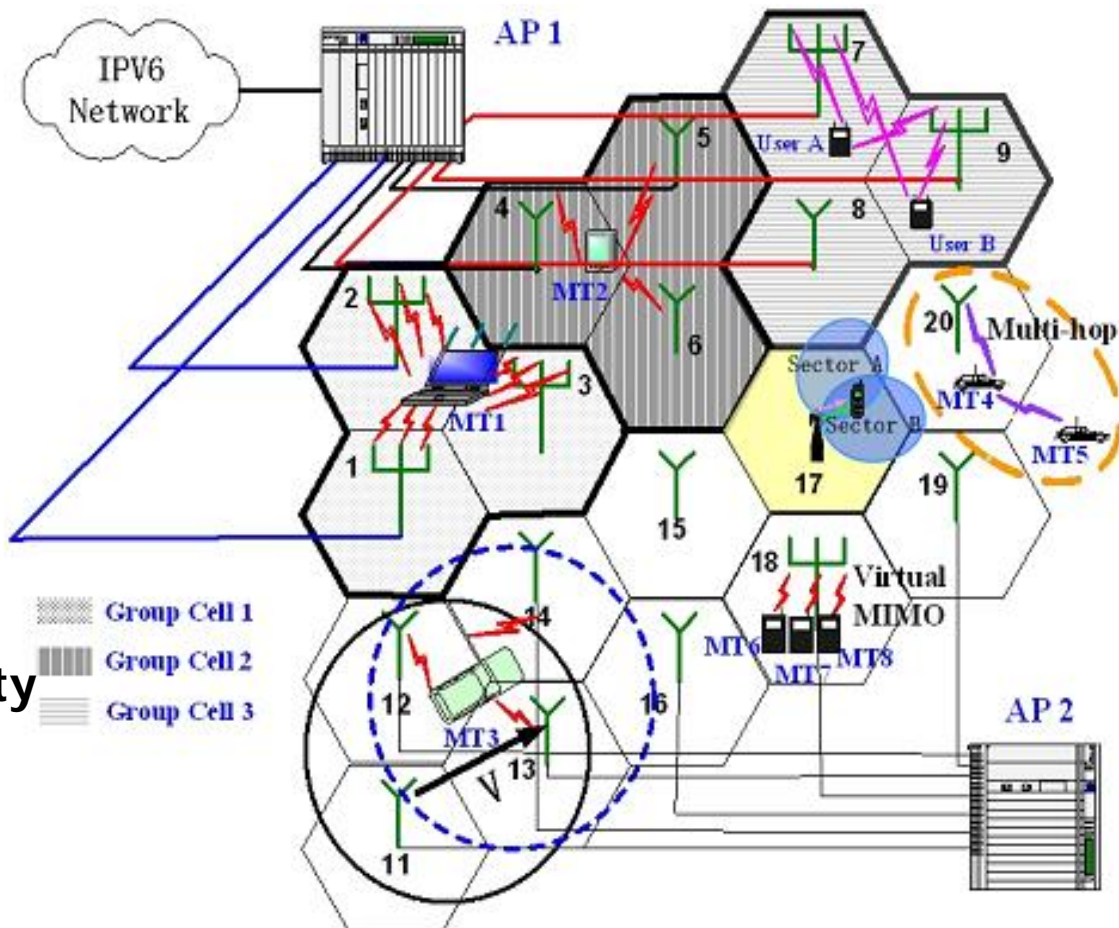
- All-IP based architecture
- Short latency

□ Novel Cellular Architecture

- Group Cell
- Slide Handover
- User always in cell center
- Solve “smaller cell” problem
- Avoid “cell edge” effect
- Avoid frequent handover
- Enlarge coverage area

□ Fully Explore Space Diversity

- Distributed Antenna Array
- Virtual MIMO
- Multi-hop, Relay



Breakthrough of B3G Theory

— Efficient Frequency Reuse Scheme

Soft Fractional Frequency Reuse

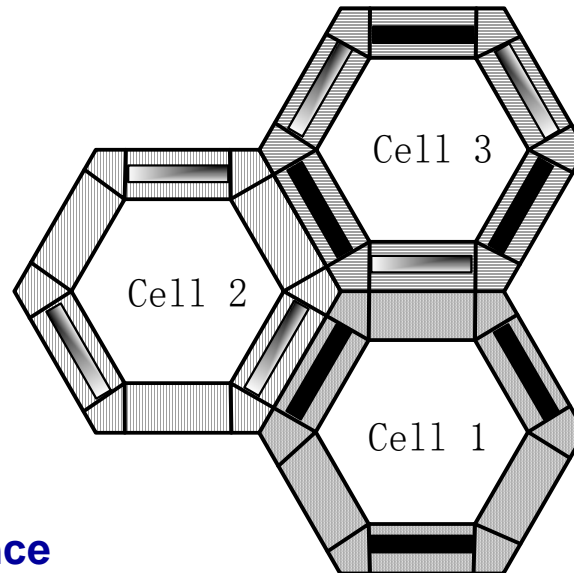
$$R_1 = [f_1, \text{related field}, (C_1, C_2, \dots, C_9)],$$

$$R_2 = [f_2, \text{related field}, (C_1, C_2, \dots, C_9)],$$

...

$$R_9 = [f_9, \text{related field}, (C_1, C_2, \dots, C_9)].$$

- Improve spectrum efficiency
- Mitigate inter-cell interference
- Improve cell-edge user performance
- Frequency plan for entire network



- denotes u_1
- denotes u_2
- denotes u_3
- denotes u_4
- denotes u_5

Extension/Fuzzy Set Theory

SFFR Proposals

Breakthrough of B3G Theory

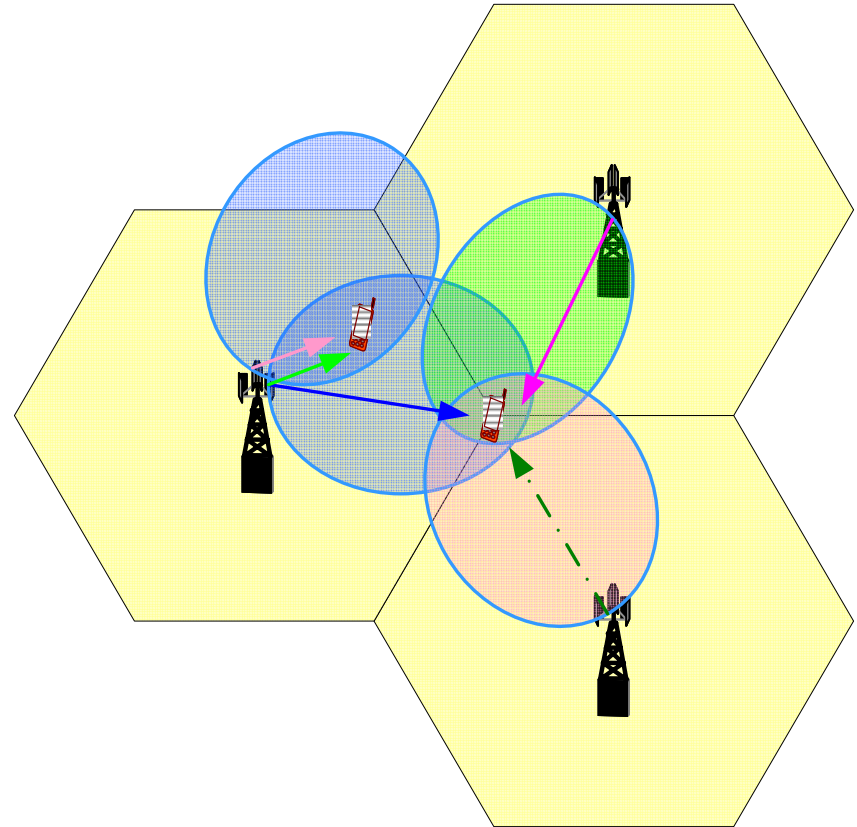
— Cell-edge User Performance Improving

Fast Cell Group Selection:

- ✓ The cell edge user is served by a group of cells and the frequency of cell group selection and updating could be performed per updating period (e.g. TTI)

Features:

- ✓ The MS is served by one or more cells (Intra-BS or Inter-BS)
- ✓ STBC or other advanced signal processing is deployed before transmission
- ✓ Serving cell group are selected and updated per updating period



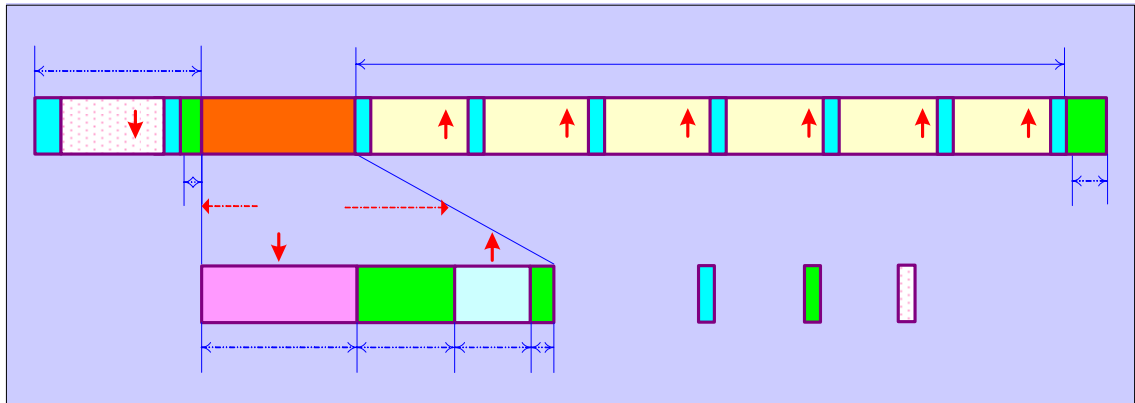
Patent Number: CN1710992A

Proposal accepted by 3GPP LTE: R1-050788



B3G-TDD Key Tech I : Frame Structure Design

Uplink frame structure

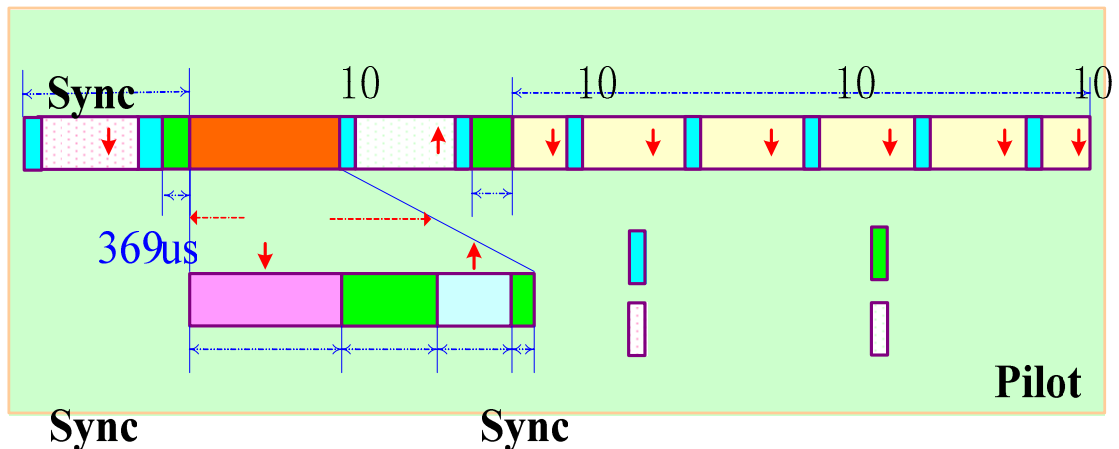


Downlink signaling

- Compatible to TD-SCDMA system
- Convenient for resources allocation between uplink and downlink
- Combined with OFDM technique
- Support 15km coverage
- Peak data transmission rate up to 100Mbps

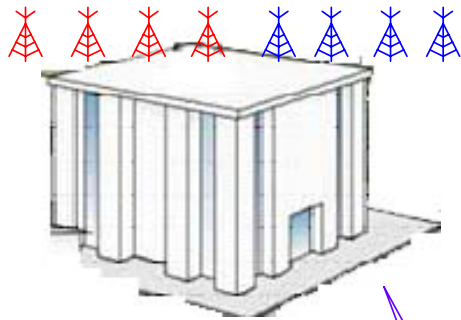
Downlink frame structure

4154 us(67 OFDM Syn

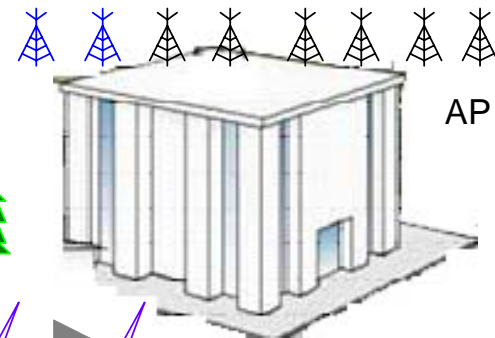


B3G-TDD Key Tech II: Flexible MIMO Schemes

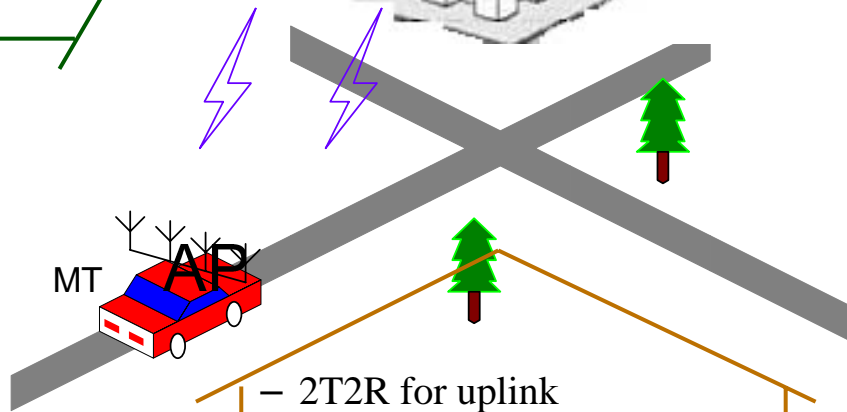
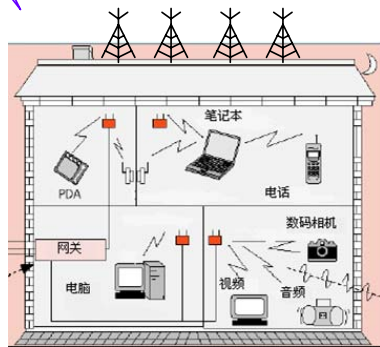
Flexible MIMO schemes are suitable for high data rate transmission in various environments



- 4T8R for uplink
- 2T4R for downlink
- Low complexity
- High data transmission rate outdoors



- 4T8R for uplink
- 4T4R for downlink
- Low complexity
- High data transmission rate indoors



- 2T2R for uplink
- 2T2R for downlink
- High data transmission rate indoors and outdoors
- Low complexity
- Fit recent research hotspots (LTE, 802.11n, Siemens...)

Applying for 2 patents

- ✓ An unbalance antenna protection method for receivers in MIMO systems
- ✓ An enhanced receiver in MIMO systems



B3G TDD System Design—— Baseband Parameters

Baseband Parameter	Values
Duplex Mode	TDD
Carrier Frequency (F_c)	3.45 GHz
System Bandwidth (B)	20 MHz
Number of Sub-carrier	1024
Number of Effective Sub-carrier	884
Effective Bandwidth	17.2656 MHz
Sub-carrier Space (ΔF)	19.5 KHz
Cyclic Prefix (CP)	216 (10.8 us)
Symbol Duration (T_s)	$51.2+10.8=62.0$ us
Modulation Scheme	16QAM
Turbo Code Rate (R)	0.5
MIMO Architecture	8 (BS) \times 4 (MT)



Scene for Indoor Demonstration

Support following services simultaneously

- Multiple VODs → media streams of high quality
- Wireless FTP download → high data rate transmission
- Internet, QQ → reliable internet access
- VoIP service → clear voice without time delay



Performance of system

- 4T8R for uplink, peak data transmission rate reaches 100Mbps
- 2T4R for downlink, peak data transmission rate reaches 50Mbps
- Block error rate is lower than 0.5%, bit error rate is lower than $1.0e-6$



Scene for Outdoor Demonstration

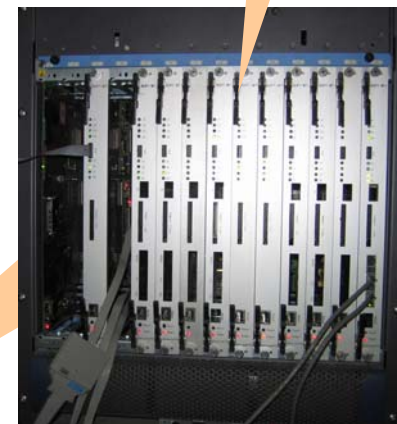


- Universal hardware platform
- Plug and play
- Modularization for system architecture
- Flexible system scale
- Full-scale distributed parallel process
- Completed SDR

flexible single board structure



Cooperative and distributed antenna architecture
Flexible MIMO schemes
Single frequency networking



powerful shelf with 14 slots



Scene for Outdoor Demonstration





BUTP Wireless Environment for B3GTDD System



RoF, Group Cell/Slide Handover, P-MIMO, FCGS, Distributed Antenna Array...



Main progress——SFPR implementation scheme

- ✓ Occupy half of the frequency resources in a Cell 1
- ✓ 50Mbps for each user
- ✓ BLER2=0.005357

- ✓ Occupy all the frequency resources in a Cell 1
- ✓ 100Mbps for single user
- ✓ BLER1=0.002321

- ✓ Occupy half of the frequency resources in a Cell 1
- ✓ 50Mbps for each user
- ✓ BLER2=0.001428

- ✓ Occupy half of the frequency resources in a Cell 1
- ✓ 50Mbps for each user
- ✓ BLER1=0.002142

- ✓ Occupy half of the frequency resources in a Cell 1
- ✓ 50Mbps for each user
- ✓ BLER2=0.000714

- ✓ Occupy all the frequency resources in a Cell 1
- ✓ 100Mbps for single user
- ✓ BLER1=0.001256



- ✓ Occupy all the frequency in Cell 2
- ✓ 100Mbps for single user
- ✓ BLER2=0.02149

- ★ AP1 distributed architecture
 - teaching building
 - - 4 antennas
 - golden sunshine
 - - 4 antennas

- ★ AP2 distributed architecture
 - rest house
 - - 4 antennas
 - library
 - - 4 antennas

- ★ The same frequency is used for AP1 and AP2



Main progress—Group implementation scheme (1)





VOD and FTP on Mobile



Wireless Video phone on Open day



Exploring Internet on Mobile



Wireless HDTV Transmission

With almost wired quality and save power



Key Concepts and Technologies of B3G TDD

Oct.31,2006

- **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*



Gbps Wireless Communication Demo Platform

AP



MT

– 4T X 6R, peak data rate 1Gbps

