China National High-tech R&D Program

Gbps Wireless Communication Testbed studied in Southeast University

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Outline

- **The project background**
- **Gbps testbed architecture**
- **System test environment**
- **Demonstration results**

Overview

- **China National High-tech R&D Program (863 Program) Year-2006 Project**

- **The project requirement**
  - **Wireless transmit bandwidth is less then 100MHz**
  - **System transmission rate on air is greater than 1Gbps**
  - **Distance transmitted is more than 50 meters**
  - **Carrier frequency is 3.5GHz**
  - **6 Transmit antennas and 6 receive antennas**

Project Objective

- **Project Objectives**
  - **Fundamental technologies suitable for hardware and software implementation to support wireless transmission rate up to 1 Gbps**
  - **A testbed verification system including one base-station and one mobile-station**
  - **Experiment on air and typical wireless data services transmission demonstration**
- **Research Contents**
  - **Low-complexity technologies of baseband physical layer link and MAC layer protocol**
  - **Wide band RF and Multiple-antennas related technologies**
  - **High speed A/D and D/A conversion and processing technologies**
  - **Real-time and embedded software control technologies**
  - **IP-based network interface and service application access technologies**

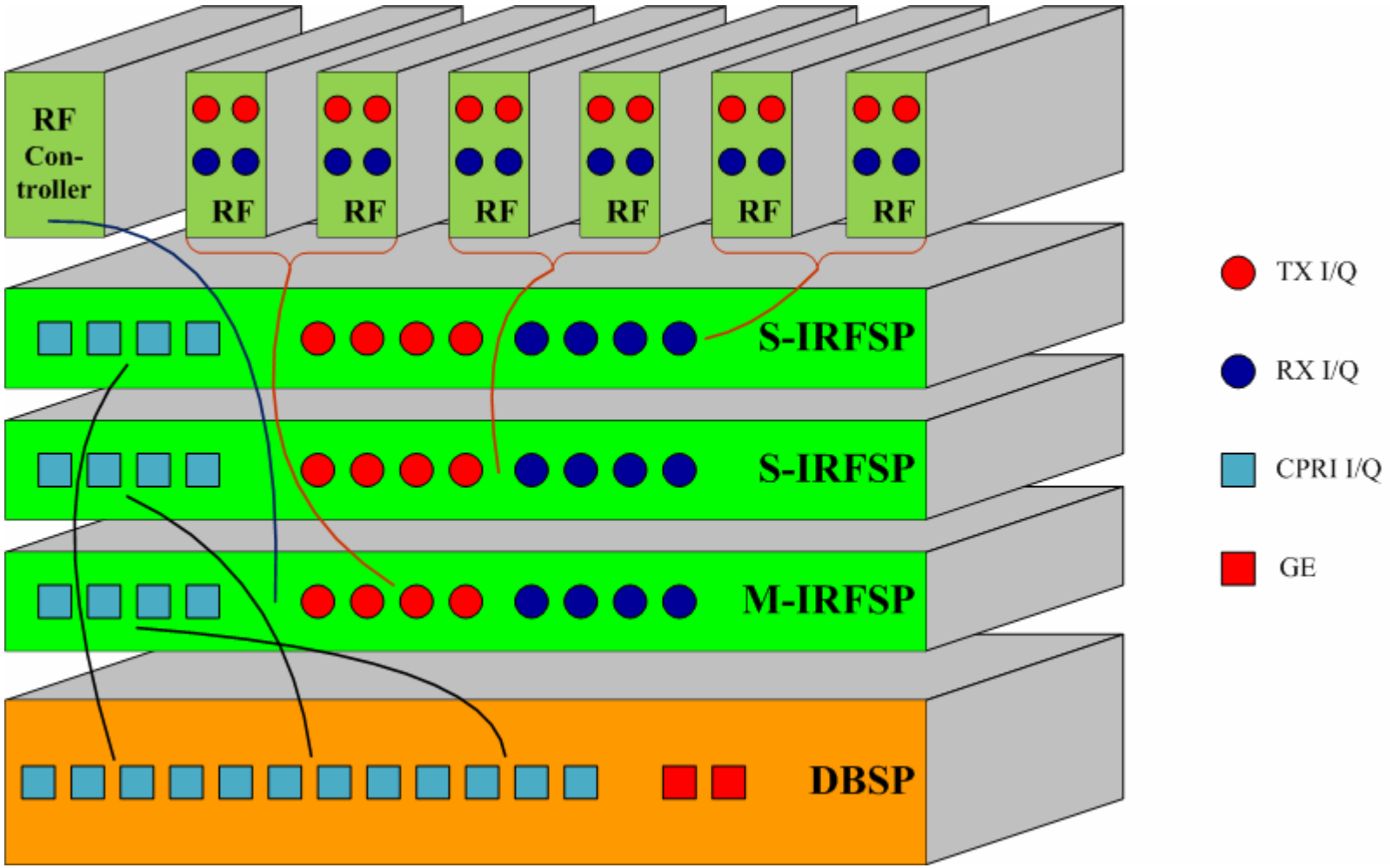
Project Objective and Partnership

- To investigate the key technologies supporting wireless transmission rate up to 1Gbps to apply for the 4G (IMT Advanced) mobile communication systems, wireless LAN and short-distance wireless communications.

Project Participation

- **Southeast University**
  - **National Mobile Communications Research Laboratory**
  - **State Key Laboratory of Millimeter Waves**
- **Huawei Technologies Co., Ltd.**

Gbps Testbed Architecture



Gbps Testbed Framework

- RF sub-system
  - RF controller module
  - 6 RF channel processing modules, each for one RX/TX antenna
- IRFSP sub-system
  - One master intermediate-radio-frequency signal processing module
  - Two slave intermediate-radio frequency signal processing modules
- DBSP sub-system

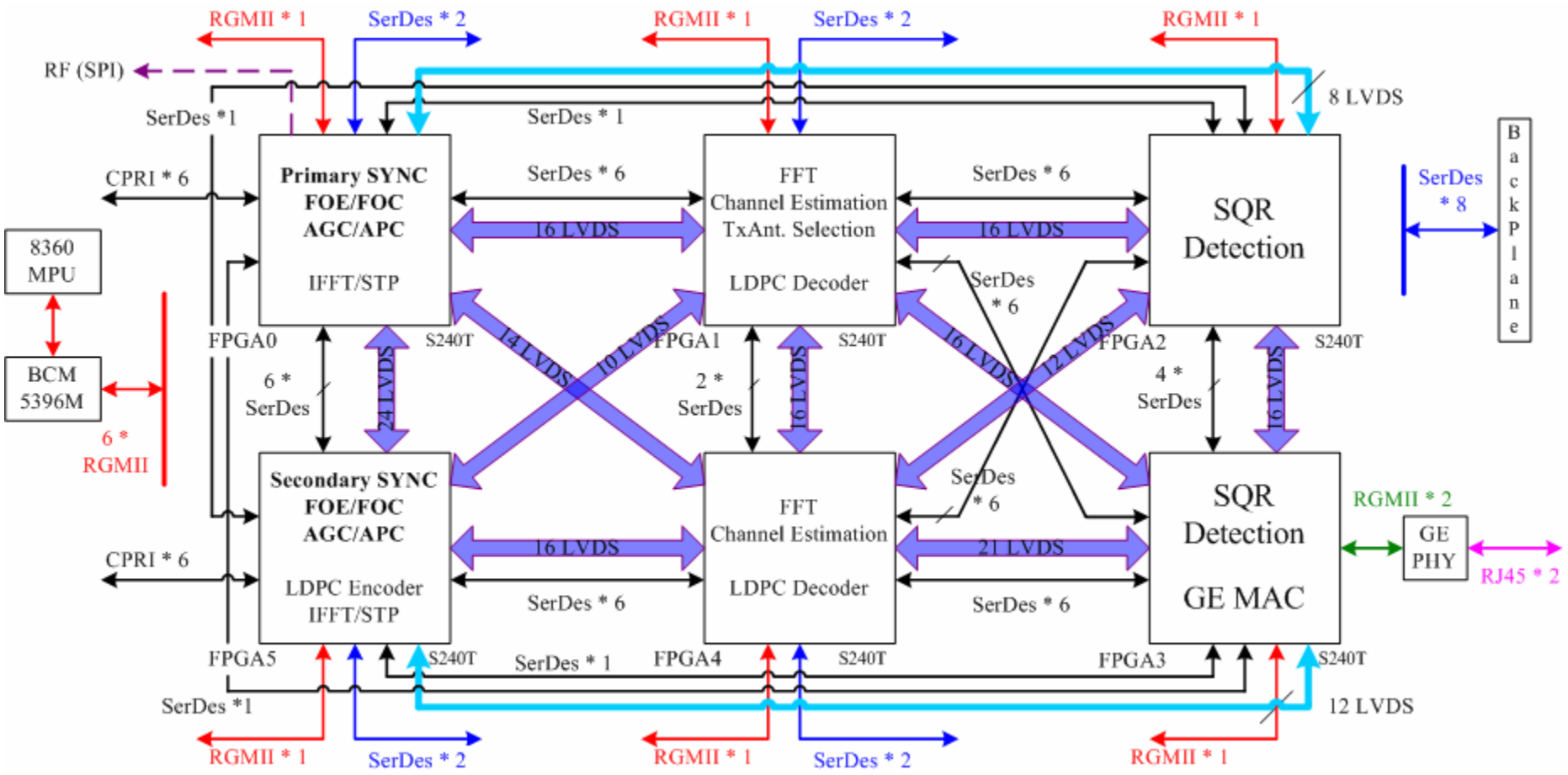
Gbps Testbed Interface

- Analog RX & TX I/Q via coaxial cable
- Digital optical fiber based CPRI interface specification
- Gigabit Ethernet

Gbps Testbed Framework

- **RF channel processing module**
  - **Receive link**
    - ✓ **LNA, AGC and frequency down-conversion**
  - **Transmit link**
    - ✓ **frequency up-conversion, APC, power amplifier**
- **IRFSP module**
  - **ADC**
    - ✓ **I/Q channel sample rate is 122.88Msps and 11-bit width**
  - **DAC**
    - ✓ **I/Q channel data rate with 122.88MHz and 16-bit width**
    - ✓ **4x interpolation filter**

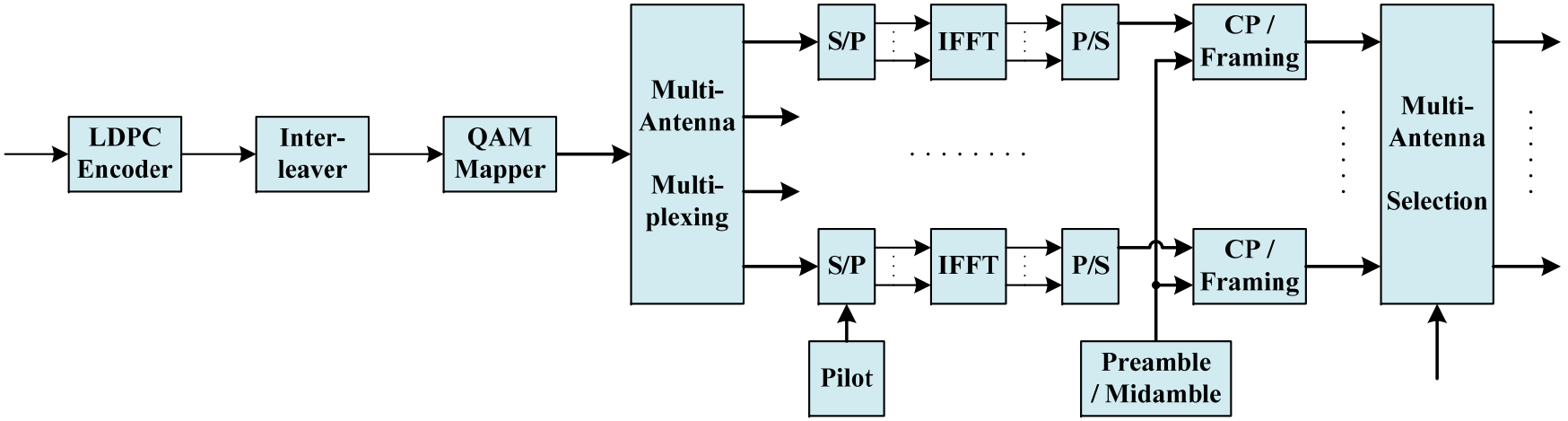
DBSP Board Diagram



- Xilinx XC5VSX240T FPGAs
- 3.125G RocketIO GTP Transceivers
- Gigabit Ethernet

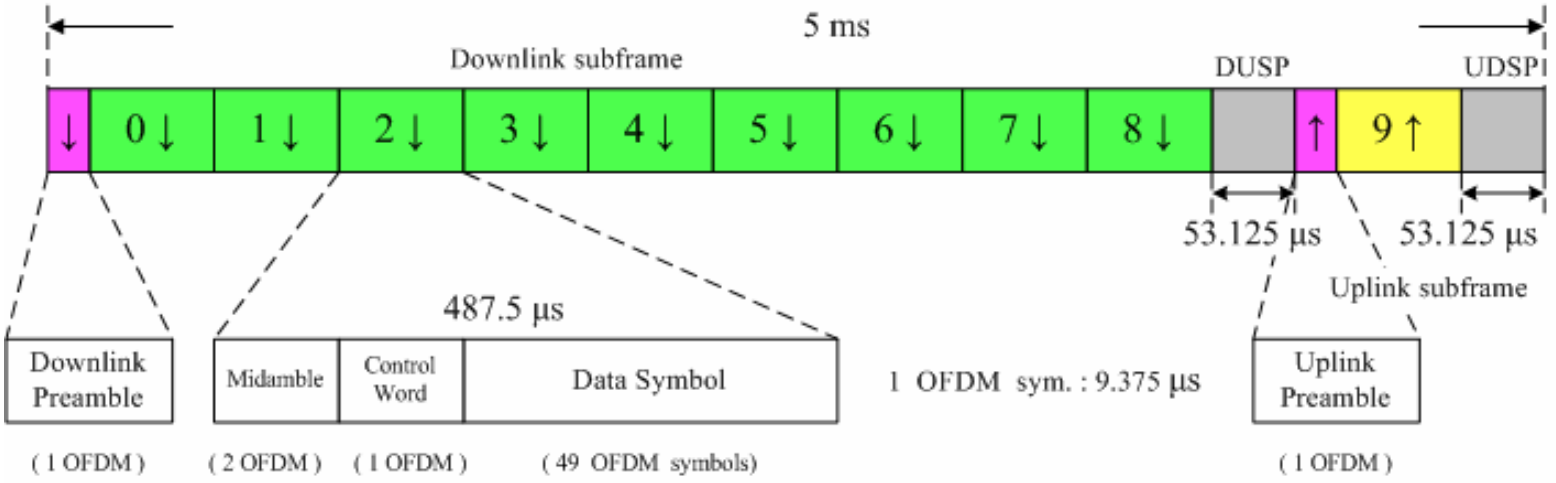
- TDD / FDD
- 4Tx/Rx to 6Tx/Rx MIMO antennas

Transmitter structure



- OFDM + MIMO multiple antennas multiplexing
- TDD + OFDMA

Frame Structure

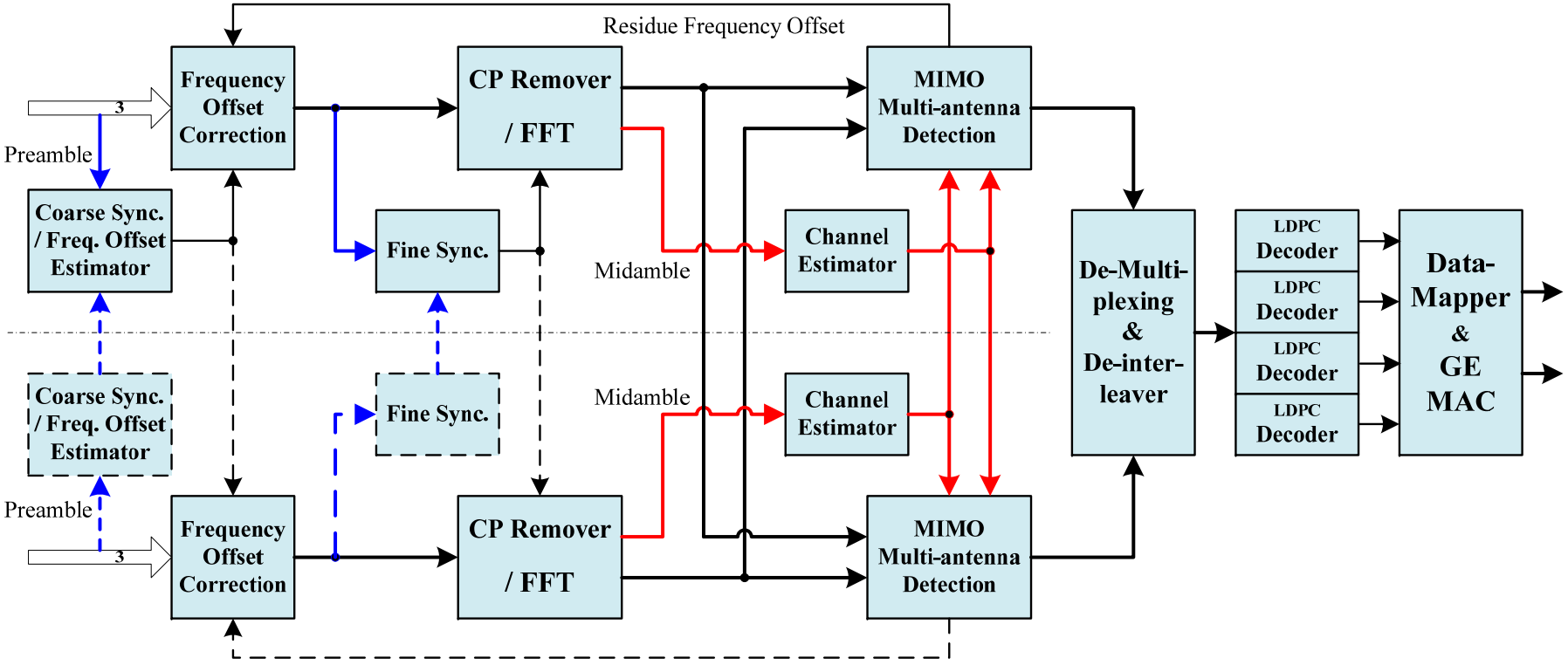


- Preamble transmitted from 4 Tx antennas
- Midamble transmitted from 4 Tx antennas by time-frequency divided multiplexing , 2 groups of antennas by TDM and 2 antennas by FDM

Testbed Parameters

Parameters	Value
Sub-carrier bandwidth, Δ_F	120 kHz
Number of sub-carriers, N_{FFT}	1024
Number of sub-carriers for data, N_D	768
Number of used sub-carriers	800
Bandwidth occupied	96.48 MHz
Length of Cyclic Prefix, T_{CP}	1.042 μ s
Period of OFDM symbol, T_{SYM}	9.375 μ s
Frame length	5 ms
Modulation scheme (Modulation Index)	16-QAM (4)
Number of Transmit & Receive Antennas	4 & 6
LDPC coding rate, R_C	5/6
Downlink information bit rate	921.6 Mbps
Uplink information bit rate	102.4 Mbps

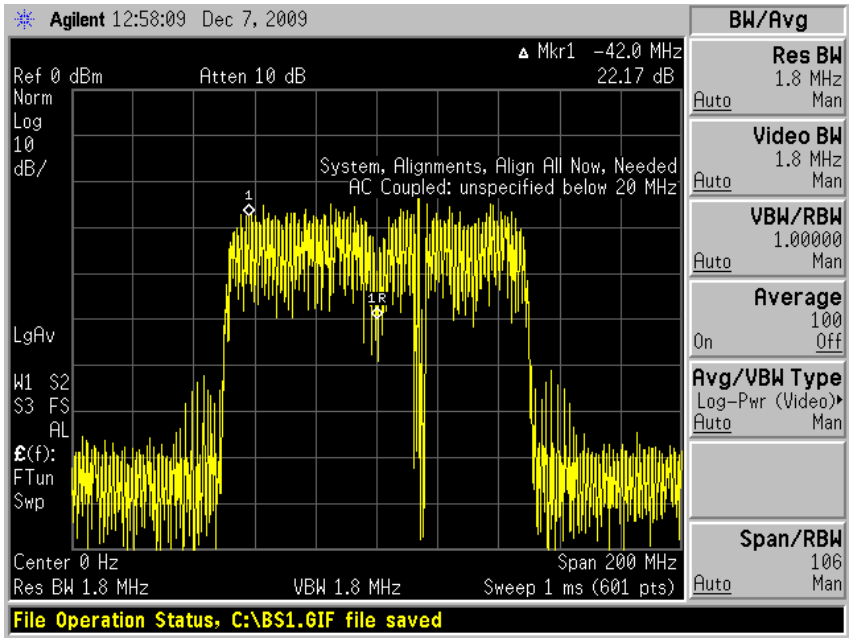
Receiver structure

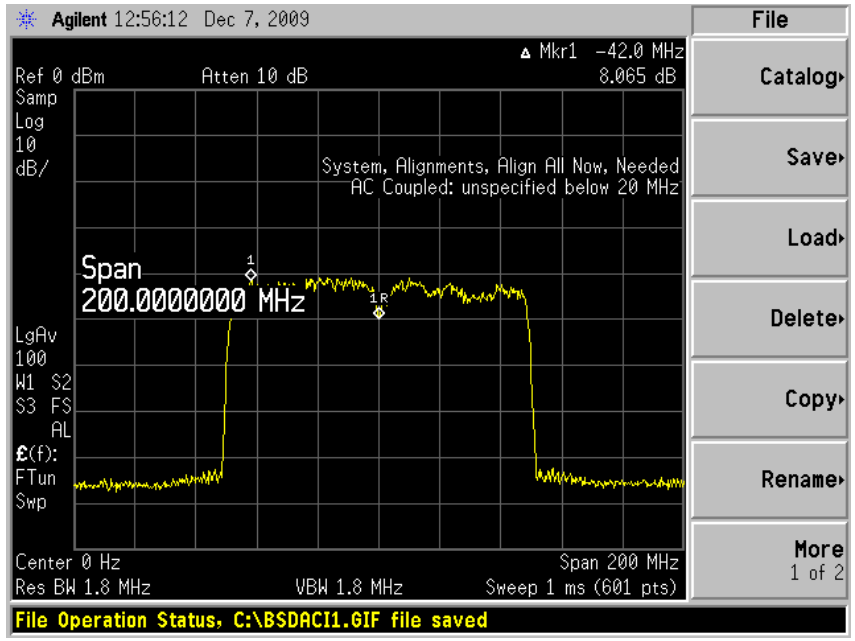


- The upper and lower parallel receive processing

- Sync./FFO Est. & Corr.
- 4Tx/6Rx ZF-SQRD
- 4Tx/4Rx MMSE-SQRD

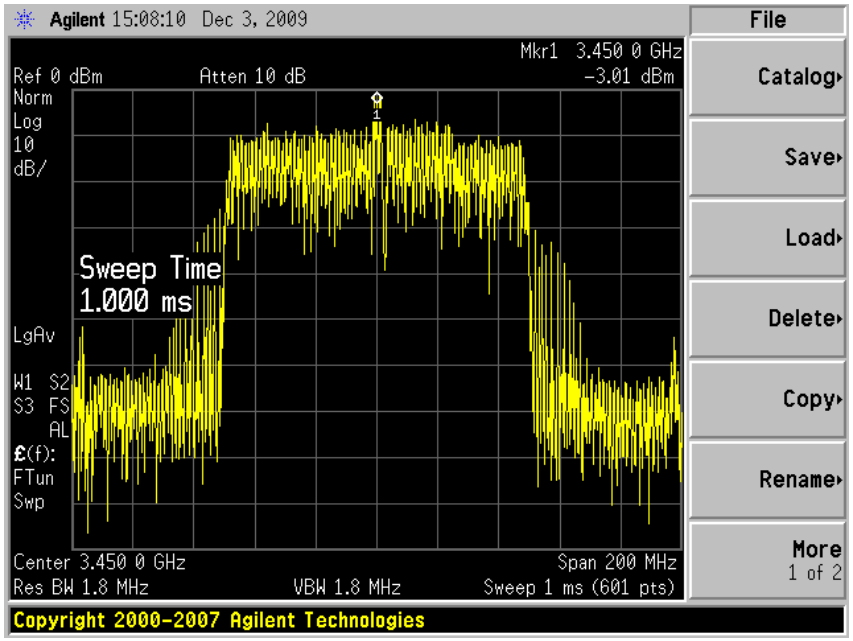
Baseband transmit spectrum

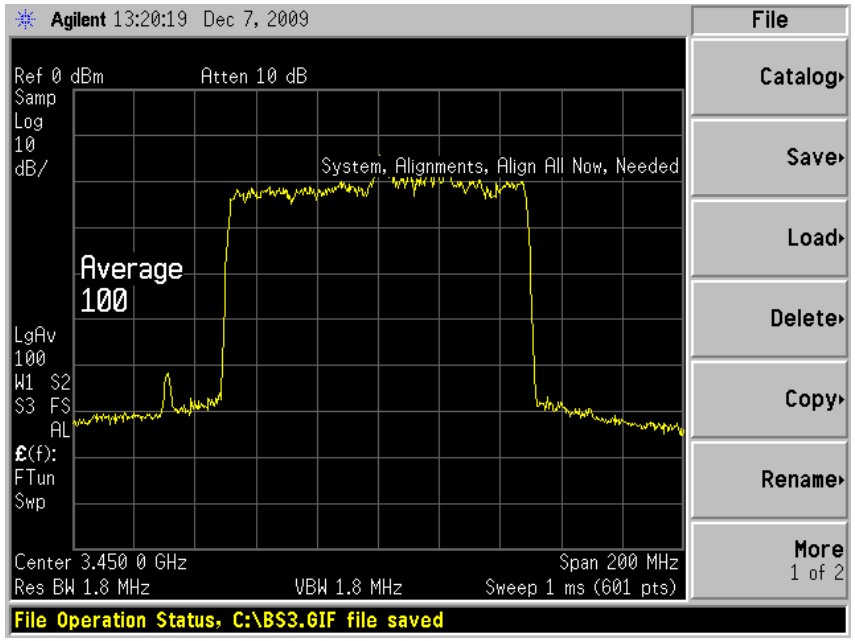




- ✓ The bandwidth is less than 100MHz

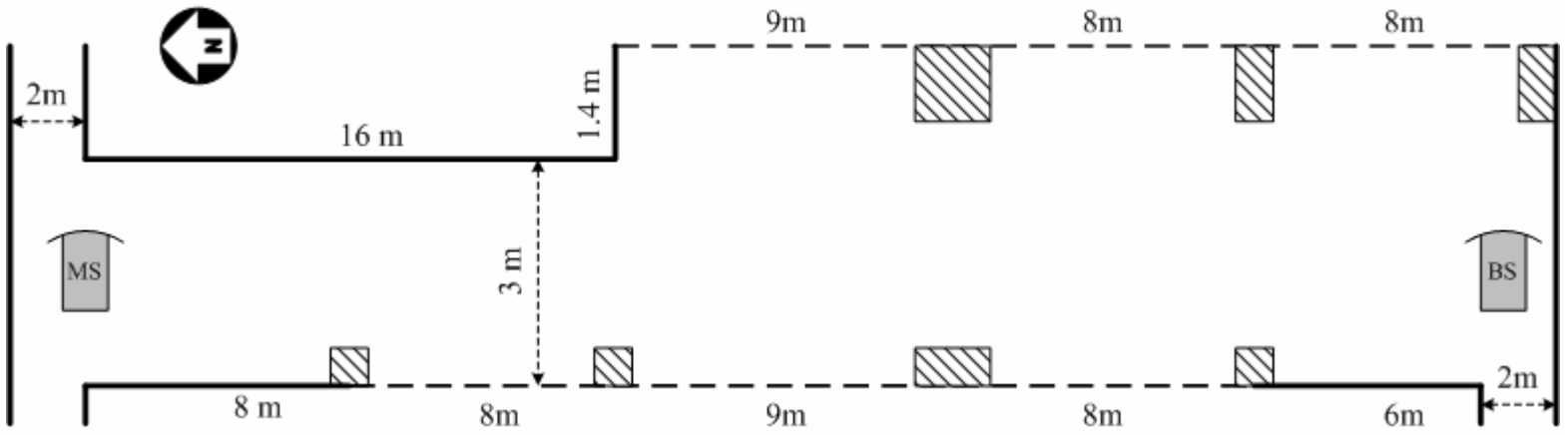
RF transmit spectrum

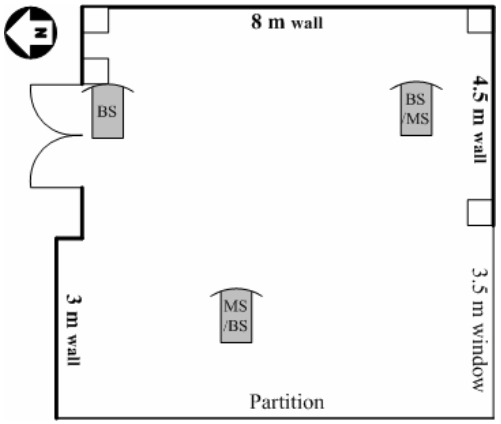


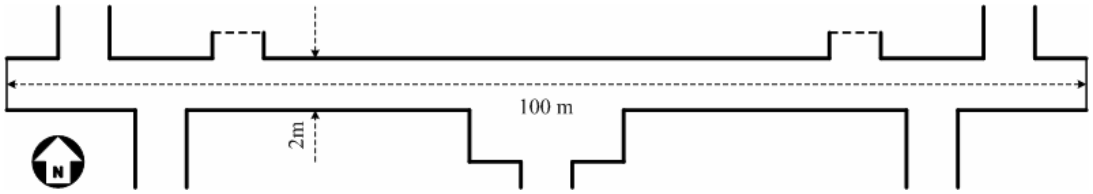


- ✓ The carrier frequency is 3.45GHz

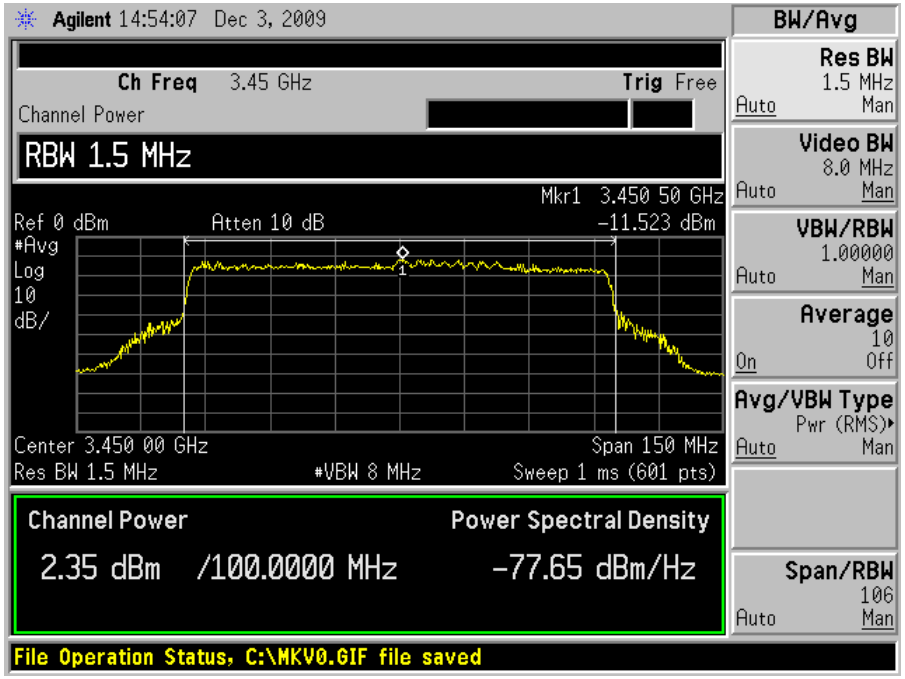
Test Propagation Environment

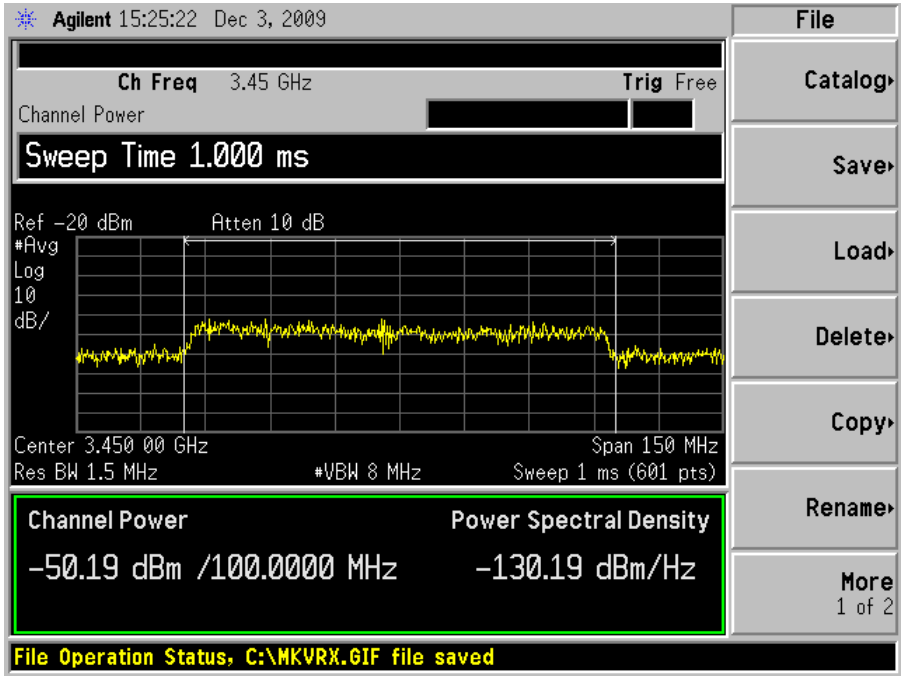






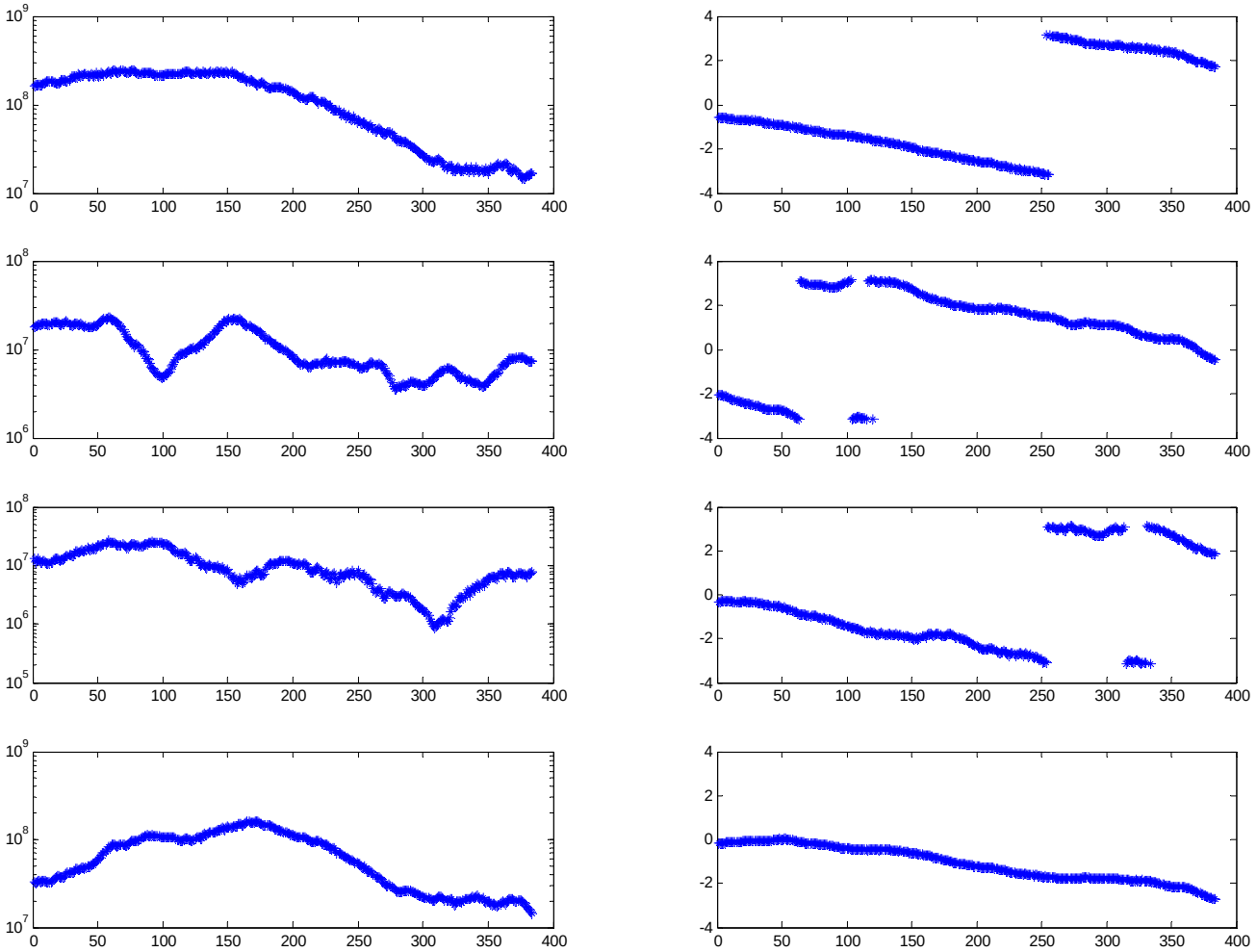
Wireless signal transmission in experiment



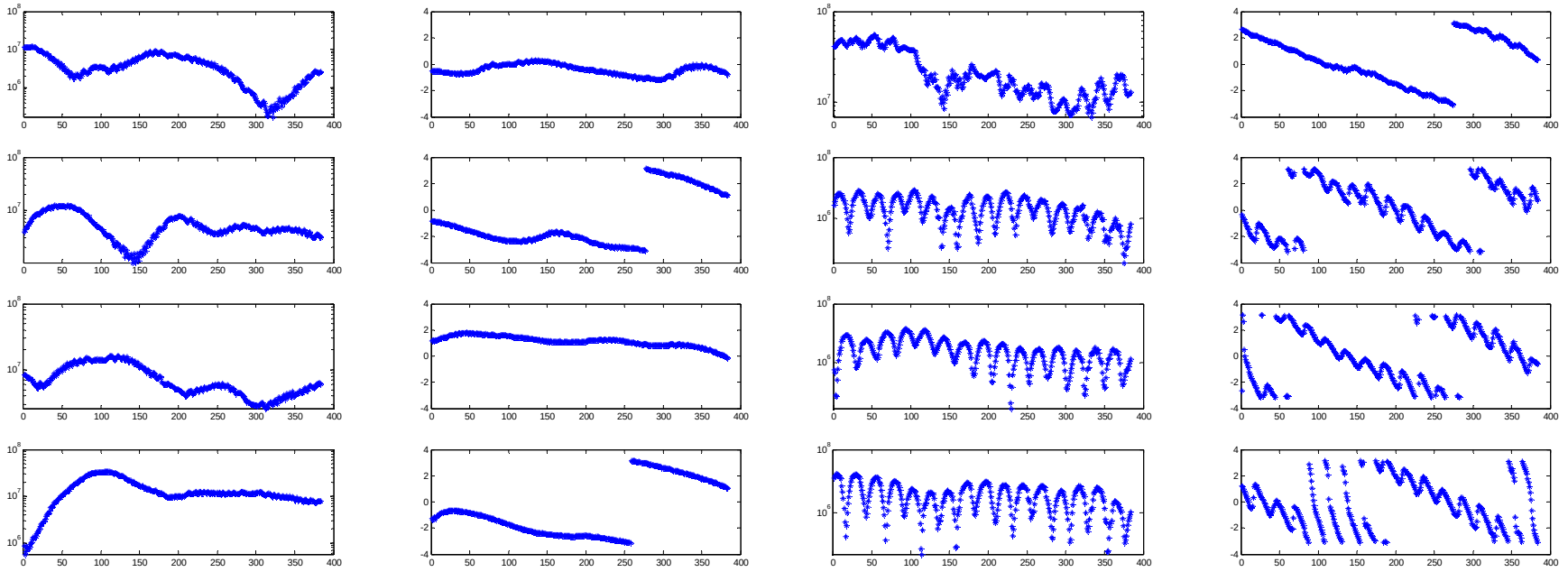


- ✓ APC = 6Ah, 41 meters distance, -53dB attenuation

Channel FR estimated



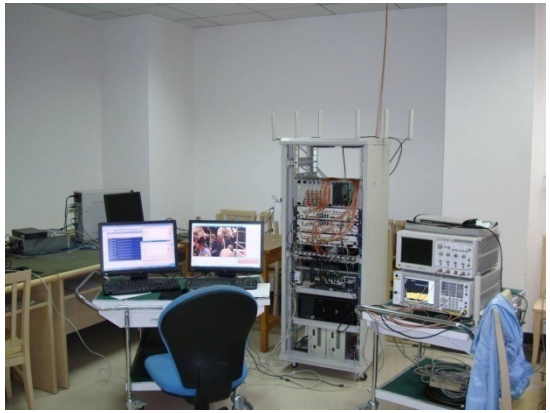
Channel FR estimated



✓ rich scattering indoor scenario

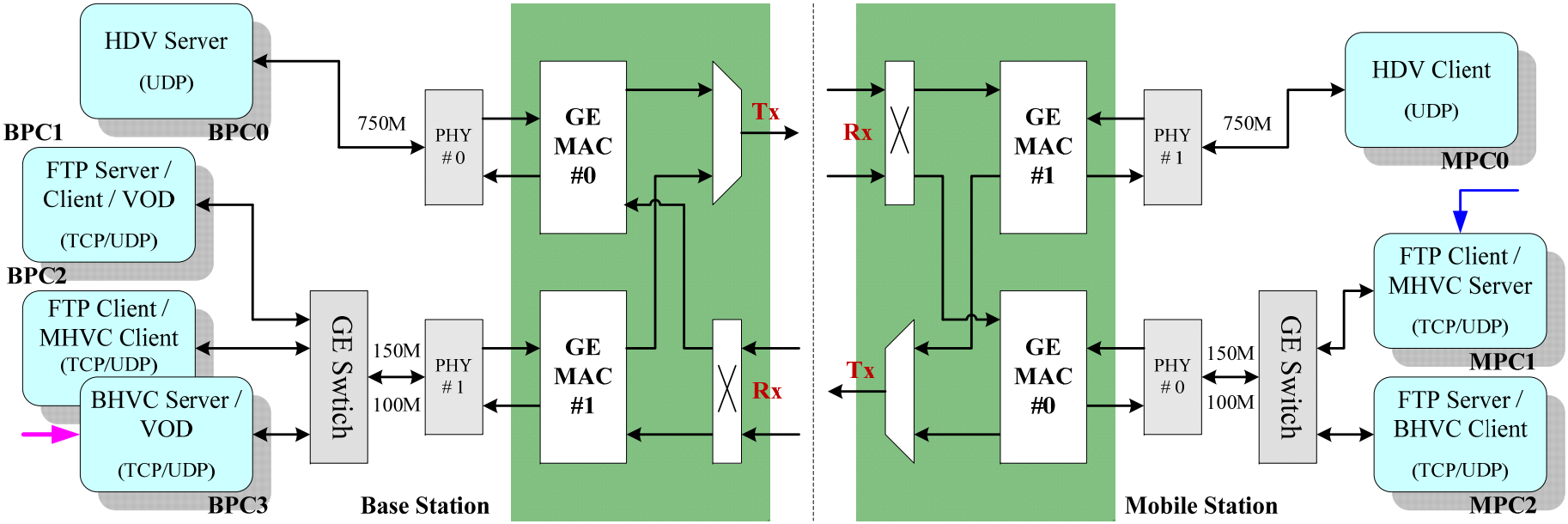
✓ keyhole longer corridor scenario

Test Environment #2



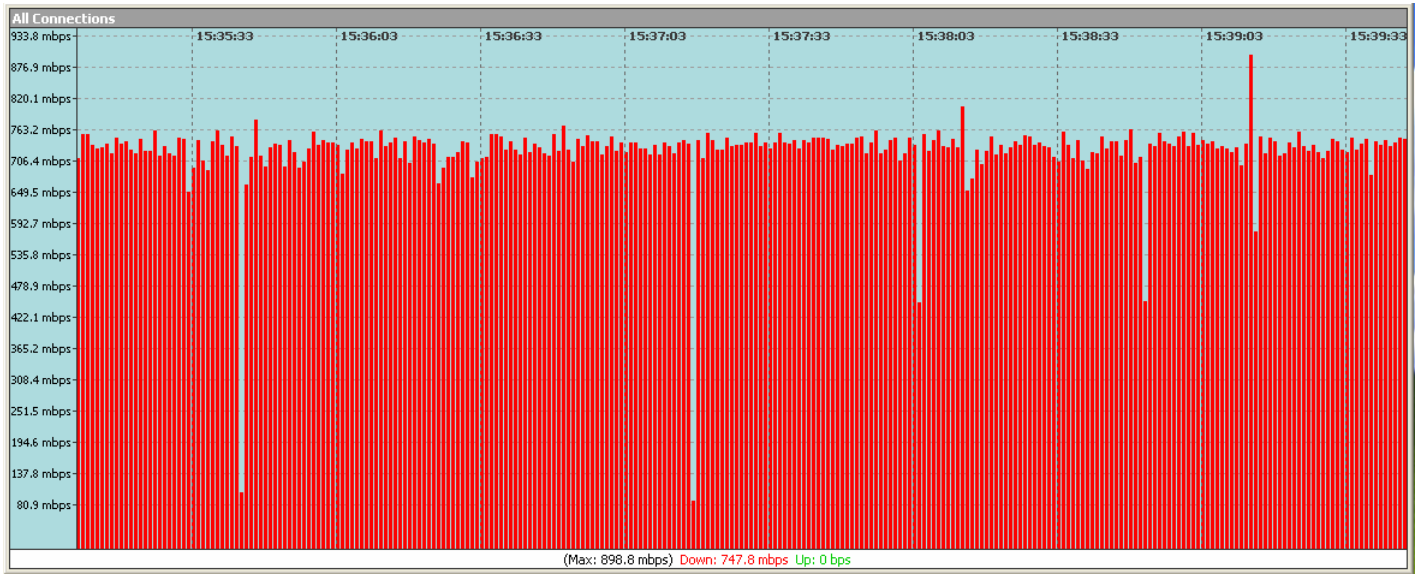
✓ APC = 58h, 6.5 meters distance

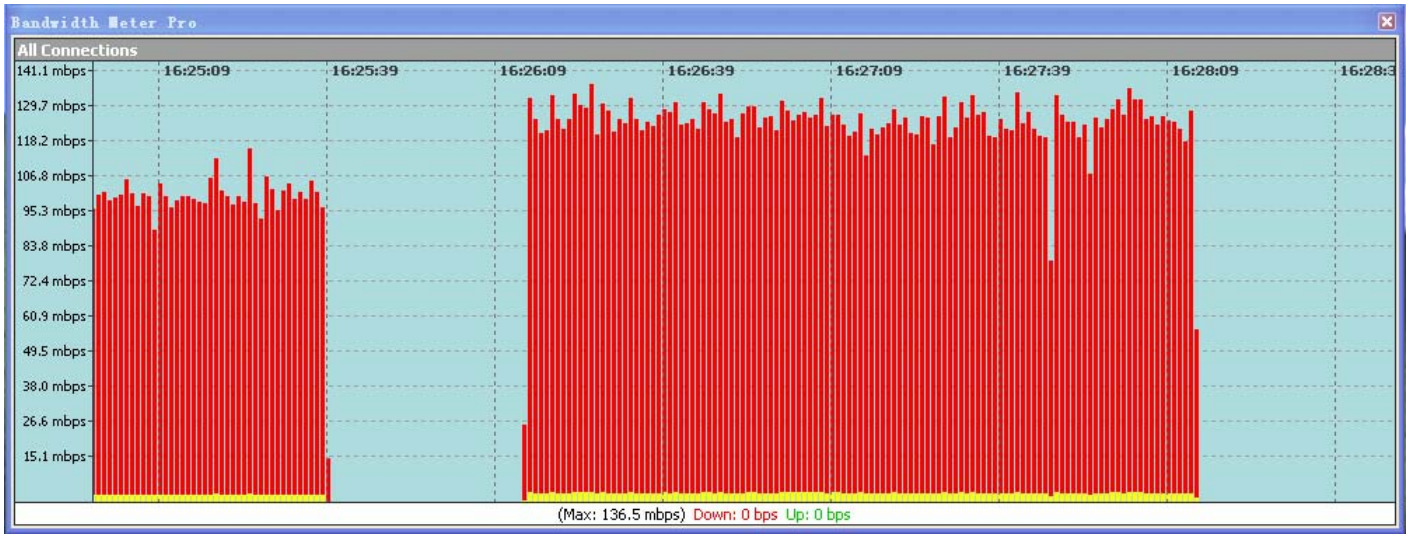
Service data access scheme



- Downlink (9 timeslots) → 1105.92 Mbps (5/6 code rate, uncoded data rate is 921.6 Mbps)
- Uplink (1 timeslot) →122.88 Mbps (5/6 code rate, uncoded data rate is 102.4 Mbps)
- Total (10 timeslots） →1.2288 Gbps (5/6 code rate, uncoded data rate is 1.024 Gbps)

Service Demo Data Rate

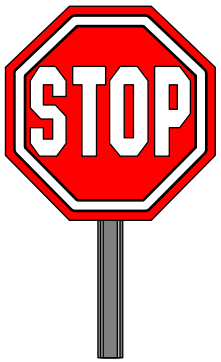




- BER 10-e6
- PER 10-e3

- Bandwidth Meter Pro
  - ✓ Uncompressed HD Video (1280*720*24-bit@35Frame) + FTP

End of Report



Thank you !