Ongoing MIMO Wireless Testbed Development in Shandong University

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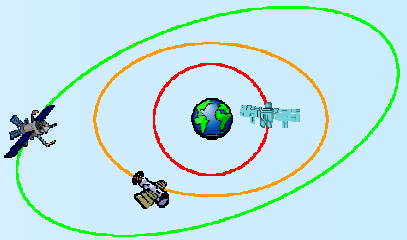
Shandong University

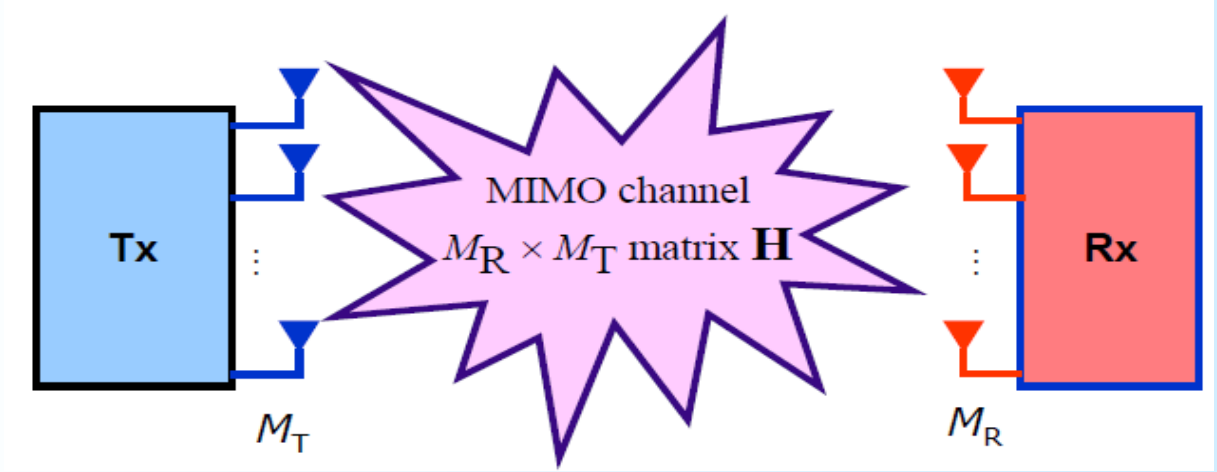


Outline

- **Introduction and Motivation**
- **Non-real Time MIMO Testbed**
- **Non-real Time MIMO Testbed**
- **Future work**

Introduction and Motivation(1)

- **MIMO-Multiple Input Multiple Output**:
  - Exploits the spatial dimension of mobile propagation channels.
  - Main benefits: spatial multiplexing gain and spatial diversity gain
  - Widely used in wireless communication standards: 3GPP LTE, Wi-Fi (802.11n), WiMAX(802.16d), mobile WiMAX(802.16e), etc.



Introduction and Motivation(2)

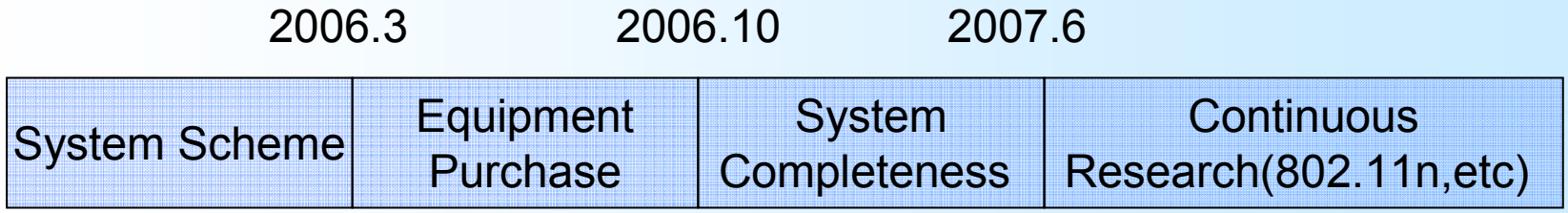
- Verification Algorithm of MIMO Techniques
  - Computer Simulation
    - Easy, low cost
    - Simulated channel model, (3GPP SCM(E), WINNER II, TGn), maybe not coincide with the true environment
  - MIMO Testbed
    - Complex, higher cost
    - True physical channel

Introduction and Motivation(3)

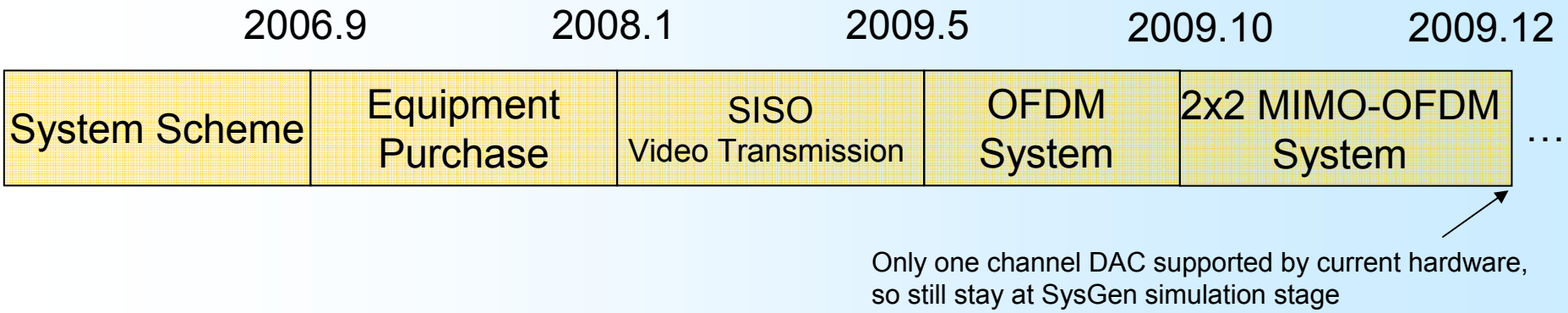
- MIMO Testbed
  - Non-real-time testbed
    - non-real-time (offline) signal processing by PC software
    - Univ. of Vienna (ICS based, 2005) ,University of Texas(Hydra,2005)
  - Real-time testbed
    - Real time signal processing by DSP & FPGA
    - ETH Zurich(2004-),NTT DoCoMo(2004-), Siemens AG 和 Heinrich Hertz(2004-),), University of South Australia(2006), Univ. of Rice(WARP,2006), Univ. of Duisburg(Sundance,2008)
    - SEU: Beyond 3G system (Gao Xiqi,2006), Gbps Wireless Communication Testbed (Wang Xiangyang, 2008)

Progress on MIMO Testbed Development in SDU

Non-real Time System



Real Time System



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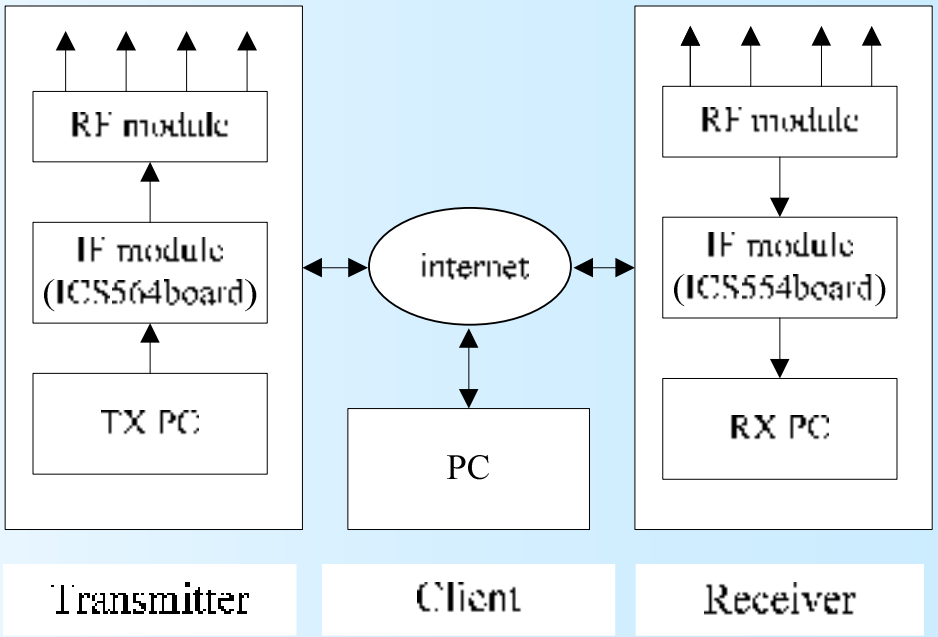
Photographs of non-real time system

Transmitter System

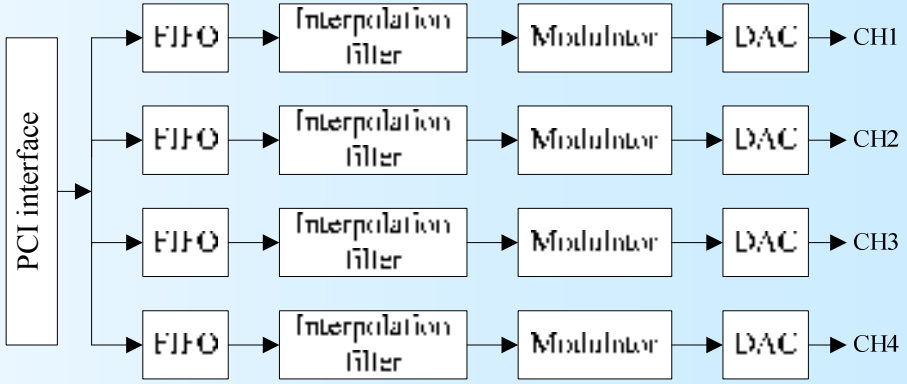
Receiver System

Non-real Time MIMO Testbed

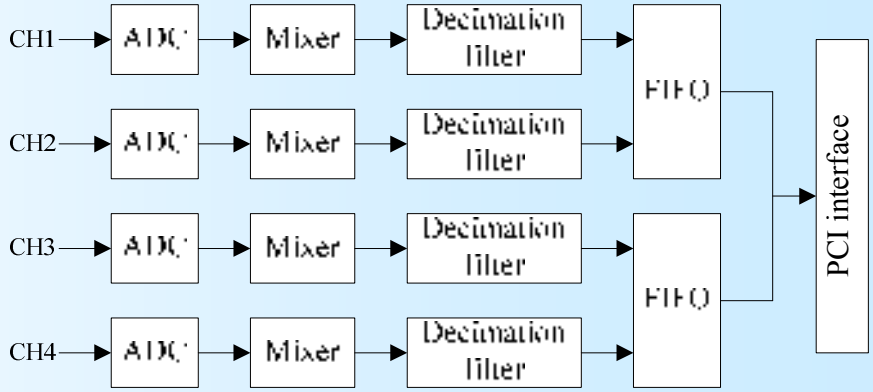
- General Description
  - Linear Antennas Array
  - Transmitter/ Receiver RF converter
  - Transmitter PC/Receiver PC: DUC /DAC, ADC/DDC
  - Client PC： Baseband Signal Processing (data generation and recovery)



Intermediate Frequency (IF) Processing



- **ICS 564 baseband-IF conversion**



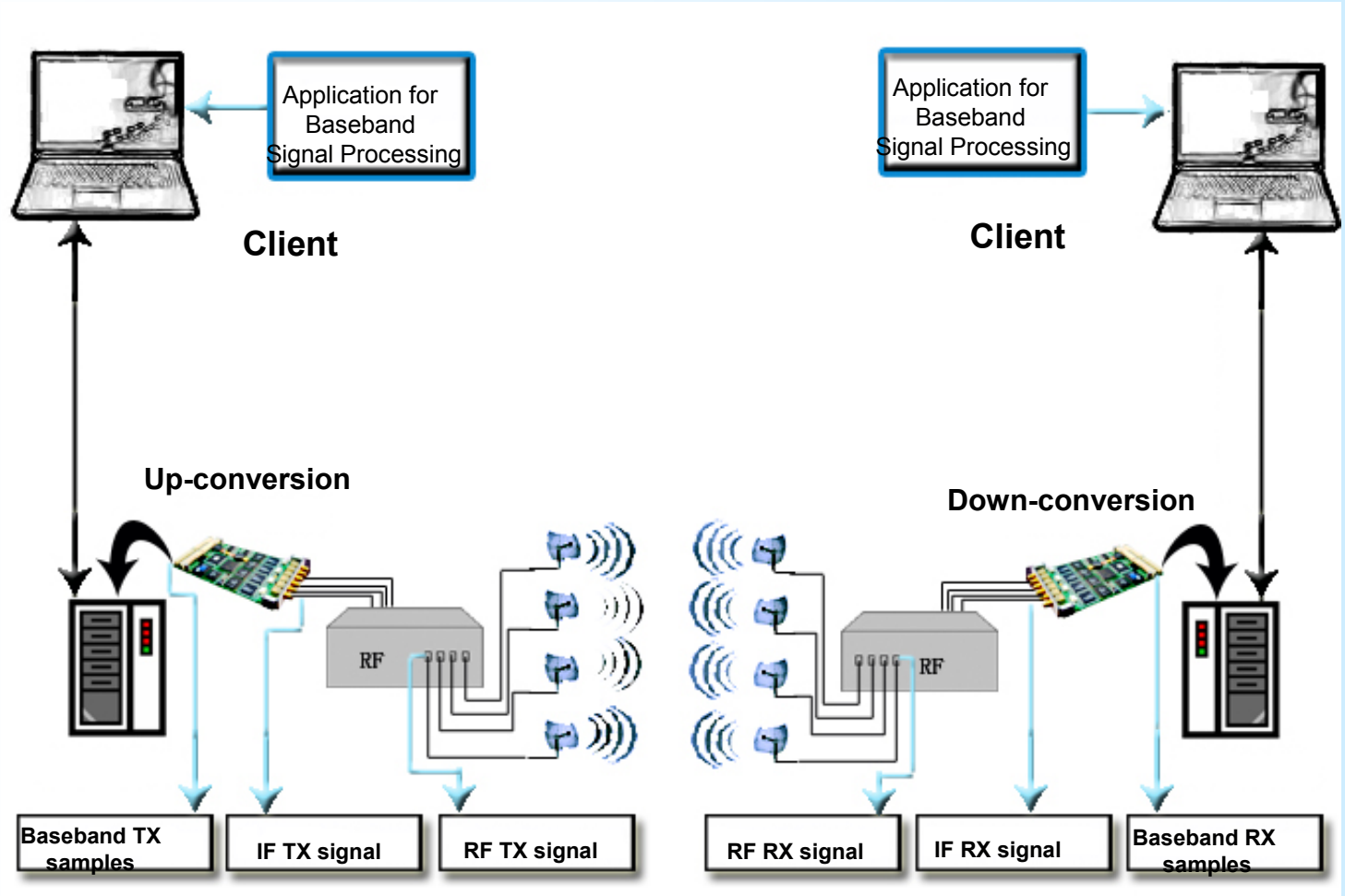
- **ICS 554 IF-baseband conversion**

Radio Frequency / IF converter

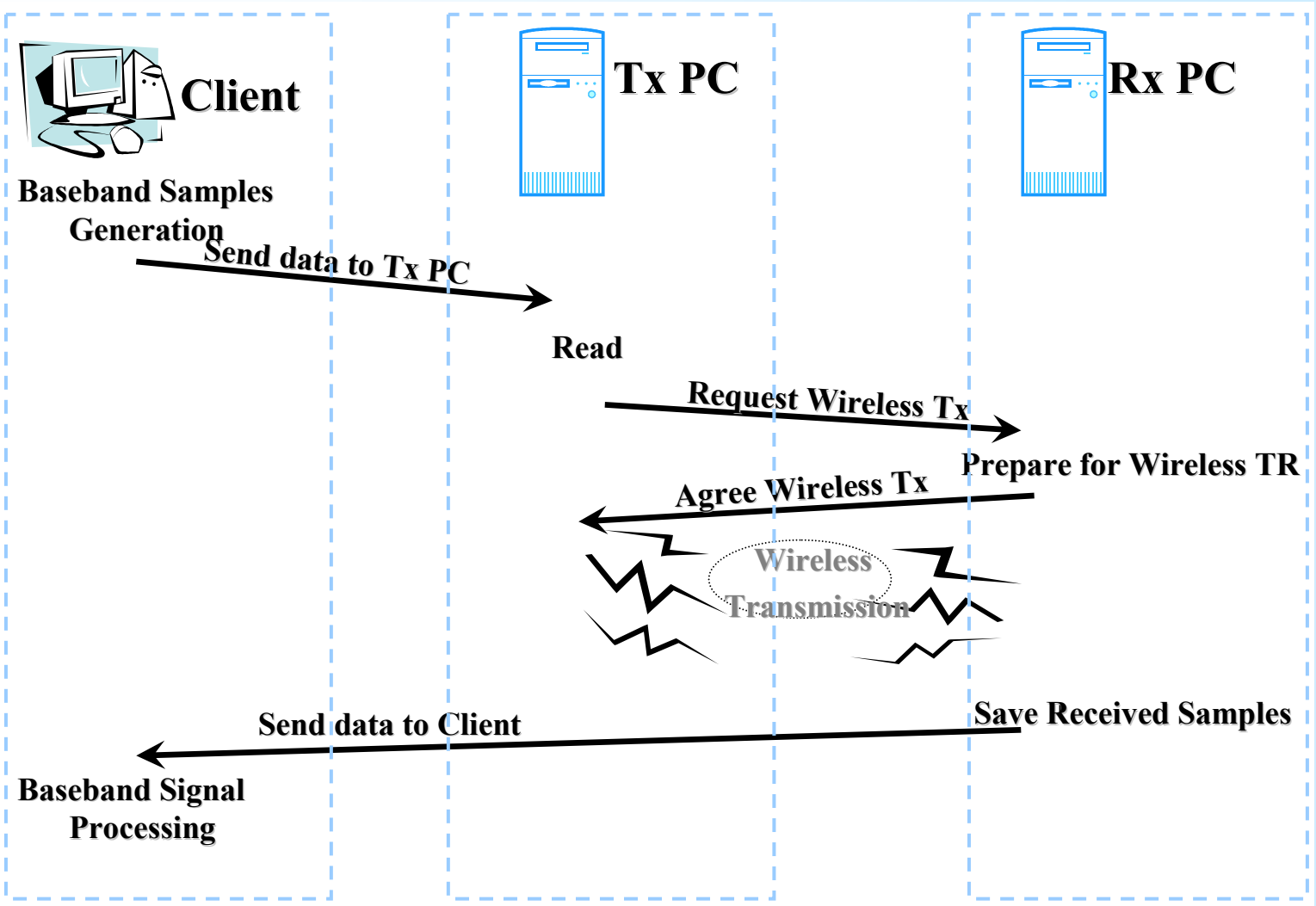
- **Parameters**
  - RF frequency： 2453MHz
  - Intermediate Frequency： 70MHz
  - Number of Channel： 4
  - BW: ≤ 20MHz(for RF), 10MHz(for BB)
  - Frequency stability of LO: △f/f≤±2ppm
  - Phase Noise of LO: Φ< -85dBc@10KHz
  - Output IM3： -35dBc
  - Power per Antenna： 20dBm
  - Isolation between channels： 40dB
  - Noise Figure: <4.5dB
  - Receiving Level: -80dBm ~ -30 dBm

  - Antenna Gain： 6dBi omni-directional
  - Space between antennas: Adjustable

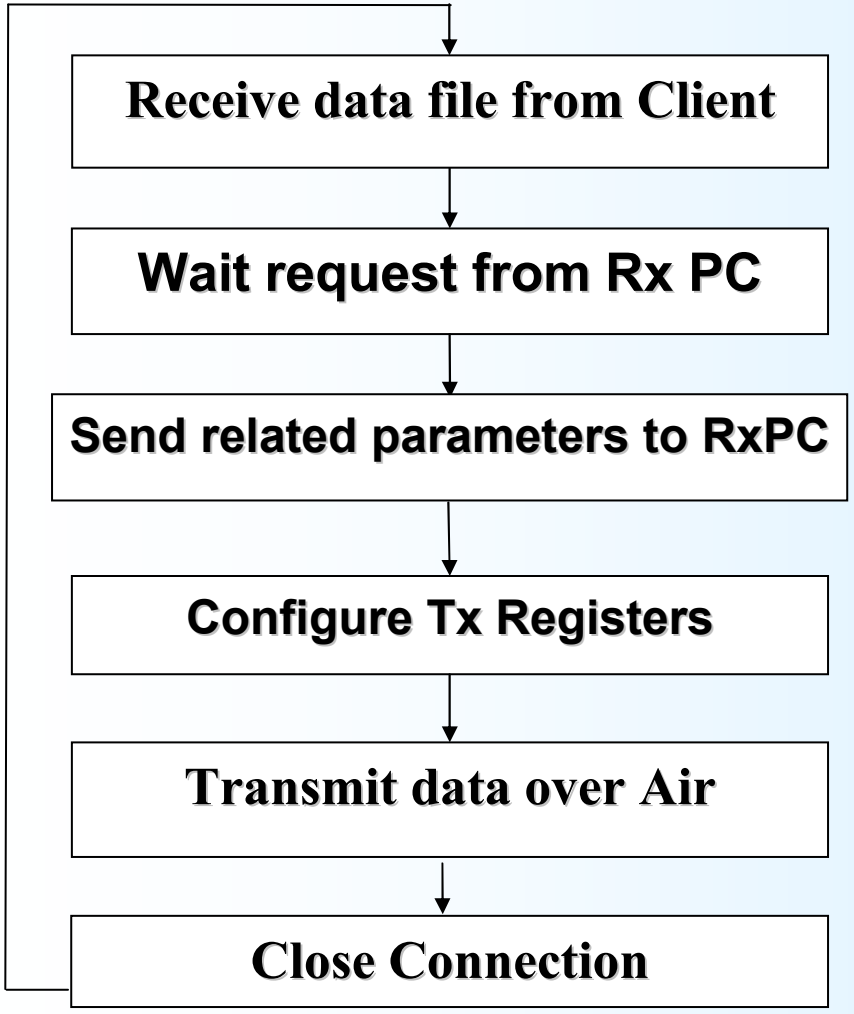
System Architecture



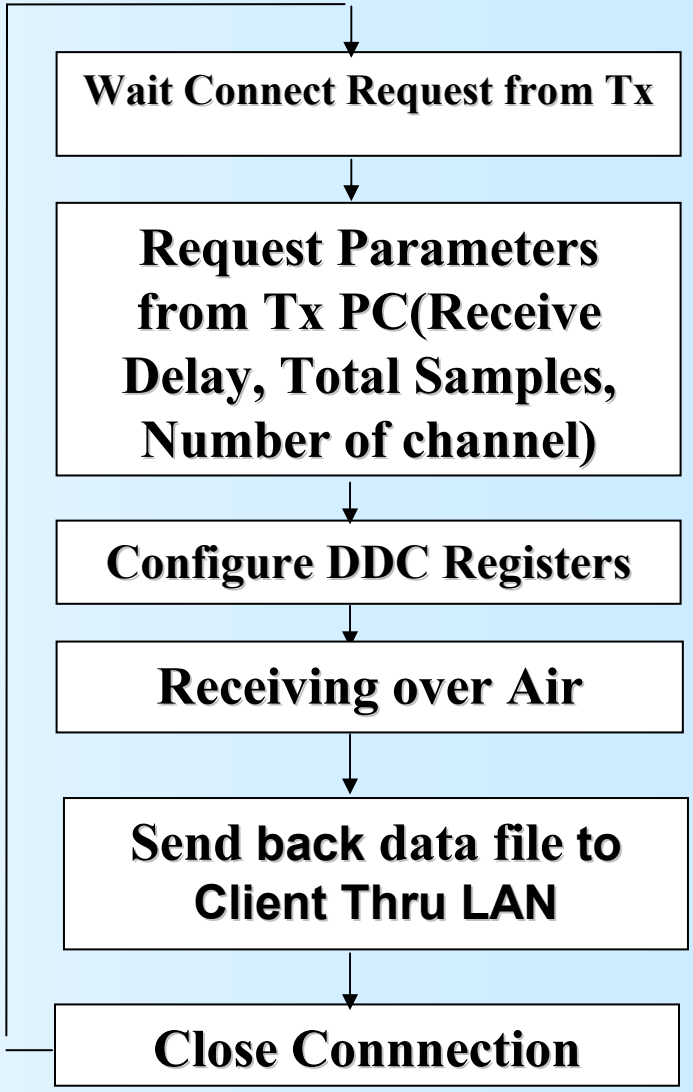
Data Transfer Flow



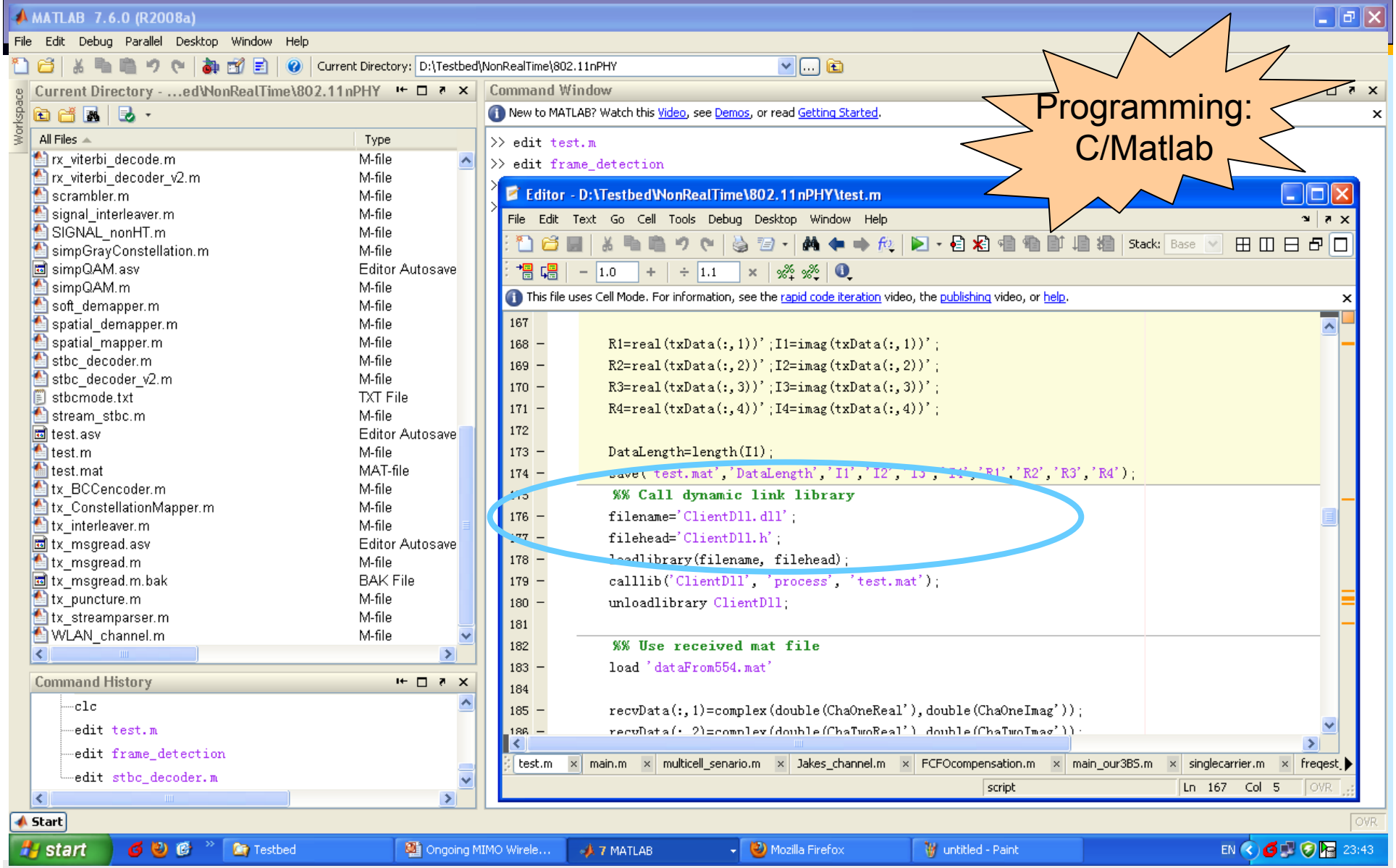
Program Flow @Tx PC



Program Flow @Rx PC

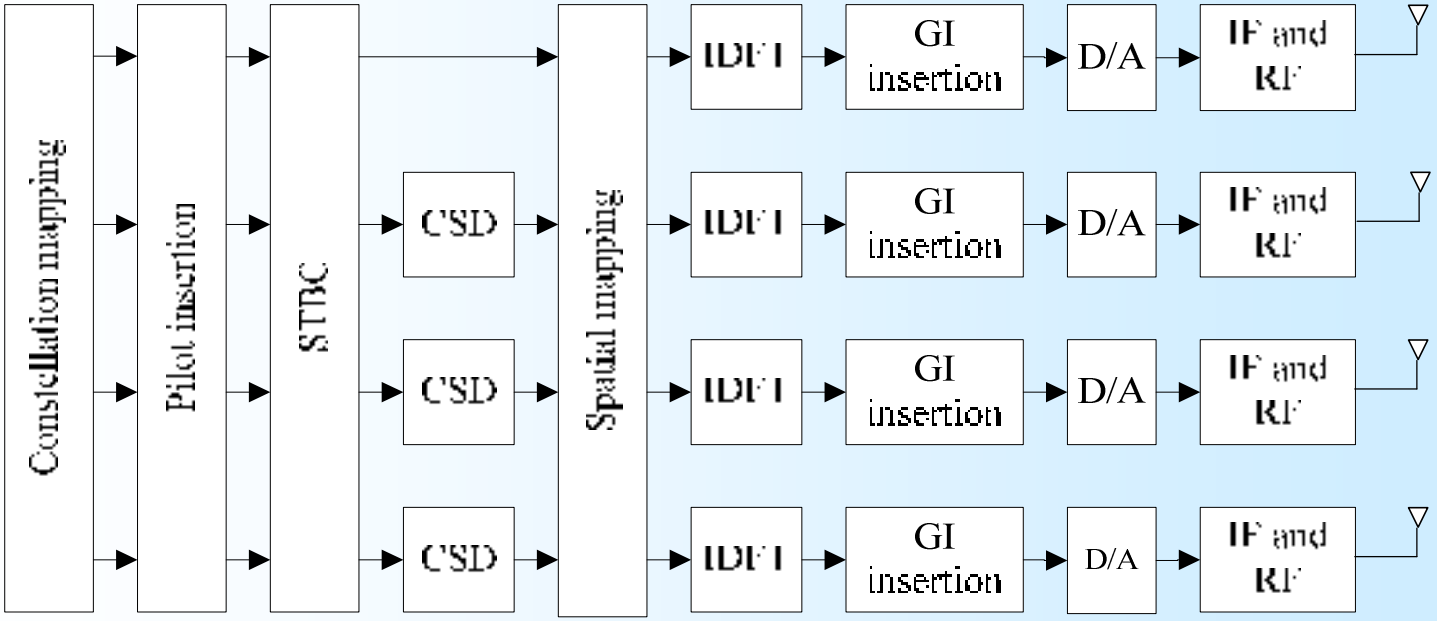


Software Programming @ Client



Research on Non-real Time Platform

- link-level Test, simplex transmission
- **802.11n System**



- WiMAX, etc

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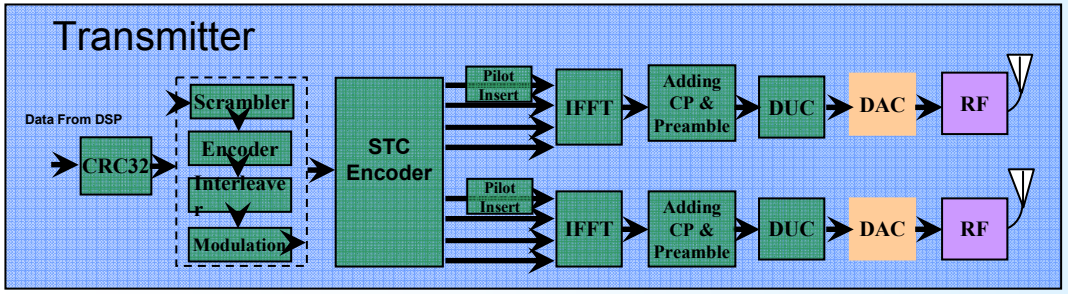
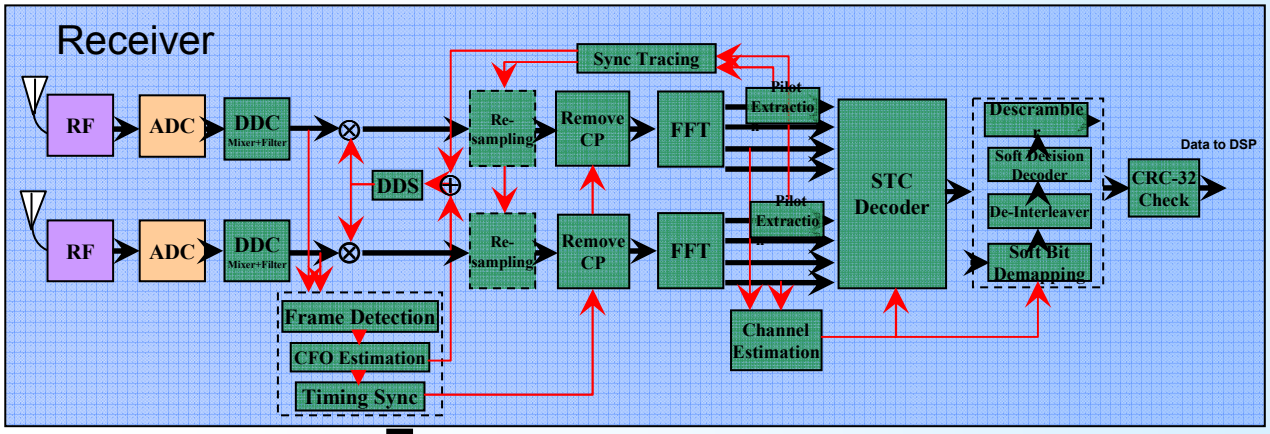
- **Real Time MIMO Testbed**
- Future work

Implementation of MIMO-OFDM System

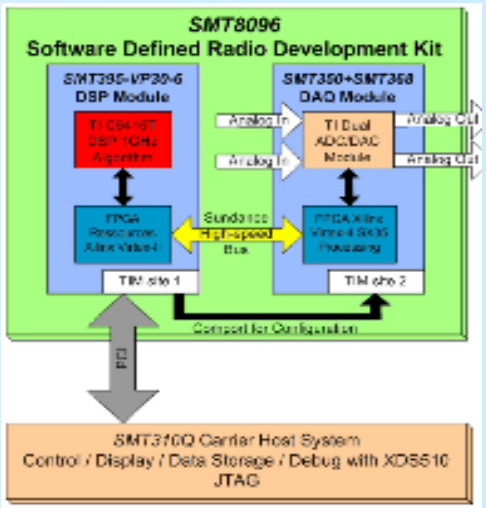




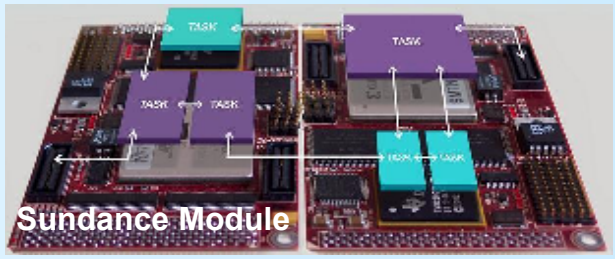
Implemented in FPGA

Sundance SMT 350

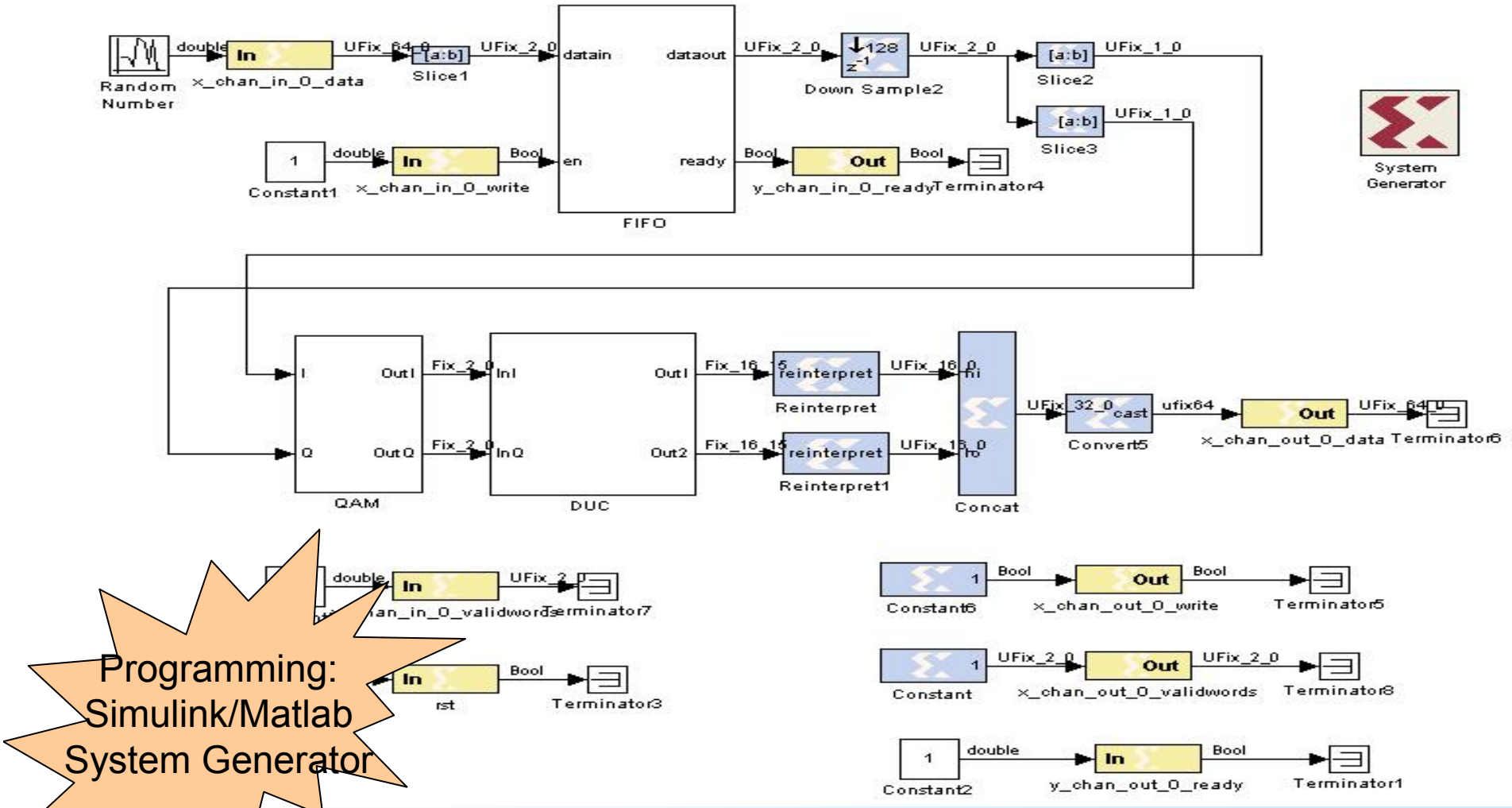
RF Module (max 4 ch)



Development Flow

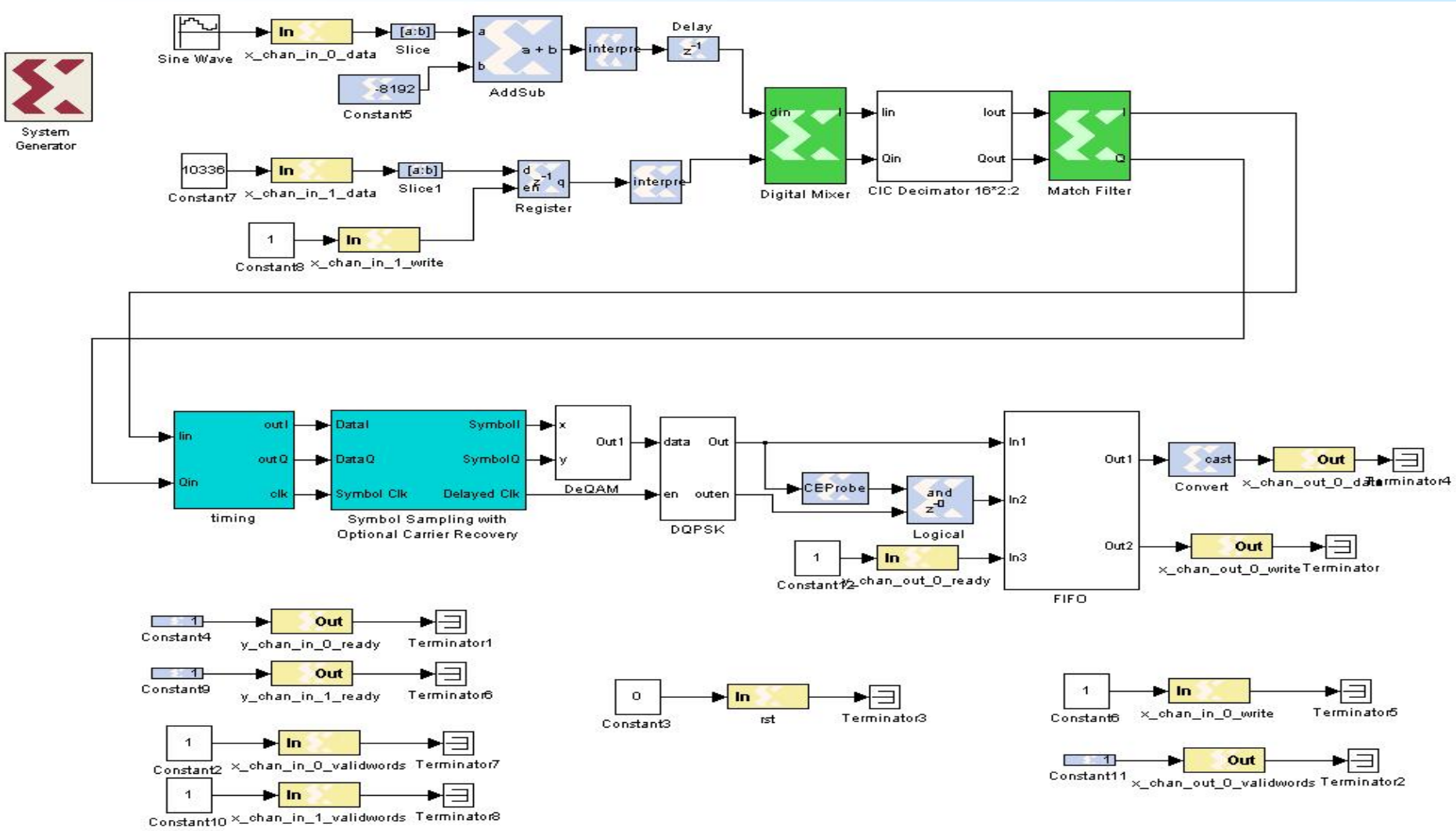


SISO Transmitter

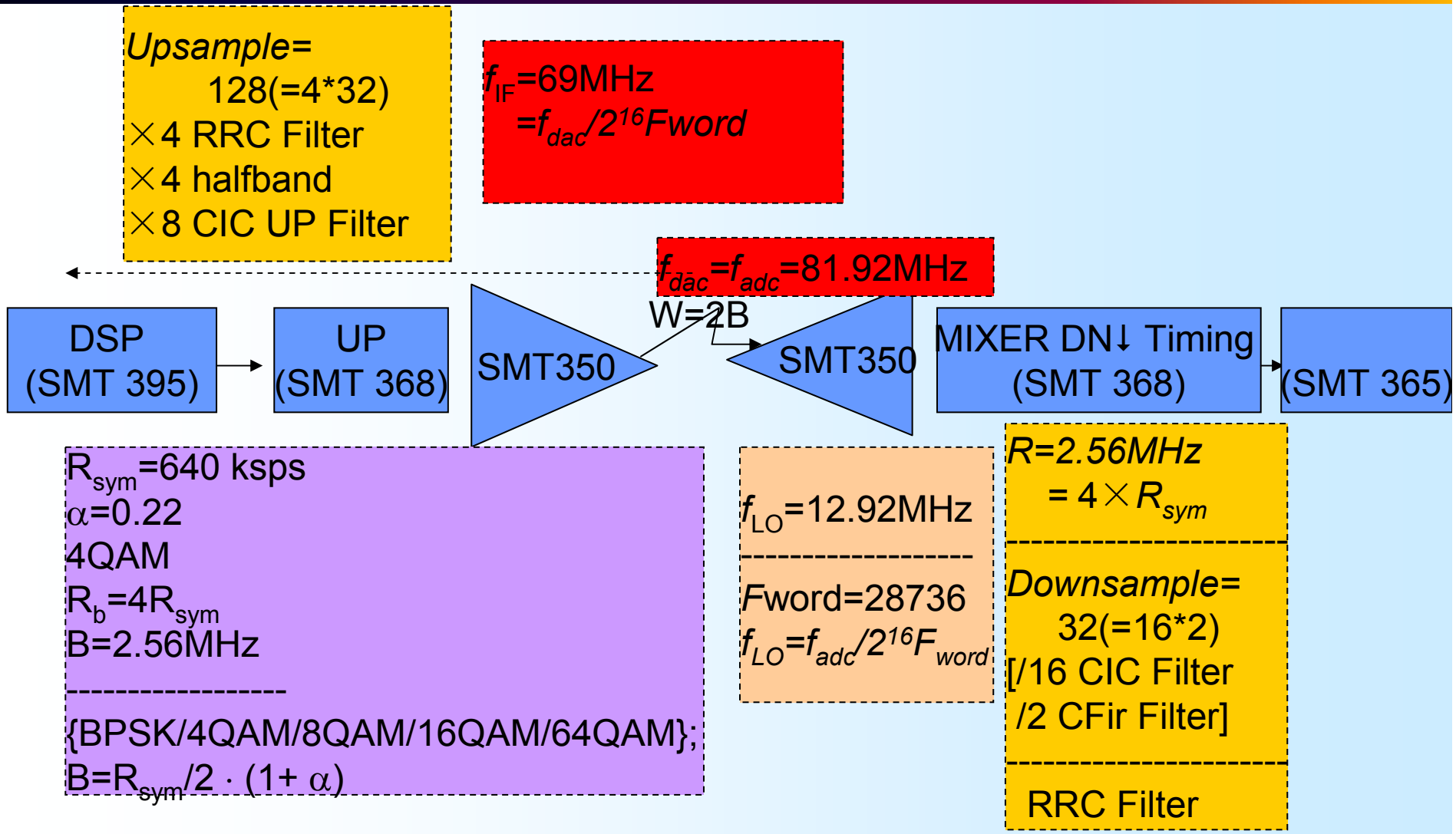


Programming:
Simulink/Matlab
System Generator

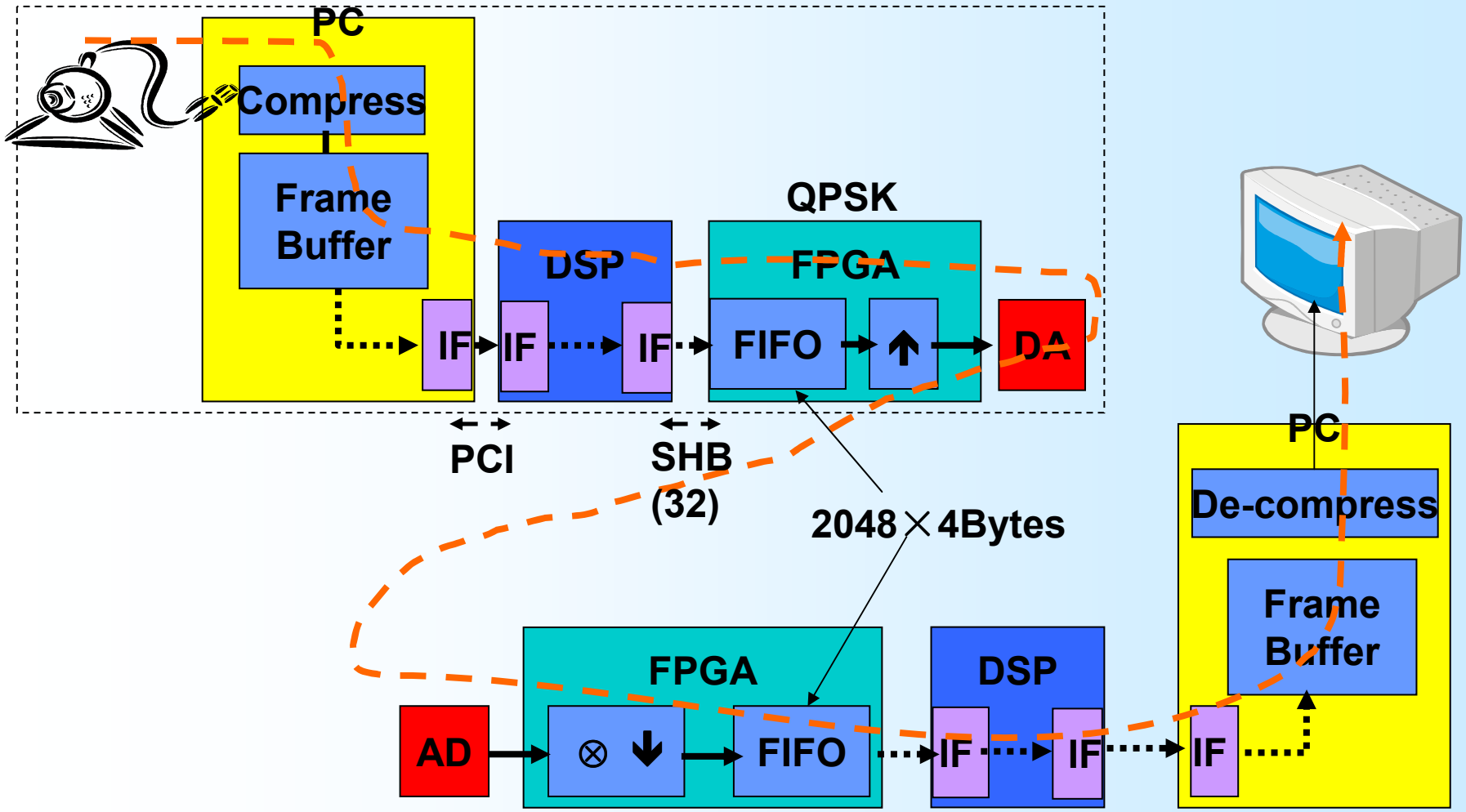
SISO Receiver



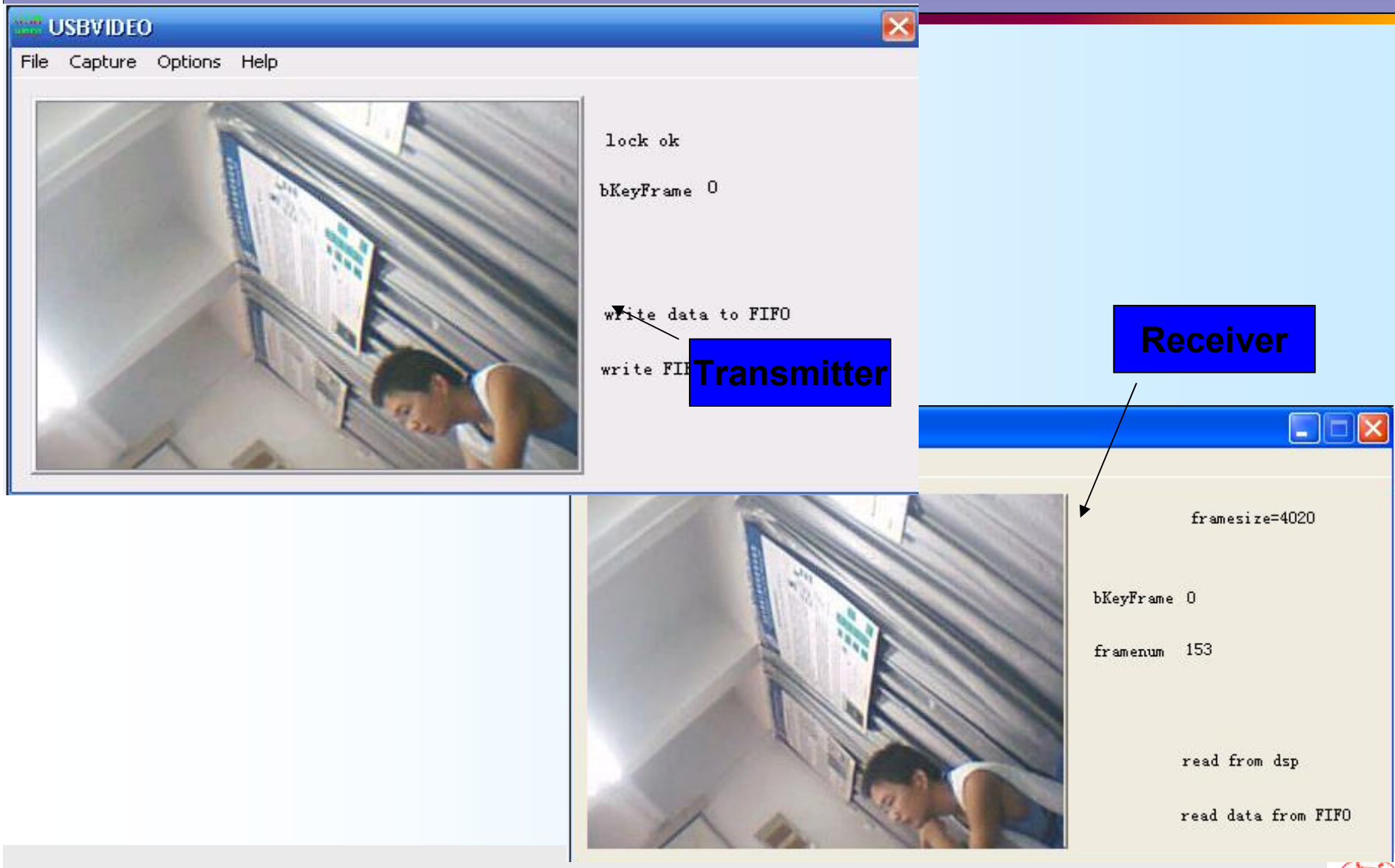
SISO--parameters



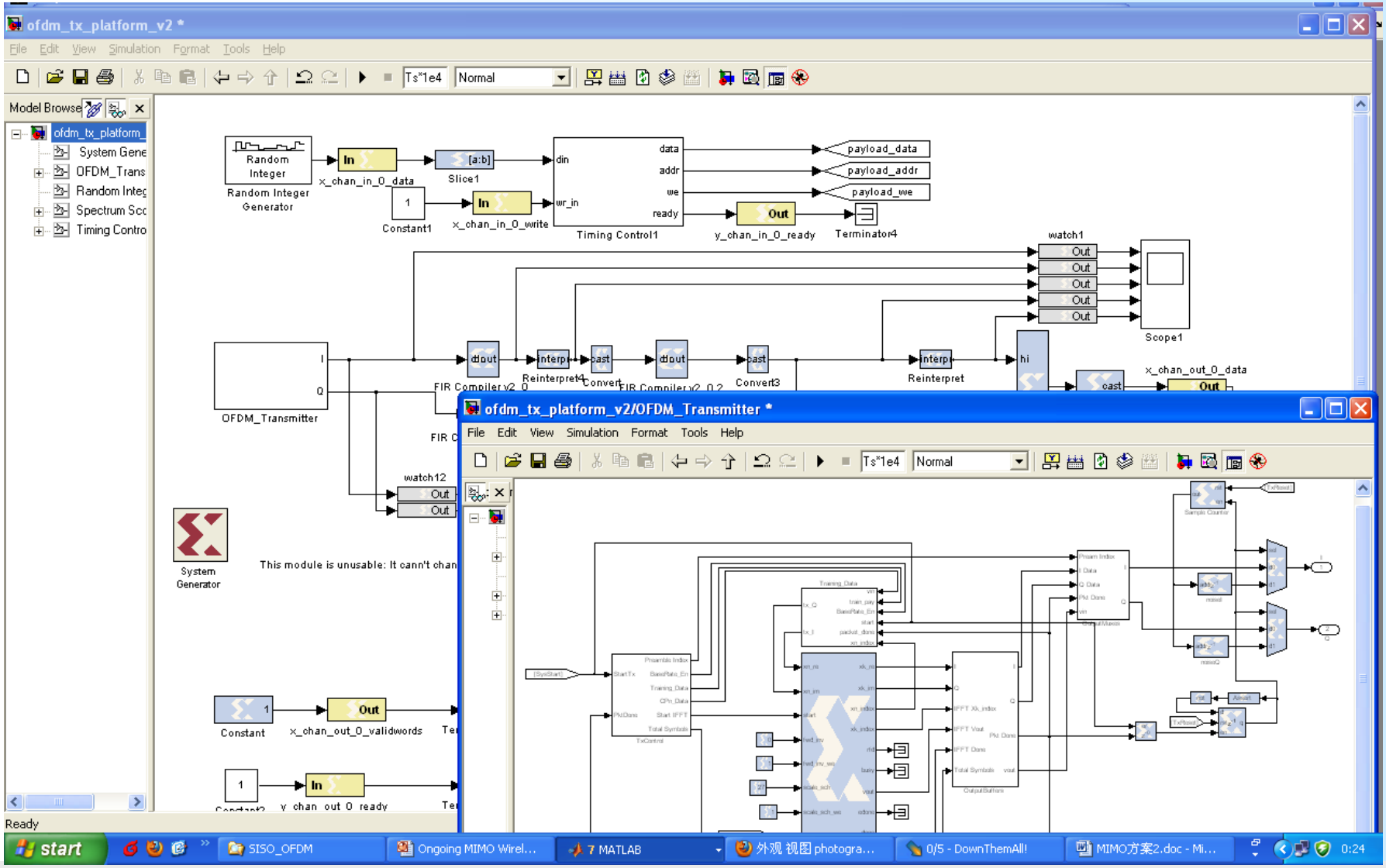
Video Transmission --Data Flow



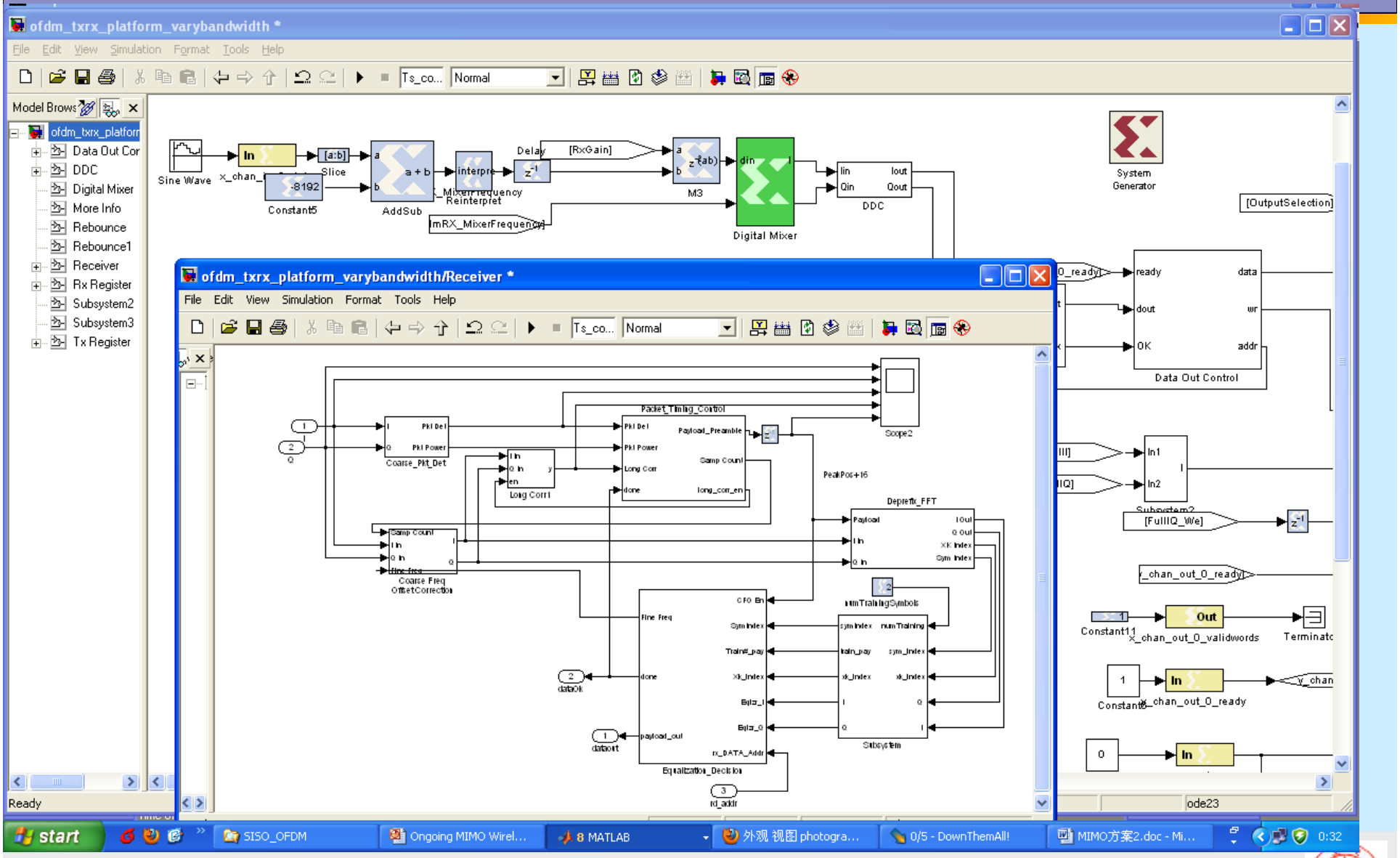
Video transmission



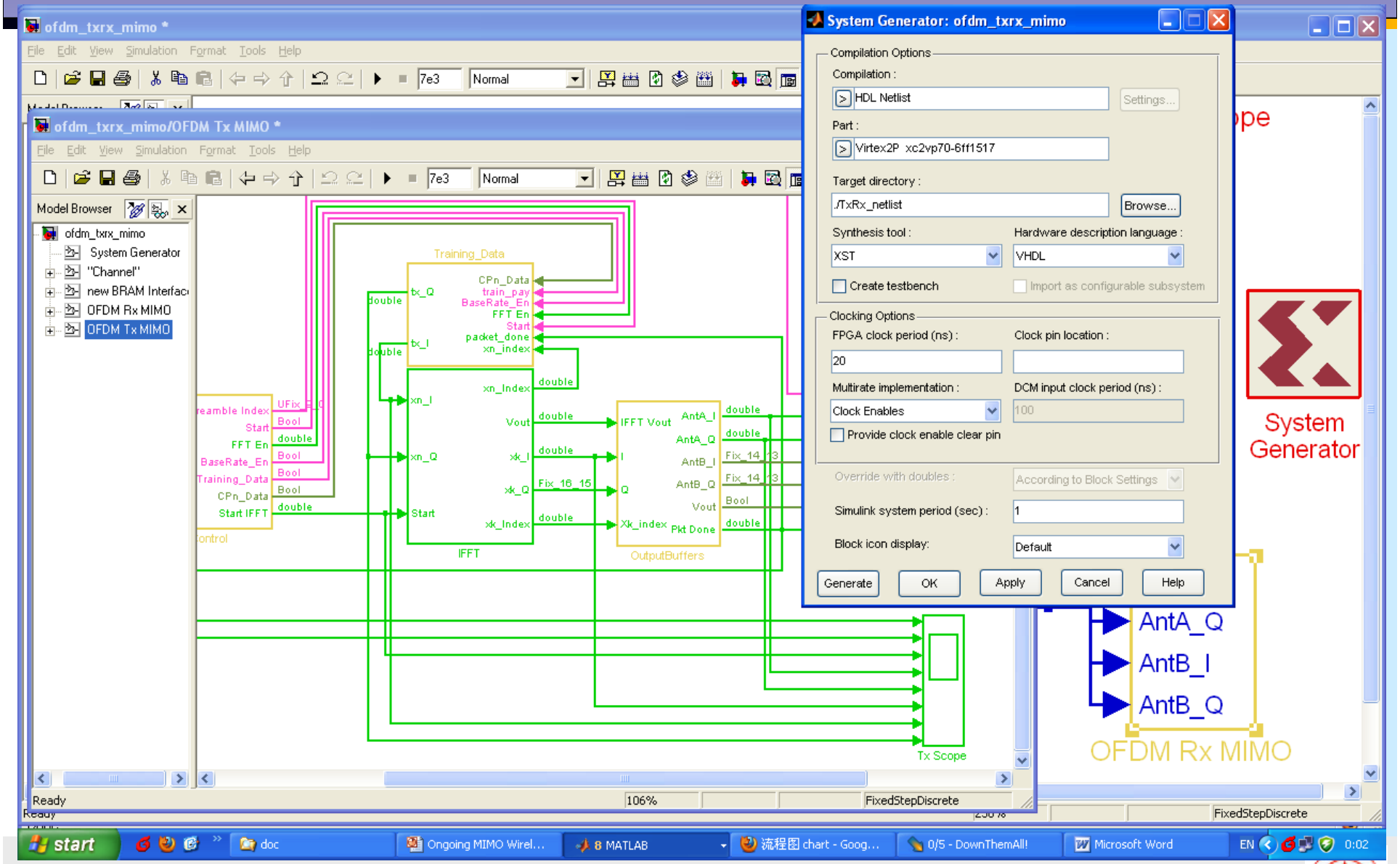
OFDM Transmitter (refer to WARP)



OFDM Receiver (refer to WARP)



Processing Simulink/System Generator



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Future Work

- Non-real Time System
  - Faster and easier development of new system.
  - Non-real Time Signal Processing
  - ICS554+ICS564 Cost about 200,000RMB (~28,600$)
    - Cheaper Solution: USRP (Universal Software Radio Peripheral) , 2 USRP1s and 2 USRP2s for Cognitive Radio testing are ordering from Ettus.

Future Work

- Real Time System
  - Real Time signal Processing
  - Complexity: more complex than C/Matlab, cimpler than VHDL/Verilog
  - Cost of Sundance SMT8036/SMT8096 cost also about 200,000 RMB
    - Cheaper Solution: System Design by reference to WARP Project.
  - Higher deployment complexity of new algorithm
    - Expected solution??? :MPP-DSP (proposal of National S&T Major Project in 2011)

Thank You

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Welcome to visit Shandong University