



SWAN: an Open Wireless Testbed for IMT-Advanced Technologies

上海先进无线网络
Shanghai Wireless Advanced Network

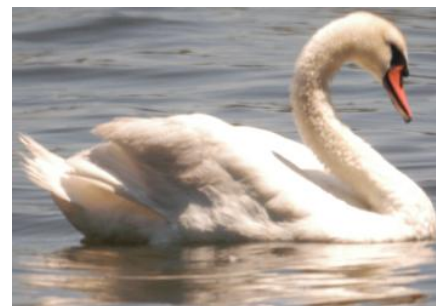
Dr Yang Yang

**Shanghai Research Center for Wireless Communications
SIMIT, Chinese Academy of Sciences**

UC4G Shanghai Workshop, 12 September 2010

Outline

- **About Shanghai Research Center for Wireless Communications (WiCO)**
- **SWAN: Shanghai Wireless Advanced Network**
 - ✓ **Software simulation platform**
 - ✓ **Indoor testing platform**
 - ✓ **Outdoor mobile environment**
 - ✓ **Application demonstration platform**
- **Case studies and demos**



WiCO: Shanghai Research Center for Wireless Communications

- Science and Technology Commission of Shanghai Municipality
- Changning District Government, Shanghai
- Chinese Academy of Sciences (CAS), Shanghai Institute of Micro-system and Information Technology
- Southeast University



→ **MOST:** International Center for Wireless Collaborative Research

→ **MOST:** International Collaboration Base of Science & Technology

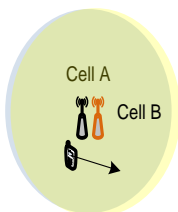
→ **STCSM:** Research and Engineering Center for Broadband Wireless Communication Technologies

→ **CAS:** Key Lab of Wireless Sensor Networks & Communications

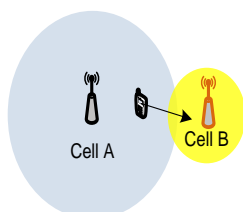


Research Focuses and Expertise

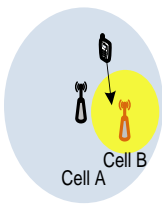
- Cognitive radio and dynamic spectrum access
- Self-organized network (SON)
- Relay technologies
- Interference management
- Networks convergence



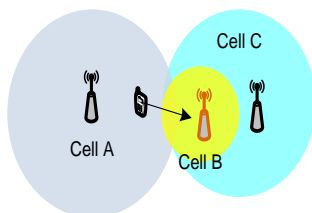
(a)



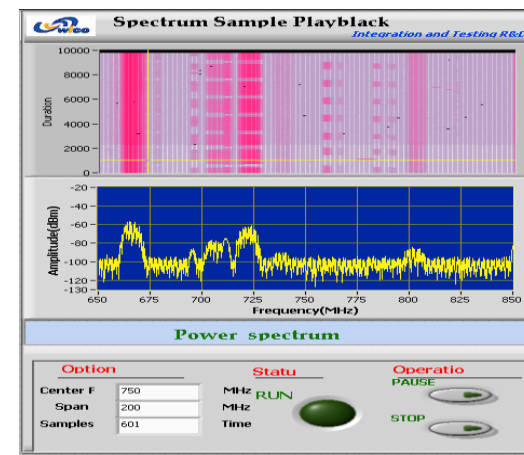
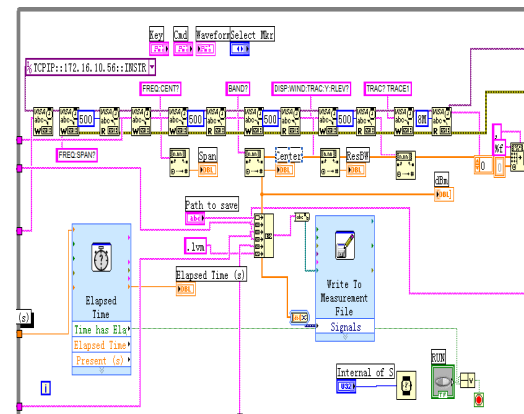
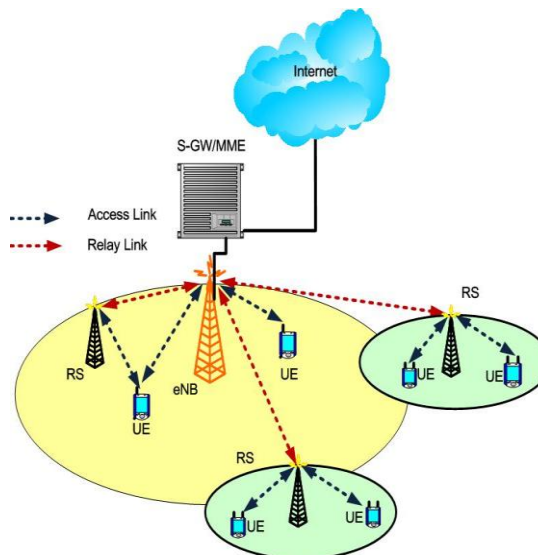
(b)



(c)



(d)



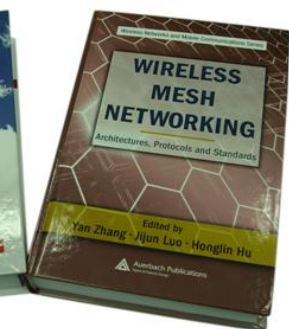
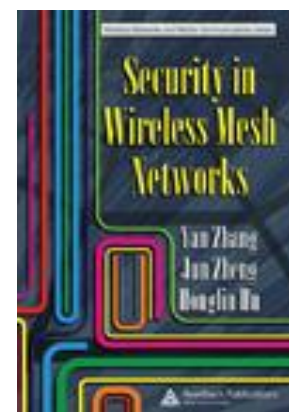
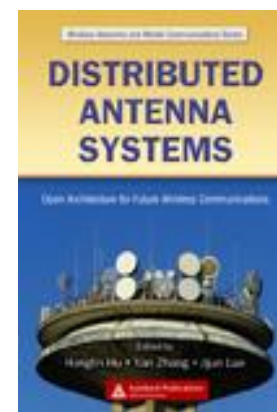
Research Outcomes (2004-2010)

140+ technical patents, 70+ standard proposals
6 books, 140+ research articles

上海先进无线网络
Shanghai Wireless Advanced Network

发明名称	申请号
一种分层软小区无线网络及其接入控制方法	PCT/CN2004/000772
一种正交频分复用系统中的信号均衡方法	200410066488.4
一种多发射多接收天线正交频分复用发射/接收机	200410084227.5
一种基于速度和位置的无线通信系统的切换方法	200410089455.1
一种自适应滤波方法及装置	200410089454.7
一种多载波	
一种基于多带滤波器组的正交复用多载波发射、接收装置及其方法	200510026962.5
正交频分复用	
一种基于多带滤波器组的正交复用多载波传输降低峰均比的装置及其方法	200510026964.4
一种通信系统	
基于多带滤波器组的单载波频分多址发射、接收装置及其方法	200510029196.8

Conference	Tdoc Number	Title	论文题目	会议名称	作者
Athens, Greece 9-13 May, 2004	R1-050480	Downlink Multiple Access Scheme for Evolved UTRA	Adaptive Transmission Mode Selection Scheme for Distributed Wireless Communication Systems	IEEE Communications Letters,	Honglin Hu, Martin Wackerle, and Jijun Luo
	R1-050481	Uplink Multiple Access Scheme for Evolved UTRA	Adaptive Frequency-Domain Interference Cancellation and Channel Equalizer for MIMO-CP-CDMA Systems	In Proc. IEEE WCNC 2006, pp.1573-1577, 2006	Jing Xu, Haifeng Wang, Shubin Cheng, Ming Chen, Zhiyong Bu
Quebec, Canada, 30-31 May 2005	REV-050663	An Introduction To MBFB Based VMC for Uplink of E-UTRA	Global Regions Planning for Adaptive Transmission Mode Selection Scheme	In Proc. IEEE GLOBECOM 2006,	Honglin Hu, Haibao Yi, Mingqi Li, Xiaodong Zhang
	REV-050664	An Introduction To OFTDM Based VMC Scheme			
Sophia Antipolis, France, 20-21 June, 2005	R1-050609	OMC Transmission Technique for E-UTRA systems	Adaptive COI Feedback Signaling for Multi-Stream MIMO Transmission	ICWMMN 2006	Zhaokang Zhang, Mingqi Li, Honglin Hu, Haifeng Wang, Bin Zhou, and Xiaohu You
	R1-050610	Adaptive dual cyclic timeslot structure for E-UTRA systems	Novel Bi-orthogonal Filter Bank Based Transmission		周斌, 程斌, 姜小东, 王慧勇
	R1-050662	OMC based interleaving FDMA for E-UTRA	Novel SNR Analysis for Adaptive Modulation and Coding in General Cellular Systems	ICWMMN 2006	李朝晖, 姜小东, 李洪波, 程斌
	R1-050663	OFDM transmission scheme in OMC sub-band for E-UTRA	Complexity-Reduced Multiscale Detection for MIMO Systems Using Sparse Decoding	ICWMMN 2006	Wei Zhao, Fan Yang, Yong Xiong
London, UK, 28 August - 2 September, 2005	R1-050781	OMC Transmission Scheme and Parameters for Evolved UTRA Uplink	Joint channel estimation and tracking in the Evolved UTRA uplink	ICET/ICWMMN'06	Xiumei Yang, Xiumei Xia, Yang Xiong
	R1-050782	Text Proposal: OMC Based Uplink Basic Transmission Scheme for TR 25.814	Novel time domain channel estimation and synchronization errors	ISSSTA	Xiumei Xia, Xiumei Yang, Yang Xiong, Jijun Luo
	R1-050784	Unifying MIMO for E-UTRA	基于载波 OFDM 系统的自适应技术	中文期刊: 通信理论与技术学报	刘斌, 刘光平, 王慧勇
	R1-050785	Text Proposal: Pilot Structure Used in Single Carrier Transmission for E-UTRA Uplink	An Improved MIMO Single-Carrier MMSE Frequency-Domain Equalization for Space-Time Block Code	IST Future 06	汪凡, 程勇
	R1-051132	Further considerations and Simulations of Unifying MIMO for Evolved UTRA	A Bidirectional Adaptive Detection for BLAST Systems Based on Delayed-Sampling	ICCCAS'06	汪凡, 程勇
San Diego USA 10-14 October, 2005	R1-051133	DFT-S-GMC: OMC based SC-FDMA for 3GPP LTE uplink	多天候系统自适应信道建模及检测算法	联大工学学报	汪凡, 程勇, 姜小东
	R1-051134	On the implementation of DFT-S-GMC	A Bidirectional Adaptive Sequential Gaussian Approximation for MIMO Systems	VTC	汪凡, 程勇, 程勇
	R1-051134	On the implementation of DFT-S-GMC	An Efficient Algorithm for MIMO Detection	ICWMMN2006	汪凡, 程勇, 程勇
	R1-051135	Performance comparison between DFT-S-GMC and DFT-S-OFDM	Multiscale Sequential Gaussian Approximation for MIMO Systems	ICWMMN2006	汪凡, 程勇, 程勇
	R1-051384	Further description of DFT-S-GMC implementation	The Multi-Level Mapping Sequential Gaussian Approximation for MIMO Detection	Wcom2006	汪凡, 程勇, 程勇
Seoul, Korea, 7-11 Nov, 2005	R1-051385	Further simulation results of DFT-S-GMC in comparison with DFT-S-OFDM	Ordered Group Interference Cancellation for Quasi-orthogonal Space-Time Block Codes	Wcom2006	汪凡, 程勇, 程勇
	R1-051386	On the PAR/CM performance of DFT-S-GMC	An Efficient Peak-to-Average Power Ratio Reduction Algorithm for V-MAX Systems	APCC 2006	程勇
	R1-051387	Bandwidth Efficiency Aspects of DFT-S-GMC	FUTURE B3D 系统性能测试	移动通信	王萍
			基于多天线系统的 OFDM 系统性能测试方法	计算机工程	程斌



IEEE Xplore Top 100 Downloads (03/2010)



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IEEE Std 830-1998

Page(s):i

Digital Object Identifier : 10.1109/IEEESTD.1998.88286

Abstract | Full Text: PDF (404KB)

2. **Combining the Wind Power Generation System With Energy Storage Eq**

Ming-Shun Lu Chung-Liang Chang Wei-Jen Lee Li Wang

Industry Applications, IEEE Transactions on

Volume: 45 Issue: 6 Date: Nov.-dec. 2009 Page(s):2109 - 2115

Digital Object Identifier : 10.1109/TIA.2009.2031937

Abstract | Full Text: PDF (1219KB)

3. **Smart Grids - the future or fantasy?**

Slootweg, H.

Smart Metering - Making It Happen, 2009 IET

Page(s):1 - 19

Abstract | Full Text: PDF (57430KB)

- This ranking list covers all R&D areas in Electronics and Electrical Engineering
- **36. Carrier aggregation for LTE-advanced mobile communication systems**
- **60. Self-configuration and self-optimization for LTE networks**
- **97. Relay technologies for WiMax and LTE-advanced mobile systems**

Standard Proposals on CR Technology

- Accepted by National ITU Standardization Promotion Group
 - Cognitive spectrum hole definition
 - Cognitive Pilot Channel (CPC) definition and function
 - Centralized decision making
 - Cognitive MAC spectrum sensing
 - Cognitive directional transmission for vertical coexistence
- The last four proposals have been accepted by ITU (Geneva, 11-21 May 2010), ITU WP5A [LMS.CRS].



Standard Proposals on SON Technology



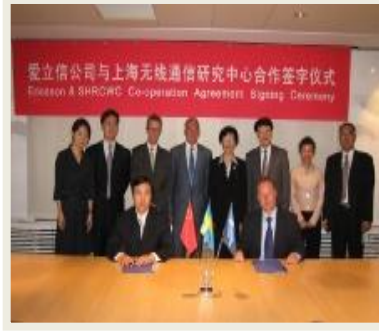
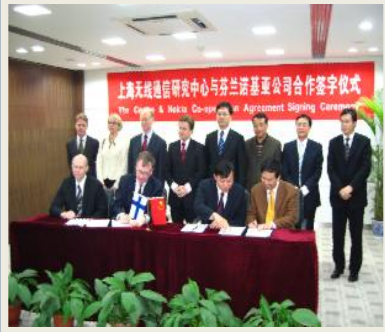
- Accepted by National IMT-Advanced/LTE-Advanced Standardization Promotion Group
 - Issue on PRACH load congestion
 - Consideration of Cell type in MRO
 - Distinguish the cause of RLF
 - HO Configuration Negotiation
 - Consideration on Unnecessary HO
 - Issues on Mobility Change Request Procedure
 - The Negotiation of Cell Reselection Parameters in MLB

Standard Proposals on Relay Technology

- L1 Relay Backward Compatibility Analysis (3GPP TSG RAN)
- Downlink and Uplink Timing Synchronization for TDD Relays (3GPP TSG RAN)
- Performance for Demodulate and Forward (DmF) Relays
- Analysis of Transmission Delay in Relay-enhanced Systems
- Distributed Link Adaptation for Relay-enhanced Systems
- On Link Adaptation for TDD Type II Relay-enhanced Systems
- Association of UE in Type II Relay-enhanced Systems
- Downlink Power Control for Mobile Relay
- Power Control for TDD Uplink
- Mode Management for Mobile Relays
- Downlink Flow Control for Un Interface
- Handover Optimization for Relay-enhanced Systems
- HARQ Timing for TDD Relays



International R&D Collaborations



WiCO-Nokia P1, 2004
WiCO-Ericsson, 2004
WiCO-Siemens, 2005
WiCO-CEA-LETI, 2005



WiCO-France Telecom, 2005
WiCO-Mobile VCE, 2005



WiCO-Prompt, 2006
WiCO-Nokia P2, 2007



WiCO-CSIRO, 2009
WiCO-Nokia P3, 2010



...



SWAN: Shanghai Wireless Advanced Network

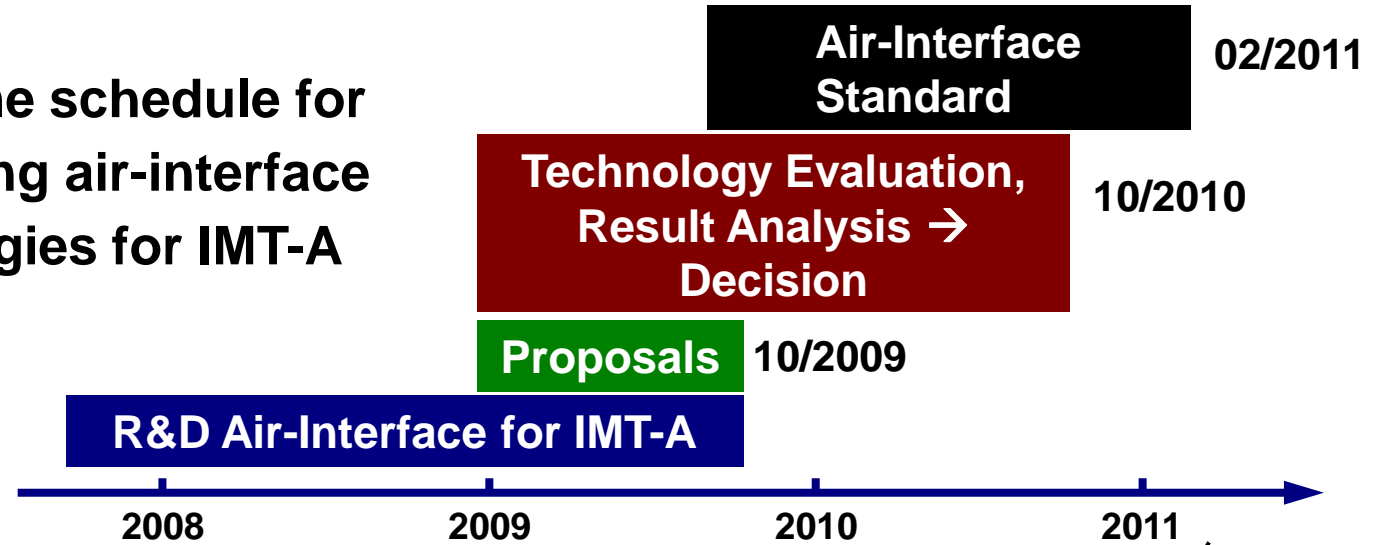
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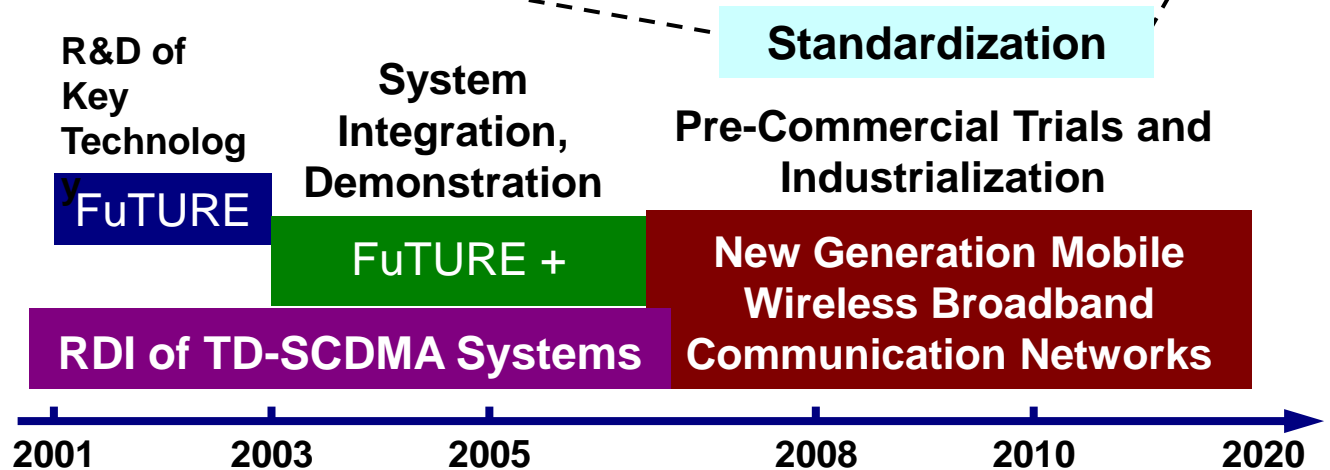
International and National R&D Activities towards New-Generation Mobile Communication Networks



ITU-R time schedule for developing air-interface technologies for IMT-A



R&D of 3G and future mobile systems in China



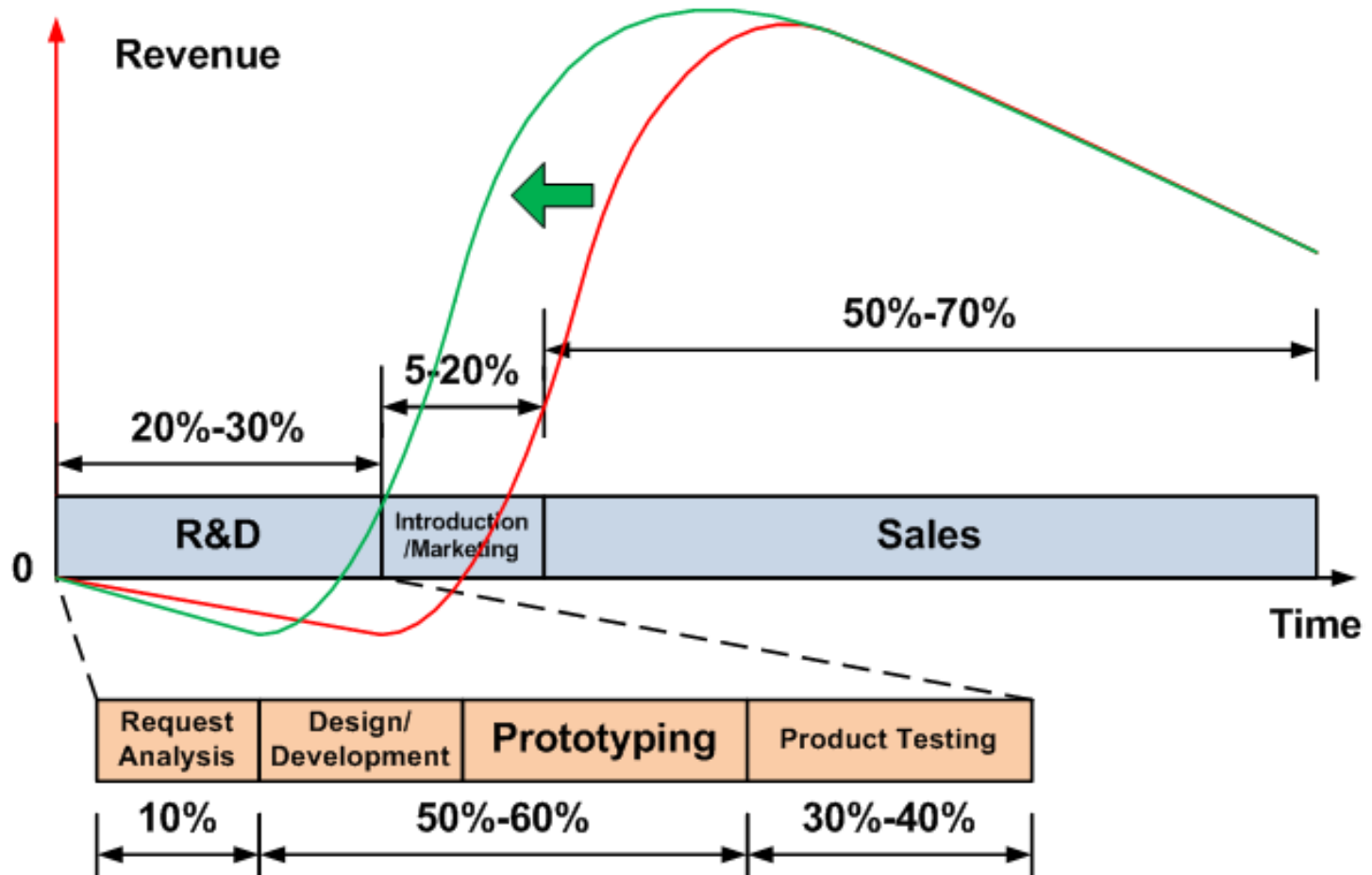
Technical Requirements



- **Wireless data rate: 1 Gbps (static) and 100 Mbps (mobile)**
- **Spectrum efficiency: 5-10 bps/Hz (D-link), 2.5-7 bps/Hz (U-link)**
- **Frequency bands: 450-470MHz, 698-790MHz, 2.3-2.4GHz, 3.4-3.6GHz**
- **Transmission bandwidth: 20/40/100 MHz**
- **MIMO support: 4x6MIMO**
- **Wireless channel models: Rice, Rayleigh, Nakagami, GSM, DCS, IS-54, IS-95, 3GPP/3GPP2 SCM, SUI, WINNER, etc.**
- **Application protocols: HTTP, SSL, FTP, Telnet, POP3, SMTP, RTSP, RTP, etc.**

Aim and Objectives

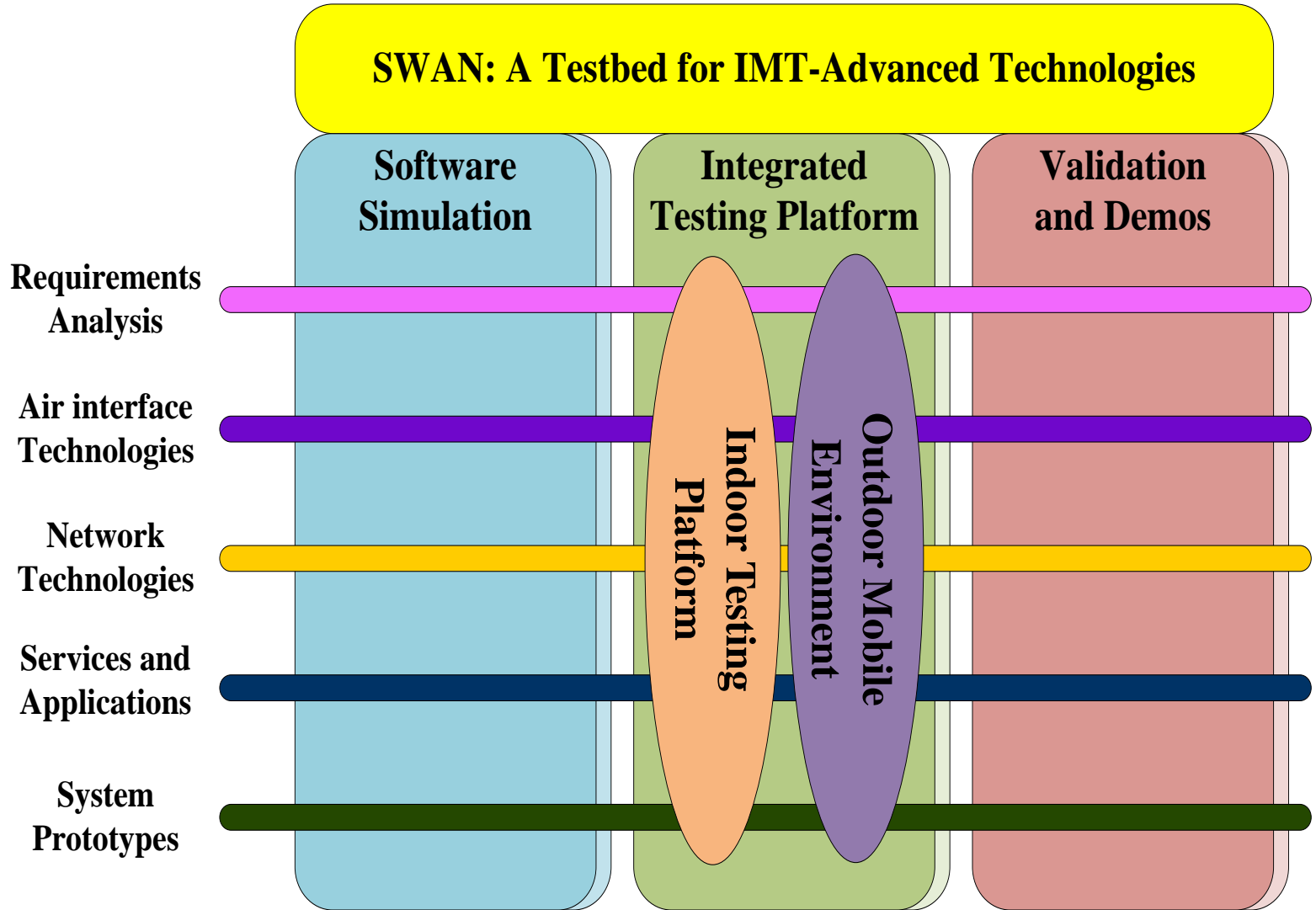
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Software Simulation Platform



- **3GPP LTE R8 uplink and downlink channels implementation**
- **Parallel computing facility at Shanghai Supercomputer Center (25K cores)**
- **Multi-cell multi-user scenarios (system-level simulation)**

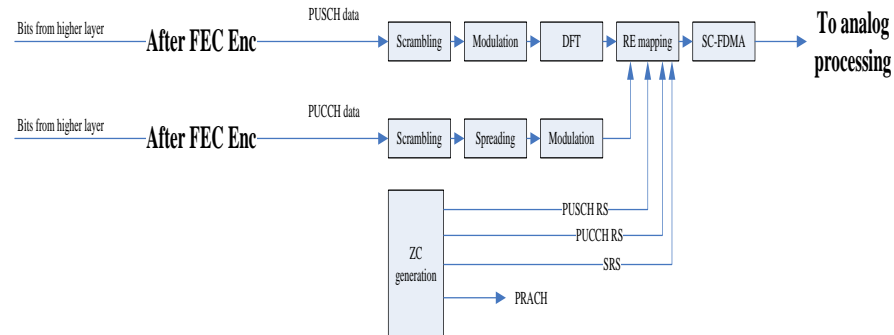


图1 UL 传输链示意图

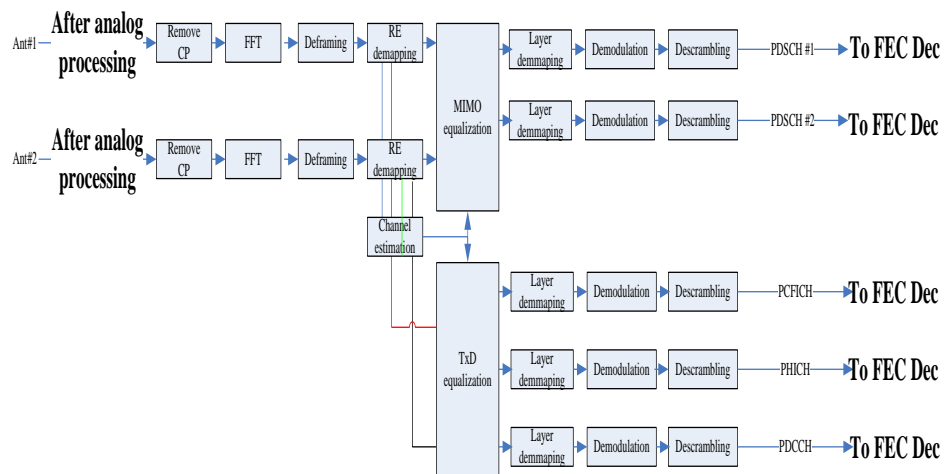
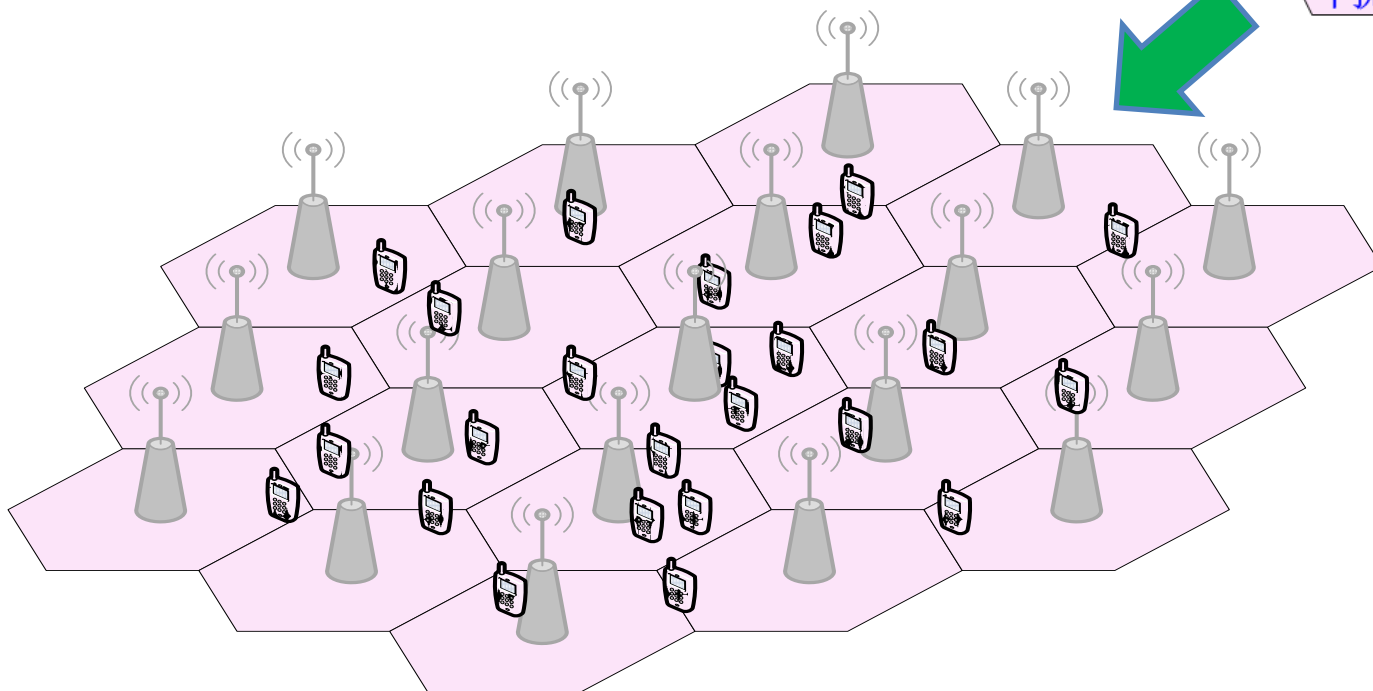
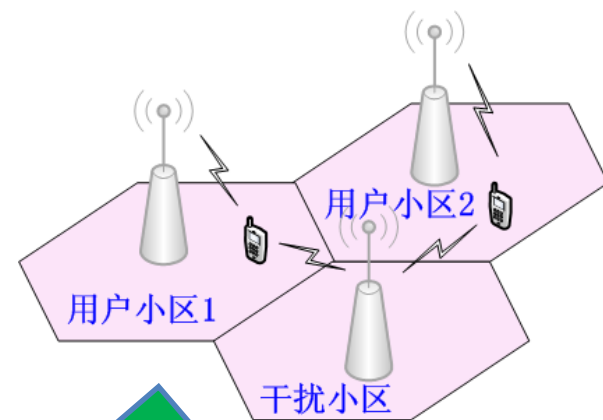


图2 DL 传输链示意图

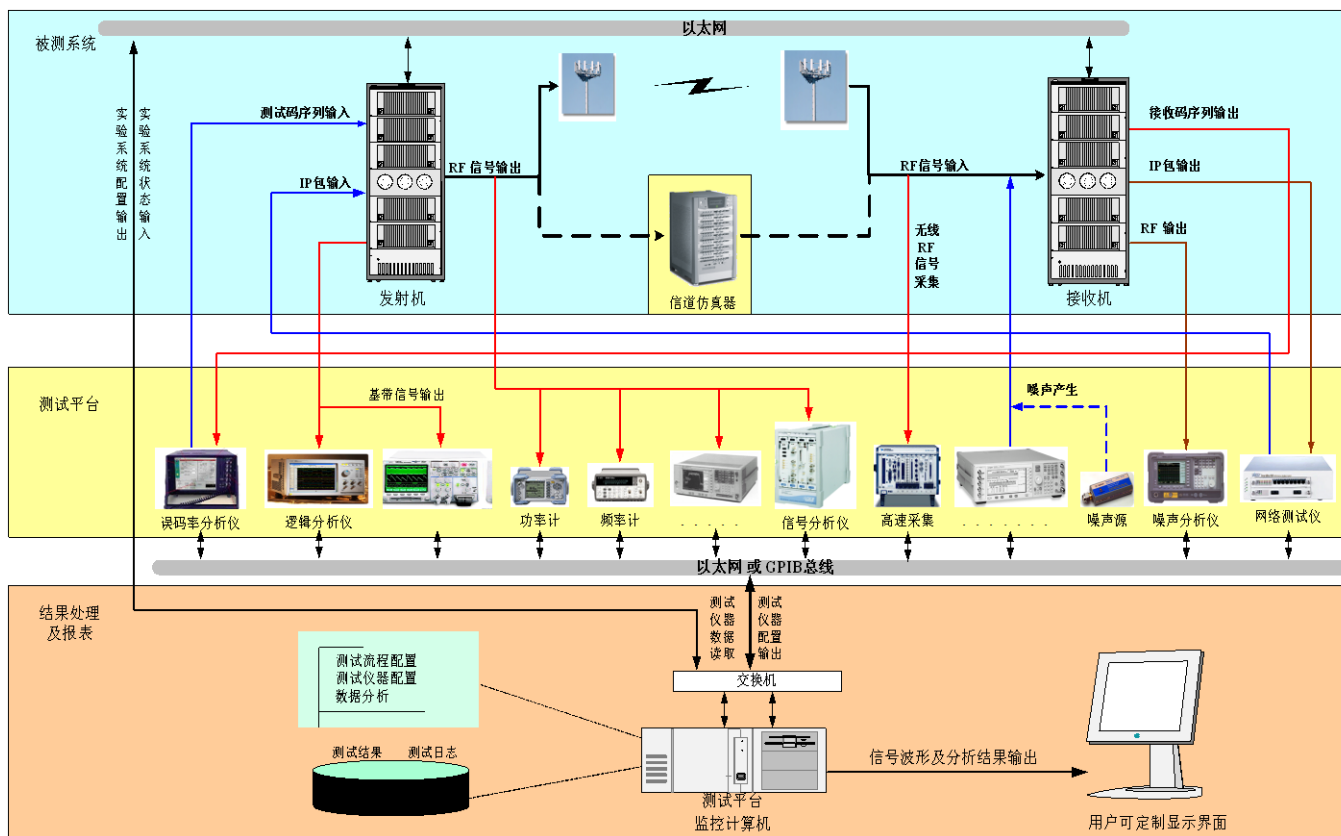
System Level Simulation

- Coordinated Multi-Point (CoMP)
- Enhanced Inter-Cell Interference Coordination (eICIC)
- MU-MIMO technology



Indoor Testing Platform

- A VISA-based open, shared and flexible testing environment



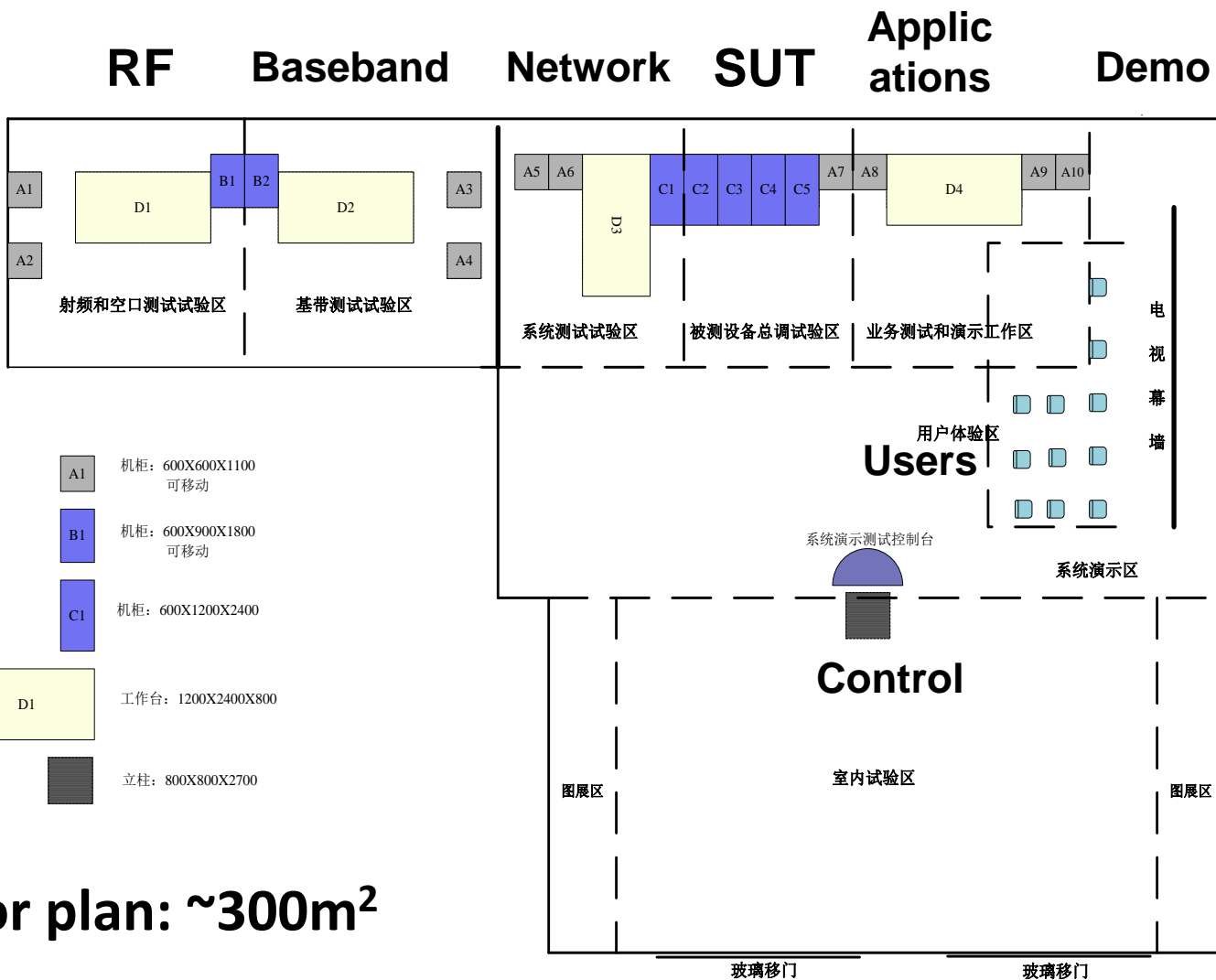
System Under Test (SUT)

Software & Hardware Equipments

Control & Demo Platform



Indoor Testing Platform



Floor plan: ~300m²

Outdoor Mobile Environment

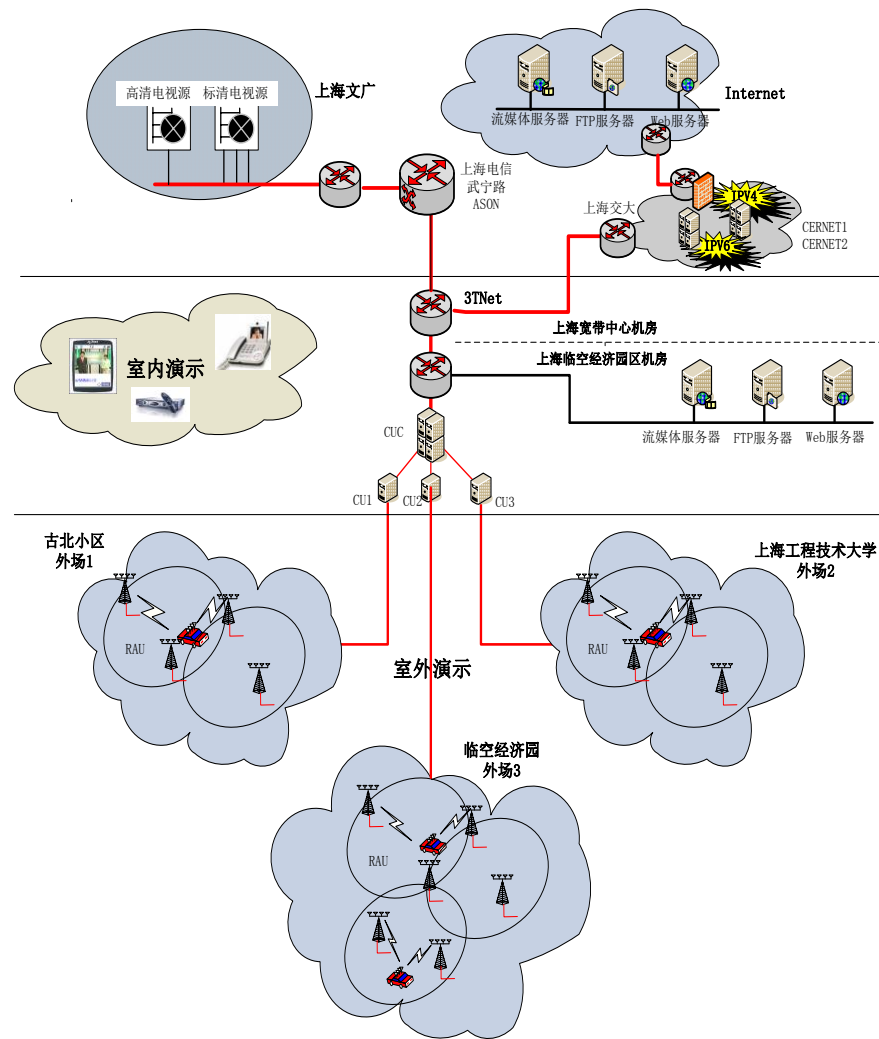


无线网络
Advanced Network



Application Demonstration Platform

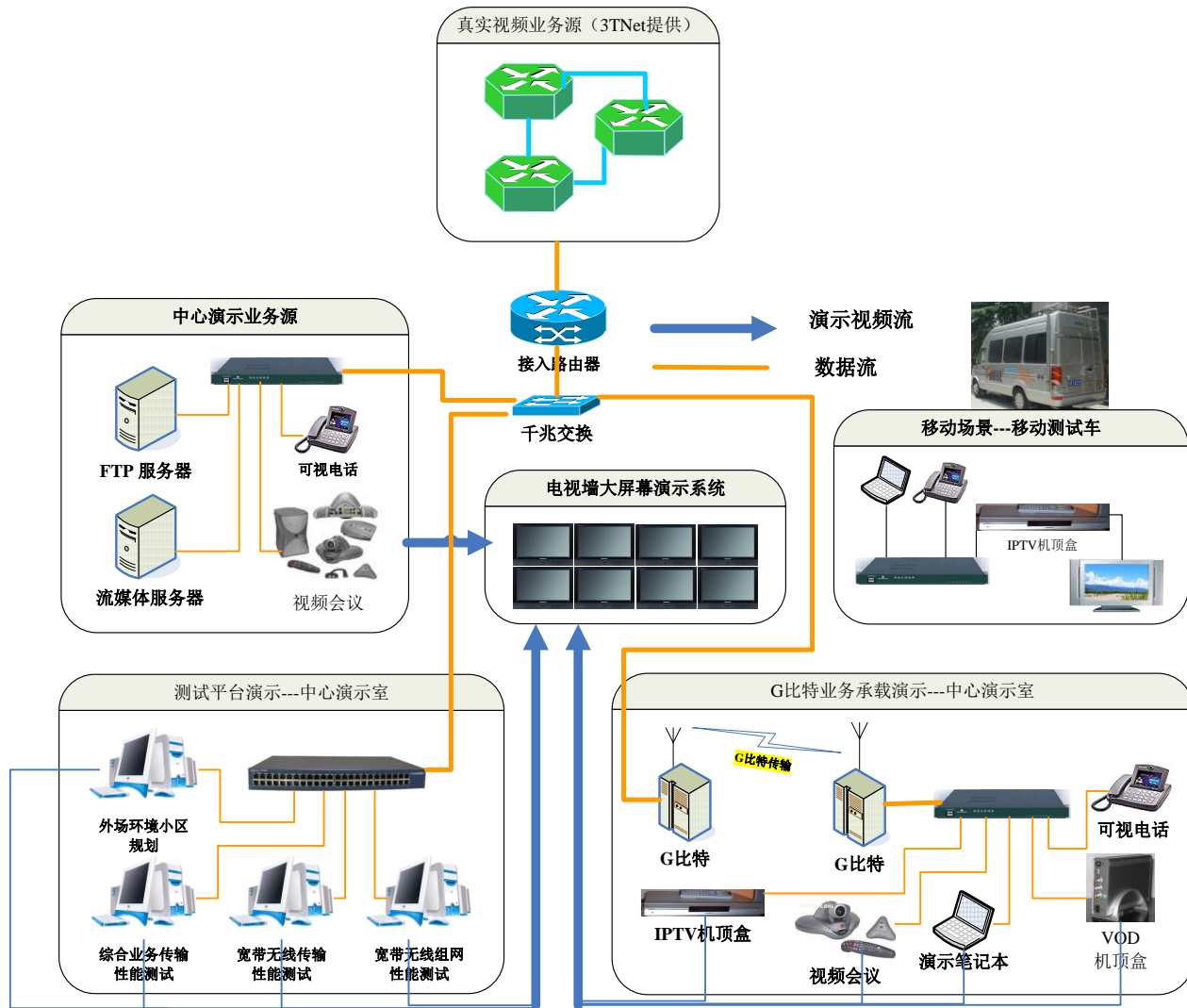
- **Broadband multimedia traffic from the Internet, digital TV programs, and telecom networks**
- **High data-rate and very bursty traffic to demonstrate the capabilities of IMT-Advanced technologies**



Application Demonstration Platform



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WWW.SWAN.SH (coming soon)



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English

SWAN故事 科研人员 现有资源 成果展示 技术研讨 合作交流 我的SWAN



- [参观指导]
- [案例]
- [成果]
- [讲座]
- [研讨会]
- [合作交流]

...[更多新闻]

提交测试需求

自主远程测试

算法共享

我来贡献

免责条款

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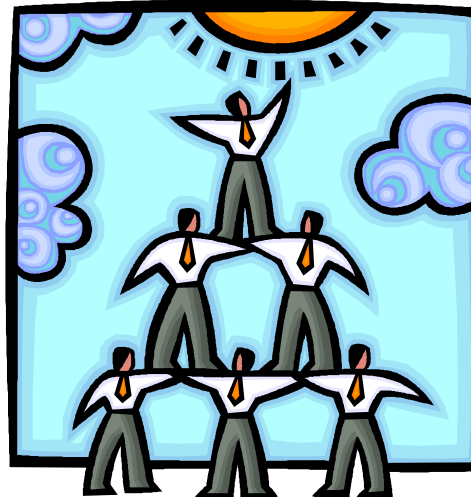
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Case Studies and Demos

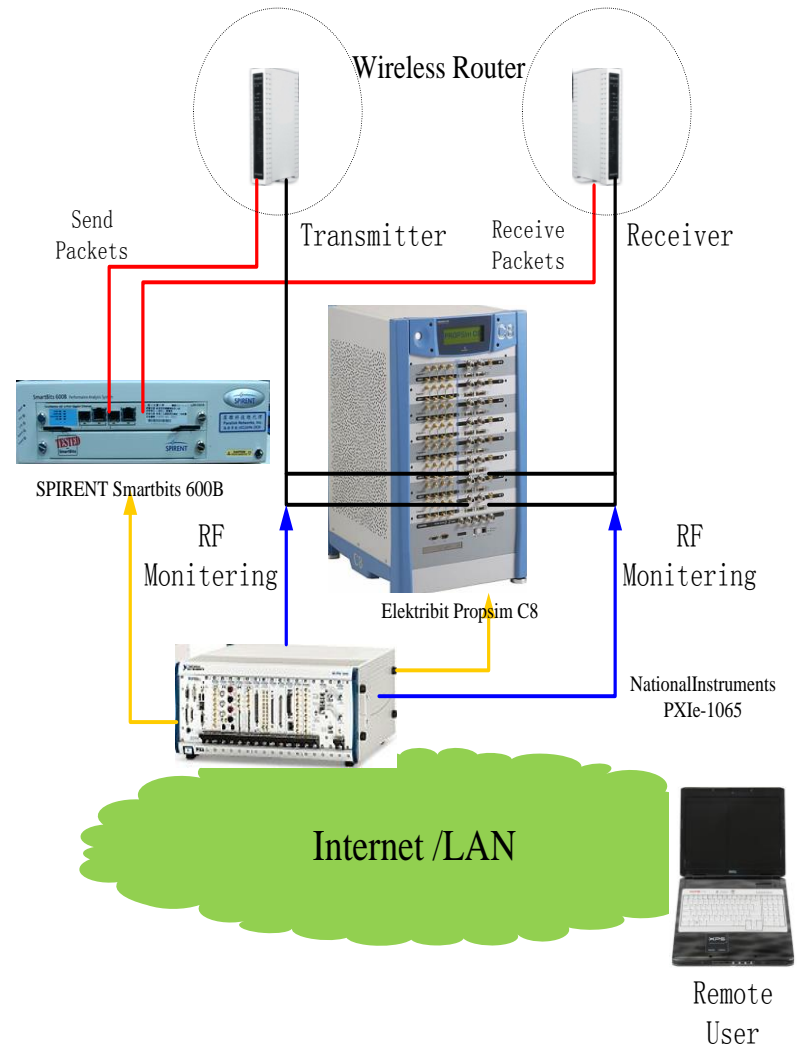
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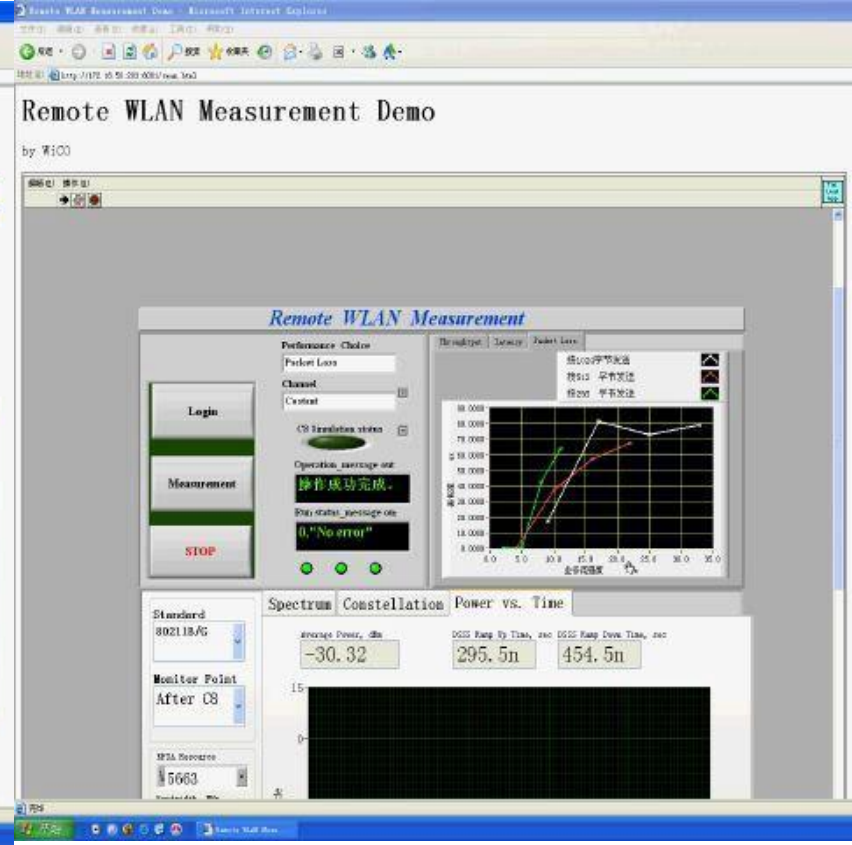
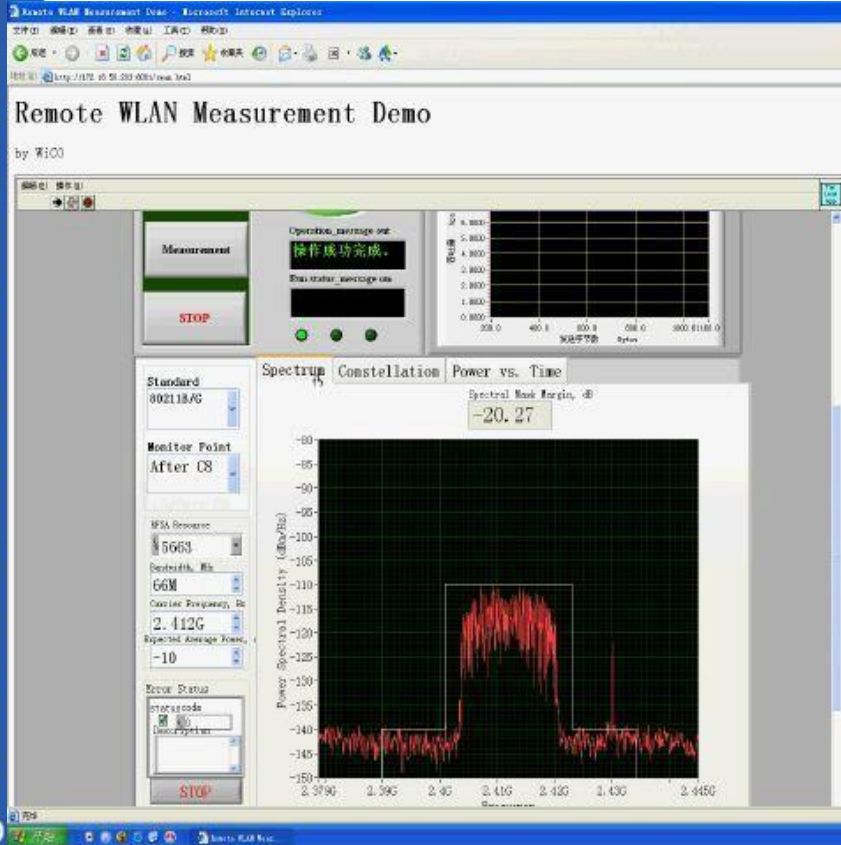
Remote Cross-layer Testing

- Web-based remote access and control
- Multiple radio channel models
- Repeatable testing
- Cross-layer metrics
 - L3: Throughput, Delay, Packet-loss
 - L1: Power spectrum density, Symbol Constellation



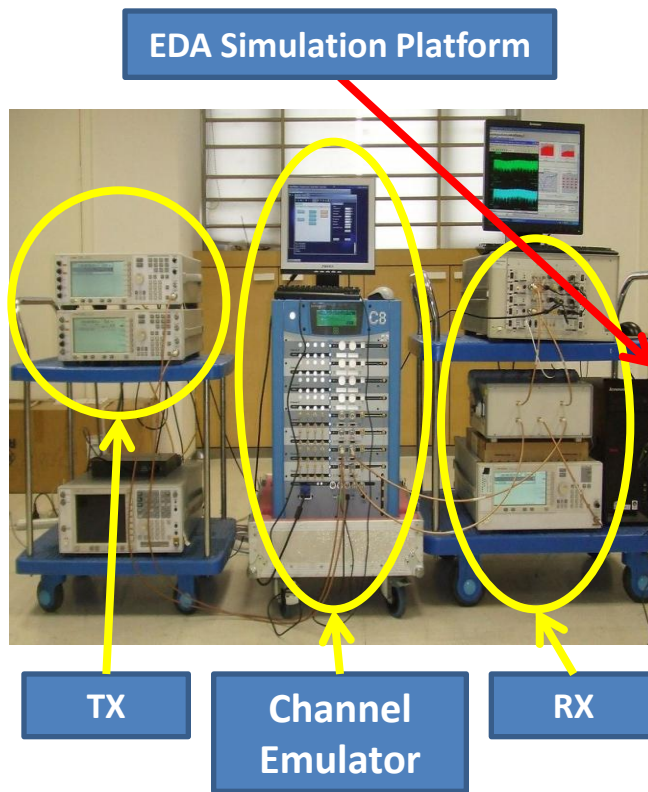
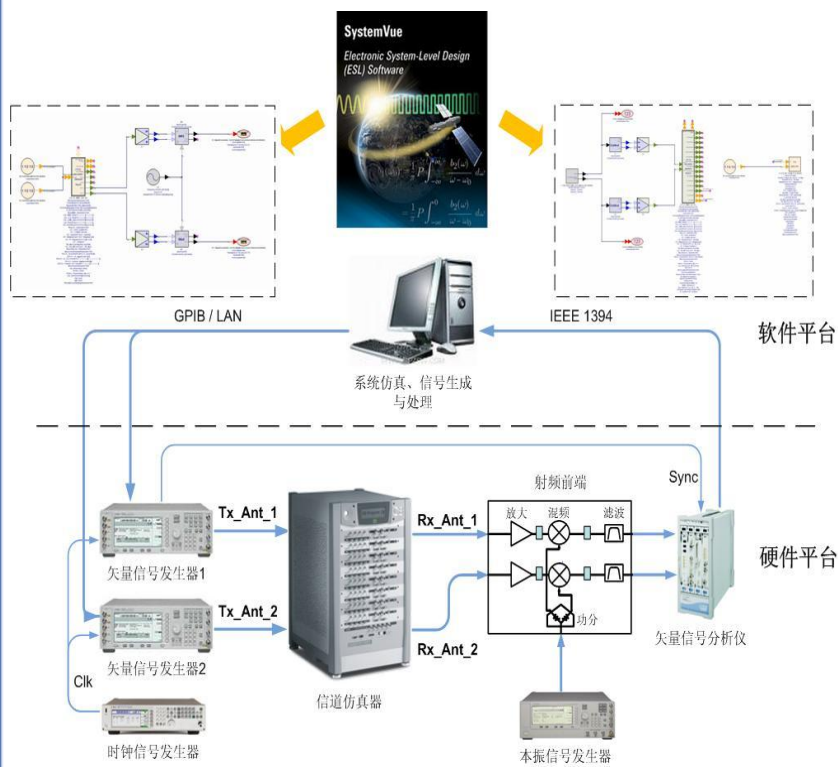


Remote Cross-layer Testing



Standardized Link-Level Development, Validation and Performance Evaluation

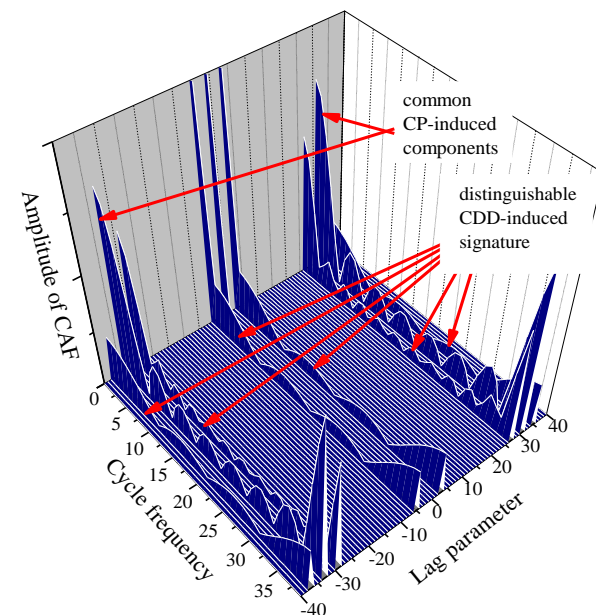
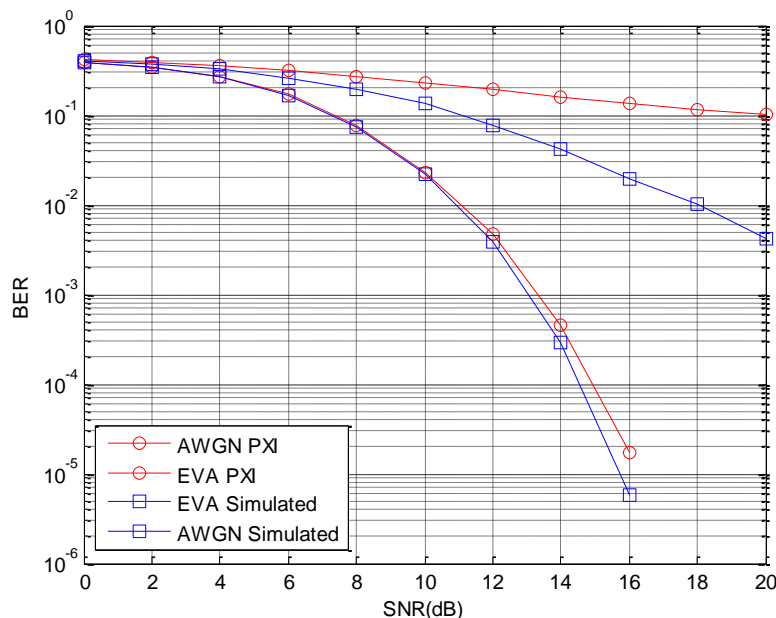
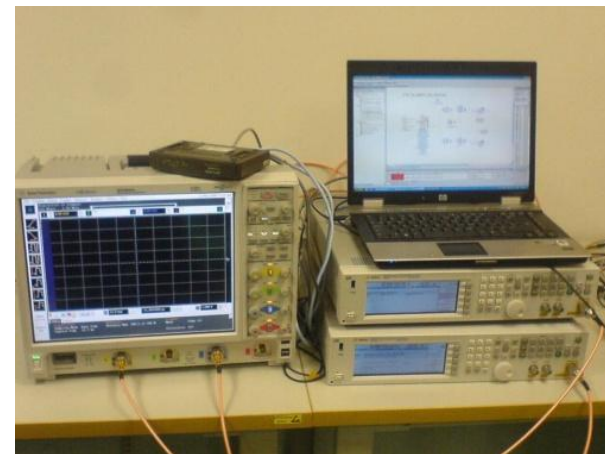
- Integrated hardware/software physical-layer testing and performance evaluation platform



Customized Algorithms Development, H/W Implementation and Evaluation

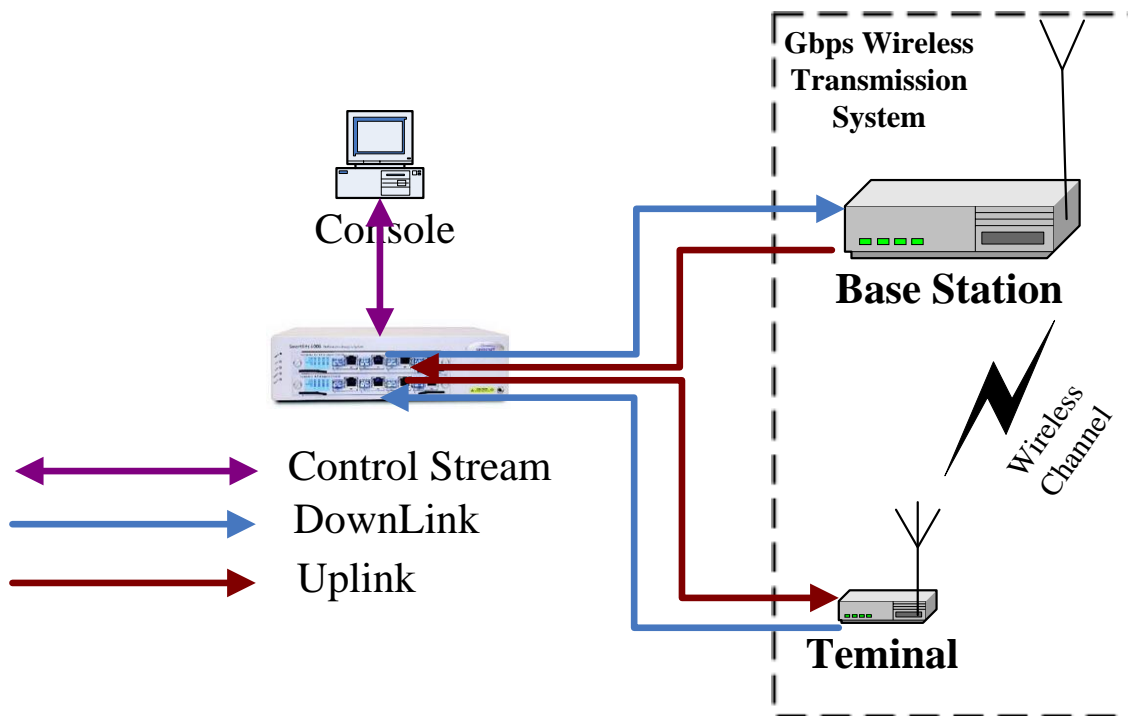


- Frequency offset correction algorithms (UESTC)
- Cyclic delay diversity (CDD) in cyclostationary signatures (WiCO)



Broadband Wireless Applications

- A MIMO/OFDM-based Gbps wireless platform
- Iperf software for performance evaluation
- SmartBits 600B for traffic generation



Conclusions

- SWAN: an Open Wireless Testbed for the R&D of IMT-Advanced Technologies
 - ✓ Software simulation platform
 - ✓ Indoor testing platform
 - ✓ Outdoor mobile environment
 - ✓ Application demonstration platform
- WiCO is keen to promote international R&D collaborations in future mobile communications technologies, for knowledge creation, technology transfer and standardization.





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