Wireless and Optical Communications Conference 2006

Wireless R&D in Hong Kong Aiming at Differentiating Our Industry

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Outline

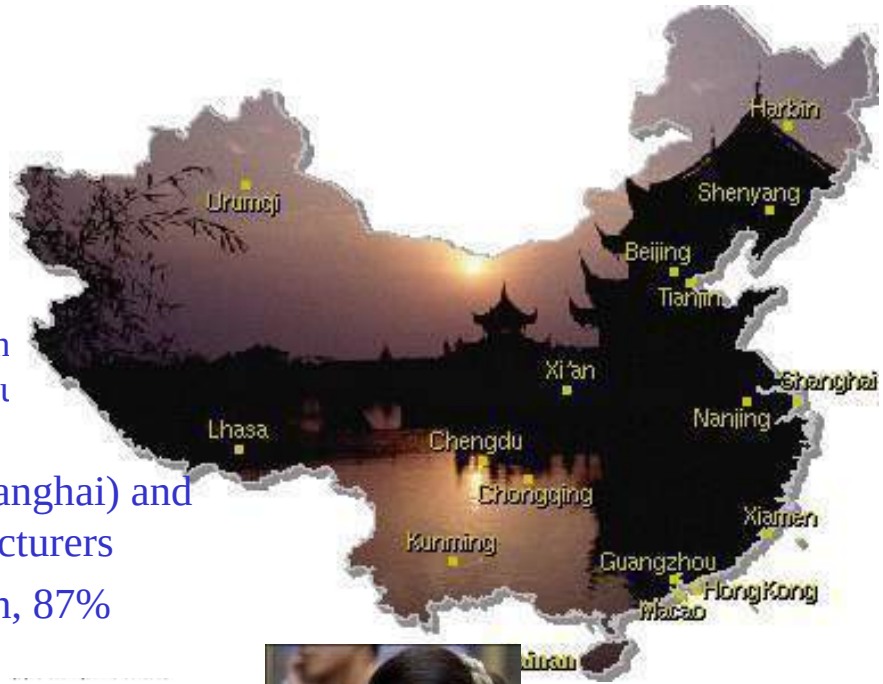
- Market and Technology
- ICT R&D Centre
- Wireless R&D
- Summary

Global Wireless Communications Market

- Mobile Phone: 674M units in 2004, 730M units in 2005, volume greater than predicted every year, 1.1B by 2008 [Gartner, March 2005]
- WiFi: 68M units in 2004, 110M units in 2005, annual growth rate 60%
- WiMAX: 2M subscribers in 2004, 17M by 2008, 802.16e is the future star [Visant Strategies, 2004]
- WPAN(UWB): projected for 2.8B units by 2008, wireless USB for cable replacement [In-Stat, 2004], wireless 1394 another huge potential market
- DTV: 54.5M units by 2005, 249M units by 2008, 350% growth [iSupply, December, 2004, etc]
- Mobile cellular, WMAN, WLAN, WPAN convergence for ubiquitous communications and multimode multifunction applications

Mobile Phone, WiFi, and BWA in China

- World Largest Mobile Phone Market Place
  - 334.8M (65M new) users by 2004, WW share 20%,
  - Penetration rate grow 6.8% 2000, 25.9% 2004
- World Largest Mobile Phone Production Country
  - 233M units 2004, WW share 34.5%
  - 25.2% growth compared to 2003
  - 103M domestic (BIRD, TCL, AMOi, Capital, Dbtel, Hisen etc), 130M foreign manufacturers (Nokia, Motorola, Samsu Sony Ericsson, etc.)
- WiFi services deployed by China Telecom (Beijing, Shanghai) and China Netcom, 70% of equipment from foreign manufacturers
- WiFi 100M USD production value in 2005, 51% growth, 87% 802.11g compliant
- Chipsets development by Silan, Spreadtrum, T3G, etc.
- Asia Pacific 45% WiMAX Market 2009, equipment US$1,988.2 M 2009, subscribers 3 M 2009.
- China 38% of regional WiMAX equipment revenue 2009, followed by South Korea 23.1%, and Japan 22.5%.
- China highest WiMAX service revenue 2009, due to its largest subscriber base developed by competitive wireless service providers.



Source: pDay, Juniper Research

Telecom in Hong Kong

- Gross telecom revenue HK$46 billion, 3.3% year-on-year growth 2005
- Public Mobile Phone Service (March 2006)
  - 14 digital networks: 2G/2.5G (10 operators), 3G (4 operators)
  - Number portability
  - 124% penetration (8.6 M subscribers)
- Local Fixed Telecom Network Services (FTNS)
  - Liberalized Jan. 2003
  - 10 licensed companies Mar. 2006
  - 54.4% penetration (3.8 M lines) Jan. 2006
- Broadband Services
  - 186 ISPs March 2006
  - Speed up to 10 M bps
  - 24% penetration (1.66 M subscribers) Feb. 2006
  - 66% of household
  - Second only to Korea
- External Telecom Services
  - Liberalized Jan. 1999
  - 231 ETS licensees
  - IDD to 245 countries/regions

- Broadband Wireless Access
  - Two rounds of consultation in Dec. 2004 and Aug. 2005
  - Allocation of 3.4~3.6 GHz band for BWA
  - A maximum of 6 licensees each with 15x2 MHz bandwidth
  - Provision of full mobility service after 1 Jan 2008
  - Hybrid selection method (pre-qualification and open auction) to be adopted

Source: OFTA, Hong Kong

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Technology and Hong Kong

- **Hong Kong's future in China**
  - 40% of all jobs (1.5 M) in Hong Kong are either directly related to or engaging in producer services for Mainland manufacturing activities.
  - Technology is a significant driver for China's future and the opportunities associated with it.
  - Hong Kong recognizes that its economical future lies in becoming a strategic part of a bigger whole (China and PRD).
- **Hong Kong and the Pearl River Delta (PRD)**
  - In 2002, PRD accounts for 33.8 % of China's international trade and 34.3 % of its inward foreign investment.
  - Guangdong produces more than 30 % of China's electronics output, 50 % of its biomedical output, 50 % of its advanced ceramics output and 68 % of its medial electronics output.
  - Guangdong's R&D expenditures in manufacturing is comparable to the combined total of Shanghai, Jiangsu and Zhejiang.
  - HK/PRD will be a leading center in China's technological future.

Technology and Hong Kong (Continued)

- **China's technology promises and IP challenges**
  - China is fast becoming both the world's largest manufacturing center and its largest market for many technology-intensive products.
  - China is begining to build up its own technology and IP bases to fully exploit these vast opportunities.
  - "Domestic IPs" are now a major priority for the government's Eleventh Five-year Plan.

- **Hong Kong's comparative advantages and opportunities**
  - Factor conditions to attract the best talent from around the world
  - Legal system to thoroughly protect the creation and practice of IPs
  - Hong Kong has the factor conditions to be an effective partner in China's IP and technological future …
  - and ASTRI is the vehicle to spearhead this mission.

ICT R&D Centre-ASTRI
A Brief Introduction

- **Hong Kong's center for applied science and technology research (established 2001)**
- **Missioned to be a strategic technology unit that creates real economical impact for Hong Kong/PRD**
  - **Establish Human Resource Edge**
  - **Practice "Customer-focused R&D"**
  - **Transfer IPs cost-effectively**
- **Focused on information and communications technologies**
  - **Enterprise and Consumer Electronics**
  - **Communications Technologies**
  - **IC Designs**
  - **Material and Packaging Technologies**

ASTRI Technology Programs

Enterprise & Consumer Electronics

H.264 HDTV Compression

Multimedia over IP

Mobile TV

Dual-mode Phone

H.264 AAC-HE

WiFi PMP

IP STB

UPnP

iFi SIP Phone

Home Media Centre

IC Design

Analog-Mixed Signal Design

charger

camera

High Voltage Analog

RF, CMOS

Low Voltage Analog

DMB-T/H

DVB T DVB H

AVS 产业联盟 AVS Industry Alliance

MPEG

H.264

STB

IPTV

PMP

Fixed DTV

mobile DTV

Communication IC

Multi-Media IC

Design Service

IP Hardening

8051 MCU

32-bit RISC MCU

MCU

System on a Chip

Communications Technologies

OFDM

WiMAX/B3G/4G Edge Node, CWMS

Re-configurable Core

Broadband Access

UWB MAC, Base Band

Turbo Charged WiFi

WiFi/WiMax

WiFi/WiMax/DxB

Method & Apparatus

MIMO

Advanced Antenna

Internal Antenna for 2.5G/3G, WiFi, DxB, WUSB

New Anode Material

Wireless Home AV Gateway P2P/P2MP, SD/HD

Re-chargeable & Env Friendly Battery

Material & Packaging

LED General Lighting

Optical Sensor

LED TV Backlighting

Photonic Package

Embedded Optical Link

System in Packaging

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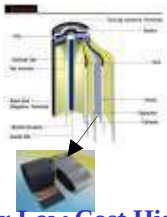
Wireless Communication System Trends

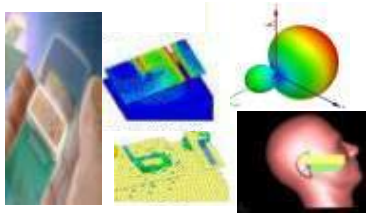
- **High data rate, high spectrum efficiency**
  - 802.11a/b/g (54Mbps) -> 802.11n(>100Mbps) -> Gigabit Wireless (>1Gbps)?
  - 2G/2.5G (19.2Kbps-144Kbps)-> 3G(384Kbps-2Mbps) -> B3G/4G(100Mbps-1Gbps)
  - Bluetooth (0.7Mbps) -> UWB (480Mbps) and best power/bits efficiency
- **Ubiquitous radio access**
  - 802.11a+b+g, 3G+2.5G, WLAN+WMAN/WWAN,…
- **Miniaturization**
  - Handset, PDA, iPOD……

ASTRI Wireless Core Technology Platform

WM^{7}F: Wireless/Mobile Miniaturized MultiMode MultiMedia MultiFunction



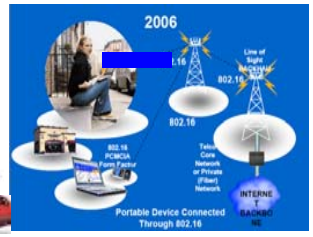
Super Low Cost High Performance Re-chargeable, High Capacity Disposable Batteries



Internal Antenna for 2.5G/3G, JacketPhone, WiFi, DVB/DAB, Multimode, WUSB …

Wireless Home AV Gateway & Adaptors P2P/P2MP, SD/HD

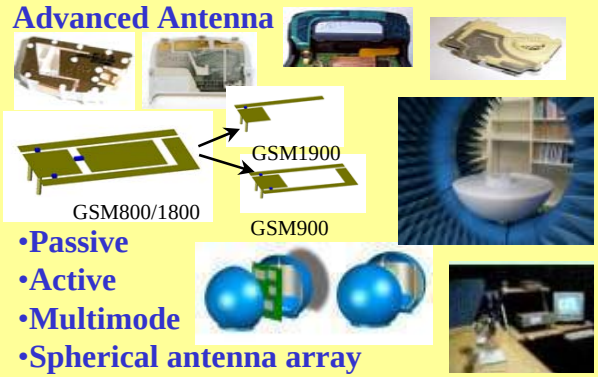
Turbo Charged WiFi
WiFi/WiMax Duo
WiFi/WiMax/DxB Trio



WiMAX/B3G/4G
Edge Node, CWMS

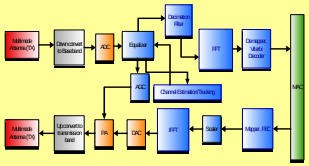
Technology Platform & Solutions: Speed, Efficiency, Power, Cost, Size

Advanced Antenna



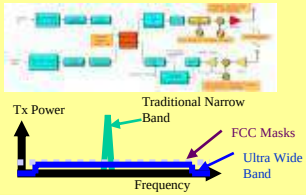
- Passive
- Active
- Multimode
- Spherical antenna array
- Terminal antenna measurement

Multimode Multifunction



- Re-configurable OFDM Core
- Dual/single core
- Concurrent mode
- Mode switching

Broadband Multimedia Access

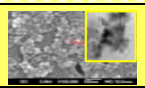


- OFDM/OFDMA
- Ultra Wide Band
- Quality of Service
- RF Management

High Spectral Efficiency

- Practical MIMO with joint antenna, RF, BB design
- Intelligent mode switch
- Wireless Filter Bank

Material and Miniaturization



- New anode material for low irreversible cap.

- Miniaturized RF components-passive, active
- Highly integrated modules: RF, digital, system; new material

- *Establish world-class IPR portfolio and technology platform to strengthen local wireless industry*
- *Joint R&D with local and international companies and organizations on advanced product platforms*

TCL · BIRD · freescale semiconductor · STL STANDARD Telecommunications LTD. · GSL · KANTAN · mti · we3 · molex · LG Electronics · vtech VTech Group of Companies 偉易達集團 · GP Electronics (HK) Limited · ZDC · ALTAI Altai Technologies Limited · SMARTBridge · wavecom

CT KTI's

Roadmap | 2005 | 2006 | 2007 | 2008 | 2009 | 2010+

KTI 1: Multimode Multifunction System Technologies

- Advanced BWA Systems
- WiFi Cellular
- Advanced Broadband Platform (PHY+MAC) & CWMS
- Advanced Broadband BTS Platform & Enhanced CWMS
- Advanced BWA

- Re-configurable OFDM Core
- OFDM Core Seed
- ReOFDM Core for DMB-TH/DVB-TH (FPGA)
- ReOFDM Core for WiMAX/DxB/WiFi (FPGA) & Platform
- WiMAX/DxB/ WiFi ASIC

KTI 2: Low Power High Efficiency Radio Access Technologies

- Wireless Personal Networks (UWB)*
- Core Algorithms and WUSB Solutions
- UWB Applications and WPAN CTP
- Embedded IP Cores & WPAN CTP Applications
- Next Generation WPAN IP/IC Solutions

- Practical MIMO Core
- MIMO Core seed
- Advanced Indoor MIMO Platform
- Advanced MIMO Embedded Chipset
- MIMO Applications for Future Standards

KTI3: Miniaturization Technologies

- RF Components
- Internal Antenna CoE
- Passive Antenna System
- Multiple Antennas
- Active Antenna for Multiple System

- Material & Modules
- NG Material for Mobile Power Source
- RF Components, Modules and IPs
- Rx & Tx RF Modules and IPs

KTI 4: Service and Application Enabling Technologies Platform

- Services Enabling Technologies
- Industry Engagement
- Mobile/Wireless Applications Platform

- Remote Home-Health-Care
- Value-added Device Solution I
- Value-added Device Solution II

- Wearable Terminal & System Technologies

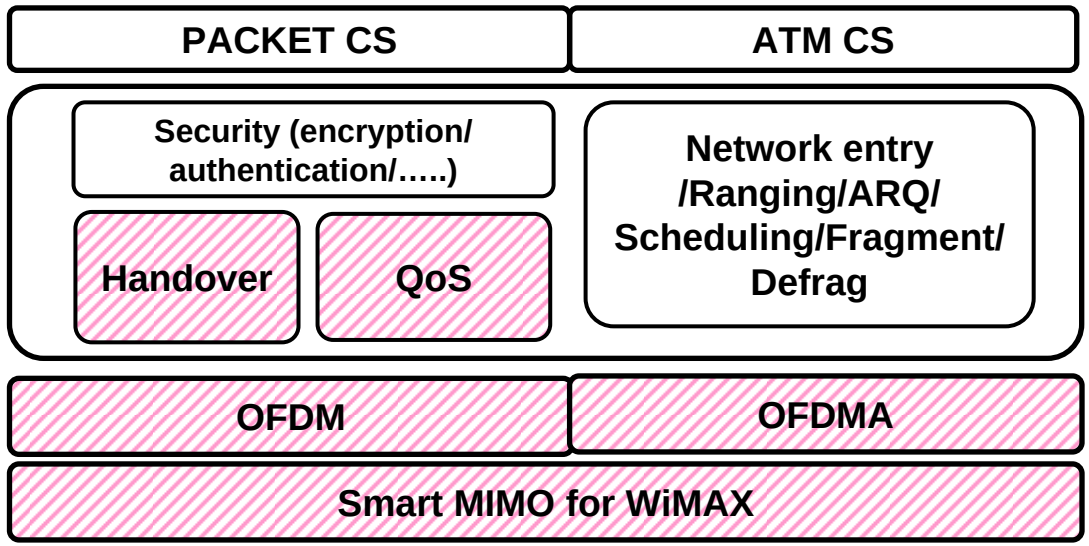
WiFi Cellular

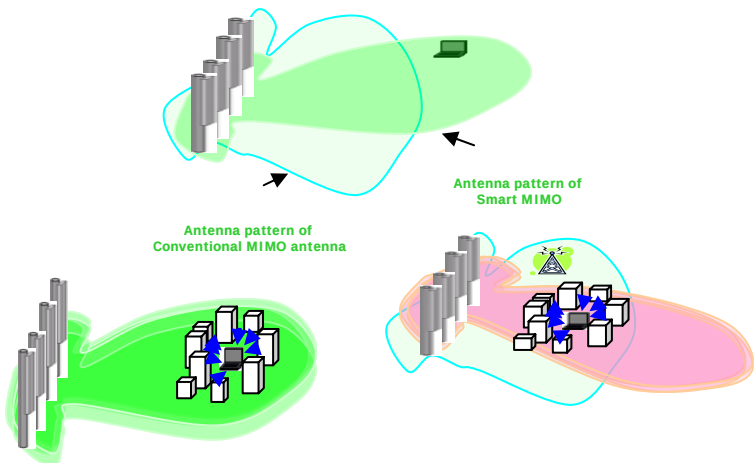
- Smart Radio Frequency Network
  - Re-configurable antenna panel
  - Smart network algorithms to enhance system performance
- SmartRF Access Point
  - Residential building and community access
  - Successful Field trial in China and U.S.
- Integrated Network Management System
  - Large scale WiFi Cellular network support

- **Strong expertise in advanced wireless communications technology**
- **Successfully spun-off as ALTAI on 1st May, 2006**
- **Hong Kong ICT Award**

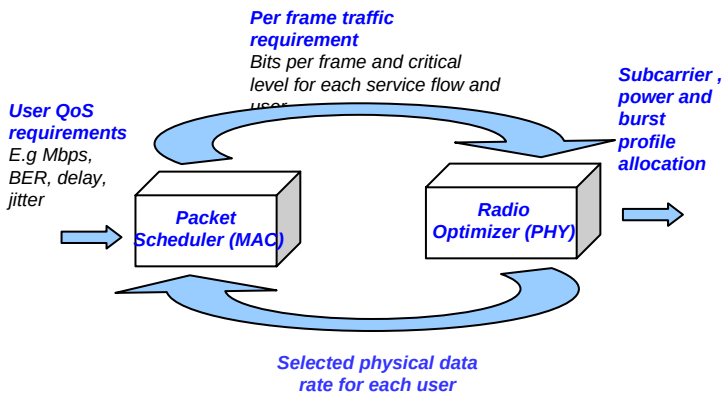
Broadband Wireless Access Technology Platform

Platform to develop PHY algorithms and differentiating IP



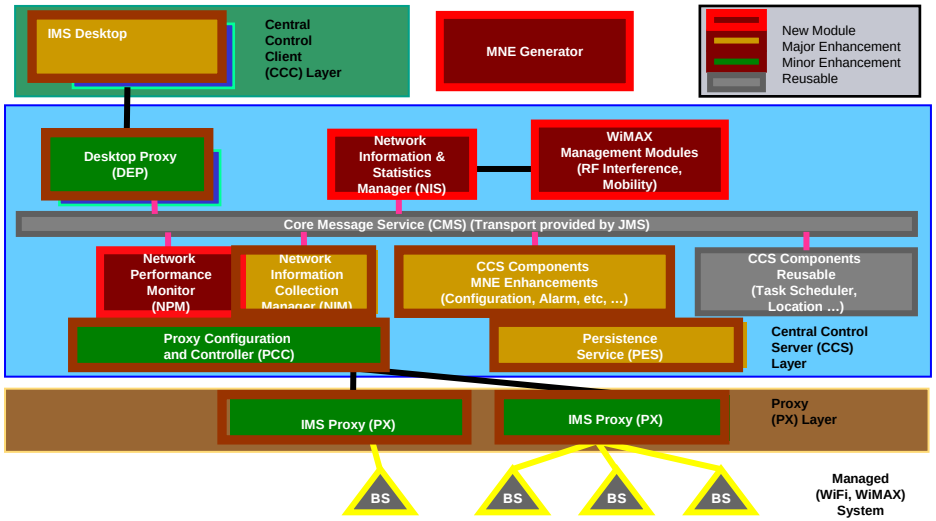


Smart MIMO for coverage extension, capacity improvement, and interference mitigation

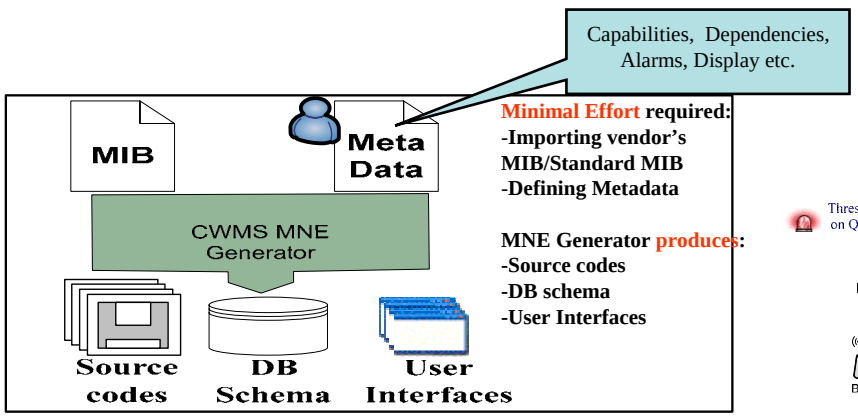


Cross-layer Optimization for QoS Improvement

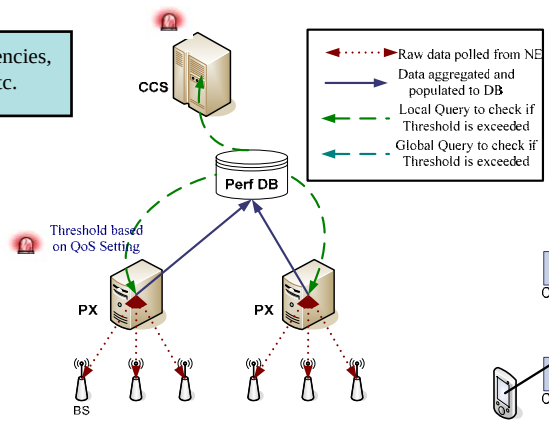
Customizable Wireless Management System



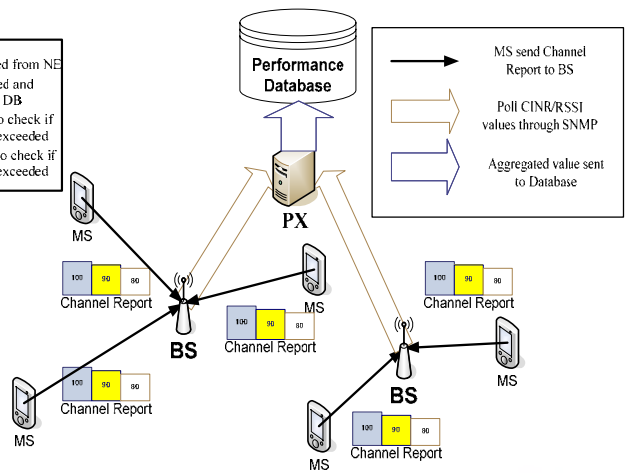
- Multiple Network Element Framework
  - MNE Generator
  - Configuration Management
  - Alarm…
- WiMAX Features
  - Performance Data
    - NIS, NIM
  - QoS Management Modules
  - RF Monitoring Module



Rapid Customization for new vendor's Equipment with Multiple Network Element (MNE) Framework



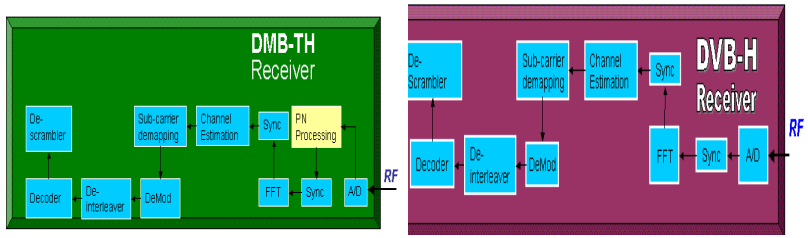
WiMAX QoS Monitoring



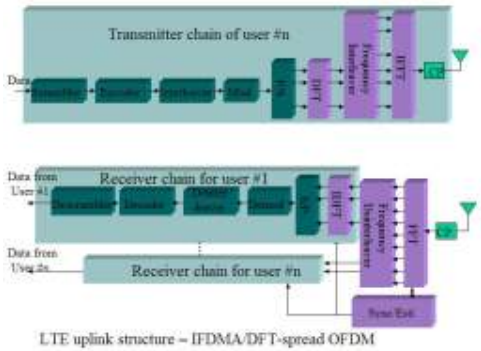
WiMAX RF Monitoring

Re-configurable OFDM Core

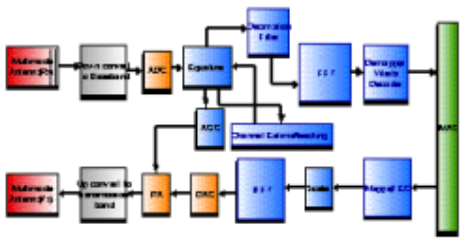
DMB-TH/ DVB-H

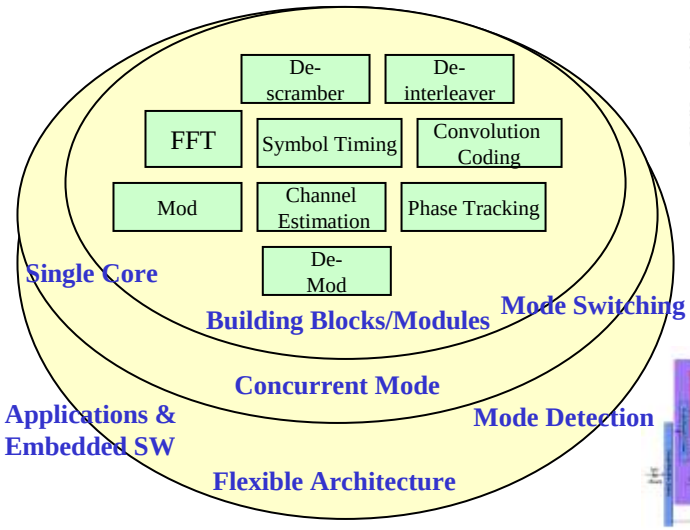


3G LTE

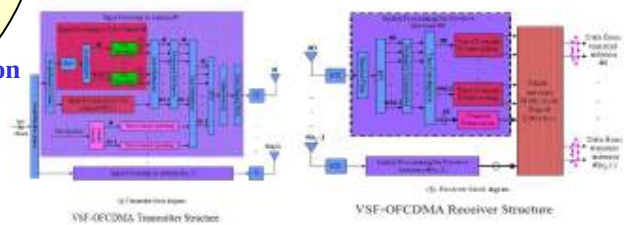


WiFi/WiMAX





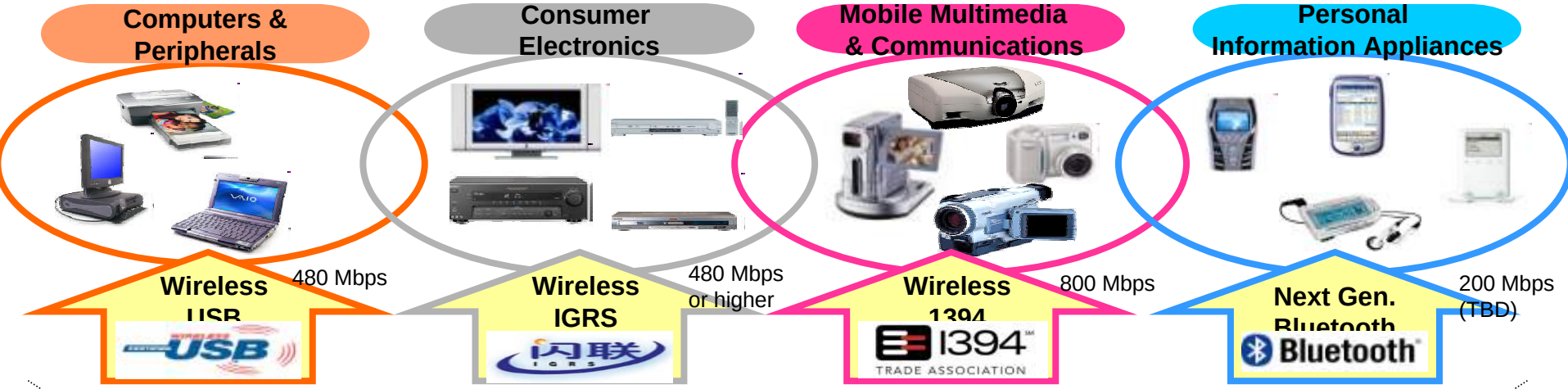
4G



Single & Multiple Mode Terminals

UWB Core Technology Platform

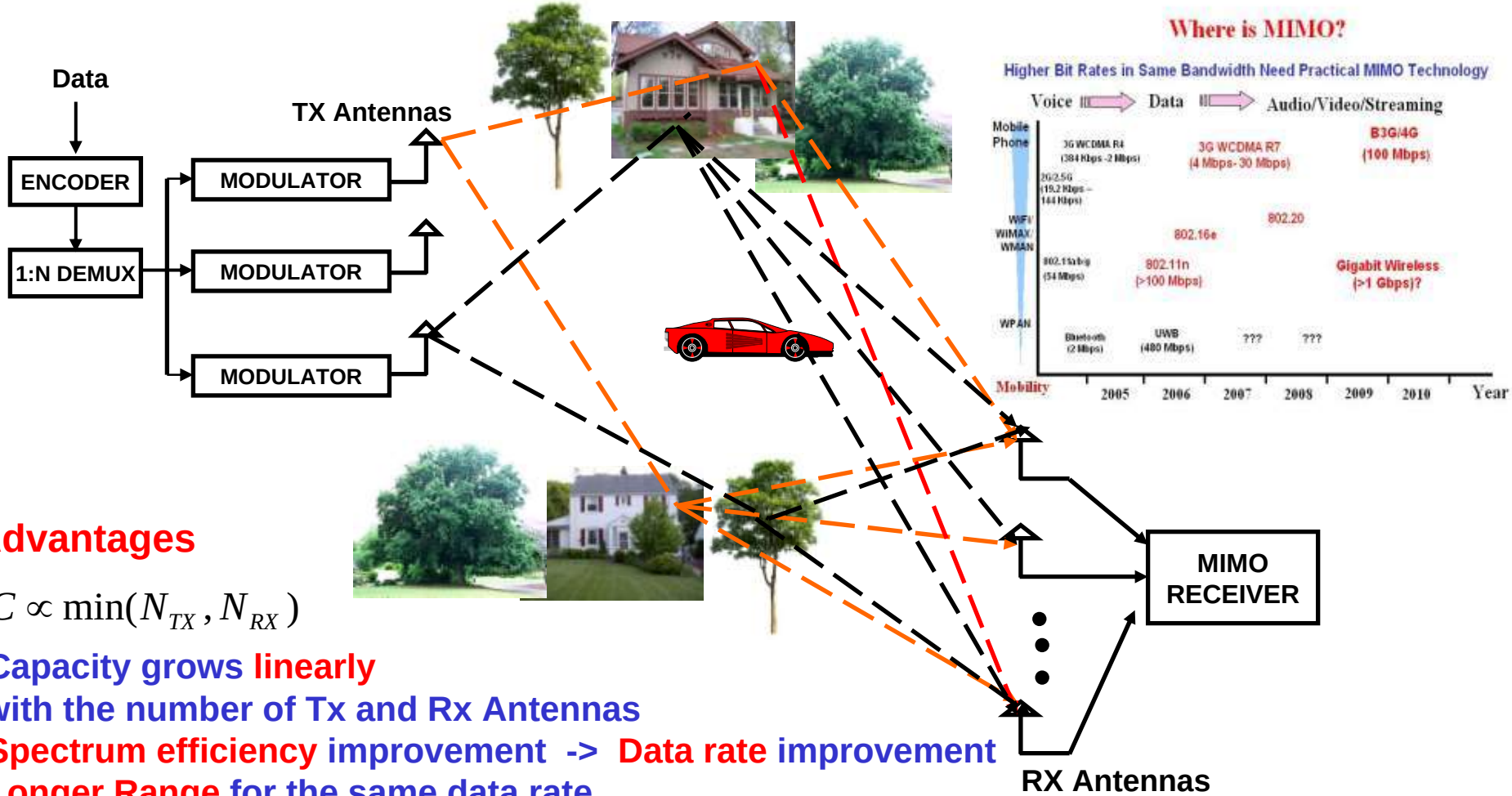
- Contributor Member of WiMedia Alliance and Wireless USB Forum
- Member of USB Implementers Forum, IEEE (802.15.3 SIG), DLNA
- Initiated IGRS-UWB Interface Standards Study Group



Single WPAN CTP Supporting Multiple Key Applications

MIMO's Promise

Multiple Input Multiple Output (MIMO) System



Advantages

$$C \propto \min(N_{TX}, N_{RX})$$

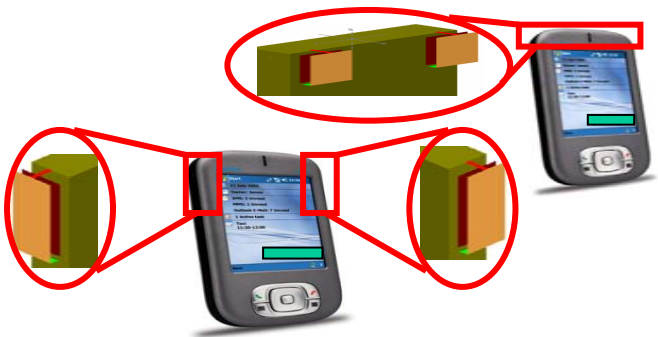
- Capacity grows linearly with the number of Tx and Rx Antennas
- Spectrum efficiency improvement -> Data rate improvement
- Longer Range for the same data rate
- Demonstrated technology in a Lab Environment (BLAST, Bell Labs, Mid 90s)

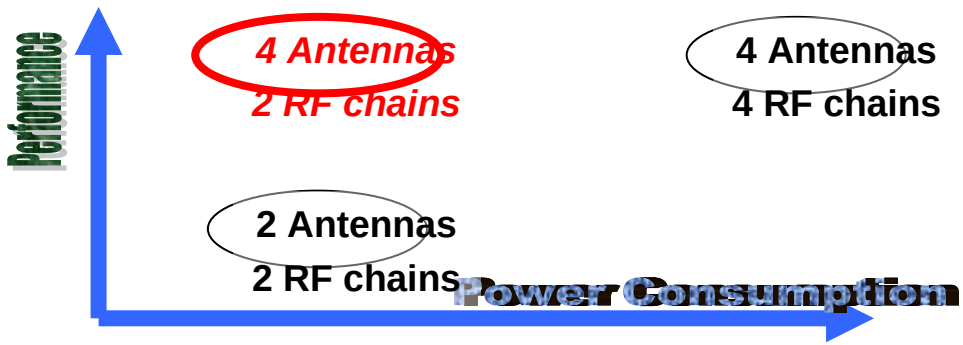
Practical MIMO Core

- **Size**: System with correlated antenna elements (10 dB loss)
- Optimize the joint design of compact correlated antenna with space-time processing

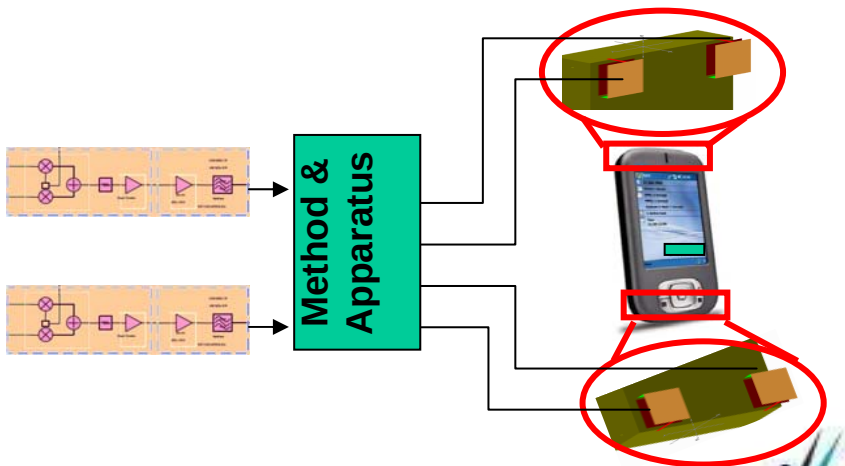
- **Cost & Power**: Low complexity RF Chains for multiple antenna system
- Optimize performance with more antennas, but same number of RF front-ends (6dB opportunity)

P-MIMO for WiFi/WiMAX-enabled PDA (Short Term)





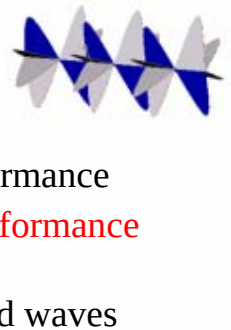
P-MIMO for UPA, LTE/AIE Smart Phone (Longer Term)



Must Have Antennas!

- External Antennas
  - Whip or Helix antennas
  - Easy to design
  - Whip is only single band
  - Excellent performance in Free Space
  - Multipath/TP performance worse for helix
  - Receives single-polarized waves
  - Higher SAR (radiation in human head)
  - Mostly Asian manufacturers

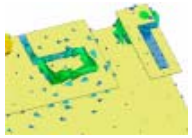
- Internal Antennas
  - More aesthetic designs
  - Difficult to design
  - Worse Free Space performance
  - Better Multipath/TP performance (1 to 2 dB better)
  - Receives multi-polarized waves
  - Lower SAR (50 to 60% lower)
  - Nokia, Sony-Ericsson, Siemens, etc.



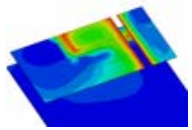
Internal Antenna CoE

Core R&D

Elecromagnetic Field Visualizations



Magnetic Currents



Electric Fields

Miniature Antenna Designs

PIFA

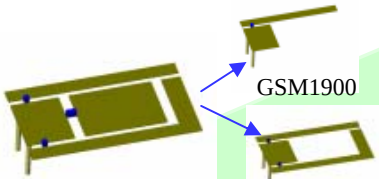
Multiple Slots

Parasitics

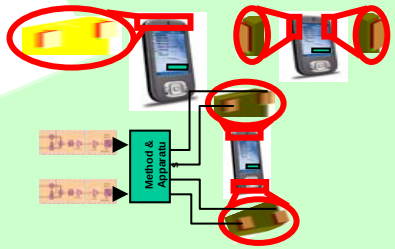
Ungrounded

Advanced R&D

Multi-Band Active Antennas



MIMO Antennas



Internal Antennas

- Improved Designs
- Lower SAR
- Better Multipath Performance

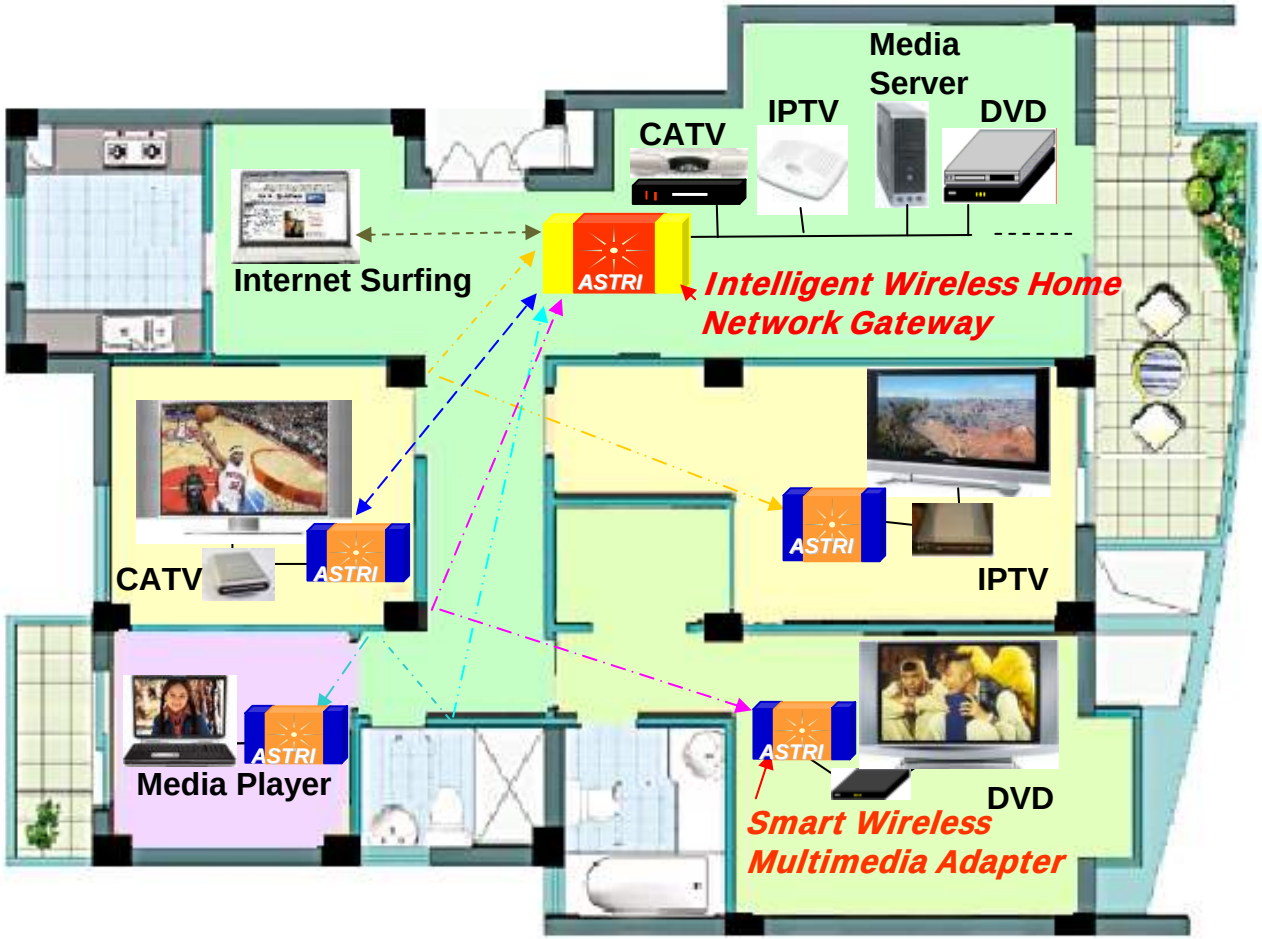
External Antennas

- Old-fashion, extrude from device
- Higher SAR

Industry Positioning

LG
NOKIA Connecting People
we3
maxon
mitsubishi
NEC
BIRD
vtech
Sony Ericsson
HTC
TCL
molex
CENTURION
MOTOROLA intelligence everywhere
Amphenol T&M Antennas
LK PRODUCTS
PERLOS
SAMSUNG
ASTRI
Huawei
ALCO
CCT
HONG KONG APPLIED SCIENCE AND TECHNOLOGY RESEARCH INSTITUTE COMPANY LIMITED
香港應用科技研究院有限公司

WHAV-An Example Application



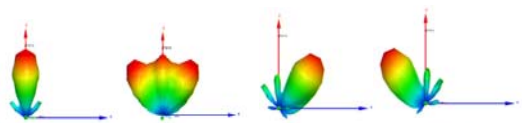
Combined ASTRI's innovative technology with off-the-shelf 802.11a/b/g chipset, this platform can

- Support various kinds of multi-media sources
  - E.g. DVD, Media Server, IPTV, CableTV, Internet Surfing
- Point to Multi-Point Multi-media transmission at the same time
  - E.g. 3SD+1IPTV

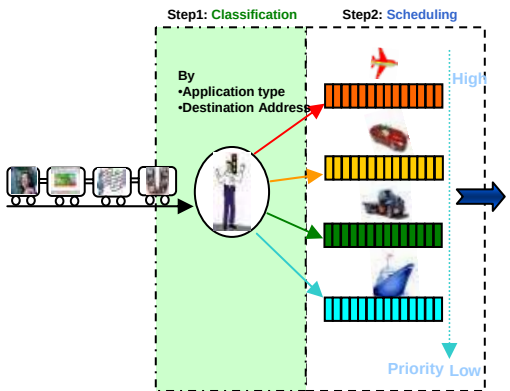
- Adaptive Beam Selection
  - *Longer and reliable link*
  - *Avoid and generate*

- Intelligent Quality of Service Management
  - *According the characteristics of different applications, guarantee their quality of service*

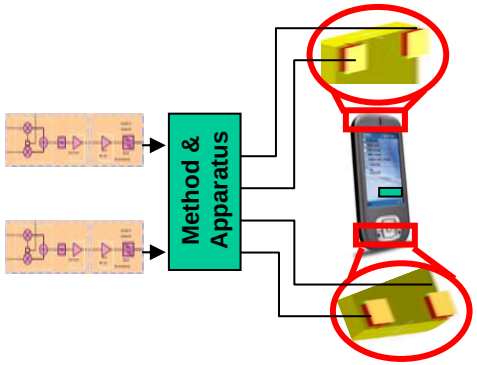
  E.g. Transmit IPTV traffic in an efficient and reliable way



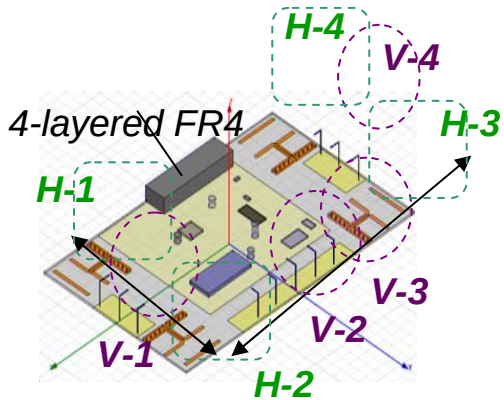
Enabling Technologies for WHAV



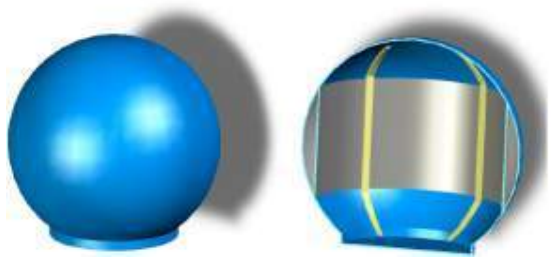
Intelligent Quality of Service Management



Advanced Indoor MIMO Platform



Compact Antenna Array

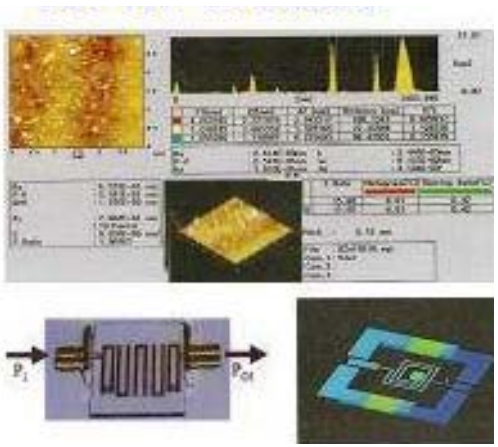


Spherical Antenna Array

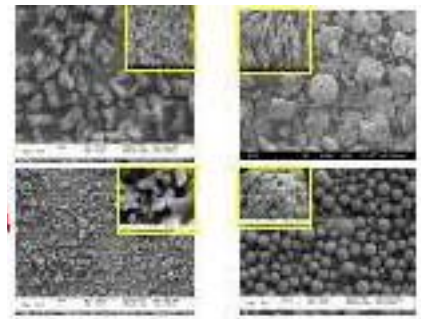
Material and Miniaturization

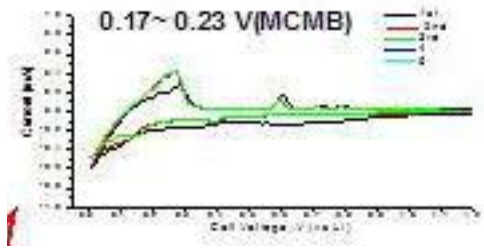
17 patents Filed, 12 patents to come

Cost Effective Fabrication for RF Module



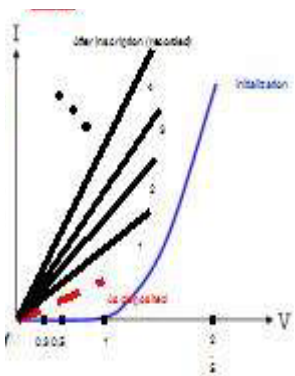
Low Cost Energy Storage



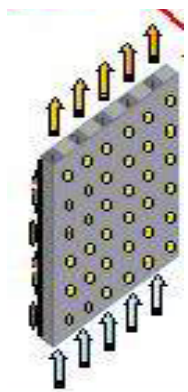


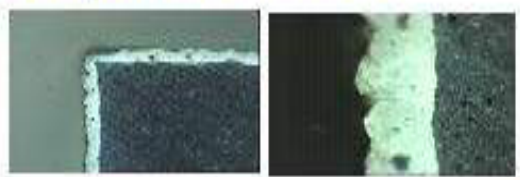
CT-AWT-M&M

Cost Effective High Density Data Storage



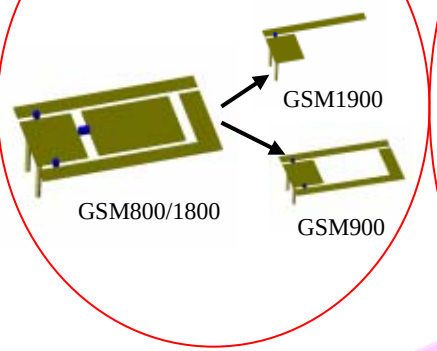
Effective Heat Dissipation Modules



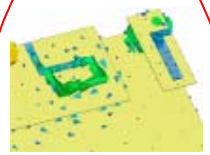


WM^{7}F: Wireless/Mobile Miniaturized MultiMode MultiMedia MultiFunction

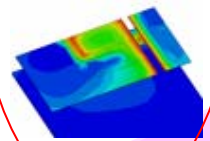
可重置天线



多系统天线



表面电流



磁场

小型天线设计

倒F平面天线

倒F平面天线-双长孔

倒F平面天线-寄生式

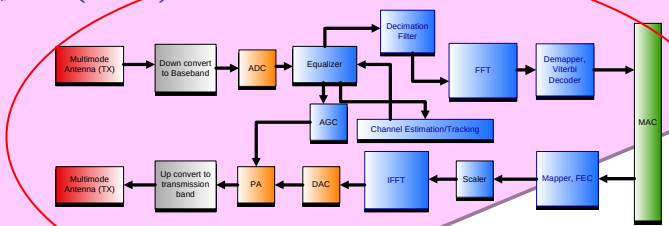
内藏未接地

内藏天線

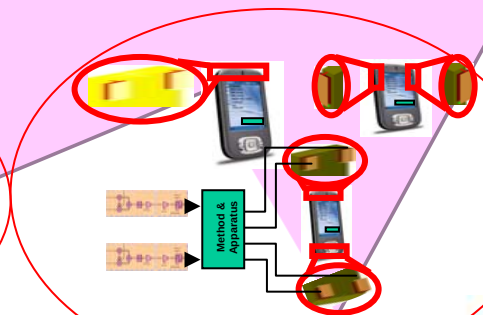
- 超索爱, 超摩托, 赶诺基亚, 造型/美学设计, 传输性能佳, 低人體电磁波吸收量(SAR降低50~60%),

外接天线

- 目前国内厂商多使用伸缩型(限单频)或螺旋型(多路径性能差), 高人體电磁波吸收量 (SAR)



可重置正交分频复用(OFDM)核心



实用多天线核心技术

vtech VTech Group of Companies 偉易達集團

TCL

Hisense 海信

NOKIA CONNECTING PEOPLE

WONGS 王氏

we3

BIRD

Huawei

MediaTek Inc. 聯發科技

ALCO

T3G Technology Co., Ltd.

ZTE中兴

MOTOROLA Intelligence everywhere

Sony Ericsson

freescale semiconductor

SPREADTRUM

BROADCOM

AMOI 夏新

香港應用科技研究院 HONG KONG RESEARCH INSTITUTE OF SCIENCE AND TECHNOLOGY

Industry Bonding

Technology Dissemination Model

CT R&D Centre / ASTRI

Technology Acquisition
Strategic Alliance

Joint Development
Consortium

Training &
Consultancy

Technology
Transfer

Key
Component
Supply

Custom Design
OEM/ODM

Turn-key
System

Spin-off
Joint Venture

Summary

- **Wireless Communications**, Consumer Electronics, IC Design, Material and Packaging
- **WM^{7}F: W**ireless/**M**obile **M**iniaturized **M**ulti**M**ode **M**ulti**M**edia **M**ulti**F**unction-fast growth and exciting opportunities for Hong Kong
- Core Technology Platforms, Core IPs, technology transfers, talents incubation,
- Local industries, universities, R&D organizations: R&D, collaboration, alliance,…

- Gateway to/from global high technology industry:

  Hong Kong