

Introduction to WiBro Technology

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- Background of WiBro Service
- WiBro Technology Overview
- Future Plan and Strategy



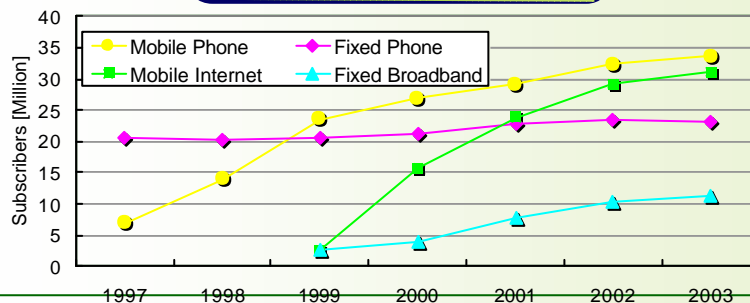
Background of WiBro Service

Market Trend in Korea (1)

□ Korea Telecommunication Market Trend

- ◆ 2001-2003 subscriber growth rate
 - Fixed BB(44%) > Mobile internet(30%) > Mobile phone(16%) > Fixed phone(2%)
- ◆ Voice market is saturated (fixed phone) or slowly growing (mobile phone)
- ◆ Data market (mobile internet & fixed BB) is growing faster than voice

Subscribers Trend

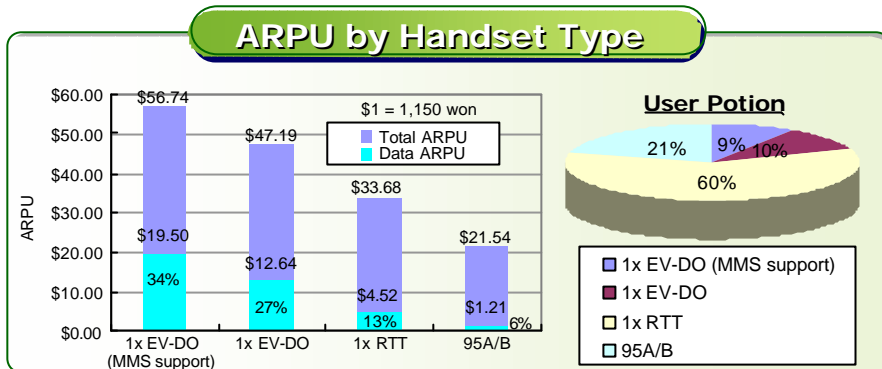


? Number of mobile phone users includes mobile internet users

Source : KISDI (Korea Information Strategy Development Institute)

Market Trend in Korea (2)

- Mobile Data ARPU (2003 Dec. SKT user basis)
 - ◆ As network evolves, data ARPU portion increases
 - ◆ Data rate is one of the key factor to increase data ARPU
 - ◆ Data ARPU is expected to keep increasing as the market churns



*Total ARPU is net of interconnection fees and signup fees

*Data ARPU = Wireless Internet revenues including phone mail revenue / internet user

ARPU : Average Revenue Per User

MMS : Multi Media Service

Source : SKT IR Data, 2004

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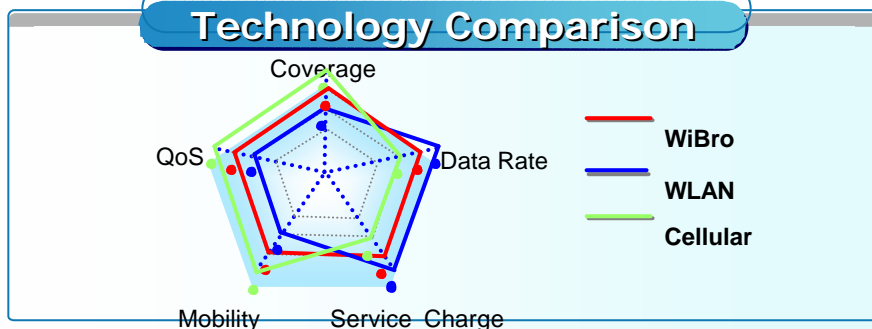
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Needs for WiBro Service

Limit of Existing Technologies

- WLAN (IEEE 802.11 series)
 - ◆ Support very high data rate but limited coverage and mobility not supported
- Cellular (cdma2000 1X, 1xEV-DO, WCDMA)
 - ◆ Support large coverage and fast mobility but data rate is low and too expensive

Technology Comparison

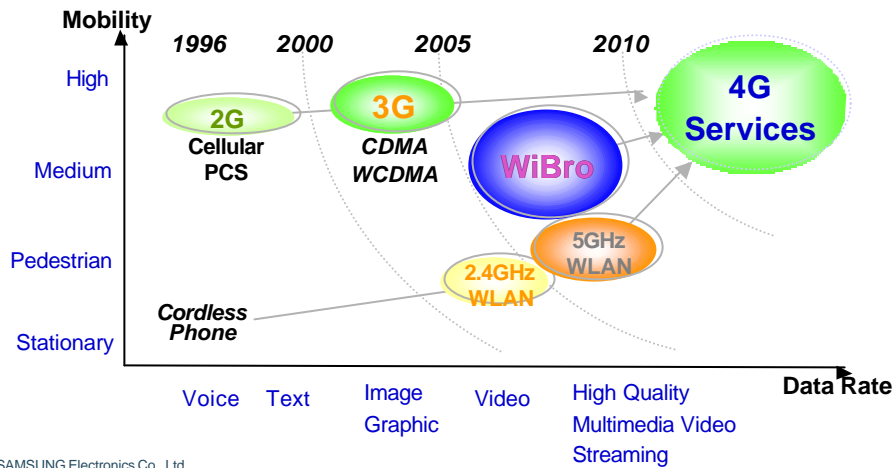


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Service Position in Network Evolution

- ❑ WiBro is now located between WLAN and Cellular service.
- ❑ In the future, WiBro service will evolve to 4G Network which provide higher data rate and mobility



HPI(High Speed Portable Internet) Project

- ❑ ETRI/Samsung HPI Project Objective
 - ◆ Development of HPI system at 2.3GHz
 - ◆ HPI RTT specification & system development
- ❑ Period: 2003.1. ~ 2005.12.
- ❑ Sponsors : HTI, KT, KTF, SKT, Samsung
- ❑ Results
 - ◆ ETRI/Samsung
 - WiBro spec proposed to TTA and accepted as baseline
 - ◆ ETRI
 - Prototype system development
 - ◆ Wired and wireless operators
 - Requirements definition

RTT: Radio Transmission Technology

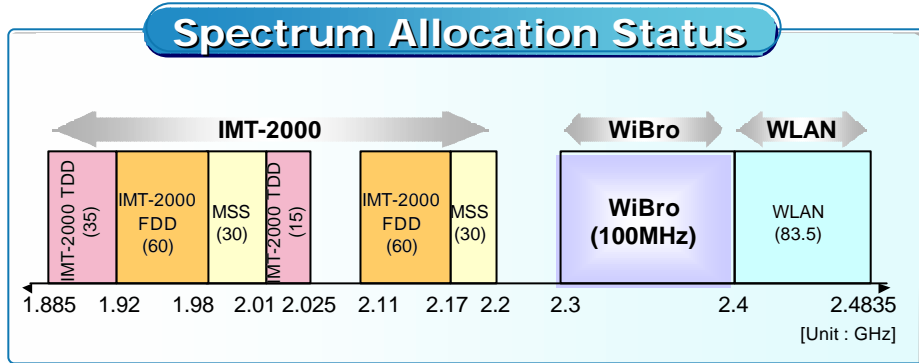
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WiBro Spectrum Allocation of Korea

❑ MIC allocated 2.3GHz spectrum for WiBro services
(Official MIC notice, Dec. 2002)

- ◆ Frequency BW : 2.3~2.4GHz
- ◆ Purpose : WiBro (Portable Internet)
- ◆ Usage : Fixed / Mobile



MIC : Ministry of Information and Communication

MSS : Mobile Satellite Service

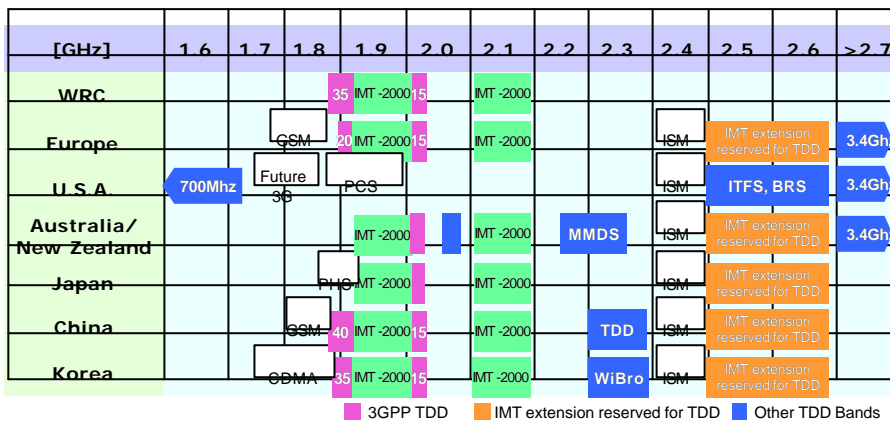
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Global TDD Spectrum Allocation

❑ Global TDD Spectrum Allocation Status

- ◆ FDD band is about 3 times larger than TDD band
- ◆ More TDD band will be required
 - For high data rate support, new systems requiring broader bandwidth etc.



3GPP TDD IMT extension reserved for TDD Other TDD Bands

WRC : World Radiocommunication Conference

ITFS : Instructional Television Fixed Service

© BRS : Broadband Radio Service

MMDS : Multichannel Multipoint Distribution System

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WiBro Technology Overview

System Requirements

High Data Rate

- Maximize sector/user throughput
- Broad bandwidth
- MAC & RRC

Mobility

- Vehicular speed mobility (~60km/h)
- Seamless service
- Longer battery usage

Full Coverage

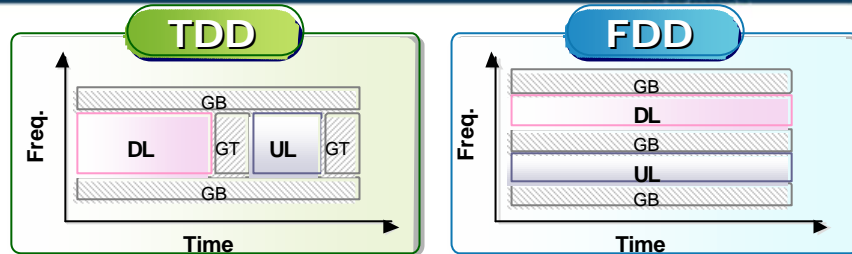
- Various types of cell (Macro / Micro / Pico)
- Easy cell planning
- Roaming with cellular & WLAN

Low Cost

- Improve spectral efficiency
- Reduce infra cost
- Multiplexing gain of packet data.

MAC : Medium Access Control RRC : Radio Resource Control

TDD vs. FDD



	TDD	FDD
UL/DL Isolation	Guard Time	Guard Band
Spectrum Efficiency	More efficient (Smaller GB)	Less efficient (Larger GB)
UL/DL Channel	Reciprocal (Easy to apply SA, MIMO etc.)	Non-reciprocal
Suitable for	Packet base data traffic	Symmetric traffic like voice
For same coverage	Need more power (duty factor)	Need smaller power
Applied system	WiBro, 802.16, 802.11a/b, TD-SCDMA,	IS-95A/B, CDMA2000, 1xEV-DO, GSM, GPRS, W-CDMA

GB : Guard Band

GT : Guard Time

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PHY Spec.

- Frequency Band : 2.3GHz (Korea)
- Channel Bandwidth : = 9MHz
- Duplex : TDD / 5msec frame
- Multiple Access : OFDMA
- Modulation : QPSK, 16QAM, 64QAM
- Channel Coding : CTC
- Cell Coverage : ~1km
- Maximum Data Rate
 - ◆ Sector throughput : DL : 18 Mbps, UL : 6 Mbps
 - ◆ User throughput : DL : 3 Mbps, UL : 1 Mbps
- Optional AAS support

CTC : Convolution Turbo Code

AAS : Adaptive Antenna System

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MAC Spec.

- ❑ Flexible BW Allocation by MAP
 - ◆ Frame by Frame
- ❑ Supports flexible QoS offering
 - ◆ rtPS, nrtPS, BE
 - ◆ Fine granularity
- ❑ Efficient MAC PDU construction
 - ◆ Variable size MAC PDU
 - ◆ MAC-level framing (No PPP)
 - ◆ Fragmentation, packing, concatenation
- ❑ Payload header suppression support
- ❑ Security support
- ❑ Sleep mode support
- ❑ H-ARQ/ARQ support
- ❑ Handoff : BBM
- ❑ AMC support

rtPS : real-time Polling Service

BE : Best Effort

H-ARQ : Hybrid Automatic Response ReQuest

AMC : Adaptive Modulation and Coding

nrtPS : non-real-time Polling Service

PDU : Protocol Data Unit

BBM : Break Before Make

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PHY Characteristics (1)

- ❑ High Spectral Efficiency Support
 - ◆ TDD
 - Minimize guard band to increase spectral efficiency
 - ◆ 10 MHz BW / OFDMA
 - Minimize multi-path interference to increase spectral efficiency
 - ◆ Support various modulation schemes (QPSK, 16QAM, 64QAM) and CTC to maximize data rate
- ❑ Full Coverage Support
 - ◆ Support cellular operation with frequency reuse factor of 1
 - High spectral efficiency & easy cell planning
 - Minimize interference using diversity subchannel based on Reed Solomon sequence
 - Compensate low SINR at cell edge using low rate coding
 - ◆ Fast handover with mobile IP

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PHY Characteristics (2)

□ Performance Enhancement considering Mobility(1)

◆ H-ARQ

- Increase the efficiency of re-transmission resulting from fading and interference

◆ Band selection AMC & diversity subchannel

- Mobile stations request to select band selection AMC or diversity subchannel by monitoring channel status
- For slowly moving users : allocate band selection AMC subchannels which have high quality channel response to increase transmission efficiency and coverage
- For fast moving users : allocate diversity subchannels distributed over whole frequency band to maximize frequency diversity

PHY Characteristics (3)

□ Performance Enhancement considering Mobility(2)

◆ Support 60km/h mobility

- Minimize distortion due to mobility using short OFDM symbol
- Apply pilot structure supporting channel estimation while moving

◆ Support fast access during hand-off

- Apply short frame length (5msec) for fast response
- Apply additional non-contention based control channel access duration

PHY Characteristics (4)

- ❑ Flexible Resource Allocation for Multiple Users
 - ◆ Asymmetric DL / UL allocation
 - DL/UL : 2:1, 1:1, 5:1
 - ◆ Multiple user acceptance
 - Support different packet scheduling algorithm and status management for each type of mobiles
- ❑ Support Portability
 - ◆ Support sleep mode to decrease handset consuming power
- ❑ TDD Adaptive Antenna System (Optional)
 - ◆ Increase coverage and data rate for slowly moving users

PDU : Protocol Data Unit

PPP : Point to Point Protocol

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MAC Characteristics

- ❑ Scheduler Design Consideration
 - ◆ Adaptive modulation & coding
 - ◆ Throughput maximization
 - ◆ Power constraint of mobiles
 - ◆ QoS guarantee
 - ◆ Fairness
 - ◆ Scheduling algorithm complexity

❑ QoS Classes in WiBro

QoS Class	Data type	Application
Real time polling service	<ul style="list-style-type: none"> • Periodic interval • Variable-sized packet • Real time data stream 	MPEG Video, Video telephony
Non real time polling service	<ul style="list-style-type: none"> • Variable-sized packet • Delay-tolerant data stream • Minimum data rate is required 	FTP, WWW
Best effort service	<ul style="list-style-type: none"> • No minimum service level 	FTP, WWW, E-mail

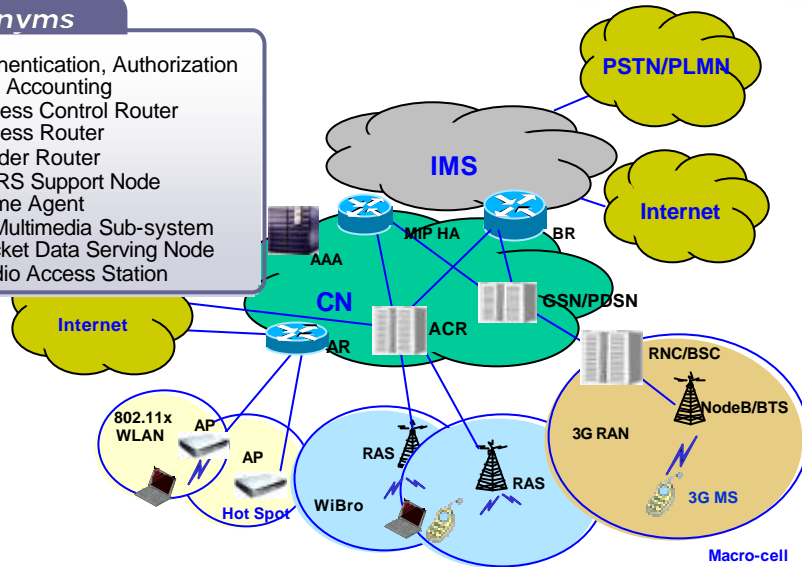
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WiBro Network Architecture

Acronyms

AAA	Authentication, Authorization and Accounting
ACR	Access Control Router
AR	Access Router
BR	Border Router
GSN	GPRS Support Node
HA	Home Agent
IMS	IP Multimedia Sub-system
PDSN	Packet Data Serving Node
RAS	Radio Access Station



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Network Element Functions

ACR

- Packet classification & header suppression
- Service flow management
- Traffic switching & integration point
- Handover management
- Session information maintenance
- RAS interface
- Core network interface

RAS

- PHY processing and air resource scheduling
- MAC management message processing
- MAC PDU processing
- CID management
- Encryption & Decryption
- ACR interface

PDU : Protocol Data Unit

CID : Connection ID

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Future Plan and Strategy

WiBro Policy of Korea

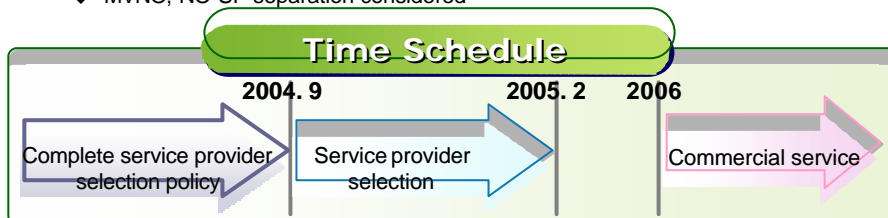
□ Standard

◆ Based on IEEE 802.16-2004 & 802.16e Draft3 or later version satisfying:

- Downlink 512kbps, uplink 128kbps at 60Km/h
- Channel bandwidth >9MHz
- Roaming between operator equipment
- TDD
- Frequency reuse factor 1

□ Service Provider Selection

- ◆ Number of service provider : 2~3
- ◆ Frequency usage period : 7 years
- ◆ MVNO, NO-SP separation considered



MVNO : Mobile Virtual Network Operator NO : Network Operator SP : Service Provider

Source : MIC

WiBro Mobile Station Development Strategy

❑ Survey Result of WiBro Demand

	Public Users	Enterprise Users
Most important benefit	❑ Cheap service charge and phone	❑ Mobility
Preferred Service charge policy	❑ Fixed amount	
Preferred type of mobile station	❑ Handheld type ? Early adopters prefer notebook type	❑ Notebook type ❑ PDA
Needs for service continuity with existing ones	❑ 78%	❑ 95%

Source : KISDI, 2003

❑ WiBro Mobile Development Strategy

- ◆ Develop low price mobile phones for public users
- ◆ Develop high mobility support mobile phones for enterprise users
- ◆ Support existing services (Develop dual mode type)
- ◆ Develop notebook internal type or card type in early market
- ◆ Move to PDA or handheld type as market matures

WiBro System Development Strategy

❑ Time-to-market Development of Standardized System

- ◆ Proof of Concept development through HPI project

❑ Capacity Enhancement Technology Adoption

- ◆ MIMO / AAS / Space time coding adoption
- ◆ Increase the throughput of slowly moving users using UL/DL reciprocal channel characteristics of TDD system
- ◆ Key technology development and TTA phase 2/IEEE802.16e standardization

❑ Alternative Low Price Solution Development for Enterprise or Household Users

- ◆ Standardize the configuration applying low power amplifier or looser RF spec to reduce network deployment cost

Appendix. Technology Comparison

	WiBro	3G Standard			WLAN
		TD-CDMA	HSDPA	EV-DO	
Peak Data Rate	DL : 18.4Mbps UL : 6.1Mbps	DL : 3.1Mbps UL : 900Kbps	DL : 14Mbps UL : 2Mbps	DL : 3.1Mbps UL : 1.2Mbps	802.11b : 11Mbps 802.11a,g : 54Mbps
Bandwidth	= 9MHz	5MHz(10MHz)	5MHz	1.25MHz	20MHz
Multiple Access	OFDMA	TDMA, CDMA	TDMA, CDMA	CDMA	CSMA/CA
Duplex	TDD	TDD	FDD	FDD	TDD
Mobility	Mid	High	High	High	Low
Coverage	Mid	Mid	Large	Large	Small
Standardization	3GPP2 & 802.16e	3GPP	3GPP	3GPP2	IEEE 802.11x
Target Market	Public/ Enterprise	Public	Public	Public	Home/ Enterprise

CSMA : Carrier Sense Multiple Access

CA : Collision Avoidance

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Q & A

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