

Introduction to **WiBro Technology**

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- **Background of WiBro Service**
- **WiBro Technology Overview**
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Background of WiBro Service

Market Trend in Korea (1)

❑ Korea Telecommunication Market Trend

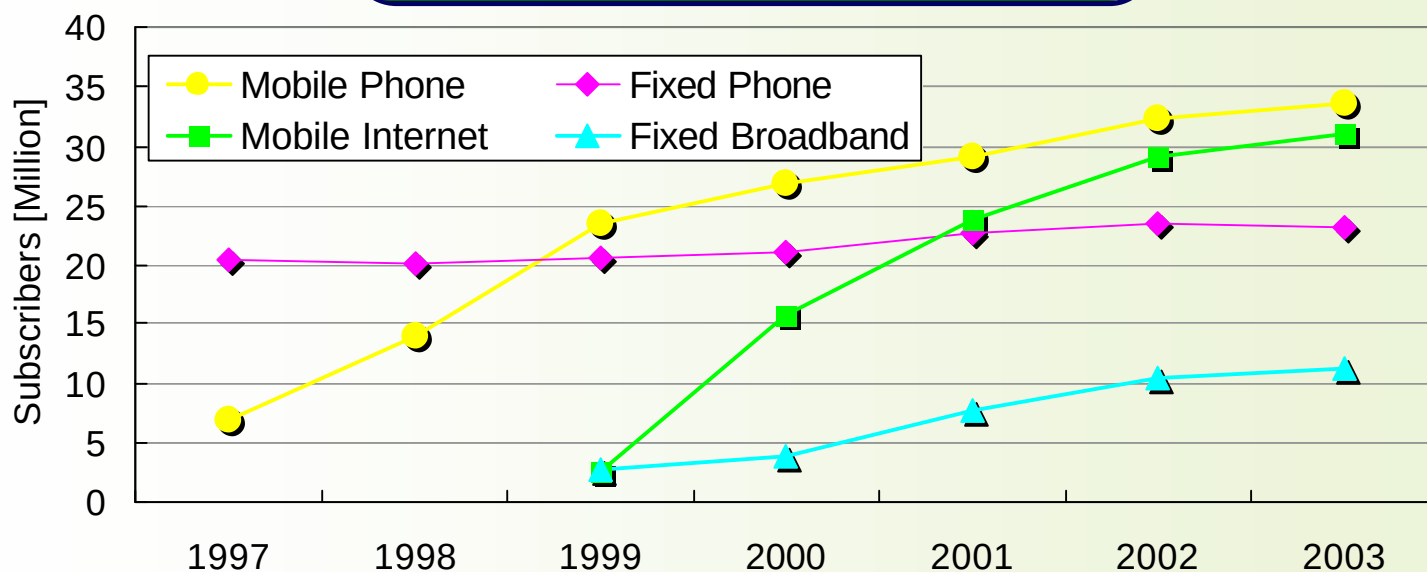
◆ 2001-2003 subscriber growth rate

➤ 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

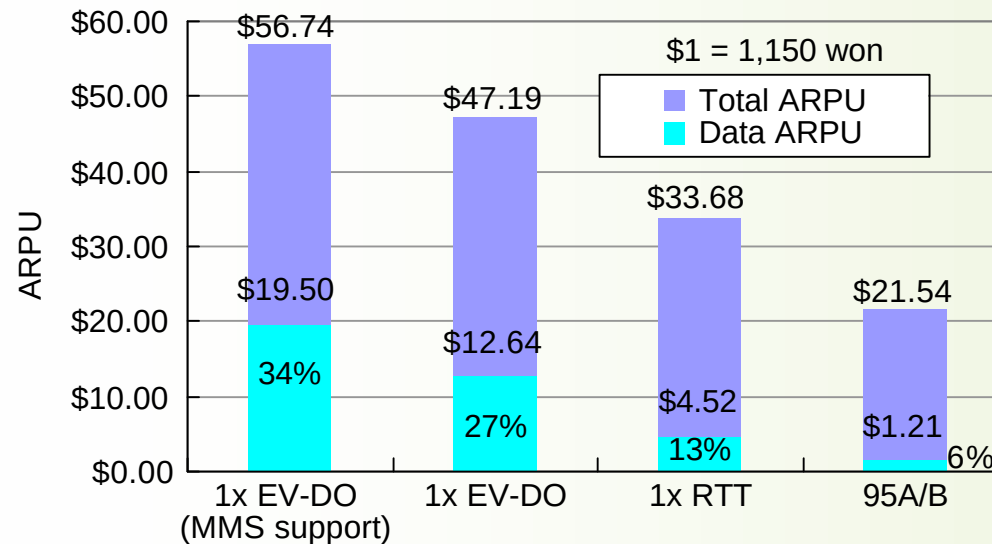
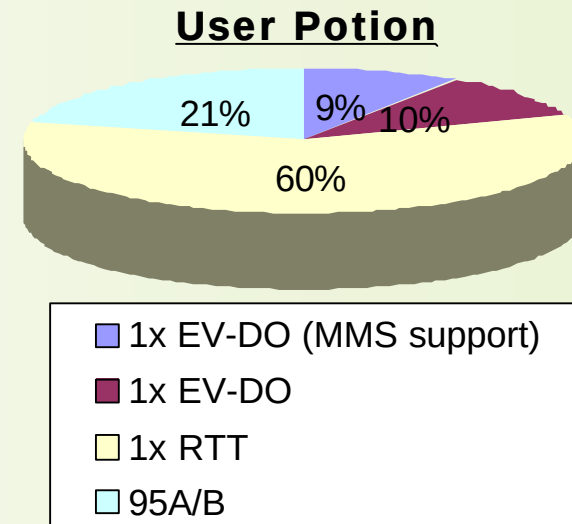
Source : KISDI (Korea Information Strategy Development Institute)

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

ARPU by Handset Type



*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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Needs for WiBro Service

Limit of Existing Technologies

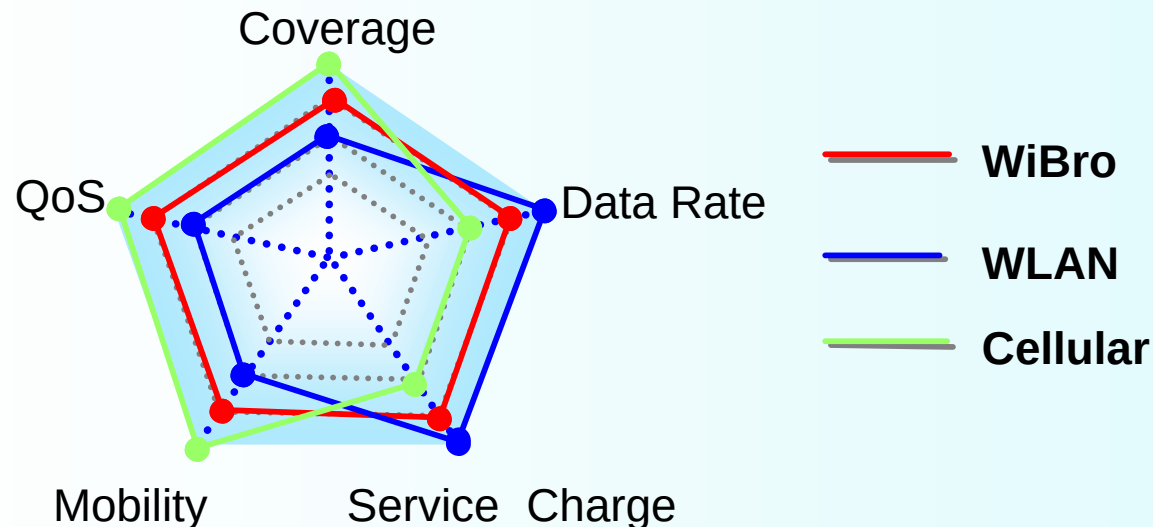
❑ WLAN (IEEE 802.11 series)

- ◆ Support very high data rate but limited coverage and mobility not supported

❑ Cellular (cdma2000 1X, 1xEV-DO, WCDMA)

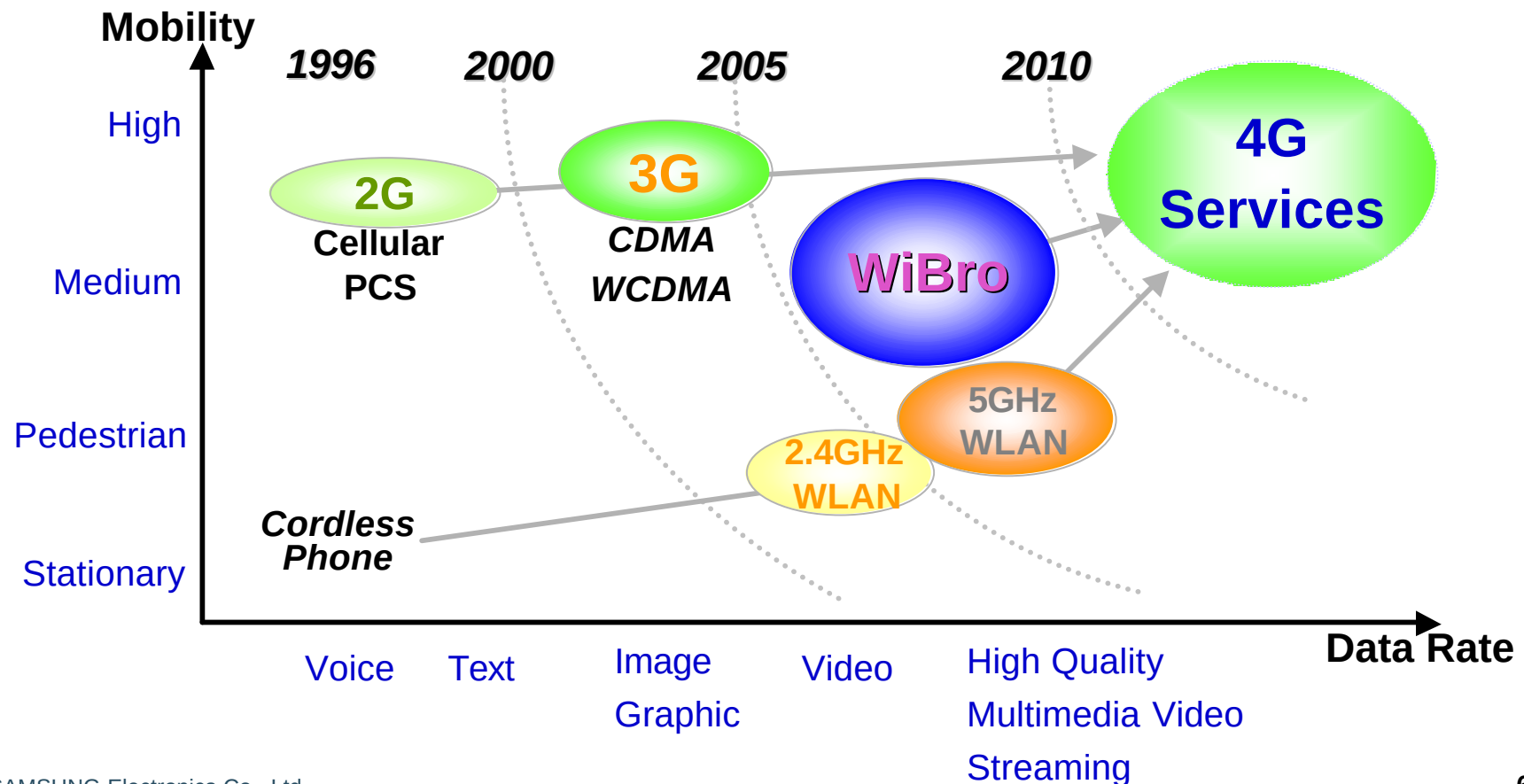
- ◆ Support large coverage and fast mobility but data rate is low and too expensive

Technology Comparison



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

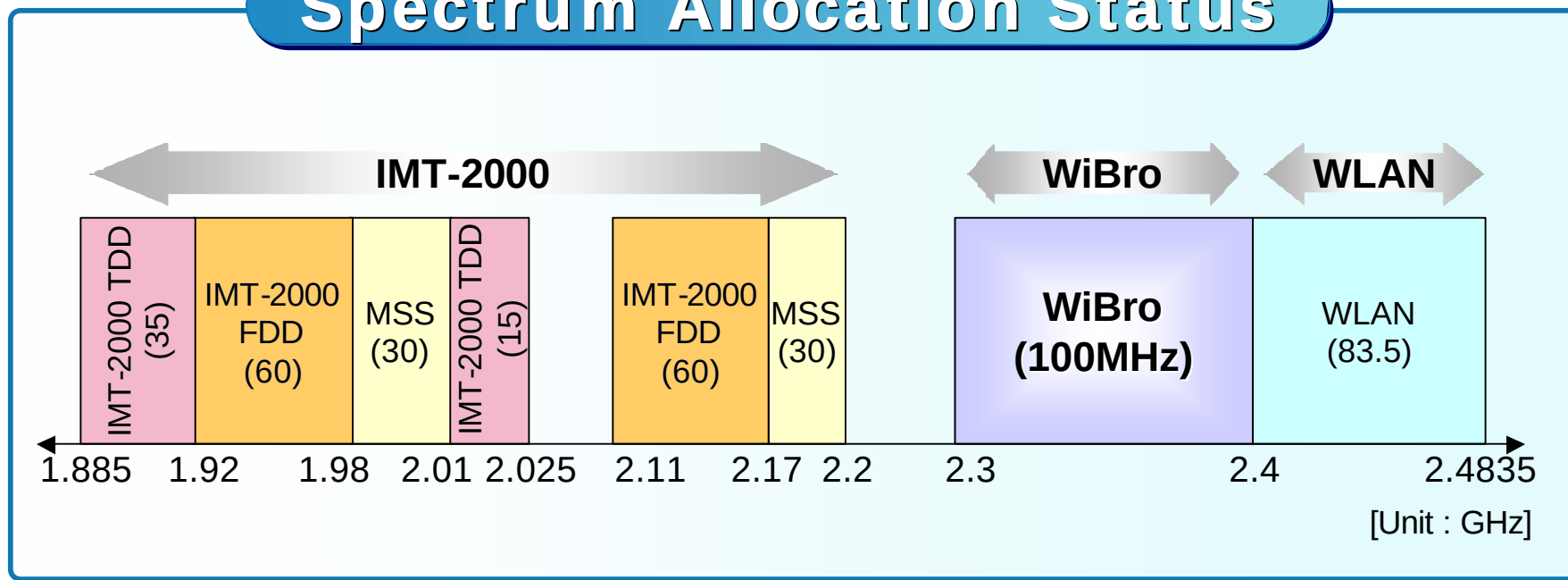
RTT: Radio Transmission Technology

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

Spectrum Allocation Status



MIC : Ministry of Information and Communication

MSS : Mobile Satellite Service

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.

[GHz]	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	> 2.7
WRC				35 IMT-2000 15		IMT-2000						
Europe			GSM	20 IMT-2000 15		IMT-2000			ISM	IMT extension reserved for TDD		3.4GHz
U.S.A.	700Mhz	Future 3G	PCS						ISM	ITFS, BRS		3.4GHz
Australia / New Zealand				IMT-2000		IMT-2000	MMDS		ISM	IMT extension reserved for TDD		3.4GHz
Japan			PHS	IMT-2000		IMT-2000			ISM	IMT extension reserved for TDD		
China			GSM	40 IMT-2000 15		IMT-2000		TDD	ISM	IMT extension reserved for TDD		
Korea		CDMA		35 IMT-2000 15		IMT-2000		WiBro	ISM	IMT extension reserved for TDD		

■ 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

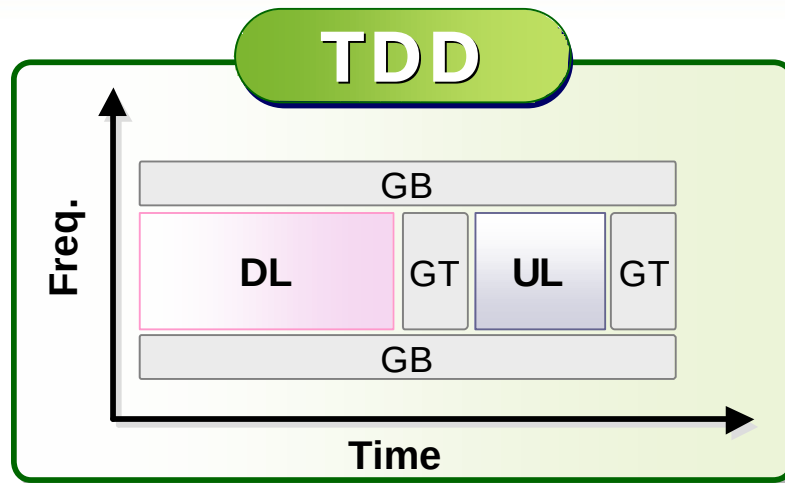
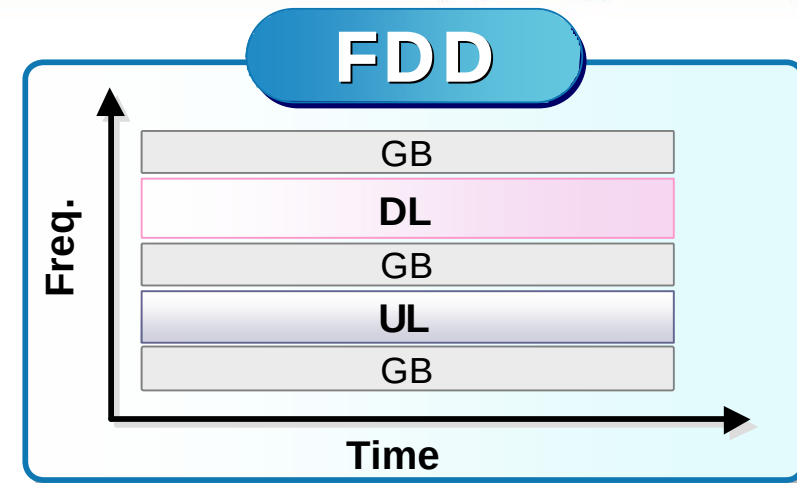
Low Cost

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

MAC : Medium Access Control

RRC : Radio Resource Control

TDD vs. FDD



	T D D	F D D
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

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

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

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

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

MAC Characteristics

❑ Scheduler Design Consideration

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

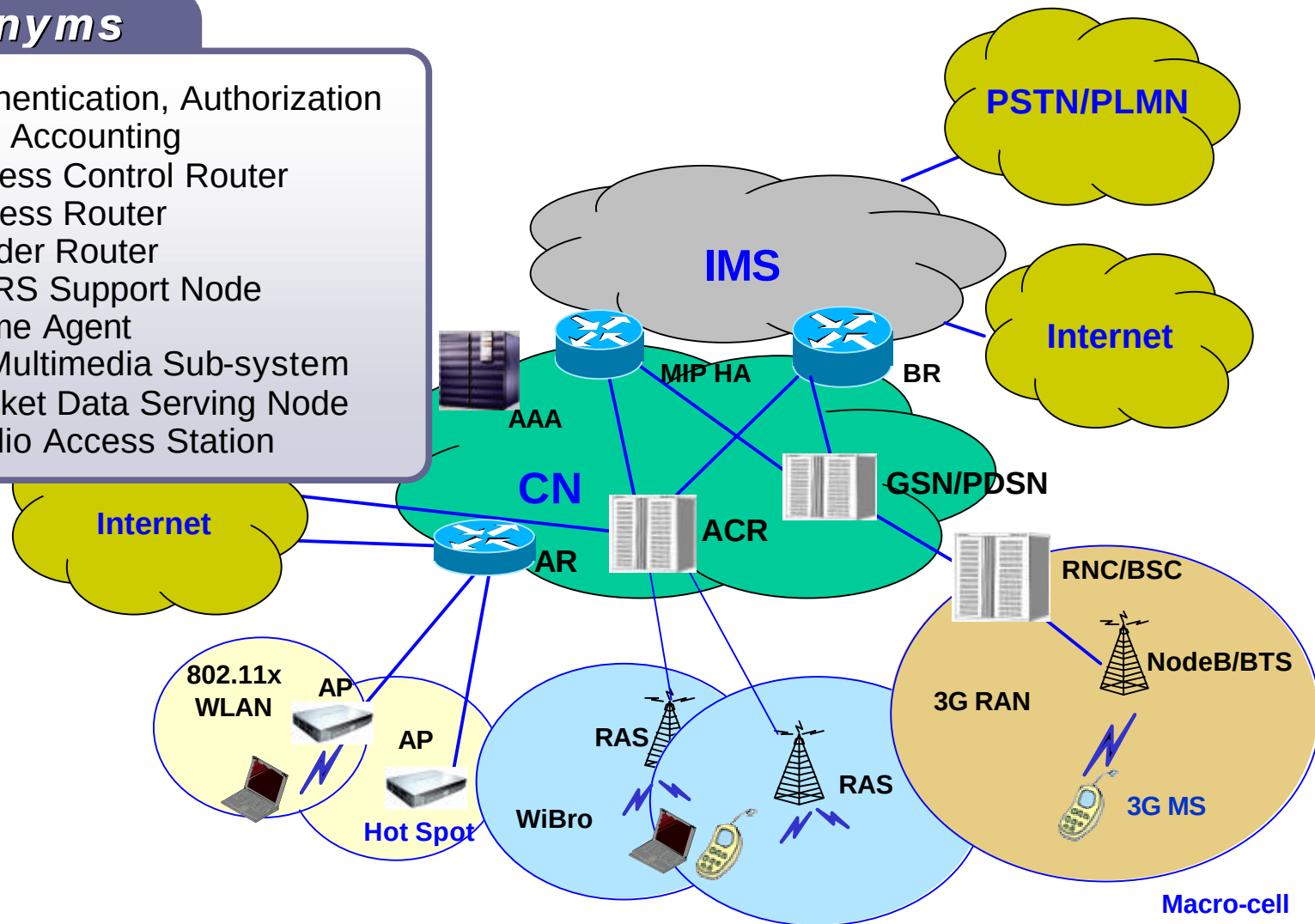
❑ QoS Classes in WiBro

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

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



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



Future Plan and Strategy

WiBro Policy of Korea

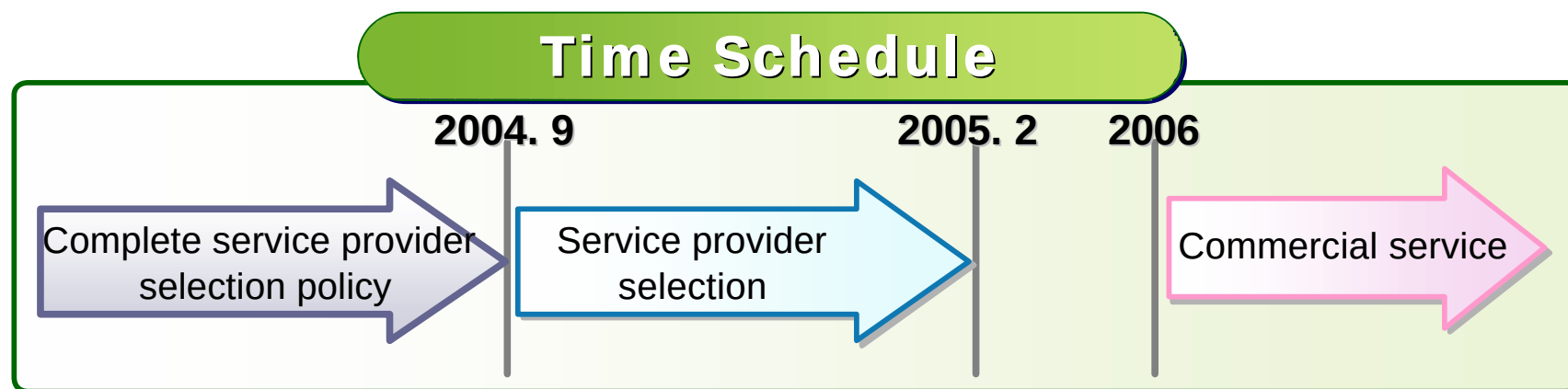
❑ Standard

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

- Downlink 512kbps, uplink 128kbps at 60Km/h
- Channel badwidth >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	TTA & 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



Q & A

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