5. Workshop des ITG-FA 5.2, Mittweida, November 4th, 2005

WiMAX and Mobility

Dr. Klaus-D. Kohrt, Siemens Communication Mobile Networks

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BWA, 2nd attempt- what is different this time?

Then:	Now:
▪ Propietary systems ➔ costly	▪ Industry consensus ➔ scale mass market devices, plug & play
▪ Truckroll installation	▪ Self install, auto-provisioning
▪ Technology seeking a market	▪ User pull, i.e. established demand from educated users
▪ Telco-driven	▪ IT-driven
▪ Fixed wireless only	▪ The promise of (some) mobility
▪ …	▪ …

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WiMAX as standardized solution is a promising complementary technology to W-CDMA / HSPA

Wireless Technology Positioning
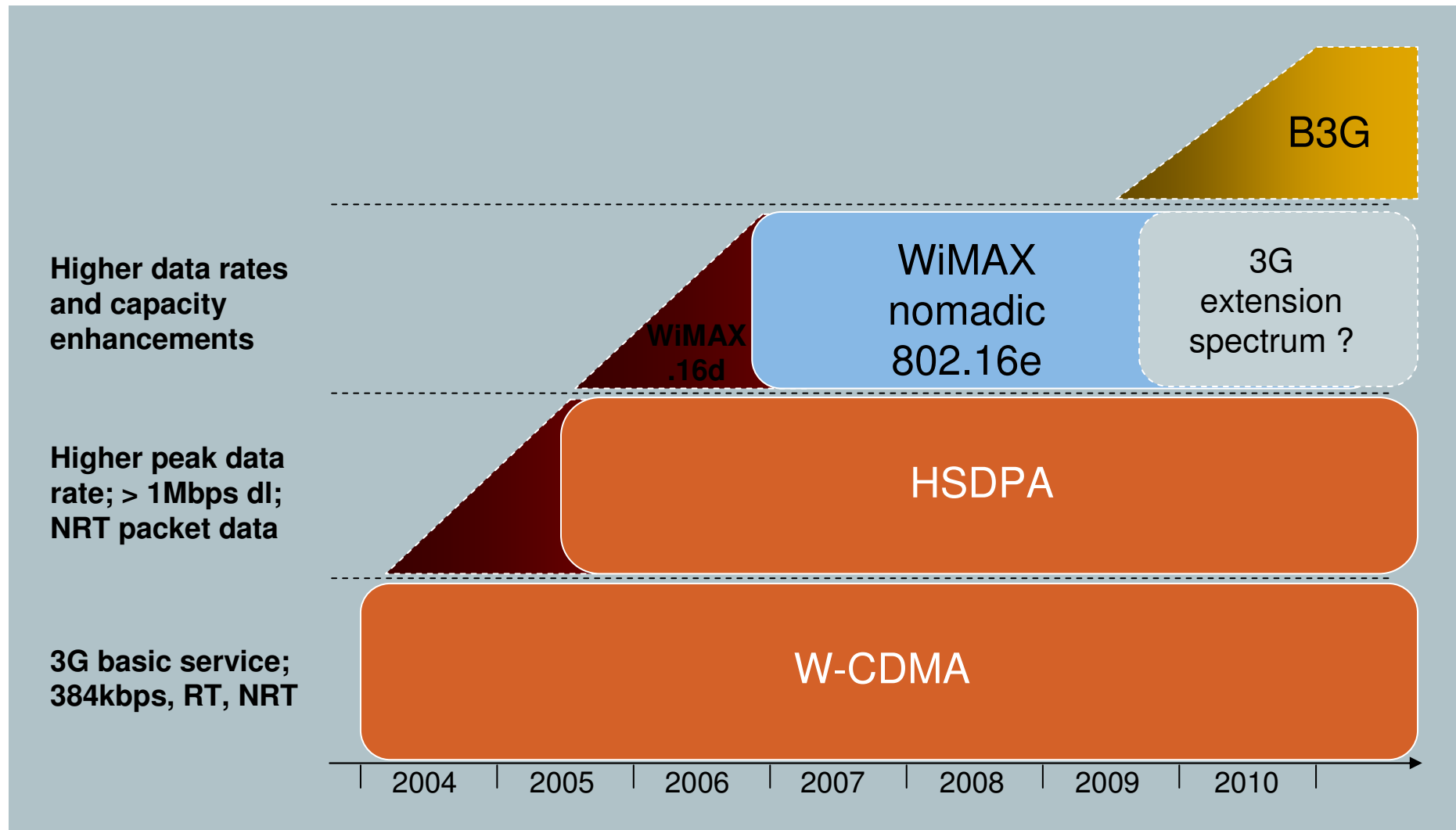
Mobility / Range
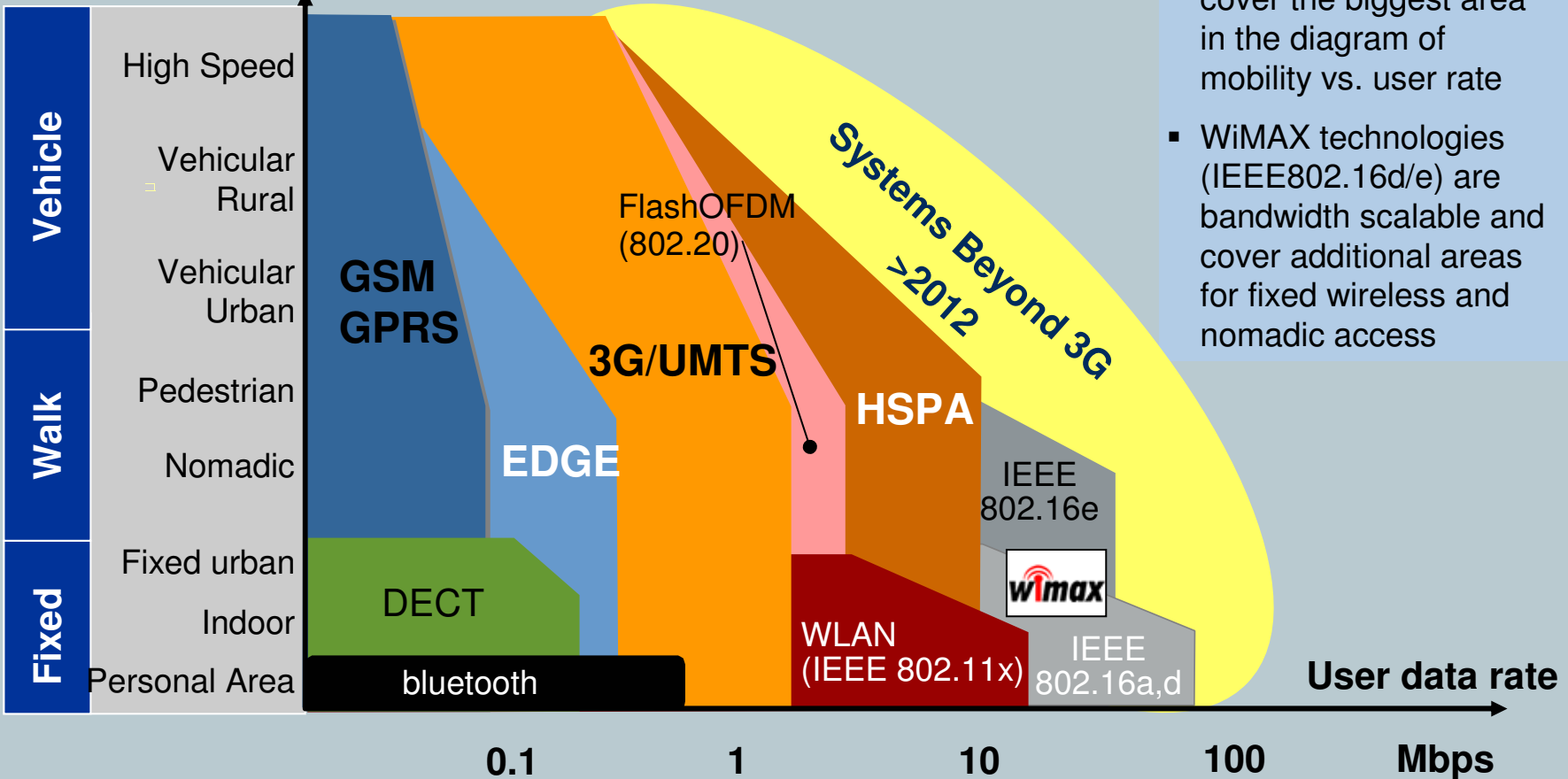
- W-CDMA and its enhancement HSPA cover the biggest area in the diagram of mobility vs. user rate

- WiMAX technologies (IEEE802.16d/e) are bandwidth scalable and cover additional areas for fixed wireless and nomadic access

Vehicle
- High Speed
- Vehicular Rural
- Vehicular Urban

Walk
- Pedestrian
- Nomadic

Fixed
- Fixed urban
- Indoor
- Personal Area

GSM GPRS

EDGE

3G/UMTS

FlashOFDM (802.20)

Systems Beyond 3G >2012

HSPA

IEEE 802.16e

wimax

DECT

WLAN (IEEE 802.11x)

IEEE 802.16a,d

bluetooth

User data rate

0.1   1   10   100   **Mbps**

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The various access technologies are addressing different telecommunication markets

	"Integrated Services Digital Network"	"Digital Subscriber Line"
fixed	POTS, ISDN (B-ISDN, ATM)	xDSL, Cable
mobile	GSM (GPRS / EDGE) UMTS / HSDPA	**IEEE802.16a IEEE802.16REVd/e** Wi-Fi / Wireless DSL

- **End-to-end Quality of Service**
- **Hard realtime (voice) Defined traffic classes**
- **End-to-end service delivery**
  - Voice, SMS, Gaming, Infotainment
- **Precise accounting, charging and billing**

- **Best effort, Class of Service enabled**
- **Interactive (http, mail) Streaming, downloads**
- **Access to the plain Internet**
  - Common web applications, e-mail
- **Usage classes, flat-rate**

→ **Wireless DSL is an attractive market segment in addition to the current mobile market.**

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Peak data rate and capacity demand of a Western European Cellular Operator

B3G

Higher data rates and capacity enhancements

WiMAX .16d

WiMAX nomadic 802.16e

3G extension spectrum ?

Higher peak data rate; > 1Mbps dl; NRT packet data

HSDPA

3G basic service; 384kbps, RT, NRT

W-CDMA

2004 2005 2006 2007 2008 2009 2010

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The search for spectrum
worldwide roaming will require tri-mode radio

Canada
2.3, 2.5, 3.5 & 5.8 GHz

USA
2.5 & 5.8 GHz

Europe
3.5 & 5.8 GHz
Open: 2.5 GHz

Russia
3.5 GHz
Open: 2.3, 2.5 GHz

Asia Pacific
2.3, 3.3, 3.5 & 5.8 GHz
Open: 2.5 GHz

**Central &
South America**
2.5, 3.5 & 5.8 GHz

**Middle East &
Africa**
3.5 & 5.8 GHz

Licensed Bands
- 2.5GHz
  (2.3-2.4 /
  2.5-2.7)
- 3.5GHz
  (3.3-3.8)

Unlicensed Band
- 5.8GHz
  (5.25-5.85)

Source: Intel, 2005

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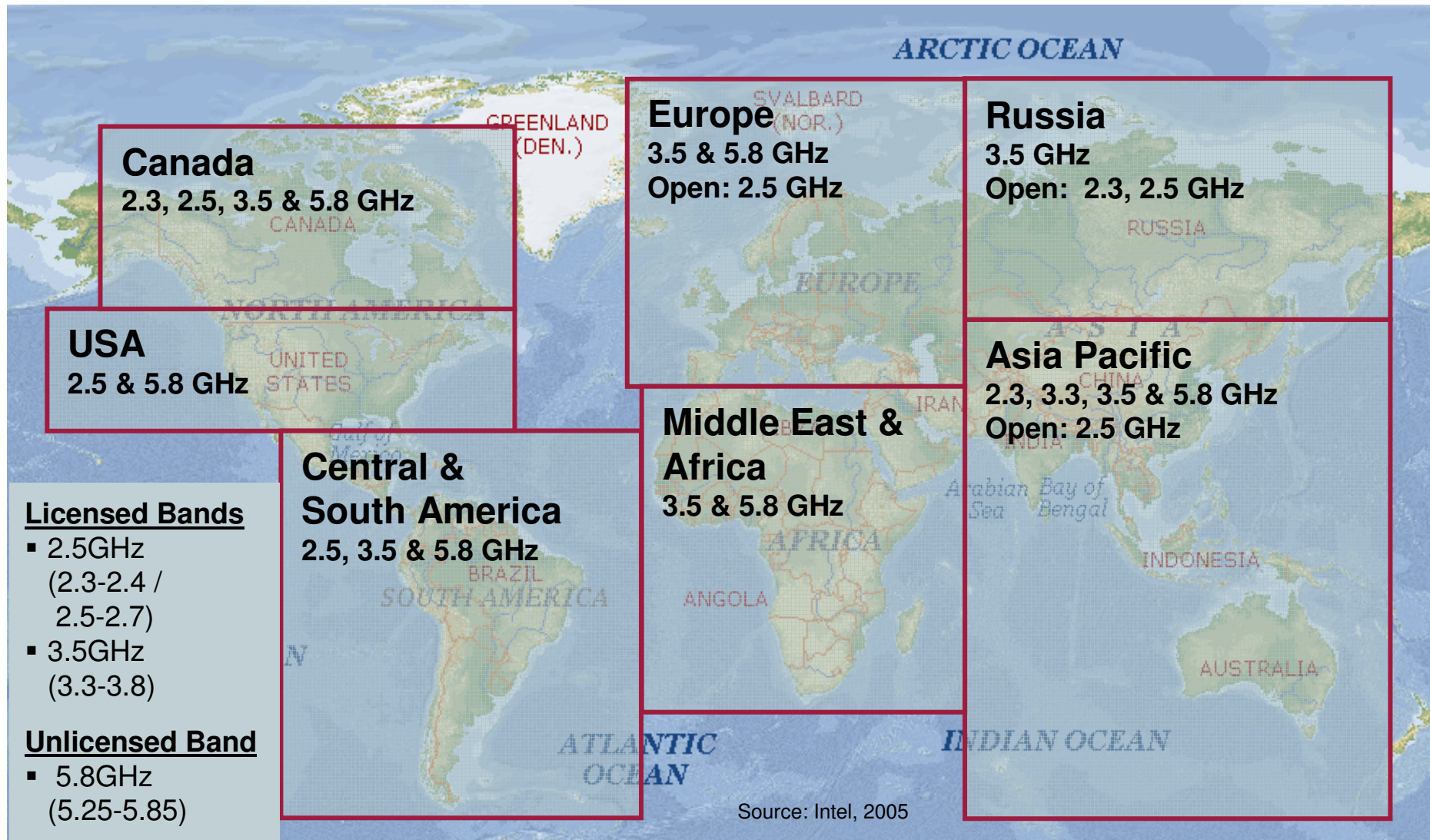
Choosing the right path depends on each operators individual situation

- Regulatory

Available Spectrum, Frequencies & Carrier Bandwidth

Data rates

Latency

Technological constraints

Capacity

Mobility

- Population density
- Spending on communication
- …

Regional constraints

Operator strategy

- Mobile / Fixed
- Service offering
- Competitive situation

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Technological constraints

Data rates · Latency · Capacity · Mobility
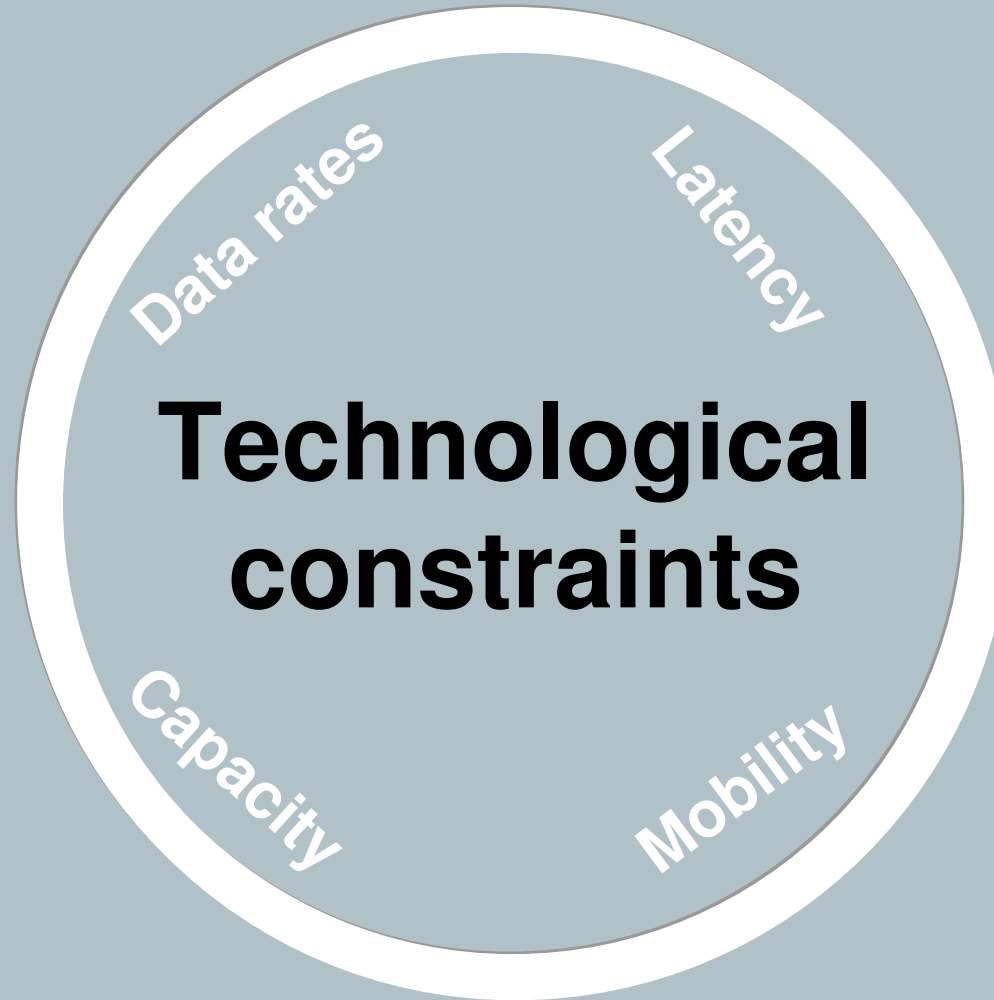
Broadband Wireless Access
The right solution for each market segment

HSDPA	WiMAX	FLASH-OFDM 450MHz
▪ For operators with a UMTS License to release the full power of W-CDMA ▪ Quick and cost-effective upgrade of existing networks ▪ Seamless 2G/3G handover – global coverage	▪ Optimized wireless-DSL services (Voice + data) ▪ Support of charging/billing typical for DSL (e.g. user classes, volume/flat-rate packages ▪ High capacity; Limited mobility	▪ Cost-efficient and fast solution for DSL-like data services ▪ Covers large geographical areas, due to frequency band of 450 MHz ▪ Optimized for data usage

High speed with full mobility

Largest capacity, limited mobility

Largest cell-size, full mobility

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BWA Solutions by Siemens
Early to market with end–to-end solutions

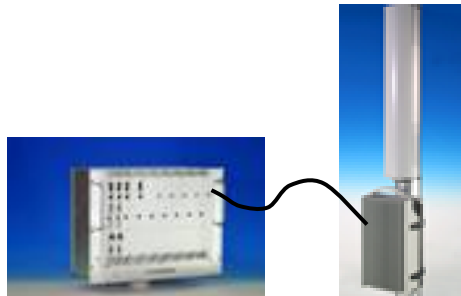| HSDPA	WiMAX	FLASH-OFDM 450MHz
▪ NodeBs HSDPA-prepared since 2002 ▪ Smooth upgrade path from 3G W-CDMA to HSDPA ▪ First Live Demo with a PC card at 3GSM World Congress, Feb. 2005 ▪ HSDPA end-to-end solution available 2005. Several operators will then go commercial with HSDPA by Siemens	▪ End-to-end: SkyMAX base station and modems presented at the 3GSM Congress in February 2005 ▪ Best-in-class in cell range ▪ First installation going live in 2005 ▪ First call in July 2005	▪ Only Siemens provides Flash-OFDM 450 MHz products ▪ Integration of FLASH-OFDM into Siemens NodeBs and NM Systems ▪ End-to-end solution now available
Delivers higher data speeds	**High capacity for hot zones**	**Cost effective high speed seamless mobile data services**

Broadband wireless access technologies complement one another as they evolve

One of the market's first end-to-end solutions for WiMAX radio networks comes from Siemens

WiMAX

- Ideal for stationary, wireless broadband internet access

- Wireless DSL and 'nomadic' notebook use

- Wireless 'last mile' solution for fixed and mobile operators

- Ideal for rural and remote areas where the provisioning of services by cable or fiber is difficult or uneconomic

SkyMAX by Siemens

- End-to-end: SkyMAX base station and Gigaset SE modems presented at the 3GSM Congress in February 2005

- Best-in-class for cell range

- Available in the second half of 2005

SkyMAX Base Station – IDU layout

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Technical Solution
SkyMAX – Complete Portfolio!

Complete Portfolio includes CUSTOMER PREMISES EQUIPMENT!

NetViewer

- One O&M system for SkyMAX and microwave PtP, PtMP
- Widespread Northbound Integration Landscape

SkyMAX Residential

SkyMAX Basestation

SkyMAX Business

Network Planning

Network Planning tools

SkyMAX family

SkyMAX BS:
- Split version
- Shelf based architecture
- up to 4(+1) Sectors

SkyMAX ST:
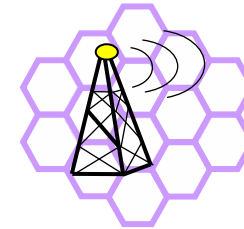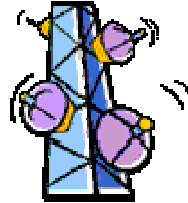- Residential Modem: Fully Indoor
- Business Modem: Fully Outdoor

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WiMAX & Mobility
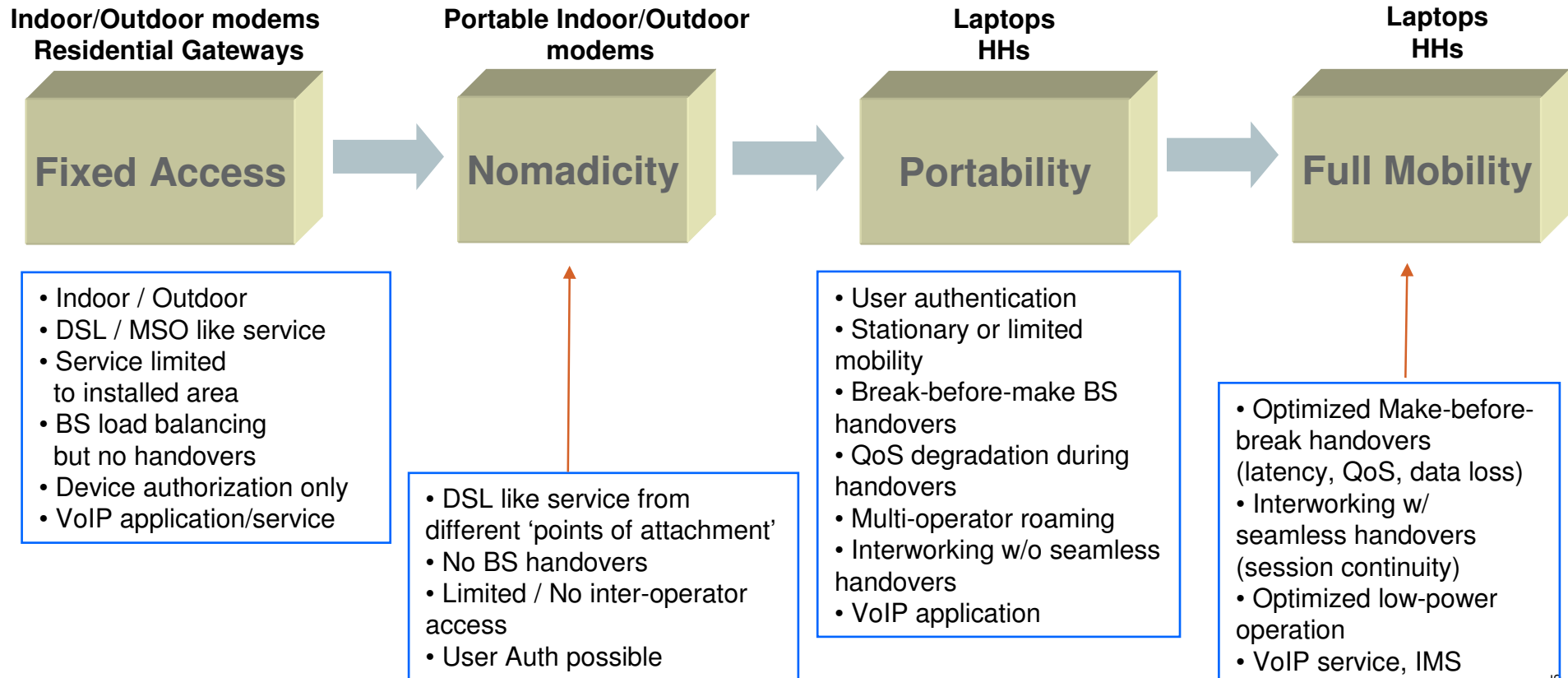
Source: Max Riegel

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IEEE 802.16 - 2004 Standards Family

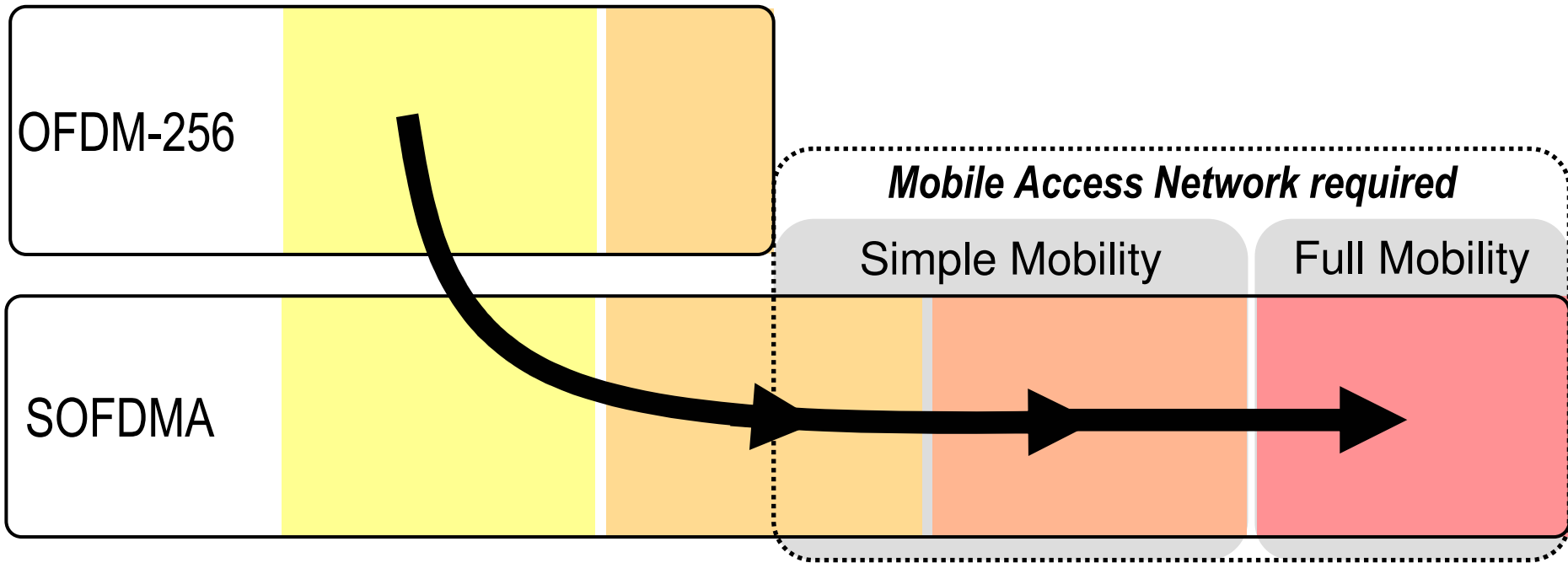|	Feeding	FWA	Cellular
Completed	December 2001	January 2003	June '04 / Mobility mid '05
Spectrum	10 - 66 GHz	< 11 GHz	< 6 GHz
Channel Conditions	Line of Sight Only	Non Line of Sight	Non Line of Sight
Bit Rate	32 – 134 Mbps in 28MHz channel bandwidth	Up to 75 Mbps in 20MHz channel bandwidth	Up to 15 Mbps in 5MHz channel bandwidth
Modulation	Single Carrier QPSK, 16QAM, 64QAM	OFDM 256 sub-carriers QPSK, 16QAM, 64QAM	1x Scalable OFDMA QPSK, 16QAM, 64QAM
Mobility	Fixed	Fixed	Portable Data mobility (<120 km/h)
Channel Bandwidths	20, 25 and 28 MHz	Scalable 1.5 to 20 MHz	Scalable 1,25 to 20 MHz
Typical Cell Radius	2 to 5 km	7 to 10 km Max. range 50 km	1 to 5 km

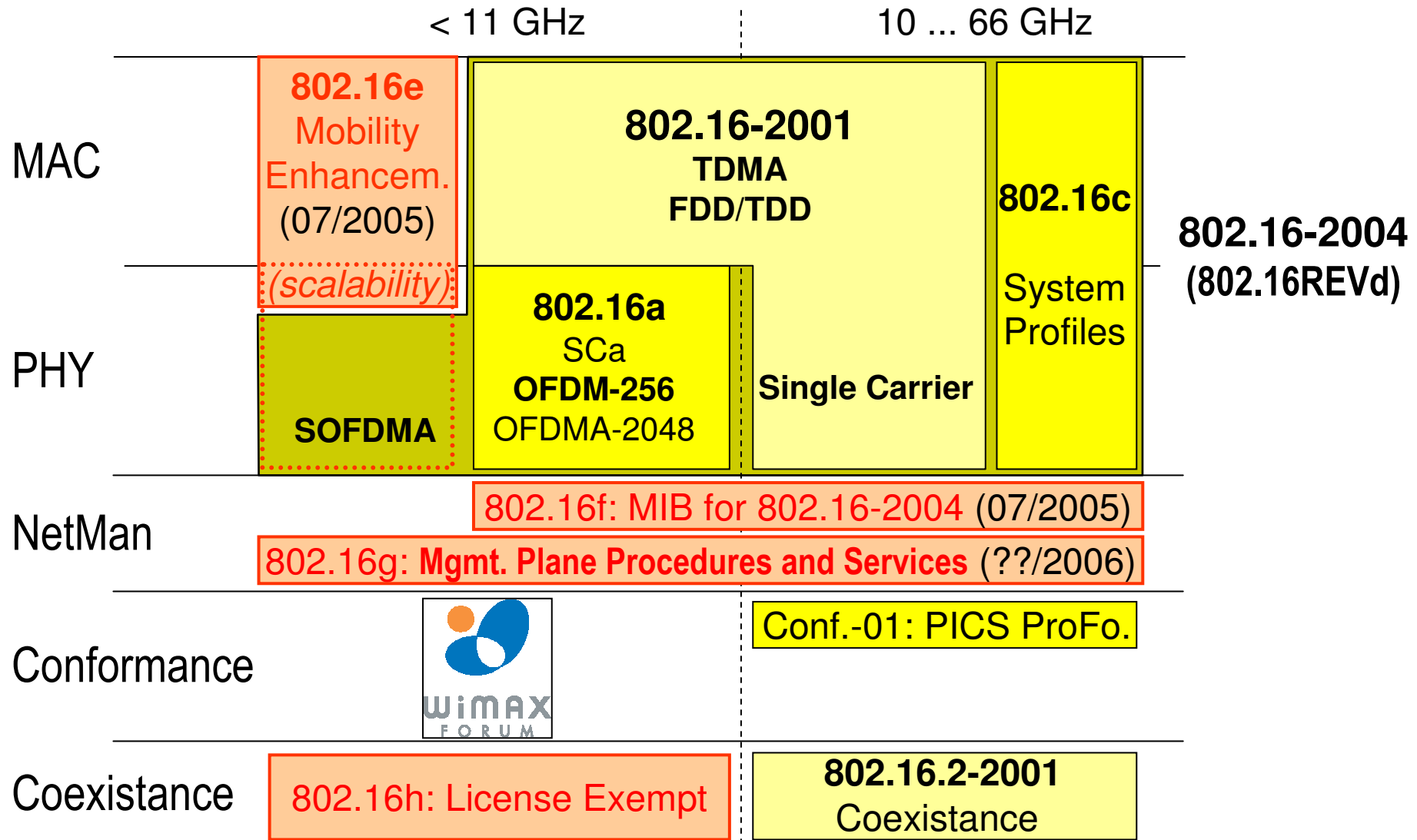**SIEMENS**

WiMAX Usage Scenarios and Evolution

Indoor/Outdoor modems
Residential Gateways

Fixed Access → **Nomadicity** → **Portability** → **Full Mobility**

Portable Indoor/Outdoor modems

Laptops HHs

Laptops HHs

• Indoor / Outdoor
• DSL / MSO like service
• Service limited
  to installed area
• BS load balancing
  but no handovers
• Device authorization only
• VoIP application/service

• DSL like service from
  different 'points of attachment'
• No BS handovers
• Limited / No inter-operator
  access
• User Auth possible

• User authentication
• Stationary or limited
  mobility
• Break-before-make BS
  handovers
• QoS degradation during
  handovers
• Multi-operator roaming
• Interworking w/o seamless
  handovers
• VoIP application

• Optimized Make-before-
  break handovers
  (latency, QoS, data loss)
• Interworking w/
  seamless handovers
  (session continuity)
• Optimized low-power
  operation
• VoIP service, IMS

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WiMAX Evolution Path

FWA	Nomadic	Portable	Mobile

OFDM-256

SOFDMA

Mobile Access Network required

Simple Mobility | Full Mobility

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IEEE 802.16 Broadband Wireless Access
... only a *Radio Interface*

< 11 GHz   10 ... 66 GHz

MAC

802.16e
Mobility
Enhancem.
(07/2005)

(scalability)

802.16-2001
TDMA
FDD/TDD

802.16c

System
Profiles

802.16-2004
(802.16REVd)

PHY

SOFDMA

802.16a
SCa
OFDM-256
OFDMA-2048

Single Carrier

NetMan

802.16f: MIB for 802.16-2004 (07/2005)

802.16g: **Mgmt. Plane Procedures and Services** (??/2006)

Conformance

WiMAX
FORUM

Conf.-01: PICS ProFo.

Coexistance

802.16h: License Exempt

802.16.2-2001
Coexistance

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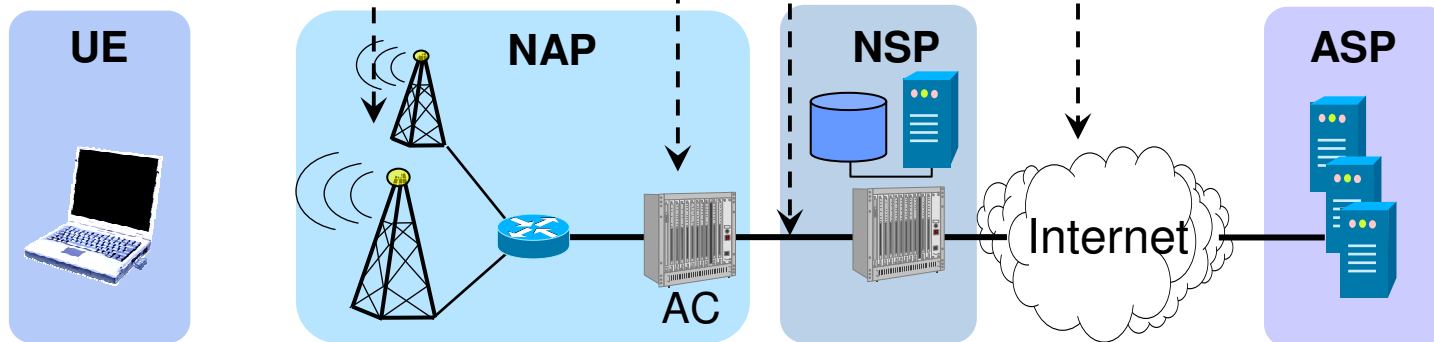## What is covered by the IEEE802.16 Standards
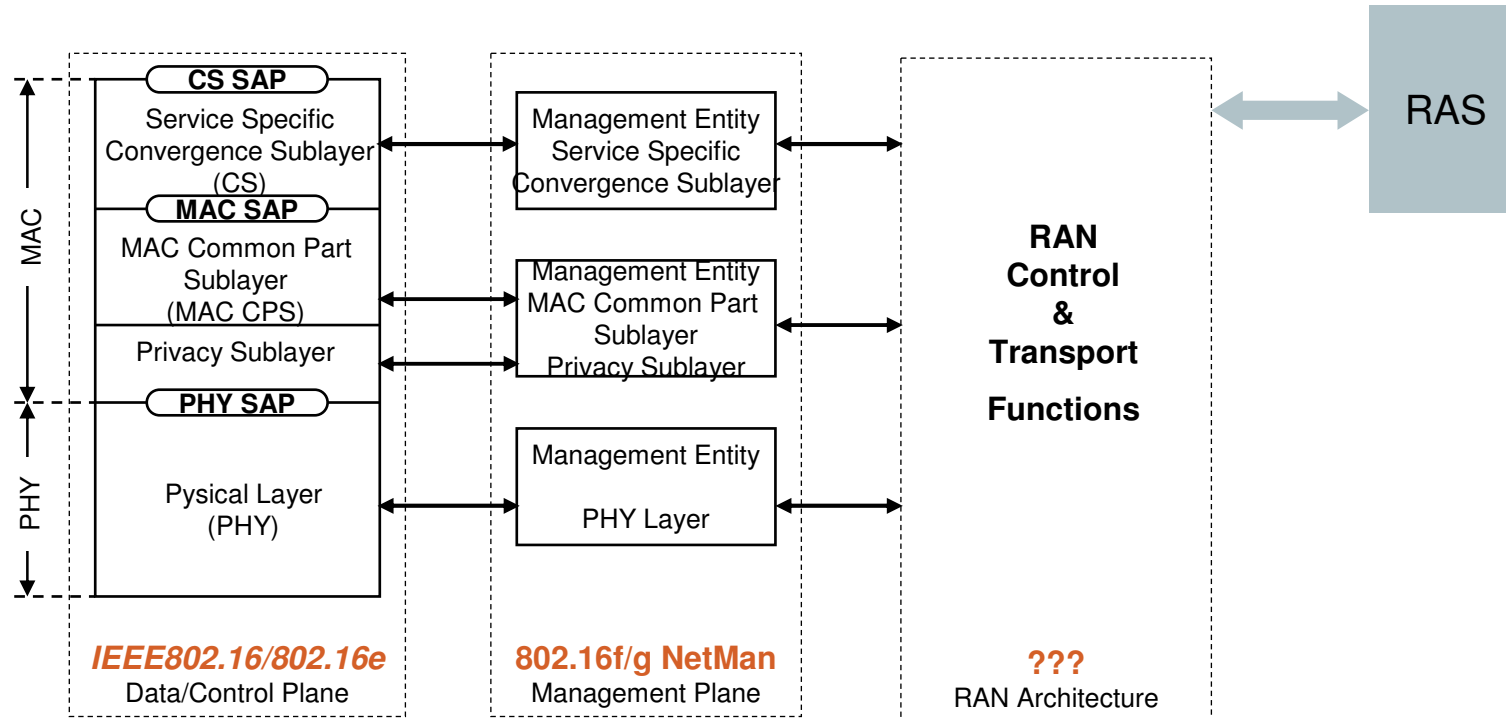
- IEEE802.16-2004 & 802.16e define only data and control plane functions

- Management plane functions are added by 802.16f & g (NETMAN)

- IEEE P802.16 does not deal with functions usually provided by the RAN

  - The standardization of the missing parts of a portable/mobile WiMAX access network has been established in the WiMAX Forum.

WiMAX Architecture is aligned to DSL

DSL Architecture

(x)DSL - Access   backhaul service

Modem ADSL

splitter

POTS/ISDN

DSLAM

ATM/ETH

BRAS   managed **IP** backbone network

WWW (internet)

PoP / Traffic Hand-over

| DSLAM access | ATM level (parent/ distant switch) | IP level (managed) | www (unmanaged IP) |

① 1   ② 2   ③ 3   ④ 4

WiMAX Architecture

UE

NAP

NSP

ASP

AC

Internet

Abbreviations:

UE
 User Equipment

NAP
 Network Access Provider

AC
 Access Concentrator

NSP
 Network Service Provider

ASP
 Application Service Provider

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WiMAX Network Architecture (logical view)
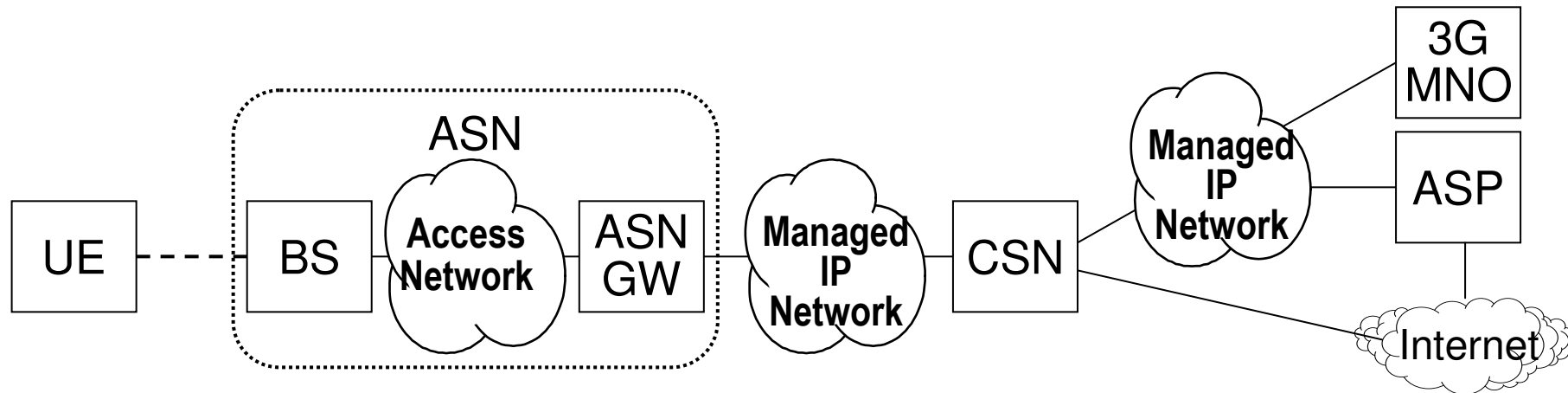
Functional blocks of the WiMAX Network Architecture:

UE: User Equipment

ASN: Access Serving Network

  BS: Base Station

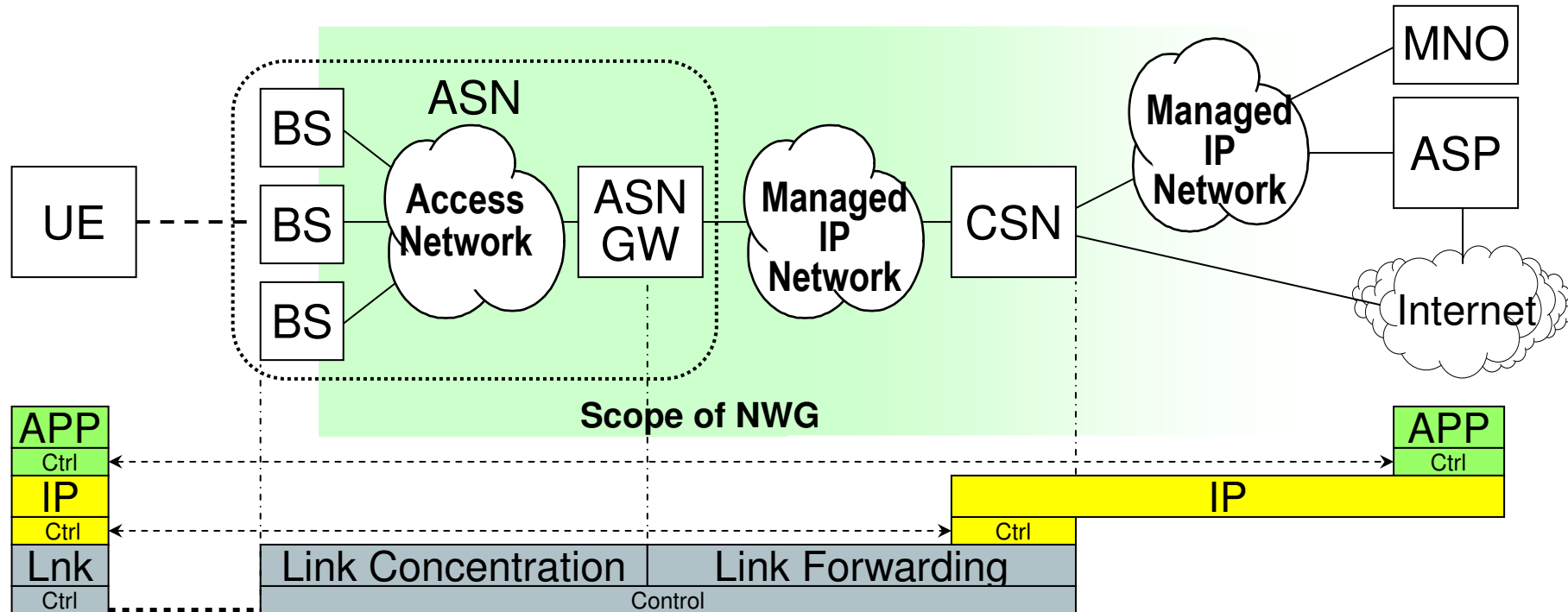 ASN-GW: *Access concentration and L2 forwarding*

CSN: Connectivity Serving Network; *provides plain IP connectivity to the UE*

ASP: Application Service Provider; *any kind of IP-based service, e.g. VoIP*

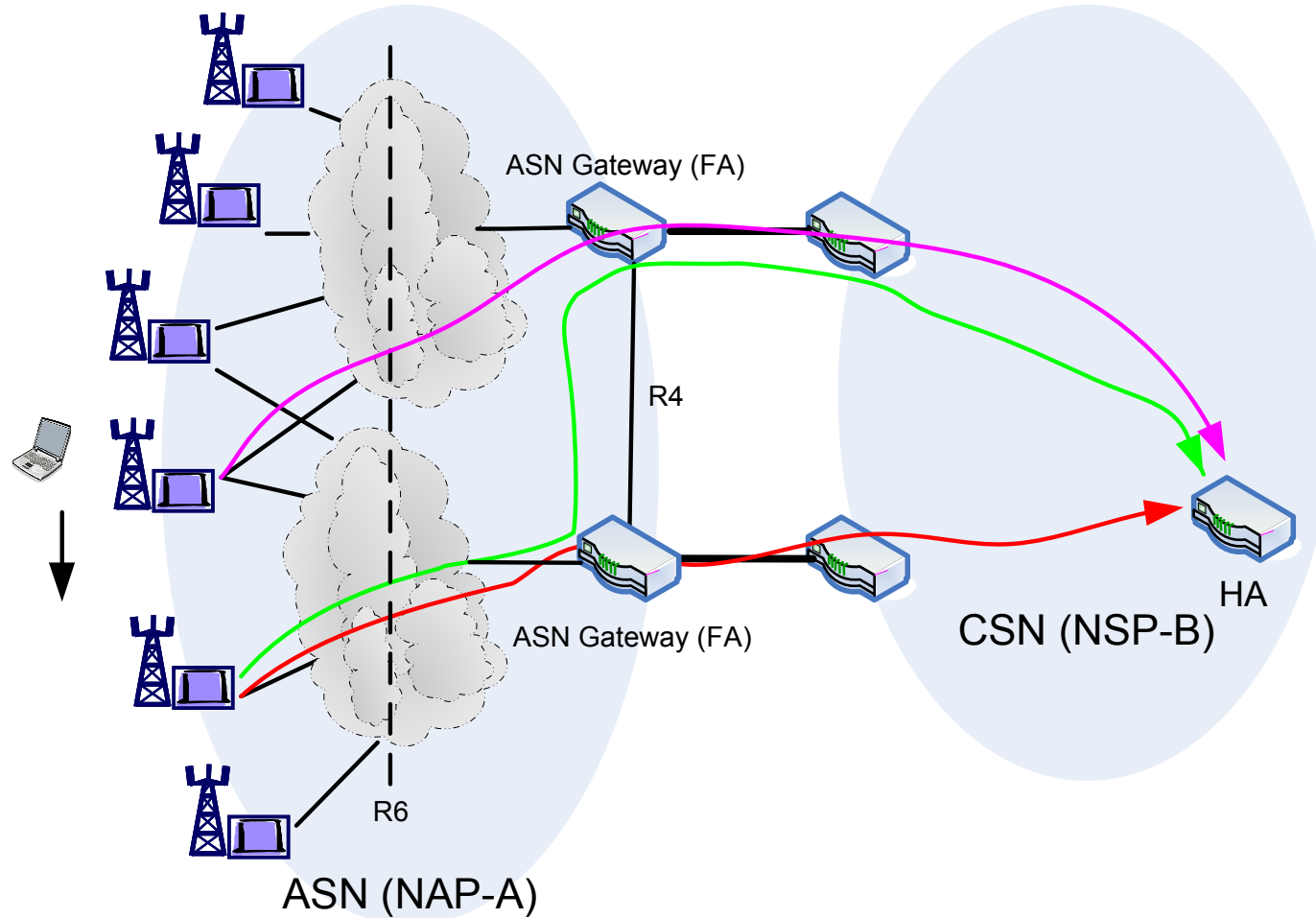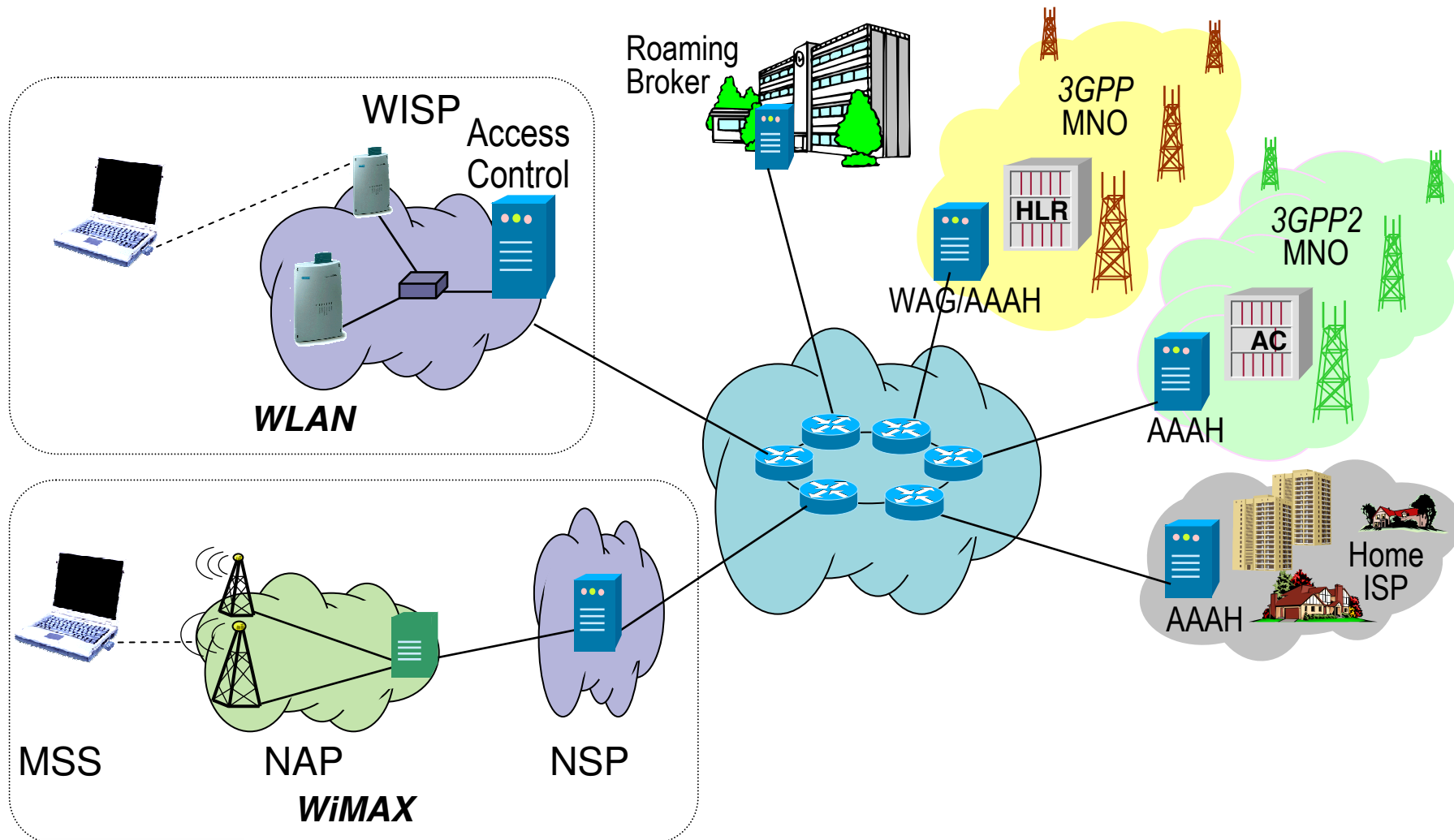**SIEMENS**

WiMAX Mobile Network Architecture

All kind of wide-area IP (access) networks are following the same structure/layers

- Plain link-layer infrastructure for concentrating traffic of individual users (most economic)
- An entity providing an IP address to the UE for access to IP based applications/services
- Applications being agnostic to the particular infrastructure based on plain IP connectivity

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Mobility Scope

WiMAX Interworking is like WLAN Interworking

Roaming Broker

WISP Access Control

WLAN

3GPP MNO
HLR
WAG/AAAH

3GPP2 MNO
AC
AAAH

Home ISP
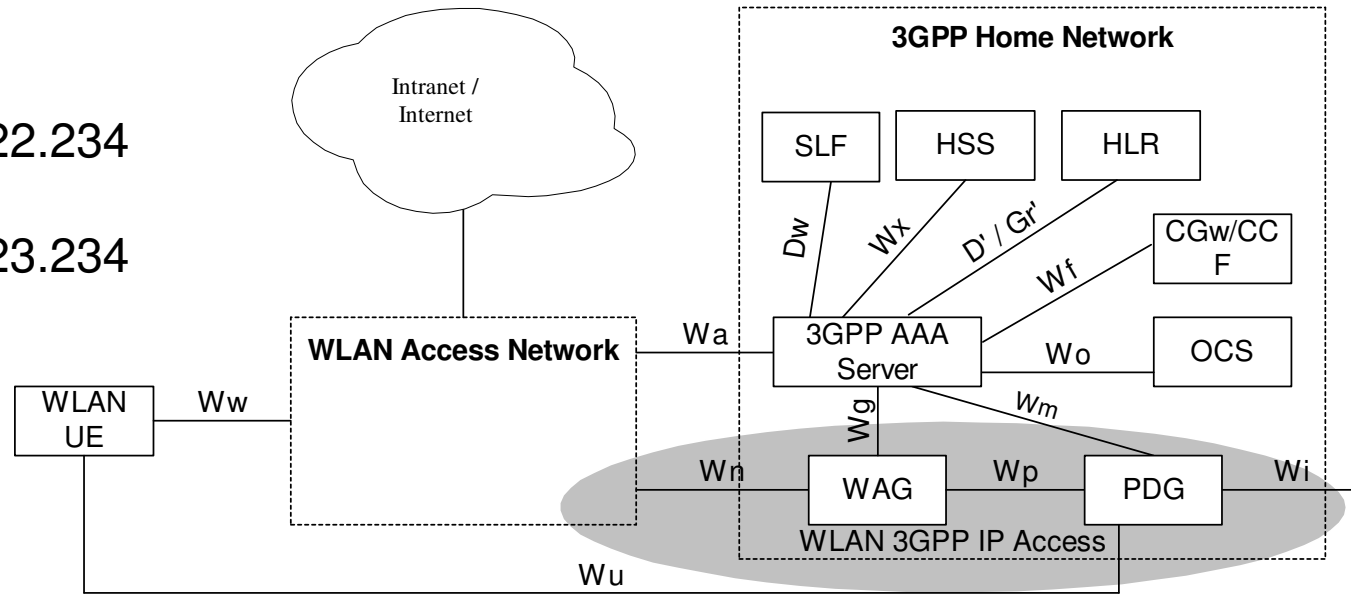AAAH

MSS   NAP   NSP

WiMAX

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3GPP WLAN Interworking Scenarios

Stage 1:
- 3GPP TS 22.234

Stage 2:
- 3GPP TS 23.234

WLAN access
- Scenario 1: Common Billing and Customer Care
- Scenario 2: 3GPP system based
  Access Control and Charging
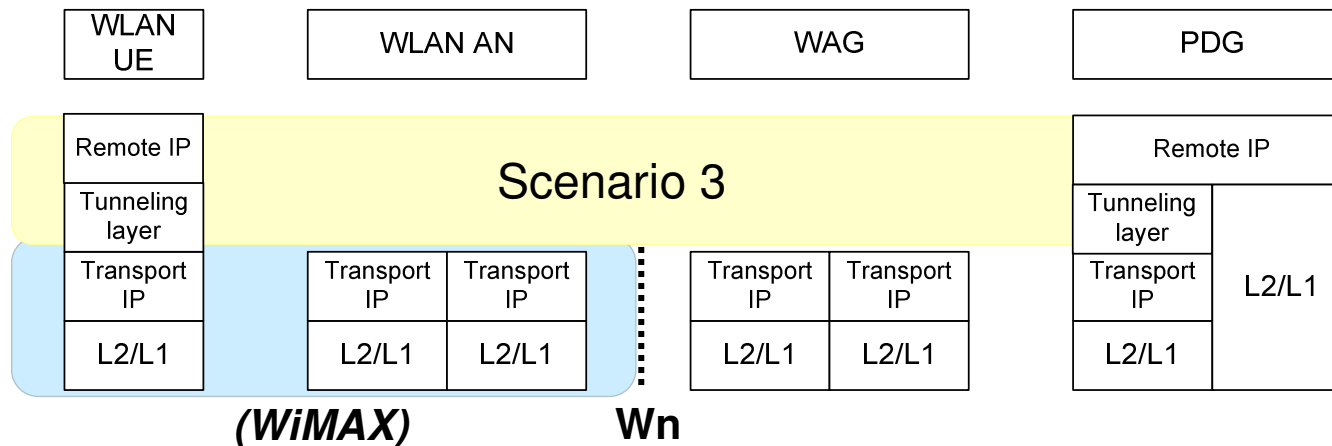
AAA Roaming

Access to 3G services over WLAN
- Scenario 3: Access to 3GPP PS based services
- Scenario 4: Service Continuity

IPsec VPN

- Scenario 5: Seamless services

tbd

- Scenario 6: Access to 3GPP CS Services

n.r.

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3GPP Scenario 3

WLAN UE	WLAN AN	WAG	PDG

Scenario 3

			Remote IP	
Remote IP			Tunneling layer	
Tunneling layer				L2/L1
Transport IP	Transport IP / Transport IP	Transport IP / Transport IP	Transport IP	
L2/L1	L2/L1 / L2/L1	L2/L1 / L2/L1	L2/L1	

(WiMAX)   **Wn**

Scenario 3 defines an E2E VPN solution based on IP connectivity

Scenario 3 may be combined with scenario 2 (dual authentication)

Wn: reference point between the WLAN Access Network and WAG

- The specific method to implement this interface is subject
  to local agreement between the WLAN AN and the PLMN

Basics of stage 3 clarified in SA3 (EAP-SIM/AKA over IKEv2)

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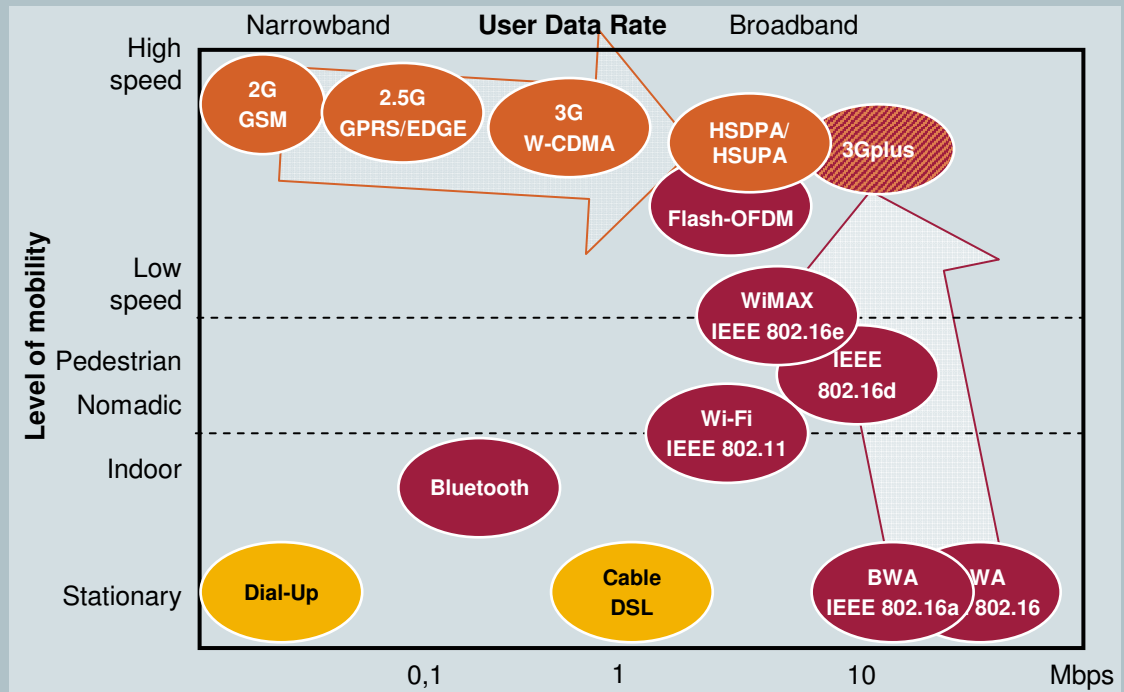# WiMAX Interworking model

© Siemens AG, 2005
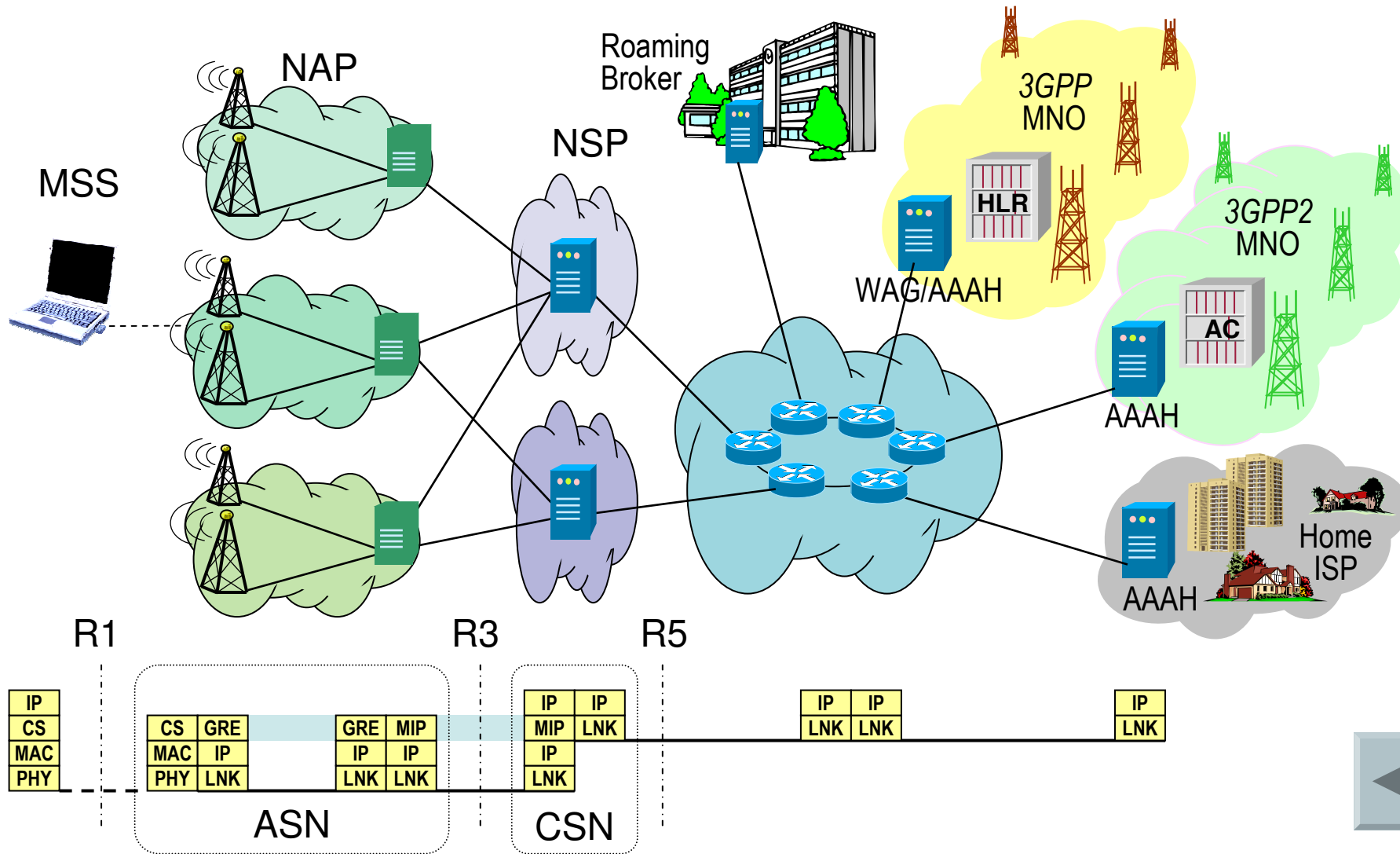
Trends in Mobile and Wireless Access
Several technologies move in the same direction: Mobile Broadband

Cellular technologies become more and more broadband
(TDD-HCR, TDD-LCR, HSDPA)

Alternative wireless technologies become more and more mobile
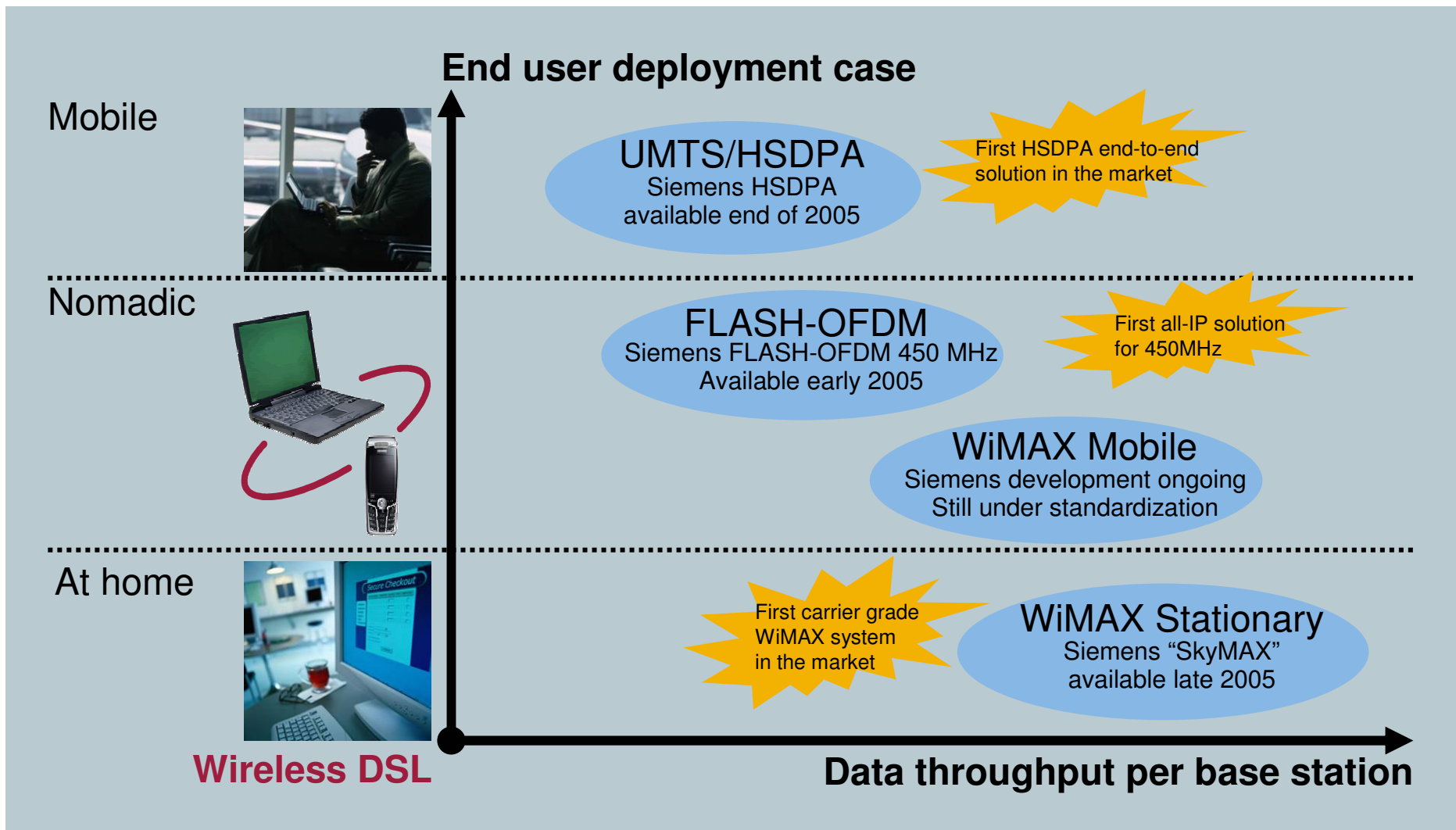(WiFi, WiMAX, 802.20)

Several technologies compete for mobile Broadband:
- not all can win, but several will coexist
- **HSPA (HSDPA+HSUPA) and WiFi / WiMAX are the winning combination**
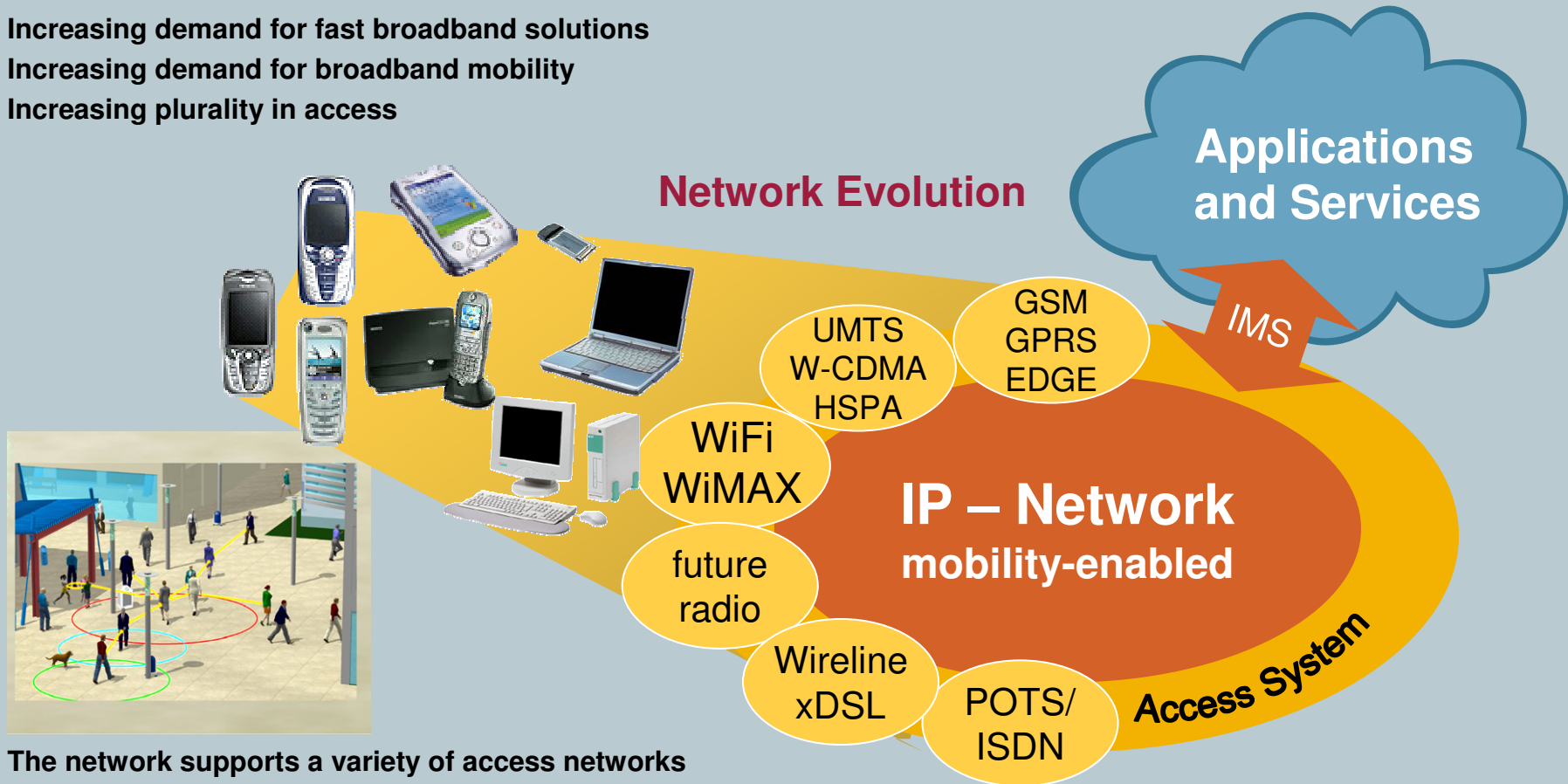
Source: Com MN SM Market Assessment

Siemens is worldwide leading in wireless broadband technologies

End user deployment case

Mobile

UMTS/HSDPA
Siemens HSDPA
available end of 2005

First HSDPA end-to-end solution in the market

Nomadic

FLASH-OFDM
Siemens FLASH-OFDM 450 MHz
Available early 2005

First all-IP solution for 450MHz

WiMAX Mobile
Siemens development ongoing
Still under standardization

At home

First carrier grade WiMAX system in the market

WiMAX Stationary
Siemens "SkyMAX"
available late 2005

Wireless DSL

Data throughput per base station

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The Next Generation Network Vision

Increasing demand for fast broadband solutions
Increasing demand for broadband mobility
Increasing plurality in access

Network Evolution

Applications and Services

IMS

UMTS
W-CDMA
HSPA

GSM
GPRS
EDGE

WiFi
WiMAX

IP – Network
mobility-enabled

future
radio

Wireline
xDSL

POTS/
ISDN

Access System

The network supports a variety of access networks

The majority of traffic is IP-based with increasing peer to peer and machine to machine traffic

Opens possibilities for new radio interfaces based on improved air interfaces (OFDM)
and support for multi-hop, ad hoc and self-organizing networks

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Thank you very much for your attention.

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