Mobile WiMAX

Max Riegel, 2006-03-16

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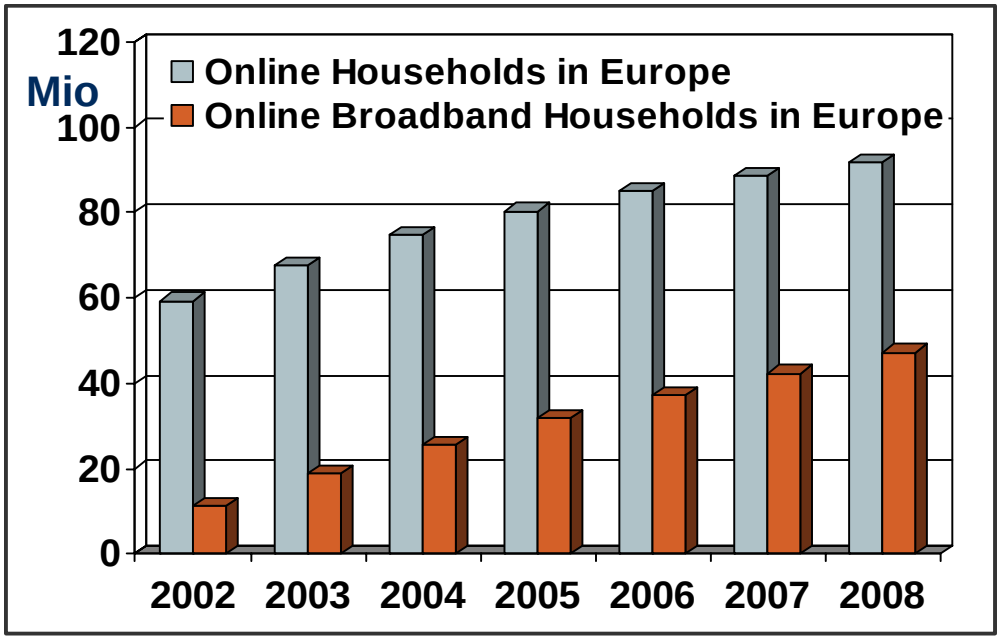
Motivation for WiMAX: Broadband Access to the Internet without wires

The broadband divide:

Until 2008 only half of all Internet households will have broadband access.



Source: Jupiter research, Nov 2003

Reasons:

- **too complicated**
  - especially for the 55+
- **too expensive**
  - especially for the casual user

Usually a wireless access network is more user-friendly and less expensive for casual users – like GSM for telephony.

- **There is business to serve the other 50% of all households with broadband Internet access,**
- **… and may extend the market for mobile terminals (Notebooks, PDAs, media-players and others) – the Intel perspective on WiMAX**

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Key figures of a wireless DSL system

- **Bandwidth per user (DL): 1 Mbit/s (like wireline DSL)**
- **Maximum number of customers per 'base-station':**
  - assuming an aggregate DL capacity of 20 Mbit/s per base-station
  - a multiplexing factor of 25
    (statistical multiplexing gain when combining the traffic of several users)
    - usual figures for wireline DSL: 30 - 150
    - according to traffic statistics from Korean DSL users:
      20 000 DSL customers are producing a peak data rate of 500 Mbit/s
- **each base-station may serve at least 500 customers (even more when going for the 'casual-user')**
- **required cell size:**
  - assuming a density of 1200 households/km^2 (urban area)
  - 15% penetration for wireless DSL
- **Coverage area per base station: about 1,7 km (diameter)**

These figures are nicely fitting into available radio technologies

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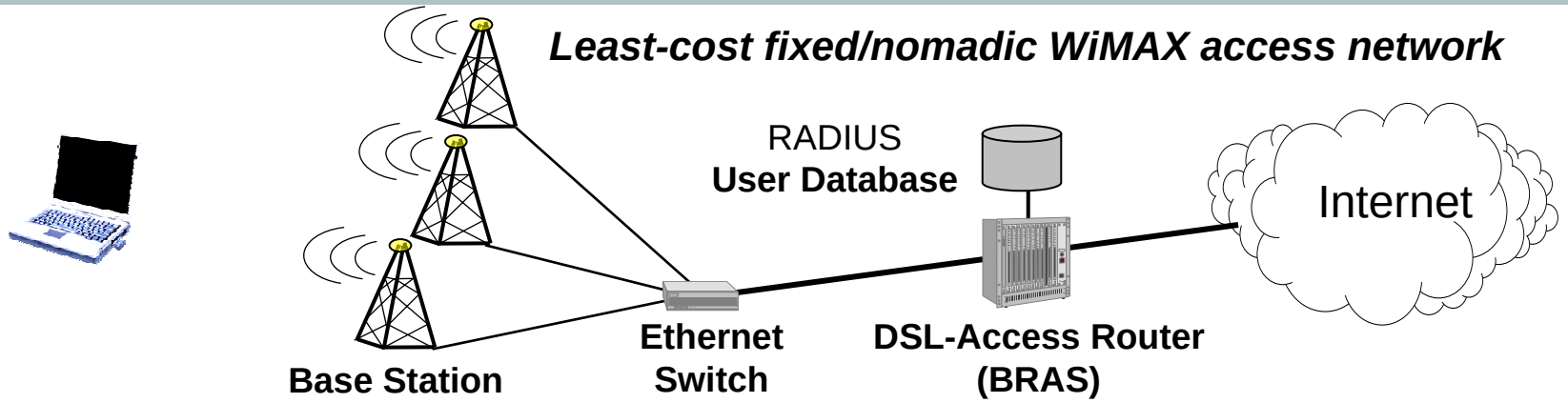
Wireless IP Access Networks are ‘mobile’



- **Plain Ethernet-switching in the aggregation network enables terminal mobility within the access network**
  - Changing point-of-attachment basestation without loosing context
  - Ethernet bridging protocol re-establishes the path when terminal is attached at another location in the network
- **Mobility support may even be offered by a third-party service provider in the Internet**
  - E.g. with Mobile IP running on top of the plain Internet connection
- **Regardless of the kind of radio interface, wireless IP access networks are able to provide ‘mobile services’**

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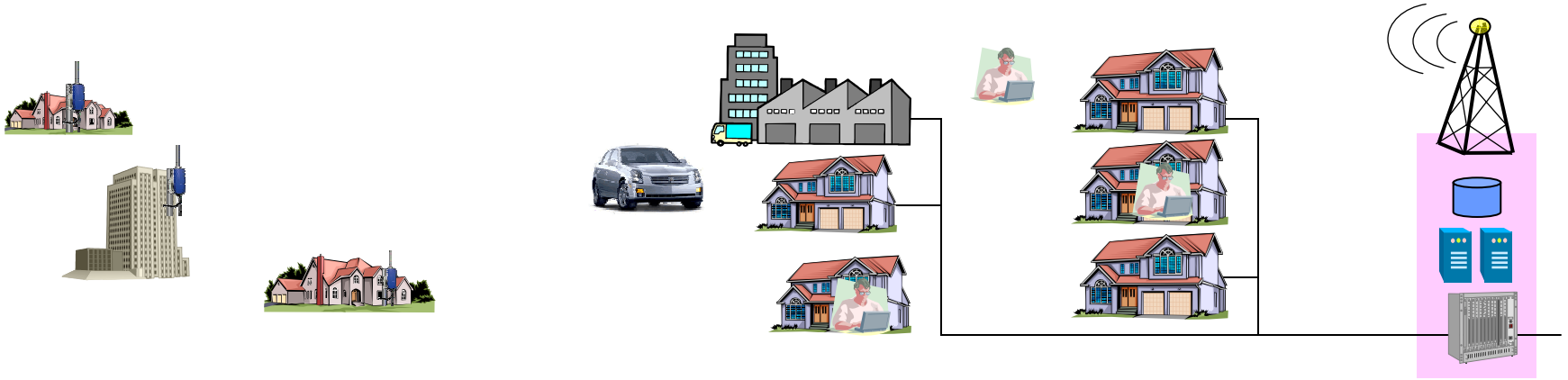
Wireless DSL deployment evolution



Today's broadband providers are tied to their wires

- **serving consumers and enterprises inside their reach**

A wireless DSL system allows to extend the DSL business serving customers without appropriate wires, and additionally also...

- **addressing customers looking for a more easy-to-use solution,**
- **providing portable and mobile access**

All together may be necessary for a successful business case!

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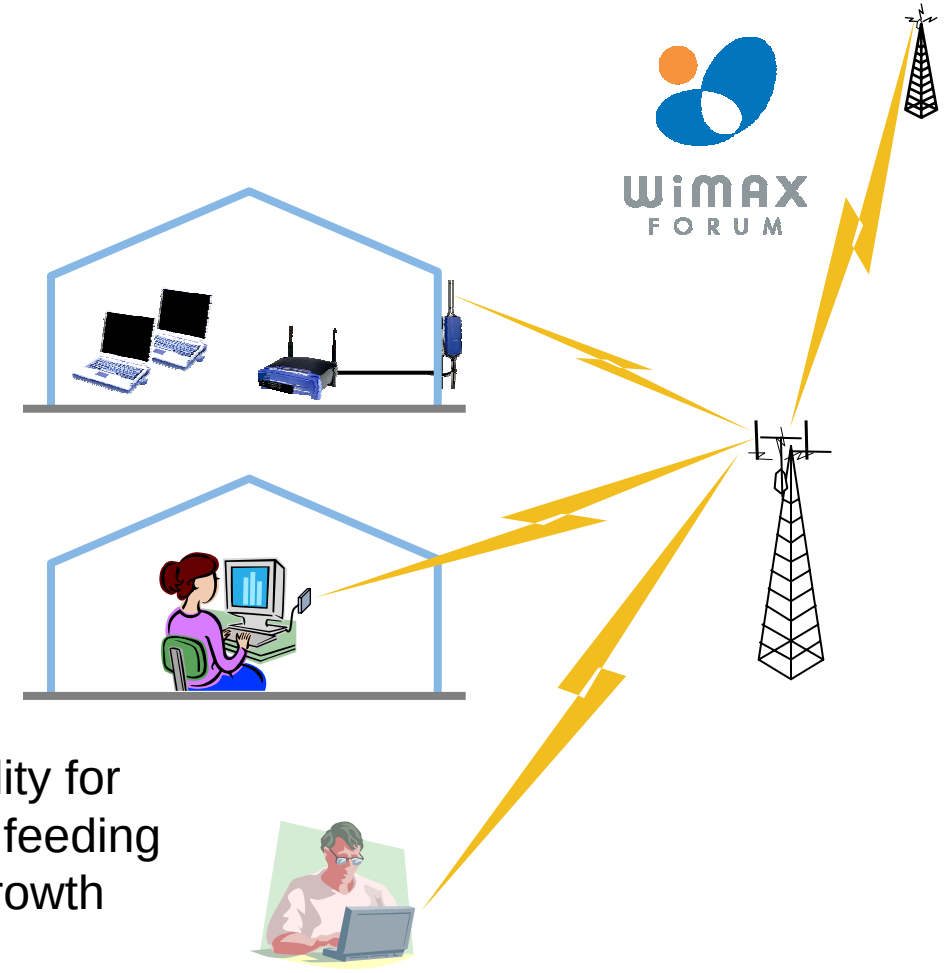
The evolution of WiMAX

- **Backhaul feeding**
  - PtP links for fixed infrastructure
  - Dedicated market w/ limited size
- **Fixed Wireless Access**
  - Wireless local loop, hotspot feeding
  - Suffers from poor CPE handling
- **Nomadic Access (Hotzone)**
  Indoor CPE thanks to better radio
  CPE may be integrated into terminal
  - Most promising for mass market
- **Portable/Mobile Access**
  Handover function enabling data mobility for road warriors, train feeding and coach feeding
  - Mobility enables persistent market growth



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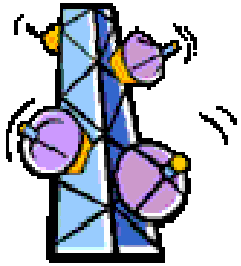
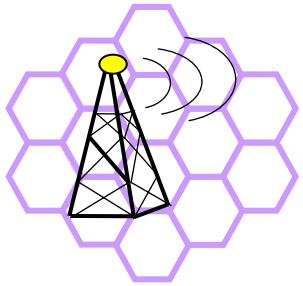
IEEE 802.16: *'One standard fits all'*





	Feeding	FWA	Cellular
Completed	December 2001	January 2003	June '04/Mobility '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 Mobile (up to 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	2-5 km	7 to 10 km Max range 50 km	1-5 km

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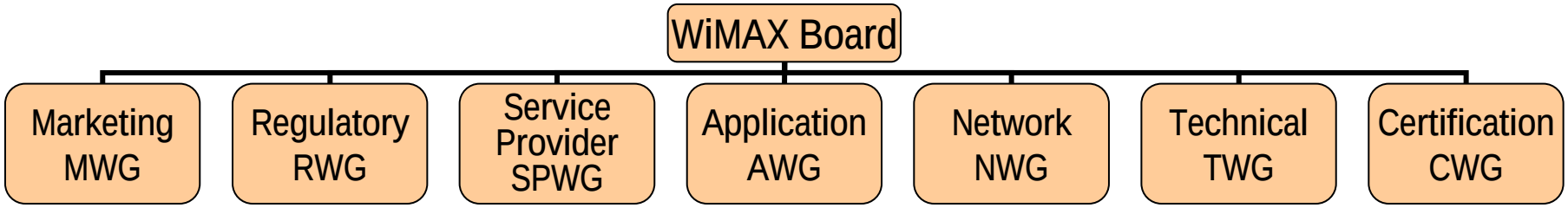
Worldwide Interoperability for Microwave Access

- **The purpose of WiMAX is to promote deployment of broadband wireless access networks by using a global standard and certifying interoperability of products and technologies.**
  - Support IEEE 802.16 standard
  - Propose and promote access profiles for their IEEE 802.16 standard
  - Certify interoperability levels both in network and the cell
  - Achieve global acceptance
  - Promote use of broadband wireless access overall
- **WiMAX Forum grew up to more than 350 members by end of 2005**
- **Chaired by Intel**



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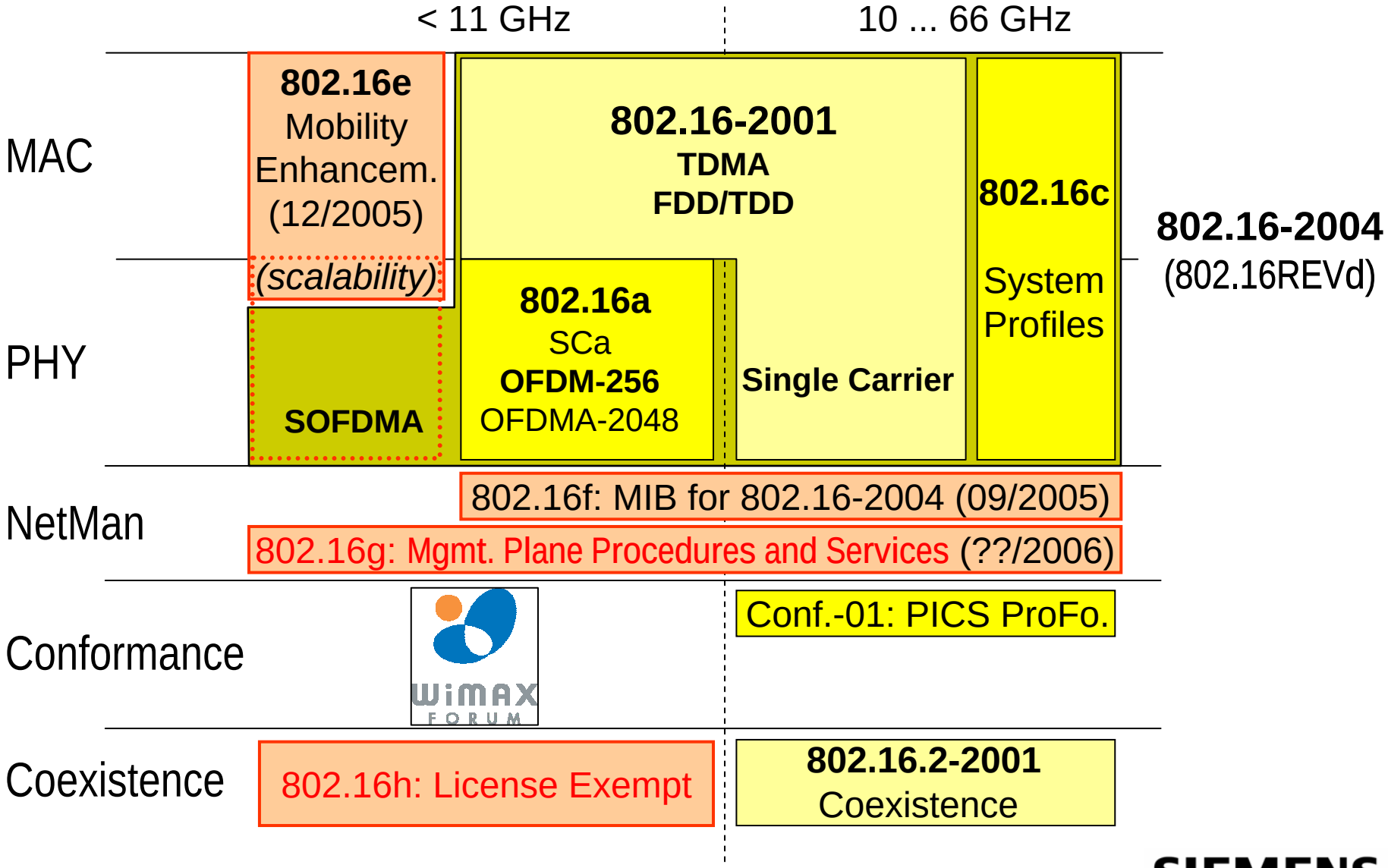
IEEE 802.16 Broadband Wireless Access



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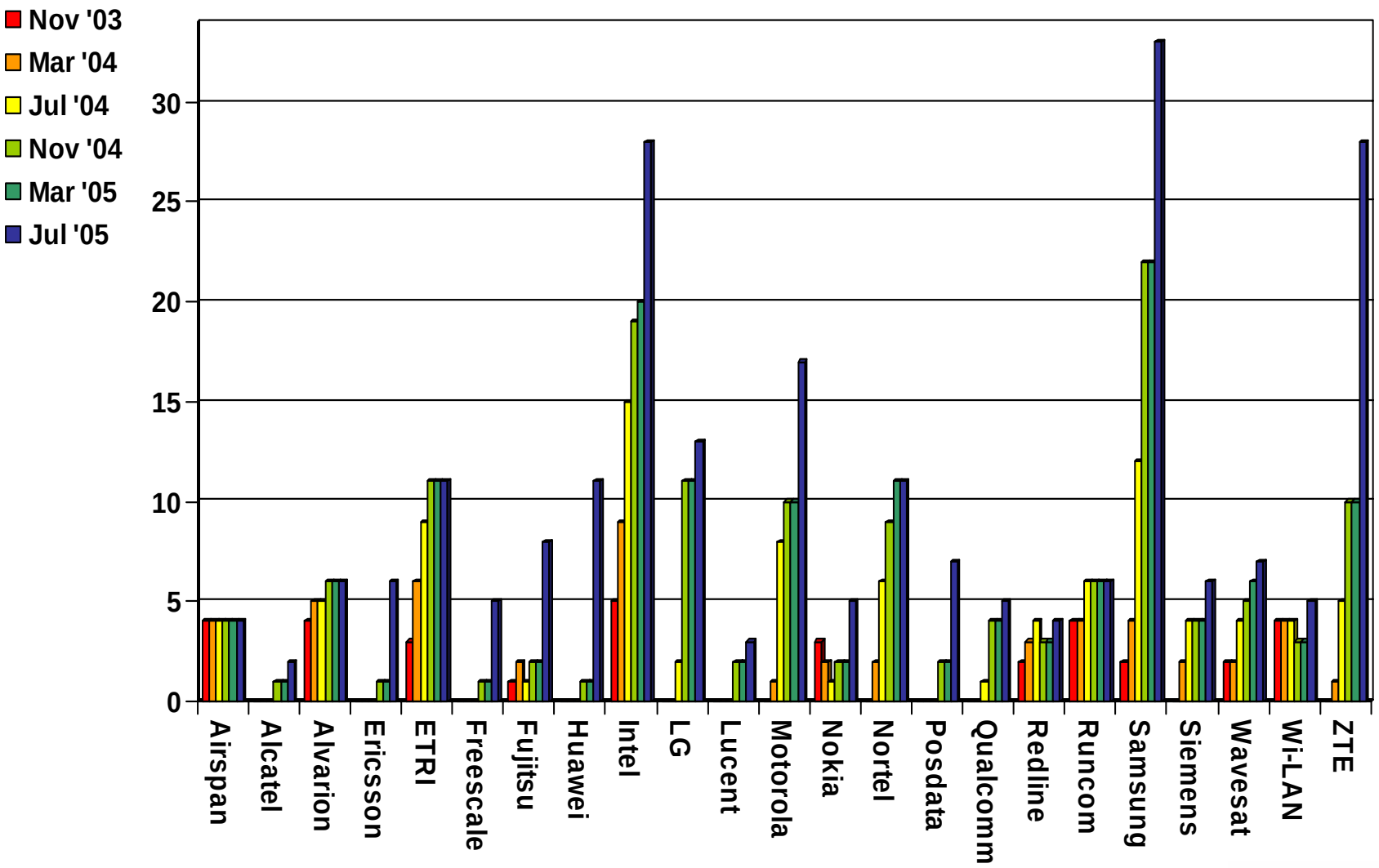
Voting membership in IEEE802.16



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‘Mobile WiMAX’ Network

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The roots of the ‘Mobile WiMAX’ Network E2EARCH WG (MINA)

- **Founded by Intel in June 2004 for development of an end-to-end industry specification for WiMAX portable and mobile wireless broadband systems**
  - Address interfaces, RAN infrastructure elements and interworking - beyond the scope of 802.16
  - Provide foundation for subsequent system level interoperability specs driven through WiMAX Forum
- **Invited companies: Alvarion, Arraycomm, Alcatel, Cisco, Intel, Motorola, (Nortel, left in September ‘04) Samsung, Siemens, ZTE**
- **Process aligned to 3GPP/3GPP2 with Stage 1 (Requirements), Stage 2 (Architecture) and Stage 3 (Protocols)**
- **Fast progress and demand for more interaction with Service Provider WG led to transition into WiMAX NWG in January ’05**
- **Extremely tight schedule for NWG:**
  - Stage 2 (Architecture): E11/05
  - Stage 3 (Protocols): E07/06

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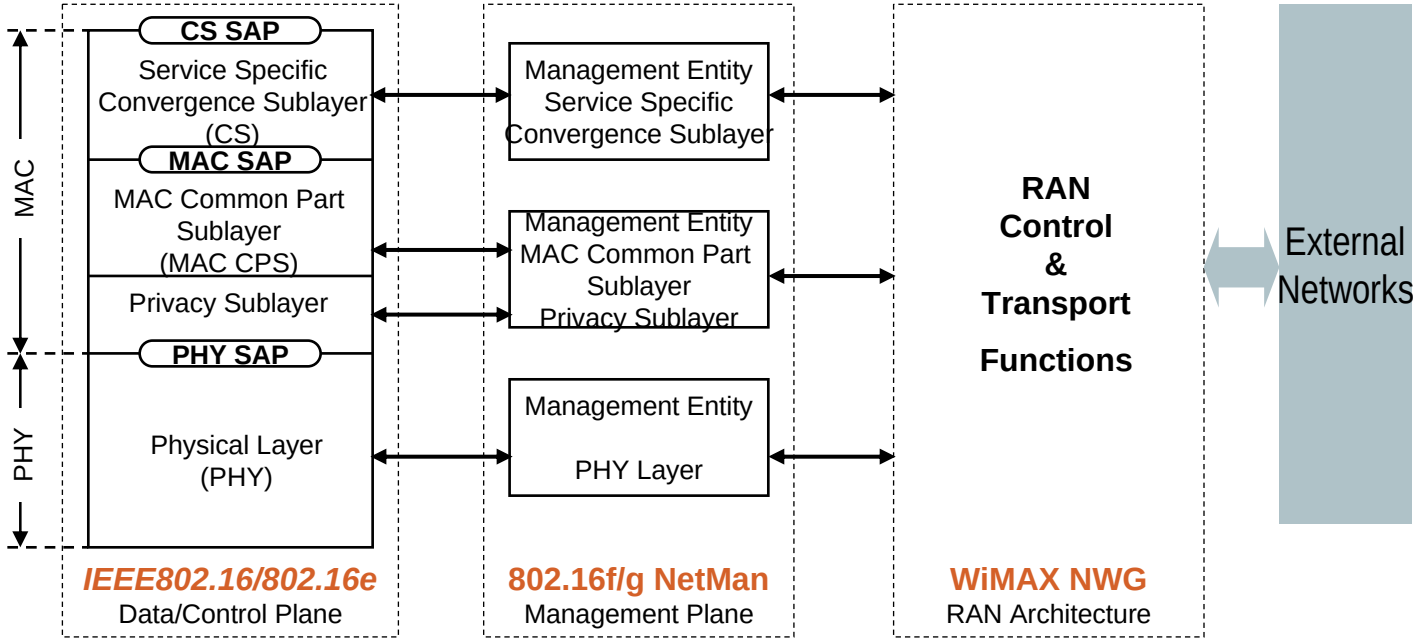
Relation IEEE802.16 vs. WiMAX NWG



IEEE802.16-2004 & 802.16e define only data and control plane

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 these missing parts of a portable/mobile WiMAX access network is the scope of the WiMAX NWG.**

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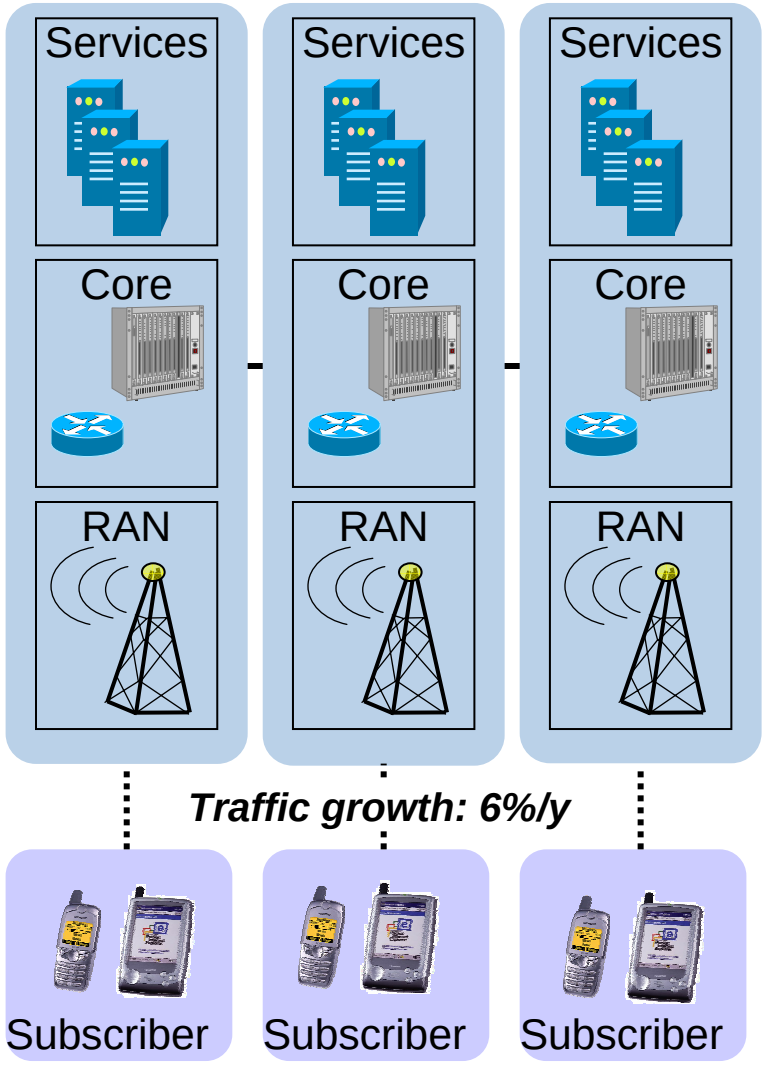
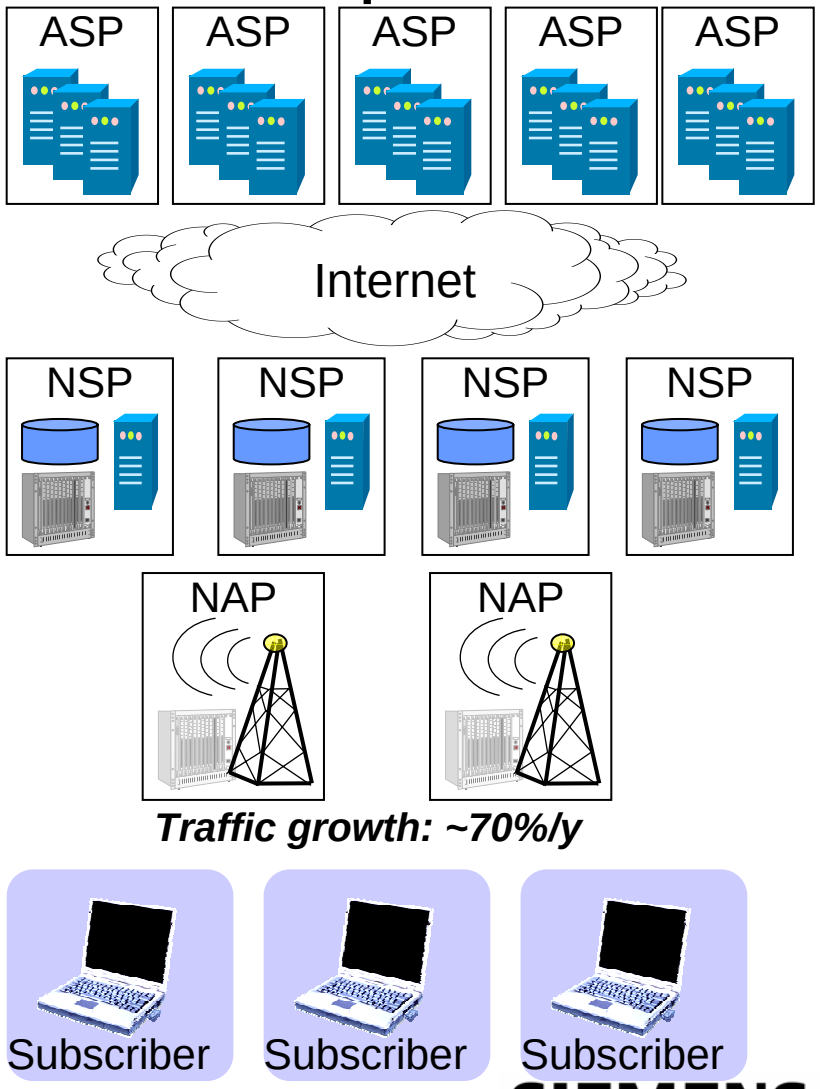
WiMAX is a different mobile business

Legacy MNO value chain



WiMAX value pattern



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Network Operator Relationships

Network Access Provider (NAP)

- A business entity that provides WiMAX radio access infrastructure to one or more WiMAX Network Service Providers (NSPs). A NAP implements this infrastructure using one or more Access Service Networks (ASN)

Network Service Provider (NSP)

- A business entity that provides IP connectivity and WiMAX services to WiMAX subscribers compliant with the Service Level Agreement it establishes with WiMAX subscribers. To provide these services, an NSP establishes contractual agreements with one or more NAPs.
- An NSP may also establish roaming agreements with other NSPs and contractual agreements with third-party application providers (e.g. ASP or ISPs) for providing WiMAX services to subscribers.

ASP (Application Service Provider)

- Provides value added services, Layer 3+ (e.g. IMS, corporate access, ...)
- Provides and manages applications on top of IP

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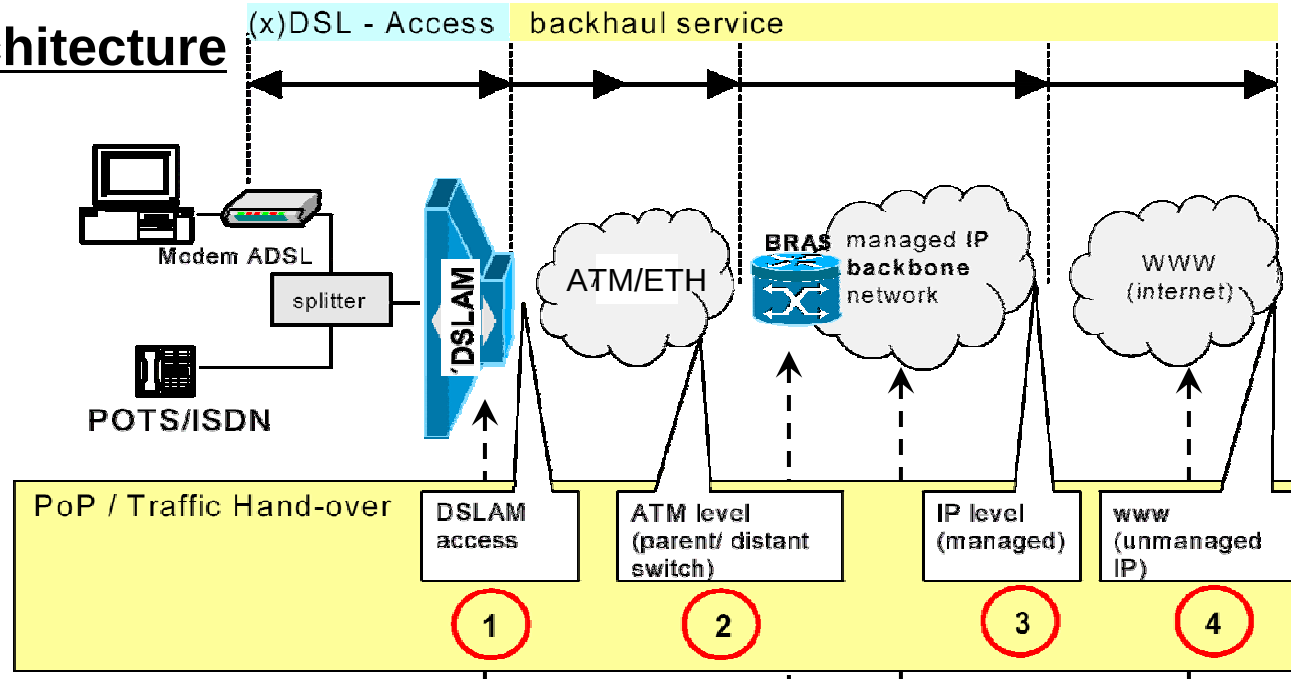
WiMAX Architecture is aligned to DSL

DSL Architecture



Abbreviations:

UE
User Equipment

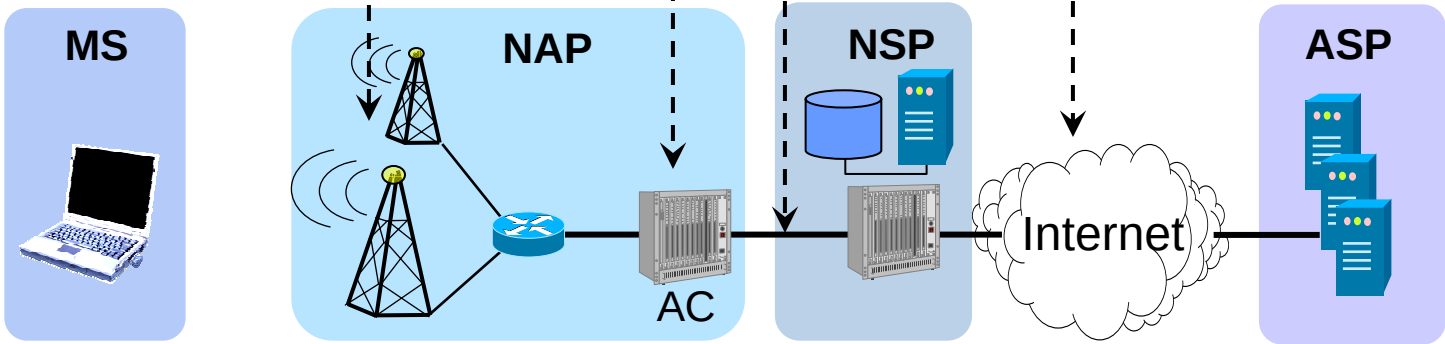
NAP
Network Access Provider

AC
Access Concentrator

NSP
Network Service Provider

ASP
Application Service Provider

WiMAX Architecture



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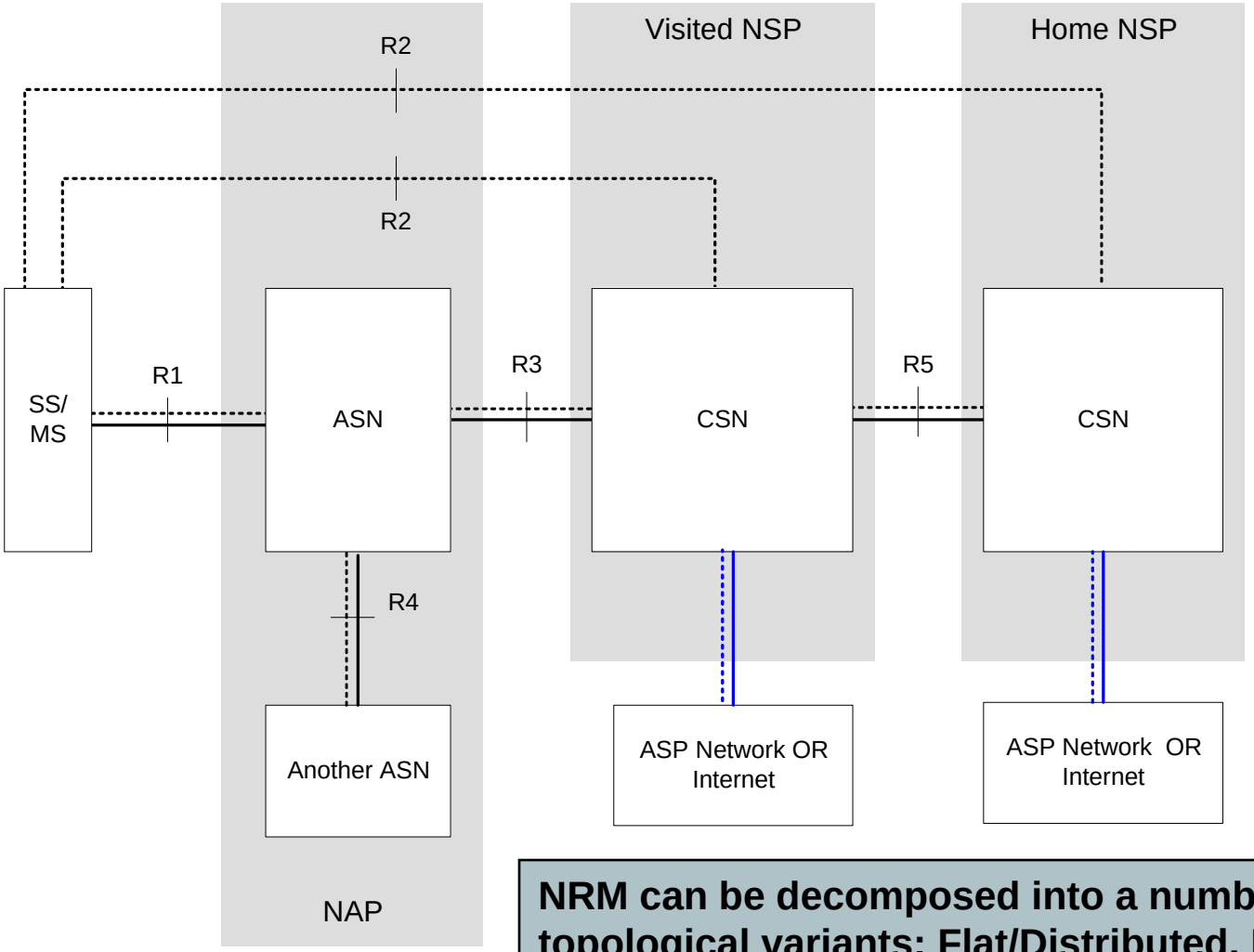
WiMAX Network Reference Model (NRM)



NRM can be decomposed into a number of WiMAX access topological variants: Flat/Distributed, Hierarchical/ Centralized, Decomposed versus Integrated BS …

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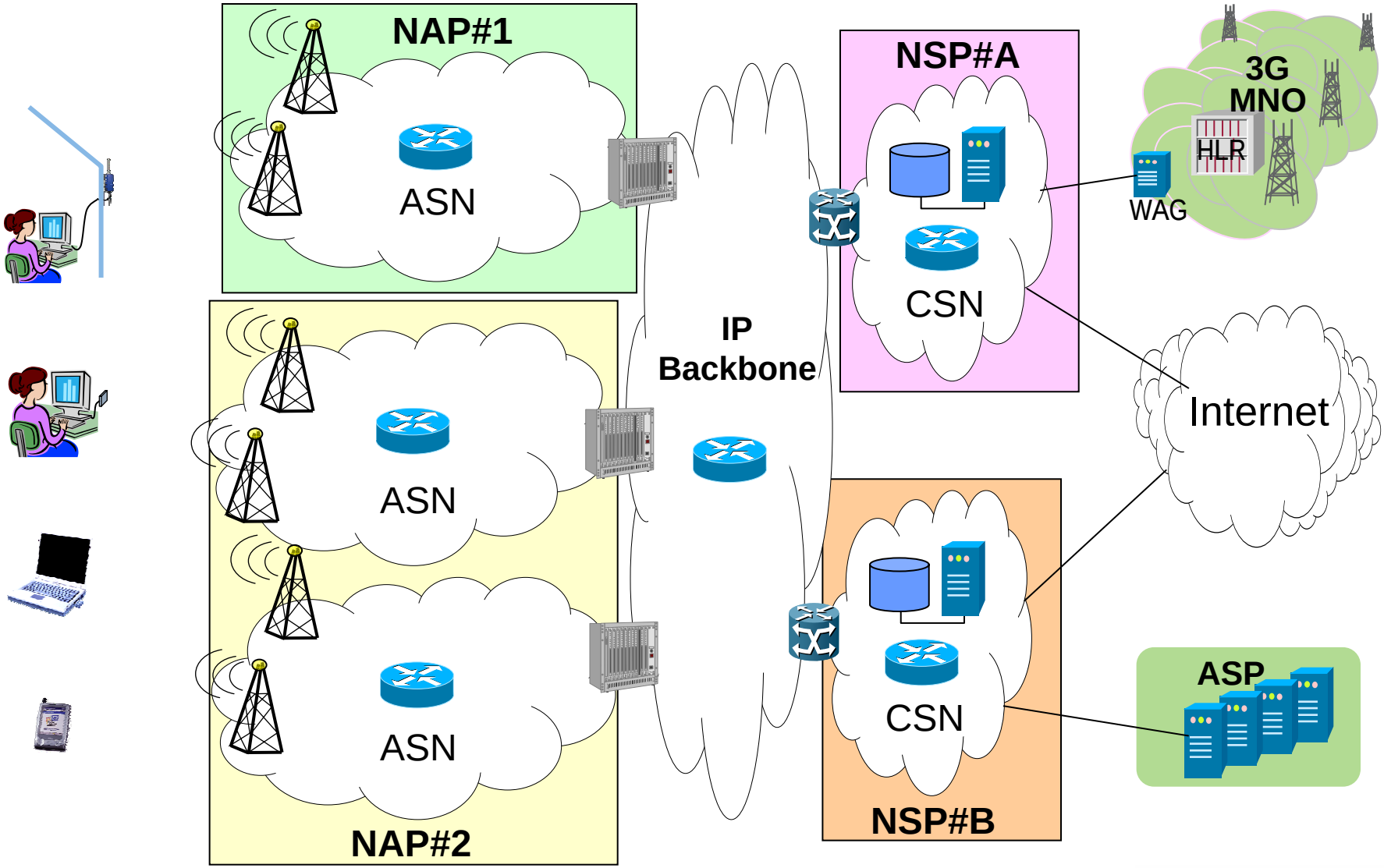
WiMAX Network Architecture w/ NAP sharing



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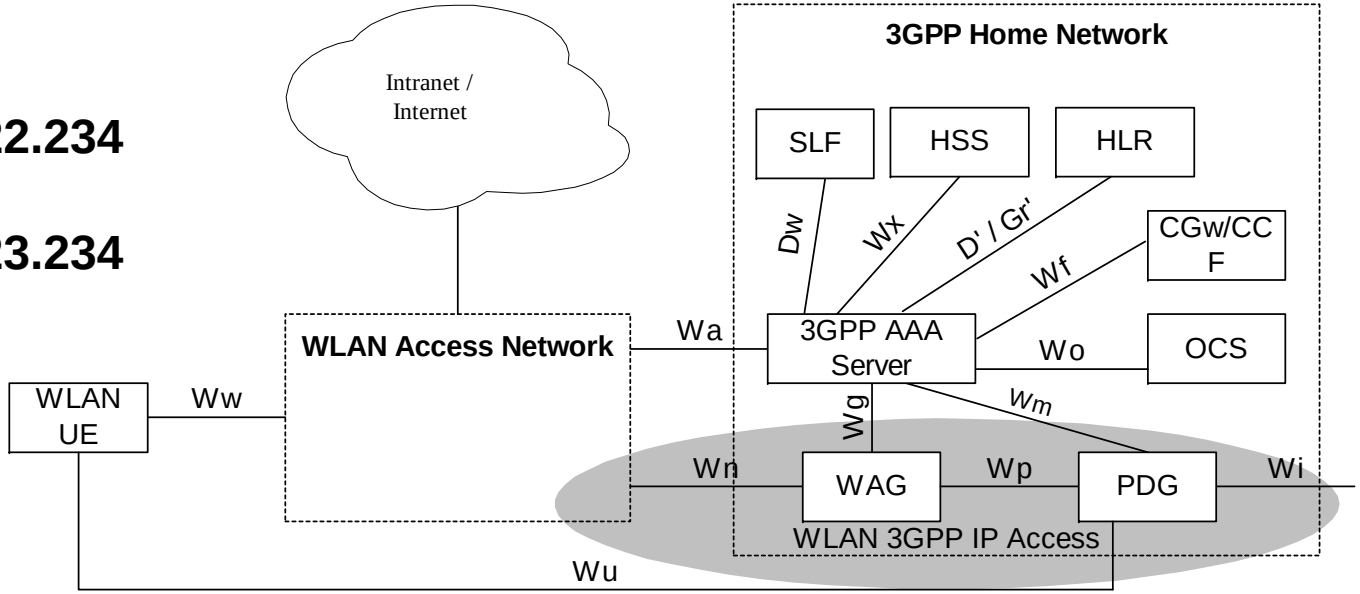
3GPP Interworking Scenarios

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**

IPsec VPN
- **Scenario 4: Service Continuity**
- **Scenario 5: Seamless services**

tbd
- **Scenario 6: Access to 3GPP CS Services**

(UMA)

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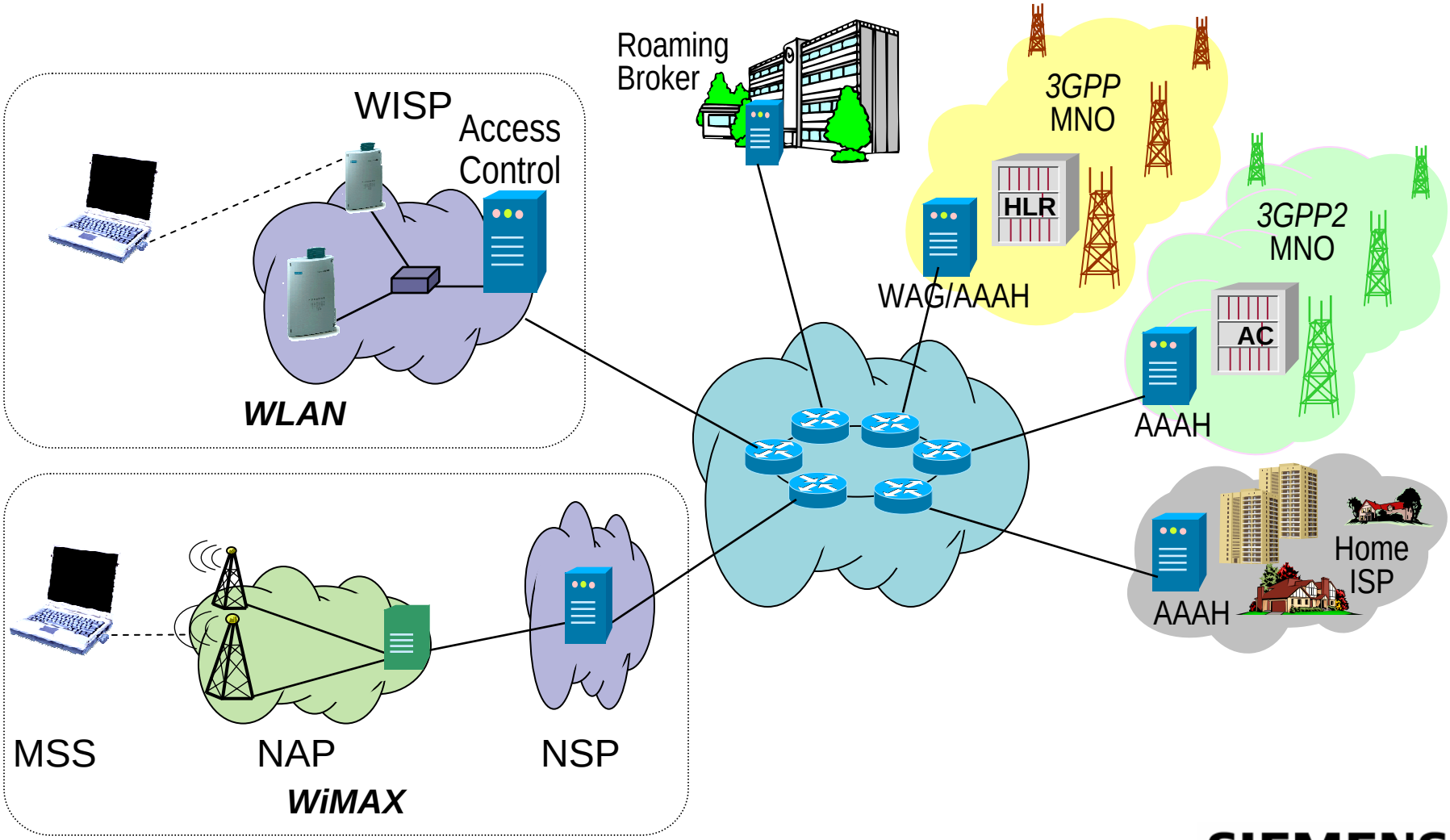
WiMAX Interworking is like WLAN Interworking



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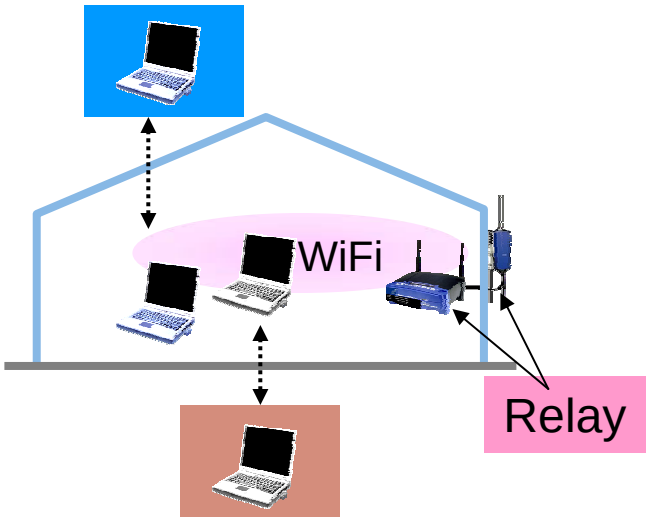
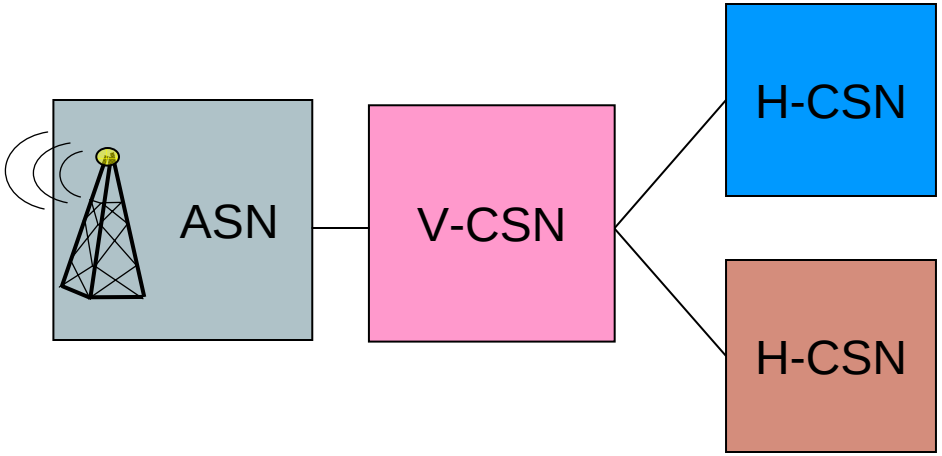
Tight Integration of WiFi with Mobile WiMAX





- **WiMAX-WiFi relays are providing deep-indoor coverage as well as connectivity in hot-spots and moving environments (e.g. trains)**
- **WiFi terminals behind relay behave like WiMAX terminals**
  - Same user credential, same user account, same service and QoS provisioning
- **Relays may be concurrently used by 'MSs' belonging to different NSPs**

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Conclusion

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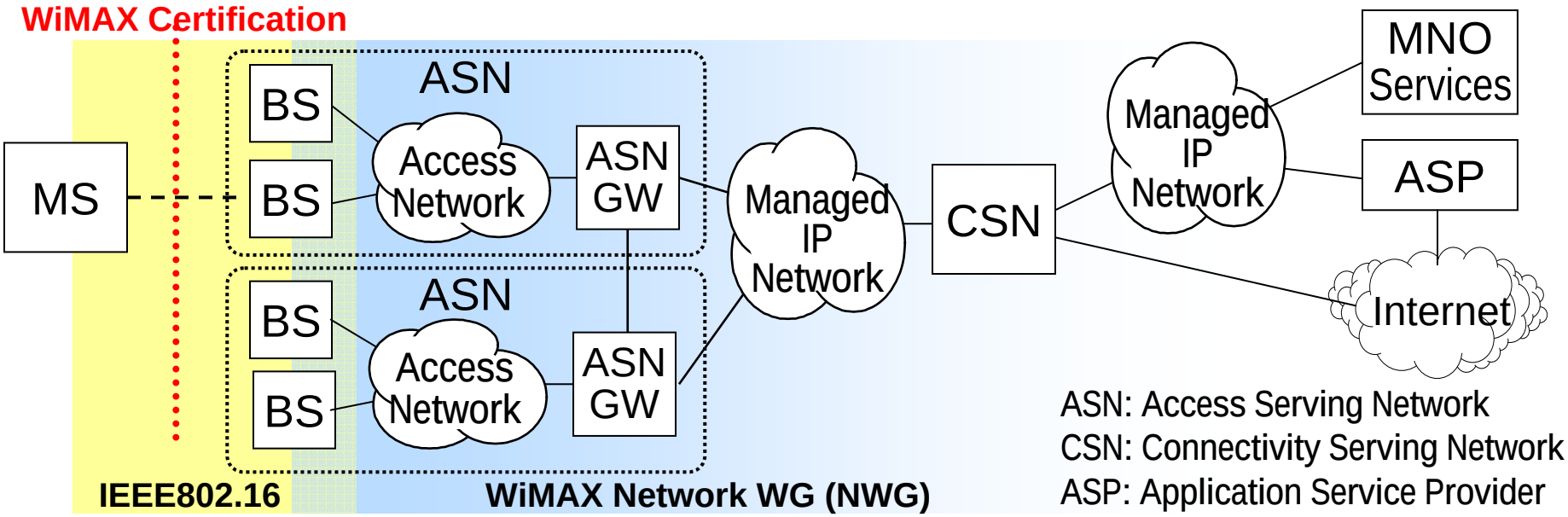
Mobile WiMAX

For comparison: Equivalent functions in a 3G network
UE NodeB RNC, SGSN GGSN, HSS IMS



- **IEEE802.16 takes care of PHY and MAC of radio interface**
  - 802.16e extends MAC & PHY for mobility *Dec. '05*
- **WiMAX provides profiles and certification for .16e** *End '05/Mid '06*
- **WiMAX NWG specifies access network architecture** *Rel 1: Mid '06*
  - based on IETF protocols, 'merged' 3GPP2/DSL/(3GPP) architecture

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Stage 2 text of WiMAX NWG available by
http://www.wimaxforum.org/technology/NWGLiaison1/

The End

Thank you for your attention!

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