Mobile WiMAX Introduction

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Overview

- Market positioning of Mobile WiMAX
  - Value generation in mobile networks vs. broadband networks
- IEEE802.16 and WiMAX Forum
- The Mobile WiMAX Network Architecture
  - WiMAX Network Reference Model
  - Mobility support in WiMAX
- IMS in Mobile WiMAX
- Emergency Services Support in Mobile WiMAX

Market positioning for Mobile WiMAX

'WiMAX' is addressing a new segment in the telecommunication market

	"Integrated Services Digital Network"		"Digital Subscriber Line"
fixed	POTS, ISDN (B-ISDN, ATM)		xDSL, Cable
mobile	DECT GSM, UMTS (WCDMA, HSDPA)		'WiMAX' Wi-Fi

- End-to-end QoS
- Hard real-time (voice) Defined traffic classes
- End-to-end service delivery
  - Voice, SMS, Gaming, Infotainment
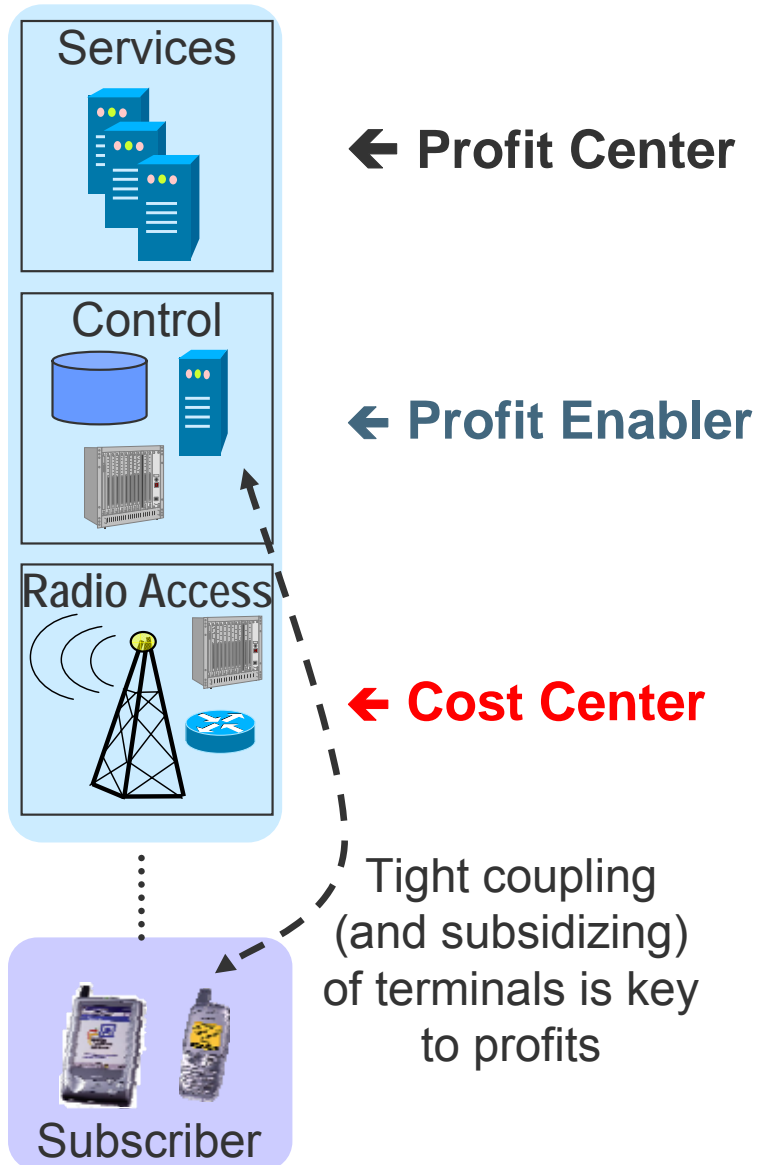- Precise accounting, charging and billing

- Best effort, DIFFSERV enabled
- Interactive (http, mail) Streaming, downloads
- Access to the plain Internet
  - Common web applications, email
- Usage classes, flat-rate
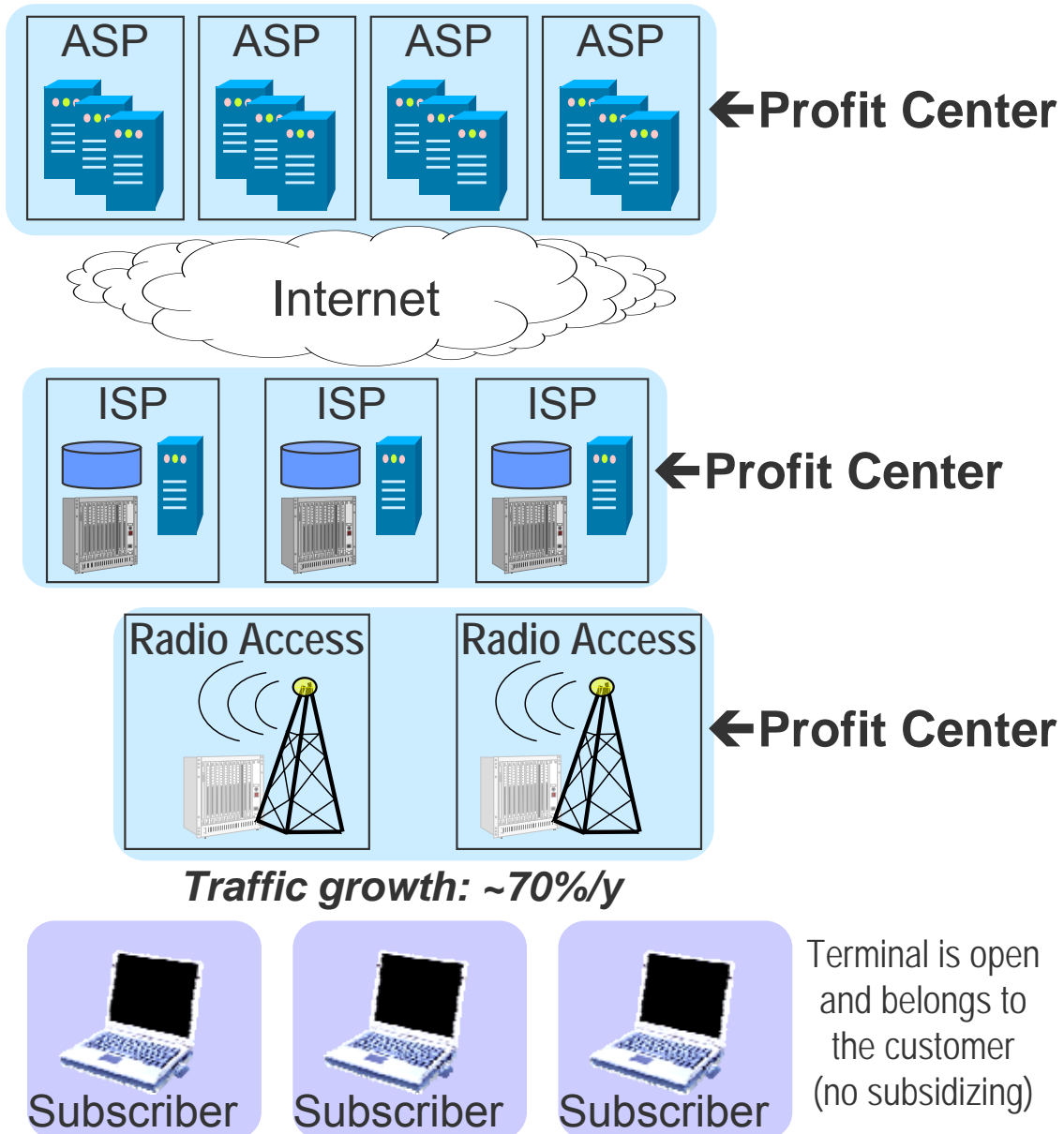
UMTS is optimized for Integrated Services
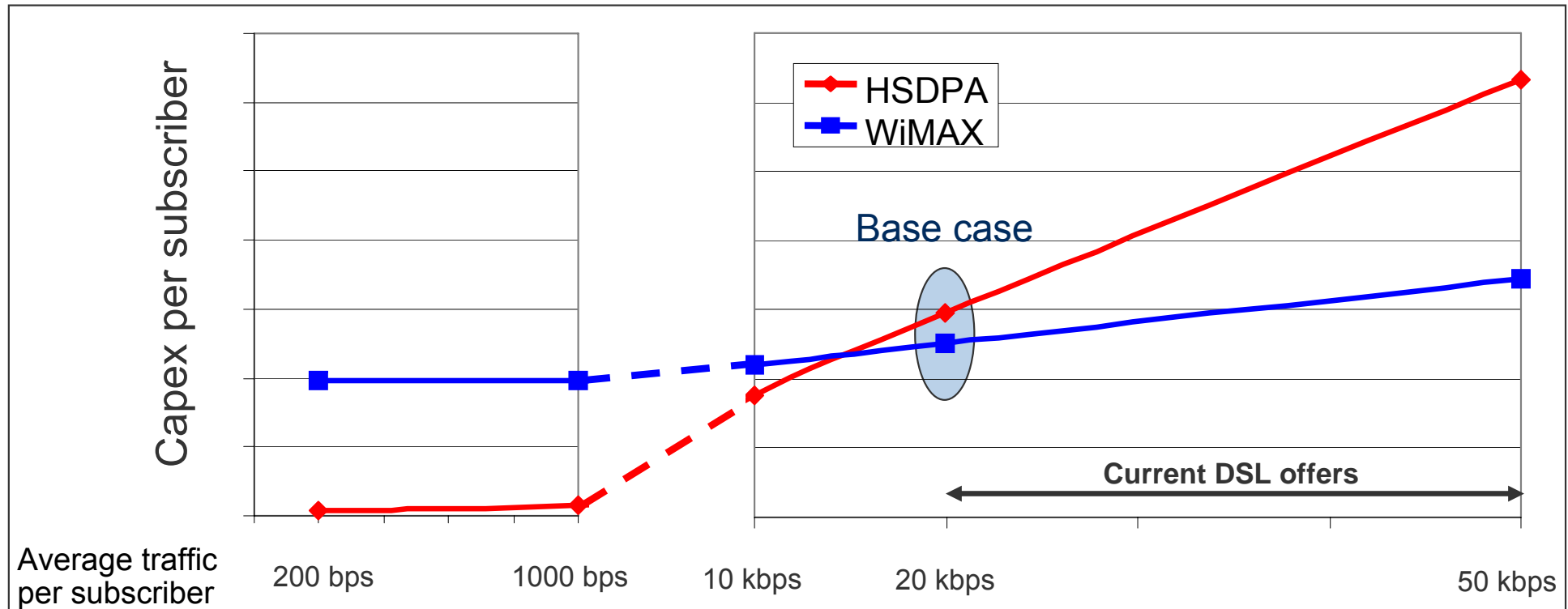
- UMTS/HSDPA does not scale well for high average bitrates
  - Investment costs of WiMAX networks are expected to be lower above ~10 kbit/s per subscriber
- With similar costs for basestations, HSDPA is burdened by its UMTS siblings in the access and core network
- The WiMAX network is legacy-free and optimized for high bandwidth

The Mobile Network Operator Value Chain

Services

← **Profit Center**

Control

← **Profit Enabler**

Radio Access

← **Cost Center**

Tight coupling (and subsidizing) of terminals is key to profits

Subscriber

- Commercial operations tend to focus onto increasing their profits
- Increasing the customer base is one dimension of increasing profits, introduction of new services is the other dimension.
- The profits acchievable by new services depend on the relation between customer value (price) and the cost for realizing the service
- Management will allways focus on high value while keeping the expenses for the realization small
  - Best example: SMS
- The radio access network is adding most to the cost, hardly anything to the profits.
  - Bandwidth is considered as a scarce resource
  - Results in traffic growth of ~7%/year

The Broadband Operator Value Pattern

ASP ASP ASP ASP ←**Profit Center**

Internet

ISP ISP ISP ←**Profit Center**

Radio Access   Radio Access ←**Profit Center**

Traffic growth: ~70%/y

Subscriber   Subscriber   Subscriber

Terminal is open and belongs to the customer (no subsidizing)

- The Internet introduced a major change in the value creation of network operators by allowing everybody to provide services to end costomers.

- Application service provision, connectivity service provision and access service provision have become independent businesses in competitive markets.

- This led to the pervasive proliferation of services over broadband pipes.

- There is a new kind of mobile service provider coming up, with services tied to the device (Apple iPod/iPhone – iTunes)

WiMAX deployment evolution
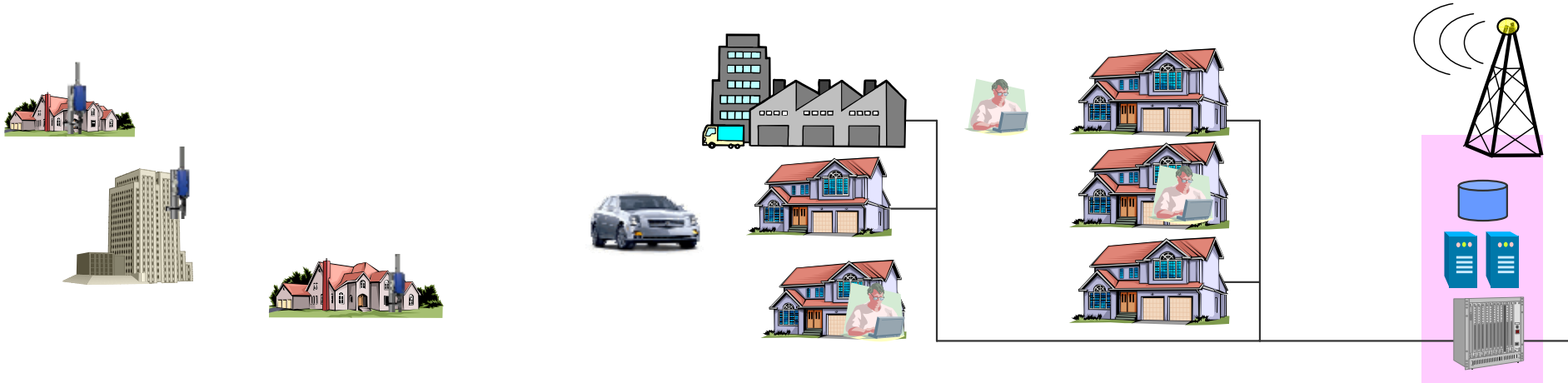
- Today's broadband providers are tied to their wires
  - serving consumers and enterprises inside their reach

- A WiMAX access network 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

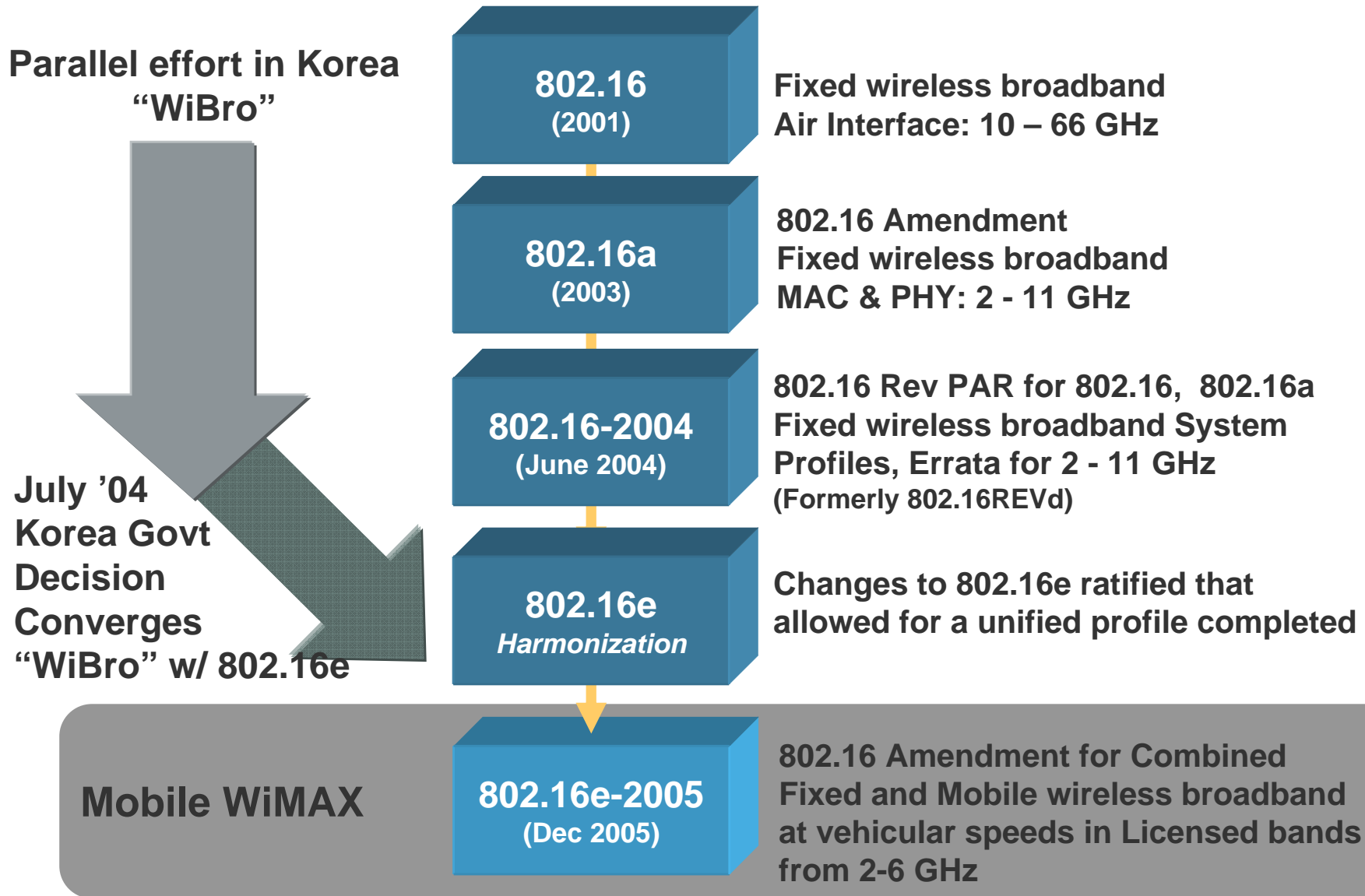**All together may be necessary for a successful business case!**

IEEE802.16 and WiMAX Forum
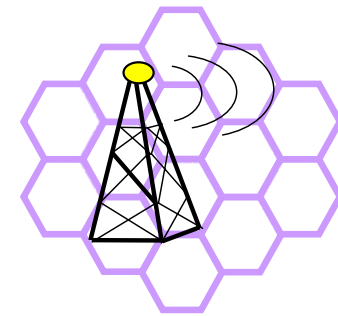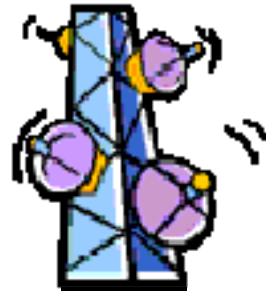
Wireless Mobility in IEEE802
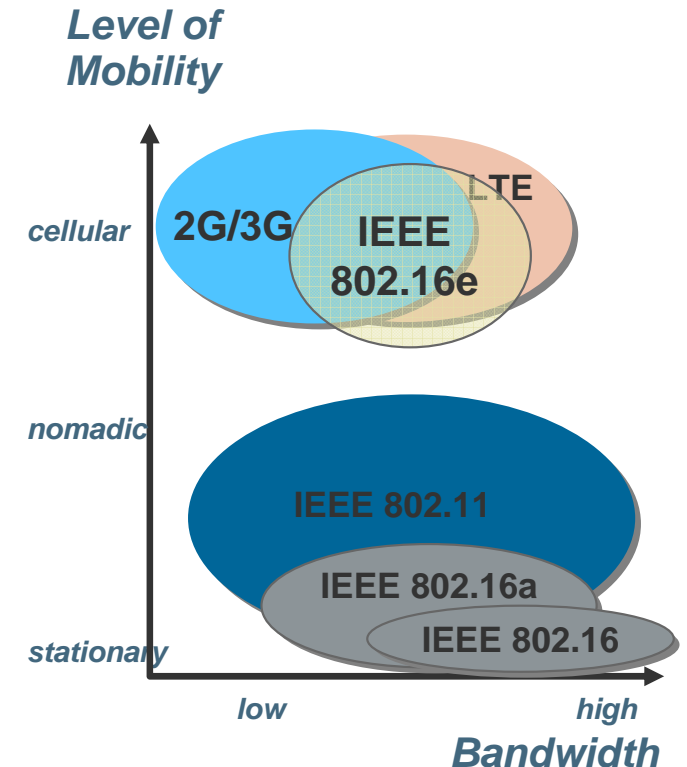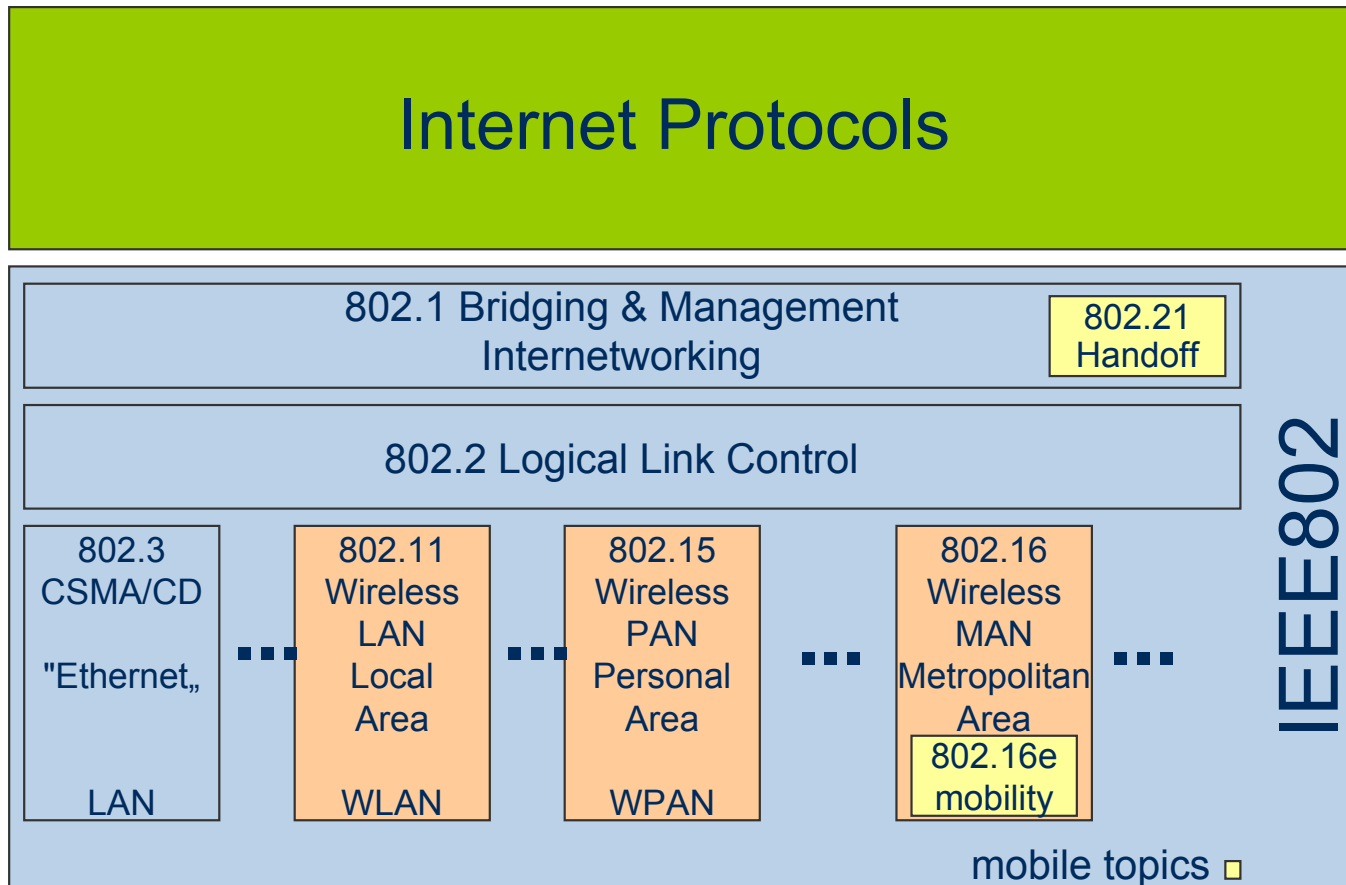
- IEEE802 provides specifications for Local and Metropolitan Networks
  - Wireless topics: WPAN (802.15), WLAN (802.11), WMAN (802.16)
  - IEEE802.16e provides cellular support including full mobility
- IEEE802 has become the leading 'radio' standardization organization
  - e.g. MMR (802.16j), Cognitive Radio (802.22)

The Evolution of IEEE802.16

Parallel effort in Korea "WiBro"

July '04 Korea Govt Decision Converges "WiBro" w/ 802.16e

Mobile WiMAX

802.16 (2001) — **Fixed wireless broadband Air Interface: 10 – 66 GHz**

802.16a (2003) — **802.16 Amendment Fixed wireless broadband MAC & PHY: 2 - 11 GHz**

802.16-2004 (June 2004) — **802.16 Rev PAR for 802.16, 802.16a Fixed wireless broadband System Profiles, Errata for 2 - 11 GHz (Formerly 802.16REVd)**

802.16e *Harmonization* — **Changes to 802.16e ratified that allowed for a unified profile completed**

802.16e-2005 (Dec 2005) — **802.16 Amendment for Combined Fixed and Mobile wireless broadband at vehicular speeds in Licensed bands from 2-6 GHz**

IEEE 802.16: 'One wireless standard fits all'

|	Feeding	FWA	Cellular
Completed	December 2001	January 2003	December '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	2-5 km	7 to 10 km, up to 50 km	1-5 km

WiMAX and IEEE 802.16

- WiMAX is a subset of IEEE 802.16
    - No new features can be added
- Mandatory features in 802.16 are mandatory in WiMAX, if included
- Optional features in 802.16 may be optional, mandatory or not included

IEEE 802.16 World

Fixed WiMAX OFDM-256

WiBro

Mobile WiMAX S-OFDMA
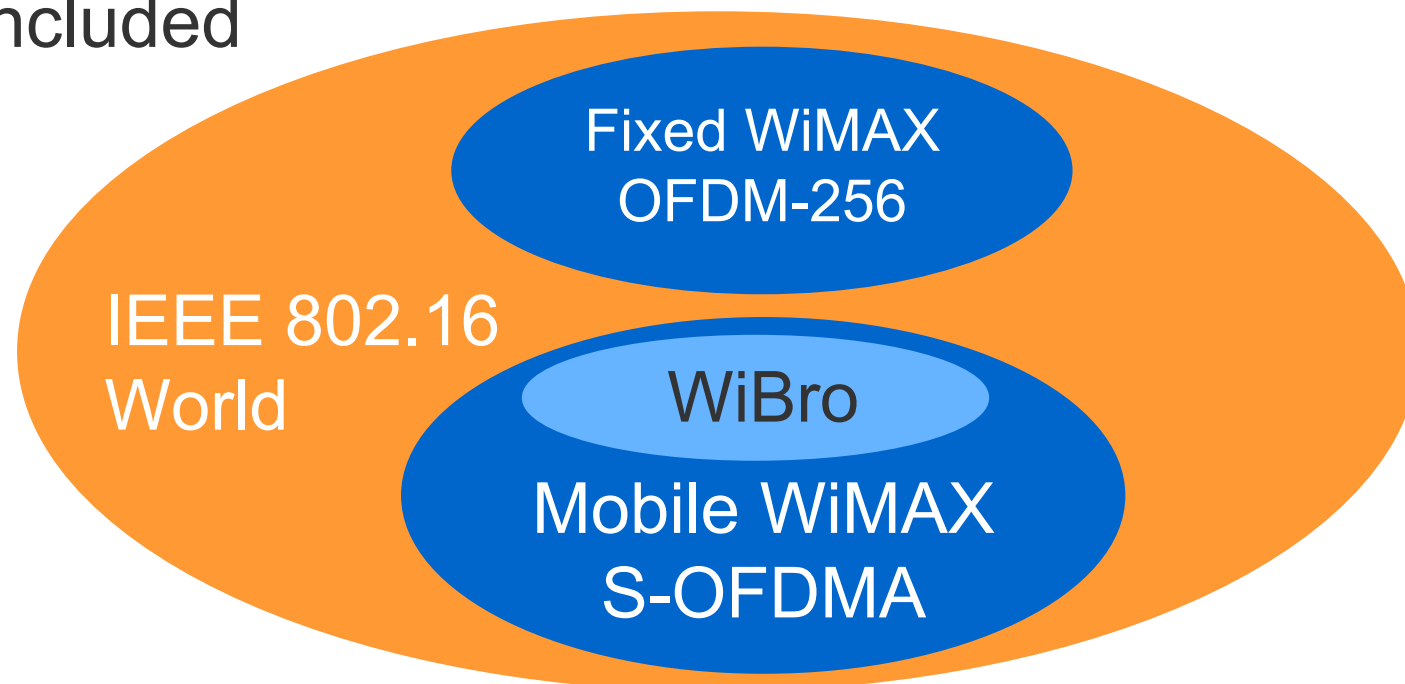
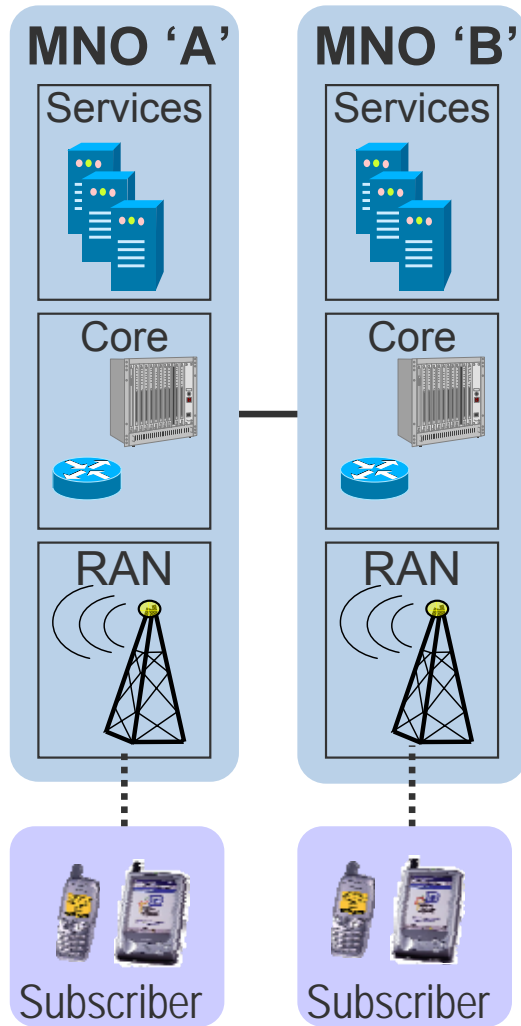# The Mobile WiMAX Network Architecture
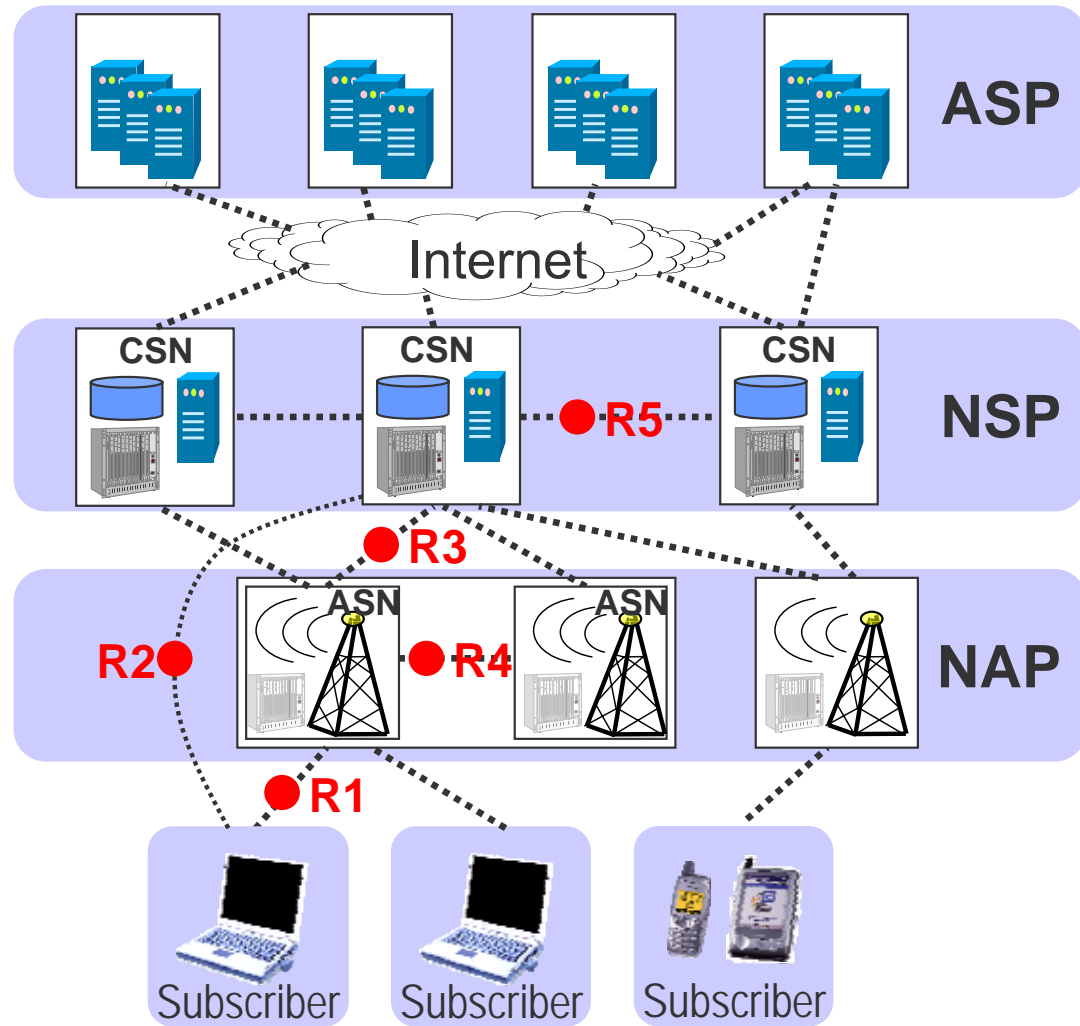
A Wireless Access Network for the Internet
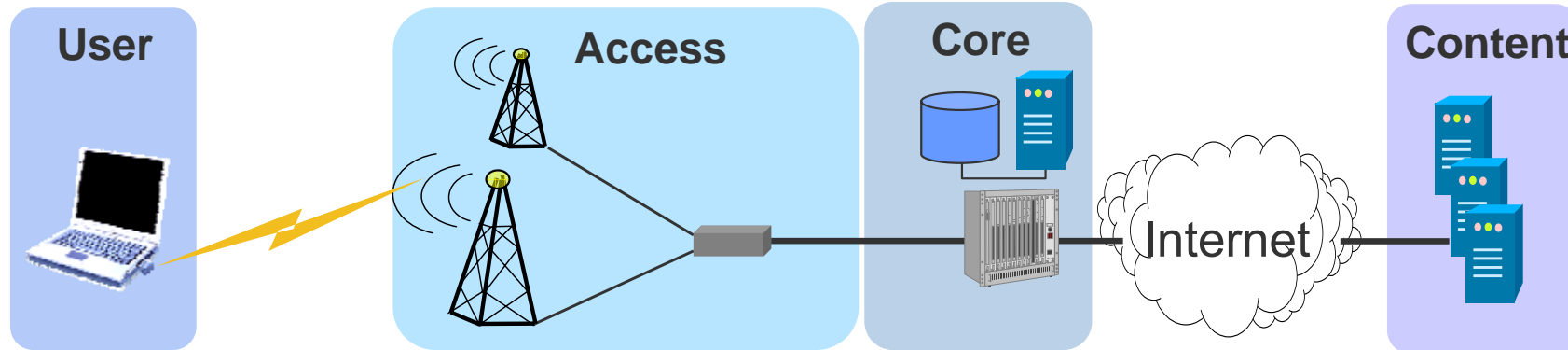
- Content is not tied to a particular Core but on the Internet
  - Split between Application Service Provider and Network Service Provider
- Often Access is operated as independent business
  - Network Access Provider does not like to deal with the consumer but concentrates on establishment and operation of its network infrastructure
  - Facilitates shared access network by multiple service providers, which is beneficial for economy of scale and ROI.

Mobile Network Architectures

Legacy Architecture

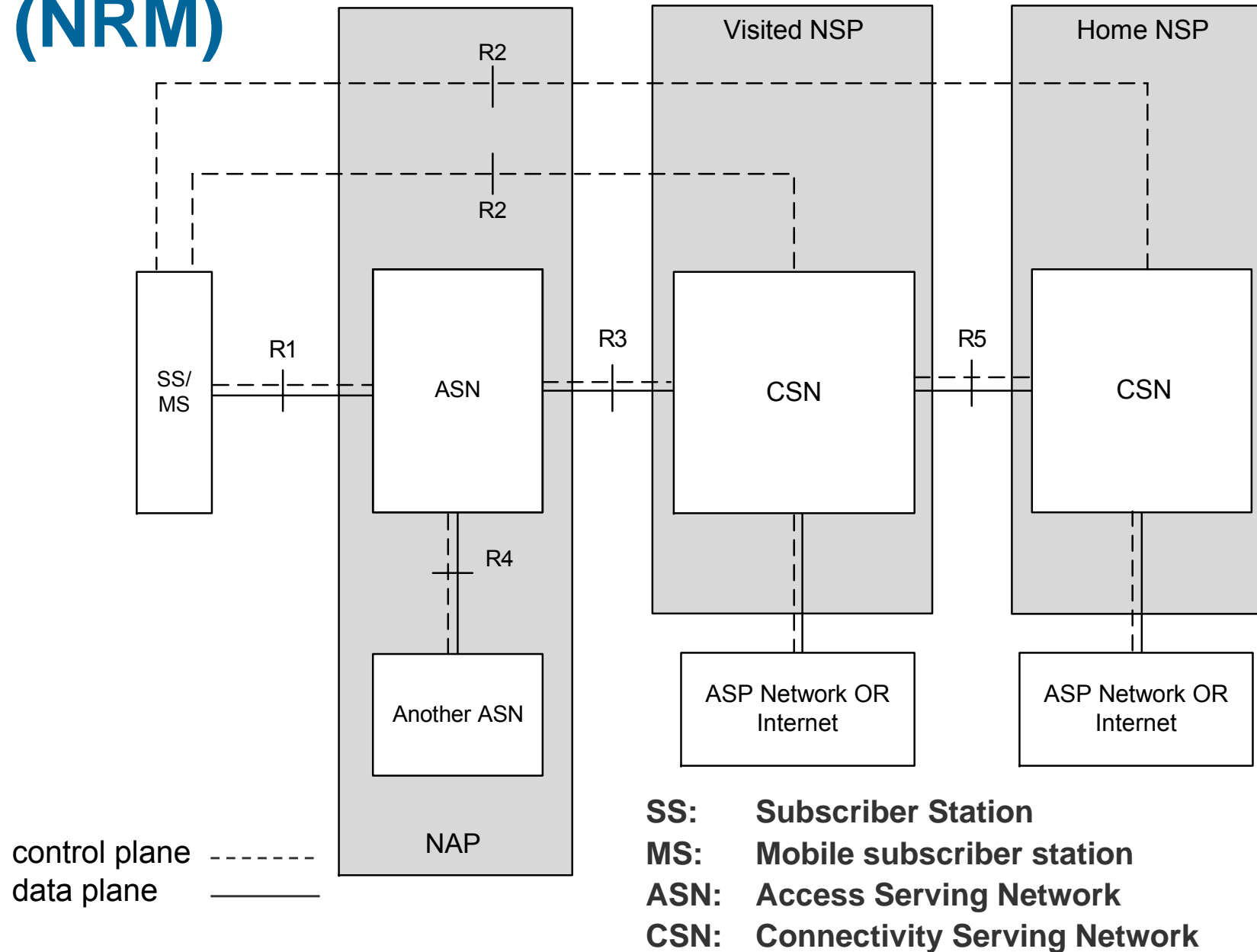## Mobile WiMAX Network Architecture

MNO 'A'

Services

Core

RAN

Subscriber

MNO 'B'

Services

Core

RAN

Subscriber

ASP

Internet

CSN · CSN · R5 · CSN

NSP

R3

ASN · R4 · ASN

R2

NAP

R1

Subscriber · Subscriber · Subscriber

Mobile WiMAX Network Reference Model (NRM)

R2

R2

Visited NSP

Home NSP

SS/ MS

R1

ASN

R3

CSN

R5

CSN

R4

Another ASN

ASP Network OR Internet

ASP Network OR Internet

NAP

control plane

data plane

SS: **Subscriber Station**

MS: **Mobile subscriber station**

ASN: **Access Serving Network**

CSN: **Connectivity Serving Network**

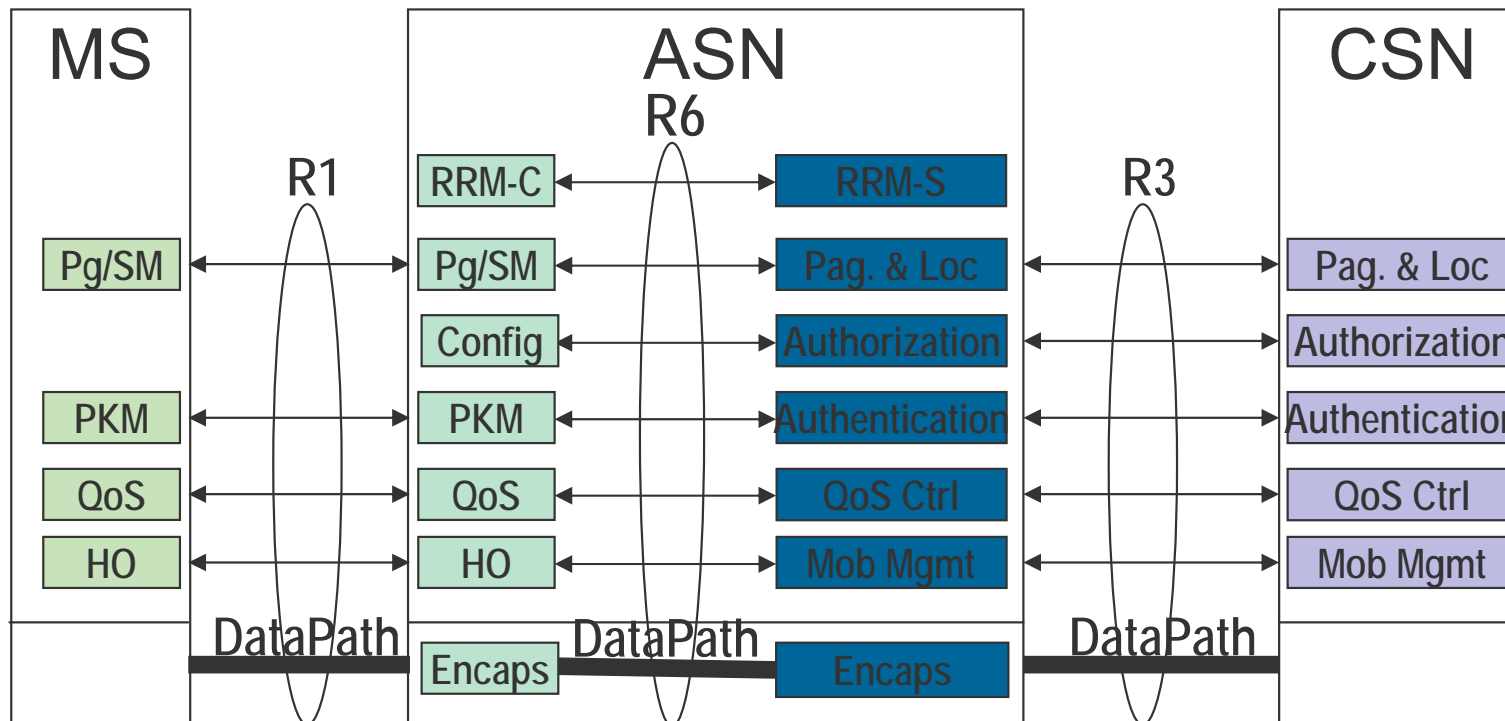# Entities of the WiMAX Network Reference Model

- CSN: Connectivity Serving Network
  Logical representation of the functions of a NSP, e.g.
  - Connectivity to the Internet, ASPs
  - Authentication, authorization and accounting
  - IP address management
  - Mobility and roaming between ASNs
  - Policy & QoS management based on a SLA
- ASN: Access Serving Network
  Logical representation of the functions of a NAP, e.g.
  - 802.16 interface w/ network entry and handover
  - Radio Resource Management & Admission ctrl.
  - L2 Session/mobility management
  - QoS and Policy Enforcement
  - Foreign Agent (FA)
  - Forwarding to selected CSN

WiMAX Network Reference Model (roaming case, HA in vNSP)
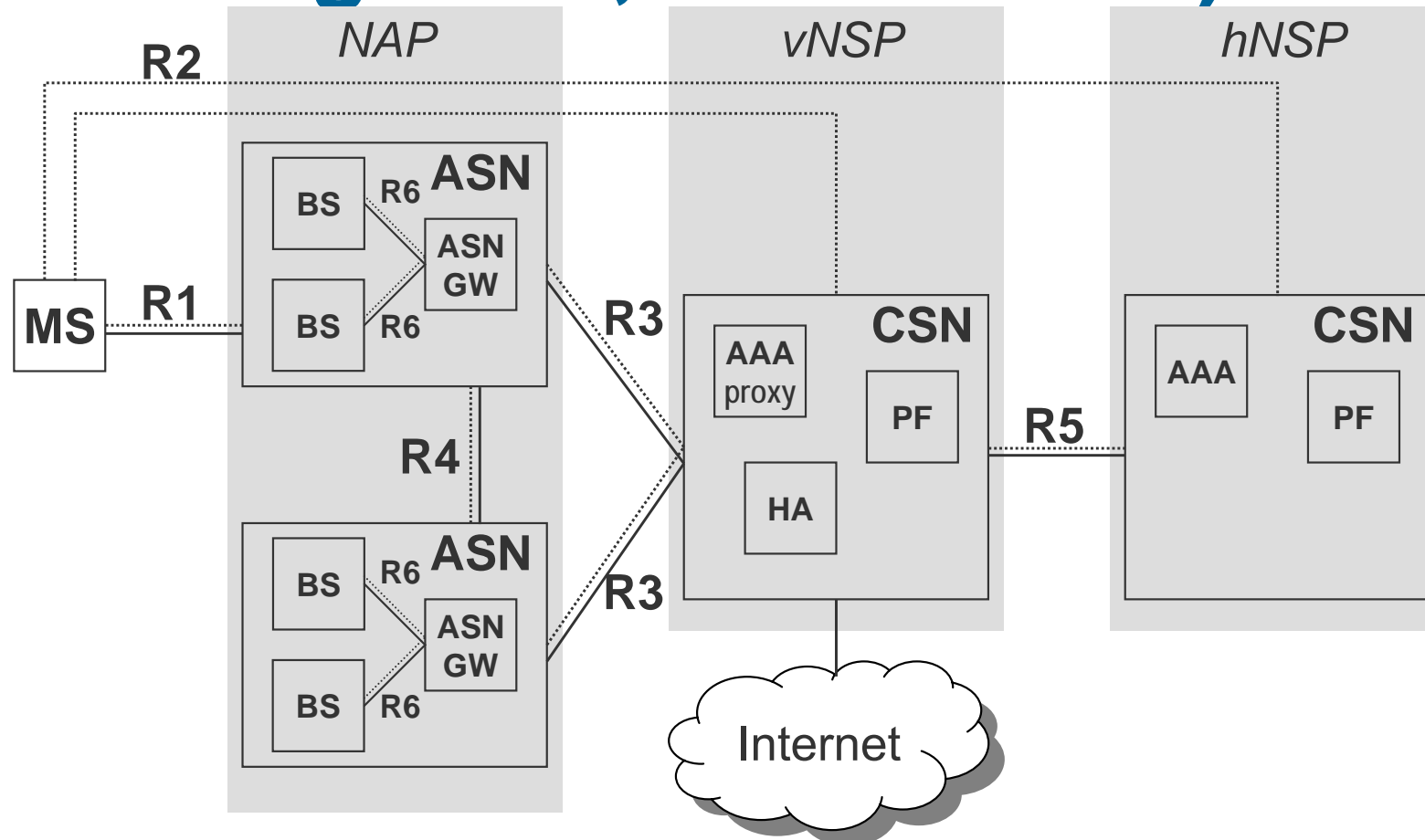
- The NRM defines also a logical decomposition inside the ASN (BS, ASN-GW)
 - Most implementations follow this logical structure

WiMAX Reference Points

| MS	ASN		CSN
	R6		
	RRM-C ↔ RRM-S		
Pg/SM ↔ R1	Pg/SM ↔ Pag. & Loc	R3	Pag. & Loc
	Config ↔ Authorization		Authorization
PKM ↔	PKM ↔ Authentication		Authentication
QoS ↔	QoS ↔ QoS Ctrl		QoS Ctrl
HO ↔	HO ↔ Mob Mgmt		Mob Mgmt
DataPath	Encaps DataPath Encaps	DataPath	

- NRM Reference Points represent a bundle of protocols between peer entities
  - Similar to a real IP network interface
- The implementation of a particular protocols over a reference point is optional
  - If a particular protocol is present, it must conform to the WiMAX specification

WiMAX CSN Anchored Mobility Management

Proxy-MIP: MIP Client resides in ASN-GW
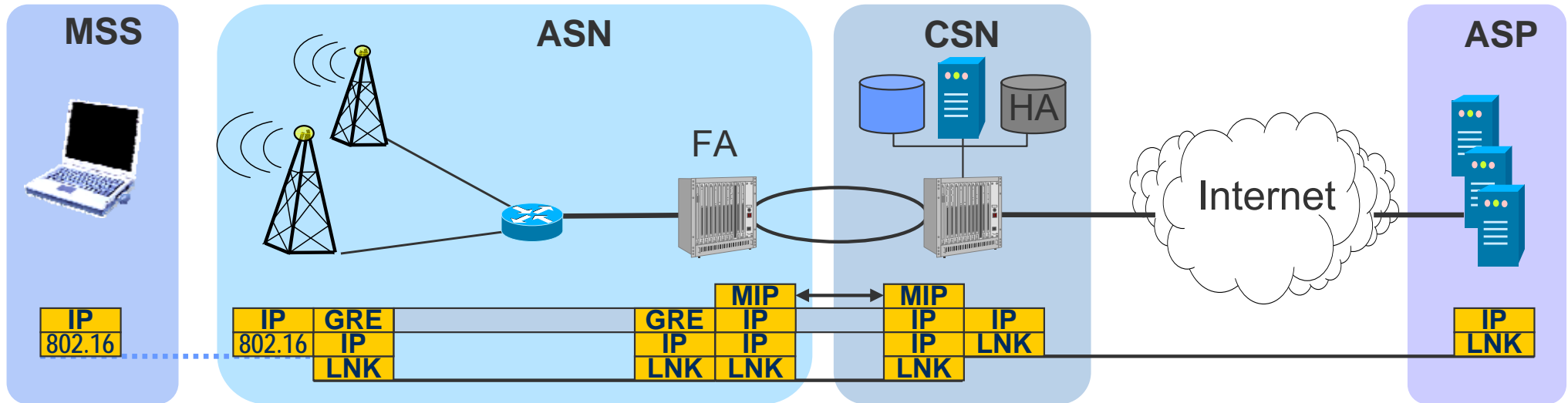
**Client-MIP:** MIP Client resides in MSS
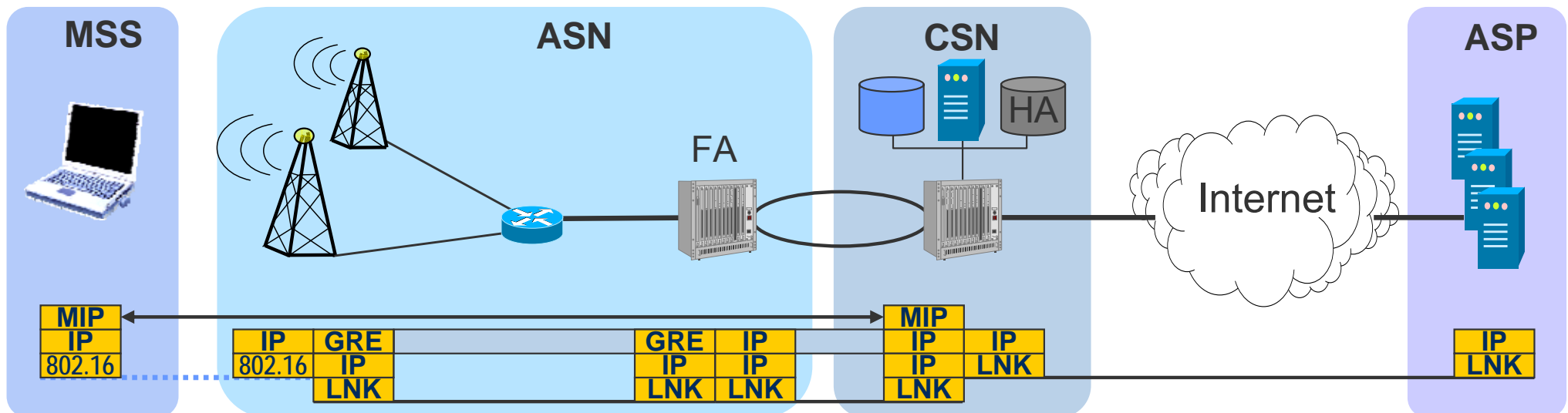
WiMAX Networking Considerations

- Interoperability enforced via reference points without dictating how vendors implement edges of reference points
- Introduces the notion of functional entities – which can be combined or decomposed by vendor and/or operator
- No single physical ASN or CSN topology is mandated – allowing room for vendor / operator differentiation
  - Standardized decomposition of ASN into BS and ASN-GW
  - CSN is fully kept opaque; no aim for standardized implementations
- Mobility is mainly achieved by ASN anchored MM (R6, R4)
  - R3 mobility (MIP) is used for path optimization, network sharing and wide-area nomadicity, but not for seamless handover.
- AAA and Roaming is based on IETF EAP supporting any kind of 'credentials' (Password, Certificate, SIM & U-SIM)
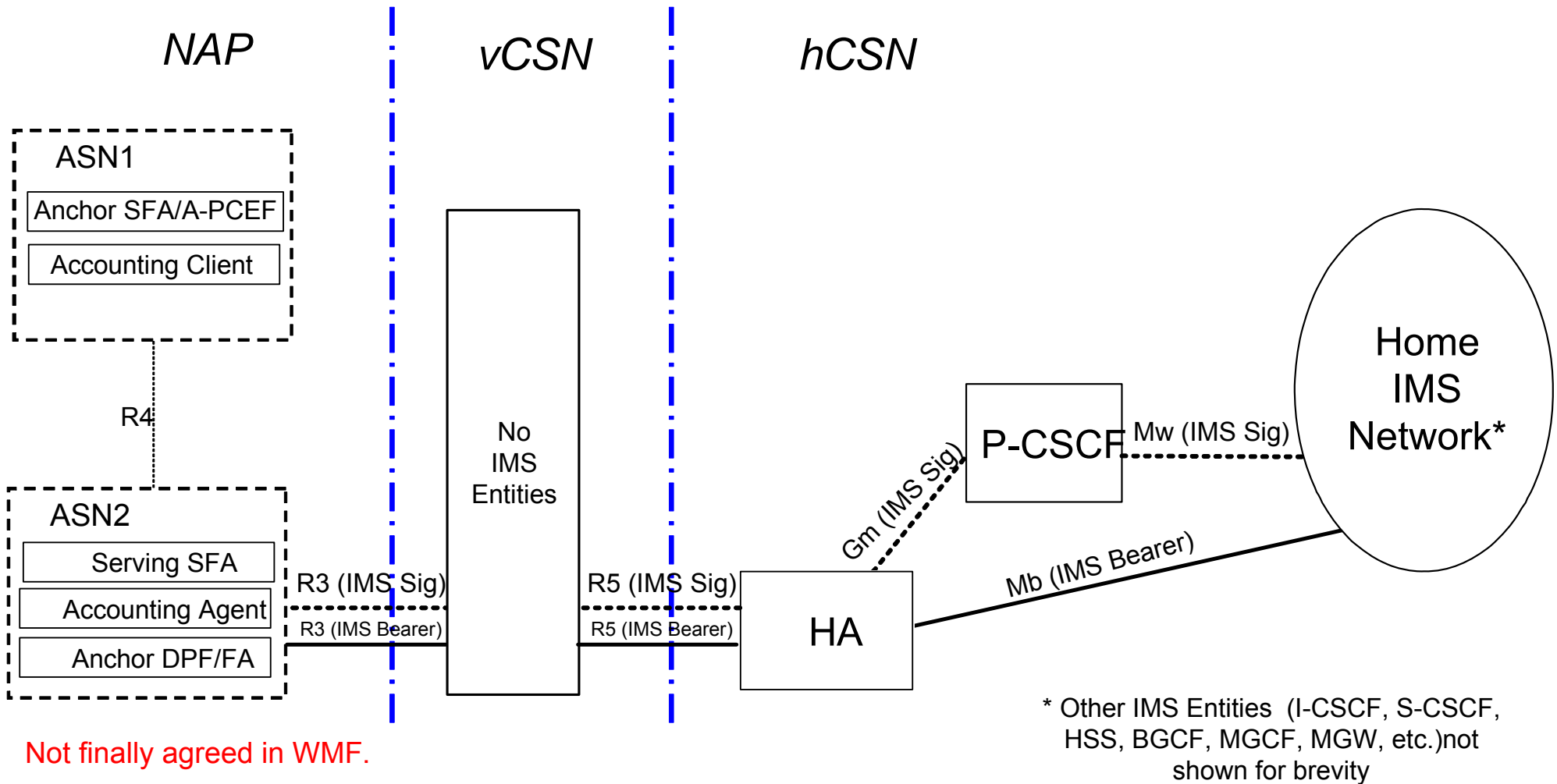
IMS in Mobile WiMAX
(in development)

WiMAX entities in IMS architecture

Not finally agreed in WMF
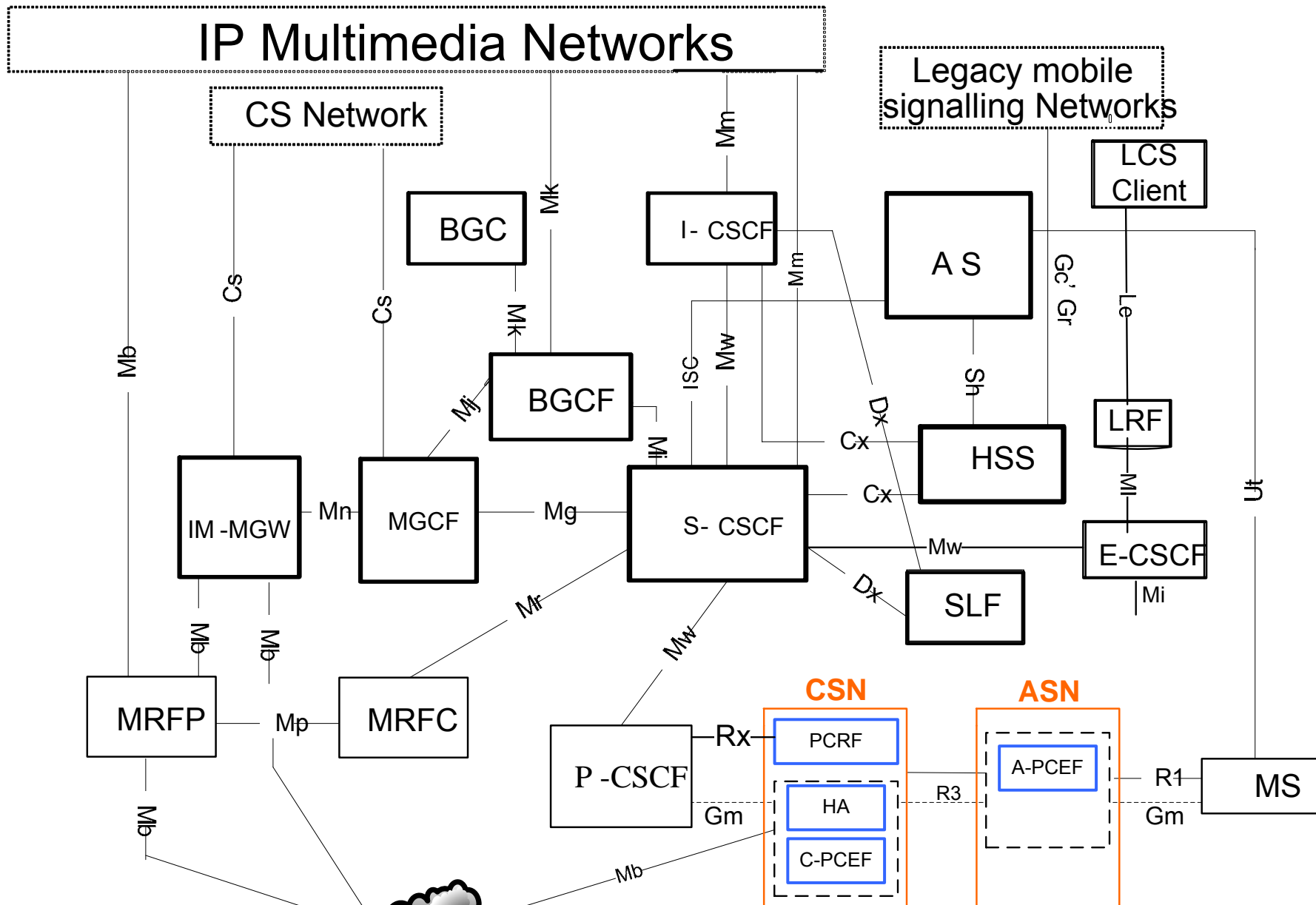
IMS Adoption in Mobile WiMAX

- Access-type and access-info will be extended by WiMAX specific identifiers.

- P-CSCF discovery will be based on 3GPP methods. In case of CMIP and DHCP, DHCP procedure might be reduced to DHCP-Inform to overcome conflicts of DHCP restrictions in case of CMIP.

- Roaming scenarios are currently under discussion. The final solution should have no impacts on IMS specific protocols.

- WiMAX will support mandatory IMS AKA based authentication and key generation as well as IPsec protection of IMS signaling (as defined in 3GPP TS 24.229 Release 7 and 3GPP TS 33.203 Release 7). In addition, SIP Digest Authentication and TLS should be supported (as defined in 3GPP S3-070635. CR0105 rev5 against 33.203).

Roaming Scenario Home Anchored

NAP

vCSN

hCSN

ASN1
- Anchor SFA/A-PCEF
- Accounting Client

R4

ASN2
- Serving SFA
- Accounting Agent
- Anchor DPF/FA

No IMS Entities

R3 (IMS Sig)
R3 (IMS Bearer)

R5 (IMS Sig)
R5 (IMS Bearer)

HA

P-CSCF

Gm (IMS Sig)

Mw (IMS Sig)

Mb (IMS Bearer)

Home IMS Network*

Not finally agreed in WMF.

* Other IMS Entities (I-CSCF, S-CSCF, HSS, BGCF, MGCF, MGW, etc.)not shown for brevity

Emergency Services Support in Mobile WiMAX
(in development)

Emergency Services support in WiMAX will likely use IMS based VoIP

legend of lines

bearer plane ——————————

control plane – – – – – – – – – –