

# WiMAX Networking Implications for IETF 16ng

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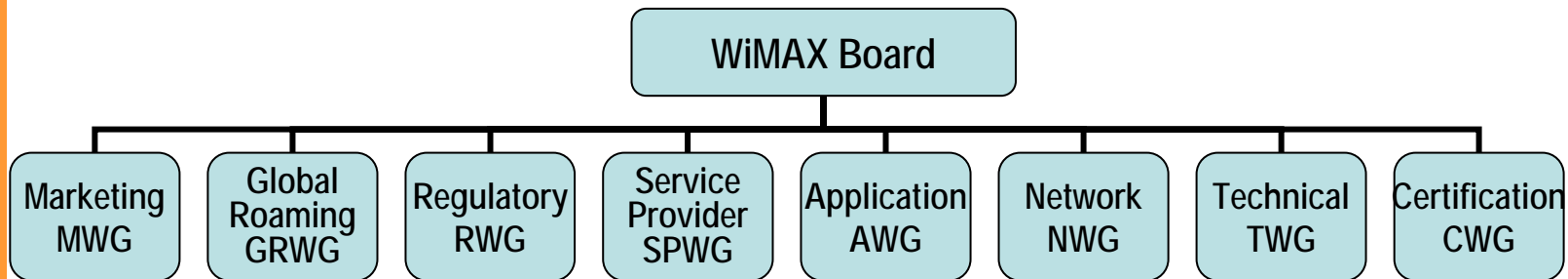
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# Overview

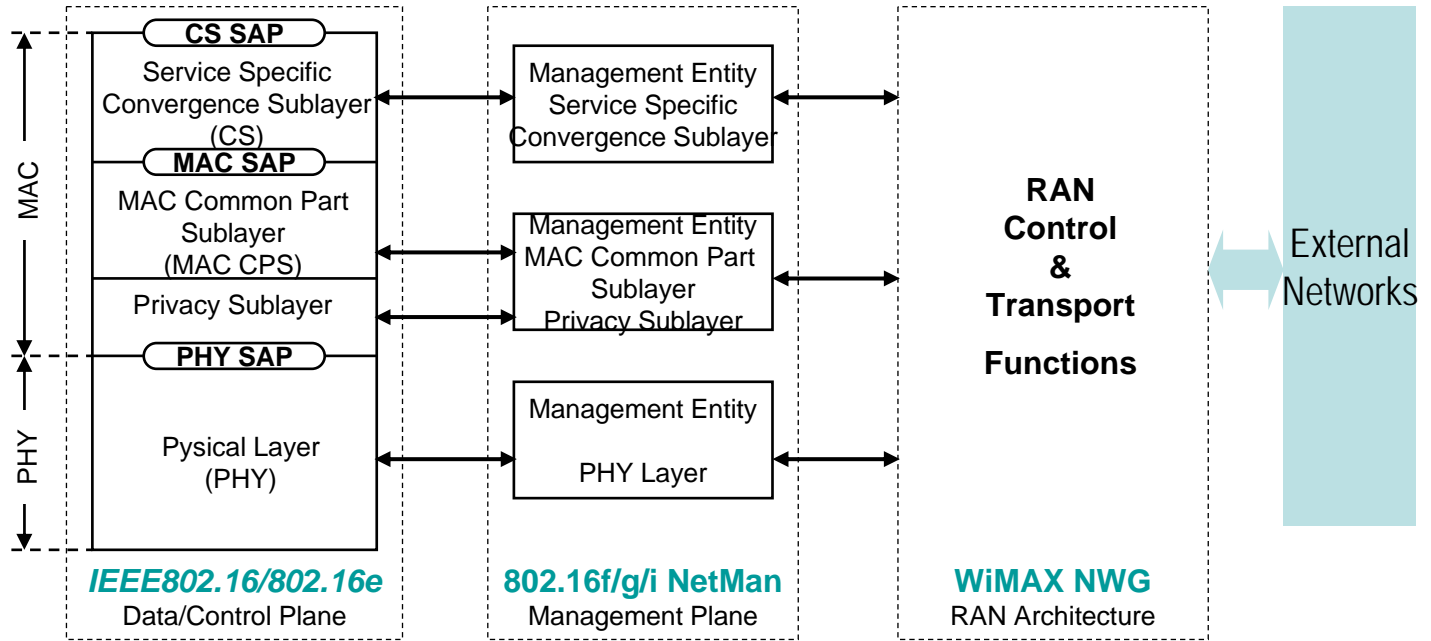
- Scope of WiMAX Forum
- Mobile WiMAX Network Architecture
- WiMAX Network Reference Model
- Reference Points in Mobile WiMAX
  - > Implications for 16ng
- ASN Anchored Mobility
- ASN Profiles and Implementation Options
- Deployment Options
  - > Implications for 16ng
- Relays in Mobile WiMAX
- Multiple Hosts Support
  - > Implications for 16ng
- Summary: WiMAX NWG Release 1 Features
- Conclusion

# WiMAX: Worldwide Interoperability for Microwave Access

- The WiMAX Forum promotes the deployment of broadband wireless access networks by supporting a global standard and certifying interoperability of products and technologies.
  - Support IEEE 802.16 standard family
  - Propose and promote access profiles for their IEEE 802.16 standard
  - Certify interoperability levels both in the network (IIOT) and the radio interface (RCT/PCT/NCT)
  - Achieve global acceptance
  - Promote use of broadband wireless access overall

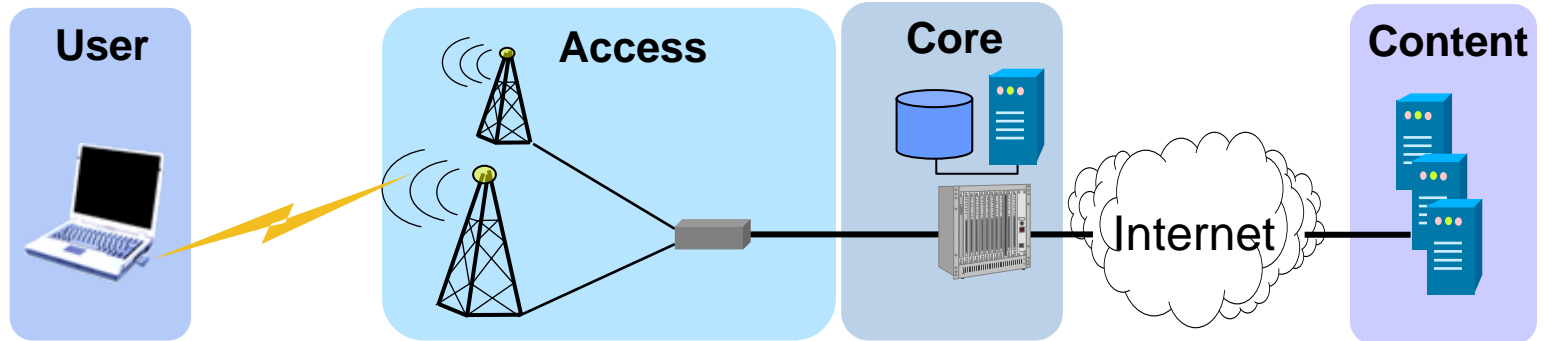


# Relation between IEEE802.16 and WiMAX NWG



- IEEE802.16-2004 & 802.16e define data and control plane
  - Management plane functions are part of 802.16 NetMan
- IEEE P802.16 does not deal with the radio access network
- The standardization of the missing parts of a nomadic and mobile WiMAX radio access network is the scope of the WiMAX NWG.

# A Wireless Access Network for the Internet

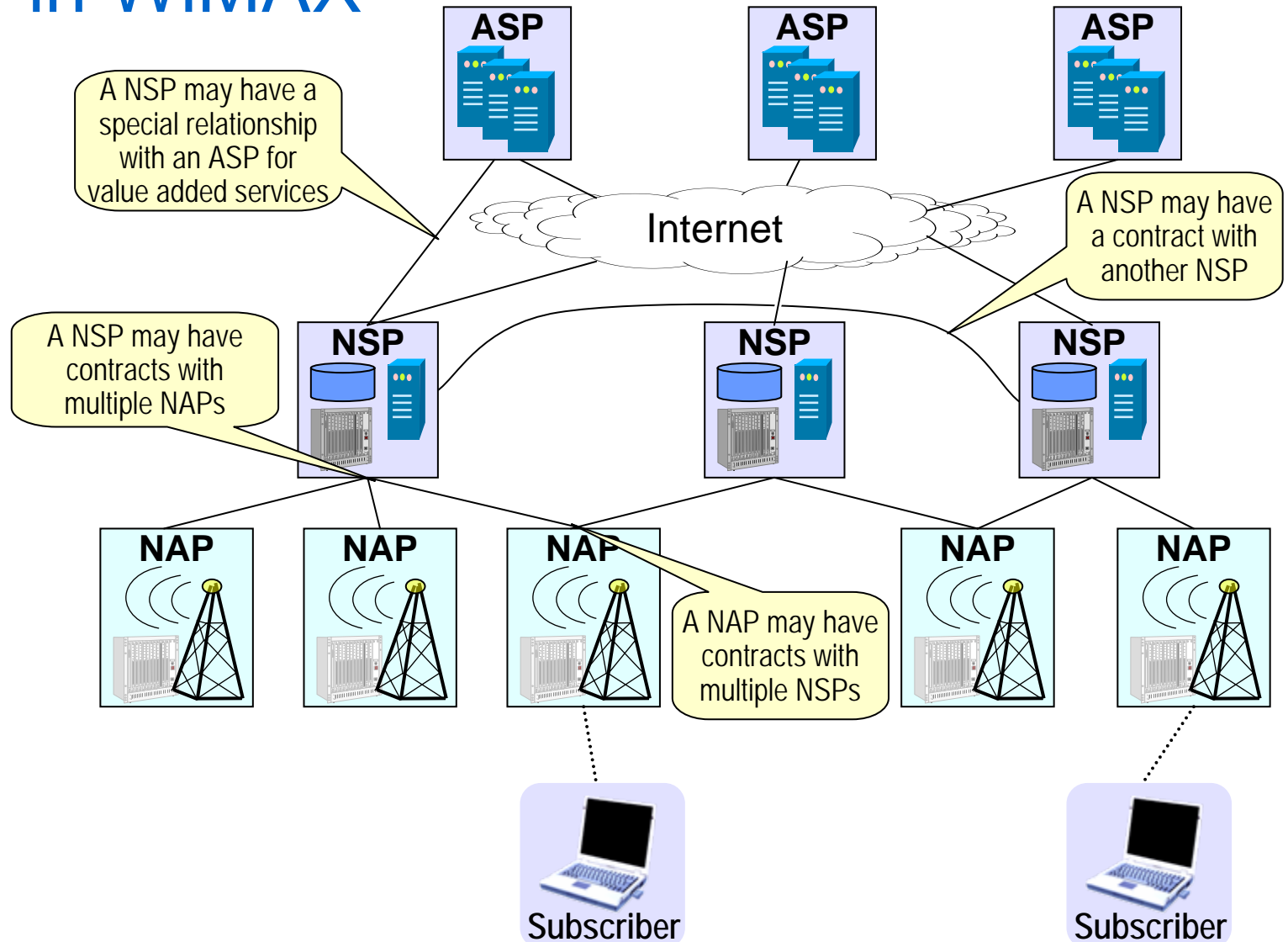


- The Internet decouples the Content from the Core
  - Split between Application Service Provider and Network Service Provider
- Often Access is not owned by Network Service Provider but operated as independent business
  - Network Access Provider does not deal with the particular subscriber but concentrates on establishment and operation of network infrastructure
  - Possibility to sell network access to multiple service providers enables economy of scale and reduces ROI

# Network Operator Roles in WiMAX

- Network Access Provider (NAP)
  - A business entity that provides radio access infrastructure to one or more Network Service Providers.
- Network Service Provider (NSP)
  - A business entity that provides IP connectivity and network services to subscribers compliant with the Service Level Agreement it establishes with 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. ASPs) for providing IP services to subscribers.
- ASP (Application Service Provider)
  - Provides and manages applications on top of IP
  - Provides value added services, Layer 3+ (e.g. VoIP, corporate access, ...)

# Network Operator Relationships in WiMAX

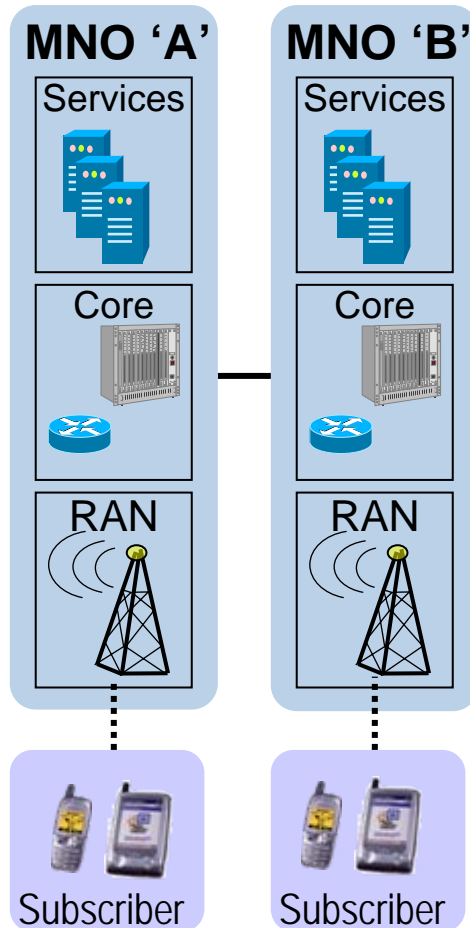


# Definition of the WiMAX Network Reference Model

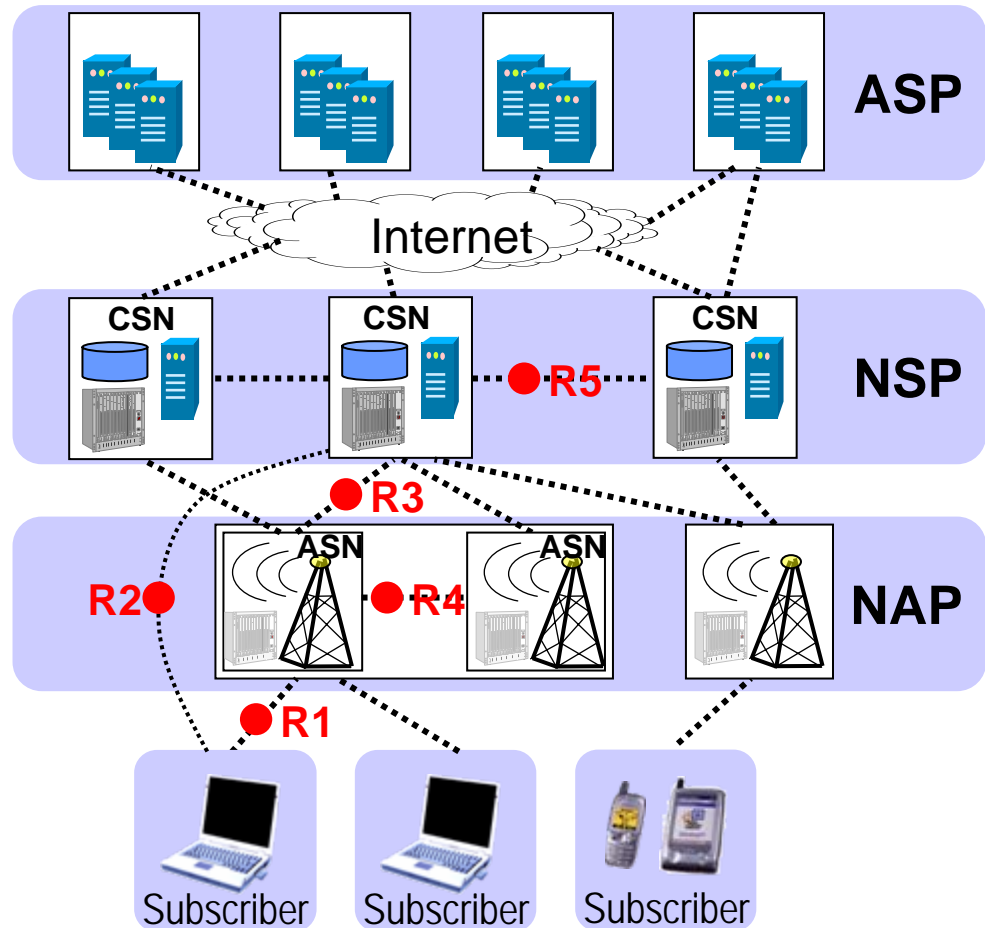
- Based on logical network entities for NSP and NAP
  - CSN: Connectivity Serving Network
    - Logical representation of the functions of a NSP, e.g.
      - Connectivity to the Internet, ASPs
      - Authentication, authorization and accounting
      - IP address management
      - Mobility and roaming 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

# Mobile Network Architectures

## Legacy Architecture

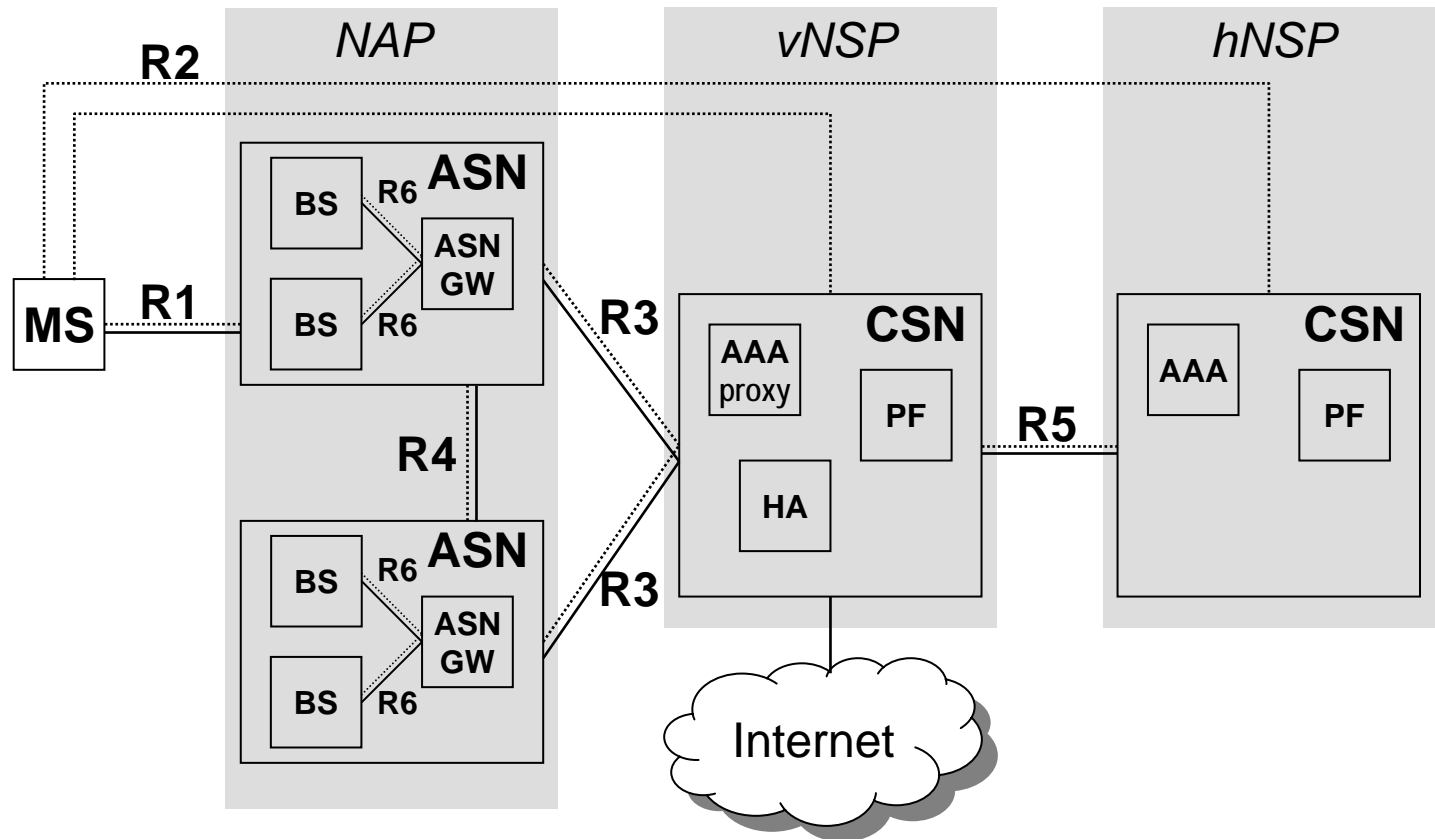


## Mobile WiMAX Network Architecture





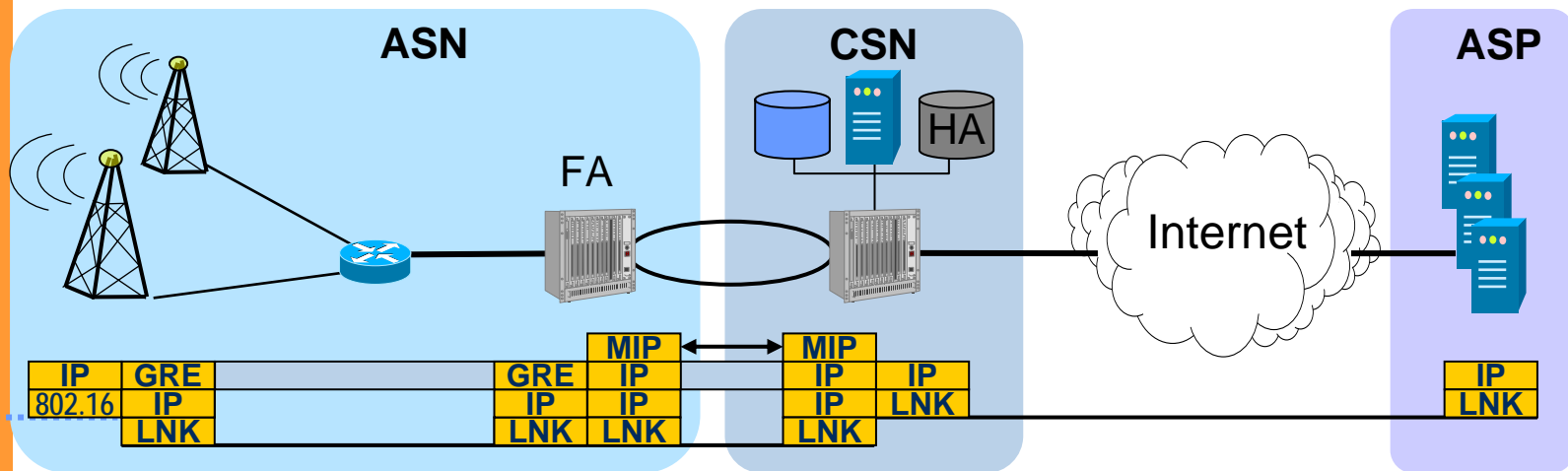
# WiMAX Network Reference Model (roaming case, HA in vNSP)



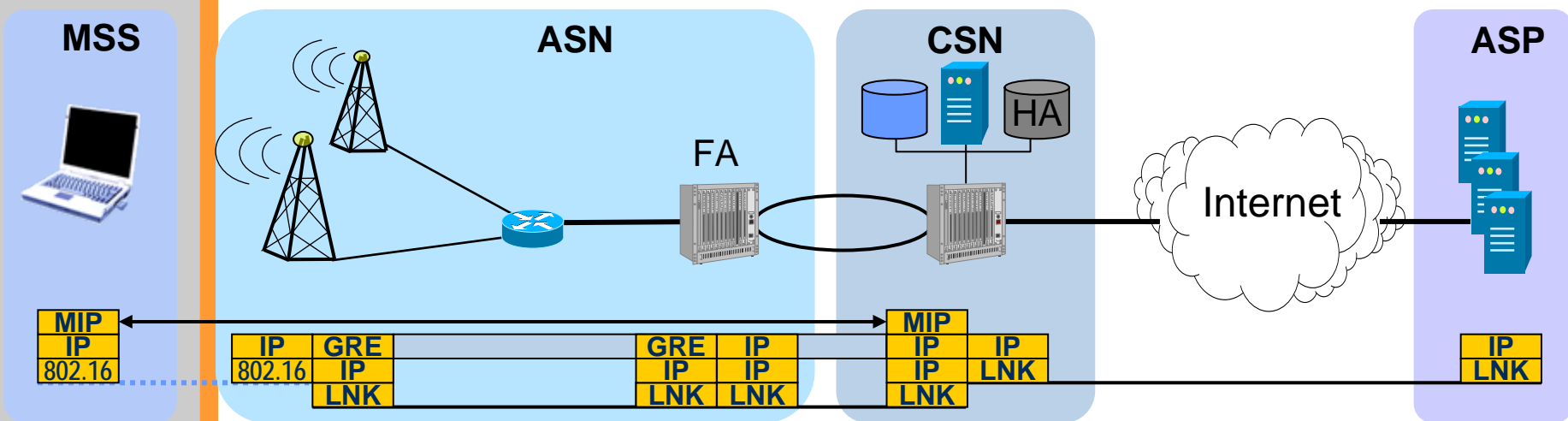
- The NRM defines also a logical decomposition inside the ASN (BS, ASN-GW)
  - Most implementations follow this logical structure

# WiMAX CSN Anchored Mobility Management

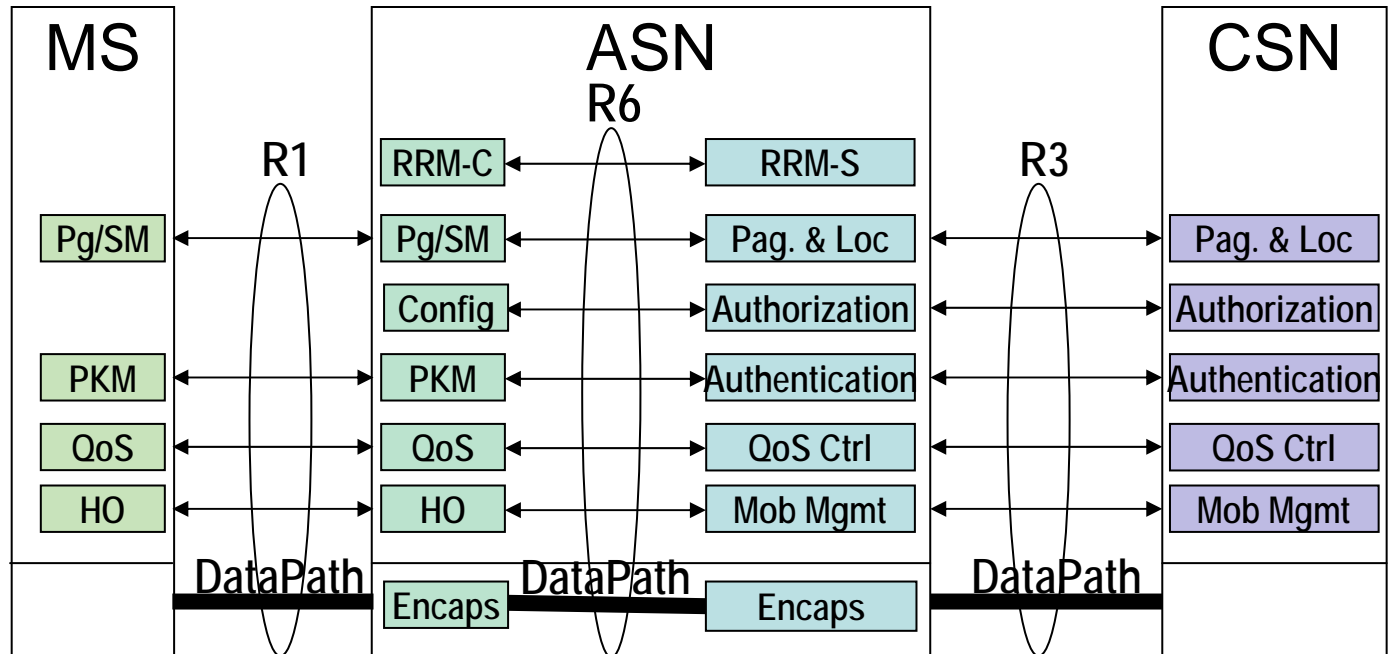
**Proxy-MIP:** MIP Client resides in ASN-GW



**Client-MIP:** MIP Client resides in MSS



# WiMAX Reference Points



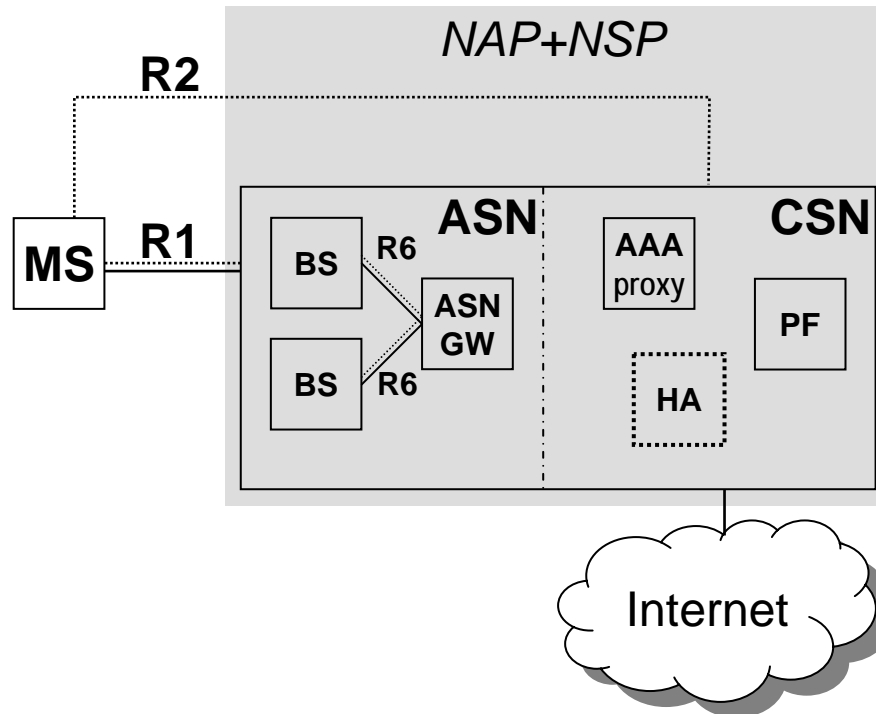
- NRM Reference Points represent a bundle of protocols between peer entities
  - Similar to a real IP network interface
- The implementation of a particular protocols over a reference point is optional
  - If a particular protocol is present, it must conform to the WiMAX specification

# WiMAX NRM 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
- Optional:
  - Further decomposition of ASN into logical entities
    - BS: Base Station
      - IEEE802.16 interface
    - ASN-GW: ASN-Gateway
      - Centralized control and traffic concentration
      - L2 mobility anchor
      - Authenticator and accounting entity
  - Several interoperable ASN Profiles

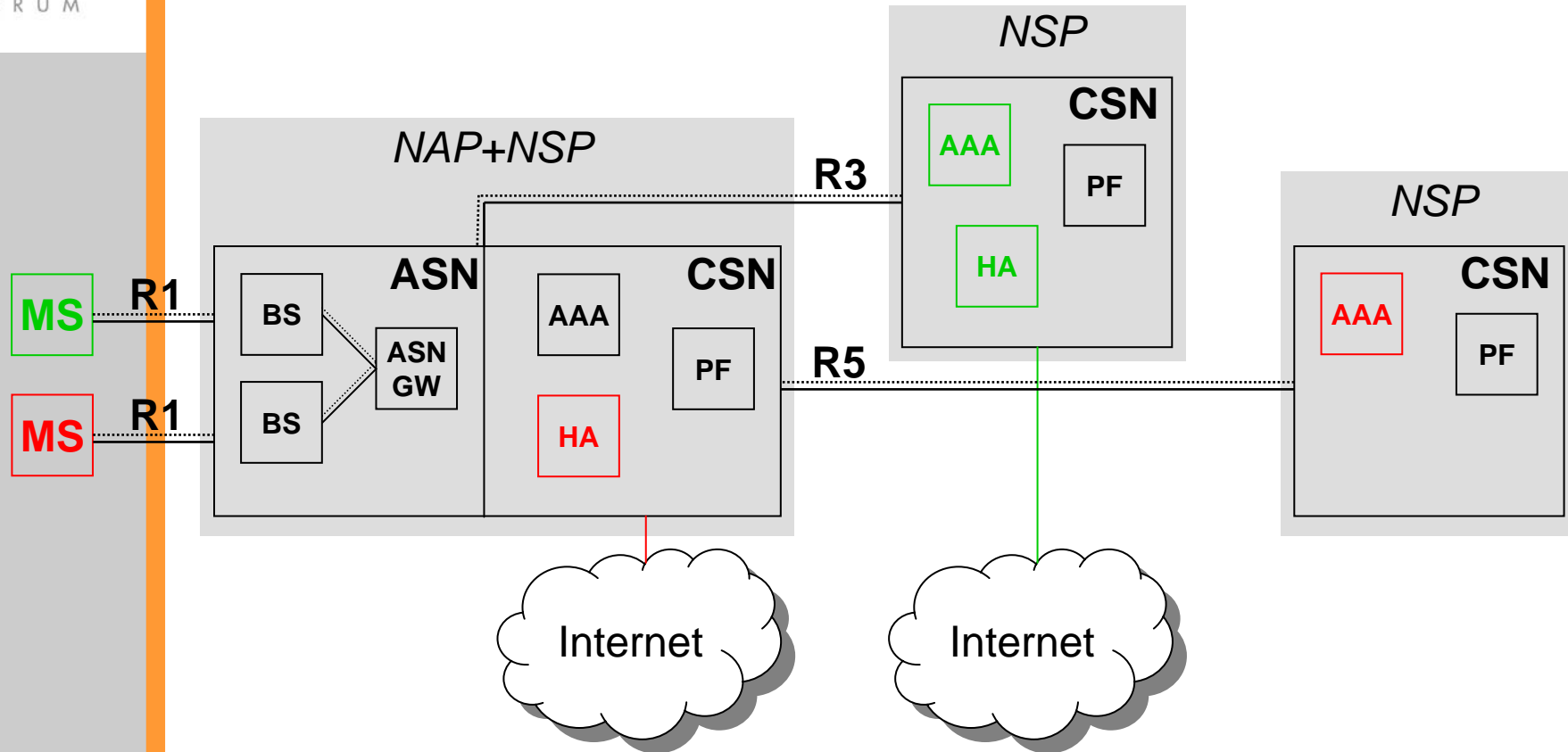
# WiMAX NRM: *The simple case*

## Stationary network deployment option



- Direct attachment of a CSN to an ASN without exposing R3 results in a stationary network model without need for MIP
  - L2 mobility still available for load balancing
    - As well as R6 reference point for ‘standard’ BS

# Real deployments will be a mixture of scenarios



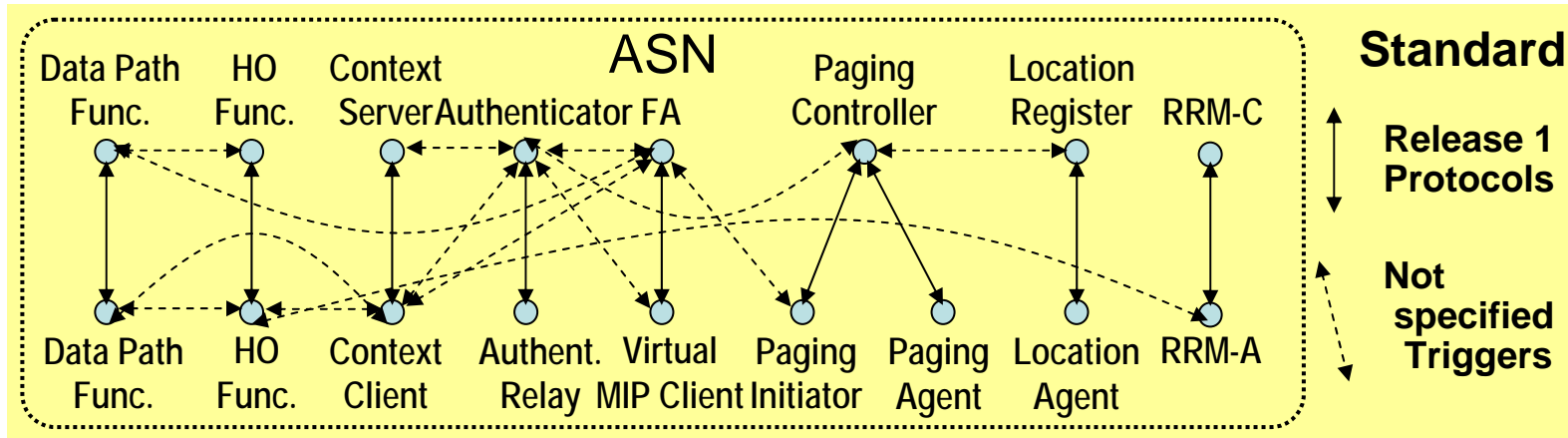
- Many access provider will implement direct Internet connectivity by a co-located CSN to minimize transport.
  - Eventually only for roaming users (no own service provider business)

# WiMAX Network Model Implications for 16ng

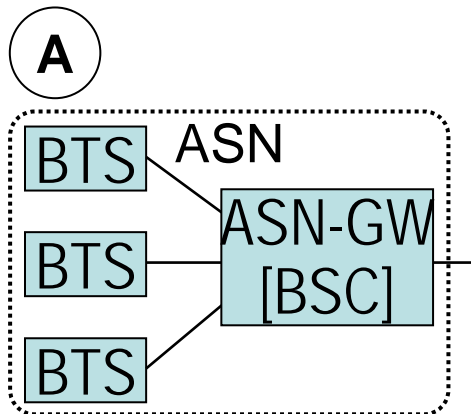
- Support for access network sharing
  - Separation of user traffic of different NSPs
  - Overlapping IP address spaces (IPv4)
  - Enforced forwarding of all user traffic to the CSN
    - Legal intercept
    - E911
    - Route optimization



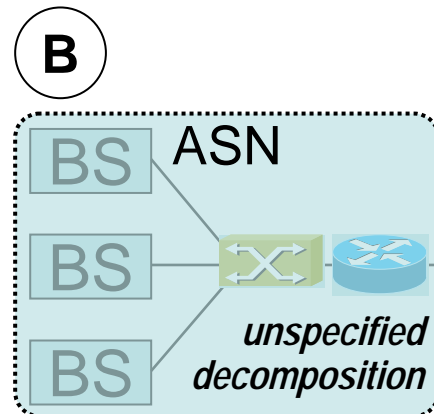
# Mapping Functions to ASN Profiles



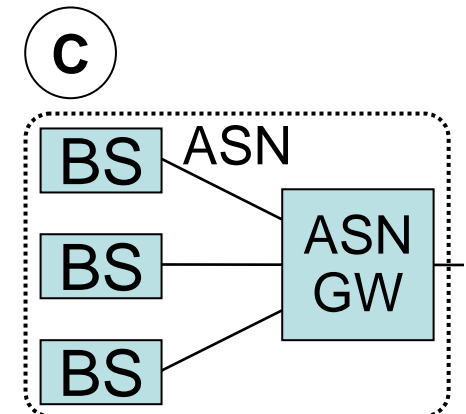
## WiMAX ASN Profiles:



- PHY and partly MAC in BTS
- Handover-Ctrl (RRM) in ASN-GW
- Routing and AAA/Pg in ASN-GW

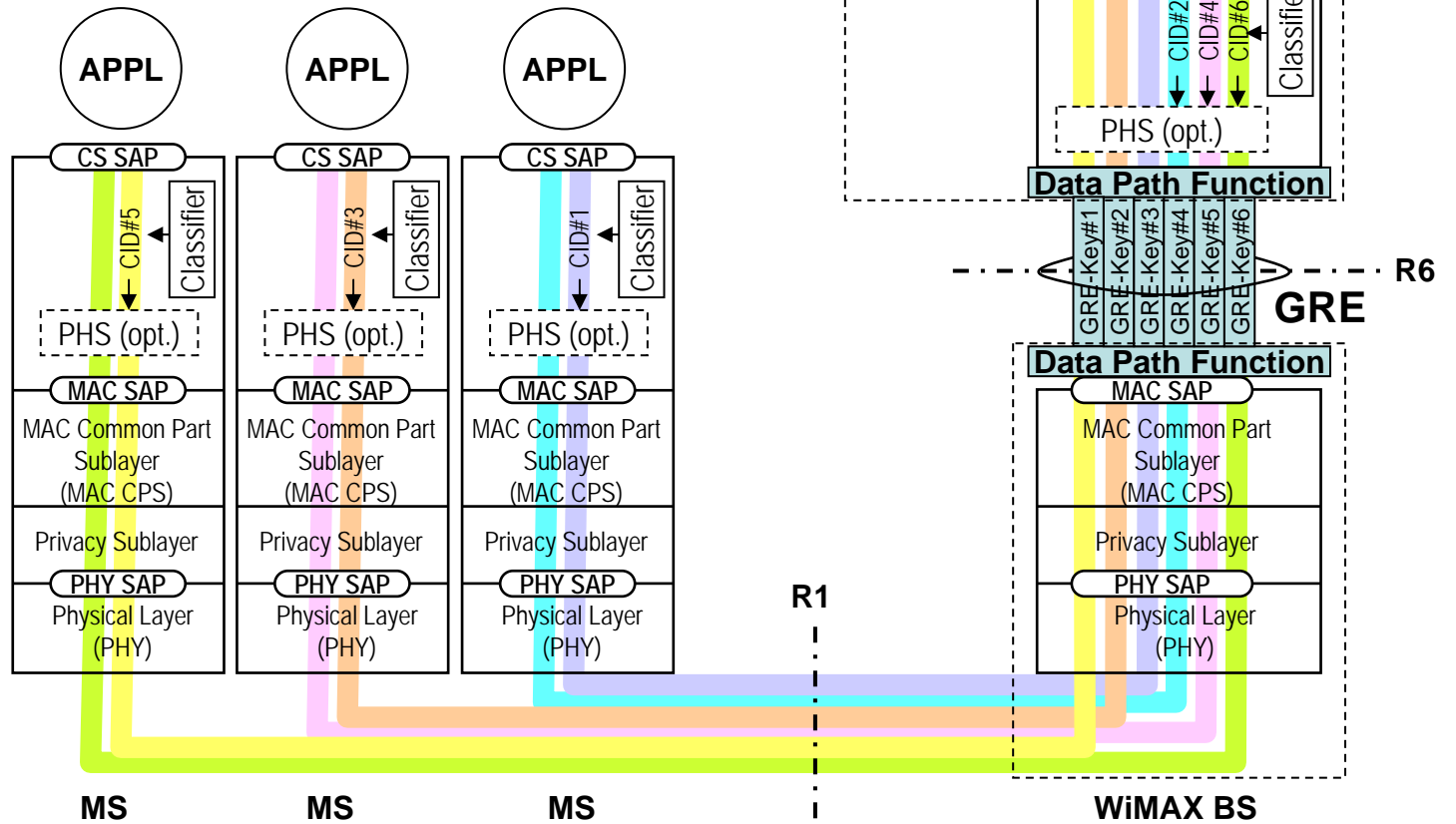


- e.g. most ASN functions in BS
- BS anchored by standard router
- Inter BS control over Ethernet

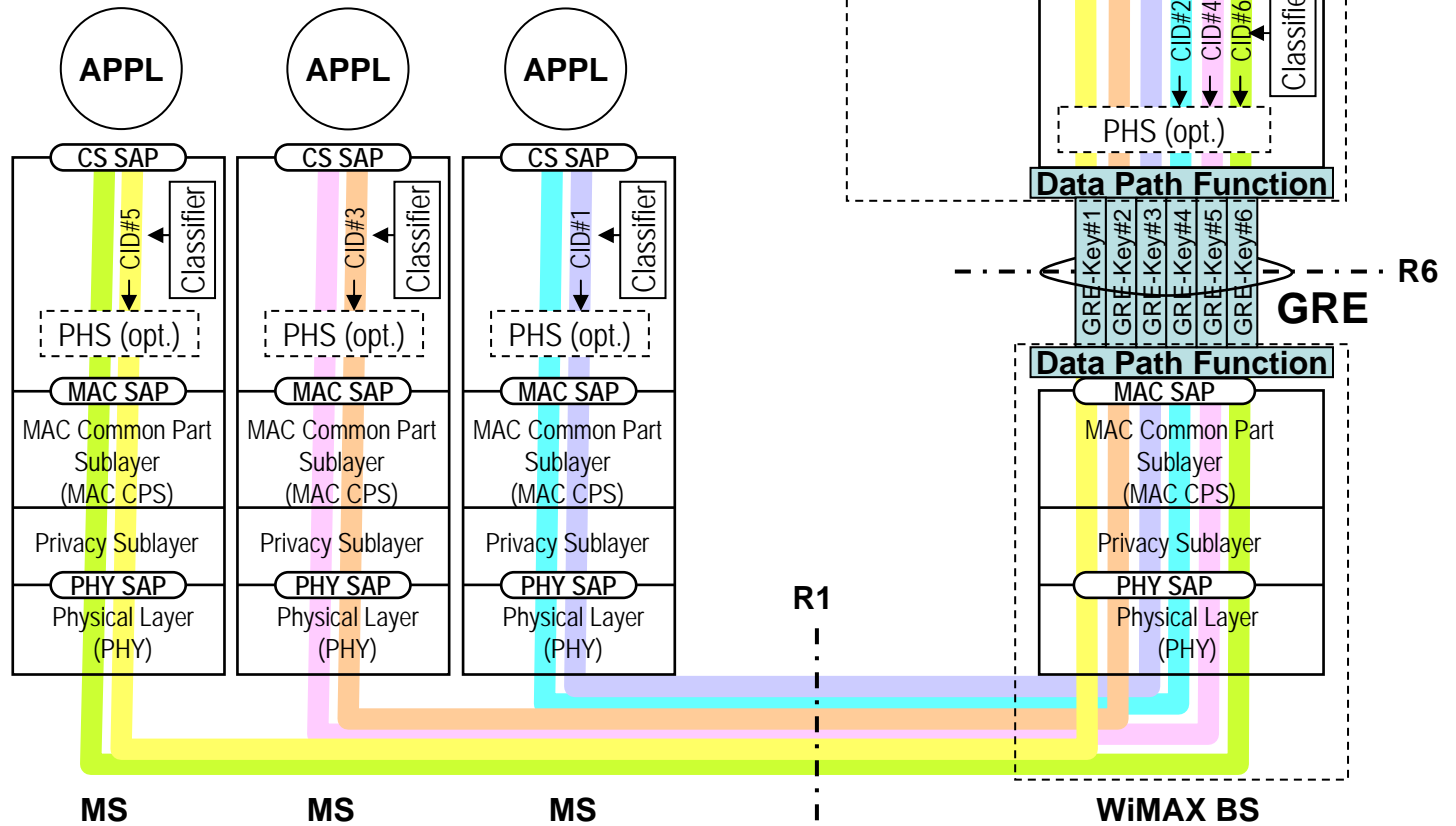


- All radio-specific functions in BS
- Handover-Ctrl (RRM) in BS
- Routing and AAA/Pg in ASN-GW

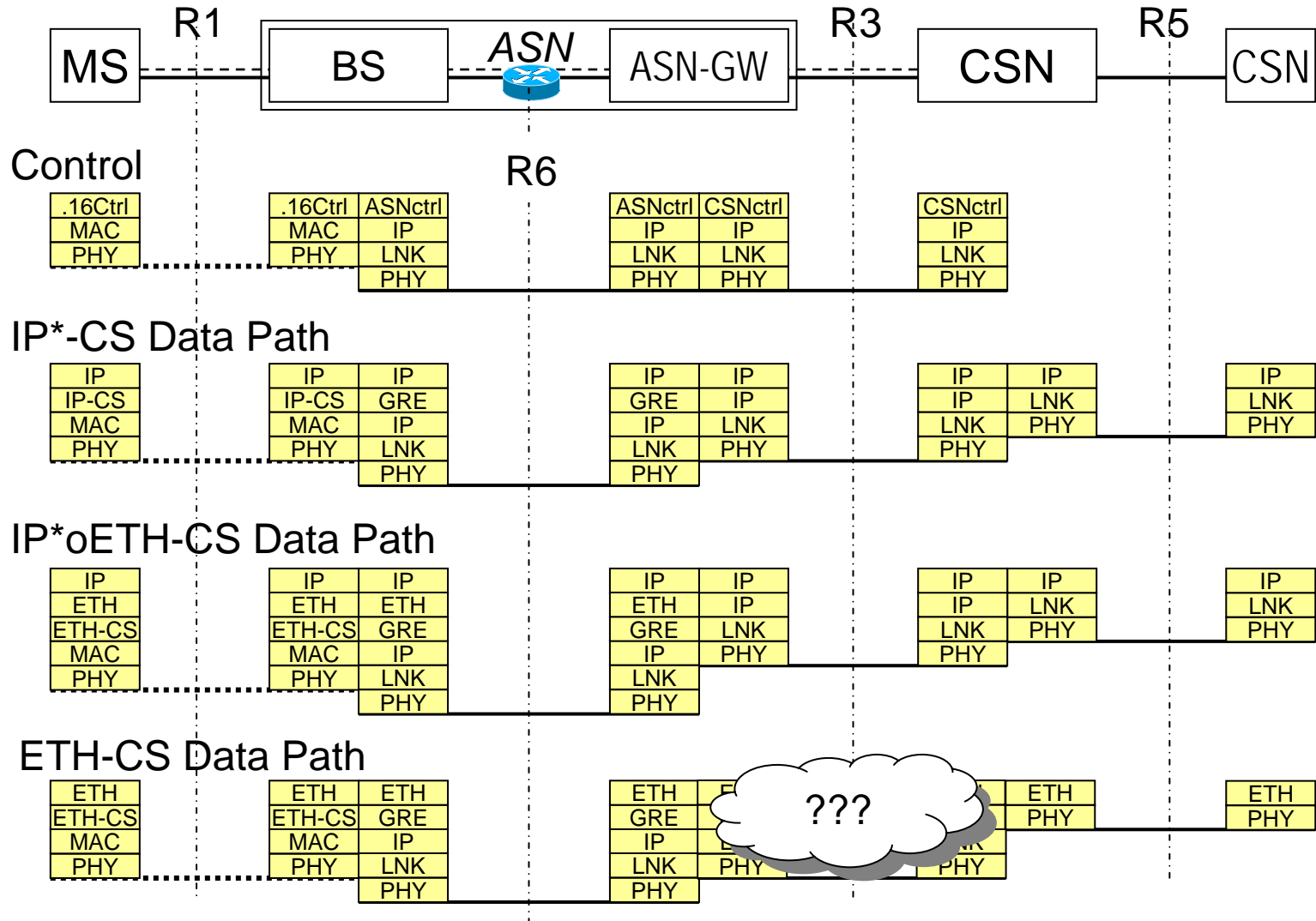
# ASN Data Plane (IP-CS Case)



# ASN Data Plane (IPoETH-CS Case)

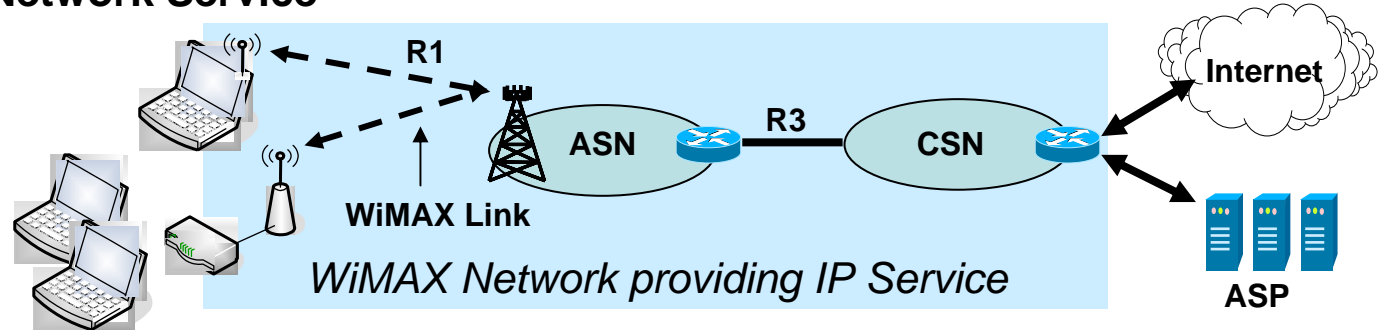


# Control Plane and Data Path Protocol Layering



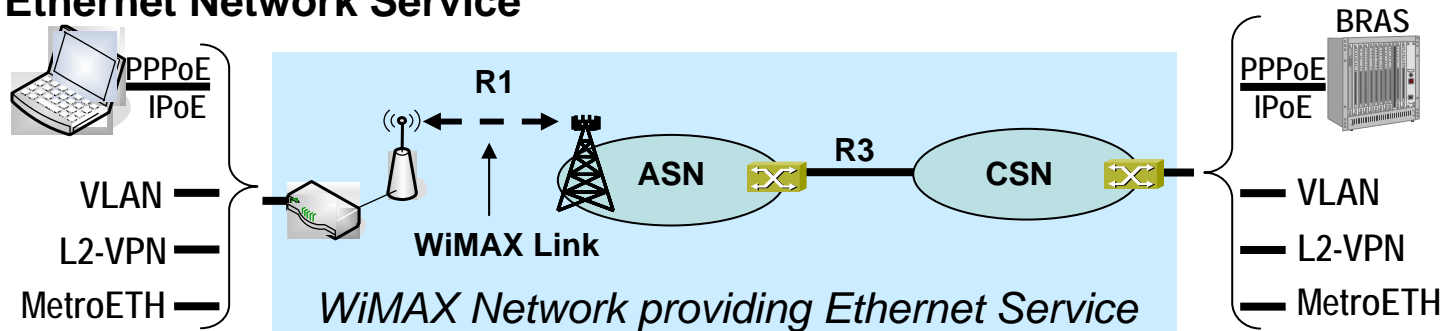
# IP Network Service vs. Ethernet Network Service

## • IP Network Service



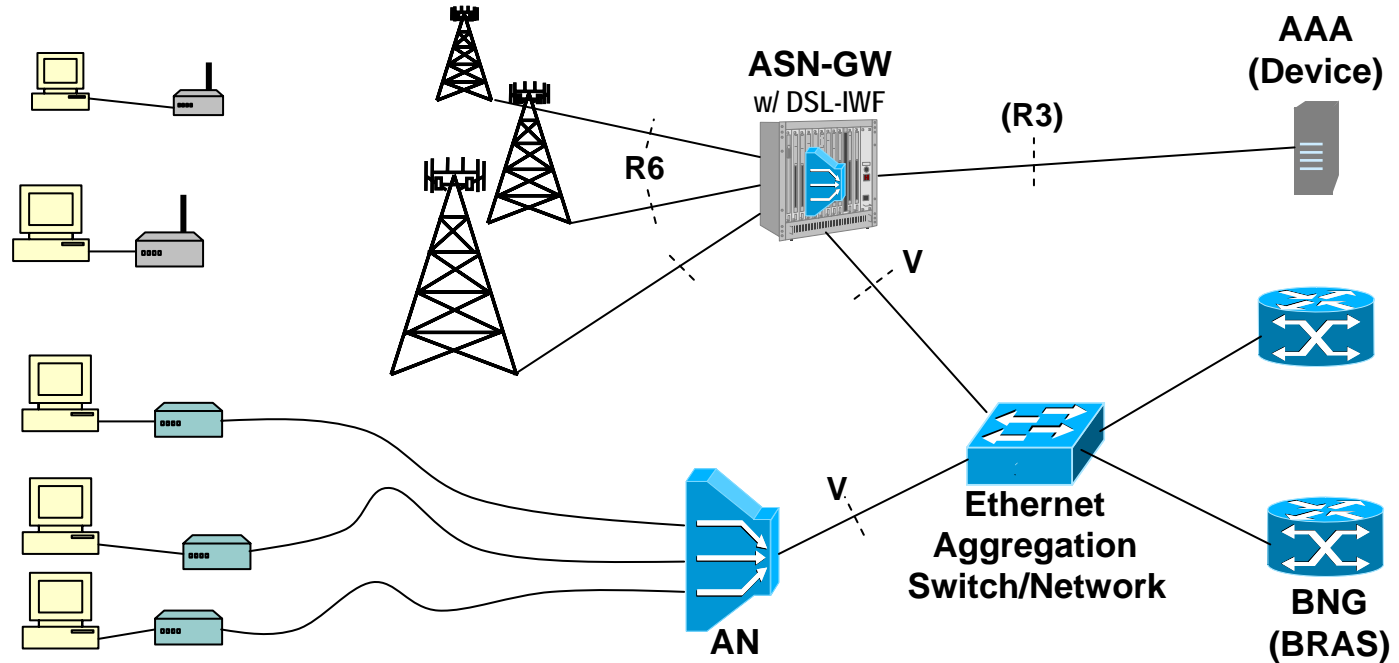
- The WiMAX network provides IP connectivity to the Internet and operator services for single hosts or multiple hosts behind a gateway.
  - Like a 3GPP or 3GPP2 mobile network

## • Ethernet Network Service



- The WiMAX network provides plain Ethernet connectivity end-2-end.
  - Like a DSL network, but without wires.

# WiMAX Interworking with DSL (over V-interface)



- ASN-GW w/ DSL-IWF looks like an AN towards the DSL aggregation network
- WiMAX AAA provides device authentication, QoS set-up and session accounting per device
- Ethernet Bridge and access router resides outside of the WiMAX network

# WiMAX ASN Model

## Implications for 16ng

- An ASN is able to serve IP-services as well as ETH-services
  - ETH-CS: Bridge and access router may reside outside of the WiMAX network
    - But still serving IP services
- ASN may have to concurrently support IP-CS, IPoETH-CS and ETH-CS
  - WiMAX assumption: A MS is deploying only one kind of Convergence Sublayer at a time
- WiMAX mandates per-SF tunneling between BS and ASN-GW
  - Convergence Sublayer is implemented in ASN-GW

# Relays in Mobile WiMAX

## Rationale:

Poor 'indoor' penetration, even more when in move

How far does it go? It depends where your terminal is!

Consider a hypothetical broadband (1Mb/s) wireless network



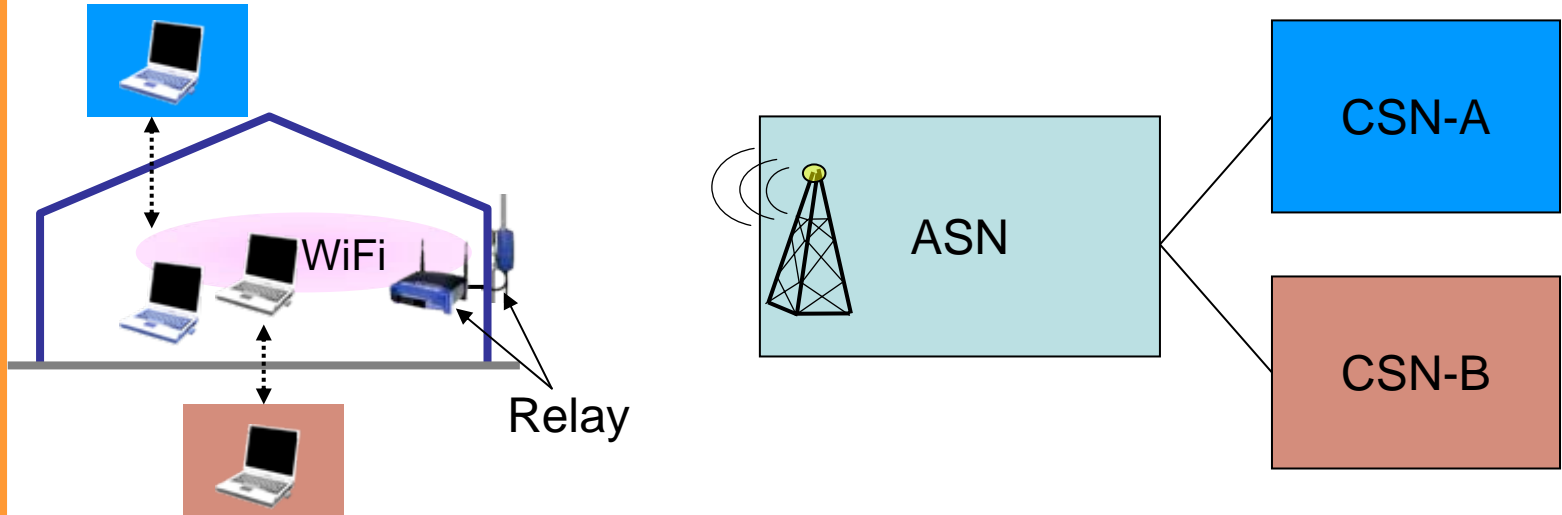
3 Sector base station at 25m to:



	Gain	Height	Building loss	Range	Relative site count
Rooftop – LOS	10 dBi	8 m	0 dB	> 30km	
Rooftop NLOS	10 dBi	8 m	0 dB	6.2 km	1
Terminal / Gateway in upstairs window	3 dBi	5 m	0 dB	1.8 km	12
Outdoor PCCard	0 dBi	1.5 m	0 dB	780 m	60
Indoor PCCard - Suburban	0 dBi	1.5 m	10 dB	410 m	230
Indoor PCCard - Urban	0 dBi	1.5 m	20 dB	210 m	800

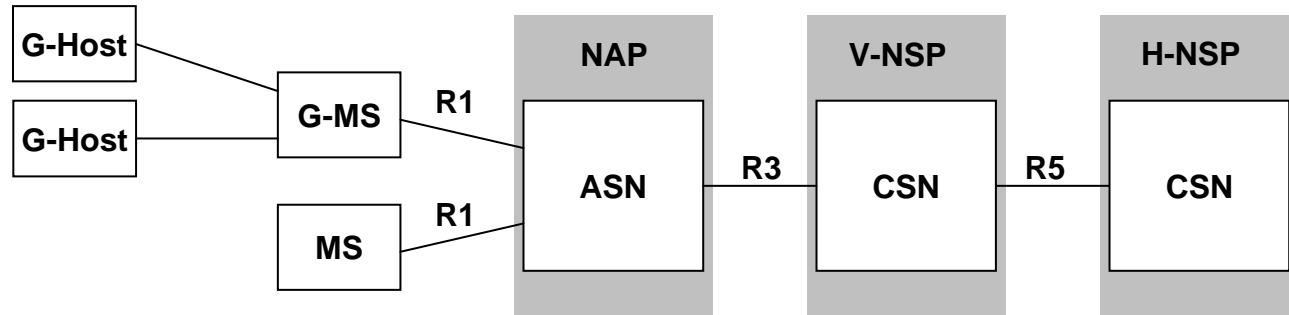
All figures except LOS based on COST231-Hata model with 10dB shadow margin and no cable losses. System operates at 2GHz with 1Mb/s from 24dBm EIRP terminal TX, 3dB Eb/No, 5dB NF RX. BS antenna = 18dBi

# WiMAX – Wi-Fi relays



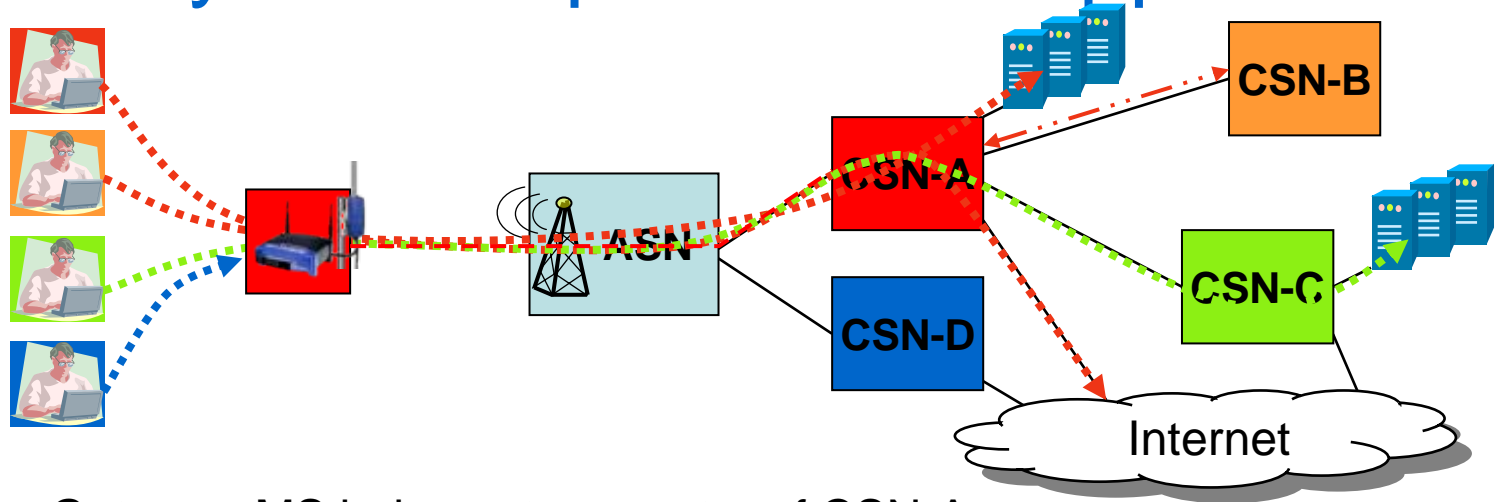
- WiMAX devices may be dual mode Wi-Fi/WiMAX devices
  - Very likely for WiMAX equipped notebooks
- WiMAX – Wi-Fi relays can be applied to solve the indoor penetration issues of WiMAX
- Relays may be concurrently used by several WiMAX subscribers belonging to different CSNs
  - Can WiMAX subscription be re-used behind relay?
    - Setting up WiFi security context and accounting

# WiMAX NWG Definitions for Multiple Hosts Support



- Gateway-MS (G-MS)  
Mobile WiMAX SS/MS that provides the multiple hosts support
- Gateway-Host (G-Host)  
Host attached to the G-MS to leverage the WiMAX network facility for external access.
  - Full Host
    - Host with direct or indirect subscription to access the WiMAX network; appears to the network like an ordinary Mobile WiMAX MS with full QoS support.
  - Limited Host
    - Host without WiMAX subscription (NAT user)

# Network Sharing and Roaming with Relay w/ Multiple Hosts Support



- Gateway-MS belongs to operator of CSN-A
  - Establishes control connection to AAA server in CSN-A
- User A gets access over the G-MS belonging to CSN-A
  - Authentication is provided by AAA server in CSN-A
- User B gets Internet Access over G-MS and CSN-A
  - Roaming without data forwarding to home
- User C gets access to his services over CSN-A
  - Roaming with data forwarding to home
- User D does not get access due to missing authentication path

CSN-B and CSN-C are not aware of the G-MS in the path

# WiMAX Multiple Hosts Support Implications for 16ng

- A MS may be a gateway serving multiple WiMAX subscriptions
  - Home NSPs may be not aware that subscriber is connected via G-MS
  - G-MS has to connect multiple independent hosts to the ASN
    - Bridging or Routing
    - Overlapping IP address spaces
    - Individual connection management

*Multiple Hosts Support will be addressed in  
WiMAX NWG Release 1.5*

# Summary:

## WiMAX NWG Release 1 Features

- Network discovery and selection with roaming support
- Authentication and Authorization based on EAP and RADIUS
- IP & Ethernet support (Ethernet optional)
- Mobility management inside ASN and directly between ASNs
- Mobility Management between ASN and CSN based on Mobile IP
  - Client MIP support as well as DHCP with Proxy MIP
- Radio Resource Management procedures inside ASN
- Sleep/Idle mode and paging support
- Pre-provisioned QoS framework
- No standardized functional decomposition inside CSN
- Two different ASN profiles for standardized function splits between BS and ASN-GW
  - Optional to implement

# The End

- Questions?
- Comments!

*Thank you for your attention!*