WiMAX Network Architecture

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Flexible Network Operator Relationships
- Supports infrastructure access unbundling from IP connectivity services
- Supports Multiple Virtual Network Operator concept
Key Architecture Features

• All IP radio access and core transport network
  ➢ Based on IEEE* 802.16/e and IETF protocols
• Support for all usage models (fixed to fully mobile)
• Access to incumbent core networks via interworking functions
• Open interfaces both within the RAN, and between the RAN and the core network
• Support for voice, data and multimedia services with appropriate QoS
Network Reference Model (NRM)

Mobile Subscriber Station

ASN

Another ASN

Another Operator’s CSN

NAP

NSP

ASN – Access Services Network
CSN – Core Services Network
BS – Base Station
FA – Foreign Agent

NAP – Network Access Provider
NSP – Network Service Provider
HA – Home Agent
AAA – Authentication, Authorization, & Accounting
Key Network Features

• **AAA with CSN for homers and roamers**
  - IEEE 802.16 security framework extended to cover mobility scenarios
  - RADIUS for AAA, evolving to DIAMETER

• **QoS**
  - Based on subscription
  - Policy enforcement

• **Mobility management**
  - Mobility management is tiered
    ▪ Intra-ASN
    ▪ Inter-ASN
    ▪ Inter-CSN when V-CSN supports the HA for mobile IP

• **Wimax/3G Interworking**

• **Charging**
  - Common Billing with CSN but different CDR (Call Detail Record) collectors
  - Common Billing with common CDR collector

• **Protocols**
  - Support for both IPv4 and IPv6
Network Nodes

- **MSS**
- **WiMAX Air Interface**
- **BS**
- **ASN-GW/FA**
- **Internet**
- **Backhaul (L2/L3 Tunnel)**
- **At the Local Switching Center**
- **Network internal (e.g., L2/L3 Tunnel)**
- **Home Agent (HA)**
- **AAA**

Short Distance (e.g., Coax, Fiber transport of RF is under consideration)

Physically connected to antenna
ASN Profiles

• Multiple ASN Profiles have been specified in WiMAX as a tool to manage diversity in ASN node usage and implementation
  ➢ Vendors (esp. BS) very concerned that they will be forced to implement every protocol option in the specification
  ➢ We cannot preclude any topological variant from serving any usage or deployment/Interworking scenario

• Release 1 of NWG Specifications on WiMAX supports 3 ASN Profiles:
  ➢ Profile A:
    ▪ Centralized ASN Model with BS and ASN GW in separate platforms through R6 interface
    ▪ Split RRM: RRA in BS and RRC in ASN-GW
    ▪ Open interfaces for Profile A: R1, R6, R4, and R3
  ➢ Profile B:
    ▪ Distributed ASN solution with the BS and ASN GW functionalities implemented in a single platform
    ▪ Open interfaces Profile B: R4 and R3
  ➢ Profile C: Similar to Profile A, except for RRM being non-split and located in BS.
ASN Profile A

Separate BS and ASN-GW, Split RRM

- BS
  - HO
  - Data Path 1 & 2
  - Authentication Relay
  - Paging Agent
  - Key Receiver
  - Context
  - RRA
  - SF Management

- ASN-GW
  - HO
  - Data Path 1 & 2
  - Authenticator
  - Key Distributor
  - Context
  - RRC
  - SF Authorization

- ASP
  - R6 to BS

- NSP
  - R3
  - Internet
  - Home Agent
  - AAA

- MS
  - R1
  - Air Interface

- ASN GW (FA)
  - R4

- DHCP Proxy/Relay
- MIP FA
- Location Register
- PMIP Client
- AAA Client
- Paging Controller

Separate BS and ASN-GW, Split RRM
ASN Profile B

Combined BS, ASN-GW

BS + ASN-GW
- HO
- Data Path 1 & 2
- Authenticator
- Key Receiver + Distrib.
- Context
- SFA + SFM

• RRA + RRC
• DHCP Proxy/Relay
• MIP FA
• Location Register
• PMIP Client/Assistant
• AAA Client

NSP
- Home Agent
- AAA

Internet

Combined BS, ASN-GW
- R1
- R2
- R3
- R4
ASN Profile C

Separate BS and ASN-GW, RRM in BS

- HO
- Data Path 1 & 2
- Authentication Relay
- Paging Agent
- Key Receiver
- Context
- RRA + RRC
- SF Management

- HO
- Data Path 1 & 2
- Authenticator
- Key Distributor
- Context
- SF Authorization

- DHCP Proxy/Relay
- MIP FA
- Location Register
- PMIP Client
- AAA Client
- Paging Controller

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<tr>
<th>ASN Profile</th>
<th>Descriptions</th>
<th>Pro</th>
<th>Con</th>
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</thead>
</table>
| Profile A   | •Centralized platform  
•Separate BS and ASN-GW  
•Split RRM: RRA at BS and RRC at ASN-GW | •Able to provide simplified pico-cell  
•Able to provide soft handover  
•Fewer backhauls for RRM messages | •Difficult Interoperability between BS and ASN-GW from different vendors  
•Heavy workload at ASN-GW  
•Fewer vendors |
| Profile B   | •Distributed platform  
•Combined BS and ASN-GW | •Simple architecture  
•Suitable for small-scale deployment | •Difficult to customize IP and wireless functions for operators  
•Expensive for large-scale deployment |
| Profile C   | •Distributed platform  
•Separate BS and ASN-GW  
•RRM at BS | •Able to provide simplified pico-cell  
•Able to get BS and ASN-GW from different vendors | •Extra backhauls for RRM messages |
AAA and Roaming Framework

- **Non-Roaming Case**

  - MS
  - AAA Client
  - AAA Proxy
  - BS
  - R1
  - R6
  - H-CSN
  - AAA Server

- **Roaming Case**

  - MS
  - AAA Client
  - AAA Proxy
  - BS
  - R1
  - R6
  - V-CSN
  - AAA Proxy/Server
  - H-CSN
  - AAA Proxy/Server
  - R3
  - R5
QoS Framework

• End-to-End QoS model

AF: Application Function
(e.g., SIP Proxy)

PF: Policy Function

LPF: Local Policy Function

Triggers QoS Requests

Home NSP

AF

PF

Subscriber Data

Via R3 & R5

ASN

SS

R1

BS

Local Policy Data

ASN-GW

AF: Application Function

PF: Policy Function

LPF: Local Policy Function
Mobility Framework

- Mobile IP based
  - Proxy mobile IP
    - Client unaware of MIP
    - Standard RFC methods implemented in network only
  - Client mobile IP
    - As per standard RFC
  - Coexistence
    - Support for both MIP-aware and other clients
WiMAX-3G Interworking

- Initial Interworking scenarios
  - Scenario 1 - Common Billing and Customer Care
  - Scenario 2 - 3GPP system based Access Control and Charging
  - Scenario 3: Access to 3GPP system PS based services
  - Other scenarios such as Service continuity & Seamless services are in the future

- Loose coupling
  - Single subscription
  - Roaming between WiMAX and 3G networks

- Requires WiMAX CSN IWU Node
  - Provides IP Connectivity between ASN & 3GPP CSN.
  - Direct Internet connectivity to MS
  - Local IP address management (DHCP, DNS).
  - NAT function
  - AAA proxy or pass-through for Wa interface
  - Bridges R3 interface with Wa and Wn interfaces of the CSN
**3GPP Overlay (3GPP TS 23.234)**

### WiMAX Elements

- **MS**
- **BS**
- **ASN GW**
- **3GPP AAA Server**
- **WAG**
- **PDG**

#### ASN BS Functions:
1. WiMAX MAC and PHY (IEEE 802.16e)
2. Each BS instance is one sector with one freq. assignmnt
3. Scheduler functions for UL and DL resources
4. Connectivity mult ASN-GW for redundancy and/or load-balancing
5. All Radio resource Control and Management functions

#### ASN GW Function:
1. L2 connectivity with SS/MS
2. CSN connectivity
3. ASN-CSN tunneling
4. FA for MIP
5. Network discovery and selection for SS
6. Intra-ASN mobility
7. Paging and Location Management VLR
8. AAA proxy to WiMAX Subscriber's HNSP

#### WiMAX CSN IWU
1. Provides IP Connectivity between ASN & 3GPP CSN.
2. Direct Internet connectivity to MS
3. Local IP address management (DHCP, DNS).
4. NAT function
5. AAA proxy or pass-through for 6) Wa interface (3GPP R6)
6. Bridges R3 interface with Wa and Wn interfaces (3GPP R6) of the CSN

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3GPP/2 Interworking with IMS

Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
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<tbody>
<tr>
<td>AAA</td>
<td>Authentication, Authorization, Accounting</td>
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<tr>
<td>ASN-GW</td>
<td>Access Service Node Gateway</td>
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<tr>
<td>BGCF</td>
<td>Breakout Gateway Control Function</td>
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<tr>
<td>BS</td>
<td>Base Station</td>
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<tr>
<td>CSCEF</td>
<td>Call Session Control Function</td>
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<tr>
<td>CSN IWU</td>
<td>Core Service Network Interworking Unit</td>
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<tr>
<td>HSS</td>
<td>Home Subscriber Server</td>
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<tr>
<td>HLR</td>
<td>Home Location Register</td>
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<tr>
<td>IMS</td>
<td>IP Multimedia Subsystem</td>
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<tr>
<td>MG</td>
<td>Media Gateway</td>
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<tr>
<td>MGCF</td>
<td>Media Gateway Control Function</td>
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<tr>
<td>MS</td>
<td>Mobile Station</td>
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<tr>
<td>MRFC</td>
<td>Media Resource Function Controller</td>
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<tr>
<td>MRFP</td>
<td>Media Resource Function Processor</td>
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<tr>
<td>PDG</td>
<td>Packet Data Gateway (3GPP)</td>
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<tr>
<td>PDN</td>
<td>Packet Data Network</td>
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<tr>
<td>PDSN</td>
<td>Packet Data Services Node (3GPP2)</td>
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<tr>
<td>PSTN</td>
<td>Public Switched Telephone Network</td>
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<tr>
<td>PDF</td>
<td>Policy Decision Function</td>
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<tr>
<td>SIP-AS</td>
<td>Session Initiation Protocol – Appl. Server</td>
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<tr>
<td>SLF</td>
<td>Service Location Function</td>
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<tr>
<td>WAG</td>
<td>Wireless Access Gateway</td>
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