Migration from WiMAX® Release 1 to Release 2

Part 2: Air Interface Migration with Network Reuse

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1. Introduction

WiMAX® Release 2 offers many improvements with respect to Release 1. A core enhancement is support for the WirelessMAN-Advanced air interface of IEEE 802.16m [3]. This follow-on from IEEE 802.16e [2] promises up to double the air interface capacity.

WiMAX operators may desire to deploy WiMAX Release 2 air interface and increase capacity on the air interface without changing the core network components. Since network upgrade CAPEX could be considerable relative to the total upgrade cost, it is highly desirable to provide an upgrade path with no impact on the network.

This whitepaper explains how the air interface migration to WirelessMAN-Advanced is feasible without spending significant CAPEX to upgrade the core network elements, such as AAA servers, home agents, and ASN-GWs. This approach maintains forward compatibility.

In order to exploit the full advanced feature set in WiMAX Release 2, it is required to upgrade the network elements to those developed as part of Mobile WiMAX Release 2 specifications.

2. Overview of WiMAX® Network Architecture

An overview of WiMAX® network architecture is provided in this section. Figure 1 shows the WiMAX network architecture, comprising ASNs, CSNs, and MSs. Note that there are no changes in the architecture between WiMAX Release 1 and WiMAX 2, so the figure's architecture applies to both releases.

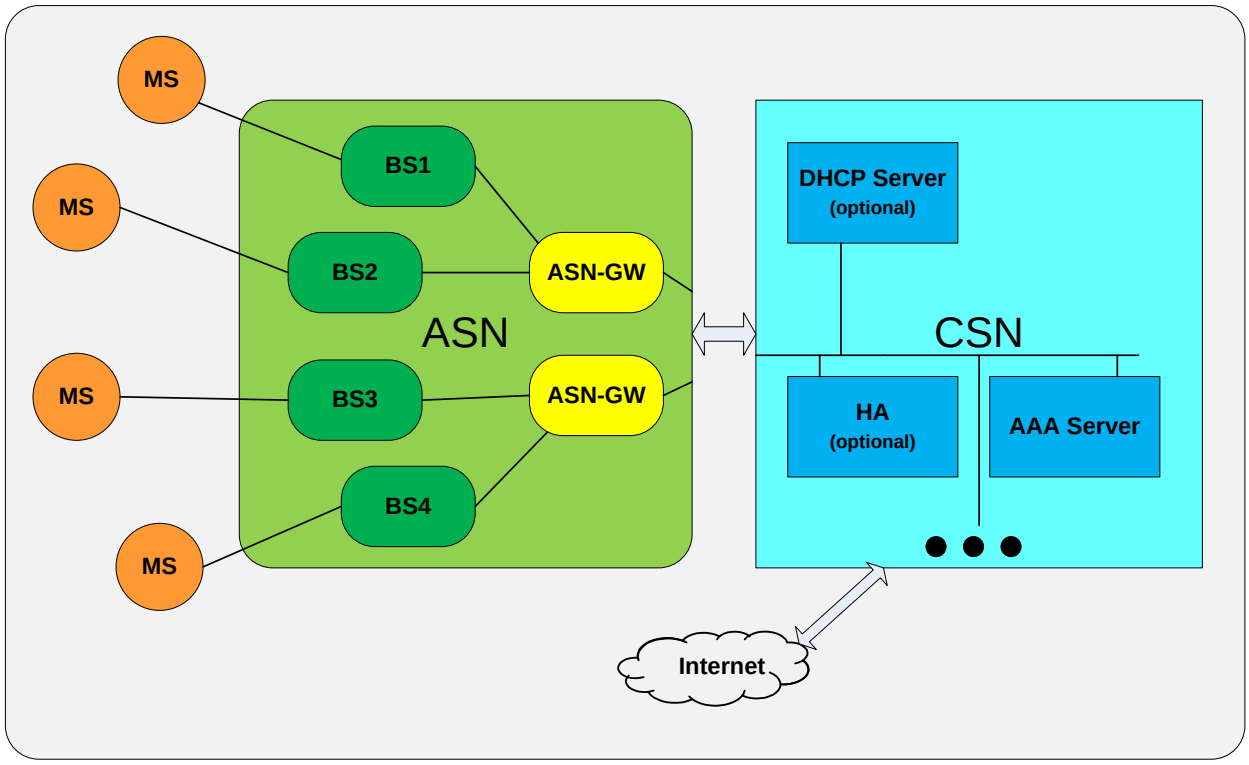

Figure 1: WiMAX® Network Architecture

The ASN – the Access Service Network – comprises the elements that provide access services to the mobile stations (MSs). It implements the base station (BS) side of the WiMAX air interface and connects the BS to the CSN – the Connectivity Service Network – and the public Internet via the ASN-GW.

The IEEE 802.16 air interface is implemented by the MS on the subscriber's end and the BS in the ASN on the network side. This paper does not describe the CSN and its many servers (of which a small part is illustrated in Figure 1).

In the ASN, the ASN-GW provides two main functions:

1. Data path entity – for transferring data between the ASN (on behalf of the MSs) to and from the packet data network (including public Internet)

2. Control entity – implementing the ASN-related functions for a per-MS control and context management (included MS authenticator, key distributor, QoS management, accounting client, idle mode location register and paging controller, CSN-anchored mobility management, etc.) and for connection with the CSN and its servers (for subscription establishments, accounting, authentication and additional services)

When an MS scans the network, it discovers BSs in its vicinity and connects to one of them. As part of this network entry process, the MS is authenticated, authorized and granted network resources. This process also includes the selection of an ASN-GW to serve the MS.

As the MS moves, it may be handed off to a different BS and in some cases be served by a different ASN-GW or even a different ASN.

Phased Upgrade path to Release 2

Phase1: Introducing Advanced Base-Stations (ABS) and Advanced Mobile Stations (AMS) based on IEEE 802.16m

The WirelessMAN-Advanced air interface of IEEE 802.16m introduces the Advanced Mobile Station (AMS) and Advanced Base Station (ABS). New air interface features are supported by the AMS and ABS, even **without** the need for upgrading the ASN-GW, AAA, and other core network elements.

IEEE 802.16m supports backward compatibility of two types. The AMS is capable of communicating with both ABSs and legacy BSs, and the ABS can communicate with both AMSs and legacy MSs.

Figure 2 shows the network architecture when WirelessMAN-Advanced ABSs and AMSs (as illustrated by the red-bordered nodes) are added to an existing Release 1 deployment. This addition could be in the form of a WirelessMAN-Advanced overlay radio network on additional frequencies or based on an 802.16e/802.16m mixed mode in existing Release 1 channels, as detailed in [1] . This figure illustrates a scenario in which legacy and Advanced BSs coexist, and a mixture of legacy MSs and Advanced MSs are connected to the network through the ASN.

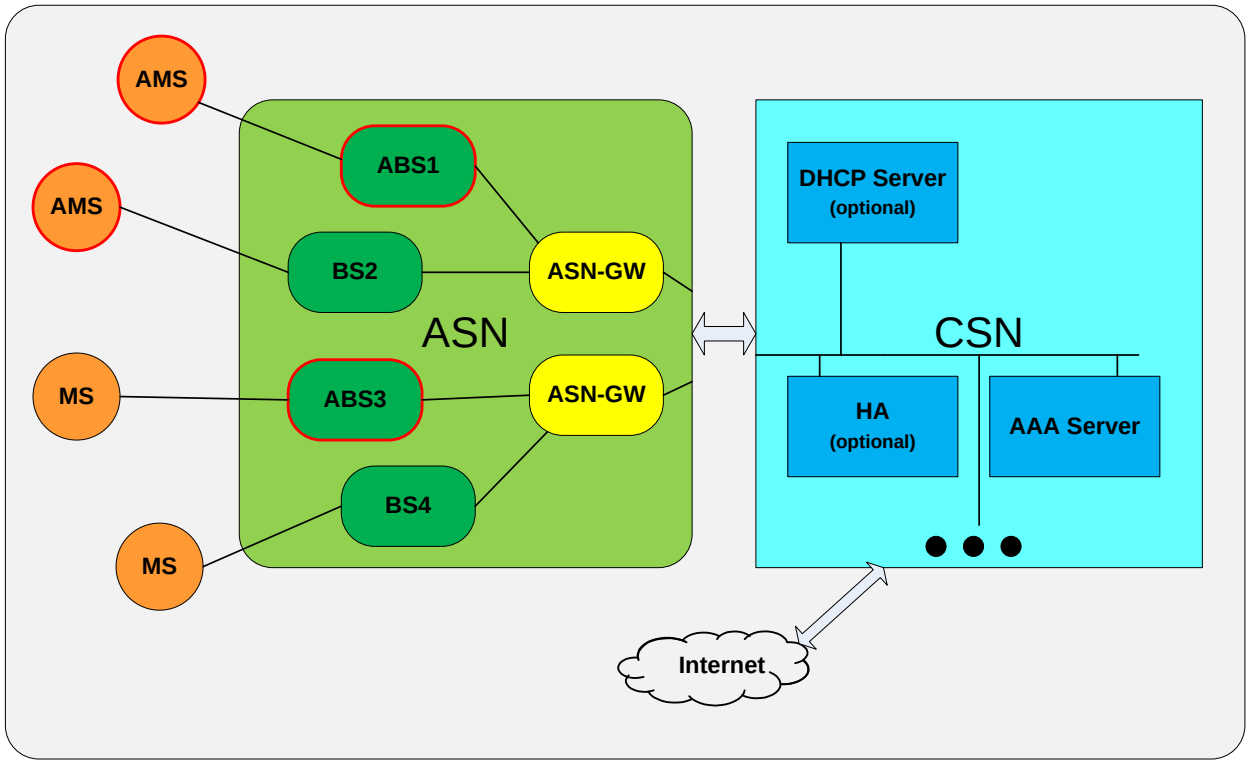

Figure 2: Phase 1 Upgrade of ABS and AMS

The Advanced BS ABS1 operates in a mixed mode, with two zones in its MAC frame: (1) an LZone implementing the legacy 802.16e air interface and (2) an MZone implementing the new 802.16m air interface.

When a legacy MS attempts to connect to the network, it will either be served by a Legacy Base Station (such as BS4 in Figure 2) or by an Advanced Base Station (such as ABS3 in Figure 2) using the Legacy Zone (LZone) of the ABS.

When a new Advanced Mobile Station attempts to connect to the network, the network will attempt to serve it with the MZone of an Advanced Base Station. But, as all AMSs are backward compatible to Release 1, if no MZone can be located (either due to geographical location of the AMS, or due to unavailability of MZone resources), the AMS can be served by either the LZone of an Advanced BS or by a legacy BS.

The 802.16e/802.16m mixed mode enables a smooth evolution of the network. The operator may gradually upgrade the BSs in the network within the same ASN. Likewise, subscribers with legacy devices can still connect to the network and experience the same services they had prior to the Radio Access Network (RAN) upgrade. They can continue using their devices on the network even after all the BSs have been upgraded, due to the backward-compatible design [1], or upgrade to AMS devices for enhanced performance and throughput.

To summarize, for a Phase 1 upgrade, as shown in Figure 2, all the WiMAX Release 1 network elements remain intact, except for introducing the ABS and AMS.

Phase2: Upgrading additional network elements

In a more advanced stage, the operator may move to a Phase 2 deployment by upgrading the ASN-GWs and certain CSN elements such as the AAA server. This may be performed either simultaneous with or subsequent to the addition of Advanced BSs in the ASN.

Upgrading the ASN-GWs provides the ability to offer additional WiMAX 2 services such as identity hiding for AMSs, improved power management of the AMS, multiple IP address allocation, and improvement of other services such as roaming.

Figure 3 illustrates this Phase 2, when ASN-GWs and certain CSN elements such as AAA server are upgraded to WiMAX 2.

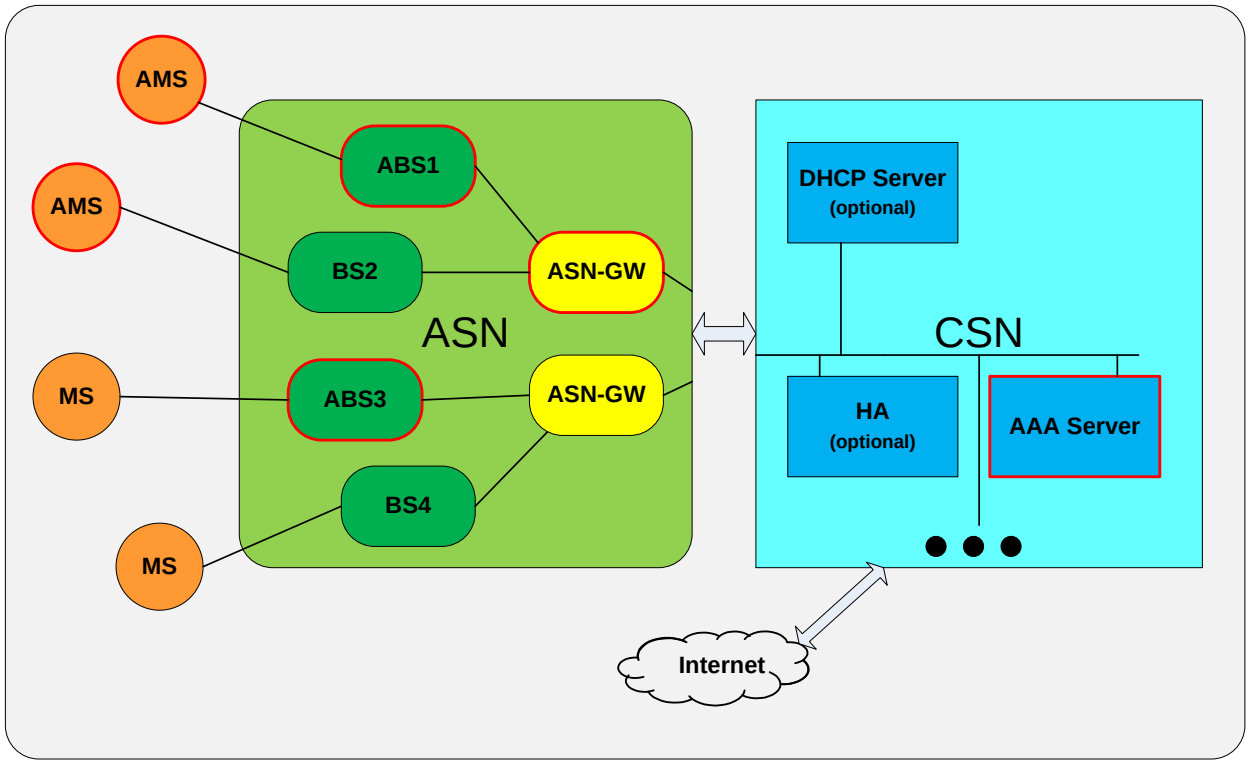

Figure 3: Phase 2 Upgrade supporting Release 2 functionality

As shown in the figure, Advanced ASN-GWs are operational in an ASN with legacy ASN-GWs.

An AMS experiences WirelessMAN-Advanced throughput and WiMAX 2 advanced services when connected to an ABS served by an advanced ASN-GW. An AMS connected to an ABS served by a legacy ASN-GW will still enjoy the WirelessMAN-Advanced throughput improvement but not the new services enabled in WiMAX 2. Phase 2 supports legacy Mobile Stations served as they would be in the legacy network.

Table **1** summarizes the benefits of the two upgrade phases.

Table 1. Upgrade Phases

Phase	Upgrade	Benefits	Comments
Phase 1	Add 802.16m advanced base-stations and advanced mobile stations	Up to double throughput in the sector coverage of ABS. Allows new advanced 802.16m air interface features that are transparent to ASN GW/ CSN.	Will work with legacy ASN-GWs and legacy CSN entities
Phase 2	Upgrade ASN and CSN entities (ASN-GW and AAA server)	Phase 1 benefits plus feature enhancements such as: • AMS identity privacy • MS Deep power save support with context retention • Faster IP address allocation • Optimized mobility management	

3. Feasible approaches for Phase 1 upgrade

Two approaches are possible for the Phase 1 upgrade.

Approach 1: A full BS upgrade from Release 1 to Release 2 if both are to operate in the same frequencies. Alternatively, add a brand new Release 2 ABS to the network on a new frequency channel.

Approach 2: A partial BS upgrade, including baseband processing cards, reusing the legacy RF front ends, antennas, power supply, etc., especially when the operating frequency band is the same.

Approach 2 would be the most cost effective from a CAPEX perspective because most components of the BS are preserved.

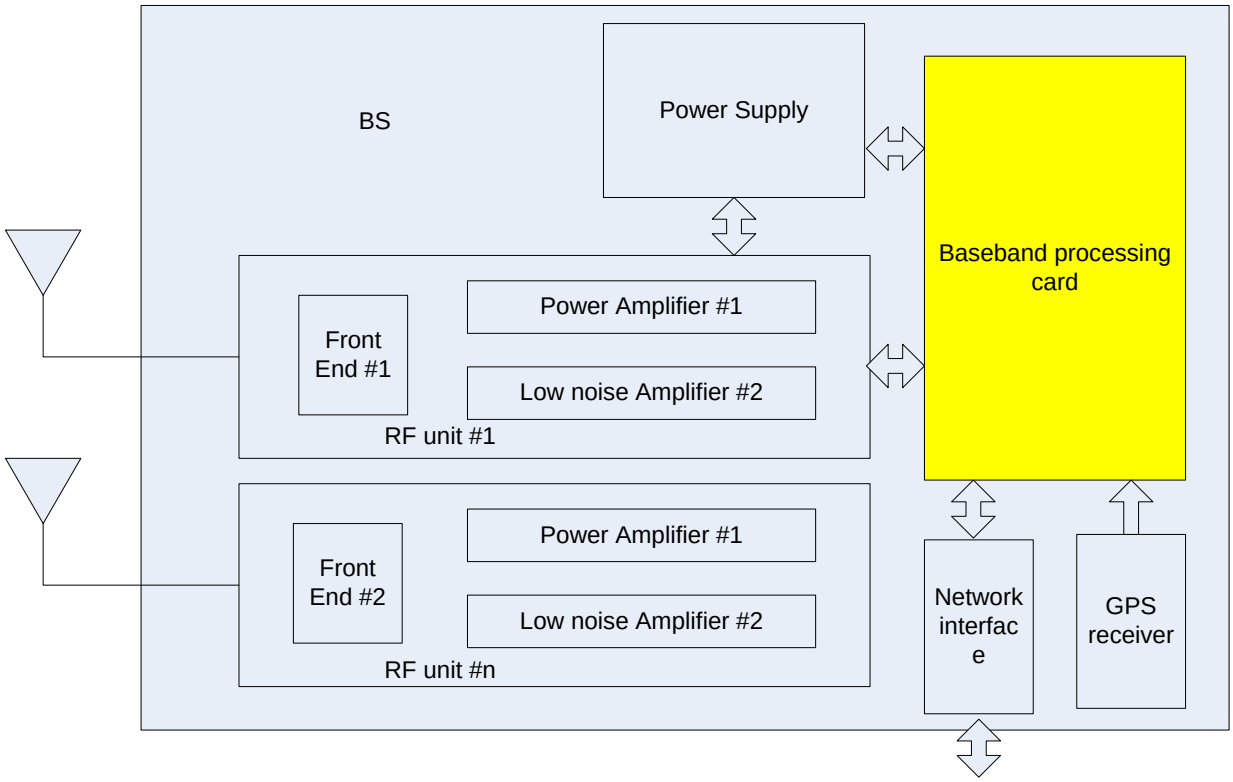

Figure 4: Mobile WiMAX BS Architecture example, illustrating Approach 2 of WiMAX R2 Phase 1 upgrade, where the baseband card in yellow would be replaced.

4. Conclusions

This whitepaper has discussed the migration of WiMAX® networks from Release 1 to Release 2, with support for the WirelessMAN-Advanced air interface of 802.16m. A phased approach for the upgrade to Release 2 was presented, in which up to double the throughout can be achieved in the first phase while reusing the legacy network equipment. This can be followed by a Phase 2 upgrade, in which WiMAX Release 2 specific services offered by the Mobile WiMAX Release 2 network are also enabled.

5. References

[1] Migration from WiMAX Release 1 to WiMAX Release 2, WiMAX Forum White Paper, August 2010.

[2] IEEE Std 802.16e-2005, IEEE Standard for Local and metropolitan area networks – Part 16: Air Interface for Fixed and Mobile Broadband Wireless Access Systems – Amendment 2: Physical and Medium Access Control Layers for Combined Fixed and Mobile Operation in Licensed Bands

[3] IEEE Draft P802.16m/D12, DRAFT Amendment to IEEE Standard for Local and metropolitan area networks – Part 16: Air Interface for Broadband Wireless Access Systems – Advanced Air Interface