# Completing the 4G Vision: *Gateways for Mobile WiMAX*

*A Farpoint Group White Paper*

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In a hypothetical word-association game, "wireless" would, we're sure, almost always be followed by "radio". No surprise here – wireless communication has its basis in radio technology, that which makes mobile connectivity possible in the first place. But equally – *if not more* – important to the success of any wireless network is the remainder of the implementation value chain, beyond the radio itself. This includes the (typically IP-based) elements that provide essential operational network capabilities, and, as we'll discuss below, many other functions that create the real value for operators and, ultimately, the users of any wireless network.

The enterprise world has long been the beneficiary of a trend towards standards and open systems that began more than 20 years ago. IP is now the only protocol that matters, and common hardware interfaces, most notably related to the various incarnations of Ethernet, have also enabled unprecedented flexibility in configuration, performance, and mission applicability even over extended periods of time. Network planners, designers, and operations staff today take the mix-and-match nature of modern network equipment for granted, and it would be difficult to conceive of building *any* enterprise network solution without the high degree of flexibility and the many other benefits inherent in this approach.

Wide-area communications networks, on the other hand, have not been quite so fortunate for most of their history. Indeed, the proprietary nature of the core technologies in both wired and wireless WANs was inherent in both the technologies of the day and the business plans of those involved. Today, however, the trend is very much in the opposite direction, to open systems. A good example here are products now appearing in the WiMAX market, representing the leading edge of the *fourth generation (4G)* of wireless WANs which will in fact be defined by open interfaces and IP. In addition to defining the first 4G wide-area wireless technology, WiMAX system architecture represents thinking very much in line with contemporary communications network design – open, highly-defined interfaces with all of the flexibility, adaptability, configurability, and performance implied. Such opens new possibilities across the board to carriers and operators, the subject of this White Paper.

## A Brief Introduction to WiMAX System Architecture

WiMAX is a set of specifications created by the WiMAX Forum [http://www.wimaxforum.org/home/] and based on standards developed by the IEEE 802.16 Working Group (WG) [http://grouper.ieee.org/groups/802/16/]. There are two standards of note here. The first is IEEE 802.16-2004, sometimes called 802.16d, which specifies a common air interface for *fixed* (both ends stationary) microwave equipment. But since the high-growth market opportunity for wireless of any form today is in *mobile* systems, the 802.16 WG subsequently issued 802.16e-2005, which specifies a mobile broadband technology. 802.16e, as it is commonly known, is now seeing significant product development and production deployments on a global basis. Farpoint Group expects that effective per-user throughput of 2-4 Mbps will become common on carrier WiMAX networks over the next few years, with monthly pricing perhaps below that currently charged for mobile broadband services with far less throughput. WiMAX will also become a platform for application deployment and could even be catalytic in the broad availability of Web services and software as a service (SaaS), which Farpoint Group believes will become the dominant model for IT in the future – mobile or not.

The WiMAX Forum has specified a number of interfaces (see Figure 1), known as R1, R3, and R6, that provide a clear delineation between the key functional elements of a WiMAX network. These include subscribers, radio base stations of various types and capacities, and external networks and their content and services. Of particular importance is the R6 interface, which connects the radio network to external networks via a key component – the *Access Service Network (ASN) gateway*. ASN gateways have long played a role in both wired and wireless networks, but the range of function, scale, and throughput required of them has grown significantly over time. The advent of WiMAX creates numerous opportunities for open-systems gateways with tremendous functionality, opening new possibilities for operators (and, again, their customers) to gain from a fundamental expansion of services and performance – assuming, as we'll cover shortly, a gateway of sufficient capacity and configurability to realize this goal.

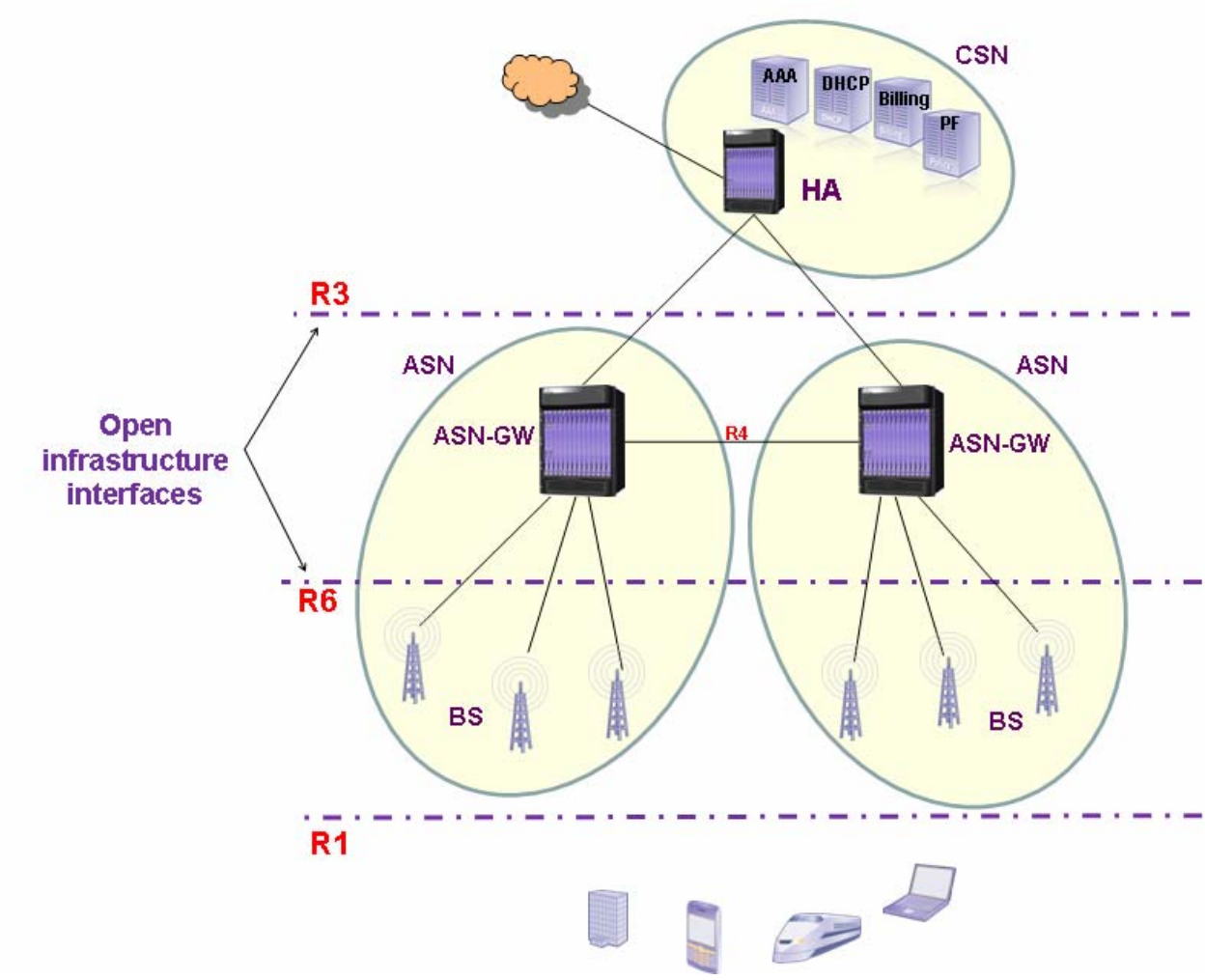


**Figure 1** – A schematic diagram of WiMAX architecture. Note how standard interfaces are used to interconnect the key functional elements. Note also the pivotal location occupied by the ASN gateway, in the path of all network traffic. In reality, a number of interconnected gateways would be used in a production implementation. *Source:* WiChorus Inc.

One other note – there is significant discussion today of the role of femtocells in future WiMAX deployments. These might take the role of home base stations, or as small indoor or outdoor fill-in cells in a variety of applications. In reality, we expect most WiMAX implementations to involve a mixture of cell sizes and types, depending upon venue, mission, and economics. This means that an ASN gateway must be able to support a wide variety of radio nodes in essentially endless combination across a potentially massive scale – but the open-systems nature of WiMAX system architecture removes much of the risk here, assuming again, of course, that the gateway selected in a given installation is up to the challenge.

## Intelligent ASN Gateway Requirements

As we noted above, the ASN gateway (simply *ASN-GW* in the remainder of this document) plays a critical role in managing subscribers, services, and traffic moving between the radio part of the network and the information resources users seek. The ASN-GW sits at a most opportune spot in the network, with access to all traffic flows. While there is no absolute requirement for a specific set of ASN-GW functions, Farpoint Group believes that there is a clear trend towards full-featured, *intelligent* ASN Gateways to leverage this strategic location in the WiMAX network, dramatically enhancing value in a number of dimensions. Among the key features that an intelligent ASN-GW can provide are:

- *Subscriber management* − While it is difficult to rank the functions of an ASN-GW, which by definition must be both broad and diverse, subscriber management must be placed near the top. This set of functions includes adding users and defining the services they have access to, as well as specifying traffic prioritization for different classes of users and their traffic.

- *Policies and CoS/QoS* − A key part of subscriber management is the ability to define and enforce network access policies, as well as class of service/quality of service on a per-subscriber, per-flow basis. Such classes of service may derive from per-user revenue levels, agreements with software providers, the inherent requirements of certain classes of service (most importantly voice, but also streaming video), and many other criteria as well, resulting in dynamic behavior based on the type of content being transferred.

- *AAA* − Authentication, authorization, and accounting are key functions of any production network. Authentication validates user credentials, authorization determines which functions or flows are permissible given a set of conditions (for example, time of day, location, contracted service level, etc.), and accounting keeps track of everything that happens for billing and other purposes. While these functions are performed on a separate AAA server, the ASN-GW can provide the mechanisms necessary to implement AAA based on subscriber, flow, or billing plan (e.g., pre-paid, post-paid, volume- or time-based), among many other possibilities. In addition, the ASN-GW can provide EAP authentication and key distribution to improve overall performance.

- *Network resource optimization* − As all traffic flows through the ASN-GW, providing it with a detailed picture of the status of all network resources, the ASN-GW is an ideal location for real-time decisions relating to the optimization of both backhaul capacity and spectrum allocation, via such techniques as data compression and load balancing. The objective is to balance user demands with available resources as optimally as possible.

- *Content management* − High-speed wireless networks like WIMAX will increasingly carry a broad variety of multimedia content. The ASN-GW can provide an operator with the ability to offer services differentiated by type of content. This can be a function of both policy as well as the ability to perform deep inspection on the fly (sometimes called *deep packet processing*). In addition, on-the-fly content insertion can provide new and non-traditional revenue opportunities.

- *Location based services* − The ASN-GW can be used to implement a variety of services based on the specific location of a given subscriber, including location-based advertising, mobile commerce, and emergency services.

- *Load balancing* − Few networks have a huge reservoir of excess capacity available on a moment's notice, and this is especially true in the case of wireless. It's therefore very important to be able to balance flows across available resources, over the air, within the core operator network, and to external resources connected to this network. Such load-balancing decisions may need to be made continuously, again based on policy, without operator intervention but with logging of all decisions and their outcomes.

- *Encryption and security* − As some WiMAX traffic may flow over networks outside the direct control of the operator, the ASN-GW needs to be able to provision secure (e.g., IPsec) connections in the interest of both security and overall network integrity. Security can also include the ability to filter traffic and block (firewall) any flows that could be potentially harmful to system, user, or application integrity or performance. Content inspection, again via deep packet processing, can also be of great value here.

- *Traffic filtering and shaping* − Apart from the filtering of suspected (or identified) malicious traffic, it is also essential to monitor traffic flows for performance-management purposes. For example, it might be desirable to filter or throttle peer-to-peer (P2P) or other user traffic. Some ASN-GW implementations will also implement flexible deep-packet processing, which is the ability to characterize traffic flows and make decisions on forwarding based again on policies but without the need for any additional information provided by a given user.

- *Mobility management* − The ASN-GW plays important role in managing the functions related to the mobility of subscribers. It can provide optimizations to enable low-latency seamless handovers, and can also implement functions related to tracking a mobile station, paging, and idle-mode management. .

- *Applications provisioning and deployment* − As applications are increasingly provisioned on the Internet and otherwise through a Web-services model, the ASN-GW can play in key role in the success of this approach by optimizing throughput, responsiveness, and resource availability.

- *Multimedia applications* − As real-time media delivery, particularly of broadcast and on-demand video, becomes a key element for carrier success, wireless networks must carefully manage network resources. Such capabilities as Multicast Broadcast Services (MCBCS) are facilitated by a properly-provisioned ASN-GW with sufficient capacity to handle this demanding application.

Given this feature set, Farpoint Group believes that the ASN-GW will become the critical component in WiMAX solutions, large and small, providing operators with a number of key benefits, as follows:

- *Customization and service differentiation* − The ability to create highly-differentiated services based on CoS/QoS (throttling/enforcement), with full support for customized provisioning, accounting, and billing on a per-subscriber/flow/application basis, will be critical in a highly-competitive and otherwise poorly-differentiated wireless broadband market. This will be the ultimate value-add for the ASN-GW, and the one with the best return-on-investment opportunity.

- *Monetization opportunities* − What this means, of course, is that the flexibility inherent in a properly designed, architected, and provisioned ASN-GW is ultimately the best route to enhanced revenues and the ability to merchandise services to the greatest benefit of carrier business objectives.

- *Network, traffic and spectrum optimization* − As we noted above, load balancing, across not just the radio and core network but also across expensive backhaul connections, has the potential to minimize investment in potentially costly additional capacity, making the best, if not optimal, use of resources already in hand.

- *Minimizing CAPEX and OPEX* − And this, in turn, leads to minimizing both capital and operational expense. The ASN-GW itself is a vehicle for a potentially huge number of functions and services, minimizing the need for the additional hardware and software that has typified 3G architectures. And the core management functions of the ASN-GW, as noted above, should serve as a powerful toolset for similarly minimizing operational expense, which, over time, will have a far greater impact on the bottom line than CAPEX.

## ASN-GW Requirements and Considerations

The open-systems nature of the WiMAX architecture allows the decoupling of the ASN-GW from the radio, creating an independent buying decision opportunity, and allowing a “best of

breed" approach in each network installation. But not all ASN-GWs have the same set of capabilities. Along with the above functionality, three additional key features come into play in defining optimal solutions, as follows:

- *Capacity and scalability* − It is critical to keep in mind that WiMAX and other 4G networks will move far more traffic than has been the case with 3G and even 3.5G services like HSPA. Faster networks demand network solutions that are free of potential bottlenecks and enable smooth, scalable growth over time. Such growth many be implemented via a broad, compatible product family, but also the ability to provision and manage multiple, cooperating ASN-GWs.

- *Management* − Farpoint Group believes that operational network management is just as important as the hardware selected. Key to success of ASN-GWs are their related element management systems (EMSes) that allow configuration, monitoring, control, policy definition, and many other functions.

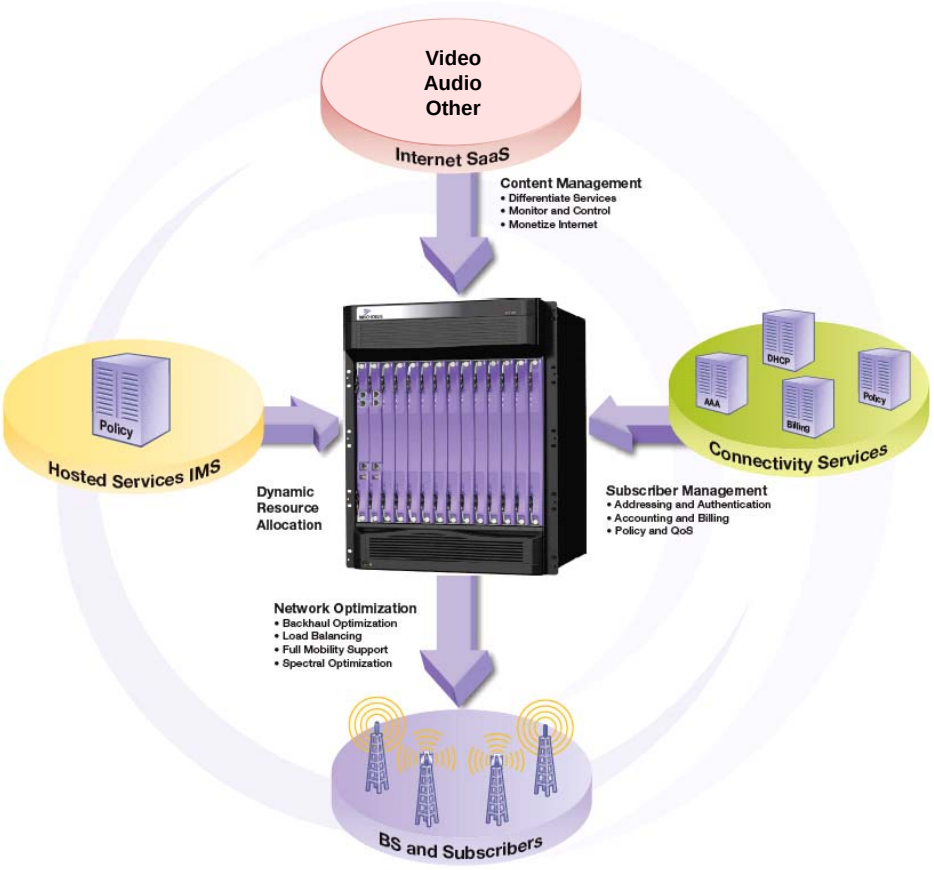


**Figure 2** – A schematic diagram of an intelligent WiMAX gateway designed for high-capacity, multi-service operations. With its strategic position in the network, the ASN-GW has visibility into all subscribers and packet flows, providing a unique opportunity to add value in content management, subscriber management and network optimization. *Source:* WiChorus Inc.

- *Reliability and fault-tolerance* − ASN-GWs will not be standalone elements in WiMAX networks; they need to function as part of a *system* solution. This includes the requirement that single points of failure be eliminated. While it is of course important that a ASN-GW be designed and engineered for reliability, it is further critical that the ASN-GW be implemented as part of a redundant configuration, allowing an equipment failure in a given location, perhaps due to a major power failure or physical damage, to be handled by redundant equipment at another location with minimal, if any, operational disruption.

An example of a high-function, intelligent ASN-GW can be seen in Figure 2. The ASN-GW is clearly becoming the most strategic asset for differentiated and profitable WiMAX networks. And, again, while many of the functions of ASN-GWs been around for some time, there is much less hierarchy in WiMAX than in 3G networks. This means that far greater functionality will be implemented in WiMAX ASN-GWs than has historically been the case. But this also means that there will again be far more opportunities for software value-add via upgrades and new features augmenting the value of the ASN-GW. Obsolescence should be less of an issue, then, and adaptability to changing business missions is similarly enhanced. This, again, is why we believe the competitive differentiation and ultimately profitability on any given WiMAX installation will largely depend upon choosing the right ASN-GW solution.

## Conclusions

ASN gateways have been an element of the system architecture of many communications systems, both wired and wireless, for some time, and their role will only continue to grow in importance as wireless networks become the default and even *primary* vehicles for an ever-increasing number of users in the future. As we have noted in this White Paper, operator service differentiation, profitability from new services, scalability over time, and the cost-effective provisioning, management, and control of subscriber services depend upon the presence of an ASN-GW that is flexible, adaptable, and powerful enough to handle the every-increasing and evolving loads typical of modern WiMAX networks. WiMAX system architecture benefits from a highly-defined and prominent role for ASN-GWs, and the open-systems nature of WiMAX allows a degree of flexibility that bodes well for the future of WiMAX itself. Even as the debate over the size and functionality of the radio nodes themselves continues, it is very clear that ASN gateways will be the elements of WiMAX solutions where the greatest benefits and returns are derived.


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