

## IS YOUR AAA UP TO THE WiMAX CHALLENGE?

Key Authentication, Authorization, and  
Accounting (AAA) Capabilities Required  
to Support WiMAX Deployments

## INTRODUCTION

World Interoperability for Microwave Access (WiMAX) is intended to reduce the barriers to widespread broadband access deployment with standards-compliant wireless solutions engineered to deliver ubiquitous fixed and mobile services such as Voice over IP (VoIP), messaging, video, streaming media, and other IP traffic.

WiMAX enables delivery of last-mile broadband access without the need for direct line of sight (LOS). Its ease of installation, wide coverage, and flexibility make it suitable for a range of deployments over long-distance and regional networks, in addition to rural or underdeveloped areas where wired and other wireless solutions are not easily deployed and LOS coverage is not possible.

Trial activity of WiMAX is under way around the globe while significant WiMAX-related announcements have been made by tier-1 operators in North America and elsewhere. As predicted, industry observers are beginning to see field deployments of fixed WiMAX, with a planned migration to mobile WiMAX.

In the meantime, the importance of authentication, authorization, and accounting (AAA) in WiMAX applications is becoming increasingly evident. Operators deploying WiMAX need to understand that the decisions they make now with regard to their AAA applications can have a significant impact on their WiMAX business and service rollout.

Standards support for AAA in mobile WiMAX today is based on WiMAX Forum Network Working Group (NWG) specifications. The WiMAX Forum is now incorporating standards support for AAA in fixed/nomadic deployments. Operators need to work with a AAA market leader with the standards insight and technical vision to help them navigate the successful implementation of a future-proof solution.

**SERVICE PROVIDERS NEED TO UNDERSTAND THAT THE DECISIONS THEY MAKE NOW WITH REGARD TO THEIR AAA APPLICATIONS CAN HAVE A SIGNIFICANT IMPACT AS THEY GROW AND EVOLVE THEIR WiMAX BUSINESS. THEY NEED TO WORK WITH A VENDOR THAT HAS THE EXPERIENCE AND TECHNICAL VISION TO ENSURE THE IMPLEMENTATION OF A FUTURE-PROOF, WiMAX-READY AAA SOLUTION.**

This paper addresses such issues and will be of interest to network planners involved in evaluating or deploying WiMAX. It examines core requirements for AAA in WiMAX and highlights the hidden costs of using a lightweight AAA solution or an open source-based AAA platform. In particular, it will help those trying to understand if their AAA server has what it takes to support fixed and, ultimately, mobile WiMAX. It also provides guidance on what to look for in a solution to ensure that it will accommodate WiMAX-driven growth and profitable service creation.

## THE ROLE OF AAA IN WiMAX

Similar to other networks, a AAA server provides the following core functions in WiMAX:

- > Authentication — Confirmation that a user requesting a network service is entitled to do so. It involves presentation of an identity and credentials such as a user name, password, and/or digital certificate. It also requires support for device authentication.
- > Authorization — The granting of specific types of service (or “no service”) to a user based on his/her authentication, the services requested, and the current system state.
- > Accounting — The tracking of network resource consumption by users.

In the WiMAX Forum’s NWG Stage 3 Release 1.0.0 specification, AAA is specified as a basic building block. It also includes some functions that are not typically supported in other AAA deployments, such as Wi-Fi. This version of the standard is focused on the use of AAA in Mobile WiMAX, including support for mobile IP.

Fixed WiMAX, as well as Wi-Fi, can use RADIUS AAA, Extensible Authentication Protocol (EAP), or a custom authentication method. Authorization attributes returned are similar to those returned for common Wi-Fi deployments. However, given that there is currently no interoperable specification governing the use of AAA in fixed WiMAX or Simple IP, each vendor has implemented its own custom specification.

Work is currently under way within the WiMAX Forum to address AAA support for fixed or nomadic WiMAX for inclusion in future versions of the standard, with the following factors being considered:

- > Fixed and nomadic WiMAX are being developed under Simple IP.
- > Deployment models are still in debate, and so it remains unclear how they will impact AAA requirements.
- > AAA will have to support EAP authentication, making it somewhat aligned with how it is handled in Wi-Fi; however, it’s possible that AAA may also require tunneling support, which is not required in Wi-Fi.

### EAP authentication support

The current WiMAX standard does not specify which EAP method to use, although there are guidelines regarding those that are suitable. The following authentication modes are supported:

- > Device-only authentication using certificates or pre-shared key.
- > User-only authentication.
- > Device and user authentication using double EAP authentication.
- > Device and user authentication using a single EAP authentication.

## FIXED VS. MOBILE WiMAX STANDARDS

WiMAX/IEEE 802.16 IS THE GLOBAL STANDARD FOR BROADBAND WIRELESS ACCESS, EQUIVALENT TO THE IEEE 802.11 FOR Wi-Fi. IT FEATURES TWO VARIANTS RELATED TO THE RADIO ACCESS NETWORK:

- > **FIXED WiMAX**, BASED ON 802.16-2004, SUPPORTS FIXED OR NOMADIC MODELS. WITH FIXED WiMAX, THE USER EQUIPMENT DOES NOT MOVE BETWEEN LOCATIONS WHILE CONNECTED TO THE NETWORK AS IT WOULD IN A MOBILITY SCENARIO. THIS FIXED WiMAX DEPLOYMENT MODEL IS WELL SUITED TO HOME OR OFFICE USE. IN NOMADIC WiMAX, THE USER TERMINAL CAN CHANGE LOCATION (e.g., THE USER CONNECTS AT A COFFEE SHOP AND THEN MOVES TO AN AIRPORT), BUT THE IP SESSION OR CONNECTIVITY IS NOT MAINTAINED AND THE USER MUST OBTAIN A NEW CONNECTION AT EACH LOCATION.
- > **MOBILE WiMAX**, BASED ON THE 802.16E-2005 STANDARD, INTRODUCES SUPPORT FOR MOBILITY. MOBILE WiMAX ALLOWS THE USER TERMINAL TO MAINTAIN CONNECTIVITY WHILE MOVING FROM LOCATION TO LOCATION — FOR EXAMPLE, A USER DRIVING FROM A COFFEE SHOP TO THE AIRPORT CAN HOLD A VoIP CONVERSATION OVER THE WiMAX NETWORK. AS THE TERMINAL MOVES, THE CONNECTION IS HANDED OFF BETWEEN BASE STATIONS (BS) AND, FROM TIME TO TIME, THE MOBILE MAY EVEN HAND OFF FROM ONE OPERATOR'S BS TO ANOTHER OPERATOR'S BS, ASSUMING A SUITABLE ROAMING AGREEMENT IS IN PLACE. MOBILE IP (MIPv4 OR MIPv6) IS THE TECHNOLOGY USED TO MAINTAIN THE IP SESSION DURING THE HANDOFFS.

The mobile station selects its preferred EAP method and communicates accordingly with the AAA infrastructure. In roaming situations, the AAA server may inform the mobile station of the authentication requirements of the visited network.

WiMAX may support the same EAP methods as Wi-Fi, such as EAP Tunneled Transport Layer Security (EAP-TTLS), EAP-Transport Layer Security (EAP-TLS), and EAP for Universal Mobile Telecommunication Systems Authentication and Key Agreement (EAP-AKA). However, a Wi-Fi deployment will not require the dual device/user authentication modes that are available in Mobile WiMAX.

Also important is that a number of EAP methods are likely to be used, including EAP-TLS, EAP-TTLS, and EAP-AKA. Consequently, in WiMAX applications AAA needs to be able to support multiple EAP methods simultaneously to ensure a seamless subscriber experience while roaming.

### Multiprotocol support

Support for Remote Authentication Dial-In User Service (RADIUS) in Release 1 of the WiMAX standard is targeted specifically at mobile WiMAX. However, Diameter support is scheduled for Release 1.5. As a result, support for migration to Diameter in the near future is an important requirement for Service Providers seeking to protect their investment in legacy applications and services and leverage new SIP-based services as they migrate to next-generation networks such as WiMAX.

### Quality of service (QoS) support

Unlike the simplistic QoS support in Wi-Fi — for example, related only to pure bandwidth with maximum rates specified — the AAA server in WiMAX must be able to provide QoS parameters to the network elements. These parameters are provisioned as part of the user profile during network authentication and authorization.

WiMAX also supports multiple traffic flows, each of which can have specific QoS characteristics assigned to it. This enables efficient traffic management and segregation, which will allow WiMAX to support service tiers and individual services such as VoIP and video calling.

### Accounting

WiMAX supports both user- and flow-based accounting. In user-based accounting, the accounting of all user flows is accumulated into a single usage data record (UDR) and reported back to the AAA accounting server.

In flow-based accounting, each UDR contains the data associated with a flow (a flow is typically related to a VoIP call, a video conference, etc.) and is reported using a single accounting record. A user session could have a number of accounting records, each related to a specific flow (and hence to the service used).

In WiMAX, many accounting records can be generated because of mobility and the use of flow-based accounting. The AAA system must be able to deal with a large volume of accounting messages. It must also support a complex accounting correlation strategy to identify usable records from the raw accounting message it receives and synthesize those records into formats that can be used by a billing system. An additional benefit is the ability to leverage new charging models. Without this capability, it is possible that a new mediation system will be needed. At the very least, a significant upgrade to the existing system will be required.

## Scalability

WiMAX and Wi-Fi are different in how the AAA server is used. In Wi-Fi, AAA servers are used for authentication once per session. In WiMAX, due to the “always on” nature of a truly mobile service, AAA servers may perform the authentication function and computationally expensive key derivations many times per session.

As a result, the load placed on a AAA server by a WiMAX subscriber is substantially higher than that placed by a Wi-Fi subscriber.

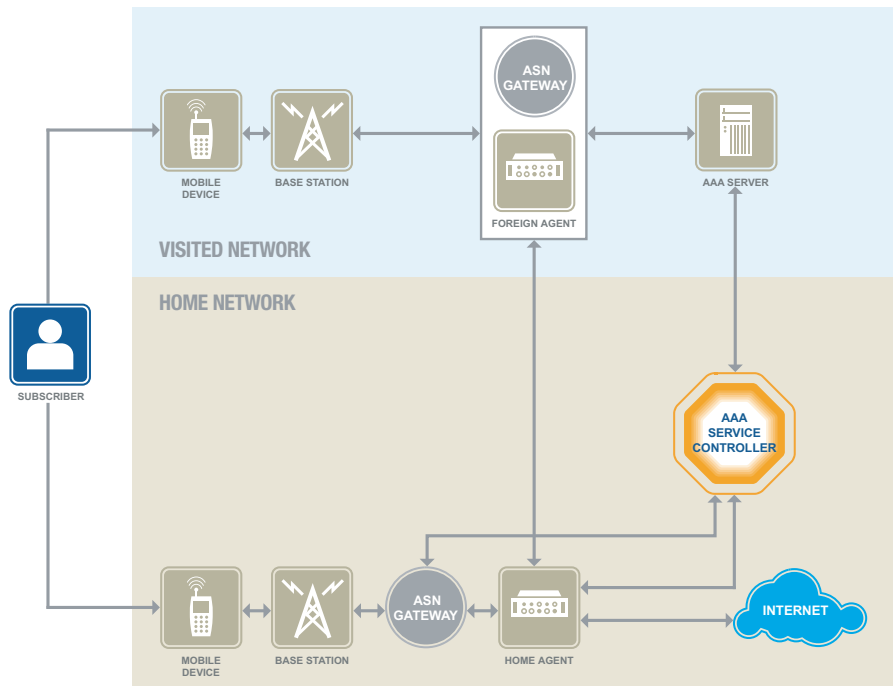
As a result, AAA servers serving Wi-Fi networks may not be able to perform at acceptable levels when scaled up to handle the number of subscribers to be supported in a WiMAX network.

## AAA CHARACTERISTICS SPECIFIC TO MOBILE WiMAX

### Mobile IP key derivation

Legacy AAA servers do not typically support mobile IP (MIP). The following examples of MIP key derivation functions are required in mobile WiMAX deployments:

- > Key derivation — Upon successful EAP authentication, the AAA server derives mobility keys and other keys from the EAP key material and distributes them to the access serving node gateway (ASN-GW). Key derivation for mobile IP is much more sophisticated than that required by Wi-Fi AAA applications.
- > Key distribution — The AAA server needs to distribute the mobility keys to the home agent (HA). The mobile IP key recovery procedure with the HA happens after the keys are distributed to the device; therefore, the AAA server must be able to store the keys and distribute them to the HA.
- > Knowledge of state — The AAA server for mobile WiMAX must be able to remember key sequence numbers and previously generated keys. A typical AAA server does not need to maintain state knowledge.



In a mobile WiMAX deployment, the Bridgewater Systems AAA Service Controller provides core authentication, authorization, and accounting functions to manage a consistent subscriber experience across both visited and home networks.

### Support for mobility clients

Mobile WiMAX requires support for proxy and client-based MIPv4 and proxy and client-based MIPv6 mobility clients. The AAA server must also be capable of deriving the appropriate keys for each mode and distributing them to the mobility agents. In Wi-Fi models, the AAA server does not need to support MIP and, consequently, could lack these important capabilities needed to support mobile WiMAX.

The AAA server should also have the ability to determine the optimum HA to which a subscriber’s session should be assigned. This allows for least-cost routing to the home network and enables wholesale providers to send subscriber traffic to the proper retailer’s HA. In addition, if the allocation algorithm is sufficiently intelligent, it can avoid overloaded or failed HAs, thereby increasing the subscriber’s chance of a successful session and a positive network experience.

### Accounting and scalability considerations

When the user is mobile, each network he or she visits will generate its own accounting messages. If user-based accounting is used, there will be an accounting message for each network into which the user roams. If flow-based accounting is used, there will be an accounting record for each flow and for each network into which the user roams.

Since Wi-Fi is not a mobile network, a single accounting record is typically generated — if one is generated at all — because most Wi-Fi networks work on a “fixed price for a fixed time” model. Service Providers will need a carrier-grade AAA system that can scale to support the increased accounting demands of mobile WiMAX.

## MARKET READINESS AND THE IMPLICATIONS FOR AAA

There is currently significant activity in lab and field trials of WiMAX, with some tier-1 operators actively engaged in mobile WiMAX trials as well as many operators planning for fixed WiMAX deployments, with migration to mobile to follow.

Service Providers that rely on AAA with limited functionality for lab trials are likely to discover they lack the robust AAA support that will be required later to sustain a high-growth WiMAX business.

There are also hidden costs in deploying a lightweight AAA solution or an open source-based AAA server, such as:

- > Lack of interoperability that leads to custom development and integration with network elements such as OSS/BSS, with attendant time-to-market issues.
- > High legacy integration costs that impact the bottom line.
- > Need to re-provision subscribers, which is disruptive and adds overhead.
- > Inability to scale to support subscriber and high transaction growth — with anecdotal reports of open source-based AAAs unable to support growth beyond 1,000 subscribers.
- > Inability to take full advantage of IP service creation (e.g., tiered services), which slows down revenue-generation opportunities.

## KEY AAA FUNCTIONALITY REQUIRED TO SUPPORT A HIGH-GROWTH WiMAX BUSINESS

Beyond the core support required for AAA services in WiMAX discussed in the previous sections, Service Providers must ensure that their AAA system is sufficiently robust while providing a full slate of functionality to support a high-growth WiMAX business:

- > **An integrated policy engine and database** that supports flexible network, service, and user policies defined at many

levels of granularity — including domains, user groups, individual users, and wholesale and retail subscriber bases — and new business models, to allow flexible service creation and reduce management overhead.

- > **A centralized, network-wide subscriber management system** that gives Service Providers the ability to centrally manage all subscribers, create comprehensive profiles that define access entitlements across all available services and networks, and avoid re-provisioning subscribers into multiple databases as new network types are integrated. A unified subscriber view also enables fast, flexible service creation that leads to more revenue opportunities.
- > **Extensive and proven interoperability** with a broad range of network elements, including OSS/BSS and other application platforms, to minimize the need for custom integration and development and accelerate time to market.
- > **Vendor and network agnosticism** to allow easy integration in mixed vendor (and access network) environments, avoid the hidden cost of vendor lock-in, and achieve a future-proof solution.
- > **Hotlining or subscriber redirection** to reduce revenue leakage and create new revenues from top-up services, for example. The ability to divert subscribers from their desired destination to one controlled by the Service Provider is particularly useful when requiring prepayment for services or delinquent postpaid accounts or even for advertising during account updates or other administrative activities.
- > **Support for lawful intercept** for compliance with such legislation as the *Communications Assistance for Law Enforcement Act* (CALEA), which demands AAA that can derive and store state information such as IP address, device type, and other relevant data about a specific subscriber session and map an IP address to a subscriber identity in real time.

- > **Prepaid and postpaid accounting mediation support**, including the ability to record, correlate, and replicate detailed accounting data for billing, reporting, and network planning, with customizable, partitioned data streaming, plus the ability to integrate with billing systems and meter a subscriber's session to improve revenue capture, eliminate the need for costly upgrades to existing billing systems or custom mediation solutions, and avoid revenue leakage.
- > **Support for migration from fixed to mobile WiMAX** to eliminate the need to re-provision subscribers and to provide a seamless transition with no disruption to existing subscriber management systems.
- > **The ability to provide support for multiple business models**, including simultaneous support for wholesale and retail.

## CONCLUSION

To effectively capitalize on the opportunities presented by WiMAX, Service Providers will need to closely examine the capabilities of AAA systems. Given the pace at which WiMAX is expected to move from trials to field deployments and then to full-service launch, now is the time for Service Providers to consider the business benefits of a robust, full-featured system that provides all the functionality required to grow their business and remain competitive.

They should also weigh the advantages of working with a vendor that is actively involved in trials and can help operators navigate through the applicable standards, so they can make the right choices moving forward.

**AT A GLANCE – AAA CAPABILITIES REQUIRED TO SUPPORT WiMAX**

	Requirement	Business Value
<b>Mobile WiMAX</b>	Mobile IP Session Key Derivation/Delivery	<ul style="list-style-type: none"> <li>&gt; Real-time management of the subscriber's mobile experience.</li> <li>&gt; Compete with other mobile broadband alternatives.</li> </ul>
<b>Core WiMAX Support</b>	Intelligent Radius Proxy	> Minimize operational impact of non-performing proxy targets.
	EAP Authentication Support	> Ensure seamless subscriber experience with support of multiple EAP methods simultaneously.
	Multiprotocol (RADIUS/Diameter) Support	> Protect investment in legacy applications and enable migration to next-generation networks.
	Hotlining or Subscriber Redirection	<ul style="list-style-type: none"> <li>&gt; Avoid revenue leakage.</li> <li>&gt; Manage subscriber experience.</li> </ul>
	Lawful Intercept Support	> Map subscriber identity to IP address.
	Postpaid Support	> Eliminate the need for custom mediation solution or costly enhancements to existing BSS.
	Prepaid Support	> Meter and manage subscriber consumption based on prepaid thresholds.
	Device and Subscriber Authentication	> Broad security controls.
	Quality of Service (QoS) Support	> Improve subscriber experience with QoS associated with subscriber session or application.
	Session-based Accounting Flow-based Accounting	<ul style="list-style-type: none"> <li>&gt; Differentiate services and appeal to a broader base of subscribers who may want to manage data services consumption in different ways.</li> <li>&gt; Enable flexible billing models.</li> </ul>
	Scalability	<ul style="list-style-type: none"> <li>&gt; Support for a high volume of accounting messages and subscriber authentications.</li> <li>&gt; Sustain future growth.</li> </ul>
	Migration Path from Fixed to Mobile WiMAX	> Future-proof solution.
	Integrated Policy Engine and Database	> Create and manage flexible network, service, and subscriber policies from single platform.
	Centralized Subscriber Management System	> Manage subscribers across all services and networks simultaneously.
	Vendor and Network Agnosticism	> Ease of integration in mixed networks.
Extensive and Proven Interoperability	<ul style="list-style-type: none"> <li>&gt; Accelerate time to market.</li> <li>&gt; Avoid expensive custom integration.</li> </ul>	
Support of Multiple Business Models; e.g., Wholesale, Retail	> Leverage new business models with common policy management infrastructure.	

## ABOUT BRIDGEWATER SYSTEMS AND WiMAX

As a principal member of the WiMAX Forum, Bridgewater Systems is actively involved in contributing to the development of WiMAX standards, in particular the WiMAX Forum Network Working Group (NWG) standard as it relates to authentication, accounting, and policy management. Because Bridgewater Systems solutions already support a range of access technologies — including CDMA, EV-DO, GPRS, UMTS, DSL, Cable, and Wi-Fi — the addition of WiMAX support will allow cable, cellular, and wireline operators to seamlessly incorporate WiMAX into their service offerings and leverage a common subscriber policy and profile repository across multiple access technologies.

Bridgewater Systems' extensive experience offers strong advantages for Service Providers considering WiMAX implementations, including:

- > **Solid background and experience in CDMA networks** — With 85% share of the CDMA market in North America.
- > **Proven technology with unmatched scalability** — From 5,000 to 64 million+ subscribers.
- > **Widely deployed** — More than 125 million subscribers in 90+ Service Provider networks around the globe rely on Bridgewater Systems software to access services.
- > **Proven performance** — Bridgewater Systems solutions handle volumes of 14+ billion transactions in a single month.
- > **Extensive data-roaming and mobility experience.**
- > **Exclusive carrier-grade focus** — With technology installed in 90+ carrier networks and significant experience in supporting carrier deployments, including 24/7 support and quick problem resolution.

## BRIDGEWATER SYSTEMS AAA SERVICE CONTROLLER

AAA Service Controller, part of the Bridgewater Systems portfolio of subscriber-centric policy management solutions for mobile, fixed, and converged operators, is a proven, carrier-grade solution deployed in Service Provider networks around the globe. Fully redundant and scalable, the solution addresses today's complex, distributed networks and their customer bases. It provides the functionality and performance needed by Service Providers who want to capitalize quickly on wireless data services enabled by WiMAX while remaining confident that their AAA system can scale to accommodate growth in subscribers, transactions, new services, and network types, including fixed-mobile convergence scenarios.

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