



Distributed Network Architecture

Alvarion's Fractalized ASN Approach:
A Practical Implementation of
Distributed Network Architecture

White Paper

Abstract

One of the key questions operators must address prior to setting up a Mobile WiMAX™ network is whether to deploy a centralized or distributed network architecture. While a centralized topology is far more prevalent than its counterpart, the distributed approach is an up-and-coming alternative deserving serious consideration.

As a world leader in WiMAX™, Alvarion works closely with operators to help them fully understand their network topology and determine the architecture most suitable to their needs. The centralized approach maintains advantages under certain deployment scenarios, however, the distributed approach has often been found to be a viable and effective alternative. In this paper, we present the advantages of the distributed approach; while these advantages lead to clear business and performance benefits, we also present Alvarion's unique *practical*, fractalized approach for implementing a distributed architecture so that operators can fully maximize their Mobile WiMAX investment.

Critical Issues for a Mobile WiMAX Deployment

Mobile WiMAX networks are becoming an increasingly attractive option for operators worldwide. Having made the decision to deploy a Mobile WiMAX system, operators need to consider several factors in order to maximize their return on investment (ROI). These factors include:

- Capital expenditures: in today's challenging economic climate, operators are more reluctant than ever to make expensive initial equipment outlays, and are looking for a system with a low entry point.
- Pay-as-you-grow model: as more subscribers are being continuously added to the network, operators must be able to invest in their deployment on a gradual basis.
- Scalability: operators need a system that easily and gradually scales up from a small to mass deployment, as business expansion is anticipated over time.
- Service availability: operators require a high performance, reliable system with no single point of failure to ensure end-to-end operational continuity.
- Transport network optimization: by freeing up the location of transport nodes for carrying various traffic types, operators can optimize their transport network and backhauling capabilities.

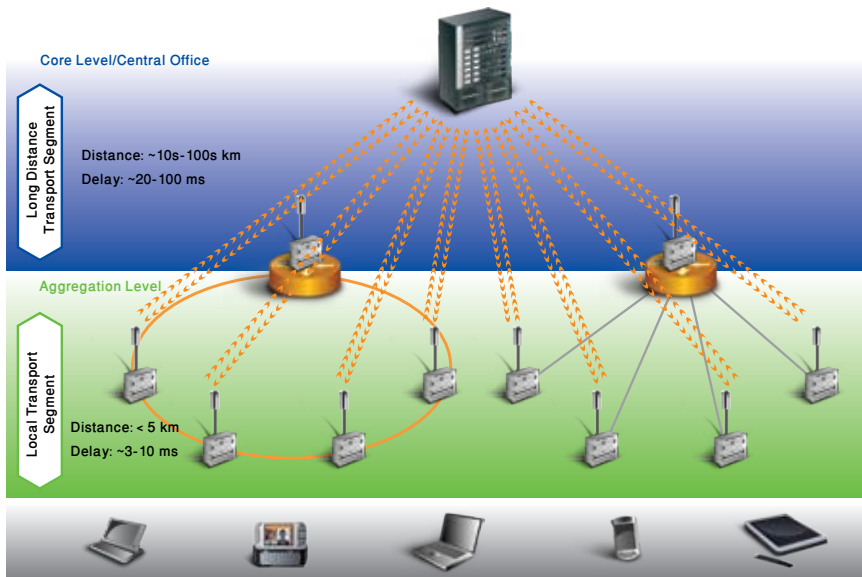
Mobile WiMAX Architecture

Two common access service network (ASN) backhauling topologies – centralized and distributed – are currently available to operators looking to deploy a Mobile WiMAX network. While centralized architecture has been the more popular approach until now, operators need to compare the models in order to determine which one of the two increases the likelihood of maximizing their investment.

Centralized and Distributed Network Architecture

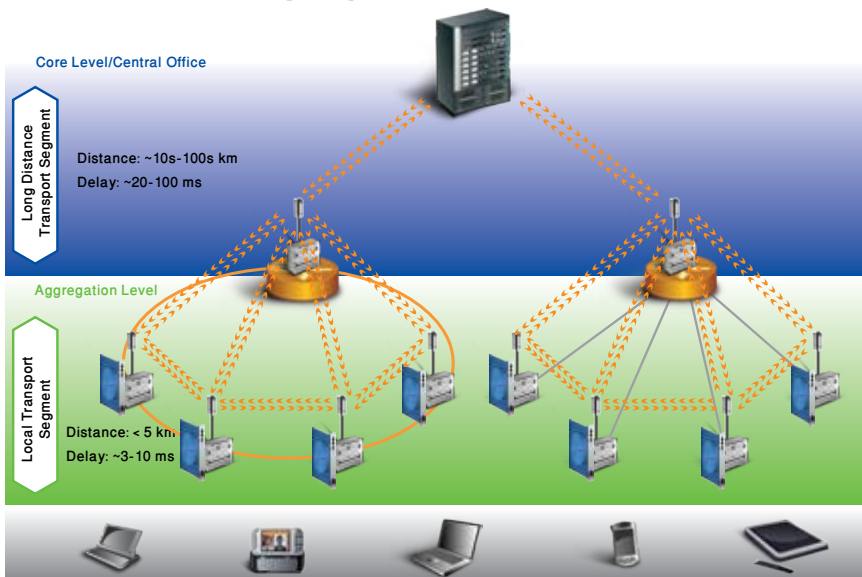
Centralized Deployment

In a centralized network deployment, an ASN gateway (ASN-GW) is positioned at a centralized venue located at the network's core or central office. With this topology, the ASN-GW needs to be large enough to serve multiple base stations (BSs) while offering network-based redundancy. In addition, all traffic needs to traverse,



and be handled by, the core network. Since the core is located anywhere from dozens to hundreds of kilometers from the BSs, which are located at the edge of the access ring, all traffic types (e.g. peer-to-peer, diversity) in a centralized deployment require long-distance backhauling to the ASN-GW.

Distributed Deployment



In a distributed network deployment, the ASN resides at every access point. Small ASN-GWs are co-located with the network BSs, which are located at the aggregation and access levels. With this topology, multiple subscribers are anchored into a specific ASN-GW.

When leaving the area where the BS is located, the user is instantaneously handed off to another BS, while still being served by the anchored ASN-GW. Given the proximity of the aggregation and access levels (e.g. less than 5 kilometers), the distributed approach reduces the amount of long-distance backhauling to the core.

Centralized vs. Distributed Deployment

By utilizing small ASN-GWs at the access level, rather than one central ASN-GW at the core, the Mobile WiMAX distributed topology offers operators a range of improved business and performance benefits compared to the centralized approach. Subscribers, meanwhile, enjoy an enhanced experience as the distributed approach brings the service edge close to the user, reducing loss-of-service and providing faster services.

Business Benefits

- **Reduced CAPEX:** operators do not need to acquire expensive transport equipment and an expensive ASN-GW server to get started, and can gradually purchase additional ASN-GWs in relation to the expansion of their business.
- **Reduced OPEX:** given the lower acquisition and maintenance costs of small ASN-GWs compared to a large ASN-GW at the core, along with the need for less long-distance backhauling, operators can significantly reduce their OPEX.
- **Lower bandwidth dimensioning:** inter-node local bandwidth is better utilized compared to expensive large trunking from BS nodes to the central ASN-GW, as is the case in a centralized approach.
- **Better operator transport topology fit:** operators do not need to identify a centralized ASN-GW location, but can adapt the location to their transport topology.

Performance Benefits

- **Localized mobility:** latency is lowered, while the probability for a controlled, smooth handover is increased due to an end-to-end delay reduction.
- **Elimination of a single point of failure:** when an ASN-GW fails, it impacts only a small segment of the overall network.
- **Enhanced mobility functionality:** there is no need to incorporate mobile IP functionality, which results in smaller packet size and less processing required by the ASN-GW.
- **Better backhauling capacity utilization:** backhauling costs for download diversity traffic (e.g. MCBCS, FBSS, data integrity), peer-to-peer traffic, and VoIP traffic with local PSTN connectivity are reduced to nearly zero.

Alvarion's Fractalized ASN Approach

As shown above, it's clear that a distributed topology provides operators with superior business and performance benefits compared to its centralized counterpart. But while the ASN-GW-to-BS ratio in a fully distributed topology is 1:1, a standard deployment does not necessarily require an ASN-GW at every BS. As such, operators would be better off determining the ideal number of ASN-GWs to utilize in order to optimize their access service network.



"A fractal is generally a rough or fragmented geometric shape that can be split into parts, each of which is (at least approximately) a reduced-size copy of the whole"

Benoît Mandelbrot,
Founder of Fractal Geometry, 1975

Recognizing the advantages of a distributed architecture on the one hand, and the need to optimally utilize such an ASN deployment on the other, Alvarion has developed a fractalized ASN approach. Alvarion's approach divides an ASN serving multiple base stations into an optimal number of identical ASNs serving fewer BSs. In this way, Alvarion is able to determine the point of optimal utilization of the distributed network architecture – that is, the optimal ASN-GW-to-BS ratio. By applying a practical ASN-GW-to-BS ratio, operators enjoy the economic and performance benefits of the distributed approach in an optimal fashion.

Fractalized ASN Benefits

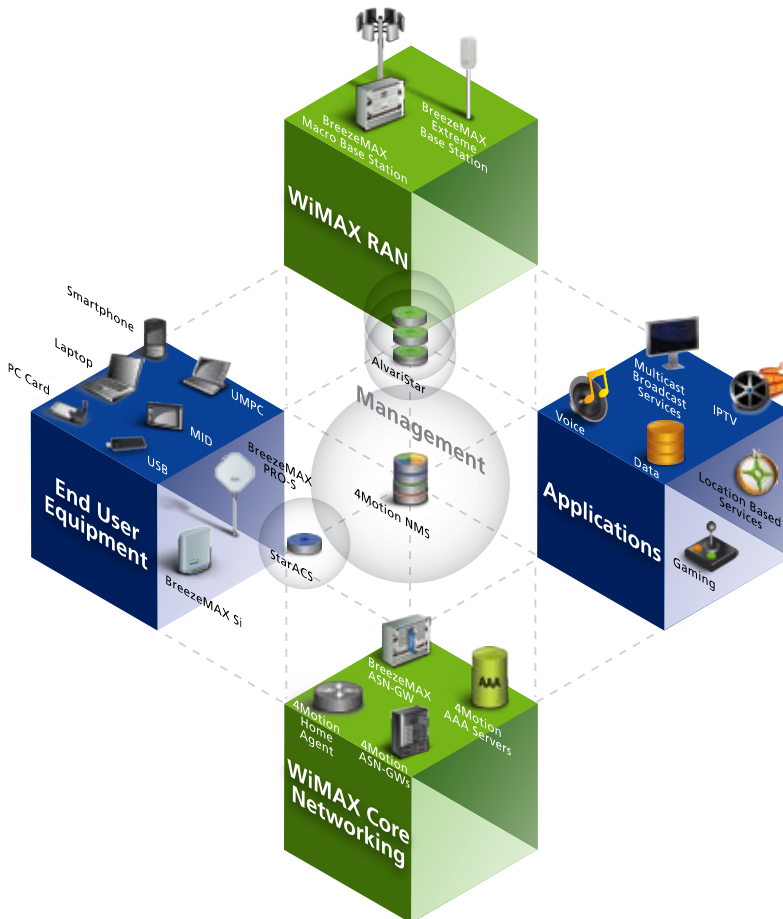
By utilizing Alvarion's fractalized approach, operators benefit even further than when opting for a fully distributed approach. With the fractalized approach, the Mobile WiMAX network offers the same high level of performance as the fully distributed approach – from localized mobility to better backhauling capacity utilization. The fractalized approach also provides operators with similar business benefits such as a lower CAPEX and OPEX. However, by determining the ideal ASN-GW-to-BS ratio, Alvarion's fractalized approach optimizes expenditures and bandwidth utilization, leading to even greater bottom-line benefits for operators, including:

- **Optimized CAPEX:** while the fully distributed approach requires the acquisition of a large number of ASN-GWs, the fractalized approach determines the ideal number, leading to additional capital expenditure savings.
- **Optimized OPEX:** utilization of an optimal number of ASN-GWs translates to even lower maintenance and operational expenses for operators.
- **Optimized bandwidth utilization:** in contrast to a fully distributed topology, where using a maximum number of ASN-GWs leads to maximum bandwidth usage, the fractalized approach uses just the right number of ASN-GWs, thereby optimizing bandwidth utilization and further lowering related expenses.

Fractalized ASN-GW: Value Proposition

The ASN-GW in a legacy system resides in the radio access network (RAN), which connects end-user devices to the core network. In contrast, the ASN-GW in Alvarion's Mobile WiMAX 4Motion® solution, which is governed by profile C architecture, resides in the core networking component – the central part of the telecommunications network. As a result, the 4Motion core networking component not only includes a home agent (HA) and an authentication, authorization and accounting (AAA) server, but also ASN-GWs. This enables separating the ASN-GW from the BS and placing the network in between the two, and, in turn, serves as the basis for Alvarion's unique fractalized approach.

Alvarion's BreezeMAX®, the industry's most advanced and robust WiMAX IEEE 802.16e-certified platform, ASN-GW plays an important role in executing the fractalized approach. Enabling operators to optimize their network design, the BreezeMAX ASN-GW is an integral part of Alvarion's value proposition for operators looking to make the most of their Mobile WiMAX deployment.

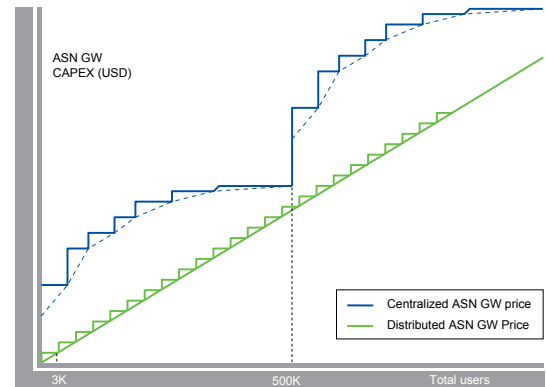


4Motion Solution Components

Distributed Network Architecture

Some of the benefits provided by the BreezeMAX ASN-GW include:

- Low entry point: since the BreezeMAX ASN-GW can be embedded in the BreezeMAX BS, operators do not need to acquire additional hardware or sites to carry out their deployment, thereby keeping CAPEX to a minimum.
- Pay-as-you-grow model: operators can easily acquire additional BreezeMAX ASN-GWs to reflect actual subscriber growth (based on a granular pricing policy of subscriber groups).
- Openness: part of Alvarion's OPEN™ WiMAX strategy, the BreezeMAX ASN-GW is compliant with all leading standards, WiMAX Forum Certified™, and fully interoperable with third-party vendors, enabling operators to maximize their ROI.
- Customization: the BreezeMAX ASN-GW can be customized to meet a wide range of operation modes and operator services.
- Fractalized ASN architecture: the BreezeMAX ASN-GW is ideally suited for the fractalized distributed approach, offering operators the full set of business and performance benefits available with such a transport topology.



Pay-as-you-grow Model

Summary

While a centralized architecture is the topology of choice under certain Mobile WiMAX deployment scenarios, a distributed architecture is often a viable and effective alternative. From lower CAPEX and OPEX to localized mobility and no single point of failure, the distributed approach delivers a wide range of enhanced business and performance benefits to operators deploying a Mobile WiMAX network.



Recognizing the value of utilizing a fully distributed topology, Alvarion, the world-leading provider of WiMAX and broadband wireless solutions, has taken the approach one step further. By determining the optimal ASN-GW-to-BS ratio, Alvarion's unique fractalized ASN implementation enables operators not only to enjoy the multiple benefits of distributed network architecture, but also to optimize their CAPEX, OPEX and bandwidth utilization. Offered as part of Alvarion's comprehensive Mobile WiMAX 4Motion solution, the fractalized distributed approach helps the company deliver an even more compelling value proposition to operators looking to deploy Mobile WiMAX networks worldwide.

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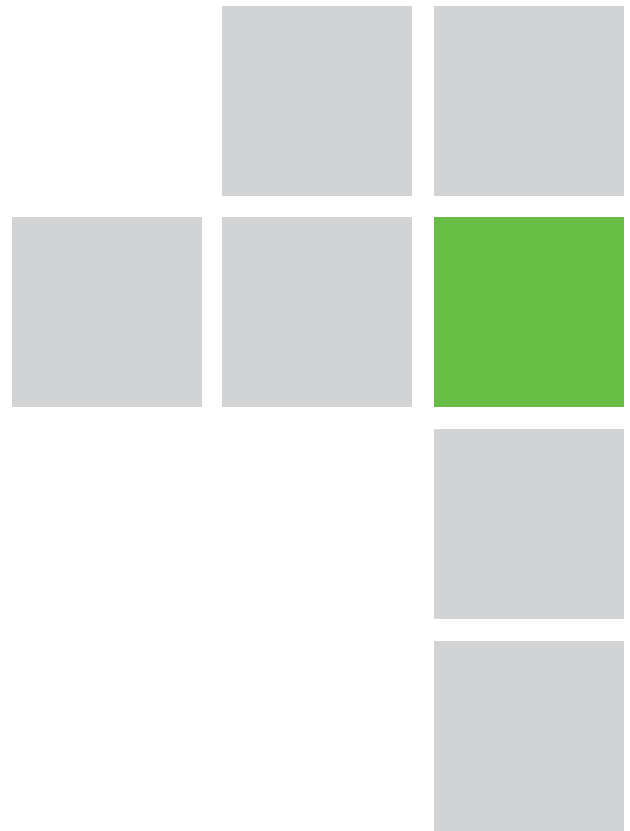
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About Alvarion

Alvarion (NASDAQ: ALVR) is the largest WiMAX pure-player with the most extensive WiMAX customer base and over 250 commercial deployments around the globe. Committed to growing the WiMAX market, the company offers solutions for a wide range of frequency bands supporting a variety of business cases. Through its OPEN™ WiMAX strategy, superior IP and OFDMA know-how, and ability to deploy end-to-end turnkey WiMAX projects, Alvarion is shaping the new wireless broadband experience.

