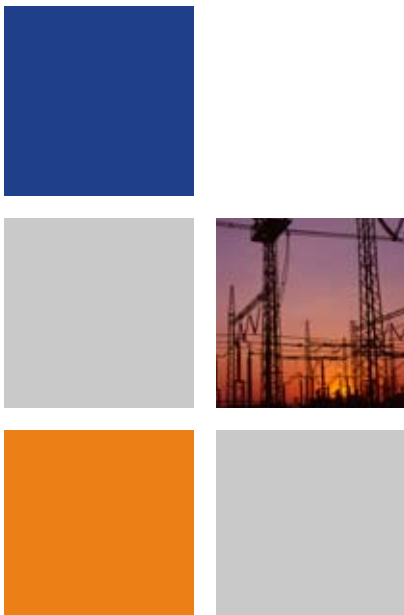




# Optimizing Smart Power Grids with WiMAX™ and Broadband Wireless Connectivity Solutions

White Paper



## Abstract

Smart Power Grids (SPGs), also known as Intelligent Utility Networks (IUNs), represent a new paradigm in electrical power distribution and management. Incorporating advanced two-way communications and distributed computing capabilities, SPGs are emerging power grids that enhance control, efficiency, reliability and safety.

In this paper we will first explore the drivers and goals of SPGs, as well as review the technologies utilized in SPG connectivity networks. Next, we will consider the key requirements for successful SPG projects in general, and those for broadband wireless SPG deployments in particular. Finally, we will discuss Alvarion's full SPG wireless connectivity solutions and their benefits for utility customers.

## The Challenge: Inefficient Electrical Infrastructure

Today's electromechanical electrical grids are inefficient networks highly prone to power failures. This situation is becoming ever more critical given that energy demand is increasing at a faster rate than energy supply, while energy costs continue to soar.

Yet simply building more power plants is not a realistic solution. First, electrical power stations are very expensive to construct and operate. Moreover, governmental agencies and environmental groups interested in reducing greenhouse gas emissions are opposed to this approach. Clearly, a new method is required.

## The Solution: Smart Power Grids

SPGs – also known as intelligent utility networks or intelligrids – represent a new paradigm in electrical power distribution and management. SPGs are emerging power grids that incorporate advanced two-way communications and distributed computing capabilities for improved control, efficiency, reliability and safety.

Unlike existing analog electrical networks that are reactive in nature, SPGs are proactive digital grids. Enabling the monitoring of power consumption in real time by both utilities and consumers, smart grids proactively reduce client-side power consumption – especially during challenging peak hours. Such demand-side management, supported by intelligent pricing policies, can lead to the balancing of power consumption, benefiting utilities and consumers alike. Indeed, industry studies estimate that modern digital energy grids could cut investments in new power plants by tens of billions of dollars, reduce power consumption by some 10%, and decrease greenhouse gas emissions by 25% (source: "A Smarter, Greener Grid," CNNMoney.com, May 7, 2008).



SPGs have gained significant momentum in recent years. Key drivers include the increasing demand for energy consumption, rising energy prices, and the growing focus on environment-friendly technologies and regulations. As a result, the smart grid is being actively promoted by the European Union, the United States, China, India and other nations worldwide. For example, the smart grid became official US policy with the passage of the Energy Independence and Security Act of 2007 (Title 13). In addition, the multitude of industry initiatives and alliances – such as the GridWise Alliance, the Smart Energy Alliance, the SPG Coalition, IntelliGrid, and the InovGrid Project – point to the growing interest in, and importance of SPGs. The International Energy Agency (IEA) estimates that more than \$16 trillion will be invested worldwide in implementing the smart grid vision by 2030 (source: “Smart Grids Power Up the Agenda Across Europe,” Smart Electric News, April 2, 2008).

## Connectivity Networks within the Smart Power Grid

SPG infrastructure is comprised of three connectivity networks – the core, distribution and access networks.

The **Core network** handles connectivity between substations and utilities’ head offices. Technologies used for core network implementation include:

- Wireline technologies
  - Fiber
- Wireless technologies
  - WiMAX
  - License-exempt broadband wireless

The **Distribution network** handles broadband connectivity for transmitting data collected by SPG concentrators and distribution automation devices (e.g. monitors, sensors, SCADA systems), which are located on the grid, to their related databases and analytics servers, which are located at headquarters. Technologies used for distribution network implementation include:

- Wireline technologies
  - Fiber
  - BPL (broadband over power lines)
- Wireless technologies
  - WiMAX
  - License-exempt broadband wireless
  - GSM

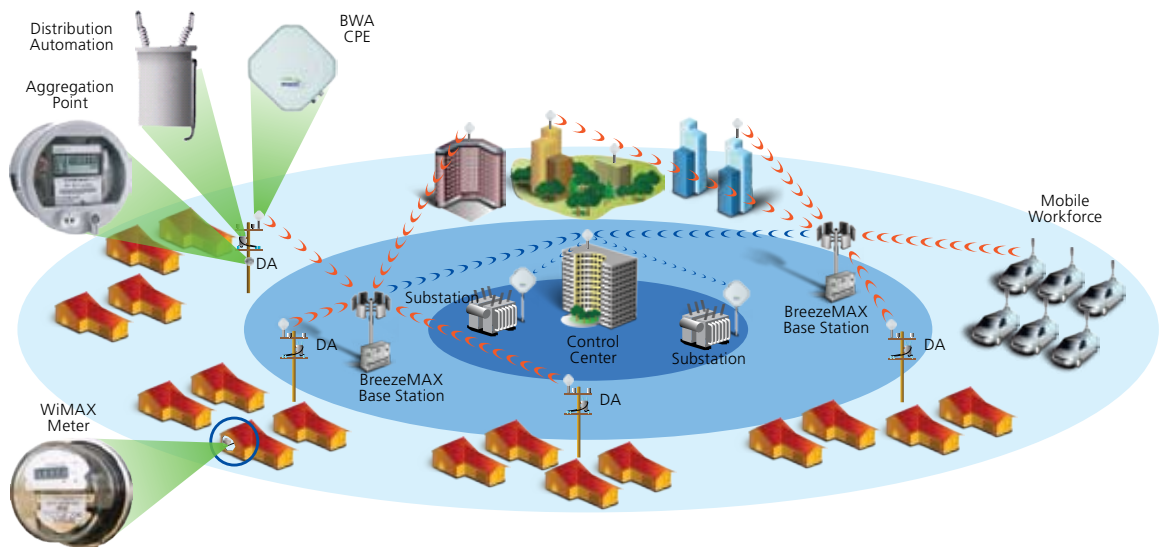
### Primary Goals of SPGs

- Significant reduction in grid operating costs via optimized power consumption
- Deferred investments in new power plants via management of peak consumption
- Improved compliance with utility monitoring regulations via enhanced control
- Substantial decrease in outages via proactive management of the power infrastructure
- Enhanced fraud detection and reporting for revenue assurance

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The **Access network** handles last-mile connectivity from smart meters located on the edge of the power grid (at homes, offices, and municipal facilities) to SPG concentrators. Technologies used for access network implementation include:

- Wireline technologies
  - PLC (Power Line Communication)
- Wireless technologies
  - ZigBee (IEEE 802.15.4)
  - Wi-Fi (IEEE 802.11)
  - WiMAX (IEEE 802.16)
  - License-exempt broadband wireless
  - GSM



*Access/last mile and distribution components of the SPG*

Depending on each utility's specific requirements and objectives, the SPG infrastructure can be based on one or more of these connectivity technologies. Hybrid deployments, aligned to each utility's specific technological and business requirements, are expected to be widely prevalent.

## Key Requirements for SPG Connectivity

When considering SPG connectivity solutions, utilities typically focus on a number of key requirements:

- **Reliable, carrier-class connectivity** to handle challenging environments
- **Secure communications** utilizing state-of-the-art authentication and encryption to improve data and network security, thereby eliminating unwanted intrusions and denial of service
- **High availability** to ensure *five nines* (99.999%) uptime
- **Standard-based solutions** to ensure interoperability
- **High bandwidth** sufficient to address current and future application requirements
- **Low latency** to support real-time applications
- **Scalability** to support future growth without having to invest heavily in upgrading existing network infrastructure
- **Enhanced flexibility** to meet varying connectivity requirements for diverse fixed and mobile applications and deployment scenarios while minimizing costs
- **Ease of installation and operation** to streamline deployments and reduce operating expenditures

## Broadband Wireless Requirements for SPG Connectivity

Broadband wireless solutions are becoming a de-facto standard for SPG connectivity, as they bring a host of benefits aligned with power utilities' business objectives and meet the key requirements discussed above. However, the significant variation between broadband wireless solutions from various wireless vendors may impact the success of an SPG project. As such, utilities also should consider the following requirements when evaluating wireless SPG solutions and vendors.

**Wide product portfolio:** Utilities often face a variety of evolving connectivity requirements to address their business objectives and technological challenges. A key consideration for utilities is whether to deploy licensed or license-exempt wireless solutions for SPG connectivity. If a licensed spectrum is available to the utility and affordable in terms of spectrum fees, then licensed solutions are preferable. If not, license-exempt solutions are an excellent alternative. Therefore, when evaluating broadband wireless connectivity options, utilities should select an experienced company offering a full range of advanced wireless broadband infrastructure solutions that can address both licensed and license-exempt frequencies, thereby protecting current and future network infrastructure investments.



**Optimized SPG wireless connectivity:** Broadband wireless solutions are widely used across the telecommunications industry for various applications. Each SPG connectivity project, however, has its own unique requirements. As such, utilities should look for broadband wireless solutions with features and capabilities optimized for SPG requirements, including:

- Carrier-class all outdoor link reliability and availability (IP67)
- Secured communication (FIPS-140-2)
- High bandwidth with low latency and sufficient quality of service for real-time applications
- Standard-based technologies (802.16e, 802.11)
- Simplified deployments (NLOS, SNR LED indicators, automatic self configuration)

**Extensive radio planning and radio frequency (RF) expertise:** Successful deployment of SPG infrastructure requires proper radio planning that will ensure full coverage and optimal layout of wireless infrastructure.

## Alvarion SPG Wireless Connectivity Portfolio

Alvarion, the world's leading provider of WiMAX and broadband wireless solutions, provides comprehensive and optimized broadband wireless connectivity solutions for smart power grids. These solutions are designed to integrate seamlessly with the various wireless technologies deployed in the SPG access network – PLC, ZigBee, Wi-Fi, WiMAX, or any combination thereof – enabling advanced hybrid deployments designed for specific utility requirements.

Alvarion offers a range of broadband wireless base station and Customer Premise Equipment (CPE) solutions that address a variety of spectrums (licensed and license-exempt) and customer-specific deployment scenarios (e.g. coverage, modulation, challenging weather conditions). Alvarion's carrier-class management platform indicates and anticipates congestion-related trends, allowing a proactive response before reaching critical proportions. With 15 years of radio planning and over 3,000,000 units deployed worldwide, Alvarion leverages its accumulated RF expertise for the benefit of its utility customers.

Based on a long track record developing dedicated solutions for specific industry requirements, the Alvarion Professional Services organization can tailor SPG solutions that meet the needs of each utility customer. With its wide product portfolio, RF expertise, strategic partnerships with complementary solution vendors, and proven broadband wireless market leadership, Alvarion is a one-stop shop for SPG network infrastructure solutions.

Alvarion offers two main solutions for SPG wireless connectivity over licensed and license-exempt frequencies: BreezeMAX® and BreezeACCESS® VL.



## BreezeMAX

Commercially available since mid-2004 and with over 200 deployments in more than 30 countries, BreezeMAX is the industry's most advanced and robust WiMAX IEEE 802.16e-certified platform. BreezeMAX delivers efficient wireless broadband connectivity over fixed, portable and mobile networks, using a variety of end-user devices. Designed for a range of frequencies in both licensed and license-exempt bands from the 2.x GHz to 5.x GHz spectrum, BreezeMAX provides greater flexibility to SPG deployments, and operates in both FDD and TDD duplex modes.



Featuring excellent sensitivity and market-leading OFDM/OFDMA radio technology, the system is sufficiently robust to operate in adverse channel conditions with NLOS links.

BreezeMAX highlights:

- Complete spectrum: 2.3 GHz, 2.5 GHz, 3.3 GHz - 3.8 GHz, 3.65 GHz and 5 GHz
- Channel width: 3.5 MHz, 5 MHz and 10 MHz
- Based on TDD or FDD OFDM/OFDMA NLOS technology
- Coverage of up to 30 km
- Capacity of up to 15 Mbps per sector
- Support of 3 sectors with 2 carriers or 6 sectors with 1 carrier
- AAS support of 2<sup>nd</sup>/4<sup>th</sup> order diversity and MIMO
- Carrier-class platform with hot swappable functionality
- Centralized network management (AlvariSTAR NMS)
- Full outdoor BST enclosure option available

### Utility Case Study

#### Customer

- North American electric power utility with 2 million customers

#### Challenges

- Provide broadband wireless infrastructure for SPG project over 10,000 sq. miles
- Connect 50,000 distribution automation (DA) devices, each with 128 Kbps bandwidth
- Connect 2,000 aggregation points, each with 2 Mbps bandwidth
- Deliver a reliable and secured connectivity solution

#### Solution

- BreezeAccess VL: 900 MHz cells
- BreezeACCESS VL: 5.8 GHz to connect 900 MHz cells to the HQ

#### Benefits

- Carrier-class, secured broadband wireless infrastructure
- Standard-based solution to ensure interoperability
- NLOS solution with high coverage and capacity
- Scalable solution to support future growth
- NMS to enable proactive performance management

## BreezeACCESS VL

BreezeACCESS VL, Alvarion's broadband wireless platform in the 5 GHz frequency, is part of the BreezeACCESS product family, the world's most deployed wireless broadband platform. Superior features such as NLOS, extended reach, high capacity in all packet sizes, encryption, and end-to-end quality of service (QoS) for time-critical applications work together to meet demanding SPG requirements.



BreezeACCESS VL highlights:

- Wide range of bands: 900 MHz, 5.x GHz
- Based on TDD OFDM NLOS technology
- Coverage of up to 30 km
- Capacity of up to 33 Mbps per sector
- Standalone or 1 to 6 sectors per chassis (up to a total of 200 Mbps)
- Mixing and matching of different bands within the chassis
- Carrier-grade 19" chassis with optional redundant power supply
- Centralized network management system (AlvariSTAR NMS)
- Configurable MIR/CIR per CPE per direction
- Full outdoor BST enclosure option available

## Alvarion SPG Wireless Connectivity Benefits

Alvarion broadband wireless connectivity solutions for SPGs offer compelling benefits to utility customers:

### Reliability and Availability for Improved Uptime and SLA Compliance

- Carrier-class connectivity
- Rugged packaging (IP67) for challenging environments
- NLOS technology
- Diversity within the spectrum to overcome interference
- Graceful degradation in case of interference
- Application and CPE bandwidth prioritization and QoS
- Proactive network management platform

### Secure Communication for Elimination of Intrusions and Denial of Service

- Application data security
  - AES 128 encryption built in
  - FIPS 197 encryption mode
  - FIPS 140-2 (upcoming)
- Network performance: broadcast/multicast limiter
- Network access security: allow/deny unauthorized CPEs

### Standards-Compliant for Ensured Interoperability and Maximum ROI

- Products and technology
  - Founder and active member of the WiMAX Forum®
  - Product portfolio aligned with industry standards: 802.16e, 802.11a/b/g/n
- Manufacturing and operations
  - Minimization of waste: ISO 14001 certified
  - Occupational health and safety management system: OHSAS 18001 certified



## Ease of Installation and Operations for Increased Productivity and Reduced OPEX

- NLOS technology
- SNR LED indicator for fast antenna alignment
- Automatic self configuration
  - Built-in spectrum analyzer with automatic clear channel selection
  - Automatic distance measuring for optimized cell performance
  - Automatic transmit power control (ATPC)
  - Best/preferred base station access unit (AU)
- Optional up/down tilt of subscriber unit (SU)
- Horizontal/vertical polarization
- Full outdoor compact base station option

## Summary

Broadband wireless solutions are becoming a de-facto standard for SPG connectivity, as they provide a range of benefits aligned with power utilities' business objectives and technical requirements. Yet given the significant variation among broadband wireless solutions, utilities should closely consider a number of key factors when evaluating wireless SPG options. Such criteria include the breadth and depth of the vendor's solution portfolio (including both licensed and license-exempt products), the degree to which solutions are optimized for SPG wireless connectivity, and vendor expertise in radio planning and RF.

Alvarion provides comprehensive and optimized broadband wireless connectivity solutions for distribution networks within the smart power grid. Alvarion's BreezeMAX and BreezeACCESS VL broadband wireless connectivity solutions for SPGs enable advanced hybrid deployments that meet specific utility requirements and deliver compelling technical and business benefits.



Solution Paper: Optimizing Smart Power Grids with  
Alvarion WiMAX and Broadband Wireless Connectivity

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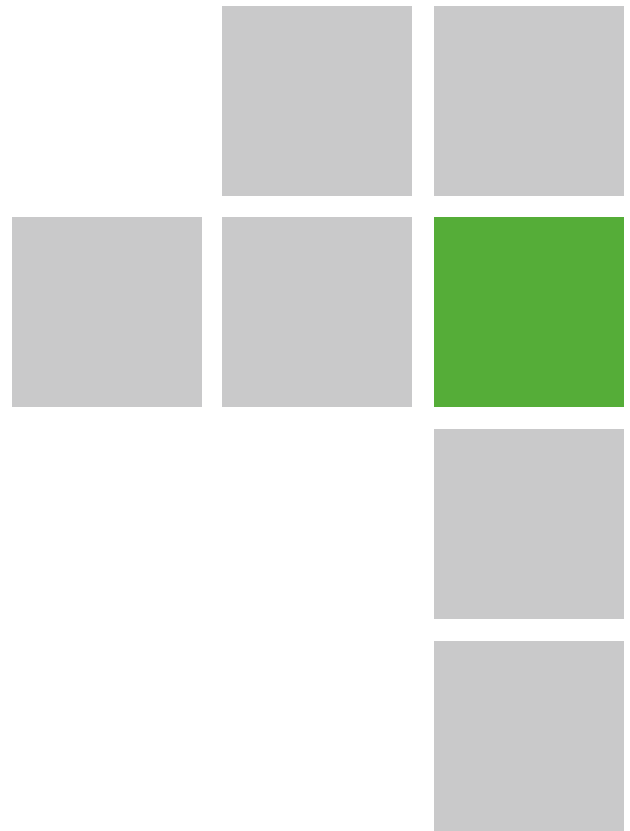
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### About Alvarion

Alvarion is the largest WiMAX pure player, ensuring customer long-term success with fixed and mobile solutions for the full range of frequency bands. Based on its OPEN™ WiMAX strategy, the company offers superior wireless broadband infrastructure and an all-IP best-of-breed ecosystem in cooperation with its strategic partners. Alvarion has delivered over 200 commercial WiMAX deployments worldwide.

