Smart Grid Standards Activity

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WiMAX Forum
Presentation Outline

• Private 4G Networks for Smart Grid: Proof Points and References
  • Typical Smart Grid Requirements
• 4G Standardization and the Smart Grid
  • 3GPP and ETSI
  • IEEE and WiMAX Forum
• 2011 4G for Utility Smart Grid Applications Scorecard
• Conclusion and Takeaways: What is the right 4G technology choice?
Private 4G Networks for Smart Grid

Questions

• What is a Private 4G Network?
• Why do utilities need 4G Technology for Smart Grid?
• Why can’t utilities just use 2G, 3G and 4G Carrier networks?

• **Private 4G**: A 4G (WiMAX or LTE) network that is operated by a utility in its own licensed spectrum, and is dedicated to their Smart Grid Applications (i.e. not a shared public network)

• **4G for Smart Grid**: A single radio network that supports all / most wireless Smart Grid Applications (Wide-Area, Field-Area, and into Home Area Network)

  • Field Workforce / Enterprise Networking ideal for carrier networks
OpenSG Conceptual Framework

4G Smart Grid Networks focused on parts of Wide-Area Network, Field Area Network and connectivity to the Home Area Network.
Utility Requirements are different to Mobile Carriers

<table>
<thead>
<tr>
<th>Mobile Carrier Network</th>
<th>Smart Grid Utility Network</th>
</tr>
</thead>
<tbody>
<tr>
<td>Focus on portability and mobility</td>
<td>Primarily fixed (except for mobile workforce)</td>
</tr>
<tr>
<td>DL traffic dominates</td>
<td>UL traffic dominates and coverage is critical</td>
</tr>
<tr>
<td>Active users per cell/sector in 100s</td>
<td>Active “users” per cell in 1,000s to 10,000s</td>
</tr>
<tr>
<td>High data rate per active user</td>
<td>Low data rate per user</td>
</tr>
<tr>
<td>Key metrics: Peak user rate, average user rate</td>
<td>Key metrics: Cell edge data rate, C-I-A*</td>
</tr>
<tr>
<td>Busy periods based on statistics</td>
<td>Predictable “peak busy” hour – scheduled events</td>
</tr>
<tr>
<td>Privacy and data integrity important</td>
<td>Security and data integrity extremely important</td>
</tr>
<tr>
<td>Multi-mode devices – seamless roaming</td>
<td>Interworking and interoperability (SG networks will employ multiple technologies – wireless &amp; wire-line)</td>
</tr>
<tr>
<td>Support Smart-Phone applications: photos, videos, real-time gaming, texting, etc</td>
<td>Primarily machine-to-machine interfaces, some video surveillance (CCTV)</td>
</tr>
<tr>
<td>Layer 3-7 Network, centralized architecture</td>
<td>Ideally a Layer 2 network, distributed architecture, Layer 3 for Mobile Services</td>
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</tbody>
</table>

* C=Confidentiality, I=Integrity, A=Availability

Carrier 4G Networks do not fit most Utility Requirements
Ausgrid: 4G for Smart Grid in Australia

• First large-scale 4G Smart Grid rollout in Australia
  • 150 Macro cell sites in Phase 1
  • Operates in Licensed Spectrum
    • 2.3 GHz TDD, 3 x 5 MHz
  • Partnered with Ericsson (Project System Integrator)

• Solution designed to support three key Smart Grid Applications
  • 4G WiMAX “Direct-to-the-meter” AML
    • 2.3 GHz 16e TDD WiMAX Module inside of a Landis & Gyr Smart Meter
  • 4G WiMAX Distribution Automation
    • New WiMAX Smart Grid Routers
      • Supporting Ethernet and Serial Interface
      • Option for Homeplug electronics
  • 4G WiMAX Mobile Workforce
    • Full Mobility support using Mobile IP and bespoke terminals for Utility vehicles

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4G WiMAX for Smart Grid in Europe

- Salzburg AG modernized their communications by implementing a 4G Smart Grid Network
  - Focus was reduce costs and better customer service.
- Salzburg AG 4G network is an overlay across their grid that allows the transfer of real-time data all the way from the individual home/office meter to the network operation center.
  - The solution also enables remote data gathering (SCADA), Distribution Automation (DA), meter data aggregation (AMI) backhauling.
- The solutions uses a higher performance Macro 3.5 GHz TDD WiMAX
- Phase 1 was completed in 2010. A phase 2 expansion of the network is being planned.
4G Standardization and Smart Grid

Questions

• Which 4G Standards can be used?
• Is one flavor of 4G better than the other?
• What are the activities in the standards?

• **3GPP and ETSI**: M2M, focused on how Carrier Networks can support Utility applications, as one use case. Not focused building private 4G utilities (at this point)

• **IEEE and WiMAX Forum**: A single radio network that supports all / most wireless Smart Grid Applications (Wide-Area, Field-Area and into Home Area Network). Focus is to allow Utilities to be their own private 4G WIMAX networks.
3GPP and Machine to Machine Communications

Status of M2M support in LTE:

- M2M is an ongoing study item in 3GPP LTE Release 10
  - 3GPP establishing requirements for Machine-Type Communications (MTC) on LTE.
  - 3GPP planning network enhancements to MTC devices.
- Builds on 3G M2M communications (3GPP TR 22.868) from 2007
  - Network Improvements for Machine-Type Communication (NIMTC).
  - Reduce operator costs when offering machine-type communication services
  - Reduce the impact of large machine-type communication groups
  - Optimize network operations to minimize impact on device battery power usage
  - Stimulate new machine-type communication applications by enabling operators to offer services tailored to machine-type communication requirements
- LTE RAN study initiated in last year.
ETS I / 3GPP M2M Architecture

- **M2M Device**
  - A device capable of replying to request for data contained within those device or capable of transmitting data contained within those devices autonomously

- **M2M Area Network (Device Domain)**
  - Provide connectivity between M2M Devices and M2M Gateways – E.g. personal area network

- **M2M Gateway**
  - Use M2M capabilities to ensure M2M Devices inter-working and interconnection to the communication network

- **M2M Communication Networks (Network Domain)**
  - Communications between the M2M Gateway(s) and M2M application E.g. xDSL, LTE, WiMAX, and WLAN

- **M2M Applications**
  - Contains the middleware layer where data goes through various application services and is used by the specific business-processing engines

*This Architecture is Carrier Centric, not Utility Centric…*
IEEE 802.16

- Two new standards under development, extending 802.16e and 802.16m (WiMAX and WiMAX-Advanced)

- **GRIDMAN Task Group**
  - Developing PAR 802.16n (Amendment to IEEE Std 802.16 on Higher Reliability Networks)
  - Heterogeneous Networks and Relay Modes for reliability and resilience, standalone network operation.

- **Machine-to-Machine (M2M) Task Group**
  - Developing PAR 802.16p (Amendment to IEEE Std 802.16 on Enhancements to Support Machine-to-Machine Applications)
  - Low Power Consumption, Large Numbers of Devices, Small Data Traffic Bursts, and Security enhancements

- IEEE develops radio interfaces only
  - Network architectures are developed by WiMAX Forum
WiMAX Forum: “Single Network” Smart Grid Vision

AMI
AMI Backhaul
Distribution Automation
EV Charging Stations
Mobile Workforce Protection Switching
Demand Response
Micro Generation

WiMAX Backhaul in 900 MHz 15.4g Collectors

WiMAX 16e in the Meter

Reclosers and CapBank Controllers

WiMAX Extending Fibre-based Tele-protection Remote I/O

WiMAX in Ruggedized Handheld Devices

Smart HAN Appliances

WiMAX controlled Consumer Solar and Wind Generation

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2011 SGWG Objective

• Develop “WiMAX Forum® System Profile Requirements for Smart Grid Applications”
  • Will lead to an interoperable profile for Smart Grid applications based on WiMAX.
  • This will cover the following Utility Smart Grid applications;
    • Customer: AMI, Dist. Generation, Plug-in EV Support
    • Distribution: Switching, Cap Banks, Monitoring, Protection
    • Operations: AMI Network Mgmt, Demand Response
    • Transmission: Line Protection
    • Service Provider: Billing, Information Portals
    • Work Force: Emergency / Dispatch / Field Operations

• Analysis of OpenSG Communication use-case requirements will drive the selection of optimizations to be used in WiMAX Smart Grid System Profile.
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Target Utility Frequency Bands

- Existing Bands / New Bands
  - 700 MHz  ← USA
  - 1.8 GHz TDD  ← Canada
  - 2.3 GHz TDD  ← Australia
  - 2.3 GHz TDD (WCS)  ← USA
  - 3.65 GHz (Semi Licensed)  ← USA
  - 1.4 GHz  ← USA
  - 5.0 GHz  ← Various
  - 4.9 GHz  ← Various

- All WiMAX bands are TDD
- System Profiles also capture key parameters
  - Channel Sizes, Spectral Mask / OOB, Re-use, Tx Powers, Special Requirements
  - Spectrum Availability and Constraints.

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- First WiMAX Smart Grid System Profile for Utilities likely to be for Canadian Utilities at 1.8 GHz
- All Canadian Utilities have access to 1800-1830 MHz
- Initial trials are now complete, mass deployment expected in early 2012 (Spring)

New Smart Grid WiMAX System Profile will likely support:
- Layer 2 Networks and Optimized Latency (direct Base Station to Base Station comms. for GOOSE Messaging / Protection Switching) Extended Range (up to 50km)
- Improved Uplink (Uplink Centric TDD Splits and Uplink MIMO)
- Improved End-to-End Security Model
**4G for Utility Smart Grids: 2011 Scorecard**

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<tr>
<th></th>
<th>4G LTE</th>
<th>4G WiMAX</th>
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<tbody>
<tr>
<td>Utility Application Support</td>
<td>Limited</td>
<td>Comprehensive</td>
</tr>
<tr>
<td>Technology Cost</td>
<td>Higher</td>
<td>Lower</td>
</tr>
<tr>
<td>Spectrum Availability</td>
<td>Limited</td>
<td>Better</td>
</tr>
<tr>
<td>Network Complexity</td>
<td>Complex – carrier centric</td>
<td>Simple</td>
</tr>
<tr>
<td>Layer 2 Network Support</td>
<td>Difficult</td>
<td>Simple</td>
</tr>
<tr>
<td>Target Network Services</td>
<td>Mobile and Limited Fixed</td>
<td>Fixed and Mobile</td>
</tr>
<tr>
<td>Integration with Public Carrier Networks</td>
<td>Easy</td>
<td>Possible</td>
</tr>
<tr>
<td>Device Maturity:</td>
<td>1st</td>
<td>3rd Gen</td>
</tr>
<tr>
<td>End-Point Silicon Cost (MM)</td>
<td>~$25</td>
<td>&gt;$12</td>
</tr>
<tr>
<td>Eco-System / Industry Support</td>
<td>Very Strong in carrier segment</td>
<td>Declining in carrier segment</td>
</tr>
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**Summary:** WiMAX does a better job than LTE at most supporting key Utility Applications (in 2011)
Conclusion: 4G Networks for Smart Grid

- Both 4G technologies can be used to create attractive Utility Wide-Area and Field Area connectivity needs
  - Each technology has their own strengths and weaknesses
- By combining the strengths of both 4G technologies utilities get;
  - Flat, layer 2 Fixed Enterprise Networks for mission critical applications (Private WiMAX)
  - Wide-Area and Field Area connectivity for aggregation nodes (Private WiMAX and Public 2G, 3G and LTE)
  - Next generation Mobile Workforce solutions (Public or Private LTE or WiMAX)
    - For Broadband Data and eventually Voice
- WiMAX Forum Members can help utilities construct their own Private Networks using both 4G standards.