Lessons from the Real World Webinar Series
How utilities are using cellular communications today

March 14, 2013
Today’s Presenters

**Jesse Berst**
Host & Moderator
SmartGridNews.com

**Sunvir Gujral**
Product Manager
Qualcomm

**Jason Ellis**
Staff Manager, Business Development
Qualcomm

**Jeff Norman**
VP of Emerging Technologies
SAIC
Agenda

1. Cellular role in smart grid
2. Cellular lifecycle and TCO
3. Advances in cellular technology
4. Cellular use cases
5. Where we are and what’s next
6. Real-world applications including “edge analytics”
<table>
<thead>
<tr>
<th>Name</th>
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</thead>
<tbody>
<tr>
<td>Jason L. Ellis</td>
<td><strong>Staff Manager, Business Development – Qualcomm</strong></td>
</tr>
<tr>
<td></td>
<td>• Responsible for <strong>Internet of Everything</strong> cellular communications, including Smart Energy</td>
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<td></td>
<td>• Previously focused on non-cellular wireless connectivity encompassing Ultra Wideband (UWB), Wi-Fi, Bluetooth, Zigbee and other low power radio solutions</td>
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<tr>
<td></td>
<td>• Over 10 years of helping regulate, standardize and commercialize wireless technologies</td>
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<td></td>
<td>• Director of business development &amp; marketing for <strong>Staccato Communications; General Atomics Advanced Wireless Group; Raytheon Systems</strong></td>
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<td></td>
<td>• Industry working groups including <strong>IEEE</strong> (Vice-Chair, Exec Committee, Technical Editor), <strong>1394 Trade Association</strong> (BoD), the <strong>WiMedia Alliance</strong> (BoD and Marketing Committees), <strong>USB-IF</strong> (various committees), <strong>Bluetooth SIG</strong> (Ecosystem and Marketing Committees) and many others.</td>
</tr>
<tr>
<td></td>
<td>• BS in electrical engineering from UCSD. Diploma in Strategic Business and International Finance from the University of Oxford. <strong>7 issued US Patents and numerous in process</strong></td>
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</table>
The World Leader in Next-gen Mobile Technologies

Celebrating 27 years of driving the evolution of wireless communications

Making wireless more personal, affordable and accessible to people everywhere

World’s largest fabless semiconductor company, #1 in wireless

S&P 100 / Fortune 500 / NASDAQ: QCOM

2012 3G/4G device shipments: 900M+
Smart Grid Leverages Qualcomm Technologies

- 3G/LTE cellular provides superior performance, reliability, security and scale
- Cellular has supported 2-way communications for C&I meters for over a decade
- Qualcomm communications portfolio addresses a broad range of smart energy applications both inside (HAN) and outside (WAN) the home
M2M Devices with 3G Enjoy Compelling Life Cycle

- 3G networks have better remaining network longevity compared to 2G–GSM
- 3G can provide smoother migration to next generation networks
- With poor data capabilities, GSM market sustainability becomes increasingly uncertain
Smart Meter—Total Cost of Ownership

Business case of 3G-enabled smart grid systems is **now** very competitive, while delivering superior performance and leveraging billion dollar networks.

<table>
<thead>
<tr>
<th>Technology</th>
<th>Typical Data Rate (kbps)</th>
<th>Message Delivery Latency</th>
<th>Present Value of Smart Meter Deployment ($/meter)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3G</td>
<td>&lt;1s</td>
<td>1s or above</td>
<td>$63, $49, $41, $99</td>
</tr>
<tr>
<td>GPRS</td>
<td>1s or above</td>
<td>1–60s</td>
<td>$57, $41, $13</td>
</tr>
<tr>
<td>RF MESH</td>
<td>9.6–100+</td>
<td>Several to 100+</td>
<td>$99, $41, $13, $9</td>
</tr>
<tr>
<td>PLC</td>
<td>&lt;1s</td>
<td>1s or above</td>
<td>$82, $41, $13, $9</td>
</tr>
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</table>

Source: Qualcomm economic model, approximate values for a typical smart meter deployment in the United States with a lifetime of 25 years.
## Common Misconceptions

M2M is now a significant focus for the cellular ecosystem, resulting in aggressive competition for smart energy wins

<table>
<thead>
<tr>
<th>Statement</th>
<th>True / False</th>
</tr>
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<tbody>
<tr>
<td>Cellular is too expensive for smart grid and carriers are inflexible to utility needs.</td>
<td><strong>FALSE</strong>: Smart meter OEMs are optimizing hardware designs to lower cellular CapEx. Operators now offer very compelling, utility-oriented business models, tariffs, longevity and SLA terms for competitive OpEx.</td>
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<tr>
<td>Private RF Mesh networks have negligible operating expenses.</td>
<td><strong>FALSE</strong>: Managing and operating a communications network requires ongoing CapEx and dedicated personnel (OpEx), which has sometimes been understated. Utilities who leverage cellular networks benefit from billions invested annually in network maintenance, expansion, and security.</td>
</tr>
<tr>
<td>Cellular networks don’t have adequate disaster recovery methods.</td>
<td><strong>FALSE</strong>: Cellular operators globally continue to invest in back-up power (generators/batteries), and portable satellite base-stations ensuring minimal outage. When an outage occurs, carriers answer to regulators. Cellular recovery during Hurricanes Sandy/Katrina and the Great East Japan Earthquake and Tsunami demonstrate rapid restorations, leveraging readily available standards-based technology and vast employee resources.</td>
</tr>
<tr>
<td>RF Mesh technology is proven technology with minimal risk to interference.</td>
<td><strong>FALSE</strong>: RF Mesh deployments have largely been proprietary, and have cumulative deployments in the 10s of millions, as compared to billions of cellular devices shipping globally. Use of any unlicensed spectrum runs the risk of harmful interference from a variety of sources, vs. licensed cellular.</td>
</tr>
<tr>
<td>RF Mesh networks allow high endpoint-to-concentrator ratios, delivering superior TCO</td>
<td><strong>FALSE</strong>: As application requirements evolve, and based on topography, we witness dramatically lower ratios of endpoints to concentrators, vastly negatively impacting the business dynamics of RF Mesh.</td>
</tr>
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</table>
Cellular Smart Meter Momentum Building

Cellular is Taking More Critical Role in Global Smart Grid

Recent Public Announcements:

- Toshiba and Landis+Gyr Take Another Step Toward the Smart Community
  February 6, 2013: Toshiba/L+G acquire cellular smart grid start-up company Consert (investment from Qualcomm Ventures)

- Itron to Deliver 3G Cellular Platform Based on Qualcomm Chipsets for the Smart Grid
  January 29, 2013: Itron collaboration with Qualcomm following their acquisition of Cellular smart grid start-up SmartSynch

- (Aclara) ESCO Announces Acquisition of Smart Grid Solutions Provider
  January 3, 2013: Metrum is a leading provider of wireless public network (cellular) comms products for utility customers

- Elster Expands AMI Solutions with Point-to-Point Cellular Capabilities
  Dec. 14, 2012: Elster announced today that it is expanding its deployment of AMI solutions, leveraging cellular point-to-point

- Grid Net Extends Full Software Support for 3G Public Cellular Smart Grid Deployments
  July 17, 2012: “Grid Net pioneered the cellular smart grid model in 2008... Over time, as component prices and bandwidth costs decreased, both telecom carriers and utilities signaled a willingness to move forward with 3G cellular public networks.”

- GE Acquires Innovative Technology to Help Meet UK Energy Efficiency and Emissions
  January 11, 2011: Meters communicate via GPRS (cellular) over the GSM Network to the Oracle database

- Trilliant Wins New Contract with British Gas for Smart Grid Comms Infrastructure
  November 18, 2010: Trilliant to provide the communications (cellular) equipment to connect smart electric meters, gas meters, in-home smart energy devices, and other future home energy devices such as solar, wind, and electric vehicle chargers
Commercial Cellular Carriers Engaging

Domestic / International Carriers Embracing Smart Grid Business

- As an example, some insight into AT&T’s offering
  - ARMZ (Portable Truckable Customer Cell Sites)
    In addition to Cellular of Wheels (CoWs) that carriers use
    https://www.wireless.att.com/businesscenter/business-programs/mid-large/remote-mobility-zone.jsp
  - AT&T Business Continuity & Disaster Recovery
  - AT&T Business Continuity Handbook
  - For information about AT&T Smart Grid / Utility
    IDC Smart Grid AMI Case Study – Texas New Mexico Power Smart Grid AMI
    Ed Davalos, Director – Smart Grid | AT&T | ed.davalos@att.com

- Carriers are discussing SLAs with utilities, and QoS is becoming available
- Contacts available for additional domestic and global operators too: jellis@qti.qualcomm.com
Sunvir Gujral, Qualcomm

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| Sunvir Gujral | **Product Manager— Qualcomm**  
  - Smart energy product management in Qualcomm Technologies’ New Markets organization. He joined the product management team in early 2012 after 4 years in chipset program management where, among other chipsets, he was responsible for managing the design, development, and introduction of Qualcomm’s first HSPA+ modem chipset  
  - Prior to Qualcomm, held integrated circuit design, software engineering and product management positions at Onyx Semiconductor, Jazz Semiconductor, Lucent and Western Digital.  
  - Bachelor and Master of Science degrees in Electrical and Computer Engineering degrees from the University of California, Irvine |
Qualcomm in the M2M Value Chain

Module based approach vs. Chip-on-board design

Generic solutions for IoE; Custom solutions for well defined use-cases
Qualcomm Modems Are Complete

Built Smarter to Work Smarter

Qualcomm Designs, Integrates and Delivers all the Pieces
Qualcomm Modems Are Complete
Built Smarter to Work Smarter

Qualcomm Designs, Integrates and Delivers all the Pieces

- Voice
- Multimode 3G/4G
- Power Optimization
- Broadcasts
- RF Multiband
- DSP
- Simplified APIs
- Connectivity
- OS Support
- GPS
- Soft AP
- Advanced Receivers

Integrated Application Processor Capable of Running Linux
Integrated Application Processor in the same chip saves duplicate memory
- PCB space saving
- Power circuit saving for Application Processor
- Superior modem performance up to HSPA for potentially more value-added service
- Pin-to-Pin compatible MDM9xxx to migrate to LTE
- DSP running at up to 600MHz available for additional processing
Integration Optimizes Total System Cost

Example: A Smart Meter—Before and After Integration

Non-integrated Smart Meter
- LCD, PCB, Materials
- Metrology
- Apps Processing and HAN Comms
- WWAN Modem
- Baseband
- Memory
- Memory CPU
- Others

Integrated Smart Meter
- LCD, PCB, Materials
- Others
- Memory
- CPU
- Others
- Memory
- Baseband + Apps Processor
- Memory

20% Lower System Cost

Integrated:  
- Apps processing
- Metrology
- WWAN comms
- HAN comms
Smart Energy Use Cases - In the Intelligent Home

Application Processing and Always Connected—Throughout the Home and the Grid

In Home Display
- Security Monitor and Control Subnet
  - Health and Fitness
  - Smoke Detector
  - Security Cameras
  - Light Switches
  - HPGP

Energy Management Subnet
- [Smart Grid HAN]
- Charging Station
- Solar Panel
- Energy Management GW
- PLC
- HomePlug
- Green PHY
- Home Gateway
- PON / 3G / LTE / DSL / Cable

3G/4G Utility Backhaul
NAN/WAN
WAN
Questions?
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<td><strong>Jeff Norman</strong></td>
<td><strong>Vice President Emerging Technologies – SAIC</strong></td>
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</table>

- 23 years of business development, telecommunications and technology experience. He currently serves as practice lead for SAIC’s emerging technologies team. He has been active in the smart grid technology arena since 2000 managing technology deployments with over twenty five electric and gas utilities.
- Prior to SAIC, he served as engagement lead with Capgemini’s Smart Energy Services practice. He has also served as vice president of Business Development for Current Communications Group, a broadband-over-power lines technology developer and service provider.
- Previously a founding employee for Main.net - PLC, a provider of power line communications; and sales management for telecom organizations: Business Telecom, Teleglobe and World Access.
- Served two terms as Technology Co-Chair for the United Power Line Council (UPLC).
Communication Architectures for Smart Grid Success

SAIC – From Science to Solutions®
• 40,000 employees, engineering focused
• Energy, Environment & Infrastructure solving for our customers mission - critical problems
• Emerging technologies focused on innovative technology and expertise

Make 'What If' Possible. Solve Today. Engineer the Future.
http://media.saic.com/engineering/home

Trends in Communications
• Market update
• Next steps in applications and architectures
• Role of public carrier in grid modernization
State of the Industry

To date, industry has deployed application-based solutions:

- Upwards of 30 million smart meters deployed in U.S. (50 million under contract)*
- U.S. smart meter market opportunity is 130 million total (electric, gas, water)
- Private field area network nodes projected to surpass 14 million annually by 2020**
- Majority of AMI local area networks are mesh wireless, tower-based RF, with limited power line communications and cellular

Source: *FERC **Pike Research

AMI = Advanced Metering Infrastructure  LAN = local area network; PLC = power line communication; RF = radio frequency; WAN = wide area networks
In 2010, 663 U.S. electric utilities had 20,334,525 advanced ("smart") metering infrastructure (AMI) installations. About 76% were installed by investor owned utilities and about 90% were residential customer installations.

1 Year for which most recent data is available.

<table>
<thead>
<tr>
<th>Type &amp; Number of Utilities with AMI</th>
<th>Residential</th>
<th>Commercial</th>
<th>Industrial</th>
<th>Transportation</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investor Owned</td>
<td>108</td>
<td>13,880,141</td>
<td>1,452,929</td>
<td>24,728</td>
<td>15,357,834</td>
</tr>
<tr>
<td>Cooperative</td>
<td>342</td>
<td>3,416,336</td>
<td>323,082</td>
<td>27,542</td>
<td>3,766,960</td>
</tr>
<tr>
<td>Municipal</td>
<td>184</td>
<td>278,198</td>
<td>44,757</td>
<td>2,471</td>
<td>325,426</td>
</tr>
<tr>
<td>Public &amp; State</td>
<td>29</td>
<td>795,233</td>
<td>84,215</td>
<td>4,826</td>
<td>884,305</td>
</tr>
<tr>
<td>Totals</td>
<td>663</td>
<td>18,369,908</td>
<td>1,904,983</td>
<td>59,567</td>
<td>20,334,525</td>
</tr>
</tbody>
</table>

By the end of 2012
30 million smart meters will have been installed

Source: US Energy Information Administration
AMI = Advanced Metering Infrastructure
Next Steps...

AMI = Advanced Metering Infrastructure
Where Do We Focus as Value Shifts Away From Smart Meters?

Applications or Architecture?

• Use a standards-based approach
  – Apply standards in developing smart grid infrastructure to economic and longevity reasons
  – Why not leverage the consumer
  – What is the role of cellular, Wi-Fi®
    • Should we incorporate existing, ubiquitous communications technologies

• How do we complement/augment centralized with distributed processing
  – Distribute the processing/intelligence to help alleviate latency and cost-of-transport issues associated with the anticipated heavy volumes of data

• What is the role for IP-based communications systems?
  – Apply Internet-based protocols (where available) as the standard for transport layer

• What is the role for Edge Diagnostics
  – Leverage multiple and existing communications
  – Local data access
  – Distributed processing

Wi-Fi = wireless fidelity
### TOTAL CELLULAR

- Total cellular connections estimated at ~6.3 billion, while total global population at >7 billion
  
  *Wireless Intelligence, Jul. 12, UN Database, Dec. 11*

### 3G/4G

- ~1.8 billion 3G connections globally as of Q2 2012, ~28% of total mobile connections, leaving a long runway for growth
  
  *Wireless Intelligence, Jul. 12*

- 2G connections expected to begin declining starting from 2014
  
  *Wireless Intelligence, Jul. 12*

- ~85 million 3G connections were added during Q2 2012, or about ~1 million new connections / day
  
  *Wireless Intelligence, Jul. 12*

- ~3.4 billion estimated 3G connections by 2016
  
  *Wireless Intelligence, Jul. 12*

- 89 LTE networks launched in 45 countries, 280 commitments in 90 countries
  
  *GSA as of Jul. '12*

3G/4G = generation

### M2M

- Machine-to-Machine device connections globally will grow by a factor of 20 in the next 10 years (2011-2021)
  
  *Analysis Mason, May ’12*
Communications Approach – Benefits of Using Public Carrier Networks

Commercial 3G/4G Networks Add Value to M2M Solutions

- **Real-time Communications**: Average latency of milliseconds (1)
- **Large Coverage**: 98% U.S. population is covered (2)
- **Standard Based**: Backed by 3GPP and 3GPP2 bodies
- **Affordable Cost**: Connectivity cost decreasing continuously (3)
- **High Scalability**: 5 billion + connections worldwide (4)
- **Reliability and Security**: Used in government and finance sectors

Source: Qualcomm

(1) CDMA Development Group; “Mobile Broadband Comparison”; March 2008
(2) Federal Communications Commission; “Connecting America: The National Broadband Plan”; March 2010
(3) SmartSynch webinar; June 9, 2010 (http://energycentral.fileburst.com/Product_webcasts/20100609_Cellular_Smart_Grid_SSI.swf)
(4) Wireless Intelligence estimate
Applications leveraging cellular

- **Smart Metering**
  - Full and selective
  - Utility & Customer Efficiencies
- **Customer Energy Management**
  - Demand Side Management
- **Distribution Monitoring & Automation**
  - Outage Management
  - Asset Management
- **Substation Monitoring**
  - SCADA
  - Load Profiling
- **Communications Aggregation**
What Is the Role of Edge Analytics?
Communications Node Enables Distributed Management

• Communications nexus for an integrated network
  – WAN communications
  – LAN communications modularity (Wi-Fi®, PLC, ERT)
  – Distributed grid management enabled by local processing and memory
  – Energy sensing applications current, voltage, power quality, power factor

Digital Grid Communications Overview

WAN = Wide Area Network; LAN = Local Area Network; Wi-Fi = wireless fidelity; PLC = power line communication; ERT = encoder, receiver, transmitter; RF = radio frequency; PEV = plug-in electric vehicle

Source: Duke Energy, “Developing the Communications Platform to Enable a More Intelligent Grid”
Questions?
You will receive a link to download a copy of the slides to the email you used to register.

Jesse Berst  
Host & Moderator  
SmartGridNews.com  
jesse.berst@globalsmartenergy.com

Sunvir Gujral  
Product Manager  
Qualcomm  
sgujral@qti.qualcomm.com

Jason Ellis  
Staff Manager Business Development  
Qualcomm  
jellis@qti.qualcomm.com

Jeff Norman  
VP of Emerging Technologies  
SAIC  
Jeffrey.a.norman@saic.com