Wireless Communications for Smart Grid

Kuor-Hsin Chang, Ph.D.
Elster Solutions
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Smart Grid

- Delivers electricity from suppliers to consumers using two-way digital technology to control appliances at consumers' homes to save energy, reduce cost and increase reliability.

- Overlays the electricity distribution grid with the information technology and communication system.

- Combines sensing and measurement with two-way communications to monitor and control the power grid.

- Integrates renewable electricity such as solar and wind power.
Smart Grid Benefits – Business Case

- Lower customer bills
  - Bill credits through Smart Energy Pricing
  - Empowered consumers managing energy use
- Improved reliability
- Automated outage reporting / faster restoration
- On-demand meter reads
- Eliminates manual meter reading
- Reduces truck rolls for turn on/off of service
- Lower energy consumption - Reduced carbon emissions
- Infrastructure that can support renewable energy generation
- Infrastructure that can support smart charging of Plug-in Hybrid Electric Vehicles
- Remote fault indication
- Voltage optimization and efficiency gains
- Peak load reductions
Energy and Smart Grid
The State of Technology

Smart Grid – Today: Efficiency Benefits

Peak reduction is being obtained and improved
• Expanded use of traditional Time-of-Use (TOU)
• Monitoring and Improvement in TOU rates
• Critical-Tier-Pricing

Voltage monitoring and control are showing…
• 6-8% reduction in voltage yields…
• 4-6% reduction in energy consumed
• Conservation / bill reduction with zero consumer involvement
2009 Data Example: One utility with 500k installed points to date (half their consumers)

- **Eliminated: 246k field visits** (in addition to billing cycle reads)
  - Saved 82k labor hours
  - Saved 443k miles
  - Saved 44k gallons of fuel

- **Improved safety across the workforce**
  - Reduced personal injury 39%
  - Reduced vehicular accidents 10%

- **Improved response to service reconnection**
  - From: 4 days after payment
  - To: 1 day, 24 hours a day, 7 days per week
Elster - The world leader

Elster sells products and services in more than 130 countries across electricity, gas, water and multi-utility applications for residential, commercial and industrial customers.

7,500 employees
200 million installations in the last ten years
38 major locations
170 Years providing utility solutions

Elster/Kromschröeder/Instromet (Gas)
American Meter (NA Gas)
Westinghouse/GEC/ABB (Electricity)
Kent (Water)
Coronis (RF) / PowerOneData (GPRS)
Utilizing Elster Communication Infrastructure for Grid Applications

Applications:

- Voltage and VAR Control
- Transformer Voltage Regulation
- Non-technical Loss Discovery
- Fault Location, Isolation and Service Restoration
- Feeder/Substation Planning
- Feeder Balancing
- Condition Assessment
- Feeder Reconfiguration
- Contingency Analysis
- Transformer Sizing
Smart Grid Communications and Smart Metering

• EnergyAxis is Elster’s communication system for Smart Grid applications
• Over 4 Million endpoints in 80 systems in 8 countries
• Production EnergyAxis systems are reading over 4M meters daily
  • Daily reads for Time of Use (TOU) data
  • Daily reads for interval (i.e. energy usage in each interval of the day)
  • >1,000 service connect/disconnects each week
• Electricity, gas, and water metering
• It’s more than metering
  • Grid infrastructure control and monitoring
EnergyAxis® Component View

Utility Network

WAN – WIC

EnergyAxis Management System (EA_MS)

Enterprise Network

LAN EA NIC

Gatekeepers

AGInodes

AGI DA Gateway

AGI DA Gateway - WAN

In-Premise Devices

HAN Zigbee and EA
Neighborhood Area Network (NAN) (Smart Utility Network-SUN)
Communication Technologies for NAN (SUN)

- Wireless based Mesh Network
  - FSK operating in 900 MHz
  - DSSS-O-QPSK based technology operating in 2.4 GHz (IEEE 802.15.4/ZigBee)

- Powerline communications

- Private licensed frequencies bands

- Standardization effort in IEEE 802.15.4g
Home Area Network (HAN)

- A communication network consists of smart appliances and renewable energy generators (solar, wind and PHEV (plug-in hybrid electric vehicle))

- Communicates Meter Data into home to enable home automation and energy management

- Energy management systems/Home automation includes policy-based control of HVAC and smart appliances
Communication Technologies for HAN

• Wireless technologies:
  – IEEE 802.15.4/ZigBee (DSSS-O-QPSK based technology operating in 2.4 GHz)
  – IEEE 802.11/WiFi

• Powerline communications

• Application protocol-Smart Energy Profile 2.0
  – Support physical standards such as 802.15.4, 802.11, P1901
Residential Demand Management

Smart Energy Profile – ZigBee and TOU

- **Challenge:**
  - Provide real time consumer usage/consumption and peak load management
  - Implement residential TOU program
  - Implement Smart Appliance control

- **Solution:**
  - Leverage SEP ZigBee Demand Response to display and control in-home use

- **Benefits:**
  - Accurate data enables consumer to determine the **optimal usage and reduce peak demand**
  - Information, knowledge and ability to better manage demand
    - Better understanding of the cost of using appliances, AC, heating, etc.
      - In general
      - At different times of the day under a TOU rate
  - Ability to manage / reduce overall energy consumption
    - Manage peaks, shift load
    - Additional benefits during Critical Peak periods
  - Control (direct/indirect) of energy use

- **Enabling Solutions/Partnerships:**
  - Displays, Thermostats, other ZigBee enabled devices
WiFi Alliance/IEEE 802.11

- Created Smart Grid Task Group in 2009
  - Promote Wi-Fi for Smart Grid
  - Extend Wi-Fi certified testing program for Smart Grid devices and applications
- IEEE 802.11 for sub GHz:
  - Study Group was formed in January 2010 Meeting in LA
  - Task Group starts functioning in the coming September meeting
IEEE 802.15.4g

- IEEE802.15.4g Task Group defines a PHY amendment to IEEE 802.15.4 to address outdoor Smart Utility Network
- AMI/Smart Meter applications
- Started as Study Group on September, 2008
- Call for preliminary proposal on March 2009
- Preliminary and final proposals presented on May 16-22, 2009
- Issued 1st Letter Ballot on April 2010
- 2nd Letter Ballot will be out early October
IEEE 802.15.4g (cont’d)

• This Standard defines a PHY amendment (and only those MAC modifications needed to support its PHY change) to IEEE 802.15.4 to address outdoor Low Data Rate Wireless Smart Metering Utility Network (SUN).

• The amendment supports the following:
  – Operation in available license exempt frequency bands, such as 700MHz to 1GHz, and the 2.4 GHz band.
  – Data rate of at least 40 kbits/sec but not more than 1000 kbits/sec
  – Achieve optimal energy efficient link margin under SUN deployments.
  – PHY frame sizes up to a minimum of 1500 octets.
  – Simultaneous operation for at least 3 co-located orthogonal networks
  – Connectivity to at least one thousand direct neighbors in dense urban deployment
  – Provides mechanisms to coexist with other systems in the same band(s) including IEEE 802.11, 802.15 and 802.16 systems.
IEEE 802.15.4g (cont’d)

- Three different PHY proposals:
  - FSK
    - Narrow band frequency hopping using FSK (GFSK)
  - MR-OQPSK
    - Based on existing 802.15.4 DSSS PHY
  - OFDM
4g (SUN) Frequency Bands and Data Rates for FSK

- 915 MHz/2.4 GHz unlicensed band
  - 50 kbps (mandatory), 150/200 kbps (optional)
- 950 MHz Japanese band
  - 50, 100, 200, 400 kbps
- 863 MHz European band
  - 50, 100, 200 kbps
- 470 MHz Chinese band
  - 50, 100, 200 kbps
- Licensed bands
  - Data rates 40 kbps or lower
4g (SUN) Frequency Bands and Data Rates for OFDM

- 915 MHz/2.4 GHz unlicensed band
- 950 MHz Japanese band
- 922 MHz Korean band
- 863 MHz European band
- 470, 780 MHz Chinese band
- Data rates from 50 kbps to 800 kbps
4g (SUN) Frequency Bands and Data Rates for O-QPSK

• 915 MHz/2.4 GHz unlicensed band
• 950 MHz Japanese band
• 868 MHz European band
• 470, 780 MHz Chinese band
• Data rates from 12.5 kbps to 500 kbps
Thank You!

Kuor-Hsin Chang
kuoar-hsin.chang@us.elster.com
www.elstersolutions.com