PAP02 Extended Work - Guidance on Use of Wireless in the Smart Grid

Proposed Framework
Updated 21Jul2011
Objectives

- Provide a fact-based assessment of wireless standards and representative technology implementations of those standards (using specific spectrum) for their ability to satisfy the business needs for the Smart Grid
- Build upon and extend NISTIR 7761
- Accomplished within 6-9 months of voluntary resources
In - Scope

- Wireless standards specifications, and representative technology implementations of those standards
- Spectrum in the range <700 MHz - <6GHz
- AMI networks and Distribution FANs
- “Last Mile” and backhaul networks
- Account for representative real-world deployment areas and their characteristics of: RF propagation factors, endpoint deployments, business application requirements
Out of - Scope

- Pricing or Costs (CapEx or OpEx)
- Simulation modeling of the wireless standards and technologies
- Detailed base-station and subscriber lat/lon RF propagation network design with associated detail clutter and typo terrain data
Framework Basics

- Use a model Smart Grid area concept described by:
  - Endpoint population and density category characteristics, based on USA-state census track data
  - RF propagation representative characteristics
  - NISTIR 7761 business application requirements
Framework Basics — cont'd

- Wireless standards/technology and spectrum modeling of the model area:
  - Using a multi-worksheet spreadsheet tool (with generalized parameter input for design factors)
  - **Minimum output:** quantity of wireless std/tech/spectrum network gear required by endpoint density category, incremental gear type/count for RF propagation factors & engineering work-arounds for subscribers, and declarations of “no endpoint coverage” conditions
Framework Basics — cont'd

- Deliverables - “Guidelines for use of Wireless in the Smart Grid”, (a separate NISTIR or volume or appendix to NISTIR 7761) containing:
  - Overview of process
  - Description of model Smart Grid Area and Characteristics
  - Description of Wireless Standards (with representative technologies and utilized spectrum bands and amount.
  - Matrix and summary of the assessment results categorized by wireless standard, spectrum band and containing: network gear type/count by density category, with incremental counts by RF propagation factor, noting work around conditions and areas of no coverage provided
Framework Basics — cont'd

Proposed Framework Details r0.1 tab Cell & External Inputs Linkage

- Census Bureau 2000 tracts & places
- Clutter issues
- Foliage issues
- AMI endpoints
- DA endpoints
- SG-Net Ref Diagram
- SG-Net Rqmts Table or Database

USA-states ➔ Model-area ➔ SG-Net Rqmts base ➔ SG-Net Rqmts addlt-input

Wireless Stds ➔ Wireless Rep Tech ➔ Othr shared parms ➔ Path lose & clutter/foliage models

Std_Tech1- SpectrumA-inputs ➔ Std_Tech1- SpectrumA-calcs

Std_Tech1- SpectrumB-inputs ➔ Std_Tech1- SpectrumB-calcs

Std_Tech1- SpectrumF-inputs ➔ Std_Tech1- SpectrumF-calcs

... ➔ Sum-Outputs

Std_Tech1- SpectrumA-inputs ➔ Std_Tech1- SpectrumA-calcs

Std_Tech1- SpectrumB-inputs ➔ Std_Tech1- SpectrumB-calcs

Std_Tech1- SpectrumF-inputs ➔ Std_Tech1- SpectrumF-calcs
# WorkPlan / Timelines

<table>
<thead>
<tr>
<th>WBS</th>
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<tr>
<td><strong>Data Gathering:</strong> finalize model area characteristics, wireless stds, techs, spectrum, appropriate wireless models</td>
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<td>Design and prototype spreadsheet assessment model, includes specifying inputs, outputs, format</td>
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<td>Assemble Content and write guidance</td>
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Follow-Up Question & Response / Resolution

Need consensus within PAP2 for following items via published reports, papers, field experience, etc for use in the modeling effort across all Stds-Technologies to be assessed:

• Fade margins

• Interference Margin

• Penetration Loss

Response: believe is this is possible
Follow-Up Question & Response / Resolution – cont’d

How to fairly estimate channel capacity w/o using technology-specific simulations? Options:

1. Accept estimates from SDOs based on their specific evaluation methodologies
   - Parameter assumptions not consistent with SG use cases
   - Results in apples-to-oranges comparisons

2. Develop a simulation methodology within PAP2 specific to SG to apply to all wireless alternatives
   - Time-consuming process & may be difficult to reach consensus
   - Probably beyond the scope of PAP2 - Version 2

3. Use NISTIR 7761 section 5.0 analytical/mathematical modeling approach

4. Use a coverage area vs. S/N ratio approach
   Assumes uniform distribution of stationary end-user terminals [restricted to higher density areas, service territory for a specific utility tends not to be uniform]
   Assumes all terminals are non-LOS
   Requires a table of S/N vs. data rate for each technology

Response: Belief is that opt 3 will be acceptable
Follow-Up Question & Response / Resolution – cont’d

How to determine or estimate Average Channel Capacity Over Coverage Area:

WiMAX proposal to plot effective data rate against % of coverage area for a specific terrain type, channel width, TDD, DL:UL.

- UL Channel capacity is the “area” under the curve – (I used area increments of 10%)
- Result takes account Terrain Type and BS antenna height
- The range and coverage area are dependent of link budget and frequency

This is similar to ATIS Aggregate Sector Throughput” vs. “Cell Radius” graphs

**Response:** believe is this is possible
Follow-Up Question & Response / Resolution – cont’d

**latency** - concurrent modeling for in the requested gear count by std_tech_spectrum specific characterized-model-area

**Response:** yes we are making progress on lining up the process steps to perform the requested output processing, but please do not short change the attention that needs to be played to the latency & reliability aspects of the SG requirements.

**Editorial:** this proposed framework effort calls for is an assessment (at a high level) of wireless and guidelines of where in SG wireless is suitable. The user could take this process and go further in their specific deployment characteristics and use this process as additional guidance on assessing wireless in their proposed Smart Grid deployment.
Follow-Up Question & Response / Resolution – cont’d

Can we bound the capacity calculation by two cases where in one case latency is irrelevant, and in the other case low latency is required by all the devices. In a real system, there will be a mixture of the two cases. What is needed is % of mix of these scenarios to do the calculation.

Response: in the framework spreadsheet details, the 1st 3 tabs have specific input for the number of meter and DA endpoints and with the SG Network TF requirements inputs, the number of payloads that have low latency and other varying degrees of latency in the mix.
Performing Simulation - Advantages of having more full-fledged simulation results are quite compelling: the results become believable, and lend greater credibility to the output.

Response: There are more ways than one to build believability of some mathematical modeling:

- use of simulation as a proxy for what might be representative of the unpredictability of network traffic events
- heuristics based on real world observations of how specific technology operates in specific conditions
- statistical results from real world event data that is transformed into probabilistic models that can be applied mathematically into the model without added simulation using random number generation per sets of probabilistic distributions

The framework proposes to use the last 2 approaches as was demonstrated in the sect 5 of v1.0 document did indicate the reasonable approach that did not require the labor that simulation requires.
Next Steps?

Reach consensus on:

Common inputs, processing, out mapping into the requested output tab

payload arrival rate: based on the SG Network requirements that are selected and scaled to specific named interfaces, per unit of time e.g. 5pm hour, there is a distribution of traffic with different payload size and latency, not a simple x mb per unit of time all with the same latency requirements. This needs to be clearly understood and consensus reached on how to account for this in the calculations.

then prepare the workplan/schedule to address all the tan shaded cells in the proposed framework details spreadsheet tabs

identify whom will commit and actively participate