Planning of Integrated Smart Grid Wireless Networks

By Mark Chapman, CEO, EDX Wireless, LLC.

Smart Grid wireless communication networks are very complex and frequently consist of many parts. At the meter level, communication is often facilitated by a RF (Radio Frequency) mesh architecture. Mesh topologies have many advantages such as resilience, redundancy and self reconfiguration making them well suited for meter-to-meter communications. The mesh structure in turn links to a repeater and collector network which is often a point to multipoint type of architecture. Tying it all together is a backhaul network, often RF microwave.

Given the above complexity, designing an integrated and optimal communications system for a large scale Smart Grid deployment is no mean feat. However, it is important that some form of modeling is done in advance for scaling and presales dimensioning and preliminary design work and to ensure the proposed solution meets the design targets for reliability and redundancy.

Planning the Meter Layer

Statistical modeling at the meter layer level can be very revealing. A detailed analysis can show: meters which cannot be connected even with meshing, groups of meters which mesh to each other but cannot reach the network , and meters which form a critical node or 'articulation point'. These latter are meters which funnel traffic from other many meters due to their advantageous RF links. A failure of these meters or repeaters can have a significant effect on overall performance and connectivity.

Meter-to-meter mesh links are typically short so the RF link is modeled statistically. But given that a typical large scale deployment may have hundreds of thousands of nodes, the possible RF routes are exponential and the resultant calculations enormous. Some form of sophisticated modeling software such as EDX SignalMX™ is needed, particularly for large scale mesh deployments.

The next layer is the collector layer, usually with the addition of an intermediate repeater layer which extends coverage from a collector itself. The planning of these layers must be integrated with the underlying meter RF mesh layer and cannot be designed in isolation.

Links into the repeater and collector networks can be long and terrain can be a significant factor. In this case, high resolution data is needed to create a reliable model of RF performance. The accuracy of data is a critical factor in initial design work as an under-designed network may result in isolated clusters of meters which cannot reach a collector or repeater. Conversely an overdesigned network will result in higher cost without any improvement in performance. Building it first and fixing it later is always a poor option. It is therefore vital that companies bidding for AMI contracts have good initial estimates that they can rely on for costing and making bids which are also compliant with performance targets and guarantees.

One critical and overlooked aspect of modeling is the geographical data being employed. As we note, the meter layer lends itself to statistical RF analysis with a standard empirical model for individual RF link performance. The analysis software may also selectively run more detailed link based analysis if a particular link has a terrain aspect across it, i.e. a longer link where there is a change in elevation.

Carving Through the Clutter

High resolution data is needed to effectively model the collector and repeater links. Unfortunately, this type of data can be very expensive and therefore not ideal for pre-sales work, initial estimates or "what-if" analyses. An alternate approach is the use of 'Clutter Carving'. This technique allows street data to be used to carve out RF "street canyons" which are incorporated into lower resolution inexpensive clutter data. This approach provides a more accurate representation of the physical environment than a simple area coverage map or mesh link study based on 'free' or low resolution data on its own. Using this method will provide a more accurate design of the Collector and Repeater layers and is a lot cheaper, making it well suited to pre-sales work and the creation of initial estimates.

Finally, tying the project together, any associated RF backhaul links can be modeled and an overall integrated model of the proposed system can be rapidly realized. This is not only highly useful for the bidding process but creates a detailed working model that can be iterated during actual implementation.

In summary, Smart Grid RF networks are large and complex. Avoiding modeling because of cost and complexity usually results in either under-designed or overdesigned networks. A comprehensive and integrated approach using automated RF planning software will result in a rapid and effective solution which will minimize overall design and implementation costs while delivering superior performance in terms of throughput, reliability and resilience.

Mark Chapman is the CEO of EDX Wireless, LLC. As a veteran in the wireless industry, Mr. Chapman has a wealth of wireless industry experience. Previously, he was senior vice president and general manager at Comarco, Inc. and president of Ascom, Inc., a Swiss provider of wireless network test equipment which acquired Comarco's WTS division. Prior roles include acting vice president of Business Development for WiSpry, a semiconductor company targeting broadband and wireless communications, and president and CEO of Ditrans Corp, a venture funded fabless developer of Digital Transceiver products. Other prior experience includes various management, sales and marketing positions at Rockwell Semiconductor (now Conexant) and serving as board member of DPAC, a provider of industrial WiFi module solutions. Chapman holds a bachelor of science in electrical engineering with first class honors from Robert Gordon's University, Aberdeen, Scotland.