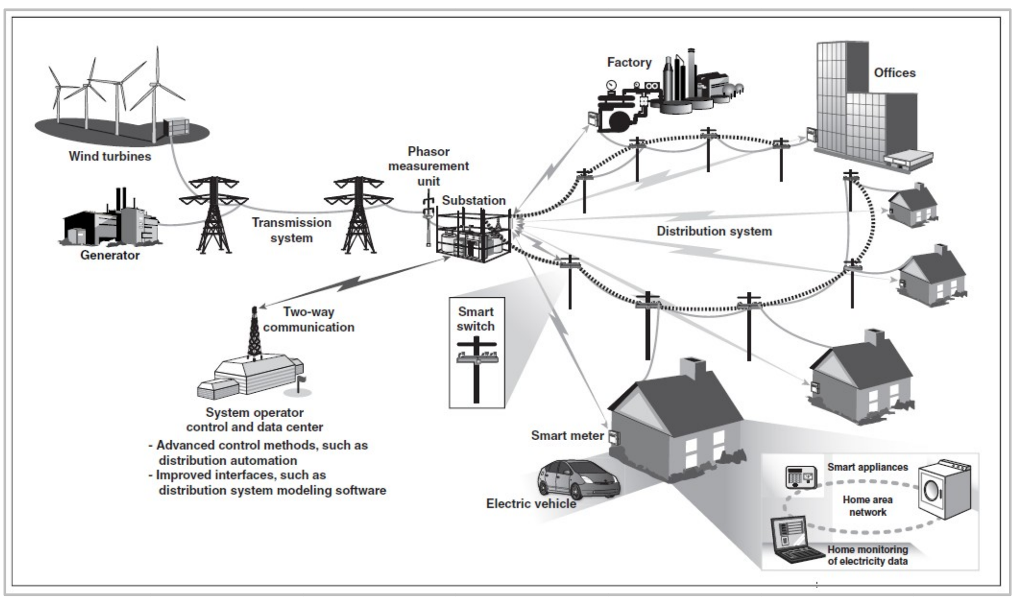
Spatial Information - Enabler for Smart Grid

Introduction:

After a long period of relative stability, the electricity industry is undergoing a major disruption of its traditional business model. The electrical meter is no longer the network end point. Home appliances are fast becoming the new touch point for residential customers. Power generation is coming from multiple sources including wind, solar, and hydro. Homes and business, the traditional customers of the grid, are becoming generators themselves, supplying energy back to the grid. On one hand, all these changes are triggering multi-fold increase in data over what is presently available to the utilities. On the other hand, utility companies own a number of critical systems to support their day-to-day operations, including Geographical Information, Outage Management, Distribution Management, Meter Data Management, Asset Management, and Customer Information Management, etc. But, most of these systems operate independently. Under these circumstances, are the utility enterprise systems ready to handle the information explosion after implementing Smart Grid solutions? Industry experts believe that, given the nature of GIS, it has the potential to unify various software applications and in streamlining business processes. In this paper, we will discuss how GIS can enable ITand operational systems for Smart Grid and the essential characteristics of GIS that form the foundation of this transformation.



Credit - Government Accountability Office, the auditing and investigative arm of the U.S. Congress'

GIS, an enabler for Smart Grid:

GIS captures the spatial nature of the utility assets. TraditionallyGIS has been used as a standalone system confined to planning, design, and engineering part of utility business.

Now, it is being seen as an enabler to increase operational efficiencies of the business processes across several departments. It is becoming the source of base data for virtual representation of the electric delivery system to make operational decisions and to enable enterprise IT systems of Smart Grid.

When the data is consolidated using GIS, it will not only eliminate information redundancies but also can unify various software applications in streamlining business processes. Thus, it can help improve the operational efficiencies across the utility. GIS also has a strong role to play in managing the Smart Grid right from planning to deployment and post-deployment phases. It helps utilities in determining the optimal locations of the Smart Grid components and in assisting smart meter deployment.

So, to realize Smart Grid, the information that exists in GIS must be accurate and trustworthy. In fact, the GIS should be spatially complete, consistent in format, topologically well-connected, positionally accurate, and up-to-date.

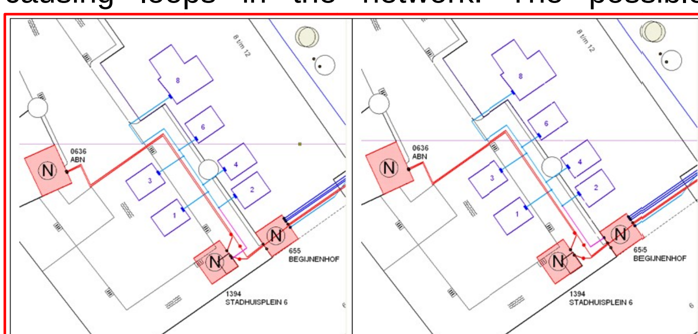
Impact of poor data quality:

There is a huge impact of poor GIS data quality on other functions such as outage management, regulatory compliances, and demand response.

Let us review a few examples.

Outage Management:

Typically, most utilities have their OMS network data model built from the distribution network data stored in GIS. With this practice, there may be incorrect data wherein either customers are not connected to any equipment, or they are connected to the incorrect equipment. Also, there maybe connectivity errors such as orphan entities, overlaps, or duplicate geometries causing loops in the network. The possible consequences could be incorrect fault prediction leading to un-located calls affecting customer restoration time, increased duration, and frequency of interruptions (CAIFI/SAIFI/CAIDI/SAIDI/CML).

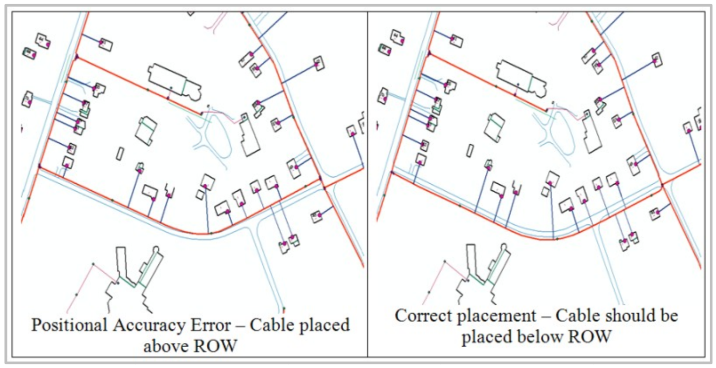


Wrong connectivity - Industrial consumers shown connected to S/S no.1394

Correct connectivity - Industrial consumers should be connected to S/S no.655

A classic example of an un-located call is shown in the diagram wherein the industrial customers are connected wrongly to substation 1394 but should have actually been connected to substation 655.

Regulatory compliance:



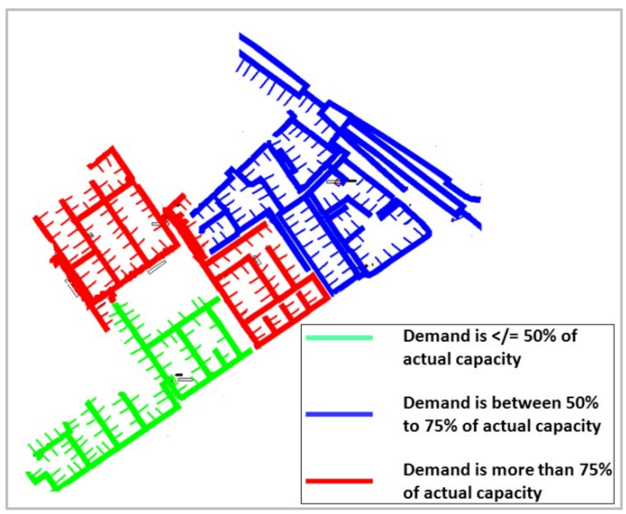
Positional Accuracy Error – Cable placed above ROW

Correct placement – Cable should be placed below ROW

In most real-life scenarios, the field dispatch of the crew depends on spatial information of the network assets shown in GIS. In case the network data is positionallyinaccurate, or the radial assets data has been captured with incorrect characteristics (size, material, make, etc.), the crew will end up excavating at a wrong location leading to operational delays, accidents (and possible fatalities), and damage to assets. The biggest and most adverse impact of all these would be that the statutory safety regulations are not met. Also, these would mean that cost and restoration times are increased.

Demand Response:

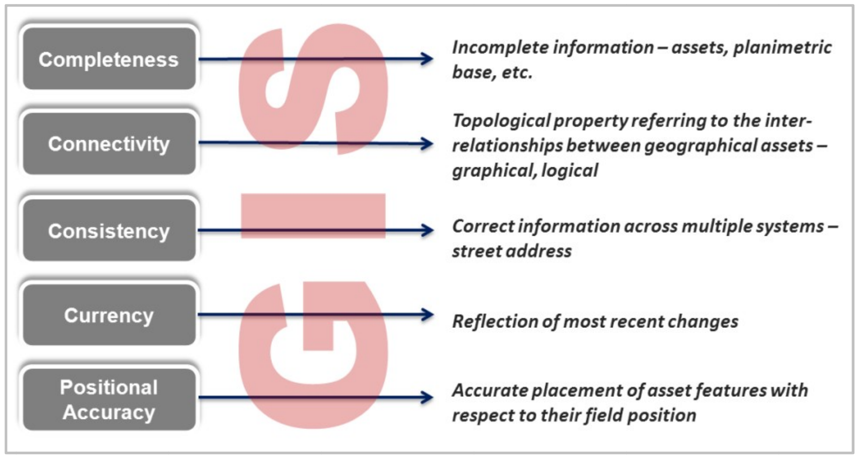
Integration of GIS with Meter Data Management System (MDMS) is a popular practice with utilities these days. But, it poses a few challenges for utilities, wherever, the customers are either not connected to any equipment or they are connected to incorrect equipment. This apart, the information is incomplete as the network asset data in GIS does not include customer information (e.g. energy sinks, embedded generation, and capacity, etc.). The disadvantages of this practice are complex access to data (meter and customer data), greater time for analysis, and difficulties in determination of demand response and load control and related decisions, all of which result in poor performance.

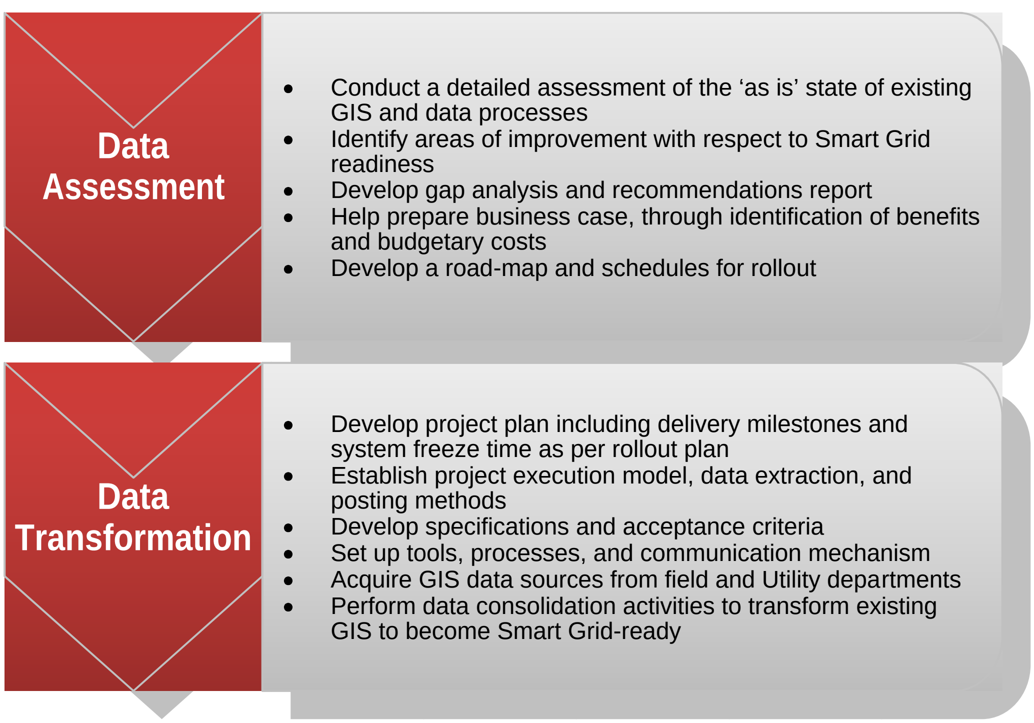


As can be seen in the diagram, network asset data (including customer information in GIS)when integrated with near real-time consumption data from Smart Meters enablesutilities to visualize their network loading status thematically and implement demand response programs better.

Recommended Approach:

It can be seen that GIS has a strong role to play in managing the Smart Grid using spatial information and its ability to visualize complex problems thematically. However, to provide solution forthe above said business needs, the GIS should be complete, consistent, positionally accurate, up-to-date, and possess physical and logical connectivity. Therefore, from a GIS perspective, a utility implementing Smart Grid should adopt a two-phased approach. The first one is the data assessment phase where the 'as is' state is studied and reports (such as business case, gap analysis reports, and recommendations) are generated. The second phase relates to the transformation based on the gap analysis and recommendations addressing the various parameters listed in the above figure. This approach is illustrated in the following diagram.





Conclusion:

The way utilities have been using GIS has changed significantly in recent years. There has been a marked shift from a standalone system to an enterprise system to handle the information explosion after implementing Smart Grid solutions where the data is accessed by thousands of people. However, there are still a few issues which are unaddressed by most utilities such as data model, data completeness, data correctness, positional accuracy, and consistency. These are preventing utilities from effective utilization of their GIS applications. Unless these issues are resolved, utilities cannot fully leverage the information in GIS for Smart Grid implementations.

Having significant expertise and wealth of knowledge in geospatial data and applications related to power utility industry, Infotech's Smart Data Services can analyze those issues and help utilities transform their GIS from their current state to reach a state where it can fully support Smart Grid.

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