

NIST INTERIM SMART GRID STANDARDS INTEROPERABILITY ROADMAP WORKSHOP

Contribution from IEEE PES Distribution Automation Working Group

Introduction :

The IEEE PES Distribution Automation Working Group is a technical group of the IEEE Power and Energy Society (PES) under the Distribution Sub Committee. It has more than 200 members from 9 countries on its membership list. The group meets generally 2 times per year (IEEE PES General meeting during summer and Joint Technical Committee Meeting in Winter) and typically 35 to 45 persons are attending those meetings.

The scope of the group is :

Treatment and advancement of design concepts and philosophies as they apply to the automation and optimization of overhead and underground distribution systems.
Development of environmentally acceptable and technically and economically feasible design guidelines.

Distribution Automation and Smart Grids

Distribution Automation (DA) definition is changing. In the past DA was mainly automatic reconfiguration. Today, the new technologies available for distribution systems bring along a list of new automated applications that can be included in a Distribution Automation project or program.

Therefore DA can have different meanings. For many utilities, Distribution Automation / Smart Grids = Smart meters. For other utilities, Distribution Automation is Capacitors controls. For some others, Distribution Automation is an extensive system including several applications that have been, or will be, implemented through the years.

The following applications can generally be identified to Distribution Automation:

- Remote controlling of feeder reclosers and switches
- Automatic reconfiguration of feeders through remote controlling of feeder reclosers and switches (this includes generally fault detection)
- Fault detection at Distribution feeder devices
- Accurate Fault location based on wave shape analysis
- Capacitors control
- Volt and Var control from sensors on the distribution systems
- Power Quality (Harmonic content) measurements

- Distribution line monitoring (Power measurements)
- Distribution underground network grid monitoring and control

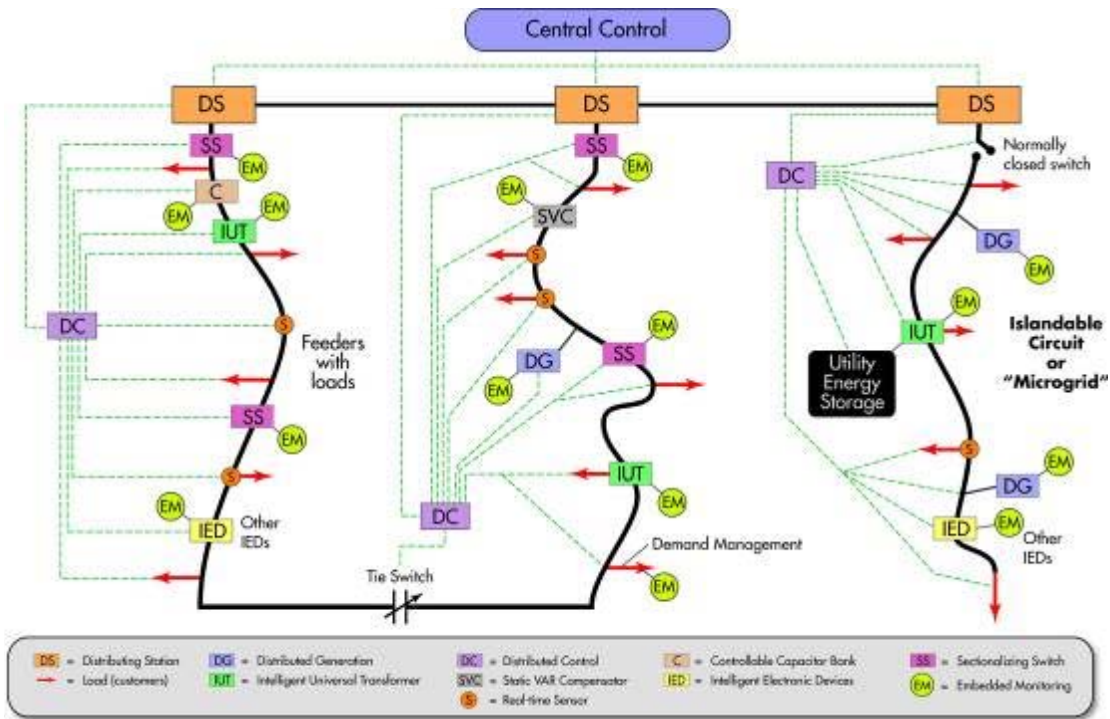
The foregoing listed applications have been typically associated with the deployment of SCADA (Supervisory Control and Data Acquisition) technology in the distribution substation and along the distribution circuits. A communication infrastructure has typically been installed with adequate bandwidth and reliability to support the use of the SCADA technology to meet the remote monitoring and operational needs of the electric distribution system. While the typical SCADA communication infrastructure does not support bulk data download, e.g. IED waveform data, this distribution automation solution is a building block for the Smart Grid and is being considered by some as the foundation to build upon in developing the Smart Grid.

The following applications have direct impacts on above applications of distribution automation but are treated by other IEEE PES WG.

- Distributed Energy resources
- Dispersed generation and micro-grids
- AMI

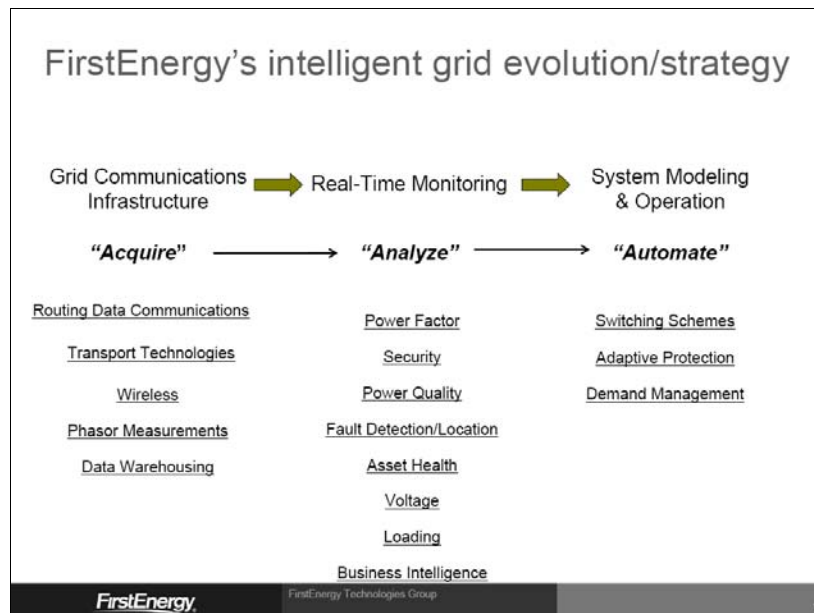
As the penetration of the AMI technology continues throughout the electric distribution system, the knowledge of the state of and the ability to remotely control the distribution system provides the necessary foundational dynamics to exploit the new AMI data and information to improve the reliability and efficiency of the electric distribution system. Thus the existing DA deployments and the AMI implementations are complimentary technologies that will ensure the achievement of utility's Smart Grid initiatives. Therefore, for the IEEE PES DAWG Smart Grid is more than Smart metering.

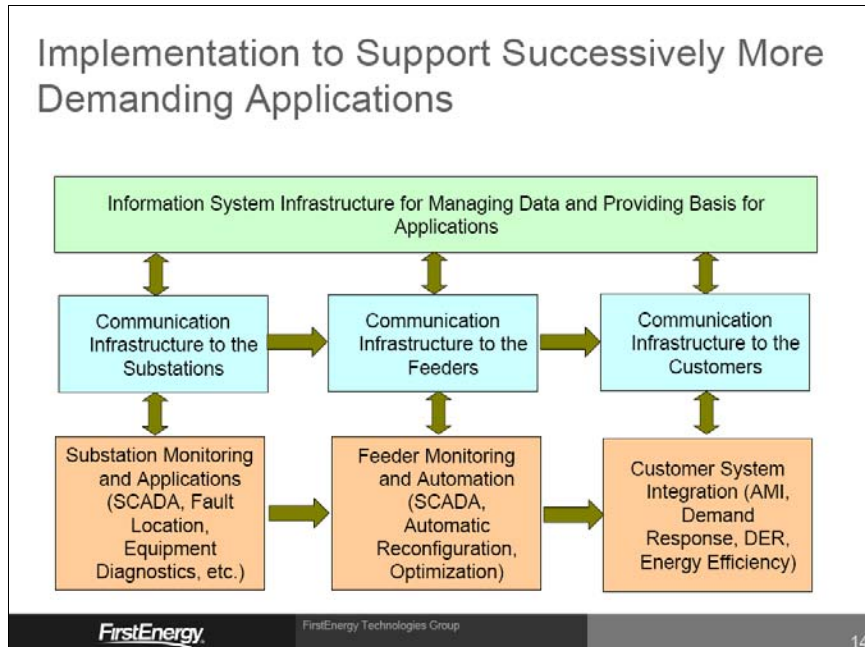
As an example, the figure below illustrates the EPRI vision of Advanced Distribution Automation including several technologies/Applications on the distribution system. (Automatic transfer, Dispersed generation/Energy storage, Intelligent Electronic Devices, Centralized and decentralized control etc...)



To implement such a Smart Distribution system, a specific set of standards is required beyond the one needed for the integration of smart meters to the information system of the distribution network.

The next figures illustrate examples of FirstEnergy’s intelligent grid evolution and the information infrastructure for managing data coming from the system.





The figure above clearly shows three coordinated systems (Substation, Feeder and Customer) that need to be coordinated to reach an integrated Smart Grid.

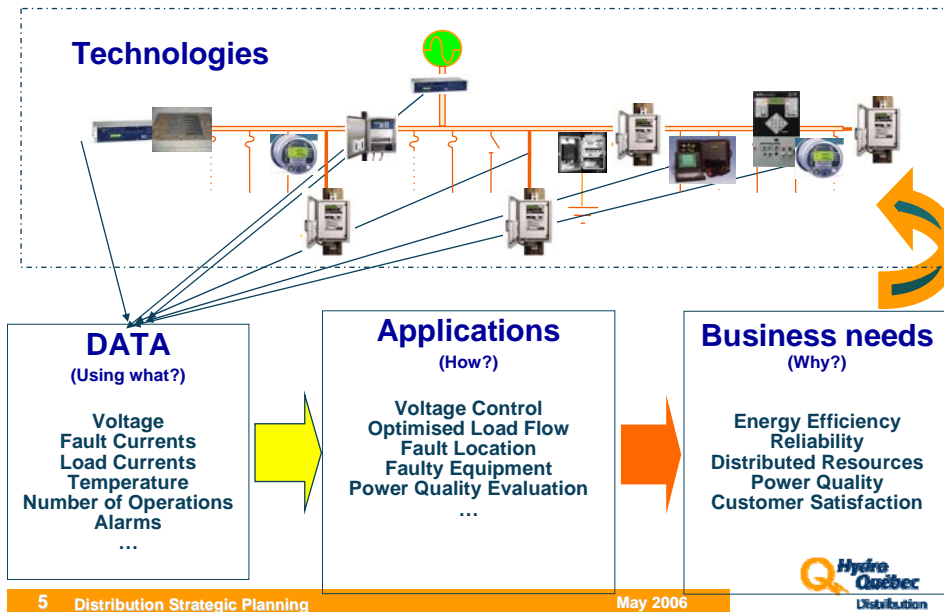
For the substation system, IEC 61850 has been successfully deployed in European substations to achieve substation automation. There is little penetration of IEC 61850 in the North American electric utility market. However there is encouragement to use 61850 for communications with automated devices along the distribution circuit. To do so in the typical North American market for the distribution (feeders) system, the concept of 61850 “Lite” has been suggested in order to maximize device communications where there is limited bandwidth. The specificity of the typical North American distribution system compared to the European distribution system, e.g. on line equipments, may result in additional requirements that only North American utilities can specify.

The necessity of interoperability for the customer (Smart meters) system is also needed and already well recognized within the industry. Along with the challenge of developing the three different sets of standards (substation, feeders and customer), comes the coordination between the different standards.

The development of the Smart Grid interoperability standards is a dynamic process which will have to adapt to the new type of loads (PHEV and Electric cars...) and generations (DER and DG) to be connected to the distribution system without compromising the reliability and power quality delivered to customers. The standards should also consider implementation of future micro-grids.

The next figure is another way to represent the flow of information in a fully integrated distribution system

Distribution Automation Flow of Information



The justification of the applications can be different for each utility depending on their own context and business drivers but, in the end, an integrated Smart grid shall be based on a common interoperability set of standards to reduce the costs.

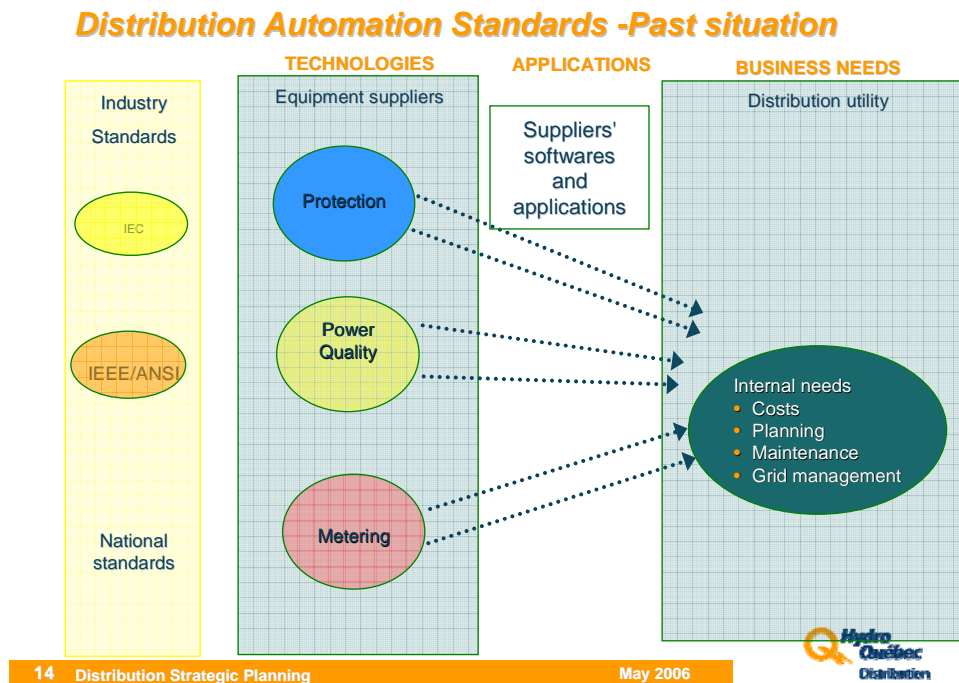
The new Smart distribution system could be inspired by what is used today for Transmission system. One inspiration opportunity is the technique being used to display phasor data. Presentation techniques have been developed to manage the phasor data over large interconnected transmission systems where the component detail is lost at the high zoom level required to view the entire transmission system. Similarly in distribution, there will be compact concentration of distribution facilities within smaller area but, again, the component detail is lost at high full-system view. So leveraging the presentation techniques for phasor data is a first step in development of the presentation for the new Smart distribution system.

To move from today's distribution network to a Smart Distribution system these guiding principles are suggested

- **The distribution network evolution must start from the actual network and gradually moves toward an intelligent grid**
- **The remote control infrastructure shall be used to gather network information**
 - This information is needed to add intelligence to the network in order to increase its performance
 - The number of location gathering information needs to be increased to improve the visibility of the network.

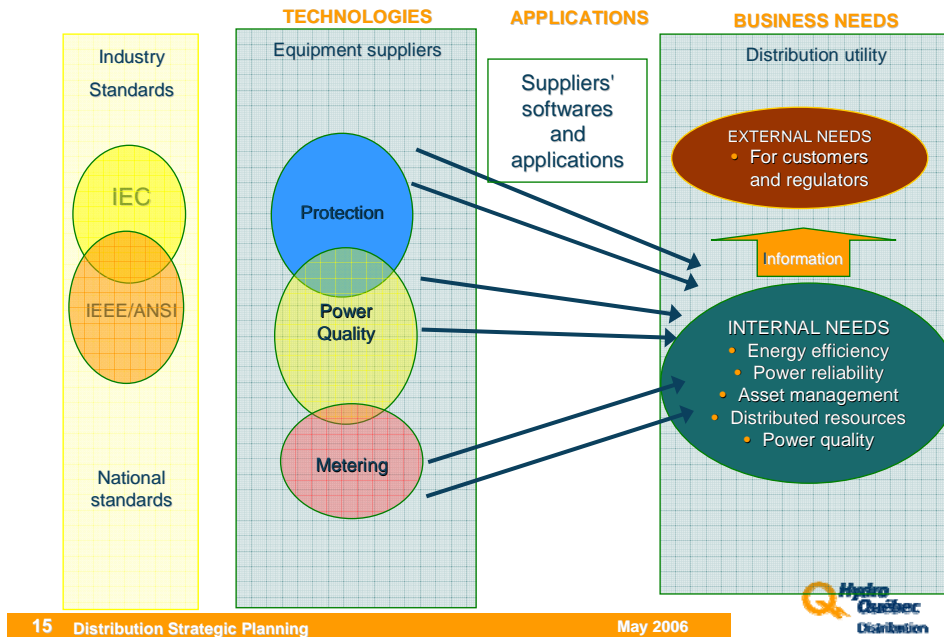
- The multiple task possibilities of modern digital equipment (i.e. smart meters, digital relays, advanced RTU, etc...) should be integrated to reduce cost
- Distribution network evolution shall consider the growing interconnection of DER
- Use transmission grid experience with automation to transpose on distribution networks (i.e. equipment, standards, ...)
- The telecommunication structure of the distribution network should evolve toward a compatible network with the transmission level
 - The ultimate goal is to develop standards (utilities with the manufacturers) defining a "Plug and Play" concept
 - The telecommunications structure evolution will include the incorporation of the new communication medium to complement the existing distribution SCADA communication infrastructure.
 - Bulk data download will be a feasible characteristic of the evolving telecommunication structure
- Distribution feeders should be seen as an extension of the substation busbar

The following three figures describes a schematic evolution of the standards.



In the past, technologies were independent from each others and the information coming from the distribution equipment were sufficient to fulfill the business needs of the distribution utility.

Distribution Automation Standards -Present situation

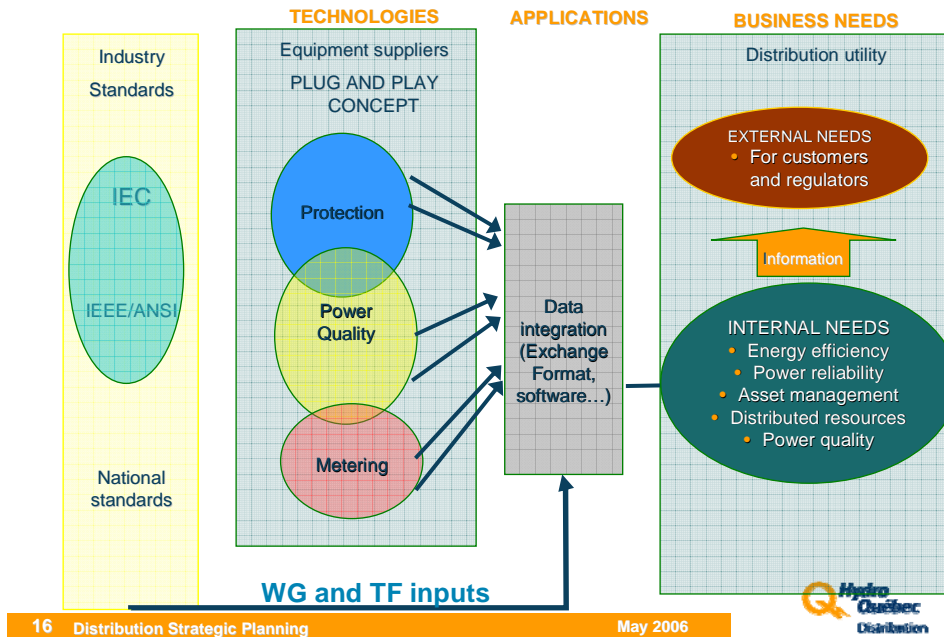


Today, customers and regulators are expecting more information from utilities. In fact, the society in general is now providing much more information to everyone through IT technologies (Cellphone and Blackberry, Internet...) and this type of availability is expected from the distribution utilities as it is for other major services providers (Banks, Phone companies, Major stores, Governments...).

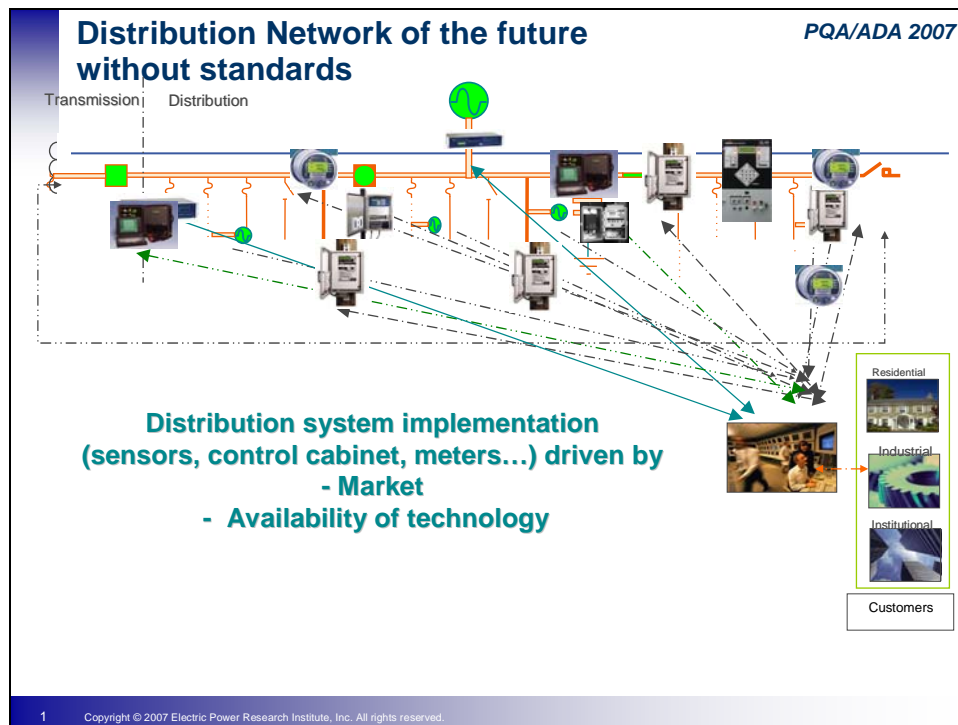
On the distribution system the type of equipment installed today is much more computerized and can provide a lot of information. Moreover, having the same microprocessor based technology, technologies are merging to provide common information that used to be coming from separate equipment e.g. Digital relays and Smart Meters can now provide PQ data. The information is flowing through proprietary systems and software from suppliers. On the other hand, there is also a certain merging between Standard bodies.

In the future, interoperability standards coming from international standards body shall facilitate the data information flow as illustrated in the following figure.

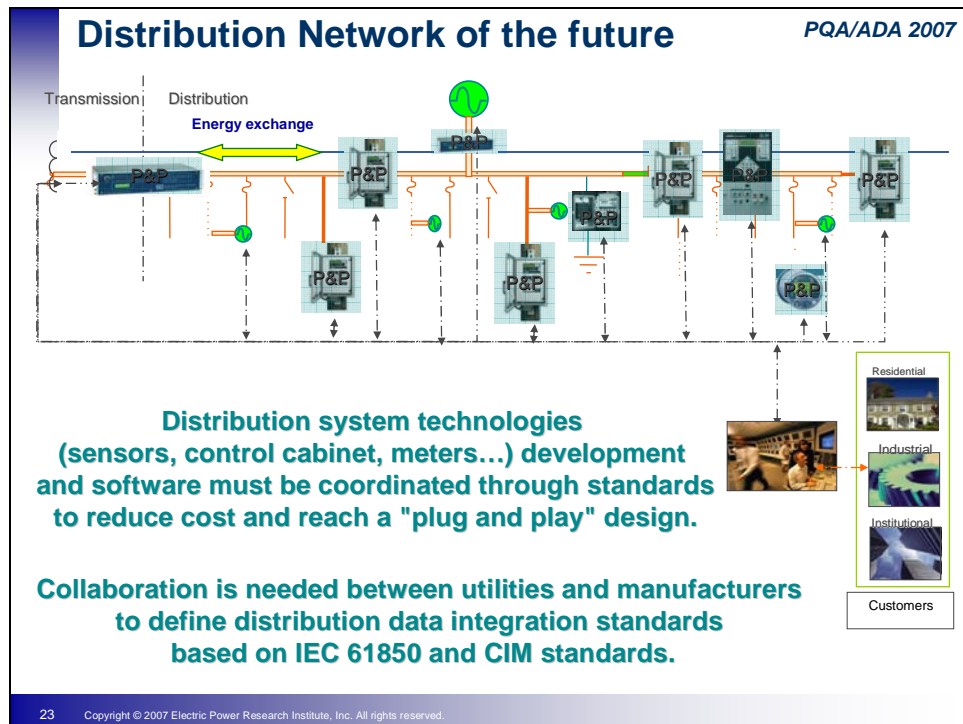
Distribution Automation Standards -Ideal situation



The next two figures show the differences between a future distribution network without interoperability standards



and an integrated distribution system based on interoperability standards such as the IEC 61850 series leading to a “plug and play” concept for the distribution equipment to be connected on the future Smart Grid.



The illustrated new communications infrastructure must have sufficient bandwidth to support the traditional SCADA communications as well as bulk data download to support advanced waveform and sequence of events analysis. The new infrastructure must be robust enough to support increased bandwidth requirements of IEC 61850 without degrading the existing communications with the automated SCADA devices along the distribution circuit.

Conclusion:

A Smart Grid design must include interoperability standards for all levels of technologies of the distribution system (Substation, feeders and customer) to optimize energy and power distribution through DA intelligent/smart applications.

Consideration is to be given to efficient management of existing legacy SCADA communications bandwidth to the automated devices along the distribution circuit.

Prepared by IEEE/PES Distribution Automation Working Group

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