How will interoperability between systems, IEDs and functions enhance the utility business?

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Abstract

While most utilities recognize the possible advantages of interoperability and networking applications still many of the applications used today are run in so called information silos, where each application has its own dedicated communication path and/or protocol. Due to the deregulation of the power industry utilities are now forced to operate much closer to the operating limits of their high voltage network and this has led to a search for solutions that allow responses in a much more dynamic way.

New solutions are preferably integrated into a single networked architecture supporting new functionality such as dynamic access to all kinds of information. Networking however does not come for free. Utilities will have to invest in the infrastructure because of bandwidth, performance, stability, access and above all information security.

1. INTRODUCTION

By controlling the high voltage network more dynamically and closer to its operational limits utilities try to operate their high voltage system based on business drivers. The key to enabling such mode of operation is timely access to strategic information which needs to be derived from the data that is available at the high voltage process. This means gaining access to the raw data, turning it into information and making it available to the end-users is the key for a more dynamic operation of the power system..

But how do we make all this information available throughout the utility? After gaining access to the raw data by installing specific systems, the big challenge is to create information out of the raw process data and make that information available at the location where it is required at the moment it is needed.

An answer to this challenge may be presented by an approach that we use every day, the search engine on the Internet. The proposed solution therefore encompasses a system that would allow any employee to search for information that provides the answers to any question. This search engine like capability would allow the utility to operate in a much more dynamic and situation driven way.

When enabling all information to be accessed from anywhere many issues however arise, which need to be addressed. Examples of questions to answer include what about information security, how does one guarantee the required data stability, performance and access?

2. THE CURRENT SITUATION

In modern days utilities there are solutions in place for the supervision, control, and data acquisition of the power system. These so called SCADA systems have been defined, installed and are operating now for many years. Recently, through the deregulation of the power industry, utilities have been facing new challenges for the operation of their high voltage infrastructure. Based on market forces, the utilities are now forced to operate much closer to the operating limits of the high voltage network in order to be more cost effective but also to support all the transmission of power though its network based on trading agreements made on new emerging energy markets.

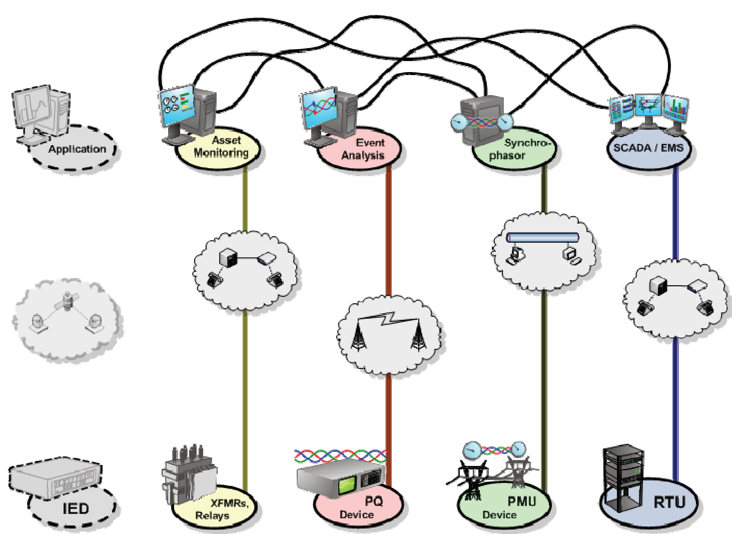

Fig. 1 Examples of information silos

This has led to a need for utilities to keep a closer watch on their assets. At first new monitoring systems were installed each using their own proprietary way for communication with the enterprise level.

Recently utilities have started to consider the integration of monitoring systems in a new philosophy in which the so called "information silos", as shown in figure 1, are integrated into a single solution that collects, manages, stores, transmits, calculates and transforms data as shown in figure 2.

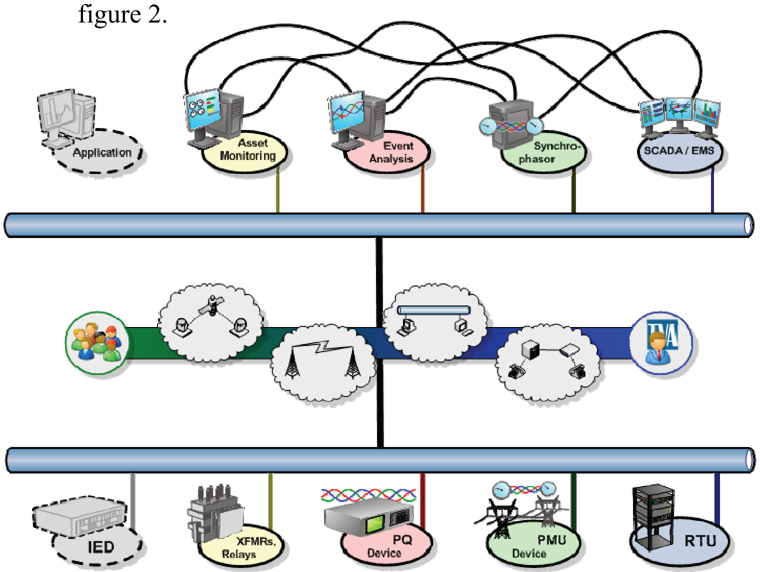

Fig. 2 Integrated substation automation strategy

This new generation substation automation systems is enabled by recent developments in the utility industry towards the interoperability of products and solutions.

The development of international standards, such as IEC 61968 and IEC 61970 defining a Common Information Model (CIM), allowing control center systems to share one data view for the definition and exchange of information is an example of this new drive towards interoperability between systems.

The introduction of IEC 61850 for interoperable communication architectures in and between substations, hydro-electrical power plants and distributed energy resources is another example of technologies adding to the possibilities for connecting systems together, thus creating networks in which free and dynamic access to information is no longer a dream but current reality.

3. DYNAMIC ACCESS TO INFORMATION

Key to enhancing the utility business lies in timely access to any kind of information available on the utility network from anywhere in the utility.

Today when a person is looking for information in the public domain, the search engine is one of his favorite tools. This because it allows him to dynamically search for information he requires at that given point in time. If a network could be created that allows such a Utility Search Engine for Remote Information for Operations and management or USERINFO™ application then this would allow utility personnel to access the available information dynamically. This would allow them to respond more accurately and timely to situations that arise with the utility.

Dynamic access to information using a search engine such as USERINFO™ comprises access to different sources within the utility network in real time. This means that these sources of information have to be interoperating and shall be networked. Furthermore in order to limit transmission delays, the used network shall have sufficient communication bandwidth. This is necessary to allow an acceptable turnaround time for any request for information. Also it allows transmitting this information to different locations throughout the utility in (near) real time.

In addition the utility will have to design and implement systems that turn raw data into information. These smart applications will have to combine different sources of information and generate more, better and more efficient information to end-users.

4. EXAMPLE SCENARIO'S

Within utilities a differentiation exists between operational data, maintenance data and management data, especially where operational data is used by the SCADA EMS or DMS system to control the high voltage network in real time. Maintenance and management data can be used for the support of the utility operations as well as the business models.

4.1. Dynamic Asset Management

When new equipment is installed the equipment details shall be entered in the asset management database. If the equipment is not networked this information in many cases shall be entered manually which can be a laborious process. When the equipment is networked however the information regarding the equipment can be retrieved automatically at the moment the equipment initializes for the first time. This avoids not only the manual entry but also assures the correctness of the data in the database thus avoiding database pollution because of wrongful entries.

Furthermore if at any given time someone within the utility needs information regarding the status of any given asset this can be acquired dynamically within a very short period of time. This does however require that all relevant asset information is accessible online.

The capability to dynamically assess details about all networked assets allows for new and more efficient methods and applications for asset management to be installed.

4.2. Accessing Power Quality information

Another application that is facilitated by networking equipment is the access to Power Quality information. More and more utilities are confronted with rules and regulations regarding the required quality of power set forth by regulators. The penalties for not fulfilling these requirements or in some cases the bonuses for performing better than required can be substantial. Therefore having the information regarding the quality of power at any given node in the network can be beneficial to several organizations within the utility.

In case of a power quality event the responsible department can assess the data recorded by the equipment quickly and perform an evaluation on the effect of the event on the overall performance indicators used by a regulator and propose scenarios to stay within the required quality thresholds.

4.3. Dynamic calculation of voltage stability and available reactive power

When building complex applications that require information to be gathered in (near) real time from multiple sources interoperability is one of the key pieces to facilitate this.

If in an area there are voltage stability problems the utility would like to have insight into not only the reasons of the instability but also the available resources within the network to counter the problem before it leads to brown outs or black-outs.

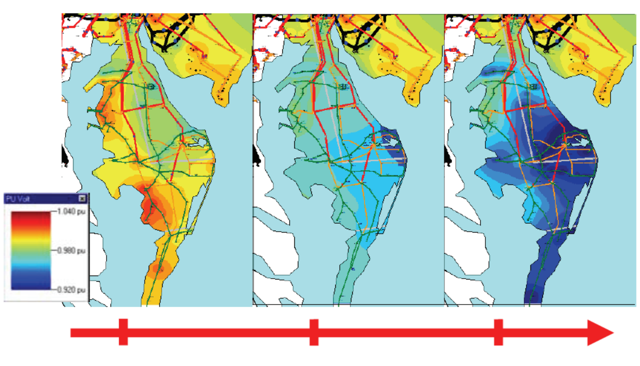

Fig. 3 Example of voltage degradation over time

One possible solution may lie in using the information from networked equipment throughout the high voltage network that gather voltage and current related data continuously and feed this information into an advanced algorithm that dynamically calculates the voltage stability, the available and controllable reactive power reserves in the entire network and presents its output to an operation as an overlayed moving image in the same fashion as the weatherman on TV showing us the buildup and movement of a rainstorm. An example of such an image is given in figure 3. We see a voltage degradation in an area over a period of roughly 20 minutes. The colors indicate the severity of the degradation.

5. REQUIREMENTS AND LIMITATIONS

When enabling interoperability between systems and networking them into a single infrastructure all information can be accessed from anywhere. This leads to the question which requirements and limitations apply. For example what about required bandwidth, what about information security, stability, performance and access.

5.1. Communication Technology

In order to provide all information in (near) real time the equipment must be connected to a communication infrastructure that supports the information throughput required. At this time there is not one single communication technology that supports the networking of all kinds of equipment can be used. This means that any given architecture shall support communication of data over a multiplicity of technologies and protocols in a seamless and interoperable way. Achieving this however is a challenge since there is not one standard solution. Development of standards such as IEC 61850 and IEC 61968 and 61970 and the harmonization between them will allow for a seamless communication between substations, hydro-electric power plants, distributed energy resources (DER) and the enterprise level within a utility. Expanding the solutions into interoperating with e.g. residential systems, the home area network or the Advanced Metering arena still leaves many questions unanswered since there does not yet seems to be a dominant technology that supports all the requirements for each of these areas.

5.2. Information security

Access to all the information within a utility can cause serious security risks which is why security must be designed into the architecture so that can be managed who should have what kind of access to what kind of information. This means that any solution shall be restrictive by default. No user shall be granted any privilege except where explicitly assigned in configuration. The USERINFO™ application shall therefore provide for assignment of privilege to an individual user or designated groups of users or roles. In addition, distinction between read-only and write access as well as privileges associated with individual devices as well as groups of devices shall be supported.

There are several security standards that can be used to build a secure architecture. For North America the solution shall at least comply with NERC Standards such as:

- CIP–003–1 — Cyber Security — Security Management Controls
- CIP–005–1 — Cyber Security — Electronic Security Perimeter(s)
- CIP–007–1 — Cyber Security — Systems Security Management

relevant are however also many other standards on security such as the IEC 62351 series that describe the communication network and system security. Once the secure architecture is in place access to the various kinds of information for a wide variety of users is supported.

6. CONCLUSIONS

By creating an interoperable networked architecture the utility can support more dynamic and (near) real time access to data from multiple sources. This allows for shorter response times to questions, problems, etc. as well as the implementation of smarter applications that support a more efficient way of operating, maintaining and managing the utility business.

The infrastructure required however must be built first which will require significant investments as well as overcoming the issues of not having interoperable solutions available at all levels.

In addition the utility will have to overcome the issues of bandwidth, information security, stability, performance and access.

We are not there yet but certainly on the way of getting there and new developments should focus more and more on providing interoperable solution for the communication of information throughout the utility from customer to enterprise and back.

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Biography

Marco C. Janssen received his BS degree in Electrical Engineering from the Polytechnic in Arnhem, The Netherlands. He has worked for over 17 years in the field of Protection, Control, Monitoring, Power Quality, Advanced Metering Infrastructures and Substation Automation. From 1990-1995 he was a Technical Specialist in the Protection and Automation group at NUON, The Netherlands. In the period 1995-2001 he was a Senior Consultant at KEMA, From 2001-2005 he was a Marketing Manager at Electron Automation, The Netherlands. Since 2005 he is the president of UTInnovation a Swiss - Dutch company providing consulting services for Substation Automation, Protection, Communication, Power Quality and Advanced Metering Infrastructures

He is member of IEC TC57 WG 10, 17, 18, 19, the IEEE PES Power System Relaying Committee and CIGRE WG B5.TF92, and B5.11. He is editor of the Quality Assurance Program for the Testing Subcommittee of the UCA International Users Group, holds one patent and has authored and presented more than 20 technical papers and he is a columnist for the PAC World magazine