Newsletter of the Business Unit Network Management

Network Management Newsletter
Issue 4/2009

Dear readers,

The economic downturn this past year has been a very difficult time for everyone in the power industry. In the midst of these challenges, however, many of our customers and partners have told me they have gained a much greater appreciation and understanding of the value that a well-designed network management system provides. Additionally, the emergence of the Smart Grid and the need for grid modernization has brought network management and its capabilities to the forefront of many discussions.

We greatly appreciate the open communication that so many of you, our industry partners, have provided. We take this feedback seriously and attempt to, whenever possible, implement your suggestions or customize our solutions in a way that meets your needs and empowers the grid.

ABB seeks to be active in venues where this valuable interaction can take place. For example, we recently held our fourth annual Network Management Forum in Heidelberg, Germany (see Page 5). We also showcased our solutions at an International Trade Fair (Page 11) and set up a Network Management Training Center (Page 12), both in India. This quarter's newsletter highlights these and other new and existing network management-related partnerships around the world.

We hope to build on our interactions with you, our customers and partners, in the coming year, and we welcome your feedback.

In the meantime, I would like to wish you all a very happy and safe holiday season. Enjoy the time with your family and friends.

With Season's Greetings

Jens Birgersson
Business Unit Manager Network Management

ABB and Fortum to develop large-scale smart grid for sustainable city project

Project in Stockholm is part of goal to make significant emission cuts in city

ABB, the leading power and automation technology group, will work on a joint development project with the Nordic utility Fortum to design and install a large-scale smart grid in a new district of the city of Stockholm.

The R&D project will test the concept of a flexible, low-emission power network in the Stockholm Royal Seaport area as part of a larger initiative to cut emissions in the Swedish capital by two-thirds by 2020. It is one of 16 global projects supported by the Clinton Climate Initiative Program for sustainable urban growth with a focus on sustainable and efficient generation, transmission and distribution of power.

ABB and Fortum will develop a variety of solutions to ensure that excess power generated from renewable energy sources in the district itself (from sources such as rooftop solar panels) can be fed into the power grid; to enable electric vehicles to draw electricity from the grid or feed it back in; to store energy; and to provide more flexibility and transparency in the distribution grid, helping to lower consumption and emissions. Stockholm's new district will have 10,000 homes and 30,000 office spaces, and will incorporate an innovation center to showcase the latest technologies being tested and deployed. "In terms of scale, this is a big step forward in the development of a smarter and more flexible urban grid that can integrate distributed and renewable energy sources and help realize the vision of sustainable cities," said Bazmi Husain, head of ABB's smart grids initiative.

"Besides seeking energy-efficient solutions that help to address climate change, the evolving grid will also need to accommodate the more active involvement of electricity consumers," said Per Langer, CEO of Fortum Sweden.

The new development is an integral part of Stockholm's effort to reduce CO2 emissions by 2020 and to eliminate the use of fossil fuels entirely within the Royal Seaport district by 2030. Local power generation and a more flexible and responsive power grid will be instrumental in achieving these ambitious environmental targets. They will also contribute to the national goal of increasing the use of power from renewable energy sources.

ABB envisions a smart grid based on industry-wide standards supporting a stable, secure, efficient and environmentally sustainable power system. It will also accommodate customer demand response management systems that allow local producers and consumers to interact with the network operator and the energy market to reduce peak loads and increase efficiency.

Fortum's operations focus on the Nordic countries, Russia and the Baltic Rim area where it operates and maintains power plants, and generates, distributes and sells electricity and heat. It distributes electricity and heat in Stockholm.

Stockholm

Innovations for ABB's Teleprotection System NSD570

Teleprotection over Ethernet based communication networks

With the introduction of the new line-interface G3LE, ABB is now offering fast, reliable and secure transmission of critical teleprotection commands over IP based communication networks. A patent pending, proprietary protocol thereby guarantees the user the same security, reliability and predictability of the command transmission as has been the standard for many years over analog or digital circuit switched communication links. For this purpose, the critical parameters of the communication channel are monitored constantly. If any of these parameters show a problem which could disturb the perfect operation of the teleprotection system, an alarm is generated immediately. In addition, a strong authentication algorithm prevents teleprotection messages from being manipulated by an unauthorized party. Integrated in the well established NSD570 teleprotection system, precise and detailed event-recording, remote monitoring and management capabilities, and a wide range of command input options are provided.

The new interface is able to communicate over electrical or fiber optical Ethernet channels with speeds of 10 or 100 megabits per second.

Open Standard and NERC CIP compliant Management Interface

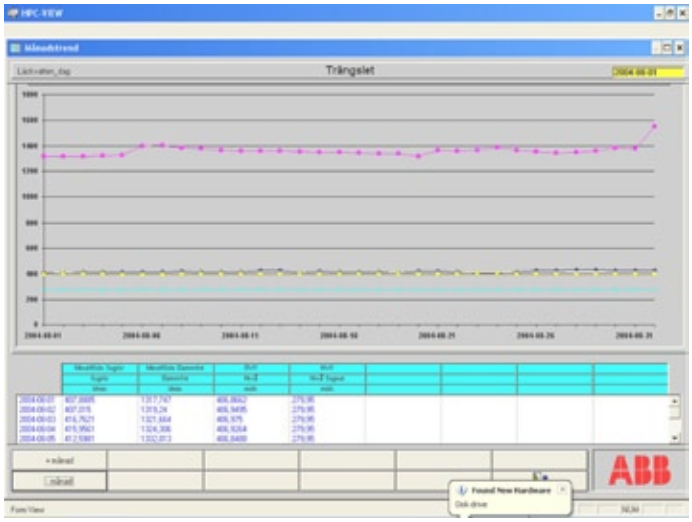
With the G3LM, a new open standard LAN management interface is introduced. It allows remote access on NSD570 teleprotection equipment over IP based networks. The integrated SNMP agent allows Network Management stations to retrieve alarm and equipment information using the open standard SNMP interface.

At the same time, several features have been integrated in order to achieve the highest possible level of cyber security, allowing our customers to operate the NSD570 teleprotection system in compliance with the NERC CIP standard. Next to a technique called Secure Socket Layer (SSL) which is used for encryption and authentication of the user access, a new user administration now allows the setup of individual user accounts and the assignment of detailed access rights individually per user. Any user activity is logged in order to detect security relevant system manipulations in an early stage.

Never give up!

Service is an important and integral part of our Network Management organization. Service can mean so many different things; for some it is additional training or consultancy, for others it is software upgrades or adding enhancements but it can also mean good old problem solving. Our Service Program is a long-term commitment where our aim is to make the installed base run as smoothly as possible and to help our customers make the best out of their systems. The following is a true story of a service call that took place not long ago.

It started when our service engineer received a call from a customer in Sweden using a legacy ABB SCADA system but since a few years back also using another and newer system for its control of hydro power plants. From the earlier system, there were a lot of old historic data stored but not imported to the newer system. The two systems were run in parallel for a time but one day it just so happened that the old system hardware more or less crashed and only parts of the data could be restored. Regular back-ups were not taken and much unfortunately for our customer, parts of this data were of great importance. The situation was getting a bit tense and after severel fruitless attempts to restore the lost historic data, our customer was about to give up! But in a last attempt they finally called the ABB Network Management service organization.



Screen shoot from the customer application that was restarted by our service team.

We received the call and decided to give it a try. After all we still know our old systems quite well and also have pretty good tools for fixing erros. So we agreed that they should send us a CD with saved data from the old system. Our task was first of all to see if we at all could read the data and if so also if it could be restored in a spreadsheet or other usable format. We took on this challenge of course, and started by reading the CD and analyzing what the contents were and see if any structures could be spotted. We found an MS-Access database, however it was in such an old format that it could not be read properly. Our engineers, some with many years of experience, had to go way back in the old archives to find the original base SCADA application. The application was loaded on an old but still running test environment and by using that succeeded to start up a copy of the old SCADA system and also to mount and - voilà - read the old database structure.

With this at hand we called back and told the customer how they could recreate the data in a readable format themselves. The customer confirmed that the procedures also worked in their office and that they could proceed using their historical data. A lot of work was obviously saved and a happy customer thanked ABB for the assistance.

Lesson learned: 1) Never give up! and 2) do not hesitate to call us to discuss what we can do for your old or new SCADA system.

Network Management forum in Heidelberg, Germany

The fourth ABB Network Management forum in Heidelberg met once again successfully with international customers, consultants and partners.

The forum combined the Network Manager forum together with the Network Manager GAS, the Network Manager experts, the remote control, the substation automation protection & control and the busbar protection forums.

The forum took place between the 6th and the 8th of October 2009 in Heidelberg. The congress hall in Heidelberg provided the appropriate framework and a stylish ambience for an unforgettable event.

After an already significant increase in attendance in 2008, this year we were able to see, with 256 applications, another 20% increase.

The focus was set on product innovations and on the presentation of realized projects. Lectures on smart grids and integrated gas functionality were presented and the new Relion® product family for protection and control was introduced.

The lectures of Network Manager and remote control forums were simultaneously translated into English for our international guests joining from more than nineteen countries.

With regards to the remote control, the most important issues were the improvements in the RTU560/RTU211, like the IEC61850 Client & Server, HMI improvements and protocol enlargements. In particular, the extensions of the functionality of the RTU have been accentuated; they now allow a larger use of the RTU in new task areas such as smart grids and automation, or permit the use in existing areas such as IEC61850.

Dr. Hermann Müller, product responsible for Network Manager, went into the areas of development, available extensions and future trends in data management. New Network Manager projects were partially presented by the customers themselves.

The highlights of the forum were the lectures concerning “Smart Grids.” They were particularly looking at the new demands on the power system which may arise depending on the scheduled change in the energy world.

The focus of the substation automation forum was the presentation of the new product family for protection and control, Relion®.

Peter Gross, Head of ABB Sales Support Grid Automation reflected on the forum: “The new product family Relion® was well received by the customers. The clear increase in the number of participants and the high quality of exchanges between forum users and ABB hosts are a clear sign that we are on the right track with this type of event.”

During the Network Manager experts forum, participants had the opportunity to exchange professional and technical novelties in the field of application of Network Manager.

The forum took a comfortable end in the “Strahlenburg” in Schriessheim. In a unique atmosphere; the participants could reflect on the events of the forum.

Stefan Basenach, new head of Network Control systems, thanked all organizers for their efforts and for the successful event, and stressed again the importance of such events for us and our customers. He is looking forward to a new and informative ABB Network Management forum 2010.

ABB Network Manager™ DMS selected by Unitil

Unitil to implement ABB's industry-leading distribution management solution

Unitil Corporation (Unitil) recently selected the industry-leading ABB Network ManagerTM DMS for its distribution operations. Unitil, an investor-owned public utility holding company headquartered in Hampton, New Hampshire, will deploy Network Manager DMS at its affiliates Utility Energy Systems and Fitchburg Gas and Electric Light Company.

Unitil will utilize ABB's Network Manager DMS to improve its business processes in the areas of outage management, storm response, and customer communications. Implementation will occur in two phases. Phase One will consist of the implementation of outage management system (OMS) functionality, with interfaces to Unitil's geographic information system (GIS) and interactive voice response (IVR) systems. Phase Two will consist of the integration of ABB Network Manager DMS with Unitil's existing AMI and SCADA systems.

"After a competitive bid process, we selected ABB Network Manager DMS based on its proven OMS and DMS capabilities, its high level of performance as exhibited at other utilities, and ABB's track record of project execution," said Kevin Sprague, Director of Engineering at Unitil Service Corporation.

ABB Network Manager DMS is an operations management system designed to help utilities reduce operating and maintenance costs while enhancing customer service. It provides advanced network modeling and management, integrated switching and tagging, trouble call and outage management, crew management, and historical archiving and reporting. The high-performance architecture of Network Manager DMS along with its advanced world map visualization interface enable operators to quickly and efficiently respond to large numbers of outages produced by storms, reducing customer outage times. Network Manager DMS also offers integrated advanced applications, such as fault location, unbalanced load flow and simulation mode, as well as interfaces to other information systems that permit organizations to leverage time-critical data across the enterprise.

"We are very excited to welcome Unitil to the growing customer base of ABB Network Manager in the US," said Salim Khan, head of ABB's Network Management business unit in North America. "We have invested over two decades of effort to make ABB Network Manager DMS the industry leader, and we continue that investment to provide our customers with the OMS, DMS, and Smart Grid functionality that they need."

Unitil is a public utility holding company with subsidiaries providing electric and natural gas distribution service in New Hampshire and Massachusetts, natural gas distribution service in Maine and energy services throughout the northeast. Unitil serves approximately 170,000 utility customers in three states.

Unitil service territory

ITC Transmission completes successful MISO drills with ABB Network Manager DTS System

ABB Network Management – delivering Dispatcher Training Simulator (DTS) systems for two decades

Last October, International Transmission Company (ITC) successfully completed its annual system restoration drills with the Midwest Independent System Operator (MISO). The objective of the MISO drills is to provide insight into restoration procedures and effective communication with customers, MISO and neighboring utilities. The ABB Network Manager Dispatcher Training Simulator (DTS) was a key part of these drills and served as a reliable tool, assisting Operators in making quick, smart operational decisions.

ITC implemented its second Network Manager system at its newly acquired ITC Midwest operations one year ago and has already experienced great benefits from both of their ABB DTS systems as part of their yearly drills with MISO. “To date, ITC has observed a year over year improvement in the performance of the Michigan DTS system” said Thirupathi Venganti, with ITC Operations Engineering, “and now, the DTS system at ITC Midwest continues in that pattern in its initial use in a large scale training drill”.

The ABB Network Manager DTS provides a training capability that realistically models the power system and interacts with the operator (trainee) in the same way as the user interface in the actual control room. By providing a high-fidelity simulation of the power system, including dynamic behavior under a broad range of operating conditions, the DTS is an effective tool for training operators to make good decisions quickly under normal and emergency conditions.

The 2009 MISO drills were conducted in two 2-day sessions in October. According to ITC personnel, this year’s MISO drill was different from the previous drills. In previous years, the first day normally involved simulating emergency system conditions that required operator’s response to mitigate various problems, and the second day entailed a large scale blackout that required operators’ response to restore the system to pre-blackout conditions. This year, both days were dedicated to system restoration. The Michigan ITC and ITC Midwest DTS systems that supported the drill responded extremely well to various operator actions. The DTS performance and the communications aspect of the drills were key elements to a smooth execution overall; making this year’s MISO drill a successful learning experience at ITC.

ABB Network Manager DTS served as a reliable tool, assisting operators in making quick, smart operational decisions. The preparation of the ABB DTS systems for the large scale Blackstart Restoration drills involved the following tasks (not all inclusive):

Accurate Power System Model: Selection of one of the latest databases for the MISO drill to ensure that the operator training scenarios included any newly added substations.

Generator Modeling: The generator model data in the ITC network model was fine tuned to achieve a higher fidelity response under steady state and dynamic conditions. The most prominent part was the modeling of generators with a stable dynamic model, particularly for fossil fuel generators. After researching the various generator models supported by ABB’s DTS software, ITC selected a model that met their specifications.

Load Modeling: ITC created load profiles and load factors based on historical load data.

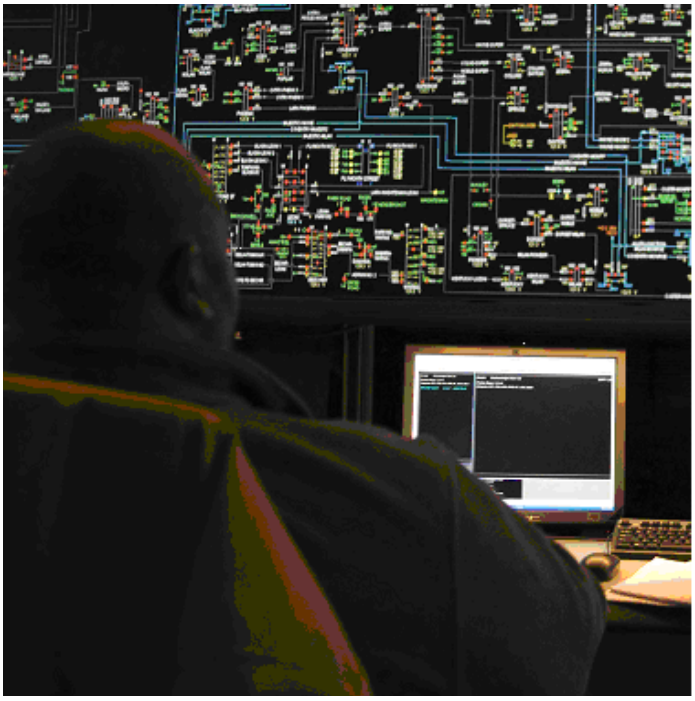
Creating a Blackout Case: The ITC Midwest system is inherently a very complex system with multiple interconnections with various neighboring utilities. Creating a case that represents a blackout condition has been a challenging task. Ultimately, a good, realistic case with most of the ITC Midwest system in the dark had been created.

Arrangements for the MISO Drill: The ITC Training and IT departments collectively created the proper environment for the drill in the ITC backup control center. This effort involved setting up of telephone lines and blast calls for effective communication, and assigning personnel to perform distribution switching and generator operations.

Thirupathi expressed ITC's appreciation to the ABB personnel for their support during the preparation and days of the drill. "We would like to commend the fine assistance of ABB's DTS group in helping us transform ITC's training practices from paper (map) based drills to highly realistic simulator drills. ABB has provided timely fixes to the reported issues and we are hoping to receive continued support in making DTS a Best-in-Class training tool at ITC" said Thirupathi.

DTS is a critical part of today's transmission operations and experiences such as ITC's demonstrate the value that the Network Manager DTS brings to ABB customers. DTS will continue to be a focus topic in ABB user group meetings to facilitate sharing of customer experiences and case studies.

ABB will continue to work with its customers and strive to make the Network Manager DTS, as Thirupathi calls it, "the best-in-class training tool".



ITC Transmission is in full prdocution with their second ABB Network Manager system.

ABB to provide multi-year support to Unidad de Transacciones (UT)

ABB has received an order from Unidad de Transacciones (UT) in El Salvador for providing a suite of support, maintenance and upgrade services for its ABB Network Manager SCADA/EMS. The contract will allow UT to enhance its operations while keeping the system at state-of-the-art information technology and controls technology standards.

The country's electricity market rules are being continuously reviewed and revised. It was therefore of utmost importance to UT to have its Network Manager system prepared for such functional changes.

UT operates the El Salvador Spot Market and is responsible for operating the country's transmission grid, maintaining security, operating the Wholesale Market, coordinating the dispatch of energy from the generation plants to the main distributions centers and managing the interconnection with Guatemala and Honduras.

The ABB Network Manager system currently in operation at UT communicates with 42 RTUs using industry standard protocols. The system also supports the information exchange with the Central America Regional System Operator (EOR).

UT analyzed the costs and benefits of performing maintenance on the current version for the next five years compared to the implementation of a 5-year system support and progressive modernization solution. The results clearly demonstrated that the 5-year plan, including the hardware update, had several advantages over any other alternative.

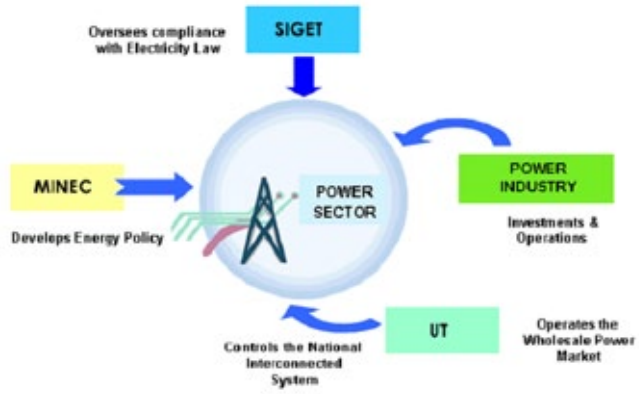
The contract provides for 5 years of software support along with two software upgrades and hardware platform modernization. These upgrades will allow UT to keep the Network Manager system updated with the functional improvements incorporated into the new releases. Of special importance to UT are the security enhancements that each new release includes. In addition to these improvements, the contract covers several support and maintenance activities such as:

- ABB personnel will be providing system auditing services to ensure that the maintenance procedures are conducted per ABB's recommendations.
- A 24/7 service support that will respond to any technical issue requiring immediate attention from ABB specialists.
- A set of annual service support hours to be applied towards problem resolution, training, development of new functionalities or consulting activities.
- Periodic technical and management meetings for tracking project activities and for implementing any necessary program changes.
- Third party software maintenance to insure that these software packages are up to date and fully supported by the original vendor.
- Training activities for maintenance and operations personnel on the changes and improvements pertaining to the software upgrades.

Mr. Luis Gonzalez, UT's General Manager, said: "The maintenance and upgrade contract will allow UT to fulfill its critical responsibilities for operating the power market and ensuring the power system's reliability. Upon power system disturbance situations, the operators will continue to receive key system data that will allow them to perform system restoration actions in very short times. At the same time the updated system will provide important data to our market participants by means of new web server implementation."

Contract Signing in El Salvador - UT's President, Jesus Gilberto Cruz Olmedo, Dr. Jaime Amado Del Valle Menjivar, UT's Attorney and Tomas Gumpel, ABB's Network Management Latin America Sales Manager

El Salvador has a highly developed power market with 7 participating generation companies, 1 transmission company, 7 distribution companies and 14 power brokers. SIGET is the regulating agency. The Economy Ministry (MINEC) develops long term strategies for increased production and better use of existing resources. El Salvador lacks fossil fuel reserves and therefore one of the unique aspects of the country's energy sector is its reliance on geothermal and hydro energy production. Thus half of the country's power production is from renewable sources.



El Salvador Power Market Structure

ABB Users' Group Meeting - Cape Town

In 1580, Sir Francis Drake called it, "The stateliest thing and the fairest Cape we saw in the whole circumference of the earth." but the Cape Peninsular in South Africa is also known as "The Cape of Storms". We experienced bits of both in our User Group meeting, which was held in Cape Town at the beginning of November. ABB Network Management has 17 customers in Africa. Eight of those Customers sent delegates to the meeting. The largest group in attendance was from Eskom, with 31 from the Central, Northern, Southern, Eastern and Western Regions.

There was a magnificent sea view at the Sea Point Peninsula Hotel where many of the visitors stayed and the first day of the meeting was held. The hotel was not far from the site of the huge, new Green Point stadium, where a number of matches in the Football World Cup, including the semi finals, will be played in June/July next year. Our co-hosts, the City of Cape Town and Eskom, are both working hard to make sure there will be no power interruptions during this period. Thousands of visitors will be converging on the Cape and in the Eskom Control Center. There is already a daily countdown to the Start.

Eskom Western Region Control Center

Mervyn Giddey from the City of Cape Town, Chris Billingham from Eskom and Gavin Sadler from ABB South Africa opened the proceedings with words of welcome. Karl Elfstadius, Head of Market and Business Development in ABB's global Smart Grid organization, then gave the Keynote Speech on "Smart Grids". This was followed by presentations from Dr. Jacek Bujak, the EMS Product Manager, on the new Network Manager Release 4 SCADA/EMS/GMS, Cristiano Bonanno from ABB Germany on RTUs and Gavin on Communications. Bruce Webster from ABB South Africa set up an RTU demo unit with Cristiano for those who wanted more information.

On day two, there were discussions in smaller groups, which provided valuable suggestions and feedback from the delegates, for improving ABB support and products. These discussions were followed by a visit to the City of Cape Town Control Center in the suburb of Newlands. System data input is still ongoing there and much remains to be done.

On day three we visited the Eskom Control Center where we were greeted with a warm welcome and some interesting presentations before going to the Control Room. Rui Silva presented a lively presentation on Distribution and then Jacek Bujak gave us the latest news on Cyber Security. It was then time to leave for Jonkershuis at Groot Constantia, which is the oldest vineyard in South Africa founded in 1685 by Governor Simon Van der Stel.

We hope we succeeded in our goal of providing our customers with valuable update on the latest developments to ABB's Network Manager, as well as sharing with them a memorable experience in this beautiful part of the world.

Cape Peninsular

Penguins at Boulders Bay

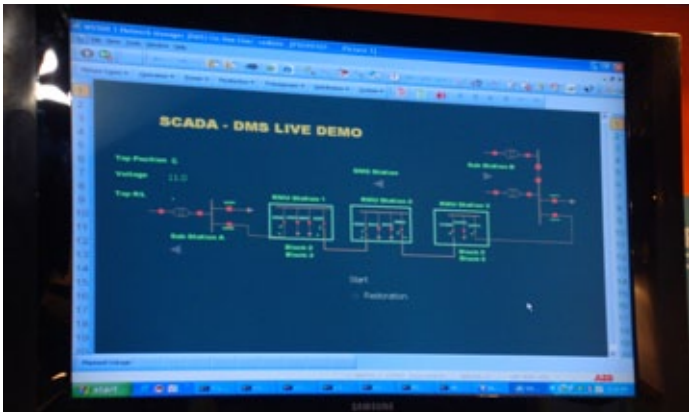
India International Trade Fair Showcase from ABB

The Ministry of Power in India had planned to showcase its R-APDRP initiative in their pavilion at the India International Trade Fair (IITF). The Power Finance Corporation (PFC), the nodal agency appointed for leading and monitoring the initiative of R-APDRP, had decided to demonstrate "R-APDRP" salient functions by way of working model. ABB partnered PFC in this endeavor to showcase one of the most important components of R-APDRP, i.e. SCADA/DMS for distribution power utilities in India using suitable demonstration. PFC guided ABB about the methodology & logic.

IITF is one of the largest exhibitions and provides a platform to showcase India's industrial progress and projects India as a worthy global trade destination and a high potential market. IITF highlights India over a broad canvas eminently focusing on technological advancements of the various departments, sectors, States / Union Territories, and offers a dynamic window to reach out to large Indian consumers.

This Trade Fair was held from 14-27th November 2009 at Pragati Maidan in New Delhi, India.

The demonstration showed the high end application of SCADA/DMS for visualization of automation of power distribution and the associated advantages that can be achieved by implementation of the SCADA/DMS system at utilities.



The SCADA/DMS software was the replica of the operational SCADA/DMS with the capability to demonstrate the major features and functionalities on the screen and the associated physical model. The following functions were displayed

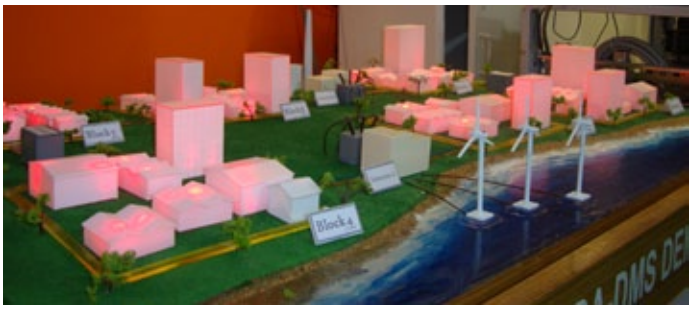
1. Case - 1 – Switch Off and On Function
2. Case - 2 – Planned Outage
3. Case - 3 – Voltage Control
4. Case - 4 – FLISR

IITF is a global platform where businessmen, technocrats, entrepreneurs and service providers converge.

The CEO and representatives of various power utilities including the power distribution utilities in India visited the pavilion of Ministry of Power where ABB's Network Manager SCADA/DMS system was exhibited.

The highlight of the event was the visit of the Union Minster for Power, Mr. Sushil Kumar Shinde, who was present at the PFC stall. The demo setup and features that were exhibited by the SCADA/DMS solution were highly appreciated.

This event provided ABB a good opportunity to showcase the SCADA/DMS solution and its applications and functionalities. It also created awareness in the end user about the importance of a SCADA/DMS system. Finally, it allowed ABB to closely interact with utility representatives.



First Training at the renovated Network Management Training Center in India

The first batch of training was held at the renovated Network Management Training Center that was inaugurated on the 20th of November 2009, included personnel from the NHPC limited (formerly known as National Hydroelectric Power Corporation). The main purpose of the program has been to impart knowledge of the Basic SCADA System and to teach the general use of the products that are part of the SCADA System.

The course schedule included hands-on training on the modules of the Network Manager system, Remote Terminal Units, Data Engineering for Network Manager and RTU 560 and 211, testing, operation and maintenance of the system. A brief introduction to the communication in SCADA was also a part of the curriculum. The training also proved to be a refresher course for the operational staff who are already working on a SCADA System.

The uniqueness of this program was that it was not for the core user of the Network Manager system, but for the generic subject of SCADA, RTU and associated systems. The government in India is seriously focused on developing such competencies and to providing more of this type of training in the future.

NHPC Limited has become the largest organization for hydropower development in India, with capabilities to undertake all the activities from conceptualization to commissioning in relation to setting up of hydro projects. NHPC Limited is also planning to take wind and tidal wave projects in the country. They are currently engaged in the construction of11 projects aggregating to a total installed capacity of about 4,600 MW. Given the renewed thrust on development of hydro power in the country, NHPC Limited has drawn up a massive plan to add over 10,000 MW of hydropower capacity by the end of XII plan (year 2017). NHPC intends to install a SCADA system at the various regions all across India.

Smarter grids are more efficient
Voltage and Var Optimization reduces energy losses and peak demands

Have you ever wondered how much electric energy the world consumes or how much energy is lost on its way from the power plants to the end users? Have you wondered how much energy could be saved or green house gas emission could be cut if such energy losses were reduced by even a small amount? ABB is a world leader in the development of new technologies to help reduce electric energy losses and the demands made on electric distribution systems.

ABB offers a wide spectrum of products to increase energy efficiency and optimize demand management. Voltage and Var Optimization (VVO) is the latest addition to smart grid applications. Differing from the traditional approach based on un-coordinated local controls, VVO uses real time information and online system model to provide optimized and coordinated control for unbalanced distribution networks with discrete controls. Electric distribution companies can achieve huge savings in the new frontier of energy efficiency improvement by maximizing energy delivery efficiency and optimizing peak demand. VVO will help them to achieve these objectives by optimizing their reactive resources and voltage control capabilities continuously throughout the year.

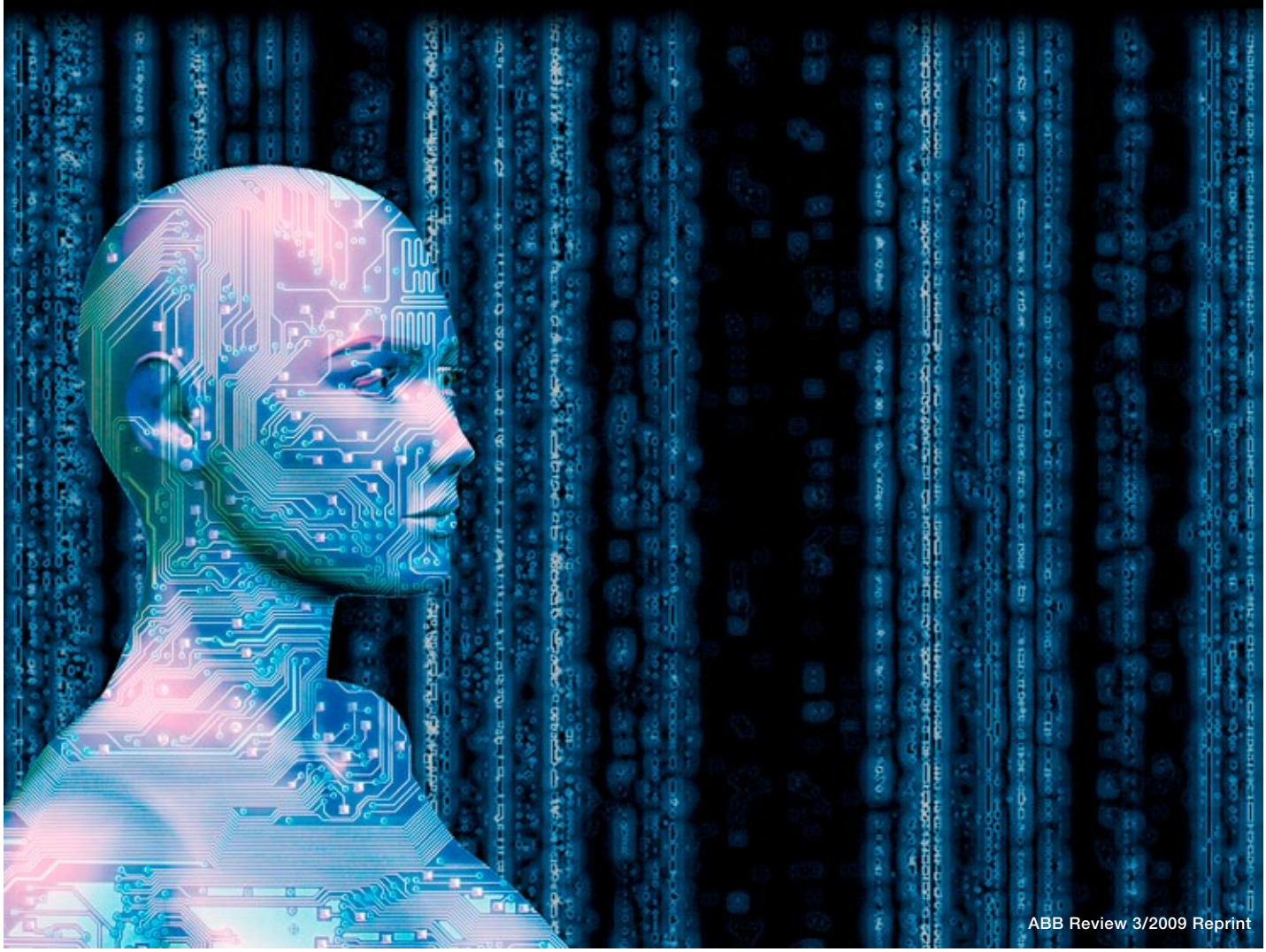
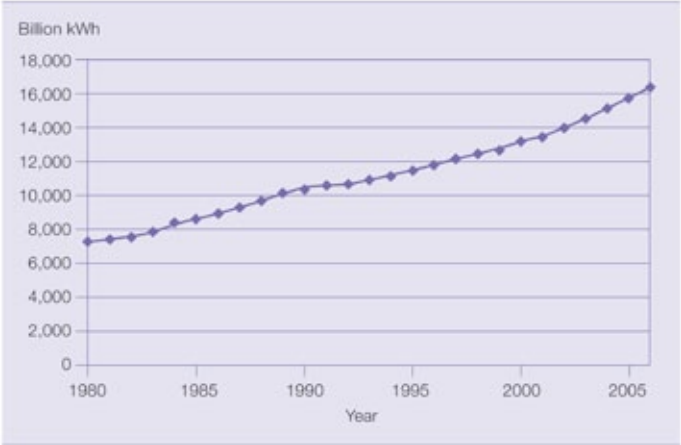


ABB Review 3/2009 Reprint

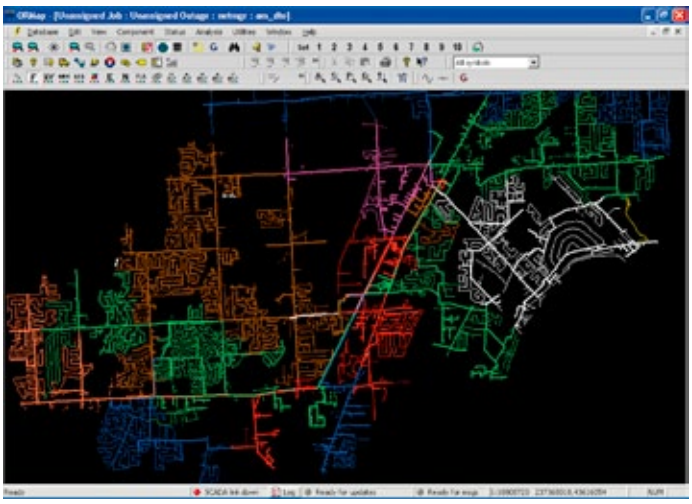
The world has a huge -appetite for electric -energy, consuming thousands of billions of kilowatt-hours (kWh) annually, a figure that continues to climb as more countries become industrialized. The world's electric consumption has increased by about 3.1 percent annually between 1980 and 20061), and is expected to grow to 33,300 billion kWh by 20302) . The world's electricity consumption for 2008 was 16,790 billion kWh so by 2030 the world demand for electricity is expected to have almost doubled [1].



World electricity consumption (billion kWh)

Electric energy losses

Currently a significant amount (about 10 percent) of electric energy produced by power plants is lost during transmission and distribution to consumers. About 40 percent of this total loss occurs on the distribution network . In 2006 alone, the total energy losses and distribution losses were about 1,638 billion and 655 billion kWh, respectively. A modest 10 percent reduction in distribution losses would, therefore, save about 65 billion kWh of electricity. That's more electricity than Switzerland's 7.5 million people consumed in 2008 and equates to 39 million metric tons of CO2 emissions from coal-fired power generation [1].



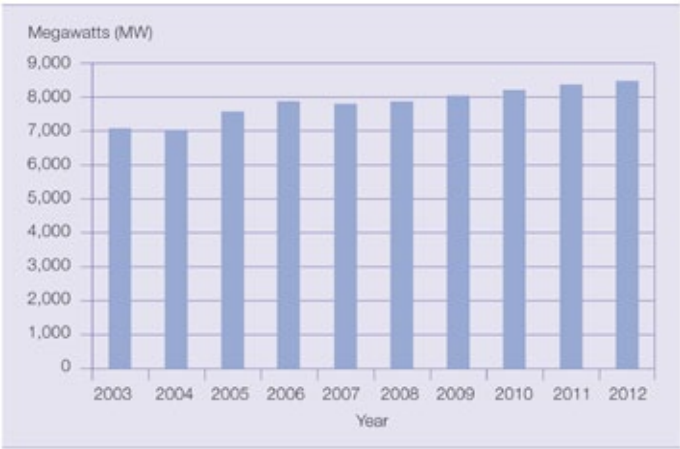
Distribution system overview from network manager system (DMS)

As the demand for electricity grows, new power plants will have to be built to meet the highest peak demand with additional capacity to cover unforeseen events. The peak demand in a system usually lasts less than 5 percent of the time (ie, just a few hundred hours a year). This means that some power plants are only needed during the peak load hours and their potential is utilized relatively infrequently. By active demand management on the distribution system, through demand response and VVO, the peak demand on the whole electric grid can be reduced. This eliminates the need for expensive capital expenditure on the distribution, transmission, and the generation systems. Even very modest reductions in peak demand would yield huge economic savings. For the United States in 2008, for example, the non-coincidental peak demand (ie, the separate peak demands made on the electrical system recorded at different times of the day) was about 790 GW. With -every 1 percent reduction in the peak demand there would be a reduced need to build a 7,900 MW power plant.

Distribution system losses

The electric distribution network moves electricity from the substations and delivers it to consumers. The network includes medium-voltage (less than 50 kV) power lines, substation transformers, pole- or pad-mounted transformers, low-voltage distribution wiring and electric meters. The distribution system of an electric utility may have hundreds of substations and hundreds of thousands of components all managed by a distribution management system (DMS).

Most of the energy loss occurring on the distribution system is the ohmic loss3) resulting from the electric current flowing through conductors (Factbox 1).



Annual peak demand reduction of 1 percent for the United States

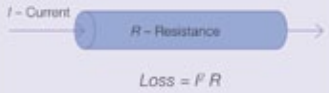
For any conductor in a distribution network, the current flowing through it can be decomposed into two components – active and reactive (Factbox 2).

Reactive power compensation devices are designed to reduce or eliminate the unproductive component of the current, reducing current magnitude – and thus energy losses. The voltage profile4) on the feeders5), depending on the types and mixture of loads in the system, can also affect the current distribution, although indirectly and to a smaller extent, thus affecting power loss.

Voltage and var control devices

Voltage regulating devices are usually installed at the substation and on the feeders. The substation transformers can have tap changers, which are -devices that can adjust the feeder voltage at the substation, depending on the loading condition of the feeders. Special transformers with tap changers called voltage regulators are also installed at various locations on the feeders, providing fine-tuning capability for voltage at specific points on the feeders.

The energy loss is due to the resistance in the conductor. The amount of loss is proportional to the product of the resistance and the square of the current magnitude. Losses can be reduced, therefore, either by reducing resistance or the current magnitude or both. The resistance of a conductor is determined by the resistivity of the material used to make it, by its cross-sectional area, and by its length, none of which can be changed easily in existing distribution networks. However, the current magnitude can be reduced by eliminating unnecessary current flows in the distribution network.



Factbox 1: Energy losses

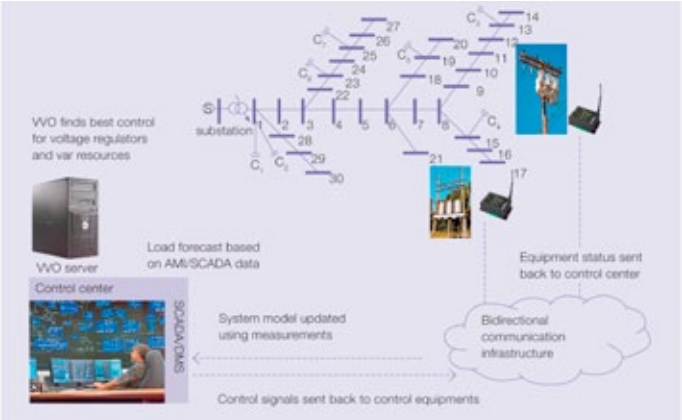
Reactive compensation devices, ie, -capacitor banks, are used to reduce the reactive power flows throughout the distribution network. The capacitor banks may be located in the substation or on the feeders.

A modest 10 percent reduction in distribution losses would save about 65 billion kWh of electricity

Traditional control verses VVO

Traditionally, the voltage and var control devices are regulated in accordance with locally available measurements of, for example, voltage or current. On a feeder with multiple voltage regulation and var compensation devices, each device is controlled independently, without regard for the resulting consequences of actions -taken by other control devices. This practice often results in sensible control actions taken at the local level, which can have suboptimal effects at the broader level.

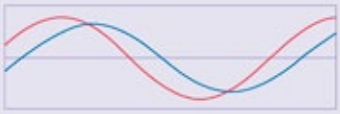
Ideally, information should be shared among all voltage and var control devices. Control strategies should be comprehensively evaluated so that the consequences of possible actions



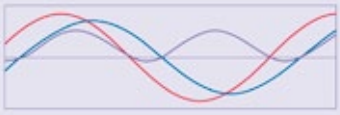
A schematic showing how VVO works

are consistent with optimized control objectives. This could be done centrally using a substation automation system or a distribution management system. This approach is commonly referred to as integrated VVO. The accelerated adoption of substation automation (SA), feeder automation (FA) technology, and the widespread deployment of advanced metering infrastructure (AMI) have over the last few years laid the foundations for a centralized control approach, by providing the necessary sensor, actuator, and reliable two-way communications between the field and the distribution system control center. Until recently, however, a key technology has not been available that can take advantage of advanced sensing, communication, and remote actuation capabilities that can be used to continually optimize voltage and var. Prior generations of VVO technologies have been hindered by their inability to model large and complex utility systems, and by their unsatisfactory performance in solution quality, robustness and speed.

The voltage and current waveforms on an AC power line are typically sineshaped. In an "ideal" circuit, the two are perfectly synchronized. In the realworld, however, there is often a time lag between them. This lag is caused by the capacitative and inductive properties of attached equipment (and of the lines themselves).



The momentary flow of power at any time is the product of the momentary current and voltage. The average value of this power is lower than it would be without the time lag (for unchanged magnitudes of voltage and current). In fact the power even briefly flows in the "wrong" direction.

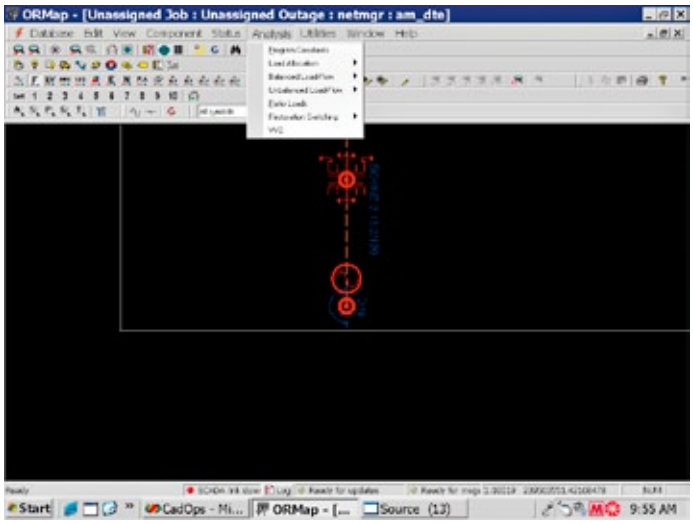


The greater the time lag between the curves, the lower the energy delivery. This lag (expressed as phase angle) should thus be minimized. The average energy delivery per time unit is called active power (measured in W). Reactive power (measured in VAr) is a measure of the additional power that is flowing on the line but cannot be put to effective use.

Factbox 2: Active and reactive power

How does VVO work?

VVO is an advanced application that runs periodically or in response to operator demand, at the control center for distribution systems or in substation automation systems. Combined with two-way communication infrastructure and remote control capability for capacitor banks and voltage regulating transformers, VVO makes it possible to optimize the energy delivery efficiency on distribution systems using real-time information .



VVO prototype screen capture

Prior method	ABB VVO capability
Single phase equivalent model	Multi-phase, unbalanced model
Balanced load	Unbalanced load
Single source	Multi-source
Radial system	Meshed system
Ganged control	Unganged control
Academic system size	Real utility system size
Offline performance	Online performance
Heuristic	Optimization theoretic

VVO compared to prior method

VVO attempts to minimize power loss, demand, and voltage/current violations6) in meshed, multi-phase, multi-source, unbalanced electric distribution systems.7) The control variables available to VVO are the control settings for switchable capacitors and tap changers of voltage regulating transformers.

Main benefits of VVO

The main benefits of VVO for distribution system operators are:

- Improved energy efficiency leading to reduced greenhouse gas emissions.
- Reduced peak demand and reduced peak demand cost for utilities

General problem definition for VVO

VVO must minimize the weighted sum of energy loss + MW load + voltage violation + current violation, subject to a variety of engineering constraints:

- Power flow equations (multi-phase, multi-source, unbalanced, meshed system)
- Voltage constraints (phase to neutral or phase to phase)
- Current constraints (cables, overhead lines, transformers, neutral, grounding resistance)
- Tap change constraints (operation ranges)
- Shunt capacitor change constraints (operation ranges)

The control variables for optimization include:

- Switchable shunts (ganged or un-ganged8)
- Controllable taps of transformer/voltage regulators (ganged or un-ganged)
- Distributed generation

Technical challenges

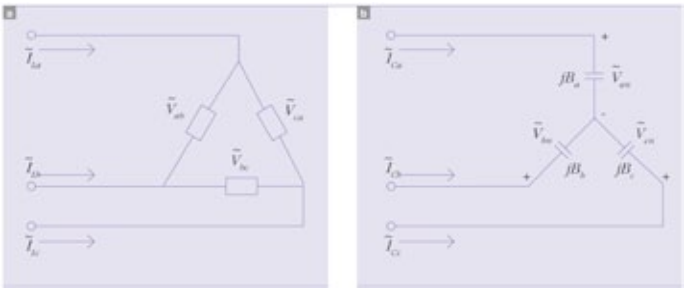
VVO in essence is a combinatorial optimization problem with the following characteristics:

- Integer decision variables – both the switching status of capacitor banks and the tap position of regulation transformers are integer variables.
- Nonlinear objective being an implicit function of decision variables – energy loss or peak demand are -implicit functions of the controls.
- High dimension nonlinear constraints – power flow equations numbering in the thousands in the multi-phase system model.
- Non-convex objective and solution set.
- High dimension search space – with un-ganged control, the number of control variables could double or triple.

Anyone who has tackled optimization problems will tell you that mixed-integer nonlinear, non-convex (MINLP-NC) problems are the worst kind to solve (See “Simply the best,” ABB -Review 1/2009, page 54).

VVO improves energy efficiency and reduces greenhouse gas emissions. It reduces peak demand, which reduces peak demand cost for utilities.

The major challenge is to develop optimization algorithms that are efficient for large problems. Since a certain amount of computation (ie, CPU time) is needed to evaluate the loss and demand for a single specific control solution (a single functional evaluation), an algorithm that requires fewer functional evaluations to find the optimal solution is generally regarded as more efficient than one that requires more functional evaluations to achieve the same objective. In the case of VVO, a single function evaluation involves solving a set of nonlinear equations, the unbalanced load flow, with several thousand state variables. The nonlinear, non-convex combinatorial properties of the VVO problem coupled with high dimensionality (large number of state variables) are the reasons why VVO has been a long standing challenge in the industry. In the last decade many in the research community have increasingly begun to resort to meta-heuristic approaches (eg, generic algorithms, simulated annealing, particle swarming, etc) to avoid the modeling complexity. The meta-heuristic approach has shown limited academic value in solving small-scale problems and in offline applications where online performance is not required.



Delta-connected load (a) and wye-connected capacitor bank (b)

ABB's next generation VVO

ABB developed a new-generation VVO in 2008 capable of optimizing very large and complex networks with online application speed. An innovative solution methodology enables the detailed and accurate modeling of the distribution system components and connections. It rapidly identifies the optimal voltage and var operation strategy from millions, if not billions, of operation possibilities using advanced mixed-integer optimization algorithms.

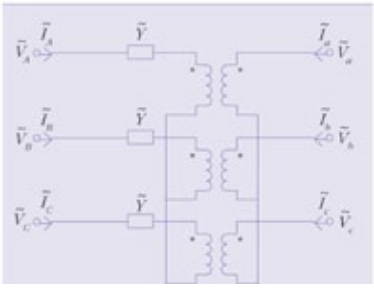
A prototype has been developed, which integrates directly with ABB's DMS. The prototype performed very well in the lab with distribution network models of a real utility system. Both the solution quality and speed robustness met or exceeded design criteria for online applications.

ABB developed a new generation VVO in 2008 capable of optimizing very large and complex networks with online application speed.

The size of the test systems range from 1,600 to 7,800 nodes and 1,600 to 8,100 branches per circuit. Optimization improved the loss from 2.5 percent to 67 percent9) and demand reduction from 1.4 percent to 5.8 percent.10)

The following table is a brief summary of the key features that differentiate ABB's VVO technology from prior methods .
To accurately model a distribution network's behavior a detailed network model is used. Phase-based models11) are used to represent every network component. Loads or capacitor banks can be delta or wye connected .

Transformers can be connected in -various delta/wye and various secondary leading/lagging configurations with or without ground resistance, with primary or secondary regulation capability .



Wye-wye connected transformer model

Both voltage and var controls can be ganged or unganged. The method works on radial as well as meshed networks, with single or multiple power sources. Voltage controls are enforced for each individual phase, using phase-to-ground or phase-to-phase voltage, depending on the connection type of the load.

One smart technology at a time

With the accelerating deployment of advanced sensor network, smart metering infrastructure, and remote control capability, there is a growing need for smart applications like VVO that optimize the operation of the distribution system. The development of the next generation of VVO technology is a demonstration of ABB's ability to bring smart grid technology to its customers.

Footnotes

1) US Energy Information Administration, International Energy Annual 2006
2) US Energy Information Administration, World Net Electric Power Generation: 1990–2030
3) The voltage drop across the cell during passage of current due to the internal resistance of the cell
4) Voltage profile refers to the spatial distribution and voltage magnitudes at different locations or nodes throughout the etwork.
5) Any of the medium-voltage lines used to distribute electric power from a substation to consumers or to smaller substations.
6) Voltage/current violations refer to the undesirable excursion from normal operating range, eg, current exceeding the maximum limit safe for a given conductor type, or voltage exceeding a limit unsafe for the consumer or falling short of a limit needed for normal operation for end users.
7) A distribution system model may have the following features: meshed (looped, with multiple paths between some nodes), multi-phase (each of the A, B, C phases explicitly modeled, rather than modeled as a single phase), multi-source (a load can get electric supply from multiple sources), unbalanced (asymmetric construction, such as a single-phase feeder, and/or asymmetric loading, ie, unequal loading on each phase)
8) Ganged control means multiple phases operated in unison, and unganged control means each phase -operated independently.
9) The amount of loss reduction depends on the controllable voltage and var resources in the system, the system loading condition, and the initial control strategy.
10) The amount of demand reduction depends on the factors that affect loss reduction as well as the load model. For 100 percent constant load, demand reduction can only be achieved through loss reduction.
11) Exact component model includes the information of all existing phases.

References

[1] CIA Online Factbook. Retrieved June 2009 from http://www.cia.gov/library/publication/the-world-factbook/

Karnataka Power Transmission Corporation Limited (KPTCL) Press Visit

ABB organized a familiarization trip for journalists from various international publications to visit facilities and project sites in Bangalore and Vadodara. The theme of the conference was 'Strengthening Grid Reliability' with a focus on the Power Products and Power Systems divisions apart from giving an insight into the growth and future plans of ABB in India.

As part of the trip the team also visited the Karnataka Power Transmission Corporation Ltd (KPTCL) Integrated Extended SCADA system on 17th of November 2009 at the Master Control Centre, Bangalore.

The overview of the system was explained by the Local Division Manager of Power Systems for ABB in India, Mr. Prakash Nayak, and various functionalities of the system were demonstrated by Mr. Vijayan EDM of ABB Network Management and his team.


ABB sieht in Indien ein zweites China

Press clipping FAZ

The journalists were told about the advantage of the complete project and also the benefits that the user can derive from the installed SCADA/EMS/DMS system.

The journalists could get a direct look at how ABB helps to monitor power delivery and quality in real time using the SCADA/EMS/DMS system delivered by ABB.

The following functions were operationally displayed to the media team.

- Network Manager Overview in reference to KPTCL project
- SCADA operation (real-time breaker operation).
- EMS overview including hydro - thermal coordination
- Generation of various reports
- Energy Billing, Energy Analysis & ABT module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