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Modern Trends in Distribution Automation

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ABSTRACT

Distribution automation (DA) has historically been focused exclusively on improving reliability, but has now emerged as a key for reducing energy loss and carbon emissions, integrating renewable generation resources, and supporting plug-in EV deployments. Innovation of distribution automation (DA) including the optimal load transfer and fault restoration began around 20 years ago in Japan. Since then, most distribution feeders are automated, and the aged DA facilities must be considered to be replaced. In replacing the system, new concepts must be introduced to the system. Namely, the small DA systems in business offices are unified and integrated into the ones in the branch of the company, and the supervised area or controlled area of one DA system becomes wider than those of the existing system. The DA functions are also innovated. On the other hand, new trend of distribution system is a connection of such distributed generators (DGs) as solar cells and co-generation systems as gas engines or fuel cells. The functions to cope with DGs are also installed to the new system. Caused by a connection of single phase DGs, 3-phase unbalance must be considered to control distribution systems. A load transfer technology in which 3-phase power flow is implemented is illustrated as a new trend for a future power distribution system. Considering the intimate connection with smart grid, the paper has pointed out the further development trends of distribution automation

INTRODUCTION

In the context of smart grid deployments today, distribution automation (DA) refers to an intelligent distribution system that is fully controllable and flexible. Such a system can help operate the grid more efficiently, thanks to its embedded intelligence. It is also self-healing in many types of power outages, which is a significant benefit for utilities and their customers. At the same time, electromechanical equipment and passive circuit elements further downstream on the grid are increasingly being equipped with intelligent sensors, processors, and communications technologies. Smarter transformers can adjust themselves without the need of human intervention. Power lines have devices that locate faults and call in fault currents and power quality issues. Capacitor banks and line regulators that work in concert with the above equipment to optimize voltage and power factors can effectively reduce costs and greenhouse gas emissions. Also, lessons learned from smart grid pilots over the last 5 years are being tallied and molded into best practices. Such progress will be a powerful driver for growth in the DA market. Navigant Research forecasts that global DA revenue will nearly double by the end of this decade, growing from $6.3 billion in 2013 to $11.3 billion in 202

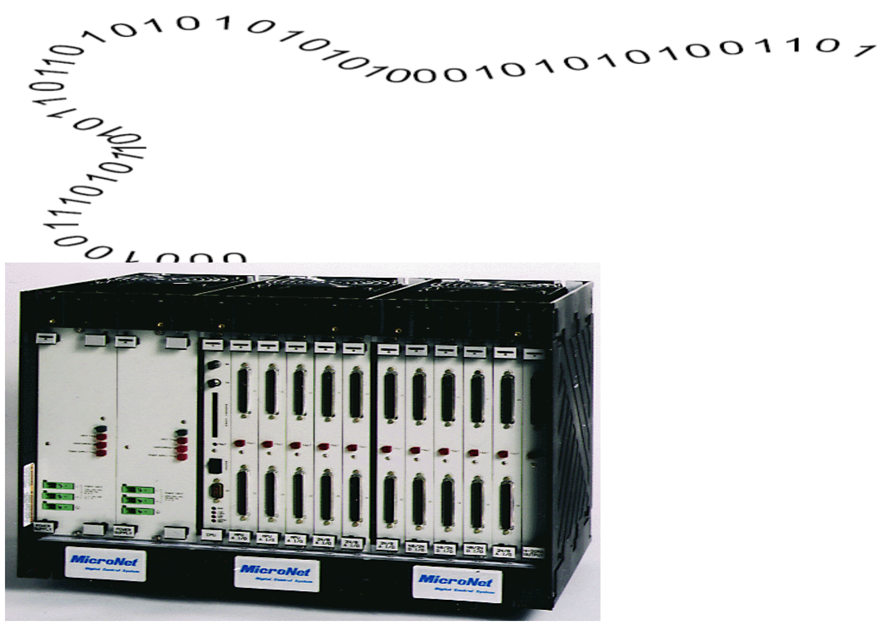
This Paper has given a full view of the developing history of distribution automation system in our country based on systematic analysis and detailed comprehension. One step further, the current situation and future aims of distribution automation have also been revealed in the following passages.

II. DISTRIBUTION AUTOMATION

1. EXPLORATION

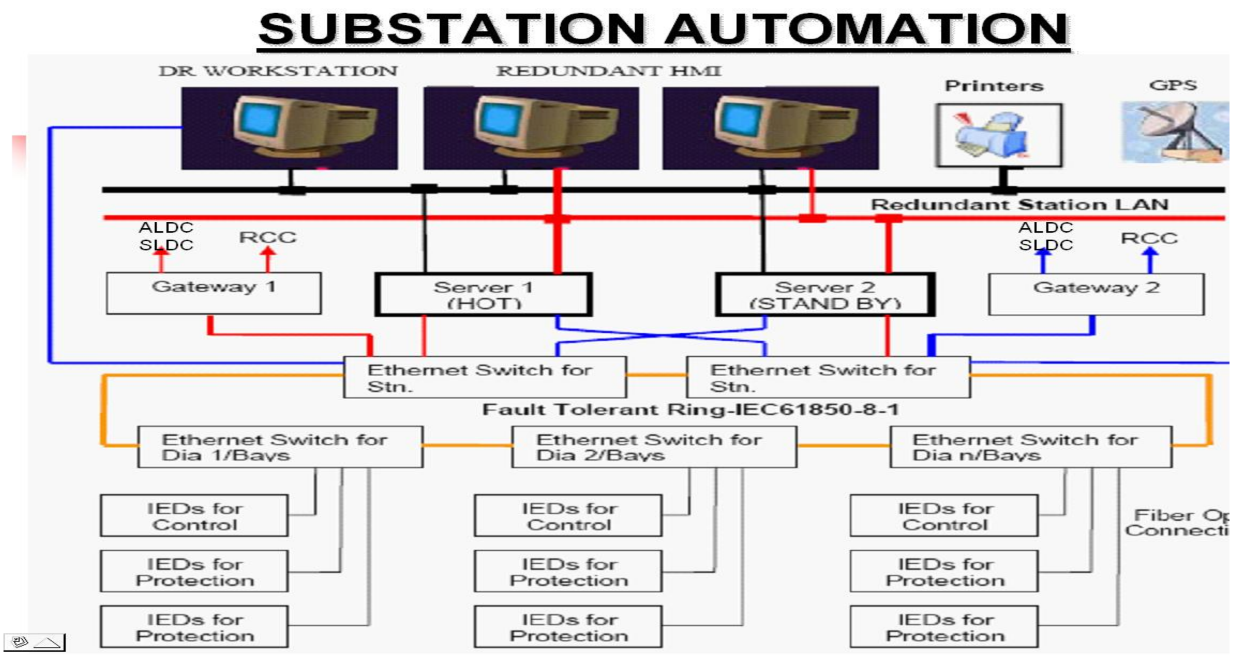
Exploration from the end of 1980s to the beginning of 1990s. At the end of 1980s, state grid in Shijiazhuang and Nantong introduced reclosers and sectionalizers for feeder automation pilot. In 1994, Xiamen power supply bureau built pilots for distribution automation and distribution network information management system. In

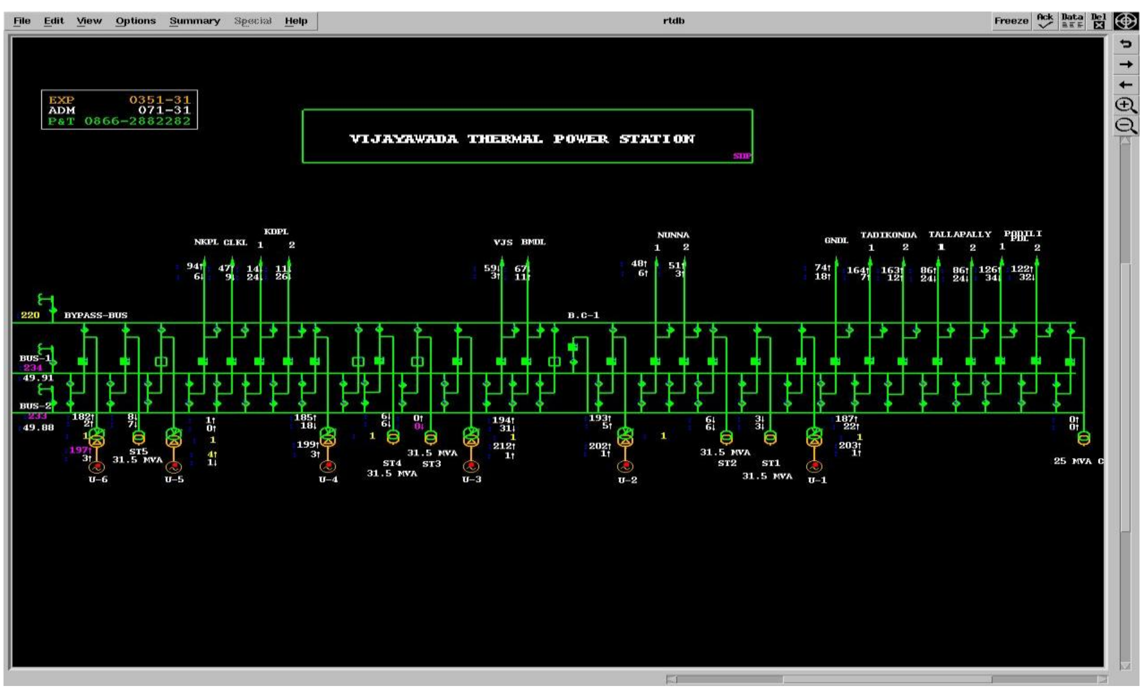
1996, Jinteng residential district in Shanghai completed the construction of feeder automation system with cables. At the same time DA system was being applied in Shijiazhuang, Yantai, Yinchuan and other districts.



2. SUBSTATION AUTOMATION

It includes adding SCADA system for remote monitoring and control Replacing the mimic panel and annunciator with a Computer (workstation) (HMI). It provides sophisticated and computerized operation, maintenance and protection to manage hazardous and complex operations. It substantially plays an active role in fast restoration and quick decisions.





3. DCS -DISTRIBUTED CONTROL SYSTEM

It is used in Power Houses for Process orientation in Local control over the devices in which acts as a subordinate to SCADA.It is independent of event orientation.

3. SMART GRIDS DA

All the smart meter data in the world isn't going to do much good if a utility is unable to efficiently and effectively interpret and extract value from it. In the first of a three-part series, long-time utility insider Kai Hui explains the operations maturity model and how utilities can use it to judge if they are making the most of the data they have available.GE Digital Energy's new time synchronization solution, ABB's latest secondary substation, a new analytics offering from C3 Energy and other platforms and devices are emerging solutions in new era. Honeywell will build a microgrid for the U.S. Army at Fort Bragg will acquire GRIDiant Corporation. Those are only two examples of the big news stories readers will find in this week's collection of smart grid wins

A Smarter Network Industry challenges

Need for more electricity
Emissions reduction
Integration and management of renewable energy
Optimal use of ageing assets
More automation due to ageing workforce
Ensure reliability of supply
Energy efficiency and security

III.REAL TIME DIFFICULTIES

(1)**Improper Design structure**: The distribution network in our country is mostly in radiant structure. The feeders are seldom or improperly sectioned. Despite hand-in-hand tie lines have been applied in distribution network, the backup power capacity of feeders is not sufficient to realize continuous power supply for power load transferred to healthy lines during the fault treatment process. Sometimes two hand-in-hand lines come from the same 10kV bus connected to the same substation, which has negative effects on its flexible power reservation. These defects give limits to the operation modes of distribution system and weaken the ability of responding to emergency situations. The effectiveness of distribution automation system is not satisfying.

(2)Lack of Facilities: The distribution automation system in early times simply duplicated the dispatching automation and power transmission and transformation technology used in main network. The transplantation is arbitrary and not fully considered. The characters of distribution network are neglected. The design and development of main station's functions in distribution automation system lacks pertinence. The power dispatching and management functions almost copied those of main station SCADA, making them impractical and pointless. What's more, the lifetime of terminals used in distribution network couldn't stand the severe environment. The steadiness of system operation is another aspect in need of improvisation. The hardware couldn't live up to the high standards of distribution automation.

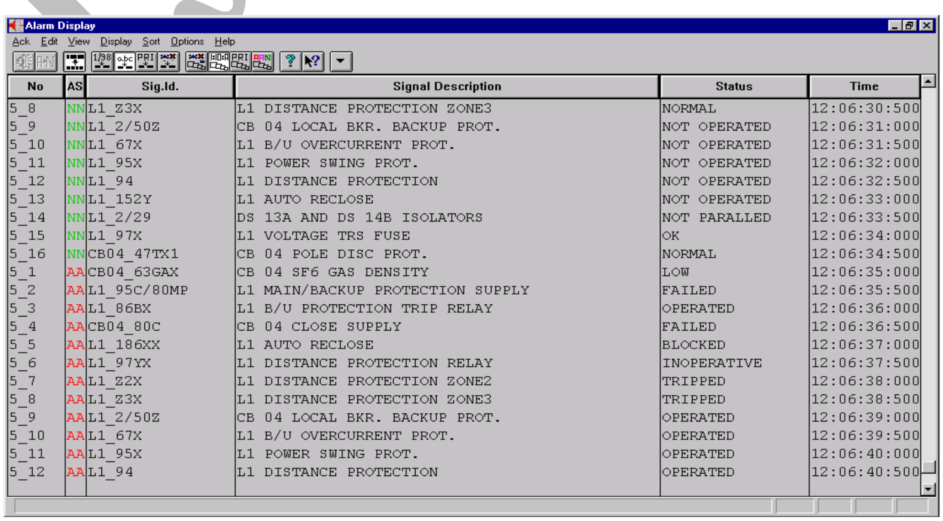
(3)Lack of Realization: Without description criteria of informatization and digital model, the distribution network information cannot be exchanged in time. The function application of distribution automation is difficult to realize. On the other hand, graph and data maintenance is not synchronized with the development of network. The accuracy, timeliness and integrality of system data cannot be guaranteed, which makes the DA system unreliable. The model of distribution network is not standard and incomplete. Its application is not optimistic.

(4)Technical Difficulties: It is one of the most important fundamental platforms of distribution automation system. It is responsible for network modeling and providing graphs. However, the software designers are not familiar with the process and theory of distribution network management. As a result, GIS is not properly fit for distribution network modeling. The static application might still be smooth but dynamic application like real-time analysis and calculation are not possible. Since there is not any delicate design or feasible plan for models, graphs and interfaces distribution network SCADA main stations, the long-term use couldn't be accessible. Generally speaking, the distribution automation level in China is still very low. Only a few districts have realized feeder automation, let alone scale efficiency. The isolated islands of automation and too many specialty divisions hinder the computerization of distribution management process. The practical functions are rather limited.

(4)High Cost: In the past, this technology was mainly dismissed because of high costs, both initially and operatively. This area of the landscape is changing as public wireless options are increasingly offering affordable, pay-for-use plans based on bandwidth consumed and the amount of data sent

IV. FUTURE OF DISTRIBUTION AUTOMATION

The state of the electricity distribution system has reached a milestone. While there have been incremental improvements in distribution system and equipment, distribution assets have not had revolutionary changes in the last half century. Distribution automation, AMI technologies, distributed generation, and the wired and connected home will radically alter the current electricity distribution business. To survive and remain competitive, the electricity distribution industry will need to move to managing in real-time, using an intelligent and reliable two-way distribution infrastructure to support a digital society, where the power network of the future will be real-time, responsive, adaptive, eco-sensitive, flexible, price smart, self-diagnosing, self-healing and interconnected with everything else.


Alarm Display

No	AS	Sig.Id.	Signal Description	Status	Time
5_8	NN	L1_Z3X	L1 DISTANCE PROTECTION ZONE3	NORMAL	12:06:30:500
5_9	NN	L1_2/50Z	CB 04 LOCAL BKR. BACKUP PROT.	NOT OPERATED	12:06:31:000
5_10	NN	L1_67X	L1 B/U OVERCURRENT PROT.	NOT OPERATED	12:06:31:500
5_11	NN	L1_95X	L1 POWER SWING PROT.	NOT OPERATED	12:06:32:000
5_12	NN	L1_94	L1 DISTANCE PROTECTION	NOT OPERATED	12:06:32:500
5_13	NN	L1_152Y	L1 AUTO RECLOSE	NOT OPERATED	12:06:33:000
5_14	NN	L1_2/29	DS 13A AND DS 14B ISOLATORS	NOT PARALLED	12:06:33:500
5_15	NN	L1_97X	L1 VOLTAGE TRS FUSE	OK	12:06:34:000
5_16	NN	CB04_47TX1	CB 04 POLE DISC PROT.	NORMAL	12:06:34:500
5_1	AA	CB04_63GAX	CB 04 SF6 GAS DENSITY	LOW	12:06:35:000
5_2	AA	L1_95C/80MP	L1 MAIN/BACKUP PROTECTION SUPPLY	FAILED	12:06:35:500
5_3	AA	L1_86BX	L1 B/U PROTECTION TRIP RELAY	OPERATED	12:06:36:000
5_4	AA	CB04_80C	CB 04 CLOSE SUPPLY	FAILED	12:06:36:500
5_5	AA	L1_186XX	L1 AUTO RECLOSE	BLOCKED	12:06:37:000
5_6	AA	L1_97YX	L1 DISTANCE PROTECTION RELAY	INOPERATIVE	12:06:37:500
5_7	AA	L1_Z2X	L1 DISTANCE PROTECTION ZONE2	TRIPPED	12:06:38:000
5_8	AA	L1_Z3X	L1 DISTANCE PROTECTION ZONE3	TRIPPED	12:06:38:500
5_9	AA	L1_2/50Z	CB 04 LOCAL BKR. BACKUP PROT.	OPERATED	12:06:39:000
5_10	AA	L1_67X	L1 B/U OVERCURRENT PROT.	OPERATED	12:06:39:500
5_11	AA	L1_95X	L1 POWER SWING PROT.	OPERATED	12:06:40:000
5_12	AA	L1_94	L1 DISTANCE PROTECTION	OPERATED	12:06:40:500

Today's utilities are looking to DA systems and AMI to support monitoring and remote control of their power systems. They seem to be obvious synergies. Even though a high level of saturation may be required to reap the full economic benefits of an AMI deployment, targeted deployments such as "end of circuit" meters to provide data for CVR initiatives demonstrate how symbiotic the technologies can be. In collaboration with Elster, Zpryme conducted a survey of 223 global Smart Grid executives in July of 2012. Ninety-five percent of the respondents agree (69% "strongly" and 26% "slightly") that the potential for utilizing aspects of electricity's AMI with DA is very high.

VI.MODERN SMART GRID TECHNOLOGIES

In a broad sense, the term "smart grid" is referred to a conventional electric power system that has been equipped with advanced technologies for purposes such as reliability improvement, ease of control and management, integrating of distributed energy resources and electricity market operations. The smart grid technologies can be categorized in the following five key areas

Integrated Communications – High-speed, fully integrated, two-way communication technologies will make the smart grid a dynamic, interactive "mega-infrastructure" for real-time information and power exchange. Open architecture will create a plug-and-play environment that securely networks grid components to talk, listen and interact

.

Sensing and Measurement – These technologies will enhance power system measurements and
Enable the transformation of data into information. They evaluate the health of equipment and the integrity of the grid and support advanced protective relaying.

Advanced Components – Advanced components play an active role in determining the grids
Behavior. The next generation of these power system devices will apply the latest research in materials, superconductivity, energy storage, power electronics, and microelectronics. This will produce higher power densities, greater reliability and power quality, enhanced electrical efficiency producing major environmental gains and improved real-time diagnostics.

Improved Interfaces and Decision Support– In many situations, the time available for operators to make decisions has shortened to seconds. Thus, the smart grid will require wide, seamless, realtime use of applications and tools that enable grid operators and managers to make decisions quickly. Decision support with improved interfaces will amplify human decision making at all levels of the grid.

Advanced Control Methods – Advanced control methods are the devices and algorithms that will analyze, diagnose, and predict conditions in the smart grid and determine and take appropriate corrective actions to eliminate, mitigate, and prevent outages and power quality disturbances. To a large degree, these technologies rely on and contribute to each of the other four key technology areas. For instance, they will monitor essential components (Sensing and Measurements), provide timely and appropriate response (Integrated Communications; Advanced Components), and enable rapid diagnosis (Improved Interfaces and Decision Support) of any event.

IV. CONCLUSIONS

The development of distribution automation system in our country has passed over thirty years but still not being prosperous. The existing problems and development directions are crucial and worth of research. This article has pointed out that weak network structure and other aspects like deficient facilities have hindered the further progress of DA system. Diversification, integration with other application systems and intellectualization are important means of improving practicality of DA system. One step further, the distribution automation should be able to realizefast fault treatment and optimization of network operation status. Consideration of new energy resources connectingwith power network has put forward new risks for researches of smart grid and distribution automation system.

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