Advance Distribution Automation Systems and Its Development in Smart Grid

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ABSTRACT

The power system has considerable improved nowadays with concept of smart grid with the construction, automation in transmission a well as distribution systems. DAS (Distribution Automation System) occupies the distribution system for automated response with the Demand by optimal utility of resources. This paper deals with a brief review on the automation system developments and challenges, this incorporates advance technologies, ncreased reliability, and minimal losses with optimal utility of asses of the assets through integrated system under uniform platform of control termed as ADA (Advance Distribution Automation System) systems.

Key words: ADA, DAS, feeder automation, customer level automation, tools of

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INTRODUCTION

The distributions systems intelligent improved on monitoring, load dispatch through new technology equipments make the automation effective. Fig.1 shows a typical view of automation system with many subsystems.

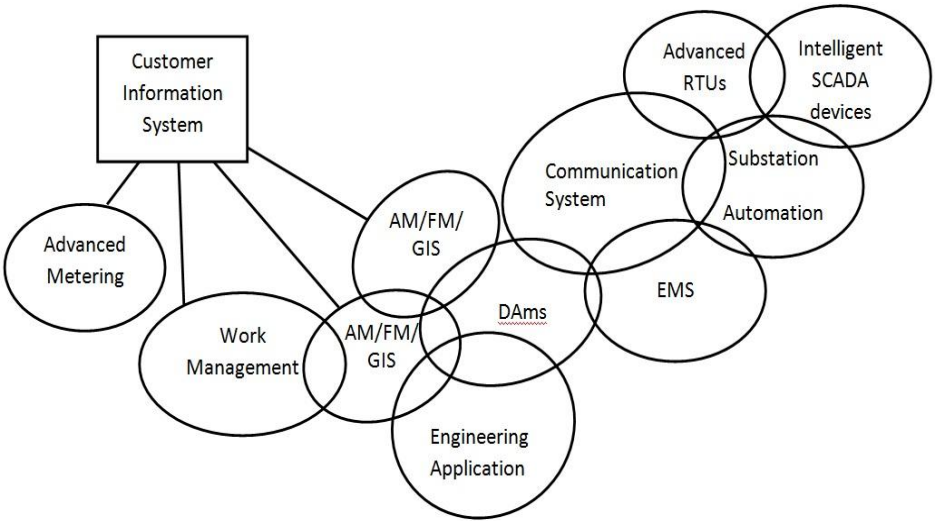

Fig.1 Over view of automation of a typical system

Many devices power quality managing devices, monitoring, VAR (Volt Ampere Reactive) [39] [38] [40] control devices etc. Automation has the uniform intelligent platform for control and maintenance for the system operation improvement optimally. Automation system road map [28]gives time frame researches and its efforts, also give the lags on ongoing researches on DAS Automation in distribution systems would ensures operating costs are reduced, contingency responses enhanced, power quality improvement, customer service increased, Outages risks are reduced and prevented, Ease recovery of system in time for reliability ensured. Integration DER (Distributed Energy Resources) with distribution makes utility, customer friendly system Power quality, and service improvement results in reliability and benefits of end users. The new technology implements make the distribution cost effective, associated market structure to develop the system. Researches made based on automation still through many technologies to optimize the cost. The implementation power electronics devices make the system control effective with many scopes.

OVERVIEW

DAS IMPLEMENTATION

This gives the important concept of automation systems to be implemented, scope, about the market, vendors. The development of automation system in both transmission and distribution system and its implementation is increased nowadays shown in Fig.2

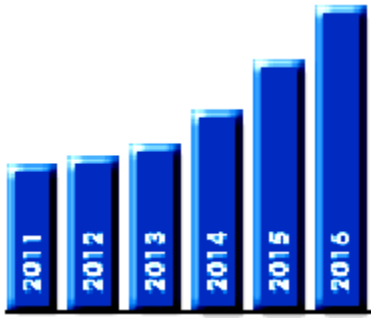

Fig.2 DAS implementation growth worldwide

Benefits on Finance gives about Quick restoration makes increased revenue, improved utilization of assets and improved quality makes customer attractive. Benefits in Operational and Maintenance includes the Reliability improved with reduced risk of outages through effective restorative, VAR control Improves voltage control [37] [35] automatically, Man power, working hour reduced, Data are Accurate and useful. Improved diagnosing methods and fault analysis and improved management, load management. Benefits related to Customer deals with Reliable service, Cost of interruption reduce in Industrial/Commercial applications and Better power quality. DAS usually implemented in two areas. Feeder and Distribution Substation, Automation and Automation on Customer Location. In the Feeder and distribution substation automation, Substation and feeder information shared under a common platform for ease of control and equipment maintenance.DAS includes supervisory control on CBs(Circuit Breakers), OLTCs(On Load Tap Changers)[34][17], regulators, capacitor [31][32]banks etc. Remote access of data in time is used in supervisory control systems. Automations on consumer location that includes the make and break of services in time, meter readings, programs usage time etc.

DAS STRUCTURE

DISTRIBUTION SUBSTATION AND FEEDER AUTOMATION ON UTILITY LEVEL

The voltage above 22kv system is usually applied for distribution automation. The primary automation is said to be distribution automation and feeder automation. The functions are listed below. Load Balancing on Transformer includes load balancing monitoring that provides the real time information about distribution system. Information helpful for load control, capacitor [33] switching etc, improves the efficiency of the power distribution system. The Fig.3 shows the over view of automation in distribution system**.**

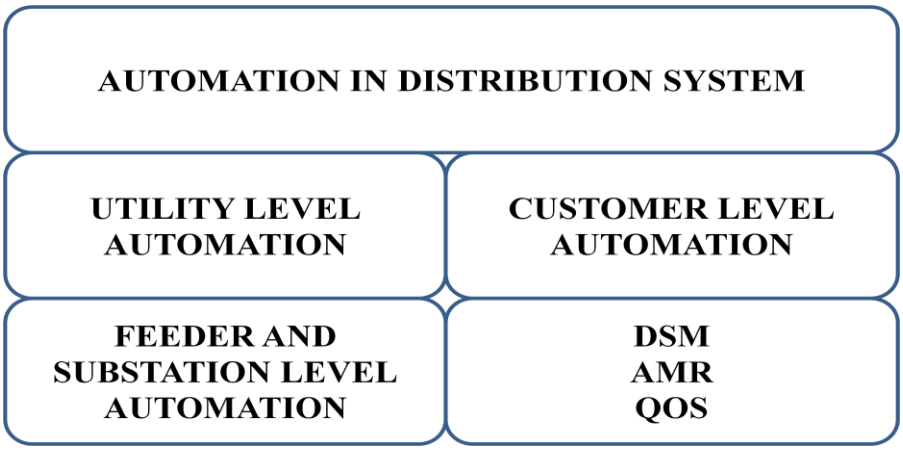

Fig.3 DAS overview

Monitoring of voltage deals with remote monitoring gives prior notifications of low voltage, demand raise and it records the data, image model in time. Voltage Regulation deals with LTCs [17] [12] help in remote control of DAS during peak hours, demands. In case of emergency conditions uses back feeding to set voltage level above the LTCs to meet the demand. Remote Switching helps in automations system employed with remote switches that separate the portion of utility feeder ease of access. Interconnection of switches on distribution to give efficient configuration for remote recovers restoration of system at faults. Fault Isolation and Sectionalizing gives about remote monitoring will gives quick access of faults, faults before Outages are intimated to take necessary actions in time. Switching of capacitor bank deals with number of one way receivers at location of capacitors for control, monitor, switching the banks at low voltage levels. Switching of capacitor banks reduces the losses increases the efficiency of system.

AUTOMATION ON CONSUMER LEVEL

Consumer location and the points of installation maintenance, access and control economically is a major constraint on the secondary automation. Demand Side Management (DSM) technology provides real time pricing/dynamic pricing which includes monitoring of power usage for a particular time, its cost, new rate are determined accordingly. Load Management gives about the non critical load and its power consumption on consumer side, managed through load management control system.AMR (Automatic Meter Reading)[8] will intimate according the preset values, usage level exceeded through the data obtained from remote configurations makes cost effective system. QOS (Quality of Service) maintains monitoring of outages, disturbances in

the system and its recover in time determines the quality of service and differs for different utility services.

CONSTRUCTION OF DA

The DA (Distribution Automation) should have the flexibility for reconstruction with quality power. For cost benefit the DA operation is evaluated before implementation. The architecture has two layers quasi data base and automatic dispatch, client calling, demand management, control etc. Unified quasi platform and distribution network acquisition based on IEC (International Electro Technical Commission) [6], standards ensure the data exchange, protective measures. For accuracy in maintenance, different system applications are coordinated under a single platform. The host reconstruction RTU (Remote Terminal Unit) [18] [19] focuses on DA construction only. Effective and flexible communication on DAS is obtained from the data of measurement, controlling, dispatching units. DA, GIS (Geographic Information System) [7] is introduced with integrated manner in all management system under uniform platform decentralization [41]. Remote terminal data gathered on load control, automation, acquisitions systems are exchanged which requires further process then analyzed. These data accessed through different operators and monitored daily. These IEC standards 61970, 61968 are used for upgrade of equipments and interfaces in DAS.

CHALLENGES ON DATA MAINTENANCES AND COMMUNICATION OF DAS

MAINTENANCE OF DATA IN DAS

New construction of substation will have its own difficulties of implementation on the automation system with the constrains like network graphics, access schemes, importing data and maintenance. Many devices in large system makes burden while upgrading of system, maintaining of data in DAS. The major problem is the changes adopted with the upgrade of equipments, maintenance with guarantee. The limitation of time is also considered for implementation to obtain access of devices, producing accurate images in time is the challenge in DAS. The power devices parameters, relative topology in DAS gives real time monitoring of distribution system. SCADA (Supervisory Control And Data Acquisition system) [14] [15] based system and advance application gives further scope for DAS. Integrated data maintenance keeping the consistency based approaches requires shared data used for automation at the instant of designing of DA. For assuring accuracy and timeliness of data information's available are integrated based on IEC61968 CIM standards [22], IEC61970 with SVG (Scalable Vector Graphics) and it's shared on automation system. A quality control deal with DA construction integrated maintenance ensures the accuracy of data.GIS based topology on DA gives higher accuracy of all the automation system. New approach in model through GIS imaging topology and DA required for quality problem on the data. For ensuring the data accuracy based routines required for topology modeling on GIS.GIS will not allow of publishing models unless existing model and error are not cleared. Automation system in distribution, GIS is integrated under quasi platform. Tests are made to solve the problem in GIS as data quality, syntax problem, image problem like pixel staggering overlap in character, inconsistency in description type. Data exchange between DA and GIS, its communication with CIM/XML (Common Information Model/extensible Markup Language) standard makes improvement in DA maintenance. The Fig.4 below shows the communication of centralized automation system [3]

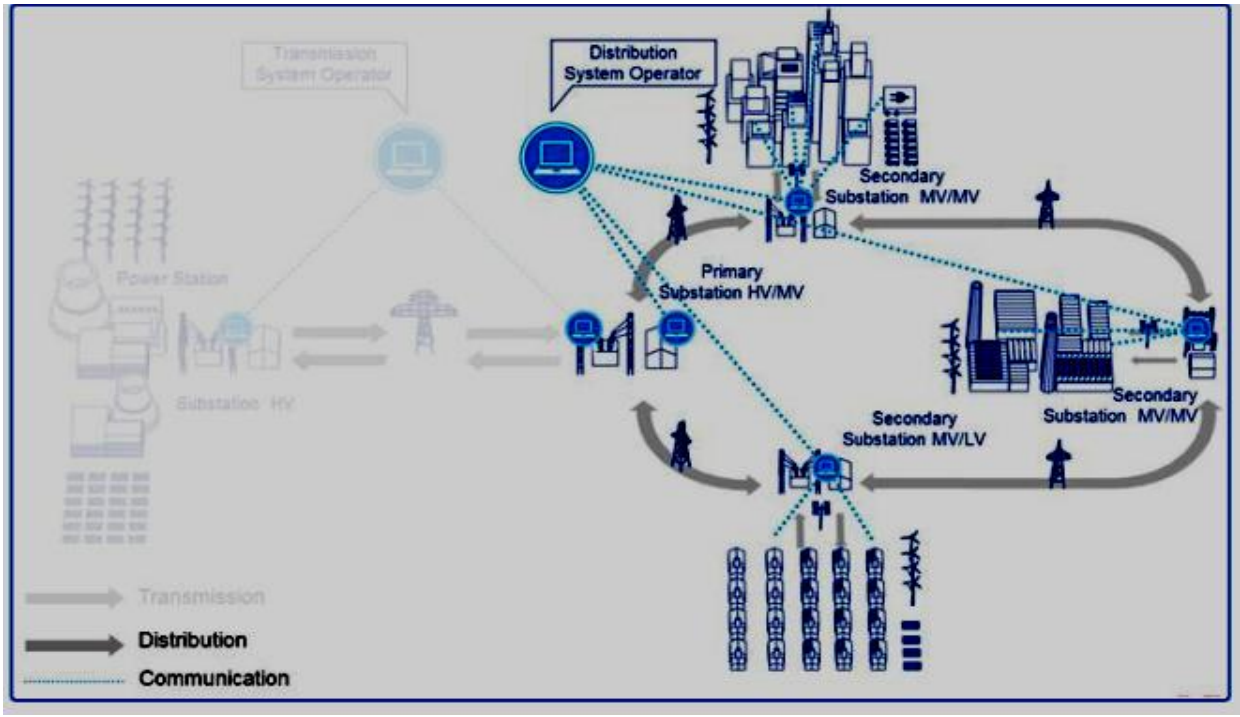

Fig.4 centralized automation and its communication

REAL TIME CONTROL WITH DATA MAINTENANCE

Real time models are made through incremental procedures, transmitting mechanism. the measurements at different prospect like management and other gives required model of real time data. On the integrated system the real time reliable data in time with proper communications enhance the system. Before upgrading or installation it's necessary to obtain the relevant information through GIS assets, models in distribution automation. To publish the image model for test, update, SVG images at debug state required. This will gives real time and accuracy in data of distribution system.

AUTOMATION WITH UNIFIED DATA PLATFORM

THE ENERGY ACCESS IN DISTRIBUTION

The energy access in distribution system rise with the concept renewable system (low carbon). A different in the way required for a flexible access of features and capacity of distributed energy. The focus on the network and energy management are required and its access at different levels on monitoring. So the demands requirements are met with DMS [27] [26] and EMS [24][25]in a uniform platform and its automation. To identify the enhancement of DG (Distributed Generation) [38] the load forecasting, distributed generations are focused at different levels. The integration of real time loads, energy storage, distributed energy, VAR control achieved by strengthening of DAS.

CUSTOMIZED POWER SUPPLY

The customization required in DA system flexible to the seasonal loads. The network modeled based on CIM/CIS international standards leads to interconnection of applications. To get reliability high quality monitoring devices are required in distribution system. EMS, DMS and

GIS information are accessed under unified platform to provide an improved network model. A new function helps in risk, source track evaluation in networks. For a need quality data improved with optimizing the automation functions and display. COBRA encapsulates operating system, hardware, gives flexible developed interface for distribution operating system. Transmission and distribution systems are integrated sometimes for ease managements provides better decision support. The real time global monitoring achieved by integration of data from distribution automation, transmission systems.

RESTORATION OF SYSTEM

Self restoration, recovery reduces the outage duration considerably. The integrated restore mechanism with number of tool like asset model, GIS, uniform grid model etc can diagnose the fault, real time isolation and helps in recovery of the system. The back tracking methods helpful on quick tracking of faults. The fault detection and isolation in quick operating mode using auto switching, programming dispatch, black start decision techniques etc. This would help to recover the power supply. The security of network constraints after faults can be calculated automatically through auxiliary restoration systems. With the real time data, topologies are made to provide auto fault identity easily, possibility of outage risks are reduced.

DAS AND ITS TOOLS

DISTRIBUTION AUTOMATION SYSTEM AND ITS CATEGORIES

Different technologies in automation helps in improvement of DAS are as below This SCADA become the part of SS (Sub Station) automation rather than the DAS. Remote monitoring control has considerably increased in substations about 75% in subsystem automation. The integrated approach on applications gives improvement in distribution system. Auto Fault locators are the important benefits in monitoring system. The monitoring is extended with identification of essential electric topology which will helps in location of faults. The management of outages are also adds improvement by the auto fault locators and its recovery in time to minimize the risk of outages. Automation in VAR compensation for quality power deals with better voltage control][16][13], loss reduction in distribution system can be achieved through close monitoring of capacitor banks and regulators. The implementation of power electronic devices makes better control on this reactive power control, gives scope for improvement on future. This will gives valid data on many aspects like voltage fluctuations, unbalance, harmonics and the characteristics of system. Distribution monitoring through acquisition systems that includes acquisition systems, become major part of distributions system through which automation of substation migrates to distribution system nowadays. The benefits of these automation makes improvement in reliability, self recovery capability which can limits the outages to some extent. Management of outages gives about GIS used for the management of outages, integrated with the customer information; electric topology reduces the possibility outage risks. This includes the work crews, reliable data management, and coordination. This outage management is not a part of system but its implementation makes the system automation effective. Fig.5 shows the construction overview of a typical automation system with its tools

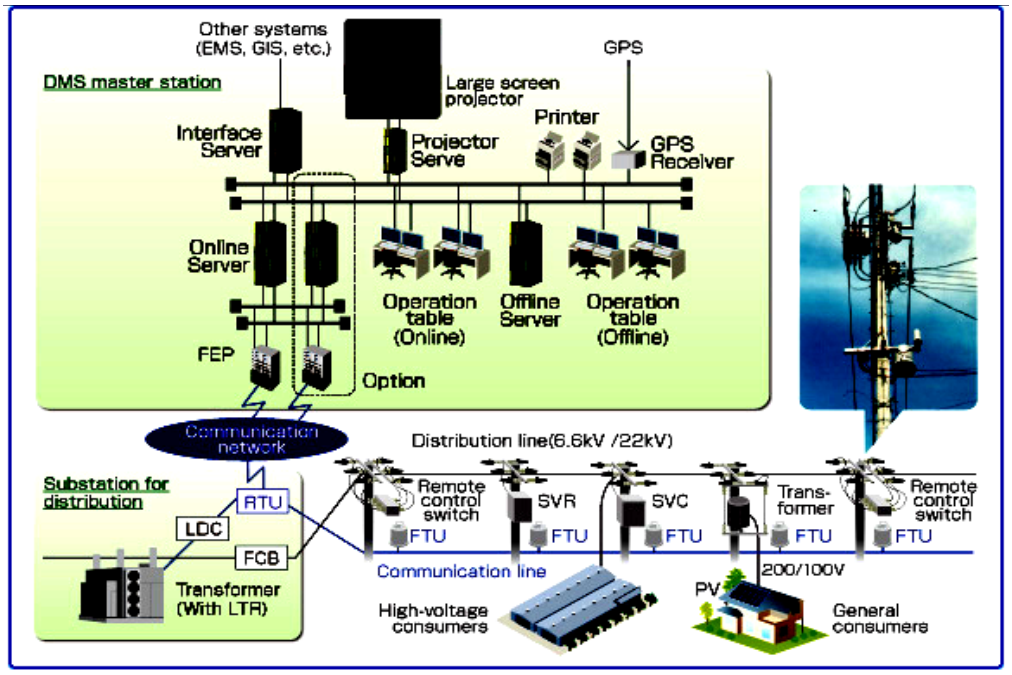

Fig.5 Automation system and its tools

Advanced Metering Systems (AMI) [20] [21] deals with advance technology which facilitates different technologies attractive for both the utilities and customer .Automated meter reading used by the utilities helpful for the customers. The automation on metering makes the load control, demand response, customer information, and applications effective. Monitoring system and its applications that includes In utilities improved quality power monitoring, through Intelligent electronic devices are widely spreading nowadays. Auto Fault locators, vast data collection through many intelligent devices makes the automation effective for diagnosis of failures. State estimation, real time control in Distribution system deals with the effectiveness of the system is improved by real time access of data, state of the system, finding ways to improve efficiency, minimize the outage risks. Through advance metering system, the real times models, monitoring are integrated on the distribution system make it more effective. Managing assets gives about automated system can gives enough details of assets, its performance (breakers, transformer, relays, capacitors etc). Information on loads, history, characteristics gives the information on assets and its conditions used for intelligent decision making programs for maintenance, replacements in time. Distributed resources and its integration deals with the automation make effective integration, utilization of energy resources feasibly. The integration of resources makes use of two way communication, system control in real time to get improvement in reliability and efficiency.

CHALLENGES AND DEVELOPMENTS

NEW TECHNOLOGIES IN DISTRIBUTIONS SYSTEM

The integrated technologies [40] of different approaches are provided with the existing system for improvements tend towards future. The decentralized reactive power control scheme switches the capacitor bank, reactive power control device in time.

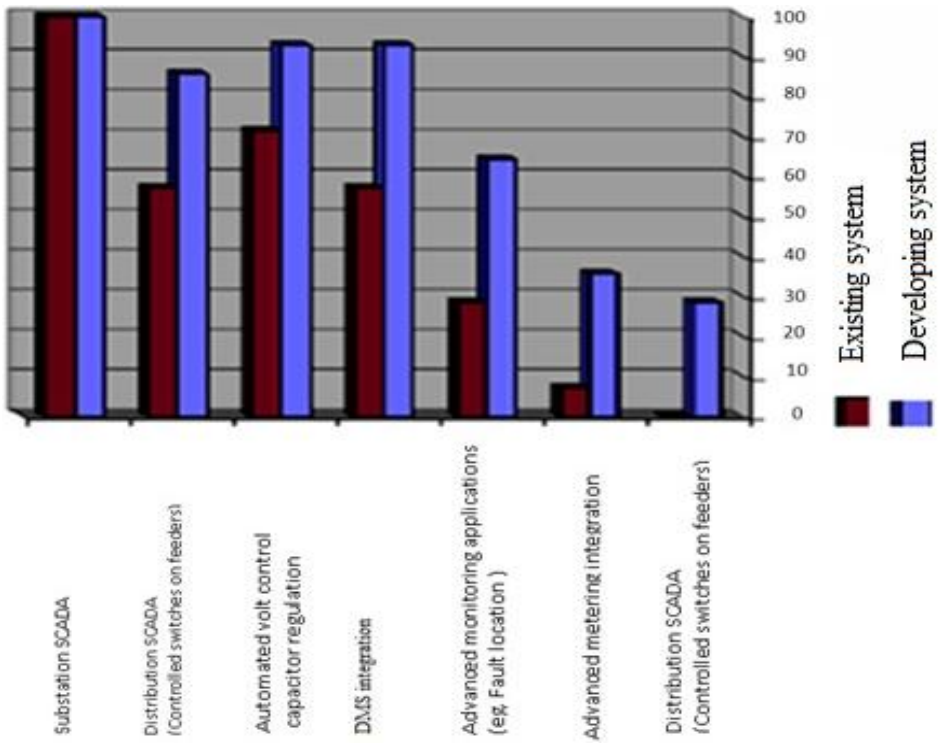

Fig.6 Existing and Developing systems world wide

By maintaining the voltage profile of feeder this approach minimizes losses in system with the existing load. This approach forms a multi agent based scheme makes a coordination between DG and RTU, at the shunt capacitors. In general the direction type relays are used in transmission system and non directional relays used in distribution system. The relays uses a reference to fix the faults it may be forward or reverse. The reversing nature of faults between the relay and source, to the grid so it makes Directional types costlier than Non directional type. The current only scheme will allows the flow of power from source to the grid, to the relay. The fault is forward direction between the relay, line it reverses between the sources, relay. So the phase angle differences of these fault currents are to be found.

DAS EXISTING TECHNOLOGIES AND IMPLEMENTATION

About 60 to 80 % of automation in substation, SCADA used for effective control and information. Reliability is ensured by utilizing system automation, improved technology on next system generations. For voltage control the capacitors, reactive power control, coordination based on automation will have different approaches. The monitoring system for power quality and its applications are integrated nowadays with distribution system.

DEVELOPMENTS OF DAS

Advanced Distribution Automation (ADA) [4] [5] [2] [29] has added advantage of remote control on distribution and feeder automation. This has the challenges associated with it as follows. Less outage, power quality maintenance. The pressure on utility to minimize the operation Cost. Market opportunities beginning to reach the distribution system, like demand response and real time pricing [23]. Pressure on system reliability and performance. Increased interconnection of DER by Interacting with all controllable devices.

ADA WITH NEW TECHNOLOGICAL CAPABILITIES

This uses a standard IEC61850 communication protocol for communication interfaces [1] [30]. Load management scheme includes the short term load forecasting and outage scheduling. This ensures increase of reliability and better utilization of work force, facilities. Coordinated protection by using IEDs, this has the functionalities like fault location, isolation restoration with contingency analysis etc. System reliability increased through proper communication. The effective maintenance reduces the capital cost, deterioration of equipments, increases the life time of system equipments.VAR coordinated control requires regulators with remote control, capacitor banks, power electronic device for control etc, this is required for non intrusive loads, better utilization of resources to maintain the quality..AMR(Automated Meter Reading)[9]system has the planned specialties of monitoring, data imaging analyzing the reporting in time, with automated KWH (Kilo Watt Hour) meters, communication data base, AMR analyzer, which supports the demand in time. DER used on DAS includes the detecting, islanding, operation and control of micro grid etc, in distribution system using transformer LTCs, VAR control, IED [10][11]based electronic control, regulators.

CONCLUSION

The concept based on novel differential relay not using a reference like other relays called as current only relay. In this concept the current does not changes between the cycles much, small change in the phase angle at the fault. By the influence of phase angle polarity the direction of fault forwarded, the analysis requires feasible solution. The challenges on this approach are change in phase, deviation in frequency, harmonic, noise as described. This current only relay intelligent protection directional type helps in ease access on the location of faults is cost effective challenge.GIS concept and the operation currently are summarized, Real time problems are considered to obtain a practical solution as follows .To maintain the ensured applicability by solving maintenance of DA data by image modeling, automatic publishing incremental method with the features on distribution system devices, maintain the timeliness, accuracy on DAS and GIS Integrated maintenance of data are required, for sudden restoration, insurance of power supply at different demands, DAS provides a flexible platform network with new model, topology has its uniformity.

REFERENCES

[1] Zavoda,F, Advanced distribution automation (ADA) applications and power quality in Smart Grids, China *International Conference on Electricity Distribution* (CICED)(2010), pp.1- 7, 2010.

[2] Uluski,R.W, The role of Advanced Distribution Automation in the Smart Grid Power and Energy Society *General Meeting* (2010), pp.1- 5, 2010.

[3] Chen Jian ,He Yan ; Zeng Rong , Service-oriented provincial-centralized transmission and distribution GIS platform China *International Conference on Electricity Distribution* (CICED)(2010), pp.1- 4, 2010.

[4] Palo Alto, EPRI, Technical and system requirements of advanced distribution automation, CA, USA: *EPRI*, 2004.

[5] Palo Alto and Clamart, EPRI, Profiling and mapping of intelligent grid R&D programs, CA EDF R&D, France: *EPRI*, 2006.

[6] Standard for Measuring Relays and Protection Equipment, 60255, *Int. Eletrotechnical Commission (IEC)*, 2008.

[7] Liang Huo, Fangyong Yuan, Design and implementation of GIS smart client based on service-oriented, 19th *International Conference on Geoinformatics* (2011) , pp. 1- 5, 2011.

[8] Mahmood.A , Aamir.M, Anis.M.I, Design and implementation of AMR Smart Grid System ,*Electric Power Conference*, (EPEC)2008. IEEE Canada, pp.1- 6, 2008.

[9] Li Li, Hu Xiaoguang, Huang Jian , He Ketai ,Design of new architecture of AMR system in *Smart Grid 6th IEEE Conference on Industrial Electronics and Applications* (ICIEA) 2011, pp. 2025-2029, 2011.

[10] Kezunovic.M, Xu,F, Cuka.B, Myrda.P, Intelligent processing of IED data for protection engineers in the Smart Grid , *15th IEEE Mediterranean Electrotechnical Conference* (MELECON) (2010) , pp.437- 442, 2010.

[11] Lisowiec.A, Nowakowski.A , Modern IED in today's smart grids, *International Conference Clean Electrical Power* (ICCEP)(2013), pp.288- 292, 2013.

[12] Jauch.E.T, Possible effects of smart grid functions on LTC transformers *IEEE Rural Electric Power Conference* (REPC) (2010), pp: B1- B1-10, 2010.

[13] Jauch. E.T, Possible Effects of Smart Grid Functions on LTC Transformers, *IEEE Transactions on Industry Applications*, Vol.47 (2), pp.1013- 1021, 2011.

[14] Parthasarathy.S, Kundur,D, Bloom filter based intrusion detection for smart grid SCADA, *25th IEEE Canadian Conference Electrical & Computer Engineering* (CCECE)(2012), pp.1- 6, 2012.

[15] Chopade.P, Bikdash.M, Critical infrastructure interdependency modeling: Using graph models to assess the vulnerability of smart power grid and SCADA networks, 8th *International Conference & Expo Emerging Technologies for a Smarter World* (CEWIT)(2011), pp.1- 6, 2011.

[16] Lecek.N, Dzafic.I, Music.M, Operationally constrained, closed loop voltage VAR control for smart distribution grids, *IEEE EUROCON* (2013), pp.1344- 1351, 2013.

[17] Elmoudi.R, Grinberg.I, Safiuddin.M, Design and implementation of Static VAR Compensator for classroom and research applications in Smart Grid laboratory, *IEEE International Conference on Smart Grid Engineering* (SGE)(2012), pp.1- 8, 2012.

[18] Castillo.W.A, Smart low side Rollover, *63rd Annual Conference for Protective Relay Engineers* (2010), pp.1- 1, 2010.

[19] Dehghanian.P, Razi Kazemi.A.A, Karami.G, Incorporating experts knowledge in RTU placement procedure using fuzzy sets theory-a practical approach *33rd IEEE International on Telecommunications Energy Conference* (INTELEC), 2011, pp.1- 10, 2011.

[20] Rahman.M.A, Bera, P, Al-Shaer.E, SmartAnalyzer: A noninvasive security threat analyzer for AMI smart grid, Proceedings *IEEE INFOCOM* (2012), pp.2255- 2263, 2012.

[21] Zhang Luhua, Yi Zhonglin, Wang Sitong,Yuan Ruiming, Zhou Hui, Yin Qingduo, Effects of Advanced Metering Infrastructure (AMI) on relations of Power Supply and Application in smart grid, China *International Conference on Electricity Distribution* (CICED), 2010, pp.1- 5, 2010.

[22] Podmore.R, Robinson.M.R , Graphic Exchange Standard for Smart Grid applications, *IEEE Power and Energy Society General Meeting* (CIM)(2011), pp.1- 7, 2011.

[23] Xi Jia, Qing Xia, Qi Xin, Chen Piecewise price mechanism to induce demand response in *Smart Grid China International Conference Electricity Distribution* (CICED)(2012), pp.1- 4, 2012.

[24] Xilin Zhang, Fan Zhang, Xiaojuan Han, Shuo Wang, Study of EMS statements production and dispatcher simulation training for regional smart grid, *IEEE International Conference Information and Automation* (ICIA)(2011), pp.870- 873, 2011.

[25] Chopade.P, Bikdash.M, Modeling for survivability of Smart Power Grid when subject to severe emergencies and vulnerability, *Proceedings of IEEE Southeastcon* (2012), pp.1- 6, 2012.

[26] Vargas.A, Samper.M.E, Real-Time Monitoring and Economic Dispatch of Smart Distribution Grids: High Performance Algorithms for DMS Applications *IEEE Transactions on Smart Grid,* Vol.3 (2), pp.866- 87, 2012.

[27] Wojszczyk.B, Deployment of advanced Smart Grid solutions - Global examples & lessons learned, *IEEE PES Innovative Smart Grid Technologies* (ISGT), 2012, pp.1, 2012.

[28] Xin Miao, Xi Chen, Xiao-Ming Ma, Ge Liu, Hua Feng, Xi Song, Comparing Smart Grid technology standards roadmap of the IEC, NIST and SGCC, *China International Conference on Electricity Distribution* (CICED)(2012), pp.1- 4, 2012.

[29] Sucic.S, Bony.B, Guise.L, Standards-compliant event-driven SOA for semantic-enabled smart grid automation: Evaluating IEC 61850 and DPWS integration, *IEEE International Conference on Industrial Technology* (ICIT) (2012), pp.403- 408, 2012.

[30] Palo Alto, Technical and System Requirements for Advanced Distribution Automation.CA: *EPRI*, 2004.

[31] S. H. Lee, J. J. Grainger, Optimum placement of fixed and switched capacitors on primary distribution feeders, *IEEE Trans.Power App. Syst.*, vol.100(1), pp. 345–352, 1981.

[32] M. Chis, M. M. A. Salama, S. Jayaram, Capacitor placement in distribution systems using heuristic search strategies, *IEE Proc. Gener., Transm., Distrib.*, vol.144(3), pp. 225–230, 1997.

[33] H. N. Ng, M. M. A. Salama, A. Y. Chikhani, Classification of capacitor allocation techniques, *IEEE Trans. Power Del.*, vol.15(1), pp. 387–392, 2000.

[34] L. Ruey-Hsun, C. Chen-Kuo, Dispatch of main transformer ULTC and capacitors in a distribution system," *IEEE Trans. Power Del.*, vol.16(4), pp. 625–630, 2001.

[35] L. Ruey-Hsun,W. Yung-Shuen, Fuzzy-based reactive power and voltage control in a distribution system, *IEEE Trans. Power Del.*, vol.18(2), pp. 610–618, 2003.

[36] H. Ying-Yi and L. Yi-Feng, Optimal VAR control considering wind farms using probabilistic load-flow and gray-based genetic algorithms, *IEEE Trans. Power Del.*, vol.24(3), pp.1441–1449, 2009.

[37] T. Senjyu et al., Optimal distribution voltage control and coordination with distributed generation, *IEEE Trans. Power Del.*, vol.23(2), pp.1236–1242, 2008.

[38] M. E. Baran, I. M. El-Markabi, A multiagent-based dispatching scheme for distributed generators for voltage support on distributionfeeders, *IEEE Trans. Power Syst.*, vol.22(1), pp.52–59, 2007.

[39] P. M. S. Carvalho, P. F. Correia, L. A. F. Ferreira, Distributed reactive power generation control for voltage rise mitigation in distributionnetworks, *IEEE Trans. Power Syst.*, vol.23(2), pp.766–772, 2008.

[40] M. E. Elkhatib, R. El-Shatshat, and M. M. A. Salama, Novel coordinated voltage control for smart distribution networks with DG, *IEEE Trans. Smart Grid*, vol. 2(4), pp. 598–605, 2011.

[41] M. Elkhatib, Novel decentralized operation schemes for smart distribution systems, Ph.D. dissertation, Univ. Waterloo, Waterloo, Canada, 2012.