International Journal of Recent Engineering Research and Development (IJRERD)
Volume No. 02 – Issue No. 01, ISSN: 2455-8761
www.ijrerd.com, PP. 01-09

A Comprehensive Analysis and Evaluation of Outage Management Systems (OMS), Part I: Using Functional Decomposition and Problem Tracking Methods

Pradeep Singh[1], Naveen Pandey[2]
[1]Research Analyst at Current Analysis Group, Global Data, India
[2]Assistant Professor, Dept. of Decision Sciences, University of Petroleum & Energy Studies, India

Abstract: The project aims at working on a similar pattern those are used in the pilot projects and develop a conceptual mechanize for Distribution Infrastructure which projects the country.
The project assumes greater significance as it aims to reduce the Aggregate Technical and Commercial (AT & C) losses which ultimately will result in saving of electricity as well as optional utilization of best practices in Transmission and Distribution (T & D) infrastructure. This will help to bridge the gap between exiting demand and supply as well as reduction in subsidy burden on the government. Usage of IT will reduce the human intervention, which will reduce the errors in system and improve the supply of quality power with reduction in AT & C losses; other benefit includes the reduction in power purchase cost for the consumer and will get the reliable & quality power as the final results in consumer satisfaction.
Keywords: Outage Management System (OMS), Extra High Voltage Management System (EMS), Operations and Maintenance (ONM), Low Tension (LT), High Tension (HT), Management Information Systems (MIS).

1. Introduction

History of Power Sector in Delhi

This is an industrial age in which electricity plays a vital role in our day-to-day life. It powers our houses, industries, hospitals and in fact our entire economy. In Delhi the first diesel Power Station was established in the year 1905 when a private English Company by name M/s. John Fleming was given permission to generate electricity under the provisions of the Indian Electricity Act 1903. That Company obtained license under the provisions of Electricity Act 1903, set up a small 2 MW Diesel set at Lahori Gate in Old Delhi. Later on, this very Company was converted as Delhi Electricity Supply and Traction Company. In the due course of time, the power generation was now done by steam instead of diesel; this was first done in year 1911.

In the year 1932, the management of Central Power House was handed over to New Delhi Municipal Committee (NDMC). In the field of power generation and distribution, a major breakthrough was achieved in 1939 when Delhi Central Electricity Power Authority (DCEPA) was established. This Company was responsible for the supply of power to the areas covered by Local Bodies, namely, the Municipal Committees of Delhi, West Delhi and South Delhi, the Notified Area Committees of Red fort, Civil Lines, Mehrauli, Najaf Garh, and the District Board of Delhi. The supply of electricity to the Municipal Committees of Delhi-Shahdara and the Notified Area of Narela was done by different private agencies.

In the year 1997, Delhi Vidyut Board was organised with the objective of creation and distribution of power to the entire National capital region. With a view to safeguard the overall interests of the consumers, Government of national capital territory of Delhi took some policy initiatives as a result of which DVB was disintegrated into GENCOs (Generating company), TRANSCO (Transmission Company) and DISCOMs (Distribution company). Only distribution business was privatized.

- BSES Rajdhani Power Limited,
- BSES Yamuna Power Limited,
- North Delhi Power Limited,
- Delhi Transco Limited.

Figure 1: Delhi power distribution companies' area wise

2. Project Overview & Analysis

The main aim of the project Outage Management system (OMS) is to provide quality and reliable power to the consumer's, continuous up-gradation of the business processes along with strengthening of its distribution infrastructure and help in reduction of the Aggregate Technical & Commercial Losses (AT&C) Losses[1].

BSES Yamuna Power Limited (BYPL) is a joint venture with the Government of NCT of Delhi is engaged in the business of power distribution in Central & East Delhi (geographical area of around 200 sqkms) since 2002. The company has been recognized for achieving a record AT&C loss level reduction of 46.5% in 11 years of its operations. The company is widely recognized for successfully brining down AT&C losses from a high of 63% in July 2002 to below 17%.

Outage Management System (OMS) project is to monitor and analyze the whole process of fault restoration of power [2], from the receipt of consumer's complaint to the normalization of supply including tracking of resources [3, 4], in the power distribution and power supply system [5].

SN	Particulars	Unit	BYPL (East & Central)	BRPL (South & West)	BSES Delhi
1.	Area	sq. km	200	750	950
2.	Customer Density (As of Mar '13)	Cons/sq km	6750	2465	3367
3.	Total Registered Customers (As of Mar '13)	Million	1.35	1.85	3.20
4.	Peak Demand (YTM FY 13)* Delhi peak demand 5642 MW	MW	1461	2338	3799

Figure 2: BSES Delhi information as on March 2013

3. Evaluation of Existing Outage Management System

3.1 Definition

A computer system used by operators of electric distribution systems to assist in the restoration of power [6]. The Outage Management System monitors and analyzes the whole process of fault restoration, from the receipt of consumer's complaint to the normalization of supply including tracking of resources [7, 8], in the power distribution and power supply system [9]. This system has been divided in two parts –

1. 11 KV and Below
2. EHV (Extra High Voltage)

The scope of this research paper is to document process of outage management for 11KV and LT and EHV distribution network installed in the organization. BSES Service area in Delhi is divided into 4 circles and 33 Districts with complaint centres and Division Offices. There are 7 modules which make up the OMS that includes Complaint Management Systems (CMS), Distribution and Operations Management Systems (DOMS), Extra High Voltage Management System (EMS), Operations and Maintenance (ORM), Street Light Management System (SLMS), Maps and Drawings (MND), Geographical Information Systems (GIS) [10].

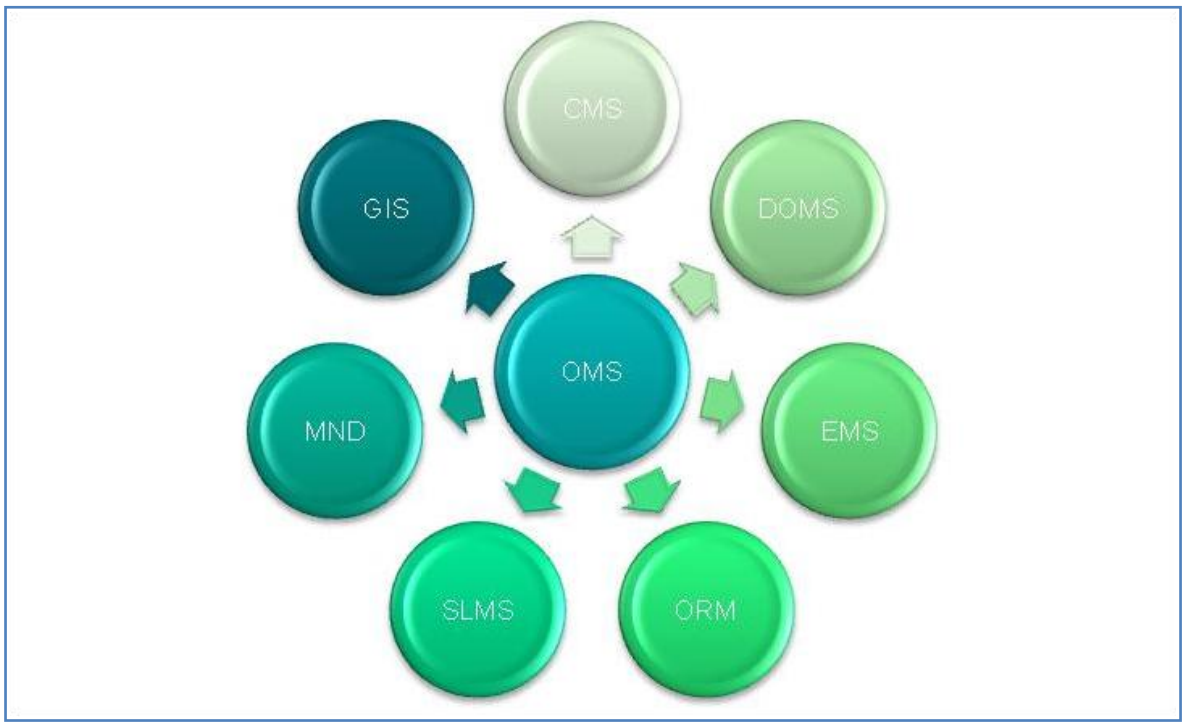

Figure 3: Outage management system (OMS) current architecture

3.2 Need of Outage Management System

In today's scenario in India, there is the major requirement of matching the demand and supply of power considering the fact that the energy deficit and peak deficit for the year 2012-13 (upto Dec) was 8.70% and 9.00% respectively. For reliable electric service have grown to the point where a utility's primary goal is providing improved network reliability as measured through optimization of power delivery performance and reductions in the frequency and length of customer outages [11]. This point was dramatically driven home recently in July 2012 India blackout which was the largest power outage in history, occurring as two separate events on 30 and 31 July 2012. The outage affected over 620 million people, about 9% of the world population or half of India's population. With stakes this high, the immediate need is quick response and service restoration.

3.3 Features of Outage Management System

- The process of operation and maintenance of 11KV and below is at present centralized at the circle level
- The consumer makes a complaint at the centralized Call Center / complaint center, for lodging his complaints

- As soon as the complaint is registered in the system, the complaint gets sorted out Circle-wise and is forwarded to the respective Circle-Control
- The Circle-Control passes on these complaints to the respective Complaint Centers /division Offices for attending to them
- It further monitors and analyzes these complaints through the outage management system installed with them
- There is further a Central Monitoring Cell located at Nehru Place where the complaints of all the circles are monitored using the OMS
- The system is further installed at higher management level for viewing the status [14, 15]

3.4 Coordination

The following two organizations are required to coordinate:

- B.S.E.S. Yamuna Power Limited
- B.S.E.S. Rajdhani Power Limited

The support functions contributing from both organizations are:

- Division ONM offices
- Data Centers
- Consumer complaint Centers
- Company Stores
- Consumer Care Centers (Call Centers)

4. Functional Decomposition of Existing OMS

4.1 Background

The current OMS is used to:

- Register consumer complaints
- Register Information of Shutdown, Breakdown and Load Shedding of LT, HT, EHV network/Grids/Substations
- Resources Management
- MIS

4.2 System Objectives and Current Functionality

The major goals of the current system are:

- Record and resolve all consumer complaints to improve company's services
- Record Resources' usage
- Use MIS for decision making to improve consumer satisfaction and Increase Company's reputation and standards

The major functions of the current system are:

- Registration of consumer complaints
- Registration of EHV, HT, LT shutdowns
- Registration of EHV, HT, LT breakdowns
- Registration of EHV, HT, LT Load Shedding
- Resource allocation to resolve user complaints, shutdowns and breakdowns
- Registering, Editing, Allocating Resources and Closing faulty equipment FIRs

4.3 Current Functional Modules

Currently the below listed seven modules are integrated in OMS:

1. CMS (Complaint Management System)
2. DOMS (Distribution and Operation Management System)
3. EMS (EHV Management System)
4. SLMS (Streetlight Management System)
5. ORM (Operation Report Management)
6. MND (Maps and Drawings)
7. GIS (Geographical Information System)

4.4 Equipment Used

The equipment used is:

- Data-Base server.
- Local Area Network.
- Client computer where OMS is to be installed

4.5 Input and Output

Input to the system includes:

- The Current Consumer Database for consumer information (SAP Database)
- The Current Company's Assets Database for resource allocation (SAP Database)
- The details of the consumer complaints
- The details of the Shutdowns, Breakdowns and Load-Shedding (manually by SCADA, ONM, COMPLAINT CENTERS and DIVISION officials)
- The details of resource allocation and complaint resolution progress

Outputs from the system include:

- List of all the registered complaints currently in open status.
- Check status and progress of registered complaints.
- List of the area where breakdown, shutdown or load shading is under action.
- Report generation for Decision making [16]

5. Problem Tracking in Existing OMS (Key Inhibitors and Issues)

According to the input received from the users there are several deficiencies in the current system, which has to be rectified [17, 18]. These are:

1. Current system is a stand-alone (Thick-Client) application which needs to be installed on each user's system, alongside Oracle client for Database connectivity [19, 20].
2. Automated Fault alarms generated and floated by the system are caught by all users and slows down the current work under process by the user many times causing Deadlocks in the system [21, 22, 23].
3. Operating System's Resource utilization is very high, which slows down low configuration computers [24].
4. The reasons of faults currently provided by the system while closing of complaints are not appropriate, updated and sufficient, which makes the user to close many complaints under incorrect cause of fault [25, 26].
5. The complaints which cannot be resolved by company due to reasons, for which company is not responsible of, are only allowed to be closed under "Power Restored" category even if the power is not restored [27, 28, 29].
6. A complaint of a specific Division is broadcast to all complaint centers which fall under that Division.
7. Current status of rectification and resolution of complaint cannot be determined by user on request of user using [30].
8. Possible causes of power supply failure cannot be determined by the current system and hence the correct estimation of restoration of the power supply cannot be determined to inform the consumer [31, 32, 33, 34, 35]. For E.g. If an area is under breakdown or shutdown then before logging any complaint from consumer of that area the system should show the user that the area is under breakdown or shutdown and the time period required for resuming power supply [36, 37, 38].
9. The current system allows a user to log multiple new and same consumer complaints, before resolution and closing of an already open complaint.
10. The information of Load Shedding is not provided or entered in OMS. So when any compliant came which belongs to Load Shedding area then complain center or call center person has no reply for user's query. And also they have to close the complaint after load shedding with wrong reason of fault [39, 40, 41].
11. Areas which are under power cut due to any Shutdown, Breakdown or Load Shedding are not visible to the user.
12. Version control not implemented in current system [42, 43].
13. CA–CR—Meter Numbers are not mapped properly.

6. Proposed System Functions

The new Outage Management System (OMS) will serve all the functions of the current Outage Management System as well as many new features as well [44, 45]. All the functions of the new Outage Management System (OMS) are described in the below figure [46, 47].

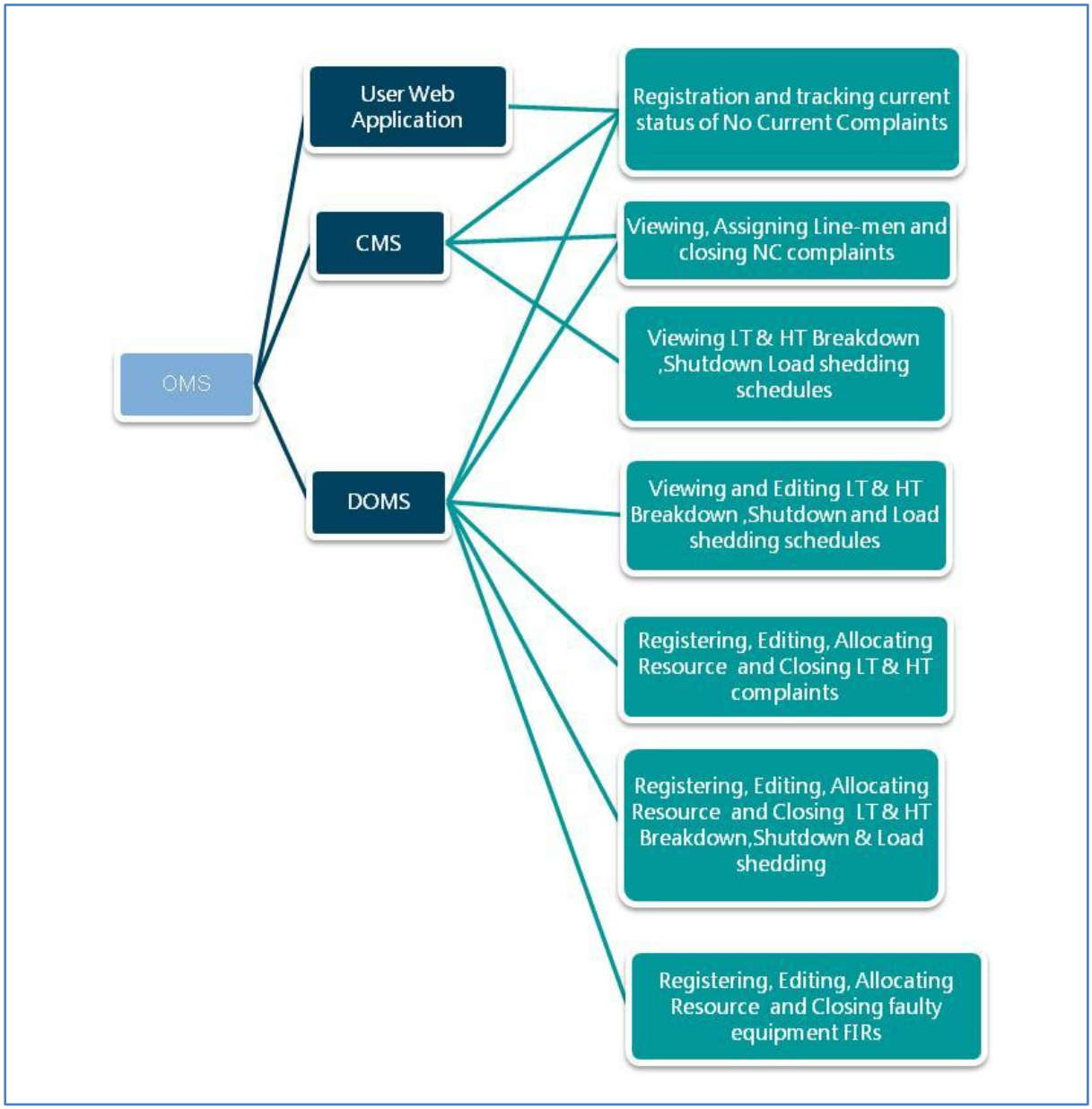

Figure 4: Functions of the new proposed Outage Management System (OMS)

7. Conclusions and Future Research

This technical research paper is focused on the working of Current Outage Management system and analyzed the different modules comprising it. This research paper examined the features and challenges of using the Outage management system. In addition, the completed evaluation about existing outage management system uncovers that improvements in on-request outage management systems have, to some degree, nullified the moderateness consider sending these arrangements, as with a compensation for each utilization valuing model even small undertakings can convey expository instruments and exploit these arrangements without focusing on significant framework speculation. Over the years, power users and engineers have primarily been able to use complex query-based analytical tools, which have restricted the use of the solution to expert users and kept casual business users and other operational users at bay.

The research study also represents the key inhibitors and issues in Existing Outage Management System, which can be rectified and solved while building new Outage Management Systems. Nevertheless, in

the future research, the new outage management system can be proposed which will overcome the gaps in the working process of current OMS and make it much more reliable, convenient and advanced system for the processes of fault restoration, tracking of resources and resolving consumer grievance's in the power distribution sector.

8. Acknowledgement

The authors would like to first of all thank Mr. Harsh Sharma, Vice- President (IT, ETG& NMG) who gave us opportunity to work with the Organization. Special thanks to Mr. Sameer Bangar, Senior Manager (OMS & GIS) who gave us his valuable time and guidance to understand the concepts of the projects undertaken and practical exposure of the software systems to work on the real time data application. The authors would also like to acknowledge Mr. Swaroop Mukhoti, Senior Manager (MIDAS) for his valuable support & guidance throughout this project. The authors are highly grateful to Ms. Manali Kasma (Assistant Manager), Mr. Naveen Chauhanand Mr. Mayankwho gave us their invaluable time and helped us to go in right direction and execute the project effectively. The authors would like to thank Mr. Anil Vaishy, Deputy General Manager (SCADA) for giving us exposure to his business processes, operations, latest practices adopted by them in order to give make the company highly efficient in delivering quality services to their consumers. Special thanks goes to officials of BSES Yamuna Power Ltd., who had shown faith in us to deputation of this Project and without their insights and helpful thoughts, we would not have gained as much knowledge as we have. Their help has sparked our interests even more! Thanks!

References

[1] Singh N. P., Yadav K. P., "Application of Business Analytics in Big Data of Power Sector" in proceedings of "5th Annual Project Management Conference, India 2013", ©2013 PMI, USA http://pmi.org.in/conference2013/updates.asp
[2] 6. Singh, P. N., and Pandey, N. C, "E-governance & GIS, Worldwide Application for Optimizing Performance of Energy Sector", International Journal of Electronic and Electrical Engineering, ISSN 0974-2174 Volume 7, Number 9 (2014), pp. 937-941, International Research Publication House.
[3] Liu Y., Schulz N. N., "Knowledge-based system for distribution system outage locating using comprehensive information", IEEE Transactions on Power Systems, Volume: 17, Issue: 2, pp. 451 - 456, 2002.
[4] Liu C. C., Lee S. J., Venkata S.S., "An expert system operational aid for restoration and loss reduction of distribution systems", IEEE Transactions on Power Systems, Volume: 3, Issue: 2, pp. 619 - 626, 1998.
[5] Jarventausta P.,Verho P., Partanen J., "Using fuzzy sets to model the uncertainty in the fault location process of distribution networks", IEEE Transactions on Power Delivery, Volume: 9, Issue: 2, pp. 954 - 960, 1994.
[6] Fan J., Borlase S., "The evolution of distribution", IEEE Power and Energy Magazine, Volume: 7, Issue: 2, pp. 63 - 68, 2009.
[7] Carter S., Nielsen T., Geisler k., "Outage management system implementation and operations experience at Gulf Power Company", in proceedings of IEEE Power Engineering Society 1999 Winter Meeting, 2003.
[8] Moreno-Munoz A., Oterino D., Carmona A., Rosa J. J. G. D. L., "Automated Meter Reading Systems in Outage Management", in proceedings of IEEE Compatibility in Power Electronics, 2007.
[9] Strbac G., "Demand side management: Benefits and challenges", Energy Policy, Volume 36, Issue 12, December 2008, Pages 4419–4426.
[10] Honghai K., Zhengqiu W., "Application of AMR based on power line communication in outage management system", in proceedings of International Conference on Sustainable Power Generation and Supply, 2009. SUPERGEN '09.
[11] Kang J., Park C., Kim E., Hong K., Lim Y., Ju S., Choi M., Lee B., Hyun D., "Design and Implementation of Network Management System for Power Line Communcation Network", in proceedings of IEEE International Symposium on Power Line Communications and Its Applications, 2007. ISPLC '07.
[12] Vale Z., Morais H., Faria P., Khodr H., Ferreira J., Kadar P., "Distributed energy resources management with cyber-physical SCADA in the context of future smart grids", in proceedings of 15th IEEE Mediterranean Electrotechnical Conference MELECON - 2010.
[13] Cleveland F., "Enhancing the Reliability and Security of the Information Infrastructure Used to Manage the Power System", in proceedings of IEEE Power Engineering Society General Meeting, 2007.
[14] Shokooh F., Dai J. J., Shokooh S., Taster J., Castro H., Khandelwal T., Donner G., "An intelligent load shedding (ILS) system application in a large industrial facility", in proceedings of Industry Applications Conference, 2005. Fourtieth IAS Annual Meeting. Conference Record of the 2005.
[15] M. Amirijoo; L. Jorguseski; T. Kurner; R. Litjens; M. Neuland; L. C. Schmelz; U. Turke; "Cell outage management in LTE networks", in proceedings of 6th International Symposium on Wireless Communication Systems, 2009. ISWCS 2009.
[16] K. Sridharan, N.N. Schulz, "Outage management through AMR systems using an intelligent data filter", IEEE Transactions on Power Delivery, Volume: 16, Issue: 4, pp. 669 - 675, 2001.
[17] Taylor T., Kazemzadeh H., Integrated SCADA/DMS/OMS: Increasing Distribution Operations Efficiency, Electric Energy T&D Magazine, Issue March-April 2009. [Available] http://abblibrary.s3.amazonaws.com/public/722b1bc76a16ae038525759a005f0d65/EE-MA09_ABB_02.pdf
[18] Chao Y. T., et al., An improvement project for distribution transformer load management in Taiwan, IEEE Transactions on Power Systems, Volume: 18, Issue: 2, pp. 875 - 881, 2003.

[19] Neumann S., CIM extensions to electrical distribution and CIM XML for the IEEE radial test feeders, IEEE Transactions on Power Systems, Volume: 18, Issue: 3, pp. 1021 - 1028, 2003.
[20] Collier S., et al., Real time distribution analysis for electric utilities, in proceedings of IEEE Rural Electric Power Conference, 2008.
[21] Wang Y., et al., A Unified Solution for Advanced Metering Infrastructure Integration with a Distribution Management System, in proceedings of First IEEE International Conference on Smart Grid Communications (SmartGridComm), 2010.
[22] Vidyanand R., Fuzzy set theory based outage determination for distribution networks, in proceedings of International Conference on Intelligent Systems Applications to Power Systems, 1996. ISAP '96.
[23] Adams M.J., Reliability on the regulatory horizon, in proceedings of IEEE/PES Transmission and Distribution Conference and Exposition, 2001.
[24] Burke J., et al., Using outage data to improve reliability, IEEE Computer Applications in Power, Volume: 13, Issue: 2, pp. 57 - 60, 2000.
[25] Celik M.K., et al., Integration of advanced applications for distribution automation, in proceedings of IEEE Power Engineering Society 1999 Winter Meeting, 1999.
[26] Luković S., et al., Software architecture for Smart Metering systems with Virtual Power Plant, in proceedings of 15th IEEE Mediterranean Electrotechnical Conference, MELECON 2010.
[27] Nielsen T. D., et al., Transforming traditional geographic information system to support smart distribution systems, in proceedings of IEEE/PES Power Systems Conference and Exposition, 2009. PSCE'09.
[28] Huang C. W., et al., An Expert System for Three-Phase Balancing of Distribution Feeders, IEEE Transactions on Power Systems, Volume: 23, Issue: 3, pp. 1488 - 1496, 2008.
[29] Saint b., Rural distribution system planning using Smart Grid Technologies, in proceedings of IEEE Rural Electric Power Conference, 2009. REPC '09.
[30] Saint B., Rural distribution system planning using Smart Grid Technologies, in proceedings of IEEE Rural Electric Power Conference, 2009. REPC '09.
[31] Tsai S.H., A fuzzy rule-based system for crew management of distribution systems in large-scale multiple outages, in proceedings of 2004 International Conference on Power System Technology, 2004. PowerCon 2004.
[32] Qian Y., et al., Scalable Distributed Communication Architectures to Support Advanced Metering Infrastructure in Smart Grid, IEEE Transactions on Parallel and Distributed Systems, Volume: 23, Issue: 9, pp. 1632 - 1642, 2012.
[33] Uluski R. W., Interactions between AMI and distribution management system for efficiency/reliability improvement at a typical utility, 2008 IEEE Power and Energy Society General Meeting - Conversion and Delivery of Electrical Energy in the 21st Century.
[34] Tram H., Selection and implementation of an outage management system, in proceedings of IEEE Power Engineering Society 1999 Winter Meeting.
[35] Kezunovic M., et al., Integration of Asset and Outage Management Tasks for Distribution Application, Power Systems Engineering Research Center (PSerc) Final Project Report, 2009.
[36] Dehghanian P., et al., Critical Component Identification in Reliability Centered Asset Management of Distribution Power Systems via Fuzzy AHP, IEEE Syst. J., vol. 6, no. 4, pp. 593-602, 2012.
[37] Kezunovic M., et al., The role of big data in improving power system operation and protection," Bulk Power Syst. Dynamics and Control - IX Optimization, Security and Control of the Emerging Power Grid (IREP) Symp, 2013.
[38] Fuangfoo P., et al., Impact Study on Intentional Islanding of Distributed Generation Connected to a Radial Sub transmission System in Thailand's Electric Power System, IEEE trans. Ind. Appl., vol. 43, no. 6, 1491-1498, 2007.
[39] Brahma S. M., Fault location in power distribution system with penetration of distributed generation, IEEE Trans. Power Del., vol. 19, no. 1, 56-63, 2011.
[40] C. Pang, et al., BEVs/PHEVs as Dispersed Energy Storage for V2B Uses in the Smart Grid, IEEE Trans. Smart Grid, vol. 3, no. 1, 473-482, 2012.
[41] P.-C. Chen, et al., Analysis of Voltage Stability Issues with Distributed Generation Penetration in Distribution Networks, in proceedings 45th North American Power Symp. (NAPS), 2013.
[42] P.-C. Chen, et al., Oct. 2012, Analysis of Voltage Profile Problems due to the Penetration of Distributed Generation in Low-Voltage Secondary Distribution Networks, IEEE Trans. Power Del., vol. 27, no. 4, 2012.
[43] Tram H., Technical and operation considerations in using Smart Metering for outage management, IEEE/PES Trans. and Distrib. Conf. and Expo. (T&D), 2008.
[44] Choi S. H., et al., The design of outage management system utilizing meter information based on AMI (Advanced Metering Infrastructure) system," IEEE 8th Int. Conf. on Power Electronics and ECCE Asia (ICPE & ECCE), pp. 2955-2961, 2011.
[45] Kuru J., et al., Innovative system integration for outage communication, The 20th Int. Conf. and Exhibition on Electricity Distrib. - Part 2, CIRED, 2009.
[46] Smith, M., et al., 2012 Annual Grid Analytics Report, Utility Analytics Institute, 2012.
[47] Malbasa V., et al, Power System Online Stability Assessment Using Active Learning and Synchrophasor Data, IEEE Grenoble PowerTech (POWERTECH), 2013.

Author's Profile

Pradeep Narayan Singh is an illustrator and author, at present he is working as "Research Analyst" at Current Analysis Group, Global Data, India. He has written about latest technological advancement in data center, to upcoming technologies in Telecom and IT. He has experience in Research and Analysis (Qualitative and Quantitative) for Telecom and IT industry. This is where; he proposes strong acumen towards the technology and related aspects and continuously looks forward to the changing technology and business aspects. He holds B.Tech in Computer Science & Engineering from G.B. Technical University, India and MBA in Management Information Systems from University of Petroleum & Energy Studies, India. As a Research Analyst, currently he is working on new tech adoption trends, economic implications, data modeling, and decision analysis respectively. As an active researcher, he has written and presented research articles in several international journals, conferences and business research reports.

Naveen Chandra Pandey is an "Assistant Professor" at the Department of Decision Sciences, University of Petroleum & Energy Studies, India. He has extensive experience in industry as well as in academics; his research areas include Project Management, IT Applications and Management Information Systems. He has completed B.Tech in Mechanical Engineering, from Kamala Nehru Institute of Technology, Sultanpur, India and MBA in Information Systems Management, from University of Petroleum & Energy Studies, India. At present he is pursuing Ph.D, from University of Petroleum & Energy Studies, India. As a research scholar currently he is working on research methodology, decision analysis, data modeling, and scope modeling respectively. As a faculty of 'Decision Sciences', he has presented research articles in several international journals and conferences.