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SPECIAL REPORT FOR SC D2
Information Systems and Telecommunication

Giovanna DONDOSSOLA IT (PS1)
Victor TAN AU (PS2)
Narendra SINGH SODHA IN (PS3)

Special Reporters

CIGRE's Study Committee D2‘s mission is to:

- Facilitate and promote the progress of engineering and the international exchange of information and knowledge in the field of information systems and telecommunications for power systems;
- Add value to this information and knowledge by means of synthesizing state of the art practices and drawing recommendations.

The Strategic Plan (2018-2025) defines the organization of the SC D2 to cope with the following objectives:

- ICT applied to digital networks from UHV to distribution (smart meter, IoT, big data, EMS…)
- Communication solutions for information exchange in the smart delivery of electrical energy
- Interoperability and data exchange (file format, frequency, etc.) between network operators, market players, off-grid premises
- Cyber security issues from field equipment to corporate IT (Governance constraints, system design, implementation, testing, operation and maintenance…)
- Technologies and architecture to ensure business continuity and disaster recovery
- IT systems to support the decision-making process in Asset Management

Three Preferential Subjects are presented in this special report:

PS1: Opportunities and challenges in ICT applied to microgrid and DER

- Communication solutions to remotely monitor and operate off-grid premises
- Facilities for control, monitoring, physical security and safety
- Standards, interoperability and cyber security issues

PS2: Potential applications and implementation of network and infrastructure virtualisation

- Opportunities and benefits using Software Defined Networking and Network Function Virtualisation (SDN/NFV)
- Issues identified in implementation and operation of virtualisation architectures
- Strategies to operate a secure SDN/NFV deployment

PS3: Maintaining reliable and secure operation in an evolving environment

- ICT to support asset management and maintenance
- Life cycle management and integration of legacy and new devices
- Situational awareness, risk management and cyber incident responses

Giovanna.Dondossola@rse-web.it; Victor.Tan@pscconsulting.com;
nss5419@gmail.com

Presentations from the Contributors are expected before 31st of July 2018.

Contributors are requested to meet the Special Reporters (rooms 361 to 364) on Wednesday 29th of August from 9 am to 4pm.

The poster session will be held on Wednesday 29th August from 2pm to 5pm, the moderator is Mrs Olga V. Sinenko.

Preferential Subject 1: Opportunities and challenges in ICT applied to microgrid and DER

Introduction

The preferential subject focusses on the opportunities and challenges provided by the ICT to the development of microgrid and DER applications. The subject covers three sub-topics related to communication technologies used to remotely monitor and operate off-grid premises; facilities for control, monitoring, physical security and safety; standards, interoperability and cyber security issues. Five papers were submitted to the preferential subject on ICT applied to microgrid and DER.

Papers

Paper No.	Title	Country
D2-101	Evaluation of a LoRaWAN Network for AMR	Greece
D2-102	Study on the construction of global energy research system based on economic-energy-electricity-environment integration analysis	China
D2-103	Analysis and visualization of residential electricity consumption based on geographic regularized matrix factorization in smart grid	China
D2-104	Implementation of Interoperability Adaptor for Interface with External Systems in Campus Microgrid	Korea
D2-106	Assuring operational communications across the sub-transmission and MV distribution electrical power grids	France

Table 1 - Papers for preferential subject 1

Paper D2-101 describes a private LoRaWAN network setup located in the Meltemi summer camp in Greece and used for a small scale evaluation of this wireless low power long range technology in an Advanced Metering Reading system. The evaluation addresses radio coverage and power consumption issues. The experimental testing confirmed the initial assumption on the battery life to be more than 15 years when 2 messages per day are sent from the meter through the LoRaWAN network.

Paper D2-102 deals with the topic of collecting heterogeneous data and analysing big amount of data. The paper advises a new method for the establishment of a global energy research platform, that is an integrated 4E (energy-electricity-economy-environment) data information system containing more than five thousand data indicators, and supporting the analysis of integrated strategies. Two application cases of the proposed platform have been described in the paper regarding the analysis of electrochemical energy storage technology and the geographic information display. The platform addresses the need of governments and global organisations to grasp the external circumstance changes in time and accurately, to analyse policy requirements and to set up energy development programs.

Paper D2-103 is also related to big data and Geographic Information Systems (GIS). In this paper the authors have demonstrated a novel real time sampling approach of power consumption, electricity capacity, and measurements status based on customers' consumption data using bi-directional broadband communication networks. Experimental results of using a novel power customer segmentation algorithm based on Geographic regularized Matrix Factorization, which combines geographic information and power usage records, showed improved performance of customer segmentation compared to the baseline approaches. The electric power usage information visualisation system based on GIS technology has been proposed to exhibit situations such as distribution network construction and equipment operation.

Paper D2-104 describes the implementation of an OPC-UA-based middleware adaptor for interfacing external systems in a campus microgrid thus addressing the inter- and intra- cell interoperability issues. From the experimental testing of the adaptors it resulted that OPC UA provides a stable data service but the communication performance have to be carefully evaluated in relation to the data point size of the microgrid.

Paper D2-106 discusses the communication technologies suitable for the operation of the sub-transmission and the primary distribution grids. This segment covers the access to larger renewable energy generators, storage, industrial loads as well as industrial and commercial microgrids. The paper describes the specificities of this communication domain, its architectural and performance requirements (i.e. latency, service availability, coverage range, bandwidth, number of connected devices). From the technology assessment presented in the paper neither the solutions deployed for the high voltage transmission corridors nor those designed for the smart metering infrastructures are able to fulfil this domain application requirements. There is no single solution fitting the variety of situations of the addressed power domain. A new set of communication solutions are being studied based on the combination of communication technologies, data compression, signal processing and smart telecom network management.

Discussion and Questions

Q1-01: What are EPU expectations of the low power wireless technologies from the IoT market in relation to their claimed performance of radio coverage, power consumption, data rate and cyber security and associated CAPEX and OPEX costs? Are they able to meet the technical requirements of EPU applications at reasonable costs?

Q1-02: How are EPUs addressing the potential of heterogeneous data sources of providing a powerful decision support system that may help in road mapping global economy strategies for an energy sustainable planet?

Q1-03: What are the potential applications of the Geographic regularized Matrix Factorization method for the EPU big data analysis?

Q1-04: What experiences on interoperability issues in microgrid implementations can be shared with the audience? How have they been solved?

Q1-05: What are the most technically suitable and economically feasible communication solutions for the time controlled, predictable, reliable and secure operation of the sub-transmission and primary distribution grids?

Preferential Subject 2: Potential applications and implementation of network and infrastructure virtualisation

Introduction

Two papers were submitted in the preferential subject of network and infrastructure virtualisation. The focus of the preferential subject is to identify opportunities, benefits and issues in server virtualisation, software defined network (SDN) and network function virtualisation (NFV) in the Electric Power Utility (EPU) environment.

Papers

Paper No.	Title	Country
D2-201	Substation Virtualisation: An Architecture for Information Technology and Operational Technology Convergence for Resilience, Security and Efficiency	Australia
D2-202	Benefit and Resolution of operational issues for information and communication systems using virtualization techniques in the electric power industry	Japan

Table 2 – Papers for preferential subject 2

D2-201 describes the benefits in implementing virtualisation technology at the edge of the network, i.e. at the substations. Many Information Technology (IT) and Operational Technology (OT) applications today require processing at the edge, due to reasons such as network latency, vast data collected (e.g. Big Data) and geographical diversity in the location of where the data originates (e.g. IoT). The paper presents a substation architecture where all applications and networks are virtualised into a common set of hardware and management systems. This allows for simplicity in implementing and managing of the applications which are distributed in various geographical locations in the EPUs.

D2-202 describes the experience of an EPU in using software-defined network (SDN) and in deploying new networks and virtual desktop infrastructure (VDI) and enhancements in disk storage via partially virtualised local disk method (PVLD). In the case of SDN, existing processes in deploying network can be complicated and involve coordination of many tasks. The EPU uses SDN to reduce the time in implementing changes or deploying new networks by automating changes to the network. The EPU uses enhancements to its VDI method to improve manageability, security and cost savings of thin client desktop systems.

Discussion and Questions

Q2-01: What are the opportunities for virtualisation technology (which includes server/application virtualisation, SDN and NFV) for EPUs? What are some of the specific use cases already adopted by EPUs, or potential use cases that might deliver value?

Q2-02: In EPUs' telecommunication networks, how do SDN and NFV fit in the larger picture of existing technologies already deployed in EPUs such as SDH/SONET, MPLS and VLANs?

Q2-03: EPU applications such as SCADA and HMI have now been virtualised and supported by the various manufacturers and software developers of these applications. What are some of the applications that are still difficult to virtualise, and what are the challenges that needs to be overcome for successful virtualisation of these applications?

Preferential Subject 3: Maintaining reliable and secure operation in an evolving environment

Introduction

ICT applied to the networks of the future, Telecommunication networks in Electric Power utilities (architectures, media, protocols...), New ICT architectures to control the bulk power systems (smart meter, smart grid, intelligent grid, control centers EMS, MMS etc...), ICT governance within utilities– in-house versus outsourced & Information security within the Electric Power Utilities are major thrust area for all EPUs across the globe. Asset Management with intervention of IT & OT has further added value.

In PS-3, 16 nos. Technical Papers were received virtually covering all above aspects & some dealt with ongoing Research & Technology more than Business management aspects. Some papers have beautifully covered the theme of PS-3. Brief summary of all Papers is given below.

Papers

Paper No.	Title	Country
D2-301	Building a Secure Network Policies, Architetura and Incident Response Case: Chesf	Brazil
D2-302	A Hybrid Communications Network Approach for Advanced Applications on the Modern Grid	USA
D2-303	Network evolution towards packet switched technologies	Finland
D2-304	IED system management solution: a universal approach for all your grid IoT integration	Canada
D2-305	Teleprotection over Multiprotocol Label Switching (MPLS): Experiences from an Australian Electric Power Utility	Australia
D2-306	Research and application of deep security protection technology in power industrial control system	China
D2-307	Challenges in EGAT Telecommunication System Integration	Thailand
D2-308	An Indian Case Study of Hierarchically Integrated SCADA system up gradation and its impact on Connected Control centers	India
D2-309	Network and Data Cybersecurity Strategy of the Electrical Power System	South Africa
D2-310	Telecommunication solutions for IEC 61850-based substations at the Spanish TSO and its practical implementation	Spain
D2-311	MAIGE – IoT infrastructure for online asset management	Spain
D2-312	Development of information-analytical system for automatic fault analysis and relay protection performance evaluation	Russia
D2-313	Approach to maintaining secure operation of various systems in Japanese electric companies	Japan
D2-314	GOOSE performance monitoring based on IEC 61850 enabled switch	Taïwan
D2-315	Data Analytics Platform for Power Equipment Intelligent Lifecycle Management	Russia
D2-316	Asset Management with ICT Support in Indian Power System	India

Table 3 - Papers for preferential subject 3

D2-301 Energy companies in Brazil, like Chesf, has brought attention to the Cyber threats & common IT security field as emerging trend in the energy sector. To protect mission critical assets and services there is strong need of setting up a comprehensive security strategy. IT and OT teams inside the company should create with investment in training and implementation an effective, well planned cyber security framework. The new communication and security systems planned by Chesf OT teams with special care to secure Operational assets, are much needed step towards the prevention and response to cyber-attacks.

D2-302 Paper describes the journey to modernize the North American electrical infrastructure, robust, flexible communications and secure network connectivity which are fundamental requirements to effectively operate and manage grid assets to satisfy the increasing customers' expectations. Innovative and novel implementations help to ensure flexibility, resiliency, and scalability as they look towards the future of an ever-evolving communication space. New network approach with lower latency, higher bandwidth and availability achieved the desired functionality offering significant functional enhancements to support current and future application needs of the modern grid

D2-303 Paper describes Migration from Time Division Multiplexing (TDM) based network technologies to packet switched technologies in the telecommunication networks of EPUs.
The motivations behind the shift from TDM to packet switched technologies are upgrading to the next generation technology when at the end of life cycle of TDM based primary multiplexers and other equipment needs to be replaced, changes in the supported services and applications change to Internet Protocol (IP) technologies & growing Capacity requirements for all telecommunications networks in the future. Packet switched transmission is more cost effective than TDM for higher bandwidth applications & when EPU need to migrate Information Technology and Operational Technology under one single network to save operational costs of the network. Multiprotocol Label Switching – Transport Profile (MPLS-TP) enables best features from TDM world like quality of service and constant latency including flexibility of the packet switched networks. Using TDM and packet technologies in parallel with so called hybrid nodes helps flexible transformation from TDM to packet based technologies. It is suggested that Hybrid can be a feasible solution for next 25 years providing risk free migration from legacy to the latest technology & common practices from IT and Telecom Sectors cannot be copied directly to utility networks.

D2-304 An EPU's ultimate goal is to improve operational efficiency by transforming data from the previously unavailable edge device into an appropriate data warehouse for actionable insights. The paper described project success to solving the complex problem of acquiring non-operational data from 7000 overhead devices spread over a large geographical area in a historian database. The solution simplified the RTU architecture and saved time and money maintaining physical hardware by converting to a fully virtual and secure product thus saving interfacing costs & resultant analysis yielded a high return on investment.

D2-305 Multiprotocol Label Switching MPLS is commonly used in Australian EPUs for multiple services securely and reliably to support operations services over a shared network including Supervisory Control and Data Acquisition (SCADA). Teleprotection over MPLS as one of the services transported over the same physical network. Proof-of-concept environment was used by collaboration between the Information Technology (IT) and Operational Technology (OT) functions of the business for suitability of the MPLS network for Teleprotection being time critical and network based.

D2- 306 Paper from China describes Power Industrial Control System (PICS) being the core component of power system. In Smart Grids advanced information and communication technologies are applied, PICS becomes more open and more intelligent towards cyber security issues. Security risks have been analyzed with challenges of PICS. They presented a deep security protection framework which consists of field control device layer, network transport layer, and primary station application layer. This framework has been used in transmission, distribution, consumption and dispatch part of

power system and has effectively improved the protection level of PICS. In future, research will focus on the non-modified devices access, lightweight cipher and anomaly analysis.

D2-307 EGAT introduced Multiprotocol Label Switching – Transport Profile (MPLS-TP) technology that can cope up with both TDM and packet technology to their existing network mainly based on Synchronous Digital Hierarchy (SDH) technology. SDH is unable to handle effectively applications which are developed packet based and require more data transmission capacity such as surveillance cameras and triple-play services. Some EPU services for control and protection, still transported through the existing network as it could guarantee the transmission time and delay. EGAT also proposed the ideas of life cycle management for communication equipment & TeleHealth program which enables them estimate the health index to inform status of each node in the network and give recommendations on purchase plans.

D2-308 An Indian Case Study of Hierarchically Integrated SCADA system upgrade to accommodate the modern technology for serving the present day needs of the system operators has been presented. All legacy SCADA/EMS systems were upgraded at State, Regional and National levels due to number of problems like higher maintenance cost, sluggish performance, non-availability of support service etc. Due to rapid expansion of Indian Power System and increasing interactions with external systems like IT, System Operation became complex and advanced data visualisation became utmost important for better system reliability. This led to a complete change in integration philosophy at National level due to different naming conventions, ICCP integrations, sign conventions; status bits transfer conventions, SoE integration, etc. at different RLDCs.

D2-309 This paper from South Africa discusses the strategy of interconnecting the Operational Technology (OT) environment and Information Technology (IT) environment with a focus of Cyber Security for an Electric Power Utility as they are challenged to move away from isolated operation networks to more interconnected networks. Third party networks connectivity provide vast opportunities, but greatly increases the cyber security risks of the existing OT systems.
The concept of Secure Areas focus on protecting the data from source to in transit and till destination and prevention of cyber security threats and allow co-existence with other networks has been discussed. The concept of an overarching integrated security operating centre and opportunity to commercialise excess bandwidth without introducing the cyber security threats to the business of tomorrow for the Power Grid are also discussed.

D2-310 This paper describes the telecommunication networks and infrastructures for the upcoming IEC 61850 projects in REE, the Spanish TSO. For Substation Automation System REE, nowadays use Asynchronous serial communications to communicate the SAS protection and control functions instead of Ethernet. This paper has presented the telecommunication infrastructure for the present and upcoming IEC 61850 projects & has been designed taking mainly into account the SAS communication requirements (low latency and high availability) and the physical implementation issues. The current legacy SAS will be replaced by a state-of-the-art IEC 61850 equipment.

D2-311 MAIGE – The use of new Internet-of-Things (IoT) low cost communication technologies, such as Low Power Wide Area Network (LP-WAN), for remote supervision of critical parameters of the assets along the distribution grid would represent a valuable step towards the digitization and improvement of the assets' supervision by online monitoring and diagnostics. This deployment paves the way, as well, for the development and implementation of advanced assets management and condition monitoring functionalities, as an added value for decision support. The MAIGE system is being tested and validated in different pilot sites, which are real networks operated by the Spanish utility Gas Natural Fenosa.
The results of these tests will allow obtaining conclusions regarding the technical and economic feasibility of this system. For this evaluation, different Key Performance Indicators will be defined in the context of the Project. The economic viability is a concern due to the investment that would be needed to scale the MAIGE system to all the assets operated by the utilities. By the time of writing this article, the components are being validated in laboratory separately, and the pilot tests have not begun

yet. However, by the time the CIGRE Session is being celebrated, the first results from the pilot tests will be available and presented.

D2-312 The paper from RusHydro, PJSC, Russia presents the results of work on the design and implementation of information-analytical system for automatic fault analysis and protection performance evaluation. Information model and algorithmic services of the System were developed according to IEC 61850, IEC 61970/61968 specifications and recommendations, however the information meta-model was extended with new semantics. Performance evaluation and detection of possible relay failures is based on automatic comparison of information received from DPR, DFR, RTU field-devices with the expected etalon operation of relay protection obtained through digital modelling. This process requires a detailed simulation of the identified fault events and modelling of relay operation. The result of these simulations is used as reference when compared with the actual information from relay devices to detect inconsistencies and alarming on possible hidden failures in relay settings or operation.

D2-313 This paper summarizes the Japanese "Guidelines for Power Control System Security and the case of shifting communication method from conventional Cyclic Data Transfer (CDT) method to an IP method, along with an update of dam management systems. This method is expected to reduce construction costs of transmission lines & IP migration creates the defence from cyber-attacks. The method of decomposing IP format to the original data and reconstructing the data to a new IP format by relay devices installed on boundaries between different networks was adopted. Finally will continue to maintain the secure operation of systems by effectively combining new knowledge, environmental changes, software, and hardware measures.

D2-314 This paper present some recommendations and solutions for GOOSE packet monitoring in IEC 61850 substations and suggest ways to set up smart alert mechanisms to help identify traffic bottlenecks locally so that substation operators/owners can implement preventive maintenance measures Ethernet technologies like packet multicast and VLAN are used to control the overall network load and improve the transmission performance between Intelligent Electronic Devices (IEDs). The growing size and complexity of substation networks and the increasing deployment of GOOSE-based inter-substation communication solutions present challenges to monitoring and debugging of GOOSE communication issues.

D2-315 The paper from Russia presents a model of the data analytics platform for obtaining reliable estimates of the functional state of the power network equipment, aimed at development of effective maintenance and repair programs, based on technologies of Knowledge Discovery in Databases. In the proposed system Data Mining is carried out by gradient boosting of decision trees. Within the framework of the presented research, methodological, mathematical and algorithmic bases of the intelligent data analytics platform were developed. Validation of the proposed model is based on technical diagnostics data covering a period from 2005 to 2017 and providing functional state estimates of real power transmission network facilities of a regional power system. In this system, the results of technical state assessment are obtained using probabilistic approach to enable further analysis of technical and technological risks and, finally, to develop efficiently-scheduled maintenance and repair strategies of the grid companies.
The developed model can be used as an independent tool – a model of an automated system for integrated assessment of power network equipment. On the contrary it can be implemented as an additional module (subsystem) for modern production assets management system (ERP – enterprise resource planning) of power network stakeholders. This gives the possibility not merely to improve technological management of high-voltage power equipment but also to develop effective investment programs of energy utilities, optimize energy and resource saving strategies, improve the tariff policy in the power industry, basing on reliable power supply against the background of variable external effects, thereby ensuring social and economic development of the country.

D2-316 This paper describes the process of gradual merger of IT & OT Systems and building up of Asset Management System by EPUs in Indian Power System. Smart Asset Management envisages

use of Smart Grid Technologies & ICT to help EPUs in management of large Asset Base. With the advent of IT Systems & Smart Grids, EPUs, for their efficient operations required reliable, secure, cost effective, scalable and interoperable Communication Technologies. As multiple Communication Technologies are now available, Smart Grids will have heterogeneous system based on economy of scale to achieve overall efficiency. For mission critical applications such as SCADA, WAMS, Distribution Automation etc., reliability, security and latency are the key issues & Fiber Optic based dedicated system is best suited. For non-mission critical applications such as AMR, AMI, Electric Vehicles, cost will be the decisive factor.
The SCADA/EMS systems were initially operated in closed group and isolated from corporate network and/or internet. In due course, Power Systems are adopting IT solutions to promote corporate connectivity & remote access capabilities. Distribution Networks are slowly transforming by Renovation & Modernization of older assets, building new assets with Smart Technology and adopting ICT interventions in business management. ICT implementation from Generation to Consumer value chain has brought about transformation in efficient Operation of Power System. Smart Asset Management is basically an established synergy between sensors, communication system and central storage system having monitoring & diagnostic system with expert knowledge for interpretation. The ICT success story is being replicated by various state owned EPUs gradually to make future networks Smart, Cyber Secure, Reliable & resilient. Using Standards-based technologies will ensure a high degree of scalability and interoperability. Having a long technology life-cycle, compliance to regulations and total cost of ownership are other key characteristics. Moreover, all communication technologies must possess the necessary measures to be resilient to cyber-attacks.

Discussion and Questions

Q3-01: Chesf"s IT (Information Technology) OT (Telecommunication and Automation) teams are jointly responsible for building a Secure Network, Policies, Architecture and Incident Responses System. Following clarifications are required (D2-301);
Whether periodic audit by third party security auditors (neutral) is envisaged for the system? Whether third party audit of individual equipment/asset is done at the time of purchase?

Q3-02: In paper D2-302, new network approach with lower latency, higher bandwidth and availability achieved the desired functionality offering significant functional enhancements to support current and future application needs of the modern grid**.**
How is the new network connected to SCADA & Data Historian System. ADMS, DERMS etc.?

Q3-03: Multiprotocol Label Switching – Transport Profile (MPLS-TP) transmission has been identified as best suited to EPUs. Next generation hybrid nodes can support TDM and packet based technologies in the same node**.**
How hybrid network, comprising multiple vendors' equipment, is monitored through a common NMS?

Q3-04: Multiprotocol Label Switching MPLS is commonly used in Australian EPUs for multiple services securely and reliably to support operations services over a shared network. Proof-of-concept environment was used by collaboration between the Information Technology (IT) and Operational Technology (OT) functions of the business for suitability of the MPLS network for Teleprotection being time critical and network based.
How is Cyber Security taken care in MPLS based system?

Q3-05: In paper D2-306, Power Industrial Control System (PICS) is open and intelligent towards deep cyber security protection framework consisting of field control device layer, network transport layer and primary station application layer. In future, research will focus on the non-modified devices access, lightweight cipher and anomaly analysis.
Whether enhancement proposed in the Protocol etc. can be implemented by the user friendly interface or expert help is required?

Q3-06: EGAT has TeleHealth program for Communication Equipments to move from legacy system SDH & Ethernet to MPLS-TP solution with Life Cycle Management approach.
Whether any pilot scheme has been implemented for comparing the proposed strategies?

Q3-07: Major SCADA/EMS upgrades of Regional & States Load Dispatch Centres were undertaken in Indian Power System with complete change in integration philosophy due to different naming conventions, ICCP integrations, sign conventions; status bits transfer conventions, SoE integration, etc. at different RLDCs.
How is it proposed to integrate the CIM models of different RLDCs during upgrade of NLDC?

Q3-08: Telecommunications now play a key aspect of the security of data, the concept of an overarching integrated security operating centre with secure areas focus on protecting the data itself from the source, in transit and at destination.
How to address time delays while accessing the network from outside due to multiple security layers?

Q3-09: Electric utilities can take effective security measures in accordance with each system's importance level and the risk assessment results.
What accuracy levels are achieved when the simulations are compared with the actual information from the relay devices?

Q3-10: In the system proposed by paper D2-314 Data Mining is carried out by gradient boosting of decision trees. Within the framework of the presented research, methodological, mathematical and algorithmic bases of the intelligent data analytics platform were developed. Validation of the proposed model is based on technical diagnostics data covering a period from 2005 to 2017 and providing functional state estimates of real power transmission network facilities of a regional power system. Ethernet switch-based solutions significantly reduce the time required to troubleshoot network issues in an IEC 61850 substation.
Whether this solution is implemented in any utility and what is the success rate for detection of faulty messages?

Q3-11: The paper from Russia presents a model of the data analytics platform for obtaining reliable estimates of the functional state of the power network equipment, aimed at development of effective maintenance and repair programs, based on technologies of Knowledge Discovery in Databases.
What issues are faced while integrating the proposed Analytical tool in the utilities having ERP system in place?

Q3-12: Paper D2-316 describes the process of gradual merger of IT & OT Systems and building up of Asset Management System by EPUs in Indian Power System. Smart Asset Management envisages use of Smart Grid Technologies & ICT to help EPUs in management of large Asset Base.
All EPUs have some old legacy Asset Management System. How gradual merger of IT & OT into Asset Management System was implemented which helped them achieve higher performance levels?