

General Report for SC D2 Paris Session 2018

Chairperson until 29th September 2018: Mr Philippe Quenaudon (FR)

Chairperson as of 30th September 2018: Mrs Olga V. Sinenko (RU)

Secretary: Mr Joël Nouard (FR)

Preferential Subject Special Reporters:

PS1 Mrs Giovanna Dondossola (IT)

PS2 Mr Victor Tan (AU)

PS3 Mr Narendra Singh Sodha (IN)

1 Introduction

Paris Session n° 47 was held from 27th to 30th September 2017. The SCD2 event included:

- working bodies meetings;
- a tutorial;
- the SC D2 regular meeting;
- the SC D2 poster session;
- the Group Discussion Meeting

2 SCD2 regular meeting

SC D2 covers all the aspects related with the use of the Information, Telecommunication and Telecontrol systems in the Electric Power Industry (EPI), both for operational and business activities. SC D2 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;
- to add value to this information and knowledge by means of synthesizing state-of-the-art practices and drawing recommendations.



SC D2 members at the regular meeting



Study Committee D2 Members 2018-2020

Chairperson



Olga V.
SINENKO
Russia

Secretary



Joël
NOUARD
France

Regular Members

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Working Bodies' Conveners

 Yasuo MATSUURA Japan JWG C6/D2.32	 Sacha KWIK Spain JWG D2/B2.39	 Jens-Tobias ZERBST Sweden WG D2.40	 Alberto DELROSSO United States JWG D2/C2.41
 Roel DE VRIES Netherlands JWG B5/D2.67	 Paddy MULVEY Ireland WG D2.44	 Herwig KLIMA Austria WG D2.45	 Dennis K. HOLSTEIN United States WG D2.46

Observer Members

 Eduardo MORALES Chile	 Josef FANTIK Czech Republic	 Christian CORNELISSEN Germany	 Georgios KORRES Greece	 Tomasz SZUDEJKO Poland
 José FREITAS Portugal	 Dan BORDEA Romania	 Jasmina MANDIC Serbia	 Alenka KOLAR Slovenia	 Wissarut YUTTACHAI Thailand

SC D2 members appointed for 2018 – 2020 period

3 Group Discussion meeting

The **Group Discussion Meeting** was opened by **Mr Philippe Quenaudon (FR)** - Chairman of Study Committee D2 on Thursday 29th August.

The SC D2 Chairman opened the SC D2 Discussion Meeting by highlighting the role of IT and Telecommunication for Electric Utilities and the contribution of SC D2.

The SCD2's scope covers all ICT topics applied to Electricity Transmission, Distribution and Micro-Grid including smart meters, Industrial Internet of Things, and big data for Energy Management System and Asset Management. It also covers all the communication solutions for data exchange, from communication infrastructure to data exchange models; and another very important field is, of course, security cyber security – from system design to governance, business continuity and disaster recovery.

He presented the issues of most concern raised by the SC D2 members. They fall into three categories:

- Cyber security and the challenges that go with it: use of Industrial IoT, Cloud-based platforms, interconnection of new flexibility providers, some issues related to regulation, methodology
- Applications field where a lot of benefits but also challenges EPU can be expected from new ICT : AI, Big Data, cloud, virtualized applications, Industrial IoT, Blockchain
- Telecommunication: Network transformation and migration issues (TDM to packet, WDM/OTN resource sharing...), new connectivity for distribution network and workers on the field (PLC, private and public wireless...), time critical operational services, time distribution and synchronization

The Chairman presented the status of the SC D2 Working Groups. Eight WG or JWG are currently active. Three are dealing with cyber security, three with telecommunication infrastructure, or services and two focused on business-related topics and data analytic.

He also presented the publications done in 2017-2018. Three Technical Brochures have been published and one is on publication process:

- TB 685 – “Communication solutions for information exchange in the smart delivery of electrical energy”
- TB 698 – “Framework for EPU operators to manage the response to a cyber-initiated threat to their critical infrastructure”
- TB 732 – “Advanced utility data management and analytics for improved operation situational awareness of EPU operations”
- TB XXX – “Design, Deployment and Maintenance of Optical Cables Associated to Overhead Transmission Lines”

The Chairman also mentioned a very interesting paper that has been published in the February issue of Cigre Science Engineer. This paper summarizes the important work of CIGRE SC D2 and IEC TC 57 on the ever interesting subject of cybersecurity. He reminded that SC D2 published a Green book, in twenty sixteen, on communication network and services. This Green Book is one of the best seller of CIGRE's publication.

The Chairman announced the next events for SC D2:

- Helsinki SC D2 Colloquium from 12th to 13th June 2019
- Chengdu Symposium – 20th to 25th Sept 2019

He announced that the 2018 CIGRE Technical Committee Award was granted to Marcelo de Araujo (BR) for his outstanding contribution to the technical work of SC D2.



The three Preferential Subjects for the present session were:

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

A total of 24 synopsis have been selected, 23 papers have been received:

- 5 on the Preferential Subject n°1;
- 2 on the Preferential Subject n°2;
- 16 on the Preferential Subject n°3.

Almost one hundred people attended the event. A summary of the papers is provided later in this report. The three preferential subjects were introduced during the Group Discussion Meeting by the Special Reporters.

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

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.



Special Reporter PS1

Mrs Giovanna Dondossola (IT) provided a few references on DER system and microgrid architectures, emerging IT and communication technologies applicable to DER and microgrid facilities, their interoperability and cyber security standards. Five papers were received and their main achievements summarised by the Special Reporter.

The papers (see Annex 1) cover LoRA WAN testing in Greece for meter reading infrastructures, big data platforms for decision maker applications analysing energy, electricity, economy and environment data, and customer consumption profiles, microgrid implementation at Seul University campus by means of a OPC-UA adaptor.

On the 5 questions raised in the Special Report, 7 prepared contributions were received from 5 countries.

According to the contributors there is the possibility to use IoT based communication architectures for condition monitoring applications with less demanding latency requirements, that consist of wireless communication links and internet protocol stacks. For smart metering infrastructures private multi-hop wireless networks represent a technically suitable and economically feasible solution in urban areas, with advantages compared to PLC or cellular networks.

Microgrid development, although essential for the electrification of Africa, still has some interoperability issues to solve. Communication performance have to be carefully tested in relation to the microgrid scale.

Several communication technologies need to be deployed for meeting the requirements of sub-transmission grids of the future. There is not one best solution, the correct design is to combine different technologies adjusted to each specific situation to achieve the goals (PLC, wireless, optical fiber).

PS 2 – Potential applications and implementation of network and infrastructure virtualisation

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).

The **PS2** was introduced by Mr Victor TAN (AU), Special Reporter. The PS was quite narrow, and only 2 papers were received but they were very good (see Annex 2).

Distributed Energy Resources and Renewables are expected to bring additional challenges to EPU, due to the large volume of data originating from various locations in the grid. These include advances in Machine Learning, Big Data, AI and IoT, which bring tremendous opportunities to the electricity industry, at the same time present new challenges to EPU in the areas of information systems and telecommunications.

In DER, data is expected to be large in volume, and distributed in nature. Centralised processing of all information in the traditional EPU datacentre is no longer sufficient. Distributed processing is required. This is where data is pre-processed at the nearest location possible, for example in the field devices and at the substations, after which the aggregated and summarised data is handed onto the central location.

Virtualisation, in the form of both the application and network virtualisation (SDN & NFV) have the potential to meet these requirements. With virtualisation, application and network functions can be consolidated into shared common commodity server hardware - this reduces the physical and power footprint of distributed processing, with the ability to form flexible interconnects between sites securely with the use of SDN/NFV. The use of SDN/NFV in EPU is in an early stage, with Telecommunication Service Providers / Carriers leading the way in implementation – however, similar to MPLS in the early days of EPU adoption, SDN/NFV will likely become successful, if its ability to improve efficiency and reduce costs is proven and brought to maturity is proven.



*Mr Victor Tan (AU)
Special Reporter PS2*

PS3 – Maintaining reliable and secure operation in an evolving environment

PS3 was introduced by Mr Narendra Singh Sodha (IN).

The papers (see Annex 3) were focused on 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 centres EMS, MMS etc...), ICT governance within utilities-in-house versus outsourced & Information security within the Electric Power Utilities are major thrust area for all EPU's across the globe. Asset Management with intervention of IT & OT has further added value.

Electricity Networks around the world are facing great challenges due to large number of upcoming Distributed Generation Devices & changes in Control & Communications equipment used for integration into the Network. Smart Asset Management based on Life Cycle Cost, Renovation & Modernization challenges of older assets & Operations best practices are being explored by EPU's across the globe. The Next Generation Grid will be Open, flexible, Interconnected and Interactive model for Energy.

EPU's OT Teams developed their own Asset Management Systems based on in-house expert knowledge. Later they had to seek support from IT Teams to merge & manage the Big Data volumes generated by ever increasing number of Operating Assets & IEDs sometimes even Outsourcing. EPU's adopted ERP with different functionalities for Business functions like Finance, Human Resource, Project Monitoring, Corporate Planning, Asset & Operations Management. Coordinated efforts by dedicated IT & OT Teams helped in slow but gradual & smooth integration of all Business Functions which brought in overall economy & efficiency in achieving higher performance levels by EPU's.



During the Discussion Meeting three papers have been selected and proposed to CIGRE central office for publication in **Cigre Science and Engineering**:

1 – Evaluation of a LoRaWAN Network for AMR.

By: N. HATZIARGYRIOU, I. VLACHOS, G. KIOKES (GR)

2 – Benefit and resolution of operational issues for information and communication systems using virtualization techniques in the electric power industry

By: H. DOI, D. KARIU, K. SAKAMOTO, M. SUSUKITA, T. SHIMA, H. NAGASAKI (JP)

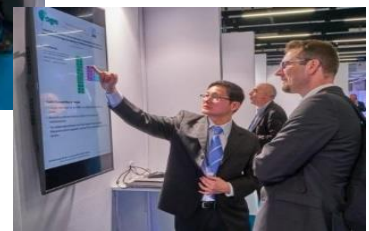
3 – An Indian Case Study of Hierarchically Integrated SCADA system upgradation and its impact on Connected Control Centres

By: P.K. AGARWALL, K.V.S. BABA, H.K. RATHOUR, A. SHARMA, A. SINGHAL, K. GAUR (IN)

Finally, the Discussion Meeting was closed by Mrs Olga V. Sinenko (RU) new chair of the SCD2.

4 Poster session

On Wednesday afternoon, a Poster Session took place. It was the opportunity for 22 Authors (over 23 Papers written) to present their work. Three Working Groups (WG D2.43, JWG D2/C2.41, JWG D2/C6.46) also presented a poster.



5 Tutorials

On Monday 27th August **Mr Dennis K. Holstein** (US) presented a Tutorial related to the Technical Brochure 698 “**Framework for EPU Operators to Manage the Response to a Cyber Initiated Threat to their Critical Infrastructures**”.

The highlight of this tutorial was the need for a security center of excellence to off-load security management from personnel responsible for operation of the secondary system. This need introduced the concept of an integrated security operations center (ISOC) that would be staffed with personnel skilled in cybersecurity threat assessment. ISOC personnel would work closely with responsible organizational units to determine the risk to reliable power delivery. In addition to the personnel with up-to-date security skills, the ISOC would include advanced technologies to monitor activities and data that could be precursors to a cyber-attack on the utility’s systems. ISOC is envisioned as the lead organization for coordinating the plans to improve security awareness and deployment of technologies to address the dynamic threat landscape. The recommendations offered in TB 698 are currently being pursued in other active working groups (B5.66 and D2.46) and are the basis for new working group proposals.

6 Annexe 1 - Preferential Subject no.1

List of the papers related to preferential subject n°1:

Paper	Country	Author	Title	Summary of the paper
D2-101	Greece	N. HATZIARGYRIOU	Evaluation of a LoRaWAN Network for AMR	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.
D2-102	China	W. KONG	Study on the construction of global energy research system based on economic-energy-electricity-environment integration analysis	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.
D2-103	China	Y. WANG	Analysis and visualization of residential electricity consumption based on geographic regularized matrix factorization in smart grid	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.
D2-104	Korea	H.Y.KANG	Implementation of Interoperability Adaptor for Interface with External Systems in Campus Microgrid	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	Country	Author	Title	Summary of the paper
D2-106	France	M. MESBAH	Assuring operational communications across the sub-transmission and MV distribution electrical power grids	<p>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.</p>

7 Annexe 2 - Preferential Subject no.2

List of the papers related to preferential subject n°2:

Paper	Country	Author	Title	Summary of the paper
D2-201	Australia	V. TAN	Substation Virtualisation: An Architecture for Information Technology and Operational Technology Convergence for Resilience, Security and Efficiency	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 EPU.
D2-202	Japan	H. DOI	Benefit and Resolution of operational issues for information and communication systems using virtualization techniques in the electric power industry	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 (PVLDD). 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.

8 Annexe 3 - Preferential Subject no.3

List of the papers related to preferential subject n°3:

Paper	Country	Author	Title	Summary of the paper
D2-301	Brazil	R. LEAL	Building a Secure Network Policies, Architettura and Incident Response Case: Chesf	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.

Paper	Country	Author	Title	Summary of the paper
D2-302	USA	J.P. KNAUSS	A Hybrid Communications Network Approach for Advanced Applications on the Modern Grid	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	Finland	A. VIRO	Network evolution towards packet switched technologies	Paper describes Migration from Time Division Multiplexing (TDM) based network technologies to packet switched technologies in the telecommunication networks of EPU's. 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	Canada	A. HAMDON	IED system management solution: a universal approach for all your grid IoT integration	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.

Paper	Country	Author	Title	Summary of the paper
D2-305	Australia	V. TAN	Teleprotection over Multiprotocol Label Switching (MPLS): Experiences from an Australian Electric Power Utility	Multiprotocol Label Switching MPLS is commonly used in Australian EPU's 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	China	W. LIN	Research and application of deep security protection technology in power industrial control system	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	Thailand	P. CHIEWCHARAT	Challenges in EGAT Telecommunication System Integration	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.

Paper	Country	Author	Title	Summary of the paper
D2-308	India	K.V.SBABA	An Indian Case Study of Hierarchically Integrated SCADA system up gradation and its impact on Connected Control centers	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	South Africa	M. TALJAARD	Network and Data Cybersecurity Strategy of the Electrical Power System	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	Spain	J.M. DELGADO	Telecommunication solutions for IEC 61850-based substations at the Spanish TSO and its practical implementation	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.

Paper	Country	Author	Title	Summary of the paper
D2-311	Spain	J. GILABERT	MAIGE – IoT infrastructure for online asset management	<p>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.</p> <p>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.</p>
D2-312	Russia	D. ZHUKOV	Development of information-analytical system for automatic fault analysis and relay protection performance evaluation	<p>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.</p>

Paper	Country	Author	Title	Summary of the paper
D2-313	Japan	T. HIKINO		<p>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.</p>
D2-314	Taiwan	J. CHUANG	GOOSE performance monitoring based on IEC 61850 enabled switch	<p>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.</p>

Paper	Country	Author	Title	Summary of the paper
D2-315	Russia	A. KHALYSMAA	Data Analytics Platform for Power Equipment Intelligent Lifecycle Management	<p>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.</p> <p>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.</p>

Paper	Country	Author	Title	Summary of the paper
D2-316	India	N. SINGH SODHA	Asset Management with ICT Support in Indian Power System	<p>This paper describes the process of gradual merger of IT & OT Systems and building up of Asset Management System by EPU's in Indian Power System. Smart Asset Management envisages use of Smart Grid Technologies & ICT to help EPU's in management of large Asset Base. With the advent of IT Systems & Smart Grids, EPU's, 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, AML, Electric Vehicles, cost will be the decisive factor.</p> <p>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 EPU's 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.</p>