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CONSEIL INTERNATIONAL DES GRANDS RESEAUX ELECTRIQUES
INTERNATIONAL COUNCIL ON LARGE ELECTRIC SYSTEMS

STUDY COMMITTEE D2
INFORMATION SYSTEMS AND TELECOMMUNICATION

2013 SC D2 Colloquium
Mysore - KARNATAKA – INDIA

Special Report for Study Committee D2

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Preferential Subject	Special Reporter
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1 Introduction

Cigré Study Committee D2 (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.

For the 2013 SC D2 Colloquium hosted by India, SC D2 has selected the following three Preferential Subjects as being current issues for the Electric Power Industry:

1.1 Role of ICT in power system.

Smart Grid development and introduction of DER require huge investments in ICT. Efficiency of power system operation is a business driver, regulations or incentives for energy markets are another business driver; what is the experience of Electric Power Industry? The papers for this preferential subject focus on the following items:

- Communication challenges for Smart Grid
- WAMS and use of PMU data for developing Analytics
- Managing ‘Quality of Service’ with high level of DER penetration

1.2 Standards, Security and Leading-edge Technologies in the context of Power Systems

To face the new requirements for a more efficient power system operation, development of ICT in Electric Power Industry is a must. What standards are to be used? What technologies? How to ensure an appropriate level of security? The papers for this preferential subject focus on following items:

- Future Control Centers with advent of Smart Grid

- Need for CIM – Application Specific & Nation Specific
- High performance computing for Real Time Analysis, Visualization and Control
- Cyber Security Challenges on account of interconnected ICT solutions across the complete value chain from end consumer to bulk generators

1.3 Renewable generation plant communications

Renewable generation plants are often outside the reach of the Power Grid's Communication System yet these generation facilities require dependable and secure communication. Different communication solutions are employed for connecting renewable plants. Following are some of the issues covered under this topic:

- Communication facilities for off-shore generation farms and interconnected systems for control, monitoring & safety
- Communication solutions for connecting private renewable resources
- Environmental, installation and maintenance issues
- Coverage & propagation issues
- Interoperability Issues
- New revenue generating telecom opportunities

A total of 72 synopses have been received and evaluated. Following the selection process only 64 synopses were accepted:

- 36 on the Preferential Subject n°1;
- 18 on the Preferential Subject n°2;
- 10 on the Preferential Subject n°3.

All the authors were informed either of acceptance or rejection of their synopsis. However, even with an extension of time to deliver the full paper, only 51 papers have been received and will be discussed during the 2013 SC D2 Colloquium:

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

2 Preferential Subject no.1

Information and Communications Technology, better known as ICT, has become an integral part of the Power Sector for better planning, supervision, operation, maintenance, monitoring, control of all activities related to power generation, transmission, distribution and commercial operations. Smart Grid enabled by ICT also needs to address issues like development of interoperable communication protocols for each domain of the smart grid, Identification of suitable communication technologies for smart grid communication infrastructure and cyber security for all communication interfaces, currently faced by the power sector. With such context in this session, 28 papers dealing with this multi-faceted issue are presented and thrust areas considered in this sub-committee are "WAMS and use of PMU data for developing analytics" (7 papers), "Managing 'Quality of Service' with a high level of DER penetration (2 papers)" and "communication challenges (19 papers)". The salient points of these papers are given in the subsequent section.

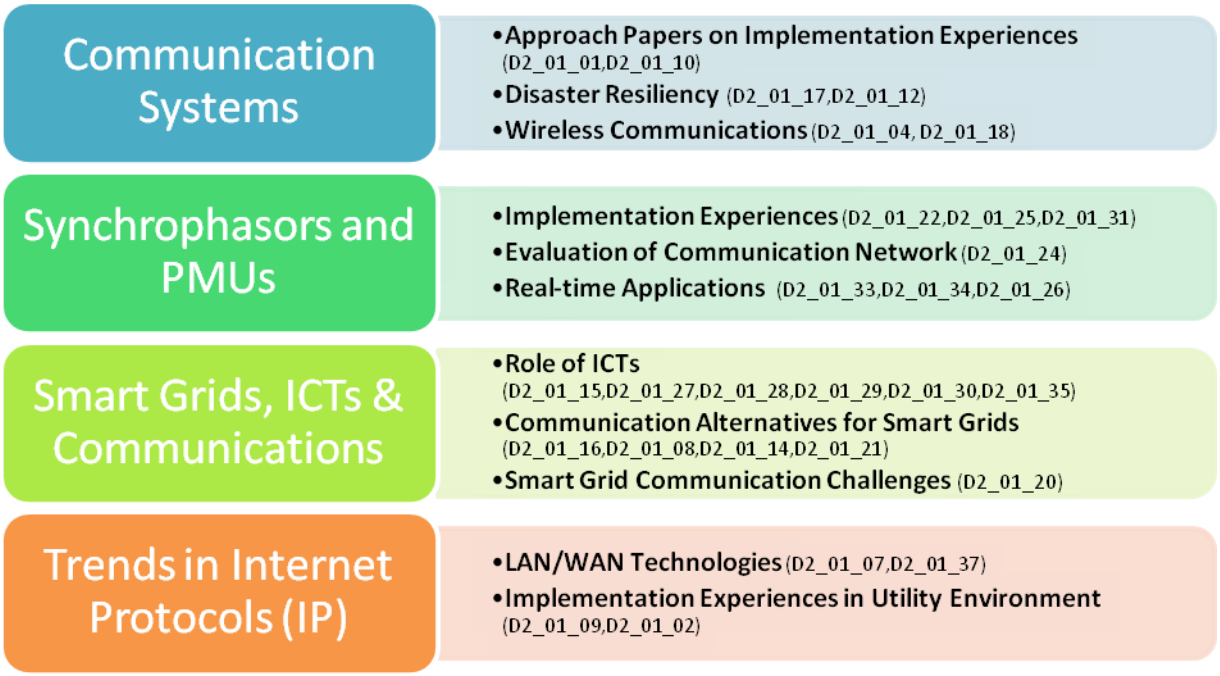
Hereafter the list of the papers related to Preferential Subject n°1 is to be found:

Paper	COUNTRY	AUTHOR	TITLE
D2-01_01	IN	Sheela Rani	Communication System for Smart Transmission
D2-01_02	BR	Rodrigo Leal de Siqueira	Challenges and Benefits of a Unified Synchronism Network CASE CHESF
D2-01_04	CH	Paul Schwyter	Smart, utility-grade Wi-Fi Mesh for Distribution Grids
D2-01_07	GB	R. Irons Mclean	Architecting a packet-based Wide Area Network to support current, developing, and future the utility use cases and applications
D2-01_08	JP	Naomasa Takahashi	Approaches to Smart Grid Communications Networks in Japanese Electric Power Companies
D2-01_09	NL	Marco C. Janssen	Trends and Concerns regarding the Use of IP and other communication transport solutions in the utility environment
D2-01_10	IN	Srinivas Patkar	The role of communication systems for smart transmission
D2-01_12	JP	Atsushi Ohara	Disaster resilient telecommunications systems for smart grid in Japan
D2-01_14	IN	Chander B Goel	Last mile connectivity challenges in Smart Grid
D2-01_15	MX	Roberto Castán	Home Energy Management System based on the measurement and control of electricity consumption of home appliances
D2-01_16	ES	Jaume Darne	Communications Alternatives for Smartgrids: The Integrated Approach
D2-01_17	UY	J. Costa	Preparing ICT towards electrical business continuity
D2-01_18	IN	Mrityunjai Tiwari	Adaptability of Wireless Sensor Network for Integrating Smart Grid Elements in Distribution System
D2-01_20	IN	Maheswaran D	Communication challenges for Smart Grid
D2-01_21	IN	Tushar Saxena	Integration of 4G Communication Network Technologies with Smart Grids
D2-01_22	IN	V. K. Agrawal	Experience of Upscaling and Integration of Regional Level Synchrophasors Pilot Projects to a National Level project
D2-01_24	JP	Yoshizumi Serizawa	Prototype and Evaluation of Communication Network for WAMPAC System Based on International Standards
D2-01_25	IN	U.G. Zalte	MSETCL Experience in developing synchrophasor system
D2-01_26	IN	Sushil Cherian	Operational Experience of Real Time Oscillation Monitoring System in India
D2-01_27	IN	Sachin Agarwal	Role of ICT in Power system
D2-01_28	IN	Kishor G. Chavan	Role of ICT in Power system
D2-01_29	IN	Harsh Sharma	Role of ICT in power system
D2-01_30	MX	Octavio Gomez	Alarms rationalization in Mexico power units
D2-01_31	IN	Uttam Mishra	Synchrophasor: Implementation, Testing and Operational Experience

Paper	COUNTRY	AUTHOR	TITLE
D2-01_33	IN	Srinu babu. Matta	Out-of-step detection using Wide Area Measurements
D2-01_34	IN	G. Vamsi Krishna Kartheek	A Smart Grid Application for Dynamic Reactive Power Management
D2-01_35	MX	Fernando Ramírez	Power quality information system based on data energy metering integration and analysis
D2-01_37	ES	Arzuaga, Aitor	WAN Network Communications Architectures for Smartgrids: Case Studies comparison

2.1 Overview of Submitted Papers

Accepted papers for presentation are further classified into broad research categories as shown in the figure below.



Most of the papers discussed on the role of ICTs for enabling smarter grids, and detailed utility cases on implementation experiences. Papers (D2-01_27, D2-01_28, and D2-01_29) specifically stressed on the role of ICTs in facilitating real-time applications for grid operation. Swiss (D2-01_04) and Indian (D2-01_18) authors in their respective papers reviewed wireless communication technologies and their adaptability for Integrating Smart Grid Elements in Distribution System. Further, Swiss authors particularly discussed the use of Wi-Fi Mesh for utility-grade applications.

It has been observed that Synchrophasors technology deployment is in the initial stage across most parts of the world (GB, IN, JP), and generally being taken up as pilot projects to experiment with operational capabilities of the technology. Papers (D2-01_22, D2-01_25, D2-01_31, D2-01_33, D2-01_07, and D2-01_24) describe various technical options for deploying synchrophasor technology for specific grid monitoring applications. Authors (D2-01_22) from India have specifically shared their first of kind experiences of up-scaling and integration of regional level pilot projects to the national-level project.

Brief summary of the papers is presented on “category + country” wise in the subsequent sub-sections.

2.1.1 Communication Systems

India

Paper D2-01_01 on "**Communication System for Smart Transmission**" describes the Power Grid Corporation of India Limited (POWERGRID) experiences with implementation of Optical Ground Wire (OPGW) based communication network and studies suitability of communication network based on Synchronous Digital Hierarchy (SDH) & Plesiochronous Digital Hierarchy (PDH) technology for meeting communication bandwidth requirement for the emerging technologies and other power system needs. Based on the author's experience, it has been identified that *OPGW based communication network is best suited* for meeting the communication requirement of Indian Power System.

Paper D2-01_10 on "The Role of Communication Systems for Smart Transmission" describes the importance of reliable utility communication networks and services for modern and high performing power grid operation. Protection of power lines and other high voltage assets as well as latest utility related standards (e.g. IEC 61850 and IEEE C37.94) put most stringent demands on real-time performance and reliability of communication. An overview of commonly used communication media/ technologies for WAN for transmission is presented in this paper.

Paper D2-01_18 on "Adaptability of Wireless Sensor Network for Integrating Smart Grid Elements in Distribution System" describes a prototyping pre-study focused on various wireless communication technologies such as Zigbee, Bluetooth, 6LoWPAN, Wi-Fi, GSM, GPRS, UMTS, EDGE and RF and their adaptability challenges in Power System Automation. Authors propose decentralized intelligence in distribution automation segment thru IEDs with communication capability. Results from an experimental setup for performance of proprietary WSN stack have been presented in the paper

Switzerland

Paper D2-01_04 on "**Smart, Utility-grade Wi-Fi Mesh for Distribution Grids"** reviewed various wireless solutions for the distribution layer, particularly the use of Wi-Fi Mesh for utility-grade applications. With sophisticated firmware algorithms used by the Wi-Fi Mesh nodes, network-planning becomes much less complex and allows utilities to deploy a fast and smoothly network. Authors suggest the various flavors of IEEE 802.11 standards need to be combined with distinctive measures to comply with the utilities' and customers' expectations. For e.g. fibre optic based backbone a Wi-Fi Mesh is exceptionally cost-efficient way deploying distribution oriented networks for operational and even for commercial use.

Japan

Paper D2-01_12 on "**Disaster resilient telecommunications systems for smart grid in Japan"** introduced telecommunications systems used by EPCOs in Japan that are based on disaster resilience and support to achieve early recovery from disasters. Authors mostly focused on presenting the initiatives undertaken by Shikoku and Tohoku Electric Power Companies as part of the activities of EPCOs in Japan to tackle the issue of recovery from disasters.

2.1.2 Synchrophasors and PMUs

India

Paper D2-01_22 on "Experience of Upscaling and Integration of Regional Level Synchrophasors Pilot Projects to a National Level project" describes the experiences of up-scaling and integration of regional level pilot projects to the national level pilot project in India.

Authors detailed out the challenges faced during the execution of project like limited communication links/channels between PMU locations and regional control centers and between regional control centers to National Control center, and issues with substations with automation system.

Paper D2-01_25 on "MSETCL Experience in Developing Synchrophasor System" describes initiatives taken up by MSETCL in developing WAMS technology with due considerations to the communication system requirements. Paper focused in brief on some of the initial integration issues involved in first of its kind experience in India of integrating Synchrophasor System with Situational Awareness System for better operation, monitoring and control with improved observability of the grid.

Paper D2-01_26 on "Operational Experience of Real Time Oscillation Monitoring System in India" illustrates automatic real-time Oscillation Monitoring System for extracting the modal information and mode shape of electromechanical oscillations. Oscillation Monitoring System has two separate algorithms called damping monitor Engine and Event Analysis Engine for analyzing ambient data and post-disturbance data respectively.

Paper D2-01_31 on "Synchrophasor: Implementation, Testing and Operational Experience" reviewed the application of synchrophasors to observe power system dynamic phenomena and how they are useful in the real-time control of the power system with operational examples and case studies. It is desirable to have PMU over traditional state estimators that provide lagging and inaccurate system information. In this context, authors described the PMU testing methods and analysis.

Paper D2-01_33 on "Out-of-step detection using Wide Area Measurements" describes a new scheme for power swing detection, which can distinguish stable and unstable power swings, and can block tripping of distance relays on a stable power swing. Authors proposed scheme fundamentally works on resistance, rate of resistance, impedance and rate of impedance obtained using synchronised measurement of data from both ends of a transmission line.

Paper D2-01_34 on "A Smart Grid Application for Dynamic Reactive Power Management" proposes Phasor Relativity Based Mathematical Control System (PRM Control System) as a Smart Grid Application for Dynamic Reactive Power Management. A specific case study on 24 bus Indian EHV system is also presented to demonstrate how the dynamic reactive power compensation can help the operator in improving system stability and security under conditions of system disturbances.

Japan

Paper D2-01_24 on "**Prototype and Evaluation of Communication Network for WAMPAC System Based on International Standards"** proposed a Wide Area Monitoring, Protection and Control (WAMPAC) system based on IEEE 1588 international standard. WAMPAC anticipated enhancing power transmission efficiency and helping cope with power system anomalies and outages. Authors described architecture and evaluation of the proposed prototype. WAMPAC comprises intelligent electronic devices (IEDs), phasor measurement units (PMUs) and central equipment (CE) interconnected by Layer 2/Layer 3 (L2/L3) switch-based IP networks in cooperation with IEEE 1588 time synchronization devices.

2.1.3 Smart Grids, ICTs & Communications

India

Paper D2-01_27 on "Role of ICT in Power system- WIDE-AREA MONITORING by PMU" gives an overview about WAMS using PMUs. Ensuring power system security requires the use of advanced tools capable of comprehensive security assessment. Online dynamics security assessment can provide the first line of defense by scanning the system for problems and providing operators to take actions. Authors briefed about monitoring swing, load on transmission corridors, phase angle and disturbance monitoring as well as protection and control related applications.

Paper D2-01_28 on "Role of ICT in Power system" presented a review of ICT and WAMS. Integrating ICT into the existing grid opens up a realm of possibilities for improving supply reliability and for putting more options for energy efficiency. Authors concluded that the future grid enabled with ICT has an immense potential to allow communication in both directions, manage grid efficiently and optimize utilization of resources.

Paper D2-01_29 on "Role of ICT in Power system" shared the experiences of smart use of ICT in 66/33/11 kV receiving stations and 11/415V substation automation. BSES Yamuna Power Ltd. has identified the essentiality of effective use of ICT to achieve rapid success in power distribution. Authors revisited basic features of ICT.

Paper D2-01_14 on "Last mile Connectivity Challenges in Smart Grid" describes a number of technologies that can be utilised in setting up an Automated Meter Reading network in India and the challenges involved in this process. Zigbee with SE, 6LowPAN, Wireless M-Bus, and Wi-Fi are some of the wireless standards mentioned. Reliability or sustained connectivity, Interoperability, Security, Ease of installation and commissioning, and Lower Cost are the list of requirements put forward by the authors for a utility to expect from AMR installations, Authors have suggested hybrid AMR network to meet the challenges of diversity.

Paper D2-01_20 on "Communication challenges for Smart Grid" presents a comprehensive comparison of the various types of communication architectures for Smart Grid with an explanation of the challenges involved in selecting the optimum type of network for various subsystems of the Smart Grid.

Technical requirements are reliability, security, speed, bandwidth as well as other key factors like Scalability, CAPEX (Initial Capital expenditure), OPEX (Operating expenditure), Open platform for easy integration to various third party devices etc. Authors specifically discussed the network implementation considerations vis-a-vis the functional specifications and physical attributes of various subsystems of the Smart Grid here.

Paper D2-01_21 on "Integration of 4G Communication Network Technologies with Smart Grids" investigated about the various ways in detail through which integration of 4G Communication network technology will play a vital role in the Smart Grids.

Uruguay

Paper D2-01_17 on "**Preparing ICT Towards Electrical Business Continuity"** described a methodology and some recommendations like using business impact analysis for ICT services to support business operations in the event of emerging events and incidents that could affect continuity of critical business functions. Methodology described by the authors is based on ISO/IEC 27031 and others standards. Authors also discussed concepts like Business Continuity Management including disaster recovery and prevention.

Japan-

Paper D2-01_08 on "**Approaches to Smart Grid Communications Networks in Japanese Electric Power Companies"** presented the reports of verification testing utilising multihop wireless system as well as using PLC system, Test results for wireless system indicate more than 98% success rate. For PLC change of Layer 2 network to Layer 3 network has resolved some of the earlier problems.

Mexico

Paper D2-01_16 on "**Communications Alternatives for Smartgrids: The Integrated Approach"** describes the importance of network architecture and the impact of transmission technology on the performance of the network. Authors focused on presenting the aspects of wireless networks with specific interest to the case of radio propagation. They also highlighted the importance of implementing Point to Point links rather than multidirectional diffusion ones.

Paper D2-01_30 on "**Alarms Rationalization in Mexico Power Units"** described the process of diagnosis and alarm rationalization methodology and implementation in the control centers of power plants operated by the Comisión Federal de Electricidad (CFE), Mexico. México' Electrical Research Institute proposed to implement the intelligent management of alarms to prepare control centers and operators of the power units in a new operating philosophy with the introduction of smart grids.

Paper D2-01_15 on "**Home Energy Management System Based on the Measurement and Control of Electricity Consumption of Home Appliances"** describes a home energy management system that measure and register household electricity consumption and costs. System described by the authors permits to build a home energy network by connecting wirelessly smart appliances and smart meters by means of In-Home Displays. System is capable of communicating with an electronic energy meter that supports bidirectional communication (utility and end-user).

Paper D2-01_35 on "Power quality information system based on data energy metering integration and analysis" describes a power quality information system based on energy metering data integration and analysis, which integrates data from diverse brands of electronic meters that possess power quality information in homologated data bases. This system contributes to systematize power quality data, electric load profiles, and power transformers loads.

2.1.4 Trends in Internet Protocols (IP)

Netherlands

Paper D2-01_09 on "**Trends and Concerns Regarding the Use of IP and Other Communication Transport Solutions in the Utility Environment"** describes the main results of the survey that was conducted by the working group D2.35 in 2012 amongst CIGRE members with the objective to identify the current and expected use of scalable communication transport solutions over optical networks by electrical power utilities.Most survey participants indicate that WDM and MPLS are seen as likely candidates to replace SDH in the future but at the same time large group indicates that they expect that SDH will continue to be used as the core technology.

India

Paper D2-01_37 on "WAN Network Communications Architectures for Smartgrids: Case Studies comparison" describes the analysis of three different WAN communication architectures compared in terms of scalability, cybersecurity, costs, performance, etc., used in large scale Smartgrid projects (Two on real life European scenarios, Third case study analyses a typical

configuration used in India). This is a paper on collaborative work between Spain and India in the area of WAN communications architecture implementations.

Brazil

Paper D2-01_02 on "**Challenges and Benefits of a Unified Synchronism Network"** demonstrates an overview of the Telecom Director Plan with a focus in the Unified Synchronism Network, operated by the CHESF, Brazil. Future communication tends to be supported by an IP platform. Electro-energetic system is evolving to respond to the IEC 61850 standard, with local Ethernet Networks and communication protocols based on the IP.

Great Britain

Paper D2-01_07 on "**Architecting a Packet-based Wide Area Network to Support Current, Developing, and Future the Utility Use Cases and Applications"** argued that just creating an MPLS WAN is not an answer to successfully transporting many use cases such as teleportation and PMUs.

Authors suggest WAN architecture needs careful design consideration to cope with multiple different application requirements across the same infrastructure and must have appropriate QoS, multicast, timing and synchronization, security, OAM, redundancy, reconvergence and resilience mechanisms

2.2 Questions to the Authors/Presenters

The questions are given below, where paper numbers are mentioned in relation to specific questions, and the author/presenter of the paper should reply to them.

The attendance is also expected to contribute actively, i.e. bring their answers to the question in order to have a constructive discussion.

Paper: D2-01_01

Q1-1. What are the Cyber-security measures been taken in the communication network implementation for Smart Transmission?

Q1-2. How would authors see modern IP based communication technologies over traditional TDM based technology over the OPGW based communication network?

Paper: D2-01_10

Q1-3. What is the scope for having integrated communications infrastructure which supports interaction between TSO, ISO, open access consumers, states operators and any other prominent loads/generation on the network?

Paper: D2-01_18

Q1-4. Could you please share the expected comparison of network coverage performance for different WSN technologies?

Paper: D2-01_04

Q1-5. Please further explain about the utility grade applications considered for testing various flavours of IEEE 802.11 standards.

Q1-6. What are the various QoS considerations for such networks? Does the audience have any suggestions on QoS in using IEEE 802.11 standards?

Paper: D2-01_12

Q1-7. The authors are invited to provide details of new IP based system and its comparison with old systems.

Q1-8. Does Shikoku and Tohoku Electric Power Companies have standalone disaster resilience and support with dedicated telecommunication systems? How are they integrated to the enterprise bus of the other utility systems?

Paper: D2-01_22

Q1-9. What are the challenges faced in integration of the PMU data with the SCADA through IEC 60870-5-104 protocol?

Q1-10. What are the measures taken to time synchronizing of the PMU data available at regional levels while taking up to national level?

Q1-11. How does the heterogeneity of the PMU devices being tackled in operation? Are there any specific experiments been done to calibrate such phenomenon's? What are the standards followed or set?

Paper: D2-01_25

Q1-12. What are the procedures followed while integrating Synchrophasor System with Situational Awareness System?

Q1-13. What are the challenges faced for the integration?

Paper: D2-01_26

Q1-14. Please, can you give more details about the event analysis engine? Are there any future plans to extend the system beyond the Prony type of analysis of oscillatory ringdown responses?

Paper: D2-01_31

Q1-15. What are the various PMU testing methods used or developed by your organization? Audience can give suggestions on best used testing methods for PMUs.

Paper: D2-01_33

Q1-16. How is the proposed out of step detection using WAMS is different from the existing in the literature?

Q1-17. Is it implemented in any practical system to distinguish between stable and unstable swings? If yes, please share the observational experiences. If not, what are the impediments in implementation?

Paper: D2-01_34

Q1-18. What are the algorithms used in predicting voltage collapse, where sensing global power system conditions derived for local measurements? At what level they run for generating alarms to the operator?

Q1-19. What are the unique considerations planned for field implementations? What are architectural requirements? How the system with the proposed technique does operates, centralized or decentralized? What is the effect on operational decisions? Please give details.

Paper: D2-01_24

Q1-20. What are the cases considered for evaluation of the proposed prototype of Wide Area Monitoring, Protection and Control (WAMPAC) system based on IEEE 1588 international standard?

Papers: D2-01_27 and D2-01_28

Q1-21. How is ICT utilized in Maharashtra, India, for implementing WAMS? What is the percentage of grid observable using such systems? Any challenges in implementation?

Q1-22. Please give your future plans on how would envision the grid operations with WAMS and necessary regulatory support requirements.

Paper: D2-01_29

Q1-23. What is the broad range of services provided to consumers after using ICT at your utility?

Q1-24. Is your Utility Company considering migrating to new Communication Systems for all 66/33/11 kV receiving stations and 11/415V substation automation shortly? In such case, which technology is being taken into account??

Paper: D2-01_14

Q1-25. Does the author have any future plans to study the applicability of AMR to the rural planning architectures in India?

Q1-26. What are the recommended criteria for selecting hybrid technologies?

Paper: D2-01_20

Q1-27. What are the specific Communication Protocols authors would like to recommend for each of the smart grid domain mentioned in the paper?

Q1-28. What could be a suitable application communication architecture(s) authors/audience would like to suggest addressing the prevailing communication challenges in smart grid deployment at a utility?

Paper: D2-01_21

Q1-29. What are the security standards followed for 4G Broadband (/WiMax) deployments?

Q1-30. Is it possible to interface IPv6 and WiMax for utility communications? Does the author or the audience have some suggestions or any implementation experiences to share?

Paper: D2-01_17

Q1-31. Does the author or the audience have experience in implementing ISO/IEC 27031 based ICT services to support business operations in the event of emerging events and incidents that could affect continuity of critical business functions?

Q1-32. Why does Minimum Business Continuity Objective (MBCO) considered as a constant by the authors? It can vary time to time depending on the dynamics of business functions. In such cases, are there any practices/recommendations mentioned in the existing standards? What are the authors/audience views?

Paper: D2-01_08

Q1-33. How does the test results can be scaled down as a reference to the other pilots? Are there any efforts on standardizing such cases?

Q1-34. Please explain the factors considered for defining the success rate of implementing both multihop wireless and PLC systems

Paper: D2-01_16

Q1-35. Authors highlighted the importance of implementing Point to Point links rather than multidirectional diffusion ones. Does it beneficial interms of cost?

Q1-36. Do you consider using Point to Point links across the entire network to share media with other services?

Paper: D2-01_30

Q1-37. What are the significant features of the process of diagnosis and alarm rationalization methodology and implementation in the control centers of power plants operated by the CFE?

Q1-38. Are there any unique requirements in operation? If so, how are they different from others?

Paper: D2-01_15

Q1-39. Is the HEMS architecture presented in the paper works for enabling consumer market participation? What are the steps should be taken in such cases where retail markets are available.

Q1-40. What are security and privacy measures considered by the authors in HEMS implementation?

Paper: D2-01_35

Q1-41. What is the reason behind considering only CEBMA curve and SARFI for representing power quality events?

Q1-42. It is mentioned in the paper about creating the common data formats to read different data bases from power quality meters and create a unique data base with the same structure and data formats. Have you explored the standards like IEC CIM/ Multispeak for such formats?

Paper: D2-01_09

Q1-43. How many of the respondents in the survey from transmission or distribution utilities are using WDM & MPLS? Which region is dominating in such implementations?

Q1-44. Would you please to describe the state of the art for these systems?

Paper: D2-01_37

Q1-45. What are the reasons for implementing three different WAN communication architectures used in large scale Smartgrid projects presented in the paper, using cellular networks only?

Q1-46. Are those Utility Companies foreseeing cellular networks as the best option for implementing smart grids?

Q1-47. Which are the standards of cellular networks that have been selected?

Paper: D2-01_02

Q1-48. Could you explain about the type of synchronism network operated at CHESF?

Q1-49. Please give details about the implementation profiles of the Unified Synchronism Network with IEEE 1588v2 and IEC 61850.

Q1-50. Please explain about the reflections of “quality of service” at CHESF.

Paper: D2-01_07

Q1-51. What are the design considerations for WAN architecture in implementing the usecases?

Q1-52. What is the influence of QoS on such designs?

3 Preferential Subject no.2

3.1 Overview of Submitted Papers

Hereafter the list of the papers related to Preferential Subject n°2 is to be found as well as a brief summary of the content:

Paper	TITLE	COUNTRY	CONTENT
D2-02_01	Future control centre with advent of smartgrid	IN	Analysis of recent incidents of grid disturbances in India has triggered the need to have a Grid Security Expert System (GSES). This system, based on WAMS, will automatically disconnect loads/generators depending upon the criticality of the grid using Real Time information. The authors have described the various considerations and strategies for implementing this next generation Smart Control Centre. It describes the drivers for upgrading Load dispatch centres for the transmission sector and for managing renewables, expectations from synchrophasor technologies (for monitoring, assessment and control). It also outlines strategies proposed for handling upgrades, parallel operations and support services.
D2-02_02	Ultra Large-Scale Power System Control Architecture	US	This paper describes concept of an ultra large scale power system control architecture that can provide the structure to handle multi-objective, multi-constraint grid control problems and support coordinated control across utility organizational boundaries and potentially, prosumer premises. Such a framework can preserve stability while solving the hidden coupling problem, the control federation problem and the tier disaggregation problem. The authors present a case for adopting the concept of Ultra-Large Scale Systems (ULS) instead of the System of System (SoS) approach, which does not fully account for the issues that arise in the convergence of four disparate networks (physical, ICT, financial and social).
D2-02_03	Achieving redundancy using configuration exchange through GOOSE communication in Substation	IN	Backup protection systems in critical substations require appropriate configuration of the IEDs. This paper explains how configuration can be achieved using Peer-to-Peer, Master-Slave and Slave-Master arrangements. It also explains how in case of communication failure, information can be exchanged between redundant IEDs. It is possible to automate porting of setting/configuration from one IED to another IED in a redundant protection scheme. The paper opens up possibilities of automating system configuration, which may be considered one of the first steps in evolving to self-healing grid systems.

Paper	TITLE	COUNTRY	CONTENT
D2-02_04	Building an Interoperable Grid with Industry-Standard IPv6 Architecture	PT	This paper describes the IPv6 Reference Architecture for smart grid networking that can be used to address Field Area Network requirements in a Smart Grid regime. The authors argue that it can also be extended to WAN, Data Centres and to primary substations for distributed control and communications optimization. IPv6 is a standards based highly secure and scalable communications platform being developed jointly by CISCO and leading organizations in smart metering and distribution automation area.
D2-02_05	Usage of CIM in System operations in India	IN	This paper describes application of Common “Information Model (CIM) to system operations in a typical ABT based scheduling and accounting regime in India. The model addresses information exchange across organizations – generating stations, beneficiaries, load despatch centres and power committees. The model has been found to be adequate for modelling energy scheduling and energy meter data, but needs to be extended for modelling energy accounting,
D2-02_07	Optimization and Control System for Energy Management in Smart Grid	IN	Operations of utility and consumer are usually independent in terms of their response/reactions to situations. However, in the smart grid of the future, both can operate together to achieve financial and social benefits through energy management systems. The authors have modelled smart grid energy management as a price-setting demand-response mechanism, by extending standard mixed integer linear programming (MILP) formulations. The model handles user comfort, emission limits, and appliance detailed level constraints and uncertainty in pricing. The model has been validated by a practical application in an enterprise building where it was observed that automatically turning off appliances and adjusting load during peak hours as suggested by the optimization module helped flatten the demand curve of the day with reduction of peak load.
D2-02_08	Cyber Security in Implementing Modern Grid Automation Systems	IN	This paper describes how modern day grid is seeing the advent of IP based automation technologies, need for integrated operations of SCADA and other systems to exchange information and introduction of new “actors” – the consumers and associated devices over which utilities have no control or ownership. It makes a case for need of security strategy to cover technology solutions and also focus on operational policies and practices. An overview of the various international security standards currently is also presented.
D2-02_09	Construction of Next-generation Security Infrastructure to Cope with New Types of Cyber Attacks	JP	This paper describes implementation of next generation security measures implemented in KEPCO to prevent leakage of confidential information by focussing on content of communication transmitted by machines infected with malware to external servers. This system enables detection of malware infections of in-house machines from the content of the communications even if the malware concerned is unknown and not yet identified by virus definition files.

Paper	TITLE	COUNTRY	CONTENT
D2-02_11	Application of a cyber security assessment framework to smart grid ICT architectures	IT	This paper evaluates the capabilities of Cyber Security Modeling Language (CySeMoL) for estimating success probability of cyber security attack for different but typical ICT network architecture encompassing DSO, Substations and DER for a sample use case of Voltage Control of active MV grids. This use case allows study of the network having multiple independent systems, with heterogeneous communication technologies and business drivers of correct and economic operation of the grid. The authors conclude that the application of the current CySeMoL version to Voltage Control Architecture variants has allowed identifying specific aspects that are not covered by the current version of the model e.g. details on communication protocols and security measures.
D2-02_12	Comprehensive Cybersecurity strategy for Smartgrid equipment manufacturers	ES	This paper describes the efforts in standardizing the process of building security based on creation of use cases, mapping them on SGAM, linking the result to the SGIS toolbox and identifying standards and gaps thereof. This approach will help in balancing security management with performance and cost aspects. The authors emphasise that knowledge and methodologies of Security must be included in the Energy sector profession just like for communication systems, to prevent over-engineered security methods that can be detrimental to the performance and cost and also to the evolution of the Smart Grid itself. They have identified a few security design tips for manufacturers that can be incorporated in devices, based on the analysis of the problem from top-down use case based and bottom-up approaches.
D2-02_13	Saturable-Core FCL Based on the Normal Conductor Direct Current Coil	CN	Recent advances in FCL technology has brought in Super-conducting DC coil based SFCLs that offer negligible impedance during normal operation and are almost invisible to the power system, but limit fault currents by offering high impedance in case of faults. However, due to instability of superconductors and prohibitive costs, SFCLs are not yet commercialised. This paper presents a Fault Current Limiter (FCL) which uses a normal conductor DC coil i.e. NFCL instead of the superconducting winding. The structure and physical principle of the NFCL are based on the saturable core SFCL. PSCAD simulation studies have shown that the NFCL is effective in the grid, in terms of impedance offered during normal and fault conditions. It also meets the requirements of auto-reclosing of Circuit breakers with the aid of rapid demagnetization and rapid excitation auxiliary circuits, apart from being cost attractive.
D2-02_14	Preventive simulation studies based on single-phase test of 750kV Magnetic Controllable Reactor	CN	Magnetic Controllable Reactors (MCR) are suitable for overvoltage, reactive power compensation and reducing overload transmission losses for super/ultra-high voltage power systems. MCR has low grid losses, low cost, small harmonics and can be directly connected to the high voltage line/bus. This paper describes usage of PSCAD for simulating study of 750kV/330MVAR MCR for three phase and single phase excitation and harmonics characteristics. The authors describe performance of the MCR for temperature rise test. Although there is no standard for MCR temperature rise test as yet, the author has provided test results benchmarked with IEC 60076-2 standard oil type transformer temperature rise test for significance.

Paper	TITLE	COUNTRY	CONTENT
D2-02_15	Research on Periodic Oscillation Test Equipment for TCR Thyristor Valves	CN	With the wide adoption of SVCs in power systems, it is important to ensure reliability and stability of their core component- the TCR thyristor valve. This paper presents design circuit of a Simple Periodic Oscillation Test equipment that can be used for carrying out cyclic triggering and blanking test under various test conditions. It also presents results of the tests conducted using this equipment to verify dynamic voltage sharing during the opening and process and shutdown of the valve. Advantages of conducting tests on the valve using this circuit are also listed in the paper.
D2-02_16	On line/Automatic and manual applications of infrared thermography in electrical sector	IN	This paper explains the concept of infrared thermograph and its applications in the areas of remote online/automatic monitoring of critical installations in substations, thermal plants, transmission equipment etc. IR thermal inspection/surveys are more effective for visualizing incipient problems that have not yet surfaced as visual damage. This technology is being adopted by utilities as part of predictive maintenance process and for localising fault locations.
D2-02_17	Cyber Security – Secure communication design for protection and control IEDs in substations	IN	Protection and Control Intelligent Electronic Devices (IEDs) integrate the electrical and automation/operational layers in the energy sector. Implementation of Ethernet based protocols in IEDs and exchange of information over intranet and internet/public networks have brought huge benefits from operational perspective, but have also introduced cyber security concerns. Remote configuration/parameterization, monitoring, remote SCADA communication, remote diagnostics and firmware updates are becoming important requirements for IEDs. It is not sufficient for the product to be secure, its integration points with the infrastructure must also be secure. This paper describes secured IED Communication, Configuration and Monitoring using Secure Socket Layer (SSL) technique.
D2-02_18	Is the stationary lithium-ion battery a good choice for the Telecommunications in an Electric Power Utility?	BR	Batteries are the lifeline of power systems because they are essential to allow uninterrupted operation and inter-communication in the system. This paper describes the efforts led by Eletrobras FURNAS, Brazil jointly with CPqD in exploring newer type of Lithium-ion battery as a possible replacement for the currently used Valve regulated Lead-acid (VRLA) batteries which have several lifecycle management problems. It describes the challenges in designing Lithium ion batteries and how these have been overcome. This type of battery design is now ready for operational validations. The paper further recommends that Lithium ion batteries being highly dependent on electronic battery management systems should be classified as electronic equipment instead of electro-chemical device.

3.2 Questions to the Authors/Presenters

The questions are given below, where paper numbers are mentioned in relation to specific questions, and the author/presenter of the paper should reply to them.

The attendance is also expected to contribute actively, i.e. bring their answers to the question in order to have a constructive discussion in particular question marked with ALL.

Paper: D2-02_01

Q2-1. Please elaborate on what concurrent upgrades are expected in distribution, generation and power market domain systems to leverage the benefit of future Smart Transmission Control Centres.

Paper: D2-02_02

Q2-2. What are the steps recommended by the authors to come out with a Control Reference Architecture for the Smart Grid of the future?

Paper: D2-02_03

Q2-3. How important is security aspect in automated configuration of redundant protection schemes?

Paper: D2-02_04

Q2-4. The authors may like to share actual implementation experiences of IPv6 based AMI/DA solutions.

Paper: D2-02_05

Q2-5. The authors may like to list use cases in the distribution segment other than scheduling/energy accounting where CIM can be used to advantage.

Paper: D2-02_07

Q2-6. How scalable is the model w.r.t no. of consumers, no. of appliances. Can this be applied to distribution grids with size of say 10,000 consumers?

Paper: D2-02_08 (ALL)

Q2-7. Is there a need for training encompassing ET/IT/OT aspects for key persons in utility so as to appreciate needs of interconnected but "secure" operation of various systems? What are the experiences of integrated automated operations of power system protection and IT/OT systems from security viewpoint?

Paper: D2-02_09 (ALL)

Q2-8. Will standardising communication protocols to support constant exchange of information and control commands between external consumers, their appliances and utilities, help prevent security incidents?

Paper: D2-02_11

Q2-9. Can we draw lessons from security handling in the conventional telecommunications domain w.r.t. access and authentication, privacy, integrity, availability etc.?

Paper: D2-02_12 (ALL)

Q2-10. What are the recommendations of the authors for integrated operations of end-consumers/ devices with utility systems – given the current state of cyber security maturity in the domain? Can a security breach occur from a consumer appliance or by consumer?

Paper: D2-02_13

Q2-11. What are the commercialization prospects of NFCLs?

Paper: D2-02_15

Q2-12. What are the considerations for commercialising this test equipment?

Paper: D02-02_16 (ALL)

Q2-13. What are the experiences of incorporating thermal imaging "Sensors" as part of mainstream telemetry equipment?

Paper: D2-02_18 (ALL)

Q2-14. What are the alternative battery technologies available in the industry today – going beyond conventional batteries/auxiliary supplies that can be used efficiently with local renewable generation sources?

4 Preferential Subject no.3

4.1 Overview of Submitted Papers

Hereafter the list of the papers related to Preferential Subject n°3 is to be found as well as a brief summary of the content:

Paper	TITLE	COUNTRY	CONTENT
D2-03_01	Renewable Generation Plant Communications	IN	The Renewable energy potential in India and its exploration is a challenging task with different technological, economical and geographical constraints. One of the biggest issues is the measurement of renewable energy in the integrated grid. The author gives here an overview of the possible technologies and their choices to enable the metering and data communication facilitation in Indian off shore renewable energy generation plants.
D2-03_03	The application of teleprotection systems in cogeneration plants	ES	Cogeneration plants play an increasingly and important role in the supply of electricity. The authors describe some technical issues such as preserving the waveform quality (voltage stability, frequency stability and phase), and detection and management of islands of generation. They give an interesting new concept on how to deal with them.
D2-03_04	Renewable Generation Plant communication	IN	The authors describe the process of integrating the Renewable Generation in the existing power grid and the challenges to achieve it. A framework of interoperable standards for the needed communications is described. Different technologies are suggested to achieve a smooth integration such as Power Line Communications, Wireless LAN (ZigBee), Wireless Wide Area Networks and WiMAX.
D2-03_05	Development of Photovoltaic Power Generation Facility Monitoring System for Decentralized Power Plant Operators	JP	This paper describes a communication system that enables centralized collection and processing of data related to photovoltaic power generation facilities. It incorporates the use of Internet, cloud computing and WEB based services. This makes possible the centralized management and efficient operations, monitoring and maintenance.
D2-03_06	Communication Architectures to Connect Renewable Energy Resources in the Residential Area	KR	In this paper, the author describes several advanced communication architectures that are used for their installations to enable customers to monitor and control the Renewable Energy Resources. This offers a chance for them to decide whether they would consume, store, or even sell the energy from/to those renewable resources. The architecture is based on different ways of communication such as wired lines based on RS485, narrow band and broadband PLC (Power Line Communication) and wireless communications.

Paper	TITLE	COUNTRY	CONTENT
D2-03_07	Renewable generation plant communications	BR	The author describes the use of an interesting new communication technology 'Meshed Network' for utilities in general and specially for supporting Renewable Generation and Smart Grids. The meshed network provides an optimized and secure infrastructure to meet the growth and needs of applications in Power Grid's. It facilitates the inclusions of applications in Renewable Generation Plants to transport voice, SCADA and other data to achieve automation of Smart Grid.
D2-03_09	Renewable Generation – Tariff mechanism for enabling DSM and DR at consumer level	IN	This paper describes an approach to facilitate DSM and DR to compensate for the inopportune availability of these sources through a tariff mechanism that will incentivise using own generation at the time of peak, and thereby helping to ease out the load on the system and peak period purchase cost savings for the utilities and provide a revenue generating option for the consumers.

4.2 Questions to the Authors/Presenters

The questions are given below, where paper numbers are mentioned in relation to specific questions, and the author/presenter of the paper should reply to them.

The attendance is also expected to contribute actively, i.e. bring their answers to the question in order to have a constructive discussion.

Paper: D2-03_01

Q3-1. Question to the authors: One of your suggestions in your case is to use GPRS. Could you give us a qualitative and quantitative comparison with the other communication technologies you have studied? For example: costs, scalability, security and management of the related infrastructure.

Q3-2. Could the audience give their view or better their experience concerning data communication with off shore renewable energy generation farms?

Paper: D2-03_03

Q3-3. In case of cogeneration, how to preserve under diverse circumstances the quality and stability of the grid (i.e. voltage and frequency)? Which Information and Communication facilities do you need to enable it? What are experiences as vendor or as utility?

Q3-4. What are the experiences of the author or audience with Power Plant Island Mode Operation or how would you enable it? Which Information and Communication facilities do you need to realize it?

Q3-5. How would you use modern IP-based technologies to achieve it?

Paper: D2-03_04

Q3-6. Could the authors or audience describe their experience in deploying and using different communication technologies to support Renewable Energies? Where to use which technology? Is it possible to relate them to the costs (CapEx and OpEx)?

Q3-7. What are your challenges concerning the Interoperability of Different Communications Systems? What are your suggestions?

Paper: D2-03_05

Q3-8. Could the authors describe the advantages of use of Cloud Computing (CC) within this project?

Q3-9. Does someone from the authors or audience have practical experiences in deploying and using of CC?

Q3-10. What are the benefits and disadvantages of CC? Could you quantify this?

Q3-11. WEB services are very useful in managing devices en services. How could we deploy and use them securely?

Paper: D02-03_6

Q3-12. Different technologies and approaches are described in many contributions. How could they contribute to motivate the energy consumer to effectively participate in the process of energy management such as reducing peak power demand and integration of renewables?

Q3-13. What could be the role of Cigré SC-D2 in for example standardizing communication protocols? Does the author of audience have some suggestions?

Paper: D02-03_7

Q3-14. What are the expectations of the author and the audience in using Meshed networks to meet to requirements of renewable Generation?

Q3-15. What are the experiences and the challenges concerning the management of those meshed networks, for example scalability and operability?

Q3-16. Which are the expectations related to the achievement of the same level as wired networks?

Paper: D02-03_9

Q3-17. What are your experiences in deploying Tariff Mechanism in encouraging the consumers to generate and consume clean energy through renewables sources? What are your expectations for the future?

Q3-18. When and where is investing in advanced metering infrastructure profitable: rural environments, residential areas, developing counties etc.? How could we reduce those costs?