Special Report - Session 3
OPERATION, CONTROL AND PROTECTION

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Introduction

The interest in Session 3 –like the interest in Cired at all– is still and constantly growing. The –once again– record number of 328 abstracts received for Session 3 underlines this growing interest impressively. Due to the extreme high number of abstracts received for Session 3 Chairman and Rapporteurs had to be –once again– quite strict in rejecting papers in order to keep quality and a manageable number of papers during the conference.

Therefore 173 abstracts were accepted by National Committees and Technical Committee (TC) and the authors were called to submit a full paper. Finally the record number of 162 full papers has been accepted for Session 3. Figure 1 gives an overview of the review process.

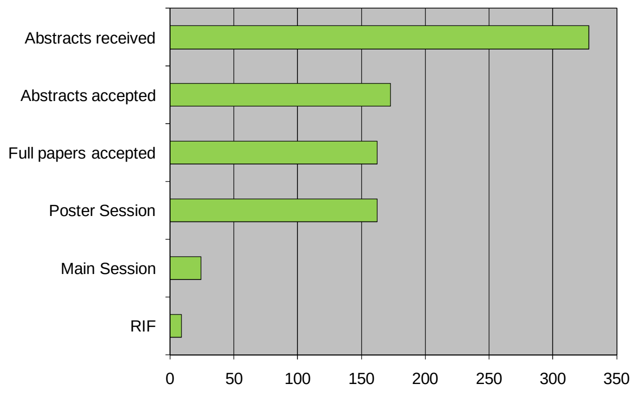

Fig. 1: Overview of the review process

All authors are asked for a poster presentation, 24 of them will additionally present their paper in the Main Session and nine papers are allocated to the Research and Innovation Forums (RIF).

Traditionally and according to the topics of the papers submitted Session 3 is structured into three blocks:

Block 1 Operation

- Distribution Management
- Condition Assessment
- Workforce Management

Block 2 Control

- Communication/IEC 61850
- Distribution Automation
- Distribution Management Systems

Block 3 Protection

- Fault Location
- Neutral Grounding
- Distributed Generation
- Applications
- Phase Measurement Units

In the area of grid **Operation** the subject condition assessment has been established. Once again a lot of papers have been submitted for this topic since it is not solved sufficiently, yet. Nevertheless it is a major problem because most maintenance and renewal strategies are fundamentally based on a correct assessment of the component condition. Another main topic in the field of grid operation is Workforce-Management Systems which have been established in many grid operating companies all over Europe. While papers presented at former Cired-Conferences, described the implementation of these Software-Tools, this time field experiences and further developments are shown.

In the area of grid **Control** two trends can still and clearly be observed: As a first trend more and more automation of

Medium Voltage (MV)-grids or even of Low Voltage (LV)-grids can be considered – these voltage levels are getting smarter and smarter. This comes along with a higher demand on communication and corresponding techniques and infrastructure. The record number of 26 papers related to communication tasks expresses that power grids and communication grids go hand in hand on the distribution level.

The second trend observed is, that SCADA-Systems are getting more and more powerful and develop towards integrated Distribution Management Systems (DMS). These systems can handle much larger grids than in the past and additionally offer a lot of assistance functions for the employees in the control centres. These functions are needed pretty much, since with distribution grids getting smarter and smarter, overseeing and controlling them becomes more difficult.

The main focus of **Protection** is one more time the location of several types of faults and neutral grounding. The trend due to Distributed Generation and Smart Grid is still a challenge for protection technology and new functions. Another upcoming issue is the stability of grids. Because of high capacity utilisation and some blackouts in the past Phase Measurement Units are important instruments to estimate grid stability. Applications and practical tests are very interesting and most important to support new protection devices and systems.

An overview of the number of papers related to the different blocks and sub blocks is given in Figure 2.

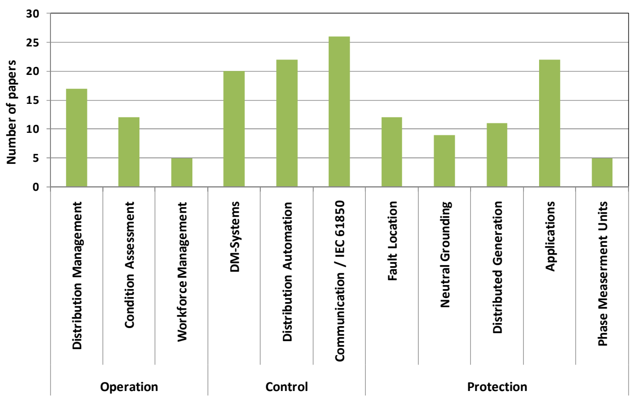

Fig. 2: Overview of the accepted papers

The majority of papers is prepared by groups of authors. In some cases these groups are composed of authors from different countries and even continents. The authors are from grid operating companies, vendors, universities and other research associations. Therefore, Session 3 of Cired 2011 truly reflects the 'state of art' of the grid operation community in case of Operation, Control and Protection.

<u>Operation</u>

Distribution Management

This sub-block covers several quite different themes and tasks related to grid operation.

Two interesting papers from Portugal (561) and Finland (890) discuss grid operation in crisis situations like under extreme weather conditions, when dozen's of MV-circuits fail during a few hours. Figure 3 shows the number of simultaneous failed MV-circuit during a storm that hided the Lisboan area in December 2009.

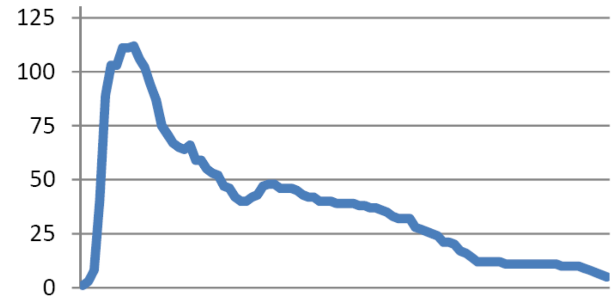

Fig. 3: Number of simultaneous outages of MV-circuits in the area of Lisbon (x-axis: 23th to 26th of December)

Three papers (844 and 1275 from Germany, 1308 from U.K.) discuss the new requirements for more and more dispersed generation connected to MV- or LV-grids and their necessary contribution to assure a constant grid frequency. Paper1275 handles the problem of more and more photovoltaic (PV) generation feeding into German LV-grids. Figure 4 shows the PV injection on a sunny summer day in Germany. The peak injection of more than 8 GW cannot be neglected anymore since this is more or less 10% of the German peak load (about 80 GW). The risk of a major disturbance in case of an over frequency event is explained in the paper. The solutions which have been found for the High Voltage (HV)- and MV-levels are discussed and differences to the LV-grid are shown in order to explain the proposed modifications.

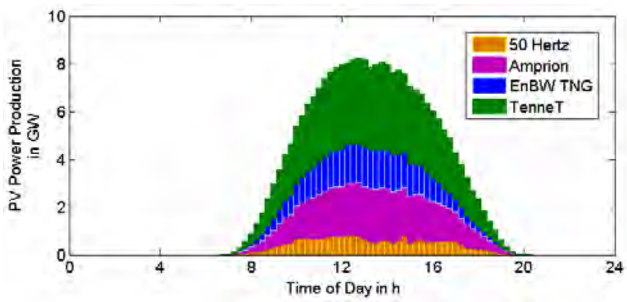

Fig. 4: German PV-injection on the 6th of September (for the four transmission grid operators)

Five papers deal with really operational tasks: Two Brazilian papers (525 and 653) discuss an environmental risk assessment system respectively operation of MV-grids when the neutral conductor is simply stolen. Paper 666 from Pakistan enhances common temperature rise prediction methods for transformers by adding the influence of relative environmental humidity. In Paper 1010 (Ireland) the capability of operational load shift from one to another substation is investigated. Paper 238 (Argentina) shows how the implementation of automatic reclosers optimizes the operational effort of HV/MV-substations.

Three papers concentrate on operational tasks of LV-grids. Paper 792 presents the monitoring results of several Australian LV-grids where the LV-system is getting more and more unbalanced, Paper 892 (Finland) discusses start up problems of LV-DC-grids. In Paper 473 (Italy) metering data is used in order to carry out advanced analyses of the LV-grid.

Paper 316 from Belgium as well as Paper 575 from Poland present smart grid pilot projects and their impact on distribution grid operation. Paper 1144 (U.K.) deals with innovative modelling techniques for the correct state estimation of MV-grids, showing a case study of the 33-kV-grid of the British Orkney Islands. Paper 99 from Turkey presents new algorithms to speed up the re-supply process after an interruption.

Finally an interesting paper from Austria (570) presents a study on islanding operation of the distribution grid in Carinthia. Practical measurements are successfully compared to the developed dynamic simulation model.

Condition assessment

The problem to determine the condition of the grid components correctly is getting more and more into the focus of grid operating companies. The condition assessment is the basis for all maintenance-strategies, whether they are condition based (CBM), reliability centred (RCM) or risk based (RBM). Therefore more and more effort is spent in the field, in order to use the limited maintenance budgets most efficiently.

Six papers of this sub-block deal with the condition assessment of MV-overhead lines. Papers 230 and 1115 (Switzerland) present a testing method for wooden poles, while in Paper 624 from Iran thermography is used to identify hot spots caused by bad contacts (see Figure 5).

Fig. 5: Bad contact (CO1) on an overhead line connection identified by thermography

Paper 274 from China presents another method to identify bad contacts focusing on fuses used in MV-overhead lines.

Papers 572 (Brazil) and 1136 (Malaysia) suggest different methods to identify defect or hidden insulators.

Two papers deal with the condition assessment of cables: Paper 373 from Canada presents a method to inject air with high pressure into LV-cables in order to find leeks in the insulation, while Paper 282 (China) suggests an oscillating wave test to identify bad XLPE-insulated MV-cables. For more condition assessment of cables see Session 1.

Distribution grid transformers are discussed in Paper 457 (Germany) and Paper 764, where a grid operating company from Indonesian presents a method to assess the condition of the transformer insulation system combining the results of electrical, chemical and physical tests.

Finally two papers discuss what should follow the right condition assessment. Paper 696 from Norway presents a condition based method to identify the most useful or necessary maintenance-projects in order to assure and optimal usage of the limited maintenance budget. Paper 903 from China combines several maintenance strategies with their different pros and cons to a new optimal strategy.

Workforce Management

In order to optimize grid operation processes and thus to increase the efficiency of grid operating companies Workforce-Management (WFM) Systems are getting more and more into focus. The papers assigned to this block discuss the technical problems to be solved as well as the organizational changes to be made when introducing such systems successfully.

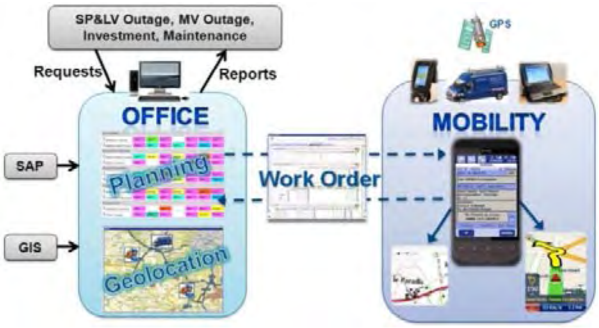

Fig. 6: Components of a WFM-System

Three papers describe concrete implementation projects: Paper 402 (France) is about the WFM-System pilot project of EDF, while Paper 809 describes an Austrian implementation. Figure 6 gives an overview of the components commonly included, while Figure 7 shows a typical dispatching board of such systems.

Paper 776 from Korea presents a combined WFM- and Grid Information-System established not only to optimize grid operation processes, but to support planning and construction processes, too.

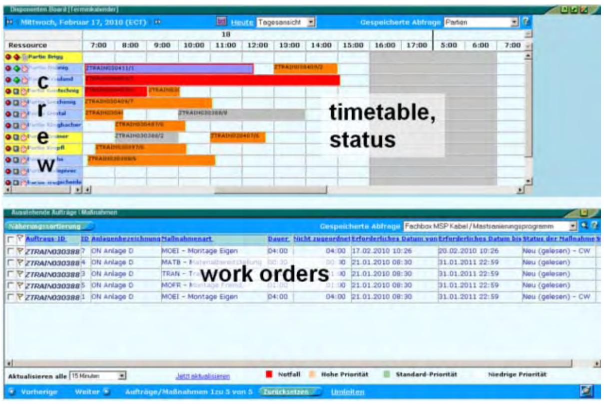

Fig. 7: Board for scheduling and dispatching of work orders

Two papers (362 from Germany and 457 from Italy) come from grid operating companies that have introduced WFM-Systems some years ago and therefore have gained a lot of experience in the meantime. The companies now try to improve the running systems with optimization algorithms to do more and more of the dispatching automatically. Both papers present different optimization algorithms and strategies to increase the performance of the dispatching process compared to manual dispatching.

Potential scope of discussion

– Condition assessment of grid components: Why is it so difficult to solve the problem? Is there a general solution trend? How about the ageing phenomenon?

– WFM-systems: Are they well introduced in the companies or are they still an experiment? How do they affect the whole processes of a grid operation company?

– Maintenance strategies: To simple or to sophisticated? How to manage the balance between data collection afford and benefits?

Table 1: Papers of Block 1 Operation assigned to Session 3

Paper No.	Title	MS a.m.	MS p.m.	RIF	PS
No. 99	Service restoration in distribution systems using an evolutionary algorithm			X	X
No. 230	New wooden poles grading: LUXPOLE				X
No. 238	Use of Reclosers in Substations 132/33/13,2 kV				X
No. 282	Study on 10kV XLPE Cable with Defects Based on Oscillating Wave Test System			X	X
No. 316	Smart grid technologies feasibility study: Increasing decentralised generation power injection using global active network management				X
No. 362	Multi-criteria Optimization in Workforce Management				X
No. 373	Verification of LV Underground Cable Insulation by Air Injection	X			X
No. 402	Smart and wireless field force management : today and tomorrow	X			X
No. 457	On-line condition monitoring and expert system for power transformers - Integration into protection and control system by using of IEC61850				X
No. 458	Scheduling and Assignment Optimisation				X
No. 473	WEB access to Metering data for advanced network analysis and fraud detection				X
No. 525	Alternative Solutions to Mitigate Problems due to Neutral Conductor Theft in MV Power Distribution Systems				X
No. 561	Utilities response to extreme condition events - EDP Distribuição Case	X			X
No. 570	Evaluation of Islanded Grid Operation Tests and Dynamic Modelling	X			X
No. 572	The Use of Artificial Neural Networks for Identification and Location of Defective Insulators in Power Lines through Current Transformers			X	X
No. 574	Using auxiliary contact for the disposition of drop-out fuse faults - A new rescue measures to shorten the restoration time and increase the power supply reliability in fault rescue				X

Paper No. Title		MS a.m.	MS p.m.	RIF	PS
No. 575	Towards advanced system operations: searching for solutions in Northern Poland				X
No. 624	Reducing Operation Costs and Losses Using Thermography				X
No. 653	Environmental risk assessment in substations				X
No. 666	Environmental Effect on Temperature Rise of Transformer				X
No. 696	Finding maintenance project to priority	X			X
No. 764	Condition assessment method for transformer insulation system in order to maintain its efficiency				X
No. 766	Electricity Facility Operation Monitoring System Using WEB-GIS	X			X
No. 792	Transformation of Energy Networks: Initial results from intensified MV and LV monitoring				X
No. 809	Introduction of a fully integrated Workforce Management				X
No. 890	Major Disturbances - Development of Preparedness in Finland during the Last Decade				X
No. 892	Start-up of the LVDC Distribution Network				X
No. 903	A Combined Maintenance Method for Complicated Conditions				X
No. 1010	Analysis of the offloading capability of a primary substation in an open radial distribution network.				X
No. 1115	Wood poles non-destructive inspections; the German example				X
No. 1136	Managing Transient Interruptions on Aged 22kV Overhead Lines in TNB Distribution Network Through Engineering Practices Assessment and Insulation Coordination Guidelines				X
No. 1144	Improving State Estimation Accuracy for Active Network Management Using Advanced Modelling Techniques				X
No. 1275	Improved Requirements for the Connection to the Low Voltage Grid			X	X
No. 1308	The impact of a high penetration of LV connected micro-generation on the wider system performance during severe low frequency events				X

Control

Communication/IEC61850

The record number of 26 papers related to this sub-block shows that communication tasks are getting more important for the control and automation of distribution-grids. Latest with the implementation of control intelligence in the MV-level, these grids need associated communication infrastructure. Grids like the one shown in Figure 8 (paper 1169 from U.S.) with a large amount of dispersed generation, storage units etc. cannot be controlled without adequate communication structure anymore. But although a lot of projects are making progress in this field, there is still an ongoing struggle for the most adequate way to communicate. Many different solutions are proposed in the papers of this sub-block.

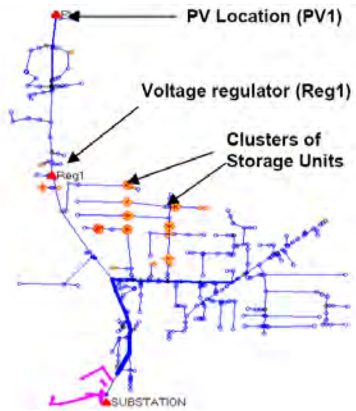

Fig. 8: Complex MV-grids need communication infrastructure

Four papers investigate and promote specific communication modes. Paper 870 from Spain suggests powerline communication as the best way to automate MV-grids, while Paper 29 (Germany) underlines the advantages of Professional Mobile Radio (PMR) – especially more security and better efficiency of the communication – and how it can improve the quality of supply. Paper 471 (Italy) and Paper 1138 (Spain) prefer broadband wireless communication.

But most of the practical implementations use several and different communication modes. Paper 1323 gives an overview of the communication requirements of smart grids to satisfy all present and future stakeholders shown in Figure 9.

Papers 504, 541, 568, 895, 1153 and 1284 present communication architecture and infrastructure concepts, solutions or pilot projects for different distribution grid voltage-levels in Portugal, Germany, Iran, Finland, Switzerland and the U.S..

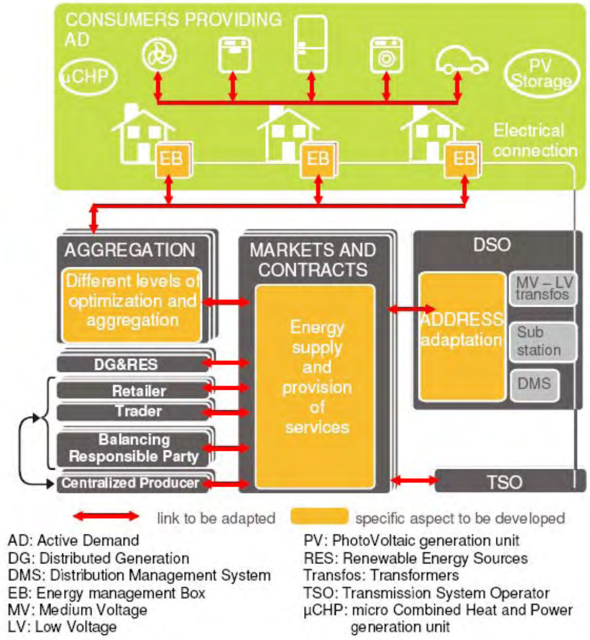

Fig. 9: Communication structure and stakeholders in a smart environment

A complete solution for the telecontrol of medium voltage transformer-substations is described in Paper 568. TETRA (Terrestrial Trunked Radio)-network or an existing regional telecommunication cable network using DSL technology is used as communication method. The widespread use of the described technical solution throughout the distribution grids in Berlin and Hamburg began in 2009. Practical experience gained from the installation, commissioning and operation of the solution is illustrated.

Figure 10 and Figure 11 show two more typical modern communication architectures, combining central and local communication systems.

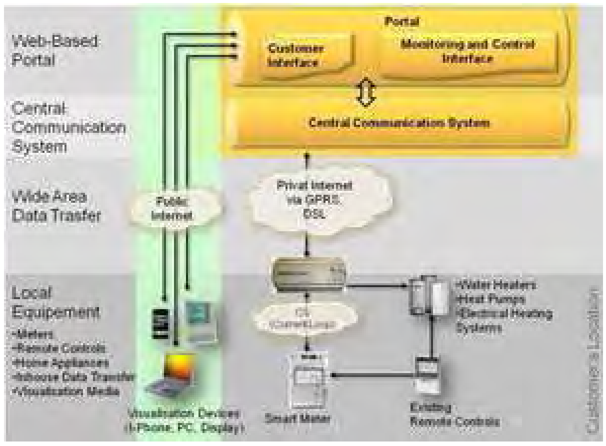

Fig. 10: Modern communication architecture for distribution grids (paper 1153)

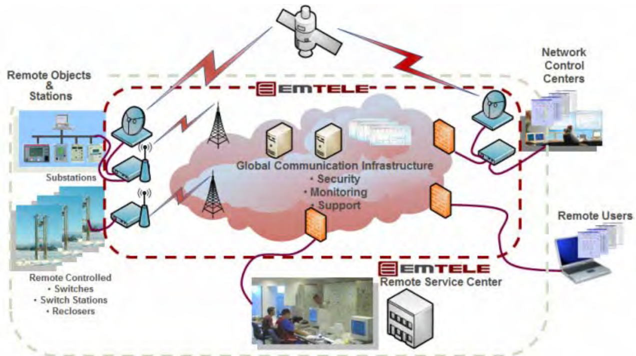

Fig. 11: Modern communication architecture for distribution grids (paper 895)

Paper 988 (Germany) presents a central data warehouse and promises a seamless communication and data management over all levels of the power system. Figure 12 shows the configuration and various enterprises to be served by the database. One problem of these central data bases providing all kind of grid and customer information is to assure the unbundling conformity of the system.

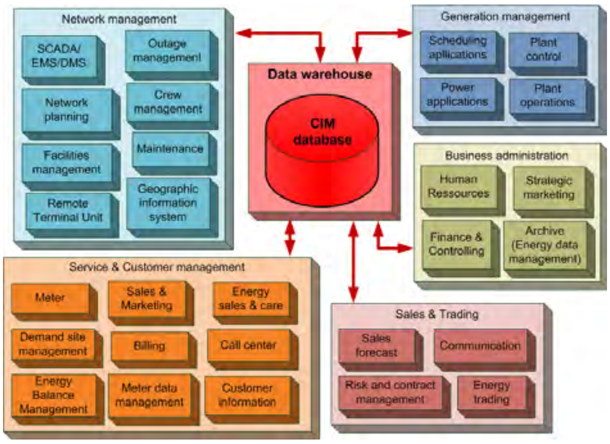

Fig. 12: Data warehouse for several IT-applications

Beside the "right" communication for smart grids, the second main key word of this sub-block is the communication standard 61850 (eleven papers at all). Even several years after implementation there are still discussions about the pros and cons of this standard, although it is widely used in the meantime –at least in various pilot projects. Practical applications of the standard are given in Paper 12 (the Netherlands), Paper 138 (France), Paper 162 (Spain), Paper 257 (Korea), Paper 422 (Spain), Paper 472 (U.S.) Paper 871 (Portugal) and Paper 1322 (Spain).

In Paper 689 from the Netherlands a graphical method to support the engineering process for substation automation according to the standard IEC 61850 is presented. Paper 790 states that the current version of standard IEC 61850 – originally developed for substation automation systems– cannot fulfil the additional requirements of modern smart grids. This paper studies the engineering process specified in Part 6 of IEC 61850 and proposes extensions to better support smart grid installations.

Paper 794 compares IEC 61850 edition 1 and edition 2, explains the differences of the editions and presents how compatibility can be achieved in practical use cases.

Finally Paper 538 (U.S.) deals with the communication standard IEC 61968 and the efforts of harmonization in this field.

Distribution Automation

Most papers of this sub-block deal with the automation of MV-grids. Depending on the country and even on the company the automation level differs pretty much. While the majority of MV-grids is still operated without any automation, the lowest level of automation is to transmit the signals of fault passage indicators to the control centre in order to locate the failure more quickly and exactly (Paper 245, France). In the next automation level more or less remote controlled switches (Paper 622, Finland) or similar devices like reclosers (Paper 482, Germany) are implemented in the MV-grid. Paper 941 (Finland) and Paper 524 (Argentina) report on the benefits in MV-grid control, when more and more MV/LV substations are equipped the monitoring and communication devices.

The final automation level is reached with the so called "self healing grids" where fault detection, fault clearance and re-supply of customers are done automatically without manual switching. All four papers deal with more or less self healing MV-grids: Two papers (Paper 133 from Canada and Paper 156 from China) present a self healing configuration to operate closed MV-loops. Figure 13 shows the operation principal. In case of a fault the related section is switched of and the customers are re-supplied automatically without a significant interruption of supply.

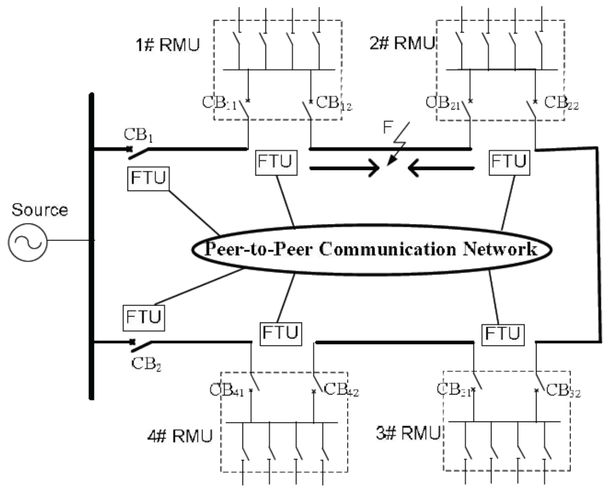

Fig. 13: Self-healing concept for MV-grids operated with closed loops

Paper 508 from Portugal suggest a combination of decentralized, self healing MV-grids and overall control by the control centre. Paper 235 from Indonesia shows the improvement of the reliability of supply in over headline grids due to self healing strategies.

Paper 1117 (Germany) gives a good overview of possible MV-grid automation levels -one of them shown in Figure 14- and the way they influence the reliability indices, while Paper 366 describes different possible automation technologies.

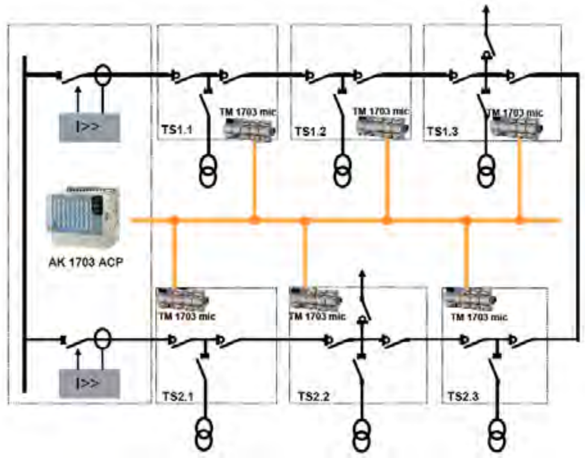

Fig. 14: Example for the automation of MV-grids

Figure 15 as an example shows the "System Average Interruption Frequency (SAIFI)" for several automation concepts, so costs and benefits can be weighted to find the optimal automation level.

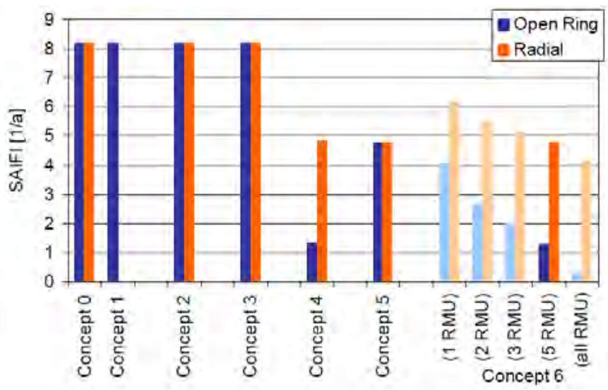

Fig. 15: SAIFI for different levels of automation

Three papers (Paper 249 from Portugal, Paper 463 from Italy and Paper 811 from Denmark) show the state of the art and coming developments in MV-grid automation in their companies or countries. An interesting aspect of the Danish paper is that automatic switching is not only used in case of a failure, but to avoid overload during normal grid operation, too (see Figure 16).

Three papers deal with the fact of voltage regulation and overload control getting more and more complicated in MV-grid with a high degree of decentralized power injection. Paper 209 from France presents a field experiment to get a real time view on the actual power system status (voltage amplitudes, reactive power etc.), Paper 1107 (Serbia) and Paper 830 (Japan) provide different methods for voltage regulation according to the actual situation of the MV-grid.

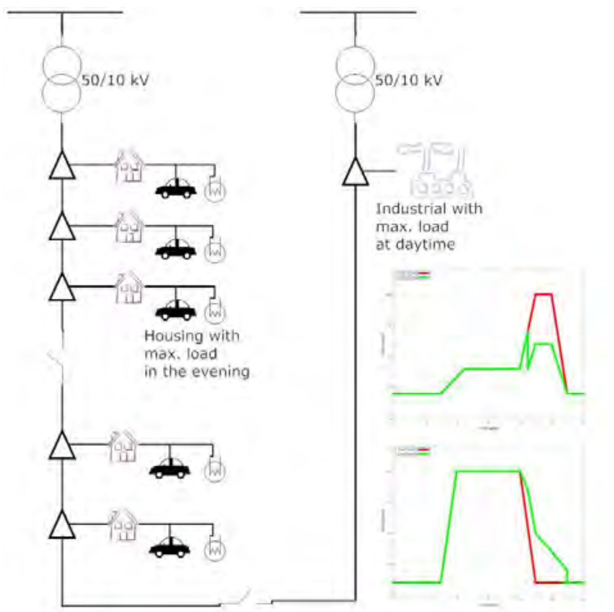

Fig. 16: Automatic switching in the grid based on load situation

Finally beside the automation of MV-grids even the automation of LV-grids is getting more and more into focus, since the decentralized injection of power –mainly by PV-power stations– has reached this voltage level, too. At all four papers deal with this task. Three papers (Paper 893 and Paper 1050 both from Finland, Paper 1094 from France) use the information provided by smart meters for the automation of LV-grids, while Paper 396 promises "intelligence for the last mile" of modern distribution grid structures as given in Figure 17.

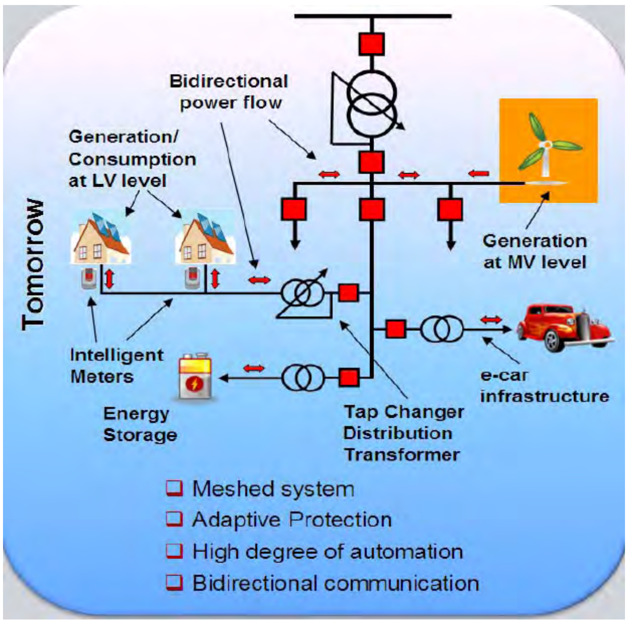

Fig. 17: Upcoming MV/LV-distribution grids

Distribution Management Systems

The papers in this sub-block deal with the ongoing development of former SCADA-Systems simply to monitor the grid towards powerful Distribution Management Systems (DM-System). Those modern DM-Systems provide much more functionality and support tools to control complex distribution grids more efficiently.

Several papers describe the ongoing development of DM-Systems: Paper 221 and 1185 present the new DM-Systems of a Korean respectively a Canadian grid operator, while Paper 358 (Austria) shows the difference between former and modern control centres architecture (compare Figure 18) and functionality quite impressively.

Fig. 18: Former and modern control centre in Carinthia

Paper 741 (Indonesia) presents a fault recovery diagram (see Figure 19) as new and helpful feature in the control centre to re-supply customers most quickly, while in Paper 281 (Russia) and in Paper 573 (China) a load monitor system is implemented for the same purpose. Paper 74 (Egypt) enhances the existing DM-System to support maintenance decisions. In Paper 976 (China) the existing Graphical Information System (GIS) is developed towards a DM-System to automat MV-grids.

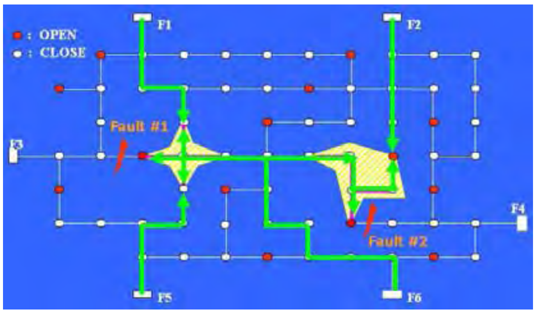

Fig. 19: Fault recovery diagram

Two Papers describe the challenges for DM-Systems coming along with distribution grids getting smarter and smarter and offer new features to overcome the rising problems. Paper 709 (United Kingdom) describes the way how smart grid initiatives change and complicate the role of grid control, while Paper 716 from the U.S. promises at least a partly solution for the problem of "the next generation DM-Systems" for enhanced utility operational capabilities and end-use consumer satisfaction. One feature is a geographical overview of customer status and crew position data as shown in Figure 20.

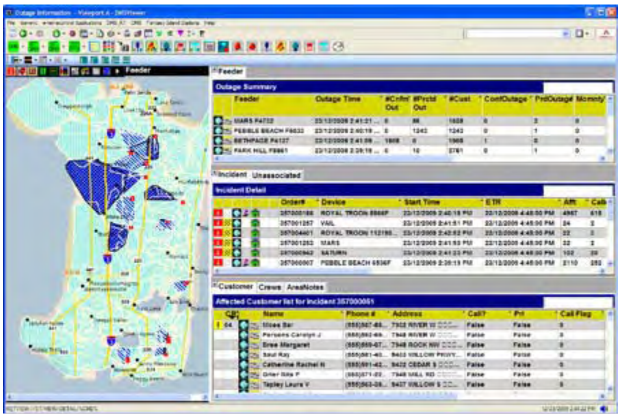

Figure 20: Geographical overview of customer and crew data

Paper 956 (Germany) and Paper 740 from Japan both present back-up systems designed to control very large distribution grids with several different control centres. In case of an outage of the primary control centre the operation responsibility for the assigned grid area is the shifted to a neighbouring control centre. Furthermore the configurations allow temporary shifting of the operation responsibility between control centres during crisis situations in order to avoid overloading of the staff.

Two papers handle the issue how to control power grids with more and more distributed generation. Paper 1159 (Italy) presents a specification for the DM-Systems needed. Due to the high penetration with wind farms the capacities borders of many MV- and HV-grids in Germany have been reach during the last years. In case of strong wind and low load these distribution networks are getting more and more overloaded. This critical situation can be mastered by reduction of feeding power only. Paper 332 describes the DM-System of one of the largest distribution grid operating companies in East Germany and reports on operational experiences over five years. Figure 21 shows the different information channels for collection and distribution of all necessary data.

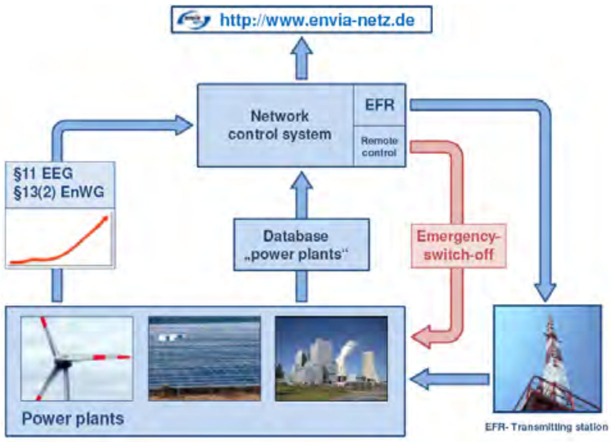

Fig. 21: Information channels in a DM-System (paper 332)

The fact that DM-Systems are getting larger and larger and more powerful comes along with the increasing danger of a serious cyber attack on those systems. Three papers (Paper

440 from Italy, Paper 685 from Portugal and Paper 685 from Germany) deal with security standards for designing, implementing, running and managing control and communication systems in grid operating companies. Furthermore they present actual cyber intrusions in control systems of distribution grids.

Two papers deal with the data needed two feed modern, powerful DM-Systems. While Paper 1022 (Portugal) presents a data model for recent DM-Systems, Paper 466 from Spain proposes an algorithm to detect and correct bad measurement data.

Finally Paper 211 (Germany) describes a novel training simulator configured especially for control centres of distribution grids. A key module of the new simulator is a reliable and field-proven power flow which is identical to the real-time version.

Potential scope of discussion

- SCADA-systems are getting larger and larger and more complicated. Is there a natural dead end for the systems and their operators?
- More MV- and even LV-automation means more secondary equipment to be maintained in the grids. Are the pros and cons really balanced?
- How much and which kind of communication is required by smart grids?
- Are cyber attacks on SCADA-systems an actual danger or just a hip subject?

Table 2: Papers of <u>Block 2 Control</u> assigned to Session 3

	Paper No. Title	MS a.m.	MS p.m.	RIF	PS
No. 12	From Smart Substations to Smart Grid - How IEC 61850 can help making power systems smart				X
No. 29	More Security, better Efficiency and Value Creation for the Electricity Distribution Industry - how Professional Mobile Radio can help				X
No. 74	SCADA Enhancement for Effective Rehabilitation Strategy of MV Cables using Artificial Neural Networks				X
No. 133	Parallel Feeder Operation Scheme Based on Distributed Automation Logic				X
No. 138	Toward an Auto-Configuration Process Leveraging The IEC 61850 Standard				X
No. 156	Development and Implementation of MV-circuit Self-healing System Based on Distributed Intelligences				X
No. 162	IEC61850 9-2 Process Bus: Operational Experiences in a Real Environment				X
No. 209	Methodology and Results of a Field Experiment of Distribution State Estimation in the French Network				X
No. 211	Operator Training Simulator for a Distribution System		X		X
No. 221	Development of Smart Distribution Management System for Predictive Operation of Power Distribution Systems				X
No. 235	Overhead line reliability indices improvement using Self-feeder automation				X
No. 245	Auto-adaptive Fault Passage Indicator with remote communication improves network availability				X
No. 249	EDP Distribution Automation (r)Evolution	X			X
No. 257	A Study on the Application Method of IEC 61850 for Data Acquisition and Exchange in Smart Distribution Environment				X
No. 281	Loading Mode Control System in a Distributed Generation				X
No. 332	Grid security management - Basis for secure operation of the distribution grid of ENVIAM		X		X
No. 358	Evolutions in the grid operation in Carinthia		X		X
No. 366	Fault Detection Isolation and Restoration on the feeder (FDIR):Pick your technology				X
No. 396	Intelligence for Smart Grids last Mile				X

	Paper No. Title	MS a.m.	MS p.m.	RIF	PS
No. 422	Minimum common IEC 61850 specification document published by the Spanish group of electricity companies ‘E3 Group on IEC 61850'	X			X
No. 440	Experimental Evaluation of Cyber Intrusions into Highly Critical Power Control Systems		X		X
No. 463	Upgrade of ENEL MV network automation to improve performances in presence of faults and to deal DG				X
No. 466	Bad data detection and identification in distribution power systems by means of principal component analysis				X
No. 471	Broadband wireless connectivity in automation and remote control of the DSO infrastructure	X			X
No. 472	Benefits of converting conventional instrument transformer data into Smart Grid capable process data utilizing IEC 61850 Merging Units				X
No. 482	Network Automation with reclosers as new components for European distribution systems				X
No. 504	Substation Automation Systems Current Challenges and Future Requirements - The InPACT Project Perspective				X
No. 508	Preventive assessment for combined control centre and substation-centric self-healing strategies				X
No. 524	Impact of telesupervision in substations M.V/L.V.				X
No. 538	IEC 61968 - MultiSpeak® Harmonization				X
No. 541	A survey on information and communication technology (ICT) applications in distribution systems				X
No. 568	Design and implementation of an innovative telecontrol system in the Vattenfall medium-voltage distribution grid	X			X
No. 573	State estimation and auxiliary fault analysis of distribution network by the load monitor system				X
No. 622	Towards self healing power distribution by means of the zone concept		X		X
No. 625	Smart Grid Cyber Security Roadmap				X
No. 685	IT Network Security for Control and Communication Systems in the Power Industry				X
No. 689	Graphical specification for IEC 61850 based substation automation systems				X
No. 709	Distribution Control Rooms Preparing for Smart Grid Complexity				X
No. 716	Enhanced Consumer and Grid Management through Integrated Distribution Management Systems (IDMS)				X
No. 740	Development of Distribution Automation System that attempts the functional enhancement by the system cooperation				X
No. 741	Intelligent Distribution Automation System Implementation Towards Modern Utility Management				X
No. 790	A Plug & Play concept for IEC 61850 in a Smart Grid				X
No. 794	Compatibility of IEC61850 edition 1 and edition 2 implementations				X
No. 811	Automation in cable distribution network (10 kV)		X		X
No. 830	Development of Voltage Regulation Method including Power Factor Control by Customers in Autonomous Demand Area Power System				X
No. 834	Integration of MV/LV substation systems and functionalities using unified telecommunication concept				X
No. 844	Introduction of system service mechanisms for DNOs				X
No. 870	Comparison of coupling methods in MV equipment for powerline communications				X
No. 871	Configuring a IEC 61850 based standard Automation System for a standard Distribution Substation				X

	Paper No. Title	MS a.m.	MS p.m.	RIF	PS
No. 893	Integration of AMM functionality into operating systems of electricity distribution company for LV network fault management				X
No. 895	Principles of renewing of field communication network of electricity distribution company				X
No. 941	Secondary Substation Monitoring and Control - Practical Benefits through Intelligent Components and Systems				X
No. 956	Multi-Site control centers for more reliable distribution management				X
No. 976	Construction and Operation of Distribution Automation System based on GIS				X
No. 988	Seamless data communication and management over all levels of the power system				X
No. 1022	Dynamic SCADA/DMS data model - Plug & Play Smart Grid solutions				X
No. 1050	Utilizing Smart Meters in LV Network Management				X
No. 1094	Using AMI for Network Monitoring and Control : new equipment as a step towards a Smart Grid implementation				X
No. 1107	Software for automatic voltage regulation implemented in remote terminal unit				X
No. 1117	Distribution automation solutions - Impact on system availability in distribution networks	X			X
No. 1138	Considerations when Deploying Multiple Distribution Automation Applications on a Single Wireless Infrastructure				X
No. 1153	Communication Network for Swiss Smart Grid Pilot Project	X			X
No. 1159	Functional specification of the DSO SCADA system to monitor and control active distribution grids				X
No. 1169	Hybrid Simulation of Power Distribution and Communications Networks				X
No. 1185	Advanced Distribution Management System in BC Hydro's Distribution Network				X
No. 1284	Developing a Distributed Intelligence Architecture for Smart Grids				X
No. 1322	IEC 61850 GOOSE over WiMAX for Fast Isolation and Restoration of Faults in Distribution Networks				X
No. 1323	Communications Requirements for Smart Grids				X

Protection

Fault Location

Most of the fault location functions described here are concerned with single phase earth faults and high impedance faults.
In Paper 84, coming from China, the research on single phase ground fault locating system in a 10 kV grid of Shanghai (grounded with Peterson coil) is shown. Newly developed fault indicators including a power supply and communication unit can be mounted on an overhead line as shown in Figure 22. With wireless communication to a master station the fault indicators can be integrated in a monitoring system.

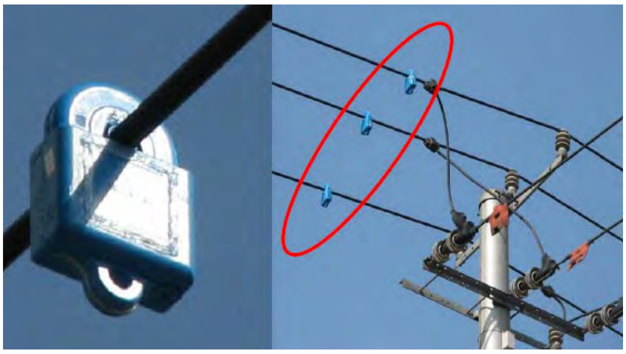

Fig. 22: Picture of fault indicators

How to detect low current arc faults in low voltage switchgear and networks is described in Paper 181, coming from Germany. More than one characteristic must be used for a safe and reliable detection of a real serial and parallel low current arc fault. To analyse the frequency spectrum is one possibility to find characteristics.

In Paper 272 (Belgium) a procedure to describe high impedance faults (HIFs) in solid grounded networks is presented. At first, it is necessary to describe the present situation to understand the difficulties for the detection. The simulation of HIFs, laboratory tests and real fault recordings are used to obtain a HIF database. The objective is to identify patterns of the typical HIF currents and to find techniques able to recognize them.

The evolution of the fault locator on MV distribution networks is shown in Paper 507 from Italy. Beginning with the first generation of fault passage indicators (FPI), which where battery supplied, several FPIs up to the fourth generation (Figure 23) are described. At the present moment some thousands of FPIs are installed and in operation, both in Italy and Rumania.

Fig. 23: Two different prototypes of integrated voltage and current sensors

The directional detection of re-striking earth faults in compensated networks is one of the most difficult tasks in the area of protection systems. In Paper 612 from Germany, the theoretical background of re-striking earth faults is introduced. Different methods to detect and signalize earth faults in networks with parallel lines and in mashed networks are used.

In Paper 644, coming from Thailand, a new detection system for broken conductors in radial MV network is visualised and described. Different methods are analysed and tested on a fault simulation. The novel introductory system with the time shifting principle can be applied to protect the distribution system.

A GPRS based fault locator system is presented in Paper 765, coming from Iran. Fault indicators use the GSM/GPRS communication to transmit information to a central server. Using a graphical interface the fault location is shown on the screen. This system has significant results in reducing the average outage time.

In Paper 793 and Paper 800 from Finland, a practical application based on novel neutral admittance shows an earth fault protection function. The theoretical description, an example of a protection scheme and the computer simulation are parts of this paper. The results of field tests in a centrally compensated HV/MV-substation match with the results of the computer simulation quite closely. Results are shown in Figure 24.

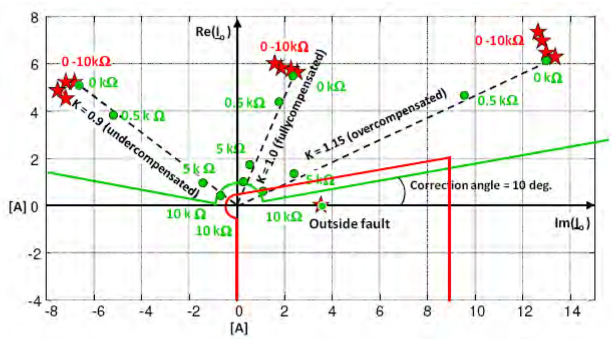

Fig. 24: Performance comparison based on field test data

“Fault location in Portuguese MV Network” is the title of Paper 848 from Portugal. Protection units are sending fault

impedance information to the SCADA system. The DPlan software determines the possible fault location on a map.
With this system the interruption time in case of a fault can be reduced.
In Paper 849, coming from China, a novel method of fault diagnostics of power systems is presented. The proposed method uses both the switching status data and the continuous time data. Testing results show that this method could work well in power systems.
Another kind of earth fault distance localization is shown in Paper 915 from Austria. A modified fault distance calculation algorithm was implemented into three distance relays from different manufactures. Field tests (Figure 25) under normal operation conditions and under earth fault tests where realized.

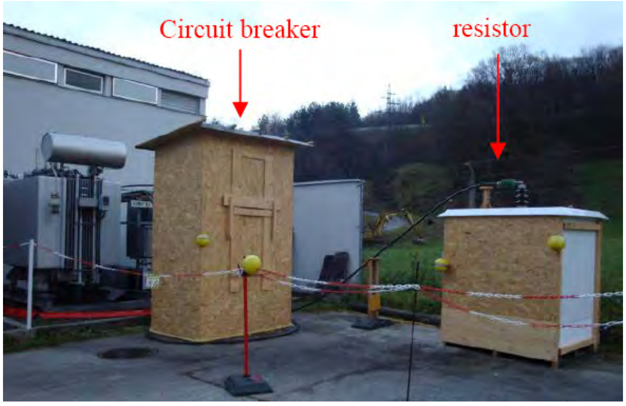

Fig. 25: Circuit breaker and additional resistor in the neutral of the test grid (both in housing)

Paper 1320 from Brazil presents a high impedance fault detection and localization method in distribution systems. Field tests were performed to collect HIF data to assist the development of HIF modelling and database building. HIF tests on seven different kinds of contact surfaces. Figure 26 depicts a staged HIF on dry grass.

Fig. 26: Staged HIF on dry grass

Neutral Grounding

The tuning of the Petersen coil in resonance earthed MV networks is a critical issue for system performance. In Paper 283 from Sweden, optimal tuning is proved in a downsized laboratory for distribution networks. Both the maximum neutral point voltage and the minimal fault current are needed to get an optimized tuning of the Petersen coil.

Temporary Overvoltages (TOV) in MV networks should be reduced, and the phase to earth fault selection becomes easier. Paper 511 from Italy dealt with TOVs following phase to earth faults in an extended, mixed cable – overhead line in radial MV networks. Both, theoretical investigations and practical tests (MV network of ENEL) show that improvements are possible.
One more time, Paper 559, coming from China, analyzes the problem of single phase to ground fault in resonant grounded systems.. The widely adopted method of zero sequence current incremental quantity is described. Field tests show that adaptive algorithm can improve the accuracy rate of fault line selection.

In Paper 560 from Spain, experimental validation results of an active grounding system for MV networks are shown. The experiences of the first real application in a MV network (conducted in Gernika – Spain) are supplemented by laboratory testing data and field details. The active grounding system allows operating MV networks with permanent faults in a safe way.

To model the network very easily and near it to its real behaviour in real time, the use of a Real Time Digital Simulator (RTDS) is shown in Paper 607 from Germany. Using a RTDS, the whole control and protection system is checked, not only the algorithm. Figure 28 shows a complete testing system with an earth fault detection system and the RTDS.

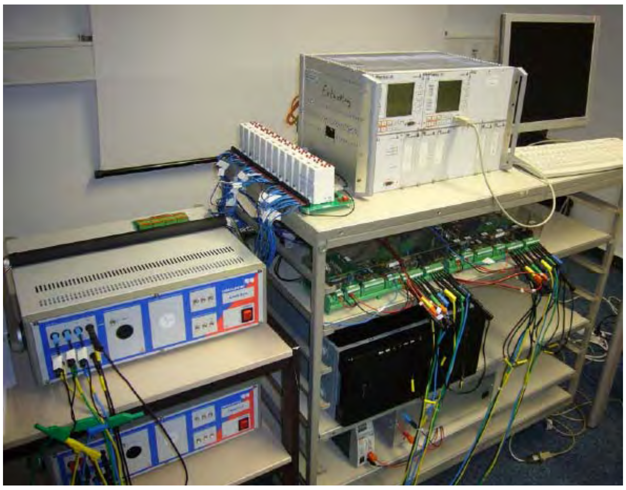

Fig. 28: EDCSys with 2 Current infection controllers and the RTDS with power amplifiers

Paper 853 from Portugal describes the reasons for changing the neutral grounding practices in Portugal (EDP). The result of the comparison between isolated neutral and neutral reactors shows, that the interruption time and the number of network incidents can be reduced. Changing the neutral grounding from isolated to reactor grounding, the quality of service can be improved.

To improve the quality of supply in Finnish MV network modern single pole controlled shunt circuit breakers (SCB) are required, adopting the phase earthing (PE) method. Paper 929 from Finland describes the development of the modern PE system to reduce the harmful short interruptions in MV systems. The SCB and its control system were tested (shown in Figure 29) and also carried out in real networks.

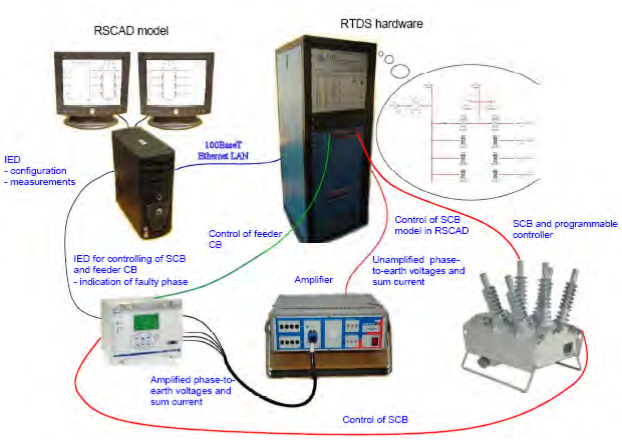

Fig. 29: Connections of RTDS hardware, RSCAD model, SCB and IED

Paper 1009 from Slovenia shows an often forgotten critical element of resistance grounded distribution systems, the neutral grounding resistor (NGR). To detect failures on NGR systems, a new failure detection algorithm was developed. Based on results and the experience of NGR failure detectors, Electro Primorska is planning to install this detection system.

The influence of the additional earthing of the affected phase during an earth fault in compensated networks is the content of Paper 1140, coming from Czech Republic. Additional earthing theory and practical experiments as well as the difference between theory and experiment are shown in this paper.

Distributed Generation

The increase of distributed generation in MV grids has a major influence on protection schemes. The stability of grids during disturbances, the changing of the short circuit current flow and the fault ride through (FRT) capabilities are impacted too.
The impact of distributed Generation on special protection schemes (SPS) is shown in Paper 66 from Iran. Uncertainties in distributed energy resources (for example wind generation) and the need to modify protection schemes is demonstrated in simulation results.

In Paper 92 from the Netherlands, different problems such as islanding, false tripping or blinding are discussed. Different scenarios and the expectation of the DSO are shown. One example of DG stay connected or DG must be disconnected is drawn in Figure 30. Paper 135 from Iran presents the influence of different load types on the performance of the control system of a micro grid.

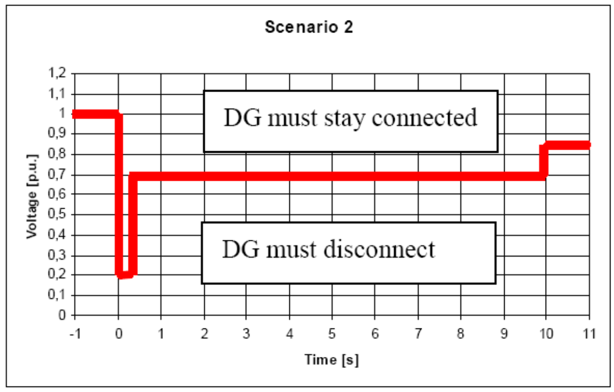

Fig. 30: FRT scenario 2

In Paper 220 from Switzerland, the influence of DG on grid protection in different protection areas (Figure 31) and fault situations is pointed out. Some of the shown requirements on protection are parts of the “Transmission Code of Switzerland”.

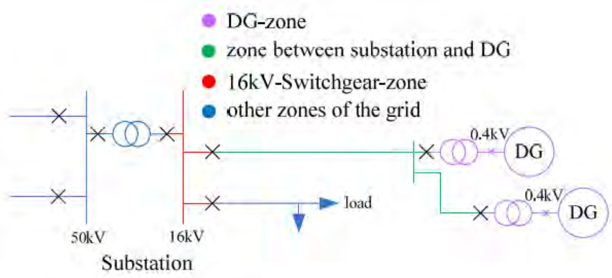

Fig. 31: Protection zones

To minimize the total risk of a system, and to utilize the DG sources optimally, risk analysis for an adaptive centralized protection scheme are made by the authors of Paper 334 from Iran. An algorithm for the protection of distribution networks in the presence of DG is proposed. The suggested method was also implemented in a real distribution network.

An agent based protection for smart distribution systems is shown in Paper 383 from Korea. The proposed agent has protection logic for use in radial and closed loop systems as well as for use with strong or weak sources.

In Paper 428 from UK, a rural overhead distribution network has been modelled and its protection system has been designed and modelled in accordance with prevailing utility protection policy.

The aim of Paper 430 (Finland) is to present an adaptive protection approach for MV micro grids based on telecommunication. The overall protection scheme must cover both grid connected and islanded modes. Islanded operation in case of a fault in some part of the utility grid is one way to achieve self healing. In Paper 431, coming from Finland too, a novel protection system for LV micro grid during normal and island operation is presented. LV micro grids, as an integrated part of future smart grids, need new grid codes where the protection requirements and settings are clearly determined.

Another part concerning to micro grid is the fluctuation of reactive load. In Paper 953 (China), the great influence of fluctuating reactive load to the supply voltage is determined and a grid connection control scheme especially for PV systems is provided.

The last Paper 1134 in this sub-block, coming from Italy, is asking for a new management of distribution network because of growing development of DG. This paper addresses the issues of the Italian anti-islanding protection system coordination. The aim is to evaluate the most used passive methods performances in case of network disturbances.

Applications

In Paper 34 from China, two protection configuration schemes to realize busbar reverse blocking protection are shown. In 110 kV / 10 kV substations, one highly redundant system is compared with a system where the traditional copper wiring cables are replaced by communication network, using IEC 61850-9-2 sampled values transmission protocol. Real projects which have been applied are running well.

How to obtain better performances on protection systems using Real Time Digital Simulation (RTDS) is described in Paper 106 from Brazil. The purpose of performance analysis of differential protection applied on 345/230/88 kV Gas Isolated Switchgear (GIS) Substation is to validate the relay that will be used in the busbar protection project. Simulation results are proving the effectiveness of the scheme and protection settings.

Paper 204 from Italy introduces a device for MV network inspection via pulse injection. The equipment includes an analyser for MV zero sequence systems and provides different insertion possibilities. The developed Detuning Monitor Device (DMD) is a portable system, operable by a local keyboard and a small LCD display and is now used by maintenance crews of ENEL.

Paper 303, coming from USA, describes the implementation of adaptive distribution protection systems based on IEC 61850. Features in the distribution feeders and substation protection relays allow them to adapt to changes in substation configuration, changes in analogue circuits, changes in load, faults in adjacent feeders and adaptions to the loss of protection IED are discussed.

In meshed distribution grids, incorrect relay tripping occurs due to the presence of certain “dead zones” along the length of the cables. In Paper 374 from The Netherlands, results of analyses of different fault situations are shown, and a strategy for mitigation of the protection malfunction problem is proposed.

The increase of decentralized wind power plants has great influence on stability, safety and reliability of a power system. Therefore, new functions in protection relays, under-voltage dependent directional reactive power relays (QU protection, Figure 32), are required.

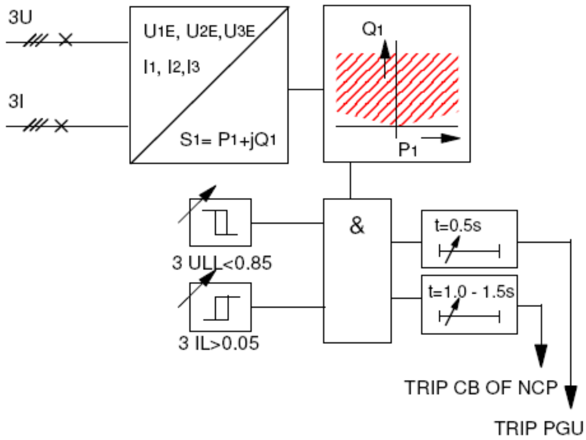

Fig. 32: Block diagram of the new QU protection function

The subject of Paper 418 from Germany is the automatic testing of the system automatics and protection functions in wind power plants.

In Paper 450 from Austria, an easy method to analyze the influence of CT saturation of the protection system is introduced. The measurement of the actual burden and the actual CT data is one part. A second part is the simulation of the fault currents and if needed the voltage, including the transient and steady-state saturation. The synthetic signals are injected into protection relays to verify if operation is acceptable under these real-world conditions.

The test of several fibre optic sensor types and the spectral analyses of arc-flash light were the pre-condition to develop a fibre type of better sensitivity. In Paper 460 from Finland, a new type of an arc protection system is shown.

In Paper 506, coming from Portugal, a new application of a discrete Evolutionary Particle Swarm Optimization-based (EPSO) methodology is described. A case study and the EPSO-based relay coordination algorithm are parts to get better solutions for protection coordination in a complex system.

Paper 517 from USA presents a novel solution that integrates protection of power transformers and power cables based on differential protection principles. The protection system intended to prove its effectiveness in providing reliable differential protection for seven parallel-connected power cables. This was the first Rogowski Coil-based line differential protection system implemented in the USA. One set of Rogowski Coils was installed in the substation on the circuit breaker bushings as shown in

Figure 33. This system is unique since it uses only one set of Rogowski Coils to provide protection for two independent differential protection systems.

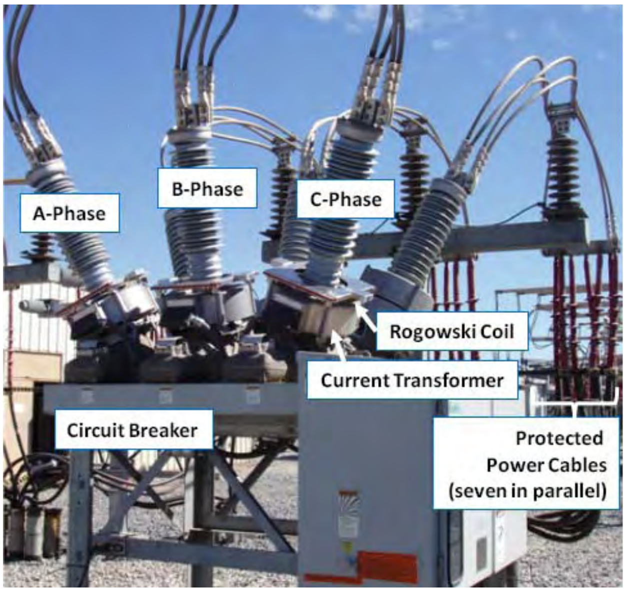

Fig. 33: Rogowski Coils installed around the Circuit Breaker Bushings

An intelligent protection system for smart grid is shown in Paper 749 from UK. In order to demonstrate the capability of this system, a field trial was established in the 66 kV System.
With modern circuit breakers (CBs) for secondary substations and digital protection relays, the number of effected customers can be dramatically reduced in case of fault. Another benefit is the reduction of SAIDI index by reducing the time of reconfiguration. In Paper 768 from France, the use of CBs in distribution networks is displayed and discussed.

Paper 804, coming from Germany, presents an advanced approach for automated and optimized overcurrent grading to face the challenges of an increasing penetration of DGs in distribution systems. The proposed method is also able to define the need when settings must be changed and when a protection scheme must be improved in order to ensure the protection system security.

Many utilities have a large installed base of direct metallic pilot-wire signalling channels for use by protection relays. Paper 843 from UK describes a digital current differential feeder protection relay that has been developed for use with conventional copper pilot-wire links. A number of the installed relays have experienced primary network fault conditions and have been demonstrated to have responded correctly.

Paper 856 from Germany describes the practical integration of protective relays information system spread over the whole enterprise. The additional complexity associated with the issues faced by a newly established power utility organisation is shown.

An interesting aspect how to use conventional power system technologies to optimize the energy-supply-structure of modern aircraft is shown in Paper 973 from Germany. Because of much higher safety requirements, further protection concepts for the electrical grid on board of aircrafts are necessary. Stepped-Curve overcurrent protection as well as impedance protection can be combined for the purpose of failure detection and localization.

In Paper 1039 from Brazil, specific studies, regarding the analyses of conventional protection schemes are presented. Based on results of studies, a few actions are indicated, in order to mitigate the problems caused by high impedance faults in rural areas and improve the performance of protection tripping and fault detection.

Fig. 34: Electric arc

The electric arc occurrence in the test is shown in Figure 34.

In Paper 1059 from Italy an advanced distance relay modelling and testing system is shown. The correct simulation of a fault is becoming an essential part of the test of relay performance in a dynamic way.

Paper 1066 from Italy deals with the protection coordination, in particular distribution systems, such as in hospitals. The real case of the primary distribution system in a hospital, whose system had big selectivity problems, is discussed.

Paper 1164 coming from Italy too, shows that after one year of experimental campaign with circuit breakers, installed along MV feeder lines, together with the refinement of protection system settings to ensure selectivity, it has been possible to assess a substantial improvement of continuity of supply.
Paper 1212 coming from Germany, deals with innovative Voltage-Sourced-Converters (VSC) for integration of “Green Energy”, without impact on system protection and power quality.
The last Paper, number 1282 of this sub block, coming from Italy, has the specific goal to describe the issues related to the loss of main (LoM) protection and to focus on the

features of the Milano Wi-Power project. A testing system was set up in the city of Milano. Figure 35 shows the communication between the master relay in the primary substation and the slave relay in the dispersed generation (DG).

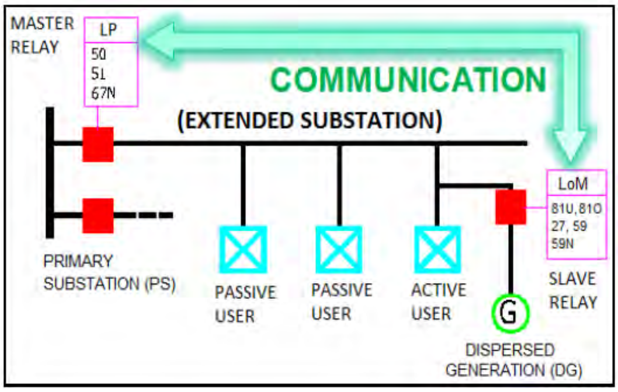

Fig. 35: Communication between PS and DG

The protection strategy includes the passive method, the active method and the communication-based method.

Phase Measurement Units

In this sub block, the different use of Phasor-Measurement-Units (PMU) in combination with other protection functions is shown. The mitigation of blackouts as described in Paper 44 from Germany, by using the fault resistance information is one possibility to enhance the operation of protection relays combined with PMUs.

Another application of synchrophasor measurement allows continuous evaluation of topical line transfer capacity (ampacity) with respect to line load and weather conditions. Paper 916, coming from Czech Republic, explains conditions, limitations and principles of methodology and presents results of experimental measurement.

Paper 919 from the UK, describes the analysis of field measurements collected over four seasons for the dynamic line rating scheme. The dynamically calculated ampacities at Skegness and Boston (132 kV line) are also analysed and a comparison is made with the standard line rating used conventionally.

Network stability analysis and energy accounting are examples for the application of PMUs in transmission and distribution networks. In Paper 963 from Germany, the benefits of synchrophasor solutions for different networks are shown. The typical User Interface (Figure 36) of the application "Island State Detection" is another useful example.

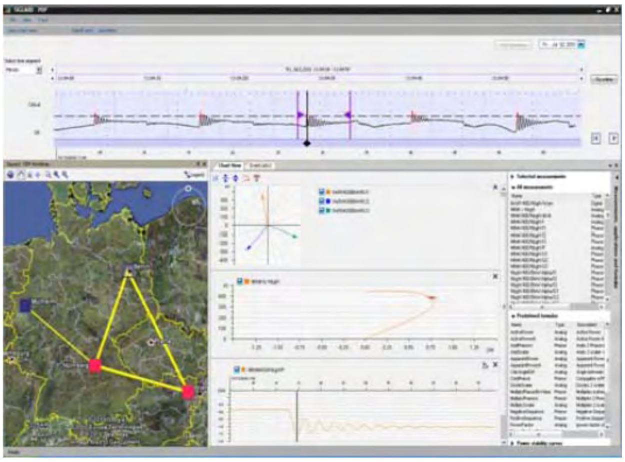

Fig. 36: Typical User Interface of SIGUARD PDP

As shown in Paper 1264 (UK) synchrophasor measurement technology can be used also in smart distribution networks. This paper presents a practical introduction to sychrophasor measurement technology, including control of distributed resources, loss of mains, model validation and frequency stability.

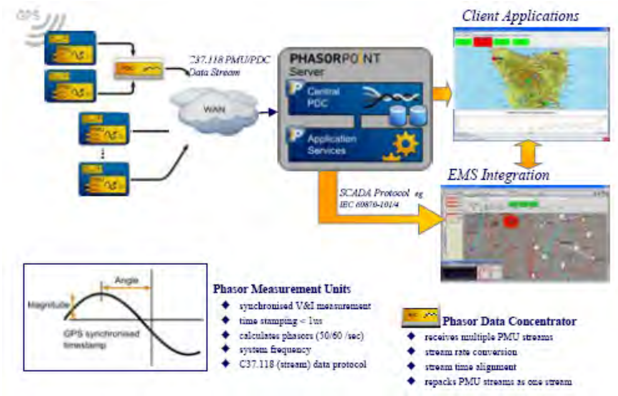

Fig. 37: Typical phasor-based Wide Area Monitoring System (WAMS)

Synchrophasor measurement technology is used extensively at transmission level for system monitoring (Figure 37).

It was widely recognised as an important technology to understand and improve the stability of the power system.

Potential scope of discussion

- Fault location is a most discussed topic. How can the problem detecting high impedance faults be solved in the future?
- Neutral grounding and single phase earth faults are a major challenge in the current discussion. The question remains how fault detection is handled in the future.
- Distributed generation of energy is a globally hotly discussed topic. How is the stability of the net maintained despite the various distributed sources of energy?

Table 3: Papers of <u>Block 3 Protection</u> assigned to Session 3

	Paper No. Title	MS a.m.	MS p.m.	RIF	PS
No. 34	Protection Configuration Scheme and Application in Digital Substation				X
No. 44	Mitigation of Blackouts due to Mal-Operation of Distance Relays by using the Fault Resistance Information				X
No. 66	Distributed Energy Resources (DER) Impacts on the Performance of Special Protection Schemes (SPSs)			X	X
No. 84	Research on single-phase ground fault locating for non-effectively grounded system in Shanghai		X		X
No. 92	Optimal contribution of Distributed Generation in medium voltage grids during a fault, now and in the future		X		X
No. 106	The Use of Real Time Digital Simulation for Performance Analysis of Busbar Differential Protection				X
No. 135	Load Type Impacts on Frequency Control of Microgrids in Transition from Grid-Connection to Islanding				X
No. 181	Current characteristics of serial and parallel low current arc faults in distribution networks				X
No. 204	Device for MV network inspection via pulse injection				X
No. 220	Impact of distributed generation on grid protection		X		X
No. 272	Methodology to Describe High Impedance Faults in Solidly Grounded MV Networks				X
No. 283	Tuning of resonance grounded networks and its effects on earth fault detection				X
No. 303	IEC 61850 Based Adaptive Distribution Protection				X
No. 334	Risk Analysis for Adaptive Centralized Protection Scheme for Electric Distribution Systems in Presence of DG				X
No. 374	Analysis of Protection Malfunctioning in Meshed Distribution Grids			X	X
No. 383	Intelligent Agent-based Protection for Smart Distribution Systems				X
No. 418	Automatic certification testing of the system automatics of wind power plants				X
No. 428	Detailed Analysis of the Impact of Distributed Generation and Active Network Management on Network Protection Systems			X	X
No. 430	Novel Protection Approach for MV Microgrid				X
No. 431	Protection System for Future LV Microgrids			X	X
No. 450	Introduction of an easy method to analyse the influence of CT saturation on the protection system				X
No. 460	Advancements in Arc Protection				X
No. 506	Application of a Methodology based on the Evolutionary Particle Swarm Optimization to Protection Coordination				X
No. 507	Evolution of the Fault Locator on MV distribution networks: from simple stand alone device, to a sophisticated strategic component of the SMART GRID control system				X

	Paper No. Title	MS a.m.	MS p.m.	RIF	PS
No. 511	Abnormal ground fault Overvoltages in MV networks: analyses and experimental tests				X
No. 517	Integration of Relay Protection Functions				X
No. 559	Method of Zero-Current Incremental Quantity Based on Wavelet Analysis of Single-phase-to-ground Fault Line Selection in Resonant Grounded System				X
No. 560	Experimental Validation Results of the Active Grounding System for MV Networks				X
No. 607	New Hardware in the Loop Tests for Earthfault Control and Protection Systems				X
No. 612	Directional Detection of Restriking Earthfaults in Compensated Networks				X
No. 644	A novel Detection System for broken distribution conductor on radial Scheme				X
No. 749	Intelligent protection system for Smart Grid				X
No. 765	Design and implementation of a GPRS based fault locator system				X
No. 768	Reduce the number of outage by introducing Circuit Breaker in the distribution network, dream or reality?				X
No. 793	Practical application and performance of novel admittance based earth-fault protection in compensated MV-networks				X
No. 800	Advancements in earth-fault location in compensated MV-networks				X
No. 804	Renewable Integration Needs Automation of Continuous Protection Grading				X
No. 843	Advances in Pilot-Wire Differential Protection				X
No. 848	Fault location in Portuguese MV networks				X
No. 849	A Fault Diagnosis Approach For Power Grid With Information Fusion				X
No. 853	Effects on the Quality of Service of changing the neutral grounding of MV networks		X		X
No. 856	Implementation of a standard integrated Protective Relays Life Time Management Structure in a newly established power utility				X
No. 915	Earth Fault Distance Localization In Inductive Earthed Networks By Means Of Distance Protection Relays		X		X
No. 916	Actual line ampacity rating using PMU				X
No. 919	Field Measurements Analysis for Dynamic Line Rating				X
No. 929	Improving the quality of supply in MV distribution network applying modern shunt circuit-breaker				X
No. 953	A grid-connection control scheme of PV system with fluctuant reactive load				X
No. 963	Benefits of synchrophasor solutions for distribution networks				X
No. 973	Optimization of the Energy-Supply-Structure of modern Aircraft by using Technologies from conventional Energy Supply Systems			X	X
No. 1009	Neutral Grounding Resistor failure detection				X
No. 1039	Evaluation and Analysis of Adjustments Alternatives for ENERSUL's Protection System in Low Load Density Regions				X
No. 1059	Advanced Distance Relay Modeling and Testing		X		X

	Paper No. Title	MS a.m.	MS p.m.	RIF	PS
No. 1066	New Protection Configuration for High Quality MV Ring Distribution Systems				X
No. 1134	Dispersed generation in MV networks: reliability of passive of anti-islanding protection methods				X
No. 1140	The Influence of the Aditional Earthing of the Affected Phase During Earth Fault on Safety of Distribution Networks				X
No. 1164	MV/LV substation circuit breakers: installation criteria, protection system coordination and operation results				X
No. 1212	Innovative VSC Technology for integration of "green energy" -without impact on system protection and power quality				X
No. 1264	Using Synchrophasor Measurements in Smart Distribution Networks				X
No. 1282	IEC61850-based loss of main Protection: The Milano WI-Power Project				X
No. 1320	High Impedance Fault Location - Case Study with Developed Models from Field Experiments				X