On the Fast Evolution towards the Optimization of Simulation, Software and Hardware for SIPS in Brazil

Jorge Miguel Ordacgi F.
On Behalf of Brazilian CIGRÉ SC B5
Iony P. Siqueira Gustavo A.G. Arruda Júlio C.M. de Lima Jeder F. de Oliveira
Chesf Cemig
Jayme E. da Silva Jr. Carlos A.F. Floriano Meronides J. Ramos José B. Mota Jr.
Furnas Eletronorte Cteep Itaipu
Luiz V.S. Puppi Fernando M. Ferreira Raul B.Sollero Rui M. Moraes
Copel Light Cepel UFF
jorgemo@ons.org.br
Brazil

1. INTRODUCTION – JORGE

The Brazilian Electric Energy Industry (BEEI) Model is based on competition of G&D utilities within their respective segments, remuneration of T utilities depending on asset availability, Power System Operator and Electric Energy Trade Chamber, which are independent institutions. Despite the successful experience with competition, all BEEI segments agree that there must have cooperative work in many activities for their own benefit: bulk power system protection is one of the most important examples of cooperation in BEEI.

In fact, Brazil has been quite successful, under a large diversity of inherent conditions, in handling bulk power system protection to cope with the following challenges:

- Aging of legacy devices that leads to performance degradation and lack of spare parts;
- Harmonization of legacy and updated resources;
- The large variety of stakeholders in the industry;
- Power system fast growth;
- Best possible benefit over cost ratio to provide more reliable electric energy supply with low prices for all kinds of consumers.

Brazilian utilities are aware of three issues that will take place along this decade:

- Experienced engineers will be retired in a few years, leaving a knowledge gap between them and the following generation of professionals, once there is a significant age difference between them;
- Substitution of hardware based digital relays by software based virtual relays;
- IEC 61850 devices and systems will be available in new substations and power plants, as well as they will substitute secondary systems of old installations.

So, Brazilian CIGRÉ SC B5 Protection and Automation is considering the possibility of creating a National WG to produce a Technical Brochure launching the basis for knowledge management and future-proof solutions for SIPS implementation in the next years. This paper deals with simulation, hardware and software resources for SIPS implementation and aims to get feedback from the International Community during PAC World 2011 Conference.

2. CONCEPTION, ENHANCEMENT AND SUBSTITUTION – JORGE

- Multi-skilled teams, as Power System Simulation and PAC specialists shall work closer;
- Long term horizon planning: Simulations shall spam larger time horizons for which the necessary resources will be contrasted to the available ones, so all upgrades in H&S resources shall be put into practice;
- Measuring, tripping and logic definitions: Simulations shall define the need for single or multiple arming, disarming, triggering and action configurations according to Figure 1:

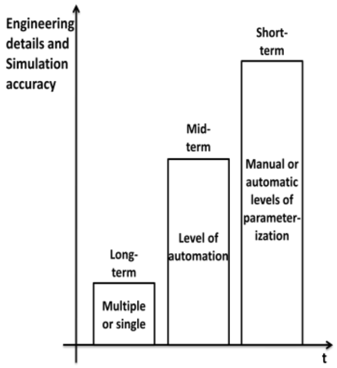

Figure 1 – Simulation accuracy increases with time
(Engineering tasks may be progressively more detailed)

- Future needs and SIPS evolution: An existing SIPS shall need to be reconfigurable according to mid-term operative simulations to face seasonal special conditions or shall need to be fully re-parameterized according to scheduling simulations.

3. IEC 61850 AND SYNCHROPHASOR MEASUREMENT ISSUES – IONY, GUSTAVO E RUI

- IEC 61850 – Iony;

The introduction of IEC 61850 in substation and power plants opens a real opportunity to implement intelligent protection and control functions that explore all the facilities of the standard. A standardized data model of all power system functions, with a standard method to access and control data and services is now a real possibility. Three main issues need to be addressed before this scenario becomes practical:

- the routing of Goose messages among substations and up to higher level control centers
- the harmonization with the CIM (Common Information Model) standard for SCADA
- the harmonization of IEEE C37.118 for synchrophasor measurements

Goose messages, using multicast Ethernet packages, are difficult to route among distinct environments, but not impossible with today network technologies. This issue has been addressed by IEC TC57 among substations, but needs real time proved applications before it becomes common. These messages are more difficult to route to centralized control centers, where advanced functions should be executed.

Harmonization of IEC 61850 with the CIM (Common Information Model) standard for SCADA, and IEEE C37.118 for synchrophasor measurements are under way. These will complete the tools necessary for real time system-wide protection and control applications.

- Synchrophasor Measurement

Synchrophasor measurement applications for power system protection and control functions have been proposed by several researchers in the specialized technical literature. However, the practical application of these ideas should be carefully analyzed. Three main points should be considered:

a) The PMU measurement itself: As the PMU dynamic performance is not specified at the current IEEE C37.118, most of PMUs products today do not have an assured performance characteristics during dynamic situations. Also, some requirements of the present standard, established for the steady state performance, may have impact on the PMU dynamic response. As an example, the out-of-band frequency rejection requirement of C37.118 might delay the PMU response time, jeopardizing the PMU response during dynamic situations.

b) The PMU interoperability: It is expected that a synchrophasor based SIPS will share measures coming from PMUs from different vendors, installed at substations that belong to different utilities. A Wide Area Protection System may need to use measurements from different places of the

Power System. This means that all PMU installed should have not only a consistent dynamic performance but also need to be interoperable.

c) The system architecture: A synchrophasor based SIPS will be strongly depend on the PMU system architecture. The system architecture will define the data latency over the network. Depending on the achievable data latency some protection and control functions might not be applied. It is possible, although probably more costly, to use an independent synchrophasor architecture for the protection and control applications, but this solution also will include some latency to the whole system performance. Due to this fact, it is estimated that only protection and control applications with response times ranging from 200 to 500ms will be viable through WAMPAC systems.

All these issues are being addressed by the IEEE C37.118 revision group and are expected to be solved in the next revision of the standard. The current IEEE C37.118 standard will be split in two separate documents, the C37.118-1, which will present the required measurement performance (including a new PMU performance class P, intended for protection applications). The C37.118-2 will address the communication requirements, including the transmission of synchrophasor data over IEC-61.850 protocol.

4. ENGINEERING – JÚLIO, JEDER E PUPPI

- Technical requirements and standards: Engineering basic requirements shall be considered since the very beginning of SIPS conception, so opportunities for substituting legacy or available H&S resources may be identified, such as wider use of IEC 61850 and C37.118 standards;
- Measurement integration and selection: Information from a single measurement device shall be shared among SIPS and all operational levels – easier within IEC 61850 environment,
- Architectural definition: SIPS shall benefit from the whole operative hierarchical structure from bay level up to National Control Center;
- Stakeholders coordination: Centralized coordination of engineering tasks for SIPS involving two or more utilities;
- New technology application: Synchrophasor measurement benefits shall be included according to the WAMPACS concept.

5. COMMISSIONING AND TESTING – IONY, CARLOS FLORIANO E FERNANDO

It is very likely to have different utilities and manufacturers involved in the installation of SIPS. For this reason, sometimes it is not possible to perform all kind of tests, for the whole system, in an integrated way. The philosophy of testing and commissioning may vary between utilities and manufacturers. Due its importance to a good performance of the electrical system, testing and commissioning of SIPS must be performed following a minimum of standardization.

1. Device acceptance test: Must be performed for each new device and includes conformity tests, functional tests and specific tests in order to verify the introduction of upgrade.

2. Device interoperability test: Must be performed to prove if devices from different manufacturers are enable to interchange data. It is very important to find incorrect communication configuration.

3. Factory acceptance test /Integration test: Must be performed before shipment and should include the components that will be used in the actual installation. The correct configuration of the individual devices regarding settings and logic must be confirmed as well as the communication between different devices.

4. Functional test: Due the multifunctional characteristic of some devices used in SIPS the functional test of all functions should be realized only during the device acceptance test. During factory acceptance test only the functions that will be applied should be tested.

5. Regression test (to be performed after making a functional improvement or software/firmware updating): Utilities usually have different approaches regarding these tests. It depends on the type and importance of the modification. The utility in charge of the test must be aware of all changes implemented during updating.

6. OPERATION – MERONIDES, JOSÉ BENEDITO E RAUL

- Mid-term operative simulations that detect seasonal special operating conditions shall provide information on the need of a SIPS reconfiguration beyond its design;
- Scheduling simulations that detect special operating conditions shall provide information on the need of a SIPS re-parameterization beyond the setting groups in service.

7. EVOLUTION – JORGE

- Long-term simulations shall take into account Power System growth;
- Engineering shall bear in mind technological evolution, in order to cope with changes of paradigms.

8. EDUCATION – IONY, RUI, E JORGE

A recurrent issue with the application of new technologies is the gap between its availability and its acceptance and complete integration with current installations. The latter is usually a technical problem, so its solution depends mainly on the application of more technology. The former is a human problem, needing not only technology, but attention to specific human limits and needs, and sufficient time to be solved. In this aspect, power system automation is now on the verge of a sharp transition from hardware based devices to software based IED (Intelligent Electronic Devices). This change, seen from a traditional electrical engineering curriculum, requires the introduction of new disciplines (and probably the revision of others, like Power System Protection and Electrical Measuring) , related mainly to communication and software technologies. These curricula must be complemented by topics such as:

- Object Oriented Software Design
- Unified Modeling Language
- Extensible Markup Language
- Object Oriented Testing
- Software Maintenance
- Configuration Management
- Protocols e Telecommunication
- Standard IEC 61850
- Network Design.

Aside from the traditional electrical engineering, usually the main professional graduation required from automation engineers, perhaps it is now time for the introduction of specific graduation curricula for power system automation, addressing the modern and specific requirements of this area. Meanwhile, some post-graduation courses, at the specialization level, are being offered by some universities and research centers that help to reduce the gap of current engineering curricula. In this aspect, the Brazilian ITAI (Instituto de Tecnologia Aplicada e Inovação) and UNIOESTE (Universidade Estadual do Oeste do Paraná) have pioneered in offering the first post-graduation course (lato sensu) on Automation, Control and Supervision of the Electric Process Based on the Standard IEC 61850, initially for the engineers from Binational Itaipu, from Paraguay and Brazil.

REFERENCES (references shall be sequentially numbered according to the topics)

[1] Author(s) – Paper title (begin words with capital letters) – Magazine, seminar or website – Month and year

[2]

ABSTRACT – Jorge

Last topic to be written,

BIOGRAPHIES

Jorge Miguel Ordacgi F. took his Electrical Engineer degree from UFF. From 1974 to 1998 he worked for Furnas, Itaipu and Eletrobras on setting calculations and disturbance analysis. In 1998 he joined BR ISO, dealing with SPSs, Control Center automation, SCADA and EMS. From 2011 on Jorge has been working with disturbance analysis.
From 1975 to 1992 he taught Power System Protection at Universidade Veiga de Almeida. He is Advisor of PAC World Magazine.
Jorge is a CIGRÉ Distinguished Member. Working for SC B5 he received a TC Award in 2006 and a Brazilian SC B5 Award in 2009.

Iony P. de Siqueira 100 words including name

Iony Patriota de Siqueira has an MsC degree (Honors) in Operations Research, an MBA in Information Systems, and a D.Sc. level in Electrical Engineering. He is a member of Cigré, IEEE and IEC (TC 57 and WG 10), former convenor of Cigré WG B5.32 on Functional Testing of IEC 61850 Based Systems, Secretary of Cigré Study Committee B5, and convenor of Brazilian Technical Committee of IEC TC 57. Currently his is vice-director and adviser for the Brazilian Maintenance Association, and Manager of Protection and Automation at Chesf. In 2009 he received the Cigre Technical Committee Award for contributions to the Protection and Automation Study Committee.

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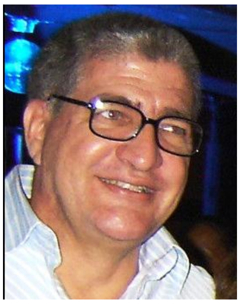
Luiz V.S. Puppi 100 words including name

Fernando M. Ferreira 100 words including name

Raul Balbi Sollero received his B.Sc. in Electrical Engineering from the Federal University of Minas Gerais, Brazil and the M.Sc. degree in Electrical Engineering from the Federal University of Rio de Janeiro – COPPE. He joined CEPEL – Electric Power Research Center in 1982, where, since 2000, is the manager of the Department of Systems Automation. His main fields of interest include power system protection and stability, signal processing, equipment modeling for transient studies and real-time power system operation. Mr. Sollero is the chairman of the Brazilian Cigré Study Committee B5 (Protection and Automation) since 2009 and is a member of IEEE.



Rui Menezes de Moraes received his B.Sc. degree in Electrical Engineering from UFF, Niterói, Brazil, the M.Sc. degree in Electrical Engineering from UFRJ-COPPE, Rio de Janeiro, Brazil and the D.Sc. degree in Power System Applied Computing from UFF, Niterói, Brazil. He is with ONS, the Brazilian National System Operator, and with UFF were teaches Power System Protection. His main fields of interest include power system protection and synchrophasor applications. Dr. Moraes is the secretary of the Brazilian Cigré Study Committee B5 (Protection and Automation) and is a Senior Member of IEEE.