Smart Management of Transmission Network in UTE

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Abstract*— Smart Grid in Uruguay has a legal framework defined by the main company of generation, transmission, distribution and marketing of energy in the country: UTE. The Transmission Area defined a development model 2015-2025 whose strategic objectives are: Optimization of Transmission Network, Optimization of the Operation Process, Avoid Collapses and Contribute to the Optimization of Generation through the various services provided from Transmission. Initiatives such as Remedial Action Scheme for the whole electric power system, Synchrophasor's Program, Asset Health Center, Control Center and development of Digital Protection, Automation and Control systems, are part of this wide portfolio of Intelligent Network Management.

***Index Terms*— Asset, Management, Operation, Optimization, Technology.**

I. Introduction

Smart Grid development in Uruguay has a legal framework defined by the main electrical utility of generation, transmission, distribution and commercialization: UTE (Administración Nacional de **U**sinas y **T**rasmisiones **E**léctricas) [1]. Even though the Electrical Network Intelligent Management philosophy has been developed in the utility for several years, its methodological focus was deepened with the support of an external consultancy process that allowed define the UTE Smart Grid Master Plan [2].

UTE Transmission Area has been working in the definition of the 2015-2025 model of development, in agreement with that Master Plan. Its strategic objectives are aligned with the utility ones, and they are:

- Network Optimization.
- Operation Optimization.
- System Collapse Prevention.
- Contribution to the Generation Optimization through Transmission services.

This paper with UTE Transmission view summarizes the main topics of the development done.

II. Smart Grid concept

A. For Transmission of UTE the Smart Grid concept is based on the following guidelines:

- Turn the existing static electrical transmission network infrastructure in a flexible and alive network that will be able to connect the new generation sources: conventional, intermittent and distributed renewable (linked directly to Transmission or from Distribution).
- Plan the future network considering the necessary expansion and improvement with targets as assuring the demand supply, holding up N-1 contingencies in all the network, allowing the connection of peak load generation plants and water pumped-storage plants, as well as being able to satisfy new market requirements, helping the introduction of new Transmission technologies and equipment to mitigate the social, economic and environmental impacts.
- Improve real-time electrical network observability and control capacity, to reach its optimal use and operation. For that it is necessary to simplify the information interchange between connected agents and control centers, monitor critical parameters for system stability purpose, improve the network assets monitoring, develop synchrophasors measurement (PMU) and its integration with the Energy Management Systems (EMS) and with data form other sources.
- Network use optimization, taking advantage of exploiting and magnifying the transmission and transformation capacity through its electrical corridors, through assets management including condition monitoring, online residuary capacity knowledge, intelligent protection and control, and WAM and WAP use, to prevent collapses and blackouts or reduce its impact by online automatic decisions. Introduce new equipment as GIS substations, higher capacity conductors, higher voltage levels, etc.

These principles are inspired in the CEN/CENELEC/ETSI Joint Working Group final report [3].

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B. Intelligent Transmission Network Management

Taking into account the RTE R&D Roadmap Implementation Plan 2013-2016 [4], the Transmission system optimization process can be seen as a three layer of knowledge that constantly interact between them (see figure 1):

- **Physical Layer** (1): is the network and its equipment. The network expansion planning. The communication systems.
- **Logical Layer** (2): is the integrated systems layer that allows the efficient use of different resources.
- **Business Layer** (3): is the layer that seeks to achieve the optimal economical exploitation satisfying customers, government and social requirements as a whole.

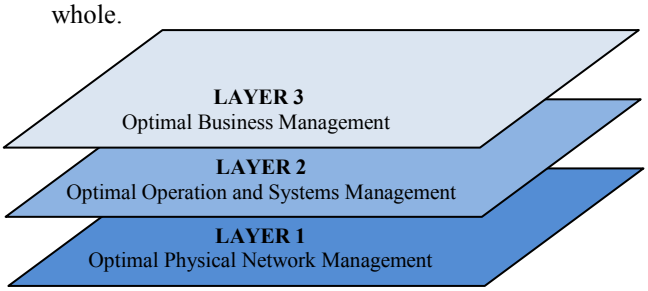

Figure 1. Optimization Process Layers.

For UTE, the Transmission Network intelligent management implies creating a systemic vision scope (in contraposition with a vision by projects, sectors or subjects).

This is achieved by:

- Collecting different projects, programs and initiatives, and linking them with management of technologies developed in the Transmission Area (and with other UTE Areas in cases of intense Transmission participation).
- Aligning and organizing them as strategic goals, and expressing clearly what it is being built in a 2020 horizon.

The strategic view towards 2020 – 2025 must be completed considering these previous inputs, for:

- Define the missing actions, projects or programs (gap analysis) to build an adequate, compatible and robust network of initiatives that satisfies the principles and goals.
- Coordinate and consolidate them inwardly to reach positive synergy.
- Organize them in portfolios, sub-portfolios, programs, projects, etc. according to Project Management Institute (PMI) methodology or similar.
- Manage the portfolios with support on the base concepts of Transmission Business Management.

Figure 2 shows on the left a short cycle (a 5 years vision aligned with the investments five-year plan) and on the right a long cycle (a 10 years vision aligned with the ten-year network expansion and improvement plan) to be used for the selection of new initiatives to be developed, and based on a maturity model [5] that is planed to be adopted and developed in 2016.

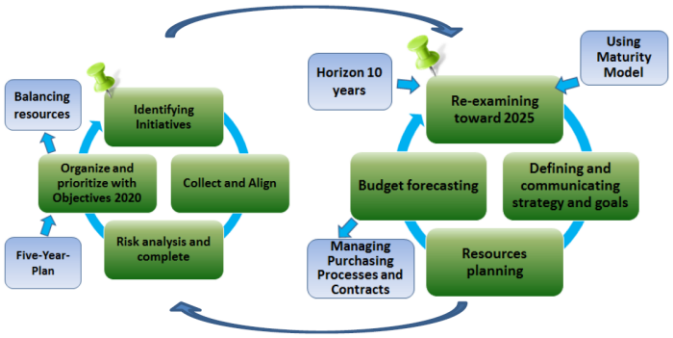

Figure 2. Self-construction and initiatives alignment cycles.

C. Transmission Business management base concepts

Even being UTE a vertically integrated utility (developing the fundamental steps in the energetic value chain as electric energy generation, transmission, distribution and commercialization), it is not exempt of the impact of the massive new unconventional renewable energy generators place in service, facing Transmission Business to new immediate challenges.

This new challenges oblige to review and deepen the Transmission Business management base concepts:

- Assure the applicable Regulations fulfillment.
- Establish a decision making process based on:
  - Actual KPIs and future KPIs forecast.
  - Opex vs Capex optimization.
  - Product quality.
  - Total life-cycle cost.
  - Sustainability.
  - Reliability.
- Develop new tools with new models and systems to simulate the growing complexity.
- Construct an Intelligent Organization, considered as an organization with learning capacity.
- Develop an execution culture based on Planned Work.
- Incorporate people security through Safety Work.
- Risk Business Management.

Organization's people and its participation are considered an essential part in all this concepts and in the portfolio's deployment and management.

III. NEW ELECTRICAL SYSTEMS CHALLENGES

Power systems face new challenges to be attended with new visions and with the development of new tools that allow handle the complexities.

These complexities can be classified in:

- **Spatial**: new projects placement or new lines realization face environmental, social and economic adversities. Generation is distributed but it must be able to circulate in the entire network.
- **Temporary**: power systems management covers times from microseconds to tenths of years. See figure 3.
- **Stochastic**: the network evaluation presents uncertainty about the long-term future, intermittent

sources of generation, load volatility, and external contingencies like sudden changes in economics, in politic and commercial relationships in the region, or the climate change impact.

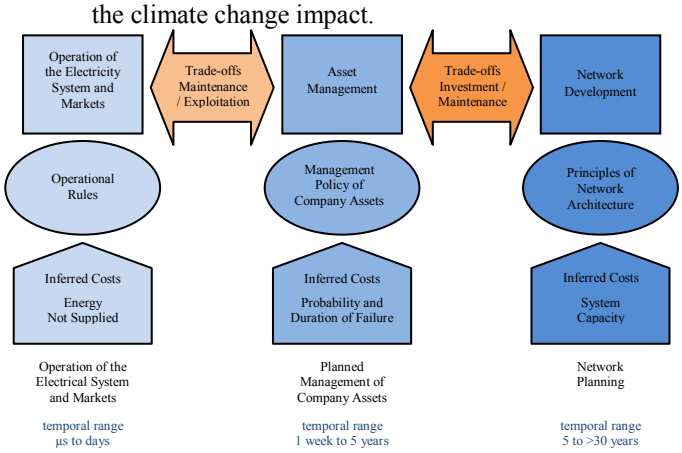

Figure 3. Optimization temporal horizons [4].

Additionally, electrical utilities are faced to changes in the working scenario due to factors like renewable energies cost fall, its accessibility for home use, that stimulate a rising number of customers to opt energy auto-production, new electric energy uses (public and private electric transport, etc.) and development of demand control aspects (virtual generation – demand following generation – advanced metering infrastructure AMI).

All of this boosts the need of create a Transmission Business intelligent management model.

IV. Intelligent Management Model Development

Smart Grid is built with the interaction of different action portfolios, aligned with the Transmissions Business strategic objectives, the Technologies Management for Intelligent Network Support portfolio, the Network Planning and Expansion Optimization portfolio, and the Transmission Business Management portfolio.

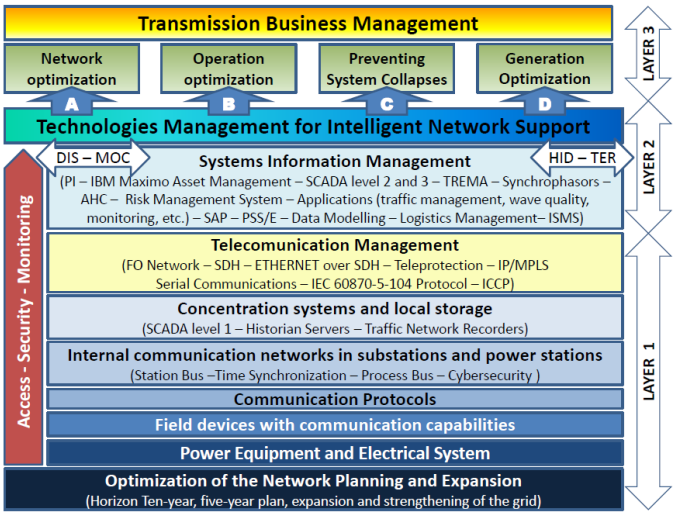

Figure 4. Transmission Network Smart Grid model.

A. Smart Grid Network model description

Layers of Smart Management Model for UTE Transmission Network are represented in figure 4. They are combined with the three optimization layers shown in figure 1.

The value aggregation processes identified with A to D letters is built with initiatives, projects, programs and sub-processes that are identified, defined and aligned using figure 2 methodology.

Layer organization allows different practical situation representation (machine-machine, machine-system, system-system, system-human, system-goals, and goals-business).

An important part of the portfolios initiatives about Intelligent Network Management already were being developed or were projected separately, not funded with UTE Master Plan resources.

The new organization according to the contribution to strategic objectives, allows understanding this grid of initiatives as a live interdependent system.

B. Considered aspects of the model

In order to reach in each layer the goals and contribution to the value addition process, which contribute to Transmission Business optimization and to the strategic objectives, the method requires from each area at least the definition of:

- Applicable standards for each management segment.
- Contribution factors of each initiative to strategic goals.
- Roadmap development.
- Required resources and implementation schedule.
- Approved budgets.
- Horizontal links between initiatives, processes and goals.
- Govern each value segment (clusters of initiatives, projects, programs, processes, sub-processes, etc.).

V. Expected Benefits and Results

A. Network optimization:

- Defer investments.
- Reduce operation and maintenance costs, in a life cycle cost optimization frame.
- Improve service quality.
- Predict failures.
- Take optimal advantage of the human team dedicated to this process.
- Migrate from preventive maintenance to condition based maintenance.
- Improve equipment condition and status information management.
- Make an available network to take advantage of business opportunities about energy and regional complementarity.

B. Operation optimization:

- Unify Transmission Control Centers.

- Optimize operation and participation of human team in the process.
- Minimize unavailability and outage times.
- Provide optimal information about the network and its status, equipment status, operational limits, and critical parameters variation concerning systemic stability or overload.
- Develop a system integrated operation model including electric generation, transmission and distribution toward national and regional markets.

C. Collapse prevention:

- Know the network behavior up to N-3 condition (for critical and 500 kV equipment) and be able to design required actions.
- Achieve a flexible, fast and reliable communication network (inside substation and between substations, control centers, etc.), to be able to implement solutions for contingencies that can occur.
- Provide intelligent systems to take action mitigating contingencies effects in critical equipment in different scenarios of generation, import-export, demand and topology. These systems take fast and reliable actions like automatic trip of load, line, reactive power, generation and interconnection.
- Integrate these systems in the operation process as a continuous real-time observability tool, and in the electric network recomposition strategy in order to avoid black start.

D. Generation optimization:

- Incorporate and integrate UTE generators to the electric network in reliable conditions, with high availability of protection, control and measurement systems, through automatic generation control (AGC) functions that link generator plants with SCADA of the National Control Center.
- Improve generators transient performance visibility.
- Influence in UTE's wind farms design processes, regarding interconnection substations. Give support to management and maintenance in some equipment.

E. Smart Grid Support Technologies Management:

- Improve network, substations and plants protection and control systems reliability, incorporating communication functions, records and remote management, strengthening substation data bus, process data bus and time synchronization, to enable high requirement applications like electrical measurements digitalization, accurate fault location, and synchrophasor measurement.
- Provide intelligent support applications for different business areas, based on reliable information obtained and produced on site with intelligent electronic devices and collected in repositories.
- Develop and manage the Information Security Management System (ISMS) for Transmission and related areas, traversing all equipment and systems layers.
- Enable the information interchange between other stake holders of the national electrical sector (generation, distribution, commercialization, regulator and agents).

F. Transmission Business Management:

- Achieve permanent policies and strategies revision to adapt and adjust the electric network and its processes, considering customers, market and regulator requirements.
- Assure Transmissions Business continuity, through optimization, product quality, sustainability and reliability.
- Complete inclusion of workers in regular processes, critical projects, and in the construction of futures, focusing in an organization with capacity of learning, developing an execution culture that allows the approach to challenges looking after people and installations security.
- Harmonize and optimize technology incorporation in processes and products.
- Work abreast with utility IT areas to achieve automation in business process management (BPM)

VI. Conclusions

The main contribution of the developed methodology is its systemic focus on different initiatives that were being developing in the utility Transmission area. It gives place to each initiative in a value added chain for UTE Transmission area goals construction, allowing its alignment with utility targets and particularly ensuring that assets sustainably add value, considering Risk Management and Asset Management.

Traditional management, where initiatives are developed separately, inhibits natural synergy between components and obliges competition for economic, material and human resources, and then do not assure neither optimization nor adequacy to the pursued goals.

Integrated initiatives management allows the risk evaluation, to understand how to achieve expected results, and know the missing activities to be added.

The Network Intelligent Management model still has not enough running to draw conclusions, but clearly contributes to the management robustness, to give visibility to initiatives, projects and programs in the utility, and to guaranty better time and resources assignment to its construction. This model protects against day to day operation problems, which would undermine against expected results without this model.

Next step is adopting a mature model to improve the capacity to guide the steps toward initiatives that strengthen Network Intelligent Management and boost efficiency and positive synergy, with the best cost-risk-performance ratio.

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