Control Centers' Upgrade in Central America: A strategic planning process approach

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Abstract

The current trend of openness and modularity on the Power Network Control Systems are conceived originally, mainly if not totally, for expanding the life cycle of the modern and coming generations of Control Centers. But there are a considerable amount of existing "old" Control Centers in Utilities with lack of experience in the exploitation and with economical limitations for replace them for new ones at one shot. In some cases, even with available budget for Control Center's modernization there is a lack of systematic recollection of the experiences on the technical evolution of the current one and about the new and demanded needs. This paper is recommending and sustaining a strategy for a planing process for the fulfillment of the new requirements or functionality to the Control Centers in Central America. It is intended to keep in mind the understanding of the real needs and combining the technological solution with the evolutionary standards and the state of the art of openness and EMS in the modernization of the SCADA/AGC Control Centers [1]. This paper is based in a characterization study of the Control Center in Central America, presenting some remarks about the partial results of such study. It is presented some complementary perspectives of the challenges to be faced for such Centers.

Key Words: Case Studies on Central American Control Centers, Control Centers operation experience, Strategic Upgrade Planning Process, Control Center Migration.

1. Introduction

In the Central America region, there is a plan of a complete Regional Electrical Interconnection which is going to demand a closer interchange of information, more operational coordination, reliable communications, interconnected network analysis, new functionality, and a Regional structure of the Electrical Interconnection amongst the Control Centers of the six countries (Guatemala, Honduras, El Salvador, Nicaragua, Costa Rica and Panamá). The experiences on the energy trading are until now coming from bilateral and different agreements and procedures amongst the Countries interconnected.

Moreover, three of the six Central American Countries are in a very advance phase for a complete renovation and technological modernization of their current Control Centers. Some of them have set the financial source for the budget and already assigned the procurement of the new Control Center. There have been some surveys about the foreseeable technical requirements for supporting this Regional Electrical Interconnection and for the recommendations on the modernization of the Control Centers by each Country's Utility and at the Regional level by PARSEICA[1] and other International Consultants. Most of these studies are focusing on the technical implementations tuned on the "the state of the art" trends on open SCADA/EMS Systems, more than focusing on evaluation on the current operational status, experiences or based in clear Utilities expansion plans or strategies.

This opportunity and dynamic situation was inducing the study: Characterization of the Power Control Centers in Central America at the Generation and Transmission level. It is also the practical base of the proposed Strategic Planning Process Approach for technological migration at the Control Centers.

[1] Programa de Actividades Regionales en el Subsector Eléctrico del Istmo Centroamericano.
(Programme for Regional Activities in the Electrical Sub-sector in Central America)

2. Context: Remarks on the Characterization of the Power Control Centers in Central America

The Characterization of the Power Control Centers in Central America is an ongoing study oriented to analyze as Study Cases the operation's experiences and problems faced from the Control Centers in the region, and to present some recommendations for conceptual and common strategy to face the upgrade and modernization trends of such Control Centers of obvious close context, constraints, opportunities and future interrelation.

So far the Study Cases analyzed are addressing that there are a very heterogeneous levels of maturity on the exploitation, operation strategies, resource capabilities, and experiences at the Control Centers. Some of them are already in operation since 13 years and others just since 2 years.

We found that there are three types of Control Centers structures, one with the commonly known "proprietary integral packet" of SCADA/AGC system, other one with a Database Server with remote acquisition data configured in personal computers (PCs) and the last one based on a SCADA/AGC system based on a network of PCs in distributed configuration for the software tasks. The last two ones were conceived for self design software and not proprietary software-hardware relation [2].

Guatemala doesn't have still a Digital Control Center, it is still working with analogue telecommands and telemetry. It seems as a special Study Case in order to see how a leap to a new and modern SCADA/EMS Control Center will impose new problems and challenges.

However, all the structures are attached, in a way or other, to particular communication protocols, database structures, etc. It should be mentioned that in the PCs based Control Centers, the major problems come from the technical difficulties of implantation of commercial software and from the high cost of self development software. The hardware is more flexible and rather cheap to change from time to time, it was included in the contract for these systems the implementation of the interface with the remote terminal units (RTU) in use from the different vendors.

In all the original Control Centers the international consultants were playing a key role as technical counselors, in those days, seventies, the concept of modern digital Control Center technology was considered new and just setting the roots. This helped to have some vision over some vendors that were proposing and trying to convince about their solution or interpretation to the functional specification defined, and not trying as close as possible the fulfillment of the specification required.

In opinion of the people with more maturity on the exploitation at the Control Centers, now is more likely that the consultants must play a role on suggestions on the functional specification proposed from the local team; on the estimation of the cost, extent and time of the required change or project; on the validation on the project award procedure and during the checking of the functionality specified for the project.

It is notorious that the design of the communication system was pointed out as the weakest and rapidly obsolescent part of the system. We find many examples of recent Control Center's installation and just few month after, it was confronting an expansion on the network or data acquisition points that saturate the communication channels capacity. One reason for such "early saturation" was the lack of information and follow up of the long, short and medium term plan of expansion. A practical explanation is the fact that the so called medium and long term plans are in function of the frequent changes of the National financial support, opportunities or priorities.

It is naturally accepted that in a Control Center the old or new functional definitions, new information requirements, new data base acquisition requirements, new communication time performance, additional alarm processing, new application software, etc., are defined from a merely technical or specification perspective, underestimating the organizational impact and the potential considerations as a systems of collaborative and interrelated "parts", already doing technical tasks and sub-tasks at the Center [3].

It has to be added that most of the Control Centers have an unclear or limited interaction between the various offices surrounding them at the Utility. In opinion of some Heads/Directors of Control Centers, the Center has to take the leading place by showing the nature of its valuable and reliable information to the rest of the Utilities' offices.

It has been notice a common unsatisfactory remarks from the operators and supporting staff members of the Control Center about some "unfriendly" application software which are demanding a big amount of data, which has to be entered by hand. As an example there is a widely distributed software amongst the Control Centers for Short, Medium and Long Term Forecasting Demand with modes of operation in different hydrological assumption and combustible cost, this software is not in use and instead of it LOTUS or EXCEL is used with an average accuracy no less than 96% in the results. Here, a good example of the "end user" importance and influence, when it is not taken in account at the

developing phases of application software or expansion plans [1].

3. Complementary perspective of challenges to be faced at the Control Centers in Central America

The Control Centers have been originally conceived and used as a tool for the reliable and economical operation of the Electrical Network. However the Control Center is increasingly seen as an investment resource of the Utility, which in general, the Utility, has limitations on available budget and is forcing to behave in terms of economic, open and competitive management concepts on the running and decisions on the overall operation.

In such context, the Control Center's upgrades must have a consistent argumentation of the benefits expected and should address technological solutions which can permit the continuous evolution without major investment and less operating and maintenance expenditures. It is also necessary to see the Control Center as a systems where the structure and organization must pursued clear definitions, defined distributed tasks and continuos evolution to optimal use of the human and technical resources.

A Control Center must be seen as a complex and dynamic system with rapid changes in the technologic trends as well as a system with a very close interaction of "end users" (operators) and supporting staff focused in achieve multiple and frequently adjusted goals by their one responsibilities and/or by the new needs at the Utility.

The Control Centers are being seen as Information Centers, from where the Utility strategies and decision are having the feedback on real and actualized information, the horizontal integration trend.

It is also clear the aim of a closer integration of the Control Centers to directly affect the power system behavior in a concept of automation and therefore in a closer coupling between the power process and the Control System, the vertical integration.

The Utilities are already walking into the concept of competitive enterprise or businesses like activity. This will imply an increasing horizontal integration of the Control Center functionality.

As far we could see the Control Centers shall start as soon as possible some plan to overcome the currents and futures challenges and problems. In such frame it is proposed the follow strategy based in planing process concepts.

4. A Strategic Planning Process Approach for Control Center's Upgrade

Here the planning approach is interpreted as a process with a long term goals, i.e. a better operational understanding and behavior, and under needs technological migration of the Control Centers in Central America, which is transformed into short terms tasks and objectives in the frame of its constraints and opportunities. The strategic planning is proposed in the following six phases or steps:

4.1. Understanding and definition of the current role of the Control Center

The first phase of the strategy proposed, and the very core of the whole approach, is to define the current Control Center's role and operation as a interrelated system of *entities*[2]. This *entities* must have clear and simple definitions and knowledge of the output, task and sub-tasks done, inputs and interrelation to other *entities* and the technical needs[3] for doing the tasks, see Fig. 1.

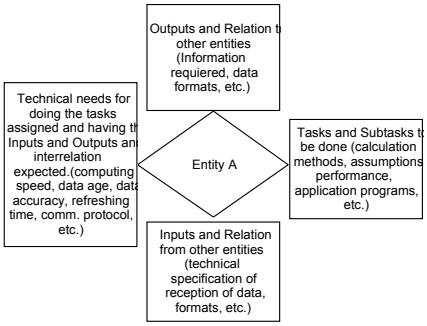

Fig. 1. Entity definition structure.

[2] Entity: office/module/functionality/application software.

[3] i.e.: computing speed, information age availability, accuracy, more information requested from RTUs, etc. All related to the hardware and physical support for the entity

This model shall define the Control Center in terms of the inside *entities*, which ones should cover all the Control Center structure (modules, responsibilities, technical specifications of the data flow required, alarm processing, application software, technical capacities in use, technical and information interrelation between the *entities*, Man Machine interface, etc.).

The human "executor" behavior has to be added in some way as inputs or relation or task performance definition of the *entity*, due to the fact that some of the process, even if the procedure is written, are biased by the practical behave of the person in charge.

The model must evolve in better definition and proposing better distribution of responsibilities and/or more *entities*, in order to increase the overall performance of the entire Utility. It must be assured that the formal description of the role, is not going to kill the initiative and creative ideas.

This phase will clarify and systematize the typical informal, pragmatic and intuitive knowledge at the Control Center. Facilitating future references and traceable evolution.

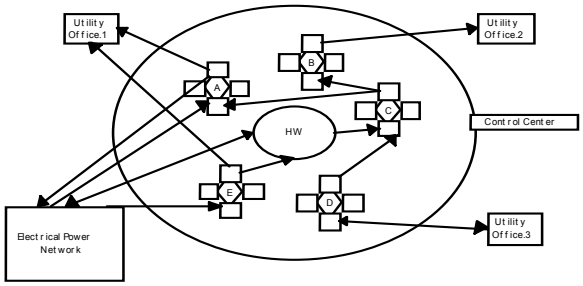

Fig. 2. Conceptual example of a Control Center modeled by *entities* relations.

As it can be seen in the example in the Fig. 2., the model allow systematic definition of the relation and needed support for the *entities* at the Control Center. Any new need or functionality could be analyzed in this context and could be seen and describe as a new *entity*. It shall be notice that HW is the hardware infrastructure as a common tool for the *entities*, it shall be described in other terms. The boxes referred as Utility's office are bringing or demanding reports or information from/to the Control Center. The tasks about the supervision and control of the Electrical Power Network is represented as well.

In parallel to this conceptual proposal, further discussion on the suitable instruments or modeling techniques has to be done. After some survey we have been found some quite applicable concepts as The Multimodel Approach defined "as one in which more than one model, each derived from a different perspective, and utilizing distinct reasoning and simulation strategies... the result can coherently correspond with the real world" [4]. The Functional Information and Knowledge Acquisition Modeling (FIKA) which is aiming to be used both to structure observation in complex environments and to structure support system functionality [5]. Some modeling of complex systems are using Object Oriented Approach, like M*-Object Methodology, which decompose the problem in organizational analysis, conceptual design, and implementation design applied of information systems [6].

As far we seen they are more oriented to knowledge organization and system information and they differ in the way of defining the level of abstraction (granulity) and attributes to the *entities* of the system. They are not including explicit technical performance, traceable technical changes, needs and implementations.

The value of any model will be laying in its ability to help us to represent the characteristics of an *entity* of the system and the system it self (Control Center and inner structure), and reasoning about it in terms of its technical attributes, traceable technical changes demanded, technical performance, easy representation, interrelation between the inputs and outputs for doing the task attached.

4.2. Formal Description of the emerging need

This step must deal with the clear way of defining emerging needs or new functionality to the Control Center in the context of the Utility expansion and evolution. This will be the assessment platform for the reasons inducing some changes (new functionality, performance changes, new application software, etc.) at the Control Centers.

The emerging functionality or need has to be defined in such way that is comprehensive and coherent with the *entity* definitions in 4.1. Understanding and definition of the current role of the Control Center, therefore for the user, possible consultant and vendor.

This phase has to deal with the technical definition of the new need, not only the wish to have a new function or new task done, but the specification of the all parameter involved for this new requirement, the advantages reached, the meaning for the Utility if this is done. This would be a good step in trying to understand by all the involved people the need to be fulfill, avoiding unnecessary misunderstanding.

We can see in the Fig. 3 an example of the structre of the emerging need, in coherency with the model's *entity* concept.

Actually a new task required from the Control Center is told to the Head/Director without any formal requirement statement. This person has to discuss with his/her team the best way to do it. Sometimes there are tasks, related to the new emerging need, that could be done from more than one *entity* at the Center or at the Utility. The problem arise about the priorities of such offices already involve in other developments and which one has the optimal chance to do it in the most effective way. The problem is currently solved in the frame on the cooperative environment of the Center staff, but it is not clear if this is done in the most effective way.

In this point we have seen that the new needs reported to the Control Center are increasingly influenced by demanding Management access to information or reports.

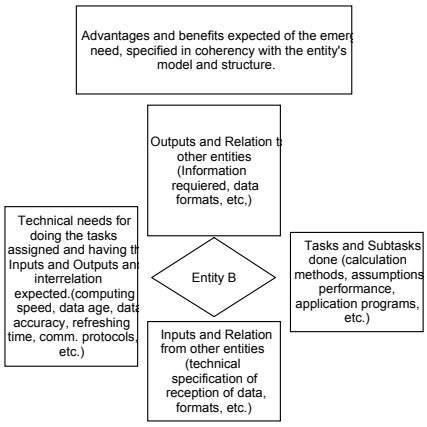

Fig. 3. Example of structure of the emerging need definition.

4.3. Definition of the effects and the demanded changes of the emerging need

In this phase must be done a clear trace of the impact, extent of the technical and organizational changes demanded by these emerging needs or new functionality in the current model of the Control Center. The new need emerging, is understood in coherency of the *entity* definition, will be addressing the changes or necessary improving in functionality and performance standards. (i.e., reliability and capability of the hardware, communication speed, software, interfaces of data, etc.) at the currents *entities* or new *entity* of the model of the Control Center.

Some restructuring in relations, interchange of operation can be foreseeable as solution. In short, covering the emerging need trying to optimize the resource available, using as a key information the comprehensive models in 4.1 Understanding and definition of the current role of the Control Center confronting it with the definition on 4.2. Formal Description of the emerging need

The results or conclusion at this stage must be that some new needs could require some minor adjusting on the *entities* or new *entity* attributes (more acquisition points of an RTU or reprogramming, new application programs, etc.) or some dramatic ones (increasing speed of the computer facilities, new channel for communication, renovation or a complete new module and new technological performance and support, time consumption, etc.), implying costly changes.

After the result in this step, it must be a reevaluation to the step 4.2. Formal Description of the emerging need, in order to reconsider the extent of the emerged need or functionality and if this worth all the impact and changes to be faced. It is a common trend to over size the extent of the needs, specially when the cost, time and efforts are not well known.

4.4. Recommendation of the source, requirements and specifications of the solution to the demanded changes from the emerging need

This step is the evaluation stage for taking the decisions about if the solution can be found inside the Control Center it self or in the commercial vendors offers and the decision of the need for consultants.

The most important objective here is define the requirements and specification for integral and open solutions, tunes with standardization trends of the technology available, and avoiding some short vision solutions with proven or foreseeable rapid obsolescence.

Here a reevaluation of the step 4.2. Formal Description of the emerging need, could be done because some added requirements on the solution's demands, as maintainability, efficiency on the solution, portability, reliability, etc., could need some reconsideration on the extent of the defined emerging need.

The consultants can play an important role in bringing the open and long term vision, specially in the deeper changes or projects.

In this phase it shall be decide how to proceed in the implementation of the work for the fulfillment of the emerge need or *entity*, both in the organizational and technical areas.

4.5. Validation and Verification of the solution to the described emerging needs

A validation and verification procedure of the solution to the emerged need, must have the final assessment about the solution. This is also a tool for the acceptance and final test on the solution achieved. Once the Control Center and the Utility have the comprehensive declaration of the need, this declaration must have the property of validation and verification.

These procedures, validation and verification, has been widely studied on the software field, but with some practical assumptions and similarities in analysis these can be applied to hardware-software systems such as the Control Center . Validation focuses on "accurate performance" reflecting the satisfaction on the needs of the user and the organization, and has been define as the "right system", often focusing on the implementation of specification (related to the phase 4.2. Formal Description of the emerging need of this strategy).The validation is more result-oriented and is for ensuring the satisfaction on the user.

Verification is process-oriented and is focuses on achieving completeness of the necessary specifications, consistency on the procedure desired, efficiency, maintainability and reliability parameters, sometimes define as the "system right" (related to the phase 4.3. Definition of the effects and the demanded changes of the emerging need of this strategy) [7].

Here again, some role of the consultants can be play in the major changes or projects.

4.6. Addition of the solution of the emerged need and new functionality to the role of the Control Center

As the model is evolved permanently, whatever instrument or approach choose, has to be defined with flexible properties, in order to update the new *entities* structure of the Control Center, once the emerged need or new functionality is implemented. The model, the statements used for the *entities* definition , have to be easily updated and remaining simple and comprehensive.

5. Conclusions

This paper is recommending and sustaining a strategy, based in a Planing Process, for a systematic and traceable evolutionary operation, definition and fulfillment of new requirements or functionality of the Control Centers in the Central America context. It is intended to keep in mind the understanding of the real needs as the key of any solution with a close follow up of the state of the art of the standards on openness of SCADA/AGC/EMS Systems [1].

The strategy proposed consist in six phases:

4.1. Understanding and definition of the current role of the Control Center.
4.2. Formal Description of the emerging need.
4.3. Definition of the effects and the demanded changes of the emerging need.
4.4. Recommendation of the source, requirements and specifications of the solution to the demanded changes from the emerging need.
4.5. Validation and Verification of the solution to the described emerging needs.
4.6. Addition of the solution of the emerged need and new functionality to the role of the Control Center.

It is clear that, in the way proposed, the maturity in the exploitation and the understanding of the Control Centers will grow up with better roots on the people and on the real needs, because the changes or additions are taking place step by step and systematically seen. With this systematic approach, which could lead to a complete replacement of a Control Center , the experiences in any of the Center can be shared with the others and from it evolve in a systematic "pool" of common knowledge and written reference.

A key concept called *entity*, have been used for implying the wide spectrum, different perspectives and multiple level of abstraction of the Control Center components.

The Fig 4. summarize the procedure of the Planning Process Approach proposed, it can be notice the **iterative development characteristic.**

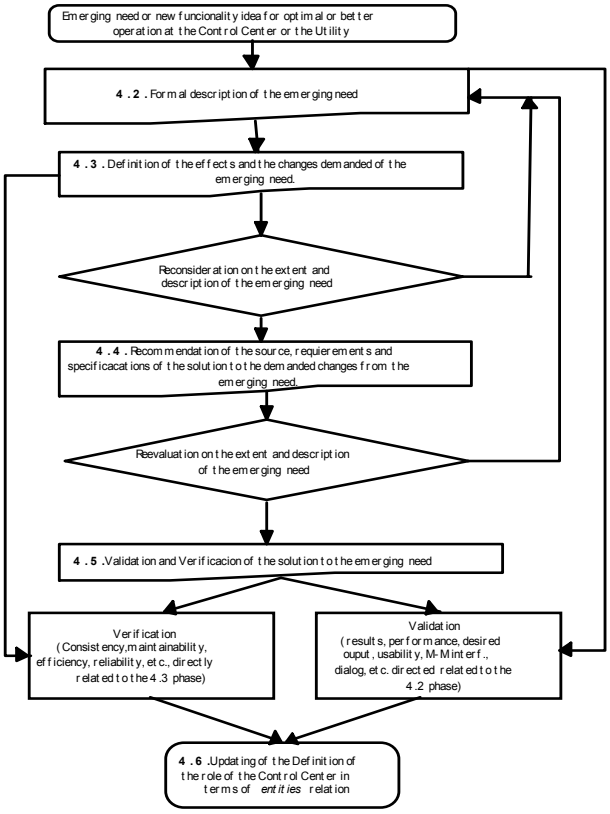

Fig. 4. Summarized procedure of the Strategic Planing Approach proposed.

The paper, in this way, is presenting an alternative strategy for the wide spread paradox of the complex systems: having working things we don't really or fully understand and don't understand what we really need, solving the problem with the ultimate solution available.

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