Experiential Knowledge in TMN

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Abstract

Actually, an expressive portion of TMN management actions lays on professionals' experiential knowledge of this specific area. This knowledge is fundamental for management activities, however it is not represented, inserted, formalized and available in the management models. This paper proposes a model to add experiential knowledge to TMN, using Case Base Reasoning approach, in a structured and standardized way, allowing the development of open support systems. Justification for using case base reasoning approach is given. A Case Framework is described. An example of custom application is presented, as well as model advantages.

Keywords

Experiential Knowledge, TMN Framework, Case Base Reasoning

1 INTRODUCTION

The management models, including the TMN Architecture [1], identify and describe what must be managed, which are the management functional requirements, which logical and physical resource properties are manageable etc. Nevertheless, these models, respecting each user's independence, do not define or describe how to manage, how to solve a management problem, how to implement a management system, etc. The experiences, in how to make and how to solve problems, are fundamental for the management success.

Nowadays, great part of the management actions is based on the experience of professionals involved in the area. These experiences are acquired through the years and individually accumulated by these professionals. Recent studies [2] have been emphasizing that "experiential knowledge" [3], in form of past memories, is an important additional source of knowledge which contributes to learning.

Experiential knowledge guides responding new situations based on similar past experiences. Thus, accompanying technologies by experiential knowledge, describing how the tasks have to be performed while taking into account specific goals and characteristics of a particular management activity, will substantially facilitate their future applications in practice. Reusing experiential knowledge can prevent the repetition of past failures and guide the solution of presently occurred problems. A decrease number of problems and their efficient solution will result in cost and time savings [4].

However, the experiential knowledge, based on previous experiences of management, isn't represented, inserted, formalized or available in the actual management models and tools. Generally, the information models contain only relevant information focused on the basic operations, administration, maintenance and provisioning (OAM&P) aspects of telecommunications networks and services. However, TMN applications are complex and involve knowledge from different natures.

From this context, it's possible to identify the necessity of introducing functionality to the TMN Architecture, which will add capacity and flexibility to the model, to incorporate experiential knowledge, in a structured and standardized way. This will allow to reuse it, when necessary, to add new and important experiences and, mainly, the constant learning.

This article's goal is to add experiential knowledge to TMN, using Case Base Reasoning - CBR approach, resulted from activities in telecommunications management environment, in order to give support in the management actions to the network administrators. The CBR appears to be the optimal approach [5,6,7] for the operationalization of experiential knowledge in practice.

Section 2 presents a brief introduction to CBR approach, where its main characteristics are highlighted. Section 3 describes this article's proposal: experiential knowledge in TMN. In section 4, some examples of applications involving CBR and network management are found. The conclusions are in section 5.

2 CBR - CASE BASE REASONING

CBR is an Artificial Intelligence technique for problem solving and learning with good application for decision-making processes and problem solving, in complex, dynamic environment, and for situations with little available information. It makes use of knowledge extracted from past experiences through real situations of idea developing, product creation, system development, projects and polices implementation, etc.

The CBR's basic philosophy is to make, knowledge from prior experiences available to new situations. From a knowledge base, similar previous situations are retrieved and a prior solution is adapted to the present context, allowing to reuse knowledge. This knowledge is represented through the cases. A case is an abstraction of an experience, composed by attributes which describe not only the experience content, but also the context in which it was inserted. Similar cases have similar solutions [8].

The CBR technique differs from the traditional Artificial Intelligence techniques (neural networks, rule based systems, etc.) because its knowledge is based in experiences, not in abstract models. It allows a continuous increment of the knowledge base and a constant learning from new experiences. A CBR system can be described in a conceptual level by the knowledge representation mechanism, indexing, storage, retrieval, adaptation and learning, and understood through the generic cycle of Figure.1.

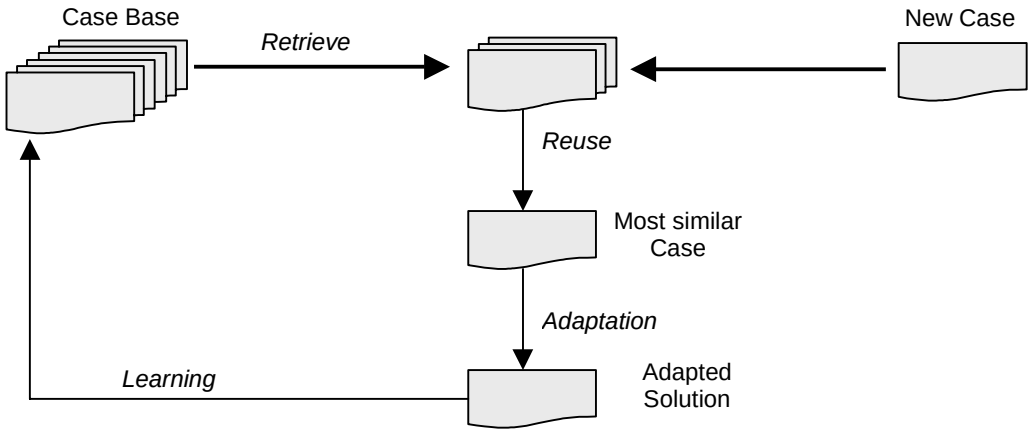

Figure.1 -Cycle CBR

The case representation is essentially the knowledge representation, where a case contextualizes a knowledge, describing an experience. Basically, a case representation includes a past experience description, an applied solution and the results obtained. The case indexing, storage and retrieval, are closely related and dependent. The goal is to built quick and efficient mechanisms which allow to store the cases in the memory, in a case base, to identify and retrieve the past experiences which are more similar to the present case.

From the present context, select the past experiences which have characteristics that match the ones from the new case. One of these experiences will be chosen for being the most similar and for having more relevant and common points with the new case. These aspects are very important to determine the efficacy of a CBR system.

After identifying the most similar case, it may be necessary to adapt the solution used before, to the necessities and restrictions of the new context. As new experiences, successful or not, are included to the CBR case base, it allows an increase and an improvement of the system knowledge base, which guarantees constant learning.

3 BASIC ASPECTS OF THE PROPOSED MODEL

The model proposed here, allows to formalize the experiential knowledge based on management experiences, through CBR and to make them available in a the management environment, in a standardized, transparent, automatic and integrated way. Inside the global architecture of the model, there are two primary components that must be considered to guarantee transparence and standardization : *Functional Architecture* and *Case Architecture.*

The Functional Architecture describes the required functionality to reuse the knowledge from management experiences. It's represented by a reasoning functional block, where contains specific functions related to the reasoning process in the CBR. It's composed by functions that implement mechanisms of indexing, storage, retrieval, adaptation and learning.

The Case Architecture makes use of object oriented principles, it describes the essential elements for the representation of TMN management cases, using the GDMO (Guidelines for the Definition of Managed Objects) [9] and the abstract notation ASN.1 (Abstract Syntax Notation One) [10]. It provides generic templates, which consist of key words to specify the components of a case.

The Case Architecture describes the knowledge base of a CBR system. It's the essential element to guarantee interoperability between the CBR support systems and the different TMN management platforms. To be distinguished from the management information of TMN Information Model, the set of management cases is stored and kept in a case base, defined only in a conceptual level, named Management Case Base – MBC. Which is aggregated to the TMN Architecture. (Figure.2)

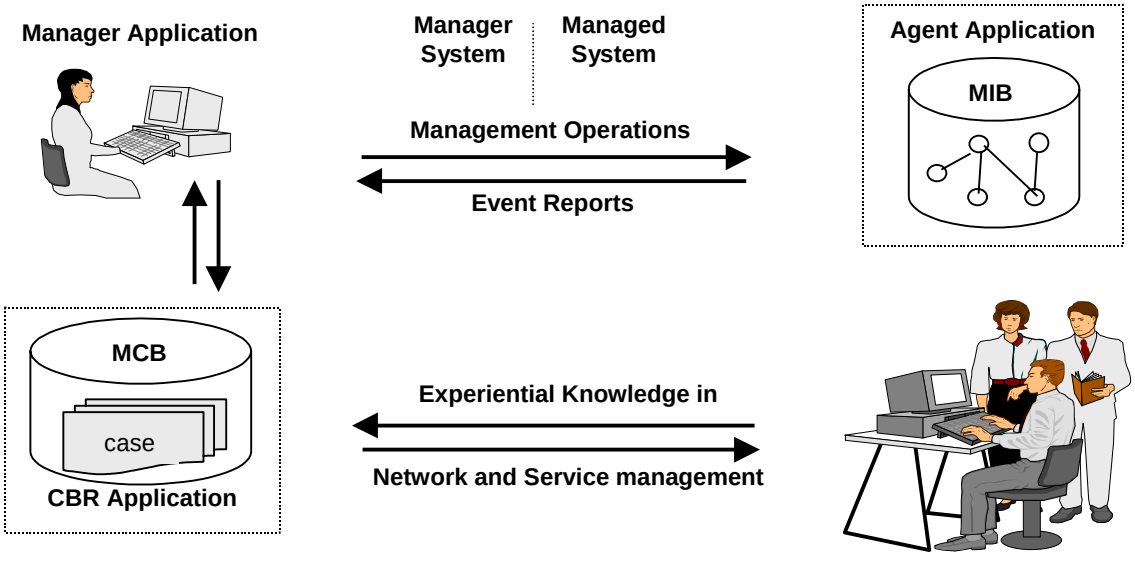

Figure.2 - Expeiential Knowledge in TMN

3.1 MANAGEMENT CASES MODELING PRINCIPLES

The management cases modeling, is based on the Object Oriented paradigm principles, where a TMN management case is an abstraction for an implicit knowledge, representing a useful experience in TMN management.

There may be cases representing experiences in equipment, network, and management applications configurations, to avoid faults, to retrieve faults, to establish security polices, to allocate resources, to implement management systems, to implement service management, to model management information, etc.

The experiential knowledge can be represented by one ore more cases, where each one of the cases represent a different or similar knowledge related to a certain domain. The cases differ through their associated properties. They define a case attribute. Cases with similar experiences are grouped by problem category, forming a tree, referred to as case class hierarchy. (Figure.3)

A management case is said to be an instance of a case class and it shares similar experiences with other members of the same class. New classes can be included through the specialization process, allowing a greater refinement of the knowledge, making it more specific in a certain kind of problem (e.g. *equipment_configuration class*, or *system_configuration class*, both derived from the *configuration class*). Together with the specialization process, there is the inheritance concept.

The case class hierarchy tree is a sub-tree of the inheritance hierarchy from the TMN Information Model [11] (Figure.3). The case class hierarchy tree starts with the *case class* which derives from the *top class*. All the management case classes are sub-classes of *case class*. This is the point for operationalization the addition of experiential knowledge to the TMN Architecture in a transparent, standardized and structured way.

Besides structuring the management cases modeling, the case class hierarchy tree also standardizes the cases primary indexing, storage and retrieval, allowing to share case bases under different TMN platforms and CBR support systems.

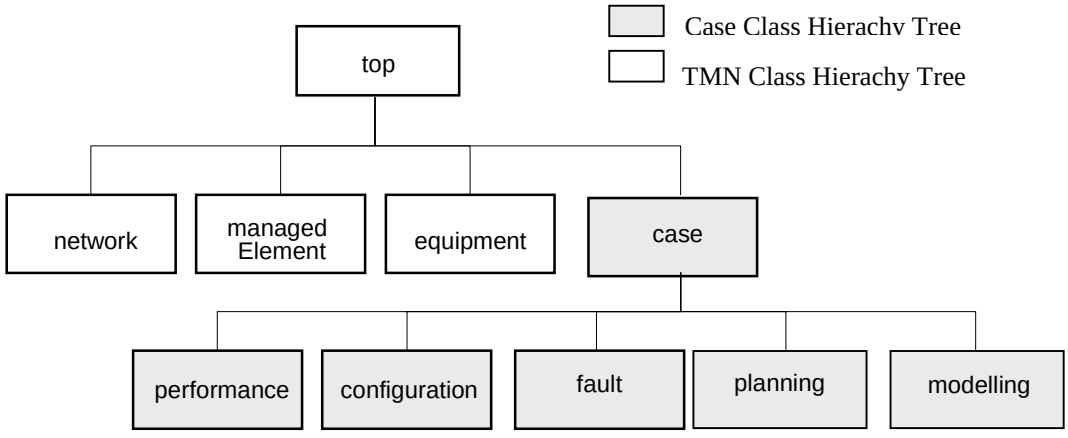

Figure.3 - Class Hierachy Tree

3.2 CASE REPRESENTATION

The case representation involves the description of relevant elements and properties of the modeled experience. The description must have enough elements to identify the case and its similarity with the other cases. In general, a case is represented by an appropriate language to the application domain. This language defines the basic terms, used to describe the problem, the solution, the adaptation, the results and the context in which the case is inserted. Attributed, actions, operations, goals, objectives, restrictions, conditions etc, are used. To guarantee the compatibility the integration with the TMN Architecture, the GDMO and its template were also adopted to model and represent the TMN management cases [12]. (Figure.4)

```
<class-label>           MANAGEMENT CASE CLASS
[DERIVED FROM                   <superclass-label>];
[CHARACTERIZED BY               [<package-context- label>       PACKAGE];
                                [<package-problem-label>        PACKAGE];
                                [<package-solution-label>       PACKAGE];
                                [<package-adaptation-label>     PACKAGE];
                                [<package-outcome-label>        PACKAGE];
                                [<package-index-label>          PACKAGE];
]
REGISTERED AS           <object identifier>;
```

Figure.4 - Generic Template for TMN Case Representation

3.3 PLATFORM INDEPENDENCE

The use of GDMO as a case representation technique and the ASN.1 formal abstract language, allows to identify and document all elements of a case, so that they can be integrated in a transparent way to any kind of implementation.

This way, any manufacturer enterprise of telecommunications equipment or any management solution provider, or even an experienced network manager can create their own case base, describing it through the GDMO, to add value to a product or to freely commercialize it as a support tool for the telecommunications network management activity.

However, to guarantee the development of a management support open systems, using these case bases, the same police used to standardize the Information Model adopted by TMN Architecture, must be adopted. This means, to use an only case class hierarchy tree.

This guarantees that all case base and CBR support application developers, will use the same templates, creating and standardizing new attributes according to specific needs of each open system. It also guarantees that all of them will use standard primary indexes to store and retrieve the cases. These indexes are the classes defined in case class hierarchy tree.

4 THE APPLICATION OF CBR

There is already an impressive number of major companies using CBR for a wide variety of tasks, as can be seen in [13]. In many of the companies (e.g., AT&T, British Telecommunications, Mercury Telecommunications, Nokia Telecommunications, etc.) CBR is been used to provide customer support services. As good examples of CBR successful applications with implications for network management, there are two systems: SMART System from Compaq Computer Corp. and CANASTA System form Digital Equipment Corp.

For TMN, SITA is developing also a proprietary system. For network fault management, the Spectrum from Cabletron Systems provides a Case Base Reasoning Trouble Ticket System. There is a CBR proprietary module to analyze alarms and try to determine a cause. Others applications, like Unicenter TNG from Computer Associates and Patrol from BMC Software, incorporate knowledge modules with CBR similar philosophy. Nevertheless, all these applications are proprietary solutions.

As it can be seen, the potential of the proposed model is enormous, once it allows CBR open solutions development as a support for the decision making process in TMN management environment, creating this way, a new segment in the market for support application for TMN management activity.

The model proposed here, allows each member involved with TMN management, it may be an equipment manufacturer, a solution provider or an experienced professional, to make their knowledge and experiences available, through case bases, to be used by TMN management centers as a support for operation, administration, maintenance and providing activities of the telecommunication network, as well as for management solution development.

The equipment manufacturers can offer their clients case bases, where they will show previous experiences in how to use an equipment properly, how to configure it, how to solve faults, what actions to take when certain alarms are reported, etc.

The software suppliers can describe experiences on agent development, managers creation, security polices implementation, resources allocation, etc. TMN experienced managers can offer their knowledge, acquired through the years. There is certainly, a great market for case bases.

4.1 DEFINING A CASE BASE

Assuming that an equipment manufacturer enterprise decides to create a case base to add value to an equipment. For example, to make a case base for configuration and optimization of a certain switch available, imaginary model *tr2311*, for different telecommunications network environments and contexts.

As it can be seen from the case class hierarchy tree in Figure.3, for example, the manufacturer creates and standardizes the *switch_tr2311 case class*, adding it to the standard case class hierarchy tree (see Figure.5). Sub-classes may be created, such as : *switch_configuration_tr2311*, *switch_fault_tr2311*, *switch_modeling_tr2311, etc.* Different experiences will be defined as case instances of these classes.

After defining the classes, the switch case base can be aggregated to the equipment and be sold as a market differential, obtaining a better price for the product. The switch users may opt to acquire the case base or not. By acquiring it, the switch cases are added to the client's own case base through specific drivers.

Right after that, these cases will be available for the client's CBR management support system, developed by himself or by solution providers, preferentially, integrated to their own TMN management platforms, similar to the TMN management information models acquisition process, which are available nowadays.

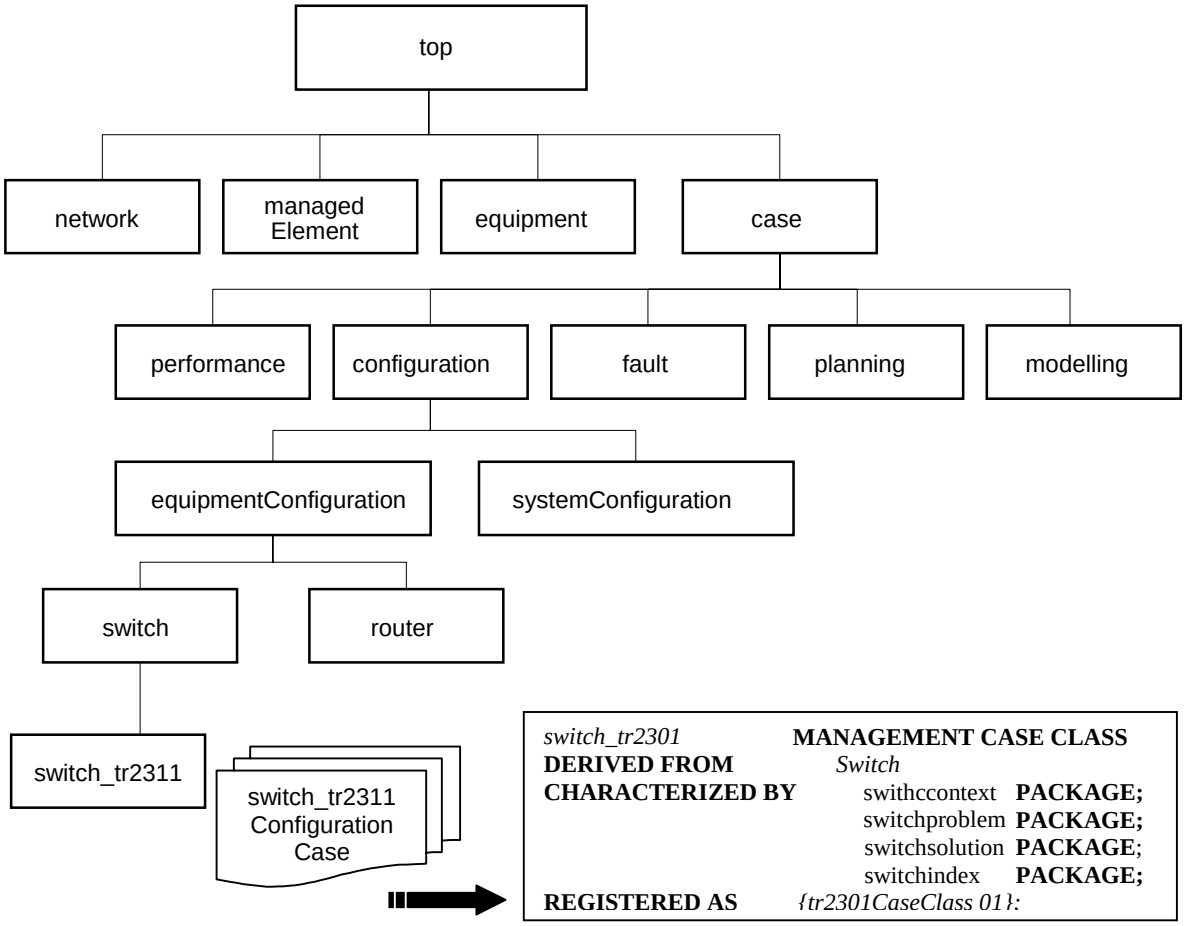

Figure.5 - Configuration Base Case for *switch_tr2301*

5 CONCLUSION

The use of CBR has shown to be efficient in different areas and application types [13], with a great potential for support for corporate and telecommunications networks management. In the market, there are several tools and management solutions that incorporate additional modules of knowledge with information from distinct nature from the ones available in the standardized MIBs. However, these solutions are proprietary and apart of the standards.

The model proposed is fundamental to increase the TMN environment potential, following the open systems philosophy, independent from the manufacturers, suppliers, etc. It's not a proprietary solution, it defines a generic and standardized model for the functional architecture, as well as for the cases architecture. Opposite to this kind of solution available in the market, it introduces experiential knowledge, through CBR approach in a standardized, with compatible TMN Architecture. Today, the presented proposal is in the Case Architecture definition phase.

Another significant point, is the use of GDMO form management cases description. This is a standard technique which possibilities to import case bases, in a transparent way, to any data base, independently from the developer, environment or system. Then, a new segment in solutions for the TMN market is created: support application, using case base reasoning, for the telecommunications networks and services management.

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