PARTNER ASSESSMENT USING MADM AND ONTOLOGY FOR TELECOM OPERATORS

Long Zhang, Xiaoyan Chen
IBM China Research Laboratory, Beijing 100094, China

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Abstract: Nowadays, the revenue of telecom operators generated by traditional services declined dramatically while the value added services involving 3rd party value added service providers (partners) are becoming the most prominent source of revenue growth. To regulate the behaviours of the partners and make the operators be able to select best service for end users, a flexible partner assessment framework is required. This paper 1) presents a flexible partner assessment framework based on Multiple Attribute Decision Making (MADM) method for telecom operators to adapt to the changing requirements of value-added services; 2) proposes ontology to model the complicated relationship in the assessment factors to achieve high extensibility for the increasing decision knowledge. From our study, the method adopted and the system proposed can handle the partner assessment problem and support service selection reasonably in telecom industry.

1 INTRODUCTION

Partner Relationship Management (PRM) is a business strategy that enables enterprises to manage and foster profitable partner relationships through the use of technology. There are many CRM (customer relationship management) providers that have incorporated PRM features in their software applications. PRM can be also considered as a component of CRM that serves the relationships of channel partnerships. However, according to Gartner report, the current PRM research situation is "large vendors still lag in functionality. Market consolidation continues, fuelled by vendors that are combining sell-side commerce with core partner management functionality." Thus it is urgent for enterprise to specify their PRM requirement to change this situation.

For an enterprise, the most important goal for PRM is to achieve "win-win", especially for large enterprises, such as telecommunication operators. Now revenue of telecom operators generated by traditional services, such as local and long-distance calls, is declining quickly, while data services, which are also called value-added services, are becoming the most prominent source of revenue growth. In data services, telecom operators provide integrated infrastructures and interfaces, while third-party service providers which are also called value-added service providers (VASPs), design and provide innovative data services to subscribers through data service delivery platform (DSDP) which is controlled by telecom operators. Revenue from data services are shared between VASPs and operators. NTT DoCoMo has more than 60,000 VASPs. China Mobile, the largest mobile operator in China, has about 3,000 VASPs and the number is increasing quickly.

One problem for operators is that these providers are easy to relapse into malignant competition to snatch subscribers with shocking means, such as pricing cheat. Operator's call centre has to handle complains from customers. This in a long run will greatly damages the operator's image and profit. All these lead to that the operators have to build some mechanism to be able to systematically and scientifically assess the VASPs (partners). Another important requirement comes from the service selection requirement. More and more VASPs would like to wrap their services as web services. The telecom operator acts as a service agent and composes the services from its partners (VASPs) to end users. There may be a lot of candidate services which are providing same function and suitable for choosing. The operator has to select among these candidates according to their historical performance records and their QoS parameters. Then the operator

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(agent) can determine to invoke the best candidate. A service assessment mechanism in partner management system is required.

The situation is that the service assessment criteria vary a lot. For example, Location Based Services (LBS) want real time service delivery while some simple services like weather forecast via short message (SMS) permit reasonable latency. We may use delivery time as critical criterion for LBS services but it is not applicable for weather forecast services. Meanwhile, telecom operators need to change the assessment method from time to time according to the changing market. For example, at the booming stage of a service, the revenue will be the operator's main concern while at a later stage, customer satisfaction will be as important as revenue. Therefore, operators need a flexible assessment framework to adapt to the changing requirements.

Traditionally, Multiple Attribute Decision Making (MADM) has been used to select partner in supply chain. MADM can balance among the assessment factors and evaluate scores of candidates, which provides the evidence for decision making. But it is usually a static selection process. In telecom industry, the operator needs the ability to dynamically select proper service among different candidates in a transaction with an end user. Also, telecom operators ask for a dynamic assessment method which will easily connect with operators' other systems and collect data to perform evaluation continuously. This paper presents a flexible partner assessment framework based on MADM method in which the assessment factors are described using ontology. The proposed ontology method models the complicated relationship in the assessment factors to achieve high extensibility for the continually increasing decision knowledge for partner assessment. Domain expert can flexibly design and revise the structure of assessment ontology, select and design assessment algorithms, replace the old ones with new ones in a plug-and-play way. All the assessment processes are described as a task, including time-based assessment task and real time assessment task. Subscriber can subscribe any kind of assessment task. From our study, the method adopted and the system proposed can handle the partner assessment problem and support service selection reasonably in telecom industry.

The rest of this paper is organized as follows. Section 2 describes the representation of assessment model in the assessment framework. Section 3 discussed the ontology for partner relationship assessment. Section 4 briefly introduces the assessment framework and a case study. Related works of MADM, ontology, and the principle of MADM methodology is described in section 5. We drew conclusion in section 6.

2 PARTNER ASSESSMENT MODEL

Assessment is a sub-process of decision making. Traditionally, the MADA methods which is one embranchment of Multiple Criteria Decision Making (MCDM) are used in computer aided evaluation system to help finish the MADM decision process when such decision process is complex. The most frequently used MADA algorithms are AHP (Analytic Hierarchy Process), TOPSIS (Technique for Order Preference by Similarity to Ideal Solution), Weighted Sum Model, Weighted Product Model, etc. MADM approaches need to define the assessment factors. In real life, to buy a car, for example, price, comfortability, security, oil spending, depreciation, and appearance are all assessment factors. These assessment factors may conflict with each other, which make it difficult for decision makers to balance. MADM provides a trade-off approach for the decision makers. It assigns each factor a decision weight and calculates the weight scores for alternatives or ranks all alternatives accordingly.

However, this kind of software does not support continuous decision process which is required by telecom operators that the assessment and decision making shall be performed periodically or on ad-hoc requests. They are also difficult to integrate with other systems in an enterprise environment and effectively manage the large volume of intermediate assessment results. Here we designed an assessment framework, which can not only support continuous assessment based on the existing MADA algorithms, but also provide effective assessment result management. First, it is necessary to define the assessment model.

Definition 1: A Candidate c is an entity which is evaluated. It is same with alternatives in common MADM literature. A candidate c relates to relationship model M, and has instances $\{I_1, I_2, \ldots, I_n\}$ to be assessed by evaluator E in assessment task T respectively.

The relationship model, instance, and evaluator will be defined below. Only the candidates who share the same relationship model and evaluator can be evaluated together in a specific evaluation task.

The candidate type and its characteristics can be defined by user.

Definition 2: A Relationship Model M is a tree, whose nodes are assessment Factors $\{mf_1, mf_2, \dots, mf_p, lf_1, lf_2, \dots, lf_q\}$, where mf is middle factor node in the tree while lf is leaf factor node. Relationship model is the basis of the assessment framework.

Definition 3: Priority $P=\{p_1, p_2, \dots, p_q\}$ is a domain expert knowledge on the factors. Different evaluators use different forms of priority. For example, the AHP evaluator use pair-wise comparisons to get each leaf factor's weight w_i, and use $W=\{w_1, w_2, \dots, w_q\}$ as its priority.

Definition 4: An Evaluator e is a model on how to evaluate instances using a relationship model. Each evaluator involves a relationship model, a priority, and an evaluation algorithm. For example, the AHP evaluator will use the priority multiplies the instance: $\{w_1lf_1, w_2lf_2, \dots, w_qlf_q\}$ as evaluator model.

Definition 5: Assessment Result S is the score of an instance being evaluated with an evaluator, which can be gotten by $S = \sum_{i=1}^{q} w_i lf_i$ for AHP evaluator.

An assessment is a one-off operation performed on the instances. Its input is the instance data $\{I_1, I_2, \dots, I_n\}$ and its required evaluator E. E can be AHP evaluator, TOPSIS evaluator or others. The output is the assessment Result S, and the rank of each candidate c according to assessment Result S. An assessment task T is an Assessment set. Assessment tasks can be classified as time-based evaluation and event-based (real time) evaluation. The task engine gets each task from knowledge base, parse and execute it. This will be described in section 4.

For time-based evaluation task, the parameters include assessment objects (candidates), time duration, evaluation frequency, evaluator and the mode to get assessment result. The instance data for a specific candidate c will be obtained every fixed sample time interval, and the assessment will be done periodically. For an event based evaluation task, the parameters include evaluation objects (candidates), time duration, the factors whose update will trigger assessment engine to do assessment, evaluator and the mode to get assessment result.

3 ONTOLOGY FOR PARTNER ASSESSMENT

Making explicit domain assumptions underlying an implementation makes it possible to change these assumptions easily if our knowledge about the domain changes. Hard-coding assumptions about the world in programming-language code make these assumptions not only hard to find and understand but also hard to change, especially for someone without programming expertise. In addition, explicit specifications of domain knowledge are useful for new users who must learn what terms in the domain mean.

We need a flexible middle layer. This will make it possible that the system structure and algorithms running upon can be plug-and-play. Separating the domain knowledge from the operational knowledge is another common use of ontologies. For example, we can describe a task of configuring a product from its components according to a required specification and implement a program that does this configuration independent of the products and components themselves.

Ontology has been playing an increasingly important role in many applications, because it provides: (1) a shared and common understanding of the knowledge domain that can be communicated among agents and application systems, and (2) an explicit conceptualization that describes the semantics of the data (Fensel et al, 2000). These two properties of ontology are crucial in modelling the complicated relationships among assessment factors and achieving a high extensibility for the continually increasing decision knowledge for partner relationship assessment. We developed a business partner evaluation ontology for the telecom domain to support the decision making process.

3.1 Partner Assessment Ontology Definition

Part of the upper level of the evaluation ontology developed for PRM is showed in the Figure 1, where the core concept *Evaluation Profile* is the common superclass to describe all kinds of business partner evaluation.

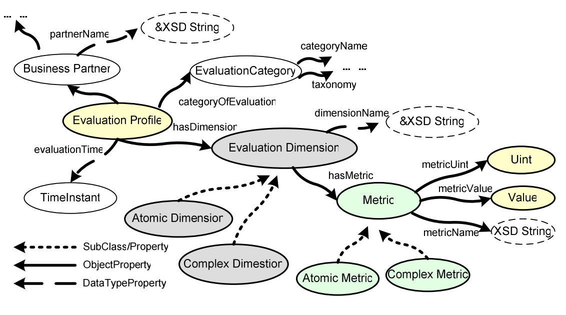

Figure 1: Upper level part of the ontology.

- Business Partner: the object to be evaluated. It has name and other attributes.
- Evaluation Dimension: a kind of measure for evaluating a business partner. The evaluation dimension can be divided into *Atomic Dimension* and *Complex Dimension*. The Complex Dimensions are composed of (atomic dimension or complex dimension) dimensions.
- Metric: a standard of measurement. *Metric* is a common superclass for all other metrics and has related property *metricUnit*, *metricValue* and *metricName*. *Metrics* can be divided into *Atomic Metrics* and *Complex Metrics*. The atomic metrics are directly measured by corresponding observers. The complex metrics are composed of other (atomic metric or complex metric) metrics.
- Evaluation Category: describes categories of an evaluation on the bases of some classification.

By applying sub-classing to the concepts in the upper ontology, we then developed the *Provider Evaluation* sub-ontology, partially showed in Figure 2. We investigated partner assessment methods of some operators. Based on our analysis, we propose the following dimensions for partner assessment.

- Service. “Service” is a complex dimension and can be divided into “Service QoS”, “Service Interface” and “Service Function” dimensions. The metrics for “Service QoS” are “Ratio of download overtime times”, “Ratio of response Overtime Times”, “Definitions and Readability”, and “Convenience for use”. The metrics for “Service Interface” are “Service’s physical connection”, “protocol of interface” and “possibility of exceptions”. Figure 3 depicts the definition of “Service”.
- Revenue. It includes “Revenue Ration”, “Revenue Incremental Ration”, “User Number Ratio”, “User Incremental Ratio”, “Homepage Visit Ratio”, and “Homepage Visit Increment”.
- Management. It includes “Follow-up Required Propagandize”, “Result in negative Report from Media”, “Violate Cryptic Agreement”, “Provide Charge Agent Service”, “Customer or Price Cheating”, “Push Advertisement without Customer Permission”, and “Cooperation Satisfaction”.
- Customer QoS. It includes “Complaining Ratio”, “Complaining Processing Ratio”, “Complaining Processing Efficiency”, and “Customer Call Switch-on Ratio”.

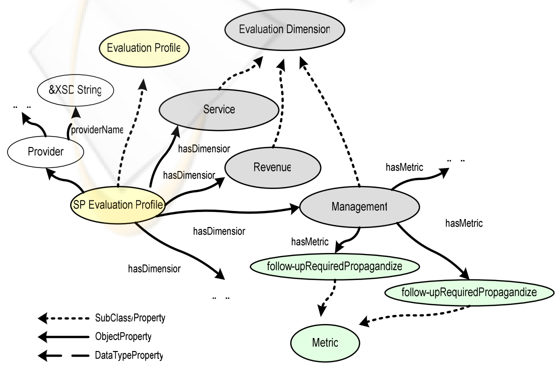

Figure 2: Provider Evaluation sub-ontology.

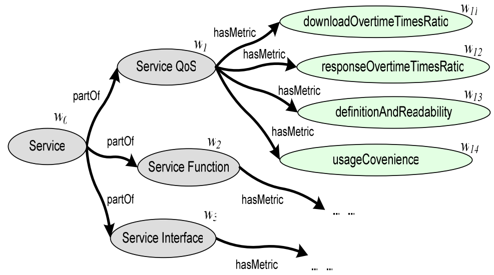

Figure 3: “Service” in Provider Evaluation ontology.

3.2 MADM based on Partner Assessment Ontology

Many MADM algorithms compose the evaluation factors as a tree. Usually, the evaluation factor tree comes from information system. With the development of knowledge base technology, an enterprise information schema will be or has been described by ontology as a reusable asset. Ontology usually has a graph structure, while evaluation factors employ a tree. In our previous work (Nanavati et al, 2005), a method was proposed to get MADM required tree structure from ontology with graph structure, which will be an important processing for building a MADM based evaluation system. The transformed ontology tree will then act as the Relationship Model defined in section 2. For example, in Figure 3, assume the sub-ontology is a tree structured one after transformation. The leaf factors are assigned with weights w_{11}, w_{12}, w_{13}, w_{14}, ... The weights of middle factors can be calculated recursively. For example, $w_1=w_{11}+w_{12}+w_{13}+w_{14}$; $w_0=w_1+w_2+w_3$.

Currently, ontology storage and query is being widely investigated in the semantic web community (Beckett, 2003; Alexaki et al, 2001). Moreover, many researchers are working on evaluating the performance of ontology repositories (Guo et al, 2005; Tempich and Volz, 2003). The candidates and instances defined in section 2 can be stored and queried using the existing techniques.

4 PARTNER RELATIONSHIP ASSESSMENT FRAMEWORK AND CASE STUDY

Based on the above definition of assessment and ontology, we design the architecture of assessment framework as shown in Figure 4. There are three roles of external actors of the assessment framework. The actors may be from telecom operation departments: 1) *Domain Expert* who defines relationship model *M*, and the specific evaluator *E*. 2) *Data Operator* who inputs information of candidate according to requirement, and inputs information of instances of the candidate as defined in section 2. 3) *Subscriber* who subscribes assessment task *T*, gets assessment result *S* using the mode predefined, and starts the assessment engine to do assessment.

Usually, the instance data are gotten from outer systems, such as *Call Center*, *Billing System*. The *Instance Data Receiver* supports both pull and push modes to get data and store into knowledge base by *Semantic Framework*.

- Relationship Model Designer

A domain expert builds its own relationship model by using existing models or creates a brand new one. In MADM approach, the relationship model can be depicted as a tree. Ontology is used to describe the tree and is stored into knowledge base.

- Algorithm Framework

All the evaluation MADM algorithms can be plugged into the *Algorithm Framework*. When a domain expert decides to use a specific MADM algorithm such as AHP algorithm, the expert can tailor the relationship model to decide the assessment factors, and select or designate each factor's weight.

- Task Manager and Task Engine

All the evaluation tasks are designed and managed in *Task Manager*: get evaluation tasks from the database and manage the execution. *Task Engine* is the place where a task is actually evaluated.

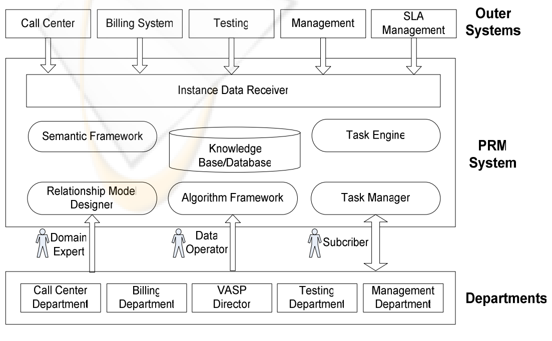

Figure 4: Architecture of the Evaluation Farm.

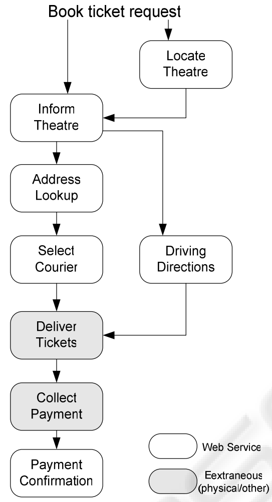

Figure 5: A case study.

- Semantic Framework

With the ontology engaged in the framework, we achieve a flexible framework and can flexibly define and change the evaluation algorithms. The *Semantic Framework* is responsible for storing data into the knowledge base and evaluating requested queries.

Based on the description, we implemented a partner relationship management prototype system. Preliminary experiments show that the method adopted and the system can handle the partner relationship assessment and give guidance of service selection reasonably.

Here a case study is used to show the usage of PRM system. A mobile operator can offer a "Ticket Master" like service. The process is depicted in Figure 5.User John sends request to his mobile operator through short message, Web portal, or IVR (Interactive Voice Representative) to book movie tickets for a theatre in his vicinity. The tickets are booked, and the theatre is informed of the booking. Since John has an account with the operator, his address is looked up. Based on the locality, the corresponding courier is selected and John's address is passed on to the courier. The courier gets driving directions from a mapping service which delivers the ticket and (optionally) collects the payment. The payment may be collected on delivery or billed to John in his next billing cycle.

Note that "Deliver Tickets" and "Collect Payment" are not web services, but are physical activities that are reflected in the electronic world by their confirmation. "Book Tickets" happens at the mobile operator. "Inform Theatre" happens at the Theatre. "Address Lookup" happens at the Directory Service Provider (DSP). "Select Courier" happens at the mobile operator. "Driving Directions" happens at the Mapping Service Provider (MSP). "Payment Confirmation" happens at the mobile operator.

A single mobile operator may have 5 theatres, 3 couriers, 3 DSPs, 2 MSPs and 3 banks registered as service providers. Therefore, partner evaluation and service selection is possible. The relationship ontologies for theatres, couriers, DSPs, MSPs and banks should be defined according to the methods described in section 3.

5 RELATED WORKS

MADM refers to the problem of selecting among alternatives associated with multiple, usually conflicting, attributes where the decision maker's preference information is often used to rank alternatives. As a branch of decision making method, MADM has gained wide usage in management and engineering. For example, Aura Reggiani uses AHP and TOPSIS to evaluate a set of a priori selected airports alternatives for airline (Janic and Reggiani, 2002). Maggie C.Y. Tam and V.M. Rao Tummala use AHP to select the vendor for a telecom system (Tam and Rao, 2001). They investigated the feasibility of applying the AHP in vendor selection for a telecom operator to improve the group decision making by a more systematic and logical approach. Work in (Ceccaroni et al, 2004) proposes the OntoWEDSS system which uses ontology to improve the diagnosis of faulty states of a treatment plant. The system supports wastewater-related complex problem-solving, and it facilitates knowledge modelling. Work in (Li et al, 2001) uses ontology to describe the competencies of an enterprise based on which a decision support system for enterprise bidding is built.

This paper distinguishes itself that it investigated a specific industry – telecom and provides a solution based on MADM for operators to assess their partners (VASPs) effectively. The ontology to model the complicated relationship in the assessment factors helps achieve a high extensibility for the increasing decision knowledge for partner assessment. The proposed system is easy to integrate with other telecom systems.

6 CONCLUSION

The paper presented a flexible partner assessment framework based on Multiple Attribute Decision Making (MADM) method for telecom operators to adapt to the changing requirements of value-added services, and proposed to use ontology to model the complicated relationship in the assessment factors to achieve high extensibility for the continually increasing decision knowledge for partner assessment. Preliminary usage of our prototype system showed that our approach was practical to be used in telecom industry. The approach would dramatically improve customer experience and the quality of services. Furthermore, this will significantly improve the competing ability of telecom operators and increase their marginal profit especially with the 3G and NGN (Next Generation Networks) bloom the data services.

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