Constructing E-Tourism Platform Based on Service Value Broker: A Knowledge Management Perspective

Yucong Duan*, Yongzhi Wang†, Jinpeng Wei†, Ajay Kattepur‡, Wencai Du**
* *Hainan University, Haikou, P.R.China.*
†*Florida International University, Miami, USA.*
‡*INRIA Paris-Rocquencourt, Paris, France.*
Email: duanyucong@hotmail.com, {ywang032, weijp}@cis.fiu.edu, ajay.kattepur@inria.fr, wencai@hainu.edu.cn

***Abstract*—In our previous work, we have introduced various service value broker (SVB) patterns which integrate business modeling, knowledge management and economic analysis. In this paper, working towards the target of maximizing the potential usage of available resource to achieve the optimization of the satisfaction on both the service provider side and the service consumer side under the guidance of the public administrative, we propose to build the E-Tourism platform based on SVB. This paper demonstrates the mechanism for SVB based E-Tourism framework. The advantages of employing SVB include that the SVB can help to increase the value added in a realtime and balanced manner which conforms to the economical goal of both long run and short run. An experiment is shown using a personnel recommendation system.**

***Keywords*-knowledge management, service value, value added, Big Data, broker**

I. Introduction

A. The service value broker

Software design patterns [15] have been proved proposed and verified successfully in the modeling processes of multiple technical domains. However for modeling for modeling service oriented computing (SOC) applications, design patterns have to be adapted according to value of Quality of Service (QoS) or business contractual aspects. We refer to this as the *Service Value Broker (*SVB*)* pattern [9]. *SVB* has already been proposed for cloud service brokerage [22] which we foresee as an important characteristics of the optimization of the E-Service composition of [16] E-Service Economics. The related definitions are as follows [9]:

- *Service Value Broker* (*SVB*): driven by a value based goal, when a direct service composition cannot meet some required constraints from the service contract [7] or service level agreement(SLA) such as response time, location, license area, available period, currency format. If the introduction of a intermediate service can help to solve these problems and enable a service composition to be qualified, the introduced intermediate service is a *SVB*.
- *Direct Service Value Broker* (*DSVB*): direct *SVB* is a special type of *SVB* resulting from a composition of services. This composition must bring more value to the stakeholder who introduces the *DSVB*. By value we mean not only monetary value but also non-monetary such as reputation and brand value, etc.

From the perspective of value analysis, a simplified formulation of the difference between constructing a traditional broker and a *SVB* is as follows:

1) *Quality driven* - For constructing a traditional broker, a composing service is chosen based on the order of the *quality* of its functionality. And for a set of composing services, the priority is in ratio to: $\sum_{integration} (quality)_{i...n}$.
2) *Price/quality driven* - For constructing a SVB, a composing service is chosen based on the order of the *price/quality* of its functionality. And for a set of composing services, the priority is in ratio to: $\sum_{integration} (price/quality)_{i...n} + \triangle_{valueadded}$.

B. Building E-Tourism on the brokerage

To cope with the challenges of E-Tourism systems such as multiple sources of data processing, high dimension of database, large linked data, huge amount of sensor data collection, and realtime response, etc, we propose to alleviate the problem solving from a knowledge management perspective in combination with a SVB based framework. *SVB* directly centers service value implementation and service value optimization. We have collected demonstrative *SVB* in [11]. In this paper, we propose to use *SVB* as the base to integrate three important sides of a service ecosystem: service provider, service customer and public administration [6]. Each of these three sides maintains an independent interest or value system and at the same time relates to others as an element of an global value calculation system. SVB is expected to function as an important source of *value added* for optimizing the whole system under the comprehensive evaluation/measure in terms of value.

The expected contributions of this architecture include the follows:

- *Enhanced knowledge management granularity* - From knowledge management perspective, SVB based architecture will leverage the abstraction level of the knowledge decomposition since problem description can be decomposed or mapped to knowledge pieces represented by various SVB elements above the data map stage in a MapReduce framework [29], and the result can be integrated as a general solution through the SVB based knowledge pieces above the level of data level of the reducing stage of a MapReduce implementation as well.
- *Value added focused* - SVB is designed to bridge the barrel of both functional and QoS sides in both individual service select and service composition to reach a measurable value increase. Under a well managed knowledge management implementation, a balanced result in terms of the comprehensive value can be fairly expected.

The rest of the paper is organized as follows: SectionII presents background knowledge and the general scenario. Section III presents the analysis of the sources of value added brought by introducing SVB and the comprehensive analysis. Section IV presents an experiment on a personnel recommendation system. This is followed by related work in Section V and conclusions with future directions in Section VI.

II. The background and scenario

A. Demonstration of E-tourism related SVB

Here we demonstrate some SVB and DSVB [11] which compose an E-Tourism system. We assume the existence of E-Contracts among stakeholder. We denote the contract on the source end of an exchange as CS, the contract on the target end of an exchange as CT, the input of SVB/DSVB contract as iSVB and the output of a SVB/DSVB contract as oSVB.

1) **Weather forecasting** ($WF \in \mathbb{D}_B$): weather forecast is a costly and challenging task, however a lot of organizations might need this service with specific precision request.
Target: $WF|_{CS} < WF|_{CT}$
$SVS = (0, \delta(WF|_{CT}, WF|_{CS}))$
weather forecasting broker: by subcontracting the weather forecasting to a professional service, it actually implement a reuse of resources including professional knowledge, etc. Similarly we can identify numerous application level brokers such as: vender broker, data cleaning broker, etc.
Solution: $WF(task)|_{CS} \rightarrow WF(task)|_{SVB}$
2) **Operation security**:($OS \in \mathbb{D}_S$) the *completeness* and *reliability* of a series of operations and behaviors of a service transaction is defined as operation security.
Operation security broker: a service which checks the atomic actions and monitors implementation of the sequence of execution or protocol of interactions can play the broker.
Solution: $(OS|_{CS} \rightarrow check(atomic)|_{iSVB})AND(OS|_{CT} \rightarrow monitor(protocol)|_{oSVB}))$
3) **Information privacy**:($IP \in \mathbb{D}_S$) during a transaction, some pieces of information which are not required or are not necessary for a transaction might be required or leaked without notice.
Information privacy broker: a service which checks and restricts the usages of service information based on a necessary-only policy may play the broker.
Solution: $(IP|_{CS} \rightarrow (check(access)|_{iSVB}ANDvalidate(necessary)|_{iSVB}))$

B. Composition of SVB

There are various situations where SVBs are composed with different cardinalities of "1:1", "1:n", "m:n", and sequences. We classify the composition modes as follows:

1) **Vertical composition**: We take the *Location broker* as an example.If requests are restricted to be "from China" while the customer want to visit "as much nations of Europe Union as possible" without additional registration. Then a solution can be built on the integration of *Location broker* which takes request "from China" while has the authority to issue the pass for only one nation.
Solution: $(LC|_{CS} = \{LC|_{iSVB}\}_{1...n})AND(\{LC|_{oSVB}\}_{1...n} = LC|_{CT})AND(\sum(coverage(LC)|_{oSVB}) = coverage|_{CT})$
2) **Horizontal composition**: We take the *Currency broker* as an example. The payment is restricted to be "Czech Koruna" while the customer has only "Thai Baht". If a *Currency exchange broker (a)* which exchange "Thai Baht" to "Euro", and a *Currency exchange broker (b)* which exchange "Euro" to "Czech Koruna" are available. The connection of the two brokers will construct a solution from this customer to the provider.
Solution: $(CE|_{CS} = CE|_{iSVB(a)})AND(CE|_{oSVB(a)} = CE|_{iSVB(b)})AND(CE|_{oSVB(b)} = CE|_{CT})$
3) **Intelligent composition**: For an agent SVB [23], to increase its general profit for providers it will consider the provider side situation such as the real time sales data and yearly historical sales record at different seasons. After a comprehensive calculation, it will offer probably a discount strat-

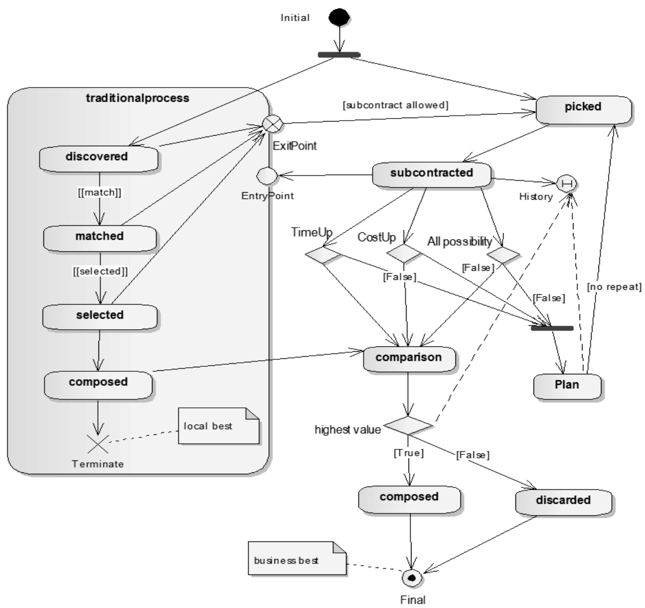

Figure 1. The SVB based processing

egy or advertisement plan, such as a case that if a customer can purchase several services as a bundle, there will be a 30*percent* discount which will be mutual beneficial to both customers and the provider. Also at customer side, if negotiation is permitted among customers, they can form **Service federations** to jointly collect and build their purchase items into service bundles to benefit from the discount offer from the provider side.

Figure 1 shows the state diagram of a E-Service in a SVB composition process. A traditional process is embedded as a comparison. During a traditional process, a service is firstly discovered and then it will go through a sequential process of " *matchmaking* $\rightarrow$ *selection* $\rightarrow$ *composition*". The result is a local solution which does not fully take advantage of the potential of the flexibility of E-Services in a scalable cloud environment. When the business value is given the highest priority, the subcontracting relationship implemented by SVB could bring potentially higher value. SVB based solution can fully explore the potential of the available resources, for the processing only when one of the conditions of: (a) the assigned search time is finished, (b) the cost reaches limit, and (c) all possible subcontract scenarios have been explored, has been met, the search will end. The result will be a global best value in terms of business gains on all parties.

C. *The general business scenario*

Figure 2 shows the general scenario of multiple service values from mainly three sources. We summarize them as follows:

1) *Provider value (PRV)* - At service provider side, business value need to be considered from the temporal dimension as short run vs. long run target which will decide specific business strategies such as new product advertisement, promotion, sell out, etc. Among providers the value can be classified into two categories:
   - *Negative competitive cost* - Negative competitive cost occurs when other business competitors who offer similar services bid for the same order or market.
   - *Positive cooperative wins* - When service vendors who offer related or similar services agree on some fixed conditions such as market share, sells area, etc, they can build some cooperations to profit from the customer side such as lifting the price of services or charges of maintenance, etc.
2) *Customer value (CSV)* - Service customers in general have independent views on the value of the targeted services. However customers can socialize with other customers to query the quality of a service from others' experiences and comments. The experience information or news/advertisment propagated through social media among customers is playing an increasing role in promoting sales and adjusting commerce behavior. Customers can also build federations to protect their shared interests against malicious service providers with shared cost. Small scale of customer cooperation can cooperate to win promotion sale packages from providers in a win-win manner.
3) *Public value (PUV)* - The public administration is the third party which can play the juridical role for solving the argumentation. The public administration also has other critical responsibilities: (i) monitor the service market through economical analysis to avoid the competition between the provider and customer side to enter an Zero-Sum game; (ii) employ public policies to intervene the strong cooperation against customer interests at the provider side, or collusive customers [28], etc.

These different sources of values are weaved together in a business transaction. Using E-contract of services as the media, the work flow can be described as follows. Firstly on the service provider side, *PRV* will be arranged to document the content and SLA of to be provided E-Services in the form of E-Contracts. Secondarily customers will find and do matchmaking of the available E-Contracts of available E-Services. During this stage, SVB can be introduced to enlarge the scope of the choice space on the customer side while increasing the chances on the provider side[10]. The key factor of the SVB

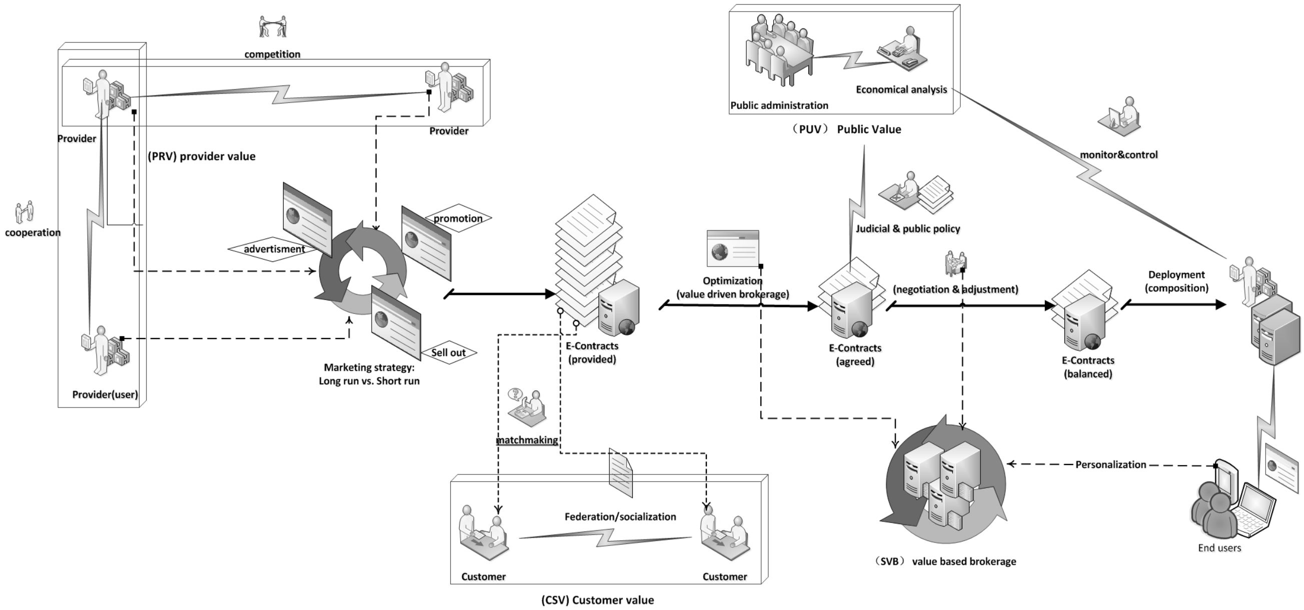

Figure 2. Integrating value considerations from multiple stakeholder with value brokerage

practice lies in making full use of the available/assigned computational resource from the customer side and the permitted sub-contract relationship to explore an optimal [9] result in terms of value measure.

D. Domain knowledge based classification of SVB

From the domain of E-Tourism, we have identified many application areas which can be implemented with SVB in different categories[11] which is shown in Figure 3.

- *Information category* - Related brokers include the translation broker[11] which deals with the language mismatching situations in multiple language information query, multiple language route planning, etc, the information broker [11] which provides optimal choices to customers for hotel reservation, flight booking, car renting, local weather forecast, traffic control, daily care, etc, and the proxy broker [11] which technically supports fixing mismatching situations such as location mismatching, time mismatching, and IP mismatching, etc.
- *Data category* - Related brokers include the format broker [11] which integrates the data or file format for channeling the information flow among various institutes and organizations, and provides realtime currency exchange [11] for payment calculation, etc, and the data QoS broker which deals with mismatching situations of the usage policy of data, privacy of data, copyright of data based usually on the data contract [26].
- *Operational category* - Related brokers include the operation broker which deals with price faulting, disaster rescue optimization, food safety surveillance, restaurant sanitary monitoring, medical care resource optimization, insurance recommendation, etc, and the service QoS broker which helps to cater the mismatching situations of availability, latency, and throughput restrictions [11], etc.
- *Intelligent implementation category* - Related brokers include the optimization broker which deals with the compositional issues of service competition and service federation [11] under related value targets. Optimization surpasses the scope of individual services which focuses on specific functionalities or quality properties, and the business broker which deals with the judical issue of service compensation, trust infrastructure, and reputation brokerage malpractice, security brokerage, local public policy enforcement, global business value calculation and balancing, and personalization based on Big data analysis, etc.

III. The analysis on *value added*

A. Sources of value added

Building an E-Tourism architecture on top of SVB are expected to have several possible advantages if well managed including the following basic situations:

- *Added value of PRV* - On the provider side, SVB can bring more business chances through relating otherwise not related business together such as creating an international language translation platform which can redistribute translation request to individual translation service providers. The added

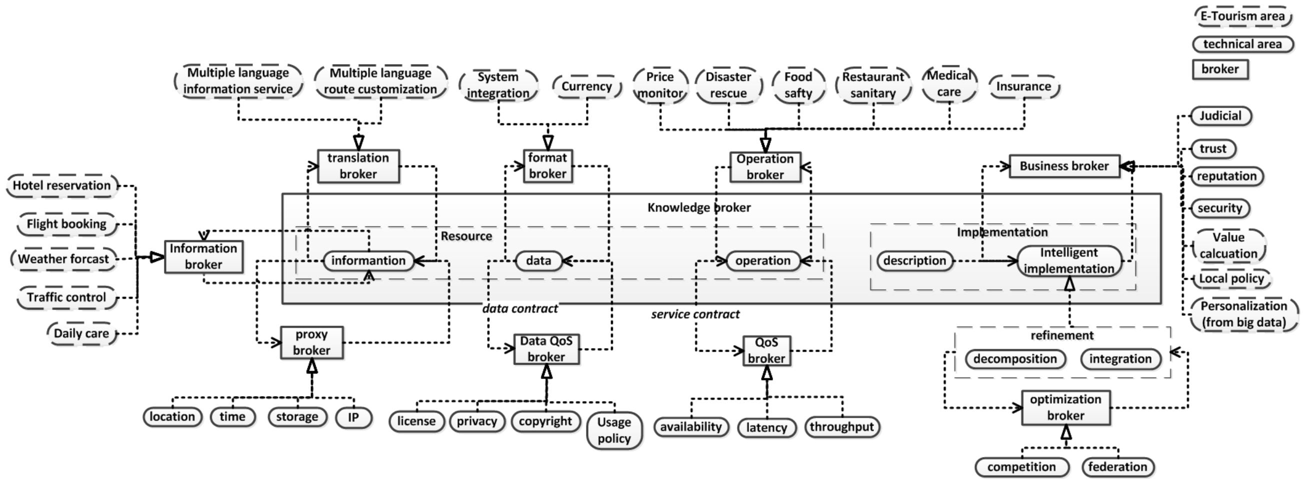

Figure 3. E-Tourism related SVB classified from a knowledge management perspective

value $\triangle_{PRV}$ on a specific provider X_P can be calculated as the multiplying of the increased amount of request $\triangle_{req}$ with the difference of the price $\triangle_{price}$:
$\triangle_{PRV}$ $(X_P) =\triangle_{req} * \triangle_{price}$
The cost on the broker provider X_{PSVB} can be assumed to be balanced to simply the calculation here for demonstration purpose. But in real situation, there can be added value on X_{PSVB} through reuse of information and operation, etc [8].

- *Added value of CSV* - On the customer side, SVB can bring more opportunities through sub-contract [9] relationships for customers to find expected services with the highest comprehensive value. The added value $\triangle_{CSV}$ on a specific customer X_C side can be calculated as the sum of the gains from the saved cost on service payment $\triangle_{pay}$, the increased satisfaction $\triangle_{sat}$ and the cost for extra searching $\triangle_{cos}$:
$\triangle_{CSV}$ $(X_C) =\triangle_{pay} + \triangle_{sat} + \triangle_{cos}$
- *Added value of PUV* - On the public administrative side, SVB can be utilized for several important purposes which include the follows:
  - *Added value of* $PUV_{competition}$- play the judical role which can lower the cost of market adjustment in comparison with the free market situation where Zero-Sum game can hurt the gain of both CSV and PRV. The gains can be calculated as:
  $\triangle_{competition}= \Sigma avoid(loss(PRV)) - cost(interfere(PUV))$.
  - *Added value of* $PUV_{cooperation}$- SVB can also be used to interfere the forming of a dominating side in the provider side through collusive cooperation which will hurt the regular competition and the gain of CSV. The gains can be calculated as:
  $\triangle_{cooperation}= \Sigma avoid(malpractice) - cost(tradeoff(PUV))$.
  - *Added value of* $PUV_{security}$- SVB can be employed to provide public qualified third party security services which will save the total spends from the individual cooperations. The gains can be calculated as:
  $\triangle_{security}= \Sigma increaseefficency(individual) - cost(security(PUV))$.
  - *Added value of* $PUV_{BigData}$- SVB can be employed by the public administration to evaluate the technological innovations such as Big Data processing for both personalization and public intelligence, and harness their implementation to avoid their malpractice in terms of both business value and social effect. The gains can be calculated as:
  $\triangle_{BigData}= \Sigma avoid(malpractice) - cost(tradeoff(PUV))$.

  The general added value brought from public side can be calculated as:
  $\triangle_{PUV}= \Sigma \triangle_{competition} + \Sigma \triangle_{cooperation} + \Sigma \triangle_{security} + \Sigma \triangle_{BigData}$.

The metamodel of SVB is shown in Figure 4. It shows: (a) the inherent architecture of SVB with regard to well known concepts such as interface, broker, E-Service, E-Contract, SLA, and public facility[6] which includes law, local policy and administration; (b) the relationship with target problems including service mismatching processing, service selection, optimization and their composition; (c) the target solution in the form of SVB value including functional value, QoS value, security value and business value in general; (d) the sources of added value related to technological innovation related to Big Data

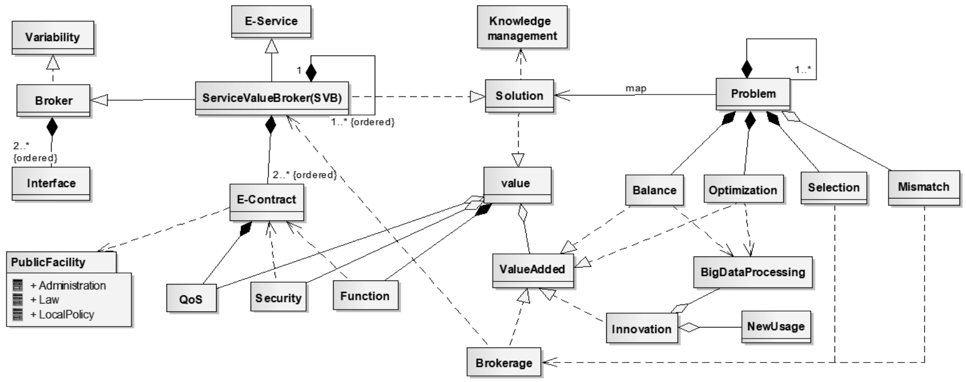

Figure 4. The metamodel of the brokerage supported value added attaining

processing, new usage discovery and SVB application. Different from traditional brokers which focus on functional value and QoS, the value which is implemented by SVB requires the composition of business value and functional value.

B. *Tradeoff on long run vs. short run*

1) Influence factors: In classical economics, the profit mode of a business transaction will be distinguished as long run vs. short run [14]. In a long run, factors such as cost and price will be modeled as variables in contrast to being modeled as fixed amount in a short run. This difference will be reflected directly to value added accumulation towards profit-maximization. For a short run mode, the value added of $\triangle_{PRV}$ or $\triangle_{CSV}$ or $\triangle_{PUV}$ will be positive as long as the marginal cost is lower than the marginal revenue which represents the added profit corresponding to the increase of a unit of production. Similarly a production decrease strategy can be made. There are several variability which should be taken as knowledge rules to guide the attaining of the profit-maximization considering both long run and short run.

- *Cost/price adjustment* - by taking advantage of the timely processing of E-Contracts, SVB can realize timely adjusting price to balance the ratio of price/cost for a short run.
- *Marketing plan* - SVB can be composed to implement complex price strategies of a long run such as at the beginning of a business, the marginal cost is allowed to be greater than the marginal price to implement the marketing strategy of advertisement, the price can be increased since after to gain the main profit, and a sold out can be planned to recollect the money flow for an investment with higher reward business, etc. The general evaluation can be positive as long as the average profit in a long run is positive.
- *History based prediction* - the transaction history of customers/providers can be analyzed based on the added value calculation on the top of SVB to make decision on the adaptation of price and production.
- *Public policy implementation* - the public side can employ the power of Big Data processing to analyze added value from various sources covering both $\triangle_{PRV}$ and $\triangle_{CSV}$. Corresponding encouragement policies can be made when the
$\sum(\triangle_{PRV} + \triangle_{CSV})$
is decreasing or the acceleration of the increase of the
$\triangle\sum(\triangle_{PRV} + \triangle_{CSV})/\triangle_{time}$
is decreasing. Intervention can also be introduced to interfere the situation that the provider side dominates the price making against customer side through the monitoring of the ratio of
$\sum(\triangle_{PRV})/\sum(\triangle_{CSV})$.

2) The general profit: We formulate economic formulas to highlight the general profit calculation in comparison with traditional business:

Traditional economics:

$$\max(profit) \approx \max(\oint_{capitalspace}\oint_{bussineslifecycle} (marginal(price) - marginal(cost)))$$

SVB enriched E-Service Economics:

$$\max(profit) \approx \max(\oint_{capitalspace}\oint_{strategyspace} \oint_{bussineslifetime}(f_{strategy}(price) - marginal(cost)) - f_{strategy}(cost(SVB))))$$

$$strategyspace \approx \frac{capability(ValueAdded(subcontract(SVB)))}{budeget_{\alpha} * budeget_{\beta} * budeget_{\gamma}}$$

α: project time plan; β: dispensable capital; γ: resource of (i) computation; (ii) storage; and (iii) network

IV. Experimentation

We implemented a prototype system to show the proof of concept of *SVB*. We pick the personalization (right lower corner of the Figure 2 as an example to show how the SVB can collaborate with Big Data analysis on *PUV* to improve both the *PRV* and the *CSV*. In the E-tourism business, recommending suitable restaurant for the tourist will increase the degree of their satisfaction, At the same time, a good restaurant recommendation will increase the profit of restaurant and tourism company, reducing complaining. Our system offers a value based brokerage service to make personalized restaurant recommendation for new customer based on previous customer's rating history. It is developed on Mahout Recommender [1]. Mahout is an open source data mining framework based on MapReduce computing model. Its recommender class is extended to support multiple recommendation algorithms. We use item based recommender and different similarity measurements to perform personalized recommendation. We use "*Restaurant&ConsumerData*" data set [2] from UC Irvine's machine Learning repository. We only use its *rating_final.csv*, which records 1161 instances of rating information. Each instance represents a rating of a customer towards a restaurant. The possible rating values are set as 0, 1, 2. We preprocess the data set and parse the following format to the Mahout recommender: "$customerid \mid restaurantid \mid customer'srating$". The output produces top ten most preferable restaurants for each customer.

The system partitions the data set into two parts. The first 80% of data is fed to the recommender to generate the preferable restaurant. The remaining 20% of data is used to evaluate the recommendation. We use Mean Squared Error (MSE) to evaluate the recommendation result. For each customer, if his rating for a certain restaurant appears in both the 20% of evaluation data and the recommendation result, we compute the MSE of those ratings. We generate the average MSE for each recommender method. Intuitively, the lower value of MSE a method can get, the higher SVB value we will get. In the real business scenario, the tourism company may delegate the recommendation service to multiple SVB. When results return from SVB, the tourism company can use its evaluation data set to measure the accuracy of the recommendation, and choose the result that brings highest value added of *PRV*, i.e., lowest MSE in this case. To simulate such scenario, we perform the Mahout item based recommender with different similarity measurements. The generated mean square error is shown in Table I. It indicates that using Pearson correlation similarity measurement will bring the highest SVB value.

[1]https://cwiki.apache.org/confluence/display/MAHOUT/Recommender+Documentation

[2]http://archive.ics.uci.edu/ml/index.html

Similarity Measurement	**Average MSE**
Co-occurrence	1.800
Log likelihood	1.797
Tanimoto coefficient	1.814
City block	1.803
Cosine	1.795
Pearson correlation	1.452
Euclidean distance	1.795

Table I
Mean squared errors with different similarity measurements in E-Tourism SVB scenario.

V. Related work

Bichler et al.[1] promote to use brokers to enhance the application level interpretability of electronic commerce. Yu and Lin[31]utilize service brokers to meet SLAs of services and construct trust network for bridging reputation information[18]. Srikumar et al.[27] use a broker to enable grid resource searching and distribution where a broker functions mostly as an autonomous agent[23]. D'Mello et al.[5] use a broker to select qualified services in terms of QoS. Loreto et al.[19] use brokers to integrate telephone business and IT world in the manner of a intermediate layer. Most of existing broker researches[21], [17], [24], [4], [20], [13] focus on using brokers to discover, match,negotiate, select and compose services with best QoS in a service composition from either a technological perspective or a business perspective. Rosenberg and Dustdar[25] use brokers to bridge the difference of heterogenous business rules. Budgen et al.[2] introduce an information broker to integrate health knowledge and data with enhanced privacy protection. SVB relates services not limited to technological level as most SLAs based approaches[31] have done but also to business level[1], [25]. Cardellini et al.[3] use brokers to realize a global cost optimization based on probabilities. By integrating business services and technology services with value modeling, SVB identifies a bigger diagram where it can be applied to gain more value added.

VI. Conclusion and future work

Service value broker (SVB) is a critical element for constructing a coming era of E-Service Economics [12] since it coherently supports IT implementation of service system and integration of business strategies under the analysis of economical goals. In our previous work we have worked on enumerating useful SVBs which can be reused directly by stakeholder [11]. To cope with the challenges facing the building of a smart E-Tourism focusing on the Big Data analysis such as social network analysis for personalization, and multiple source information analysis for government decision making, we propose to build a problem solving framework from a knowledge management base on the SVB. The general target is to easy the complexity of the E-Tourism system building and the comprehensive improvement of the profiting on the service provider side, the satisfaction and acceptance on the customer side and the efficiency and precision of the market surveillance and control from the public administrative side.

In the future, we will improve the added value modeling modules on each parties and consider comprehensive business application. We would like to apply the prototype system to collect first hand feedback from the E-Tourism markets in specific agencies in Hainan province for further modifications and deeper Big Data analysis. The future work will also include exploring the direction of SVB composition for MashUp development[30].

Acknowledgment

This paper was supported in part by China National Science Foundation grant 61162010 and by Hainan University Research program grant KYQD1242.

References

[1] M. Bichler, A. Segev, and C. Beam, "An electronic broker for business-to-business electronic commerce on the internet," *Int. J. Cooperative Inf. Syst.*, vol. 7, no. 4, pp. 315–330, 1998.

[2] D. Budgen, M. Rigby, P. Brereton, and M. Turner, "A data integration broker for healthcare systems," *IEEE Computer*, vol. 40, no. 4, pp. 34–41, 2007.

[3] V. Cardellini, E. Casalicchio, V. Grassi, and R. Mirandola, "A framework for optimal service selection in broker-based architectures with multiple qos classes," in *SCW*, 2006, pp. 105–112.

[4] F. Casati, S. Ilnicki, L.-j. Jin, V. Krishnamoorthy, and M.-C. Shan, "Adaptive and dynamic service composition in eflow," in *CAiSE 2000*, pp. 13–31.

[5] D. A. D'Mello, V. S. Ananthanarayana, and S. Thilagam, "A qos broker based architecture for dynamic web service selection," in *Proceedings of AMS2008*, pp. 101–106.

[6] Y. Duan, "A Survey on Service Contract," in *SNPD*. IEEE Computer Society, 2012, pp. 805–810.

[7] ——, "Service Contracts: Current state and Future Directionsmeasure," in *ICWS*, 2012, pp. 664–665.

[8] ——, "Value Modeling and Calculation for Everything as a Service (XaaS) based on Reuse," in *Proceedings of SNPD 2012*. IEEE Computer Society, 2012.

[9] Y. Duan, A. Kattepur, and W. Du, "Service value broker patterns: Integrating business modeling and economic analysis with knowledge management," in *IEEE ICWS*, June 2013, pp. 615–616.

[10] Y. Duan, A. Kattepur, H. Zhou, Y. Chang, M. Huang, and W. Du, "Service value broker patterns: towards the foundation," in *IEEE ICIS2013*.

[11] ——, "Service value broker patterns: An empirical collection," in *IEEE SNPD*, 2013, pp. 675–682.

[12] Y. Duan, H. Zhou, Y. Chang, M. Huang, S. Chen, A. Elfaki, and W. Du, "Characterizing e-service economics based on e-contract and driven by e-value," in *IEEE ICIS2013*.

[13] R. Farmer, A. Raybone, R. Uddin, M. Odetayo, and K.-M. Chao, "Metadata discovery for a service-broker architecture," in *Proceedings of the 2008 IEEE International Conference on e-Business Engineering*, pp. 173–178.

[14] M. Feldstein, "Domestic saving and international capital movements in the long run and the short run," National Bureau of Economic Research, Tech. Rep. 947, 1982.

[15] E. Gamma, R. Helm, R. E. Johnson, and J. M. Vlissides, "Design patterns: Abstraction and reuse of object-oriented design," in *ECOOP*, 1993, pp. 406–431.

[16] A. Kattepur, A. Benveniste, and C. Jard, "Optimizing decisions in web services orchestrations," in *ICSOC*, 2011, pp. 77–91.

[17] A. Kumar.p.s, G. Mahadevan, and G. Krishna.c, "Article: A qos towards dynamic web services recapitulation and selection," *International Journal of Computer Applications*, vol. 54, no. 4, pp. 12–18, September 2012.

[18] K.-J. Lin, H. Lu, T. Yu, and C.-e. Tai, "A reputation and trust management broker framework for web applications," in *Proceedings of the IEEE EEE*, 2005, pp. 262–269.

[19] S. Loreto, T. Mecklin, M. Opsenica, and H.-M. Rissanen, "Service broker architecture: location business case and mashups," *Comm. Mag.*, vol. 47, no. 4, pp. 97–103, Apr. 2009.

[20] B. Moore and Q. H. Mahmoud, "A service broker and business model for saas applications," in *AICCSA*, 2009, pp. 322–329.

[21] Z. Pan and J. Baik, "Qos broker-based trust model for effective web service selection," in *Proceedings of the 11th IASTED SEA2007*, Anaheim, CA, USA, pp. 590–595.

[22] D. Plummer, "Cloud services brokerage: A must-have for most organizations." [Online]. Available: http://www.forbes.com/sites/gartnergroup/2012/03/22/cloud-services-brokerage-a-must-have-for-most-organizations/

[23] Z. Qian, S. Lu, and L. Xie, "Mobile-agent-based web service composition," in *4th Intl. conf. on Grid and Cooperative Computing*, pp. 35–46.

[24] S. Ran, "A model for web services discovery with qos," *SIGecom Exch.*, vol. 4, no. 1, pp. 1–10, Mar. 2003.

[25] F. Rosenberg and S. Dustdar, "Design and implementation of a service-oriented business rules broker," in *CECW*, 2005, pp. 55–63.

[26] H. L. Truong, M. Comerio, F. D. Paoli, G. R. Gangadharan, and S. Dustdar, "Data contracts for cloud-based data marketplaces," *IJCSE*, vol. 7, no. 4, pp. 280–295, 2012.

[27] S. Venugopal, R. Buyya, and L. Winton, "A grid service broker for scheduling distributed data-oriented applications on global grids," in *MGC*, 2004, pp. 75–80.

[28] Y. Wang and J. Wei, "Viaf: Verification-based integrity assurance framework for mapreduce," in *IEEE CLOUD*, 2011, pp. 300–307.

[29] Y. Wang, J. Wei, and M. Srivatsa, "Result integrity check for mapreduce computation on hybrid clouds," in *IEEE CLOUD*, 2013.

[30] J. Yu, B. Benatallah, F. Casati, and F. Daniel, "Understanding mashup development," *IEEE Internet Computing*, vol. 12, no. 5, 2008.

[31] T. Yu and K.-J. Lin, "A broker-based framework for qos-aware web service composition," in *EEE*, 2005, pp. 22–29.