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Research on C2 Capability Package Service Discovering Algorithm based on Information Description Framework*

Topic 1

Xianpeng Huangfu (STUDENT), Honghui Chen, Junxian Liu, Xueshan Luo

Xianpeng Huangfu
(Corresponding author)
Key Laboratory of C4ISR technology
College of Information System and Management,
National University of Defense Technology,
ChangSha, 410073,China
Tel:(86)0135-4860-1470 Fax:(86)0731-457-3577
xphuangfu@yahoo.com.cn

Honghui Chen
Key Laboratory of C4ISR technology
College of Information System and Management,
National University of Defense Technology,
ChangSha, 410073, China
Tel:(86)0133-0848-0588 Fax:(86)0731-457-3577
chh0808@gmail.com

Jin Huang
Unit 61541
Beijing, 100094, China
Tel:(86)0139-4905-6507
huaixiaozigold@163.com

Hao Xu
Beijing, China
Tel:(86)0138-1056-3696
rugbytj-2007@sohu.com

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Abstract: With the development of military transformation and information technology, the traditional pyramid Command and Control (C2) System will surely be changed to flat and net-centric C2 architecture. The construction research of C2 Capability Packages based on Service Oriented Architecture (SOA) has been brought forward, which have advantages of loose coupling, duplication and integration, and they can be dynamically composed to form new C2 System according to operational mission. The service discovering is an essential process for constructing C2 Capability Package. However there are some problems of service invalidation, Universal description, discovery, and integration (UDDI) not supporting service selection and optimization, and services found cannot efficiently satisfying the demand of user requirement, the paper brings forward C2 capability package service discovering algorithm based on a new information description framework. Firstly, the concept and academic basis of the new service formalized description framework is presented. Secondly, service selection algorithm determines the service set which satisfies users' fundamental requirement. Thirdly service optimization sort algorithm makes a service sort list according to a defined index of comprehensive effectiveness. Finally through an experimental analysis, the paper validates that optimized algorithm efficiently improves recall and precision rate of service discovering, which strikes a stable base for the improvement of C2 capability package comprehensive effectiveness.

Key words：information description framework；C2 capability package；service discovering algorithm； Analytical Hierarchy Process (AHP)

1Introducion

With the information development and software architecture progress, the idea of SOA has been paid more attention to. In civilian technology, Web Service has been greatly developed as a SOA realized technique. In the road of C2 development, the construction of Command and Control Capability Package based on SOA is being studied. Kim [1] studied public usage condition of Web Service between 2003 and 2004. The quantity didn't increase a lot, but only about 34% services can be used, moreover each week 16％ Web services that were registered lapsed. Furthermore UDDI register center doesn't provide the function of service filter and optimized sort, which cause the low recall and precision rate. Civilian services are such a case, to those military applications which face complicated battlefield environment and high strengthened confrontation, the improvement of service recall and precision rates are of great necessity.

The rest of the paper is organized as follows. In section 2, we introduce a new information description framework. In section 3, we bring forward an efficient C2 Capability Package service discovering algorithm which includes 2 phases. Firstly service selection algorithm can determine the fundamental service set according to users' needs. Secondly, service sort algorithm makes a service sort list according to a defined index of comprehensive effectiveness. Through an experimental analysis, the paper validates that optimized algorithm efficiently improves recall and precision rates of service discovering process in section 4. Finally section 5 concludes this work and outlines some future work.

2 Information Description Framework of C2 Capability Package Service

2.1 Information Description Framework

Zhong Yixin presented "Information theory" in 1984. If you want to know something, to describe a system, the only method is to acquire all the information about the thing and the system, through all the possible approaches. That is to mean, the state and transformation mode of interior structure and exterior relation should be acquired.

There are four fundamental questions during the use of service: what it does，how well it does，how it works，how to work with it。These four questions cover the needed information during the

whole process. This information can be divided into three levels: service pragmatic information, service semantic information and service syntax information, which are depicted in Fig 1.

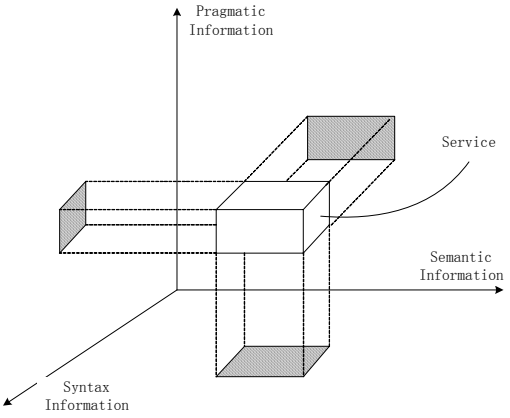

Fig1 the three levels of information

Defination1 Service Pragmatic Information， *PrI*

PrI is service available information for service users. The availability of service lies on the users' demand status, which is decided by the relation between the needs and the provided service. *PrI* is the set of the following parameters。

$$\Pr I = \{respTime, satiDegree, \sec Lvl, authLvl, confLvl, ...\}$$

respTime represents service response time. *satiDegree* represents users' satisfying degree. $\sec Lvl$ represents service security level. *authLvl* represents service (information/ control) authority level. *confLvl* represents service secret level, etc.

Defination2 Service Semantic Information， *SeI*

SeI is the information about service meaning, the core of which is service function information. The meaning of service is that the provided information or operation can satisfy users' certain needs. The function information is included in the change of input and output information. The study on semantic algorithm description is most popular.

Defination3 Service Syntax Information， *SyI*

SyI is the set of service interface, message format, transport protocols and accessing location etc. The service syntax information is tightly related with concrete platform and technological environment. For example, Web Service Description Language (WSDL) can be viewed as a subset of *SyI* .

$SPSet = \{S_1, ..., S_k\}, k \geq 0$, is the set of industrial and technological criterion followed or adopted by services, and S_k is one of the according criterions.

Service Information Description Framework is a new concept, and has the following characteristics compared with other service modeling method:

（1）Reference[3][4] have made study on service discovering algorithm from service semantic hierarchy. Because semantic hierarchy is just an inner aspect of service, it cannot demonstrate the total information of service and cannot satisfy the users' needs in algorithm analysis. So it cannot describe the total aspects of service.

（2）Reference[5] has established service *QoS* model: node dimension, service dimension and method dimension, based on which service discovering algorithm is studied. Information Description Framework is established in another system of dimensionalities, which describes service hierarchy model from another point of view. Compared with *QoS* model, it covers a larger extension, and is

more scientific.

2.2 The Hierarchy structure of C2 Capability Package

C2 Capability Package, based on SOA, is constructed on the fundamental services provided by integrated information fundamental establishment. C2 Capability Packages support various joint command and control. According to the characteristics and requirements of operation task, the necessary C2 Capability Packages can dynamically construct C2 System and finish the operation mission. Every operation node on the operation grid can get the necessary information freely, and realize “plug and play” of C2 Capability Packages. Once the mission is accomplished, the operation nodes release the operation resources. The abilities of dynamic reconfiguration and reallocate operation resources can improve the agility and effectiveness of joint command and control.

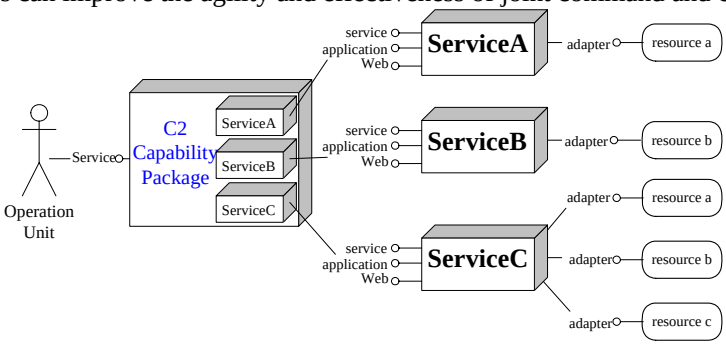

Fig2 The hierarchy structure of C2 Capability Package

The hierarchy structure is depicted in Fig2. The quality of service discovering algorithm determines the quality of discovered service, and the quality of service determines the comprehensive effectiveness of C2 Capability Package. How to discover services which satisfy users’ fundamental needs? How to select service whose comprehensive effectiveness is better than others? The above two questions are key factors which determine comprehensive effectiveness of C2 Capability Package.

3 Service Discovering Algorithm based on information Description Framework

C2 Capability Package is composed of various services. Because UDDI register center doesn’t include the selection and filter mechanism, which cause the low recall and precision rate, and service optimized sort in the precondition of satisfying the fundamental needs cannot be realized either. Under Information Description Framework, the paper brings forward service formalized description, through service selection algorithm, services which satisfy users’ fundamental needs are discovered, then through service optimized sort algorithm based on AHP, C2 Capability Package services are sorted according to comprehensive effectiveness.

3.1 Service formalized Description

Information Description Framework describes service information of C2 Capability Package from many aspects, in service discovering algorithm it is necessary to select those parameters that are influential to the discovering algorithm. To sum up, these parameters can be divided into three kinds: selection match restriction, for example interface type, message format and transport protocol etc. Quantitative parameters are the restrictions that can be Quantificational. Qualitative parameters are the restrictions reflecting qualitative information. The popular service discovering algorithms only consider the restriction of quantitative parameters, and don’t consider the influence of other selection match restriction and qualitative parameters. Information Description Framework will consider the influence of the three restrictions. Firstly, two parameters should be preprocessed.

（1）Selection match restriction should be selected firstly, and the concrete parameter values are determined from selected items.

（2） Qualitative parameters should be quantificationally processed. There are many popular methods, and in this paper we don’t extend any more.

Defination4 C2 Capability Package Service *cpS* description vector based on Information

Description Framework:

$$cpS = \{(\Pr I_1,...,\Pr I_l),(SeI_1,...,SeI_m),(SyI_1,...,SyI_n)\} \quad (1)$$

The according three vectors are pragmatic information vector, semantic information vector, and syntax information vector, which support the practical parameter measurement and users' requirements of service parameters.

Defination5 The restriction relation $r(q,u)$ is the dual relation in corresponding dimension space for each $q \in Q$. q is the practical value of service parameter. u denotes the users' expected value. If there are n users, the expected value is calculated as follows:

$$u = \sqrt{\sum_{i=1}^{n} u_i^2} \Big/ n, 1 \le i \le n \quad (2)$$

For selection match restriction, the basic restriction relation set can be described as $R_s = \{=,\neq\}$, For quantitative and qualitative parameters, the basic restriction relation set can be described as $R_t = \{<,=,>,\le,\ge\}$.

Defination6 For each $q \in Q$, the users' needs restriction to target service can be described as $r(q,u)$, $r \in R$. The users' needs to C2 Capability Package service can be described as:

$$reqU = \{(r_{11}(\Pr I_1,u_{11}),...,(\Pr I_l,u_{1l})),(r_{21}(SeI_1,u_{21}),...,(SeI_m,u_{2m})),(r_{31}(SyI_1,u_{31}),...,(\Pr I_n,u_{3n}))\} \quad (3)$$

$r_{ij} \in R_s \cup R_t, 1 \le i \le 3, 1 \le j \le \max\{l,m,n\}$;

If the user doesn't need a certain attribute, then the corresponding attribute is empty. If the user doesn't need a certain information vector, then the corresponding information vector is empty. If the user doesn't need all information description vector, then the all information vector is empty[7].

3.2 Service Selection Algorithm

Service discovering has many similarities with traditional information search, but the former one has more calculating complexity. The techniques are not mature, and most of service discovering techniques make use of semantic and ontological information, which take service automatic and intelligent degree as the goal. It introduces some estimation criterion in information search to estimate the performance of service discovering technique, for example, recall and precision rate. Three methods of Keyword-Based, Frame-Based and Deductive retrieval are compared by the three parameters of Precision、Recall、Hardness, which is depicted in Table 1.

Table1 the comparison of service discovering techniques

Service discovery technologies	Precision	Recall	Hardness
Keyword-Based	Low	High	Average
Frame-Based	High	Low	Average
Deductive retrieval	High	High	Hard

As we know from Kim's study, the lifecycle of service is not the same, in UDDI register center there are not the effective management of service lifecycle. So through the matching of keyword or ID, we cannot make sure the discovered service is useable, and whether the users' fundamental needs can be satisfied. Based on service formalized description, service selection algorithm determines service set which satisfy users' fundamental needs. Algorithm 1 is as follows [8]:

Algorithm 1 SelectbyMultiPara($reqU$, cpS)

Require: $cpS \neq \phi$

1. **for**(i=0;i<3;i++)
2. **for**(j=0;j< $reqU[Dimension].length$;j++) **do**
3. select all paras ($r_{ij} \in R_s$ && $r_{ij} == '='$)
4. **if** $reqU[\Pr I] \neq null$ **then**
5. $Dimension = \Pr I$
6. cpS =SelectbyPara($reqU$, $Dimension$, cpS)
7. **else if** $reqU[SeI] \neq null$ **then**
8. $Dimension = SeI$
9. cpS =SelectbyPara($reqU$, $Dimension$, cpS)
10. **else if** $reqU[SyI] \neq null$ **then**
11. $Dimension = SyI$
12. cpS =SelectbyPara($reqU$, $Dimension$, cpS)
13. **return** cpS

SelectbyPara($reqU$, $Dimension$, cpS)

1. $cpS_{set} = \phi$
2. **for** (j=0;j< $reqU[Dimension].length$;j++) **do**
3. **if** $reqU[Dimension][j]$ is false for corresponding reality value of $cpS[Dimension][j]$ **then**
4. **break**
5. **else**
6. **add** $cpS[Dimension][j]$ to cpS_{set}
7. **return** cpS_{set}

With the support of information description framework, from the three dimensionalities of PrI,SeI,SyI , firstly algorithm 1 confirms the parameters or set of R_s , secondly confirms the corresponding parameters of R_t , if one parameter doesn't satisfy the users' fundamental needs, then the corresponding service is abandoned.

3.3 Service Optimized Sort Algorithm

After the service selection algorithm, service set cpS_{set} includes the candidate services that satisfy the users' fundamental needs. The comprehensive effectiveness of C2 Capability Package relies on candidate service quality. The higher of the candidate service, the greater comprehensive effectiveness of C2 Capability Package. Here we bring forward the definition of service effectiveness of C2 Capability Package. In a certain operation environment, that is the degree of service accomplishing the overall function to achieve the expected goal. In the Information Description Framework, the service effectiveness of C2 Capability Package is the degree to achieve the expected goal in the three dimensionalities of PrI,SeI,SyI .

Due to AHP is fit for solving half structural complicated problem. The method makes the different factors reasonable through dividing mutual correlative layers. According to the subjective judgment of objective reality, the relative importance of every layer's factors is described by fixed numbers. Then mathematical method is made use of to determine the relative importance value of all factors in each layer. Finally through the overall sort of all layers, the sort of all schemes are determined.

The optimized algorithm doesn't consider the restriction $R_s = \{=, \neq\}$. For $R_t = \{<, =, >, \leq, \geq\}$, because

the dimension is not the same, the parameters of this kind should be pretreated:

$$q' = \begin{cases} 1/q, if\ R_t \in \{<,\le\} \\ q, \quad if\ R_t \in \{=,>,\ge\} \end{cases} \quad (4)$$

, $q \in \{\Pr I, SeI, SyI\}$.

AHP is the aggregation of quantitative and qualitative methods. Because of the participation of people's subjective factors, the algorithm is prone to coming forth big errors. The optimized algorithm [9] 10] [11] [12] can effectively reduce the influence of subjective factors, and improve the precision. For convenience, l,m,n are used to denote the parameters quantities of PrI,SeI,SyI in cpS_{set}. The service optimized algorithm is divided into four steps:

- Step 1: The hierarchy structure is established according to C2 Capability Package service effectiveness.

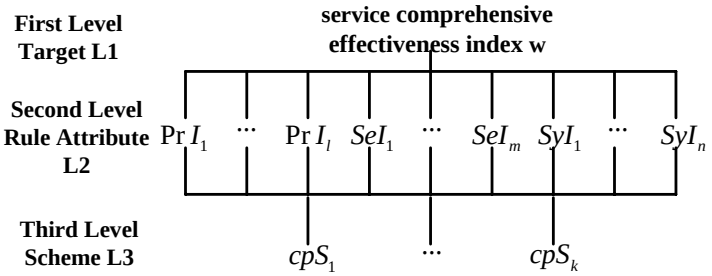

Fig3 Service selection hierarchy structure

- Step 2: The judgment matrix is constructed.

For the factors in each layer, pair to pair relations are compared relative to the corresponding higher layer's factors. Serial judgment matrixes are constructed. In order to decline influence of some individuals, if there are n users, the context compared weight is calculated as follows:

$$w = \sum_{j=1}^{n} w_j \times \lambda_j + \gamma, 1 \le j \le n, 0 \le \lambda_j \le 1, \text{ 且 } \sum_{j=1}^{n} \lambda_j = 1 \quad (5)$$

, λ_j is the weight of the j th user, γ is the influence of objective factors.

Table2 Level L2 estimation matrix

W	Pr I_1	…	Pr I_l	SeI_1	…	SeI_m	SyI_1	…	SyI_n
Pr I_1	1	…	$w_{l,1}$	$w_{l+1,1}$	…	$w_{l+m,1}$	$w_{l+m+1,1}$	…	$w_{l+m+n,1}$
…	…	1	…	…	…	…	…	…	…
Pr I_l	$w_{1,l}$	…	1	$w_{l+1,l}$	…	$w_{l+m,l}$	$w_{l+m+1,l}$	…	$w_{l+m+n,l}$
SeI_1	$w_{1,l+1}$	…	$w_{l,l+1}$	1	…	$w_{l+m,l+1}$	$w_{l+m+1,l+1}$	…	$w_{l+m+n,l+1}$
…	…	…	…	…	1	…	…	…	…
SeI_m	$w_{1,l+m}$	…	$w_{l,l+m}$	$w_{l+1,l+m}$	…	1	$w_{l+m+1,l+m}$	…	$w_{l+m+n,l+m}$
SyI_1	$w_{1,l+m+1}$	…	$w_{l,l+m+1}$	$w_{l+1,l+m+1}$	…	$w_{l+m,l+m+1}$	1	…	$w_{l+m+n,l+m+1}$
…	…	…	…	…	…	…	…	1	…
SyI_n	$w_{1,l+m+n}$	…	$w_{l,l+m+n}$	$w_{l+1,l+m+n}$	…	$w_{l+m,l+m+n}$	$w_{l+m+1,l+m}$	…	1

Compared the C2 Capability Package services in **L3** with rule attributes in **L2**, the **L2—L3** judgment matrix is depicted in table 3. The space is filled in relative weight value just like table 2.

Table3 Level L2—L3 estimation matrix

$\Pr I_1$	cpS_1	…	cpS_k	…	cpS_1	…	cpS_k	$\Pr I_l$	cpS_1	…	cpS_k
cpS_1	1	…		cpS_1	1	…		cpS_1	1	…	
…	…	1	…	…	…	1	…	…	…	1	…
cpS_k		…	1	cpS_k		…	1	cpS_k		…	1
SeI_1	cpS_1	…	cpS_k	…	cpS_1	…	cpS_k	SeI_m	cpS_1	…	cpS_k
cpS_1	1	…		cpS_1	1	…		cpS_1	1	…	
…	…	1	…	…	…	1	…	…	…	1	…
cpS_k		…	1	cpS_k		…	1	cpS_k		…	1
SyI_1	cpS_1	…	cpS_k	…	cpS_1	…	cpS_k	SyI_n	cpS_1	…	cpS_k
cpS_1	1	…		cpS_1	1	…		cpS_1	1	…	
…	…	1	…	…	…	1	…	…	…	1	…
cpS_k		…	1	cpS_k		…	1	cpS_k		…	1

- Step 3: the factor sorts of each judgment matrix and consistent verification are made.

For the established judgment matrix, the corresponding factors' weights are calculated, and consistency of judgment matrix is verified. The so-called hierarchy odd sort is the calculated weight value compared this layer's factors with the upper layer's corresponding factors. The weight value is to calculate the largest eigenvalue and the largest eigenvector, that is:

$PW = \lambda_{\max} W$, P is the judgment matrix of different layers. $\lambda_{\max}$ is the largest eigenvalue of judgment matrix P, W is the standardized eigenvector corresponding to $\lambda_{\max}$, and the heft of W is weight value of the corresponding factors' odd sort.

The numerical value in judgment matrix is gained generally by experience and data documentation. So it is hard to maintain consistency. For the military problems with more influential factors and large scales, it is much harder. To judge the result is rational or not, we should make consistent verification of judgment matrixes.

Defination6 The coincidence indicator $CI = \frac{\lambda_{\max} - n}{n-1}$, the stochastic coincidence indicator

$$CR = CI / RI \qquad (6)$$

, RI is the average stochastic coincidence indicator.

When the judgment matrixes have full consistency, $CI = 0$. The larger CI, the worse consistency of judgment matrixes; When $CR < 0.1$, we think the coincidence of judgment matrixes is satisfying, otherwise the adjustment is needed.

- Step 4: The overall sort and consistent verification are made.

Making use of odd sort in the same layer, the hierarchy overall sort is to calculate weight value compared the layer's all factors with the upper layer's all factors.

For **L2**, the overall sort is the odd sort of this layer. For **L3**, if this layer's factors $cpS_1,...,cpS_k$ are corresponding to **L2**, odd sort result is $w_{cps_1}{}^i,...,w_{cps_k}{}^i$, then the overall sort of **L3** is calculated according to table 4.

Table4 Level L3 element sort matrix

L2—L3	$\Pr I_1$	…	$\Pr I_l$	SeI_1	…	SeI_m	SyI_1	…	SyI_n
	w_{pri_1}	…	w_{pri_l}	w_{sei_1}	…	w_{sei_m}	w_{syi_1}	…	w_{syi_n}
cpS_1	$w_{cps_1}^{\ 1}$	…	$w_{cps_1}^{\ l}$	$w_{cps_1}^{\ l+1}$	…	$w_{cps_1}^{\ l+m}$	$w_{cps_1}^{\ l+m+1}$	…	$w_{cps_1}^{\ l+m+n}$
cpS_2	$w_{cps_2}^{\ 1}$	…	$w_{cps_2}^{\ l}$	$w_{cps_2}^{\ l+1}$	…	$w_{cps_2}^{\ l+m}$	$w_{cps_2}^{\ l+m+1}$	…	$w_{cps_2}^{\ l+m+n}$
cpS_3	$w_{cps_3}^{\ 1}$	…	$w_{cps_3}^{\ l}$	$w_{cps_3}^{\ l+1}$	…	$w_{cps_3}^{\ l+m}$	$w_{cps_3}^{\ l+m+1}$	…	$w_{cps_3}^{\ l+m+n}$

The overall sort of cpS_k in **L3** is

$$w_{cps_k} = \sum_{i=1}^{l} w_{pri_i} w_{cps_k}^{\ i} + \sum_{i=l+1}^{l+m} w_{sei_i} w_{cps_k}^{\ i} + \sum_{i=l+m+1}^{l+m+n} w_{syi_i} w_{cps_k}^{\ i} \quad (7)$$

Defination7 The coincidence indicator of overall sort $CI = \sum_{i=1}^{m} w_{cps} CI_i$, the stochastic coincidence indicator $RI = \sum_{i=1}^{m} w_{cps} RI_i$ (8)

The stochastic consistent proportion of overall sort $CR = CI/RI$, CI_i is the coincidence indicator in judgment matrix P according to w_{cps}, RI_i is the stochastic coincidence indicator in judgment matrix P according to w_{cps}. When $CR < 0.1$, we think the consistency of judgment matrixes is satisfying, otherwise the adjustment is needed.

Algorithm 2 CpsSortOrder(w_{cps_k}, cpS_{set})

Require: $cpS_{set} \neq \phi$

1. **for**(i=0;i<k;i++)
2. **for**(j=i+1;j<k;j++)
3. **if**($w_{cps_j} < w_{cps_i}$) **do**
4. $cpS_{\max} = cpS_i$
5. $cpS_i = cpS_j$
6. $cpS_j = cpS_{\max}$
7. **return** cpS_{set}

Based on the overall sort w_{cps_k} and candidate service set cpS_{set}, the sort according to service effectiveness can be realized through algorithm 2. The upper in cpS_{set} are those services whose comprehensive effectiveness are higher than others. The lower are those services whose comprehensive effectiveness are lower. It provides supports to select the optimized services for users, and strikes a stable base for the improvement of C2 capability package comprehensive effectiveness.

4 Experiment and Analysis

Making use of performance estimation criterion, experimental analysis uses recall and precision rates to weigh the quality of service discovering algorithm based on Information Description Framework. The experiment is based upon the following hypothesis.

Hypothesis1 According to reference[1], under the military environment, 34% services are useable, and every week 16% registered services are invalidated. The sampling cycle is a week. The weight value in optimized algorithm is assumed as 0.8. The subjective influences are not considered. The service parameter quantity set is $Num_{l+m+n} = \{9,12,15,18,24\}$. The candidate service quantity set is $Num_{cpS_{set}} = \{100,200,300,400,500\}$.

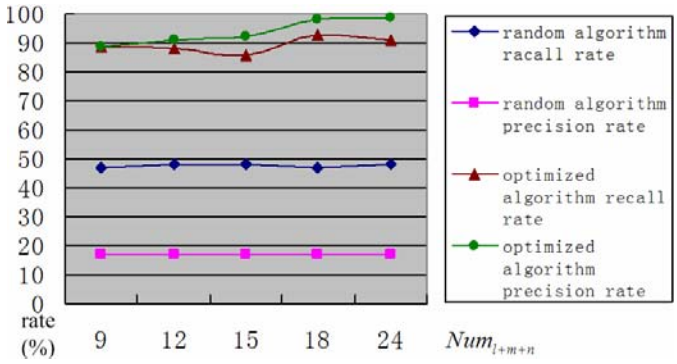

Fig 4 stochastic and optimized algorithm recall and precision rate change as service parameters increase

In a cycle, if the service quantities are 300, the stochastic algorithm and optimized algorithm recall and precision rates change as the quantities of service parameters increase, depicted in Fig 4. With a fixed candidate service quantities, the recall and precision rate of stochastic algorithm are both low, as the time increase, the recall and precision rate will decline continuously. For the optimized algorithm, because the algorithm includes two steps, with the increase of parameters quantities, service can be described more exactly, and can satisfy the users' expectation, the recall and precision rate can stay at a high level, and the precision rate will be higher and higher.

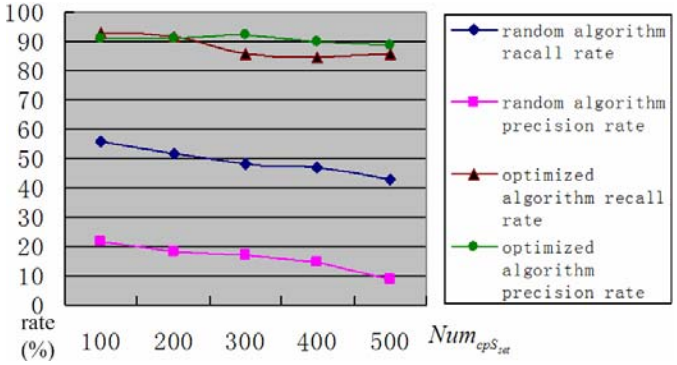

Fig 5 stochastic and optimized algorithm recall and precision rates change as service quantities increase

In a cycle, if the quantities of service parameters are 15, the stochastic algorithm and optimized algorithm recall and precision rates change with candidate service quantities increase, depicted in Fig 5. With fixed quantities of service parameters, as the linear increase of candidate service quantities, the recall and precision rates of stochastic algorithm both decline, and the decline speed of precision rate is faster than that of recall rate. For the optimized algorithm, the good algorithm structure can guarantee the high recall and precision rate with the great increase of candidate service quantities.

5 Conclusion and Future Work

Based on Information Description Framework, the paper brings forward the formalized description of C2 Capability Package from the three dimensionalities of PrI, SeI, SyI . For restriction R_s and R_t, we establish the processing principle and make the dimensions unified. The service selection algorithm is established, which can satisfy the users' fundamental needs. The optimized algorithm can improve the service recall and precision rate. Finally by the experiment and analysis, compared with stochastic algorithm, the paper validates that optimized algorithm efficiently improves

recall and precision rate of service discovering. In the future work, we will continue to focus on the service discovering and composition problems, to improve the comprehensive effectiveness of C2 Capability Package。

Reference

[1] Kim SM, Rosu MC. A survey of public web services [A]. In: Proceedings of 13th international conf. on World Wide Web (WWW2004). [C]. USA: ACM, 2004.312-313.

[2] Wei Wei, Luo Aimin, Chen Honghui, Shu Zhen. Research on service information description framework in C2 Capability Package [J]. Journal of China Academy of Electronics and Information Technology. 2008, 3(3):262-265.

[3] Cui Xiaohong, Liu Xingwei, Yao Shuhuai. Research on Semantic Web Services Matching Algorithm[J]. Journal of Xihua University. 2006, 25(4):18-23.

[4] Xu Zhuoming, Shi Lei. Research on Web Services discovering algorithm based on semantics[J]. Computer Application and Software. 2006, 23(5):21-23.

[5] Guo Deke, Ren Yan, Chen Honghui, Luo Xueshan. A Qos-Guaranteed and Distributed Model for Web Service Discovery[J]. Journal of Software. 2006, 17(11):2324-2334.

[6] David Ferbrache. Network Enabled Capability: concepts and delivery[J]. Ministry of Defense, Journal of Defense science, 2003,8(3):104-107.

[7] Evren Sirin, James Hendler, Bijan Parsia. Semi-automatic composition of Web services using semantic description[C]. Accepted to Web Services: Modeling, Architecture and Infrastructure workshop in conjunction with ICEIS2003.

[8] Tao Yu and Kwei-Jay Lin. Service selection algorithms for web services with end-to-end QoS constraints[C]. In Proceeding of IEEE International Conference on E-Commerce Technology (CEC'04), 2004, pp.129-136.

[9] Katia Sycara, Massimo Paolucci,, Anupriya Ankolekar, Naveen Srinivasan. Automated discovery, interaction and composition of semantic Web service[J]. Journal of Web Semantics, Volume 1, Issue 1, December 2003.

[10] Massimo Paolucci, Takahiro hanamura, Terry R. Payne, Katia Sycara. Semantic Matching of web Services Capabilities[M]. Springer Berlin/Heidelberg. 2002.

[11] Thomas H.Cormen, Charles E.Leiserson,Ronald L, Rivest and Clifford Stein. Introduction to Algorithms[M]. MIT OpenCourseWare. 2001.

[12] M Schlosser, M Sintek, S Decker, W Nejdl. A scalable and ontology-based P2P infrastructure for semantic Web services[C]. Peer-to-Peer Computing. Second international conference. 2002.