

# The research on service composition trust based on cloud computing

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**Abstract**—According to the characteristics of services at multiple levels under cloud computing environment, a modeling mechanism of service composition trust is proposed. Analyzing QoS of sub service, matching it with trust evaluation standard, so the static trust evaluation of sub service is obtained. Processing the existing historical data of service composition, it can get the dynamic trust evaluation of sub service. The mode of service composition is put forward, and the algorithm of service composition trust is designed. The algorithm is based on sub service trust, considering the sub service weights and mode of service composition, has the characteristics of high accuracy and adaptability, and is suitable for application of service composition under cloud computing environment.

**Keywords**—cloud computing; service composition; trust; modeling; QoS

## I. INTRODUCTION

In recent years, with the development of computer technology and network, application based on cloud computing is more and more widely. Resource is unlimited in cloud computing, so the number of services provider is increasing and type of services that are provided by service provider through cloud computing is more and more. A single service provider generally focus on business in a certain field, and the service provided by him has the characteristics of single and limited functions, so it often can only satisfy some applications, such as weather forecast, hotel reservation and so on, can not meet the large and complex application system. At present, the demand of service in cloud computing environment presents multi function and complicated, the traditional design idea and development process is very difficult and expensive. Making use of the existing service, combining many sub services into a new integrated service according to the function, semantic and logic relation, it can speed up the system construction, reduce the cost of system development, and can meet the demand of complex application [1].

The core of service composition under cloud computing environment is the problem of reliability. For a user, the reliability of service composition is the main problem of his attention. The reliability of service composition depends on the

service composition trust. The service composition trust is higher, user's satisfaction is high. The traditional service composition trust much considers the safety problem, selects sub services according to QoS of sub service, and less considers the difference between theory and practice and mode of service composition, therefore it can not adapt to the cloud computing environment. Sub services often are supplied by different providers and have heterogeneous, exotic characteristics [2], so the trust provided by these sub services is static, unilateral, and different when sub service is used in practices. It is difficult for system to select, match sub service and accurately calculate trust [3]. This paper presents a modeling mechanism for service composition trust based on static and dynamic trust of sub services. The mechanism fully considers the mode of service composition and QoS of sub service, gets the trust of service composition by trust algorithm based on the historical data. The mechanism can make trust higher accuracy, and improve user's satisfaction.

## II. THE MODELING MECHANISM OF SERVICE COMPOSITION

Service composition combines multiple sub services into a service according to certain rules based on user's needs, and can realize complex function application. Service composition mainly is in three ways: parallel, series and series-parallel. Sub services are independent without any constraint in the parallel composition mode. Failure of a sub service does not affect other sub service operation, but only service results may be influenced such as information integrity. If a user wants to know the Haikou tourism market (transport, hotels, attractions, and shopping malls), service composition combines the traffic service, hotel service, view spot services and shopping services together in parallel way according to user needs, then the service feedbacks results to the user. If the hotel service is failure, the user can also learn about other information. Parallel combination method is relatively simple. Sub services are no longer independent and there are certain constraint relations between sub services in the series composition mode. Failure of a sub service will lead to the failure of composite service such as logistics service. A Logistics service is composed of a plurality of sub services (collection service, traffic service, deliveries service), and there are constraint

relationships between these services: first, these sub services are combined together in certain order, secondly when the previous sub service have be completed, the next sub service can be to start. The serial-parallel mode is a combination of parallel and series, and has features of both parallel and series combination. For example, tourism line service is a typical combination of serial and parallel. In the practical application system, the serial-parallel mode is widely used.

Service combination is relation with combination mode when choosing sub services. Parallel combination mainly considers the matching degree of user needs and sub service function, focuses on data integrity. In addition to considering function matching, the response time is an important parameter to choose sub service for series composition.

The trust degree of service composition is related with sub service trust, but also concerns about the combination rules. The rules of combination mainly relates to the position and weight of sub service in service composition. Sub service trust is high, does not necessarily ensure that trust degree of service composition is high. Same sub service is differences in weight because of different position in service composition. The trust and the cost are proportional to: the higher the trust, service fee is higher, so it should select sub services according to the sub service weight and trust. If a sub service weight is higher, its trust also is required highly. For those sub services that have lower weights, requirement of trust can also be lower, so it can cut down the cost of service composition.

The trust modeling of service composition includes sub service trust modeling and composition service trust modeling. Sub services completes single service function, is the foundation of service composition. Because service providers focus on different areas of business, QoS provided by services is differ in thousands of ways, the parameters and index also are different. The trust modeling of sub service abandons differences of different business, considers the common properties of sub services, and establishes unified trust evaluation model based on success rate, response time and accurate rate as the basic indicators. The success rate presents the success probability of sub service; the accurate rate presents integrity and accuracy of response information. With the increasing of service function and type, the basic indicators of unified trust evaluation model are not immutable and frozen, and changes with the actual application situation [4].

The trust modeling of service composition is based on sub service trust, considers the relationship between sub services and difference of actual trust degree, and calculates trust by the algorithm. The trust modeling of service composition process is as follows:

- (1) Selecting sub services based on service composition function needs.
- (2) Getting QoS of sub service, and determining the static trust according to the unified trust evaluation model.
- (3) Processing and mining the history interaction data of sub service, and obtaining the dynamic trust.

(4) Calculating the static weight and the dynamic weight of sub service, and determining the sub service trust.

(5) Determining the service composition mode, order and weight of sub service and constraint relations in accordance with the service function, and obtaining service composition trust through the algorithm of service composition.

The service composition trust modeling is shown in Figure 1

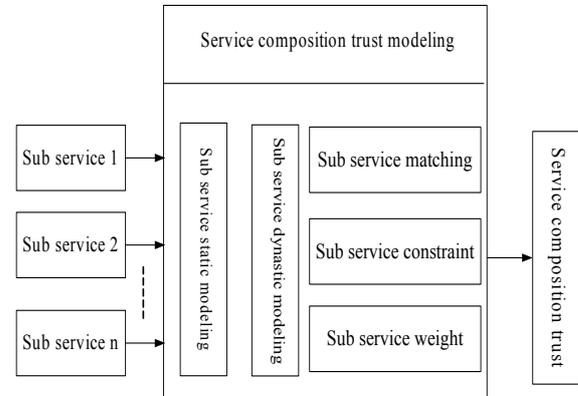


Figure 1 The service composition trust modeling

### III. THE SUB SERVICE TRUST

The sub service trust modeling includes static modeling and dynamic modeling. The static modeling is based on QoS of sub service and parameters of service composition evaluation model. It mainly considers the success rate, response time and accuracy rate. The dynamic modeling considers the difference of the actual operation parameters and QoS of service, and is determined by the historical data. The richer is historical data, the more accurate is dynamic trust.

#### A. The static trust modeling

The QoS of a sub service from service composition  $W$  have  $n$  parameters, and it can be expressed as  $QoS(a_1, a_2, \dots, a_n)$ . The  $a_1$ ,  $a_2$ , and  $a_n$  represent the success rate, response time and accuracy [5]. If a parameter does not exist, the value of the parameter is 1. The success rate and accuracy rate are used to be express as probability. The value of the success rate and accuracy rate is in the range of  $[0, 1]$ , can be obtained directly from the QoS. The response time is different for these sub services, and the accuracy is also different, so the response time must be converting: response time is divided into multiple levels; each level is corresponding to a time range. A response time which belongs to same time range is done as the same class, can be converted to a value that is in the range of  $[0, 1]$ . The finer is Classification granularity, the higher is the accuracy of the numerical conversion. The classification of response time is related with service composition function. The real-time services such as telephone service, it require a higher response time, so classification is required much detailed. For some other services such as email, text messages,

real-time requirement is not too high, Classification granularity can be appropriate to relax. [6]

The static trust of sub service F is obtained by the following formula:

$$T_s(W, F) = a_1 \times r_1 + a_2 \times r_2 + t \times r_3 \quad (1)$$

The parameter t is the conversion value of response time; r1, r2, r3 are the weights corresponding parameter values. The value of  $T_s(W, F)$  is in the range of [0, 1]. The values of r1, r2, r3 are not fixed, are relevant with the sub service function relevant, and selected based on practical experience and historical interaction data.

### B. The dynamic trust modeling

As service providers vary widely in cloud computing environment, some sub service providers exist the possibility that exaggerate trust. When a combined service is in the actual operation, the quality of sub services is different with static trust, so the service composition when chooses sub services still not completely trust the static trust, must consider indicators of the actual operation of the sub services.

The combined service W calculates the dynamic trust of the sub service F based on the satisfaction of service quality when F is running. The satisfaction is defined as S: the trust of the sub service F when F is running is greater than or equal to the static trust of F, then satisfaction is 1; less than the static trust, satisfaction can be expressed as:

$$S(W, F) = \frac{T_r(W, F)}{T_s(W, F)} \quad (2)$$

$T_r(W, F)$  is the actual trust of the sub service F, is calculated by the same formula as static trust, and its value is in the range of [0,1]. If W runs n times, F also runs n times, and then the dynamic trust of F can be calculated by the following formula:

$$T_d(W, F) = \frac{\sum_{m=1}^n S_m(W, F)}{n} \quad (3)$$

The dynamic trust of sub service is related to the number of combined service runs. The more is the number of runs, the more is abundant data, and so the more reliable is the dynamic trust.

### C. The sub service trust

The sub services trust is determined by static and dynamic trust, and is related to the weights of the two trusts. The sub trust service F is calculated as follows:

$$T(W, F) = T_s(W, F) \times r_s + T_d(W, F) \times r_d \quad (4)$$

$r_s, r_d$  are the weights of the static and dynamic trust.

$$r_s = \frac{1}{n+1} \quad r_d = \frac{n}{n+1} \quad r_s + r_d = 1 \quad (5)$$

n is the number that combined service has already running. It known from the formula: the static and dynamic trust is variable, and changes with the increasing in the number of runs. When combined service is the first time to run, because

there is no historical interaction data, so the static weight is 1 and the dynamic weight is 0. It means that sub services trust completely is determined by the static trust. With the increasing in the number of service composition, the static weight begins to decrease, and the dynamic weight gradually increases, so the dynamic trust impact on trust is stronger that sub-service trust is more dependent on the dynamic trust [7].

## IV. THE SERVICE COMPOSITION TRUST

### A. The parallel service composition trust

Combined service W is composed of n sub services in parallel mode, shown in Figure 2:

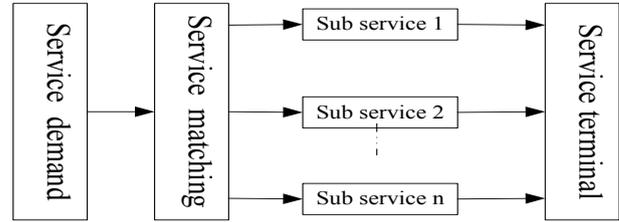


Figure 2 The parallel service compositions mode

The trust of combined service W is shown as follows

$$T(W) = T(W, F_1) \times r_1 + T(W, F_2) \times r_2 + \dots + T(W, F_n) \times r_n \quad (6)$$

$r_1, r_2, r_n$  are weights corresponding with sub services. There are two ways to determine values of these weights: If the service needs for the status and importance of sub services are provided, weight can be obtained by the service demand. For example, when different user query Haikou tourism market (transportation, hotels, attractions, shopping malls, etc.), the focus is different: user A wants to know information followed by transportation, attractions, hotels, etc., user B wants to know information followed by attractions, hotels, transportation, attractions, therefore the weight of attractions service is different in user A and user B. If the service needs only describe functional requirements and the status of sub services keeps same, it can be considered that weight of all sub service is same and shown as follows:

$$r_1 = r_2 = \dots = r_n = \frac{1}{n} \quad (7)$$

For parallel systems, function of sub service is completely independent, response time can be relaxed, integrity and accuracy of data is requires highly. When service composition in parallel manner chooses sub services, in addition to considering the sub service trust, it should try to choose the sub service that is high accuracy.

### B. The series service composition trust

Combined service W is composed of n sub services in series mode, shown in Figure 3:

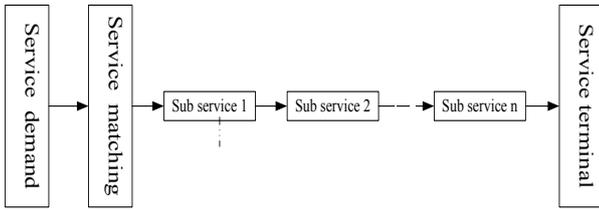


Figure 3 The series service composition mode

The status and importance of all sub services are same in series composition mode, and failure of a sub service will cause the entire failure of combined service, therefore, each sub service has the same weight.

The trust of combined service W is shown as follows:

$$T(W) = T(W, F_1) \times T(W, F_2) \times \dots \times T(W, F_n) \quad (8)$$

It is more complex when selecting sub services in series mode. In addition to considering the trust, response time and accuracy should be investigated that are related to function of combined service.

### C. The series-parallel service composition trust

Combined service W is composed of 5 sub services in series-parallel mode, shown in Figure 4:

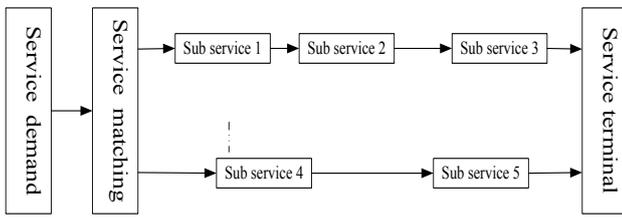


Figure 4 The series-parallel service composition mode

According to the calculation formula of the series and parallel service composition trust, the trust of series-parallel service composition can be calculated as follows:

$$T(W) = [T(W, F_1) \times T(W, F_2) \times T(W, F_3)] \times r_1 + [T(W, F_4) \times T(W, F_5)] \times r_2 \quad (9)$$

r1, r2 are the weights corresponding to two parallel branches.

## V. CONCLUSIONS

The service composition is mainly used for complex applications under the cloud computing environmental. It is

based on demand for service, combines many simple sub services into a service in accordance with certain rules to complete complex functions, and has the advantage of easy implementation and low cost. Unlike traditional mode of service composition this mechanism considers exotic and heterogeneous characteristics of services under cloud computing environment, researches the trust of service composition from many aspects such as the mode of service composition, sub service trust and matching degree. It designs the algorithm of sub service and the model of service combinations. Simulation results show that the trust of service composition obtained through this mechanism has high reliability..

## ACKNOWLEDGMENT

This work was financially supported by the Foundation projects: Hainan University serving local economic and social development project (project number: HDSF201310), the natural science foundation of Hainan Province (project number: 614232) and the industry-university-research special fund of Hainan Province (project number: CXY20140002).

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