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Evaluation of Quality of Service through Genetic Approach in Telecommunication Based Semantic Web Services Composition

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Abstract : Quality of service plays an important role in the semantic web services composition. The telecommuni-cation domain follows the Parlay X standard which supports only syntactic web services descriptions. As the subscribers require additional services instead of isolated services, there is a need to implement a composition framework which helps the users to find the required service which is a time consuming process. The existing composition model doesn't address the issues of client's requirement. So the novel approach was proposed based on genetic algorithm which fulfils the subscriber's constraints efficiently. The proposed approach fo-cuses on parameters; response time, execution time, reliability, throughput, availability and Accessibility. The experiments are performed in a simulated environment.

Keywords : Genetic algorithm, Parlay X, quality of service, Semantic Web services, telecommu-nication.

1. INTRODUCTION

Semantic web services acts as an important paradigm model for distributed computing. Even though in semantic web, devices have an ability to find, execute, composite and provide the information in an understandable way. The Semantic is enhanced with syntactic web services which help for any computer that runs an application has an ability to search, select and request the required web services. The syntactic Web service has three components, service provider, service registry and service consumer. These services use a XML language which helps to find the right service through the parameters of its input, output, Precondition and execution. So the users can find the right service, provides the service location, and also the protocol for invoking the service, and it also helps to formulate the data to be sent to the service [6].

The Parlay X standard in telecommunication provides the important interface accessed by operators and focuses to advantage Web service functionalities in how the information is exposed as 'services' to the application developer. These services helps the users to "find, bind, invoke" paradigm by allowing services to be published and discovered through a service registry, and invoked through the discovered WSDL document. At present the web services in the domain of telecommunication is following the parlay X standard. The parlay X has given a set of standard web service API''s for the telecom. The each of the services will have its own interface, services and types [11]. The Parlay X does not support intra-enterprise integration techniques ie, Common Object Request Broker Architecture (CORBA) or Remote Method Invocation (RMI), but instead uses HTML and decouples application logic from data by using XML for representing any kind of data. [20]

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Quality of service [3] plays an important role in automatic semantic web service composition. The quality of service helps to identity the best semantic web service from a set of similar services. he authors considered parameters under two categories. Performance based quality of services are Response time, Execution time, Throughput. Dependability based quality of services are Scalability, Availability, Accessibility. These parameters give the subscriber guarantee and certainty to use the right services. The quality of a web service can be widely classified into performance, dependability and security [13]

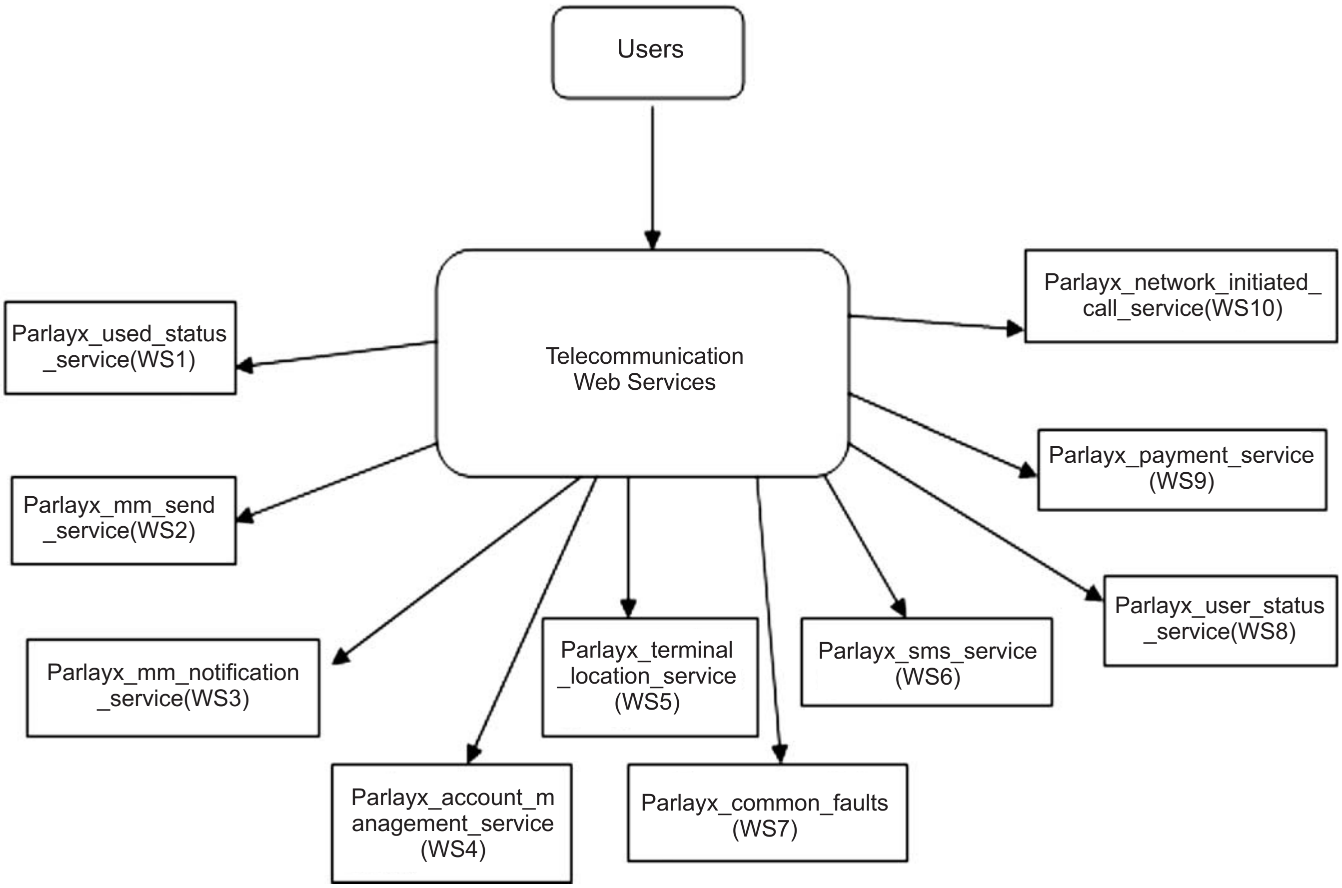

Figure 1: Basic Services of Parlay X

2. RELATED WORK

2.1. Quality of services for web services discovery and composition

In [14] the authors have proposed a semantic service discovery framework for various contexts used by users. The authors have given rating for the services by a management system. In [16] proposed a discovery model for Qos web services, this approach considers only the reputed management system. In [5] authors have proposed an agent based framework for web services discovery with Qos parameters that helps the users to find the correct services. In [9] the authors developed a prototype based on true selection in IRS-III which is a Web Service trust Ontology (WSTO) model. In [8] a multiple criteria decision making with weighted sum model (to select a service) and integer programming (IP) approaches with branch and bound (to select an optimal solution) have been proposed. In [10] constraint satisfaction based on solution which combine simulated annealing [1, 4, 15] approach with Tabu search [7] has been proposed. The Tabu search is used for generating neighbour plans and simulated annealing heuristic is applied for accepting or rejecting the neighbour plan. In [2] a QoS-based web service composition algorithm that combines local strategy and global strategy has the following features. Initially, the services that have low QoS value are eliminated by local strategy and then the problem has reduced to a multi-dimension multi-choice 0-1 knapsack problem solved by the heuristic method.

In general the automatic composition for web service focuses to rectify the issue where single service cannot satisfy the target mentioned by the service users. Different methods have been implemented, which includes Artificial Intelligence [17] based planning, Logic-based [18], Matchmaking-based [19], Graph-Theory-based [23] and Golog-based [21].

2.2. Quality of Service Properties in web services

The first issue for managing quality of web services for the web based systems is to find the properties of semantic web services. In [22] author has proposed a model that calculated the QoS for the composite web services through aggradations formula. This approach was widely used for most of the QoS related web services composition problems. The QoS properties used in this paper are response time, cost, availability, reliability, reputation and accessibility.

- **Response time :** The maximum time taken to produce a response after receiving the web services request. It can be found as

  Response Time = (Web Service response) - (Web service request).

- **Cost :** How much amount of money is charged by the service provider for accessing the service and it can be calculated as

$$\sum_{k=1}^{k=n} \mathrm{cost}(\mathrm{WS}(k)) \tag{1}$$

- **Availability :** Probability of whether the web service is accessible for the user

  Available time = 1 – (D/U)

  Where D = down time of the web service

  U = up time of the web service

- **Reputation:** Depends on the user's satisfaction of the web service. Different users may have different opinions on the similar web service. The reputation value is based on the average ranking given to the web service by the end users.

  Calculated as

$$\text{Reputation} = \sum_{k=1}^{k=n} (\mathrm{R}(k)/n) \tag{2}$$

  Where Rk = ranking given by the users to the web service

  n = number of times the particular web service is be ranked by the end users.

- **Accessibility:** It is the capability of serving the Web Service request. The Web service might be available but not accessible because of a high volume of requests

  Accessible time = (1– (D/U))

  Where D = down time of the web service

  U = up time of the web service

3. PROPOSED FRAMEWORK

The framework has been proposed to convert the syntactic web service (WSDL) to OWL-S. The proposed approach converts the syntactically web service into a semantic web service by Converting the WSDL into OWL-S. The provider publishes web services as Web Service Description Language (WSDL). The conversion is done by using ontology. The semantic enhanced web service consists of Profiling, Modeling and Grounding. The profiling explains about functionality of the service. The Modeling describes about working methodology of the service. The Grounding provides details about accessing the service.

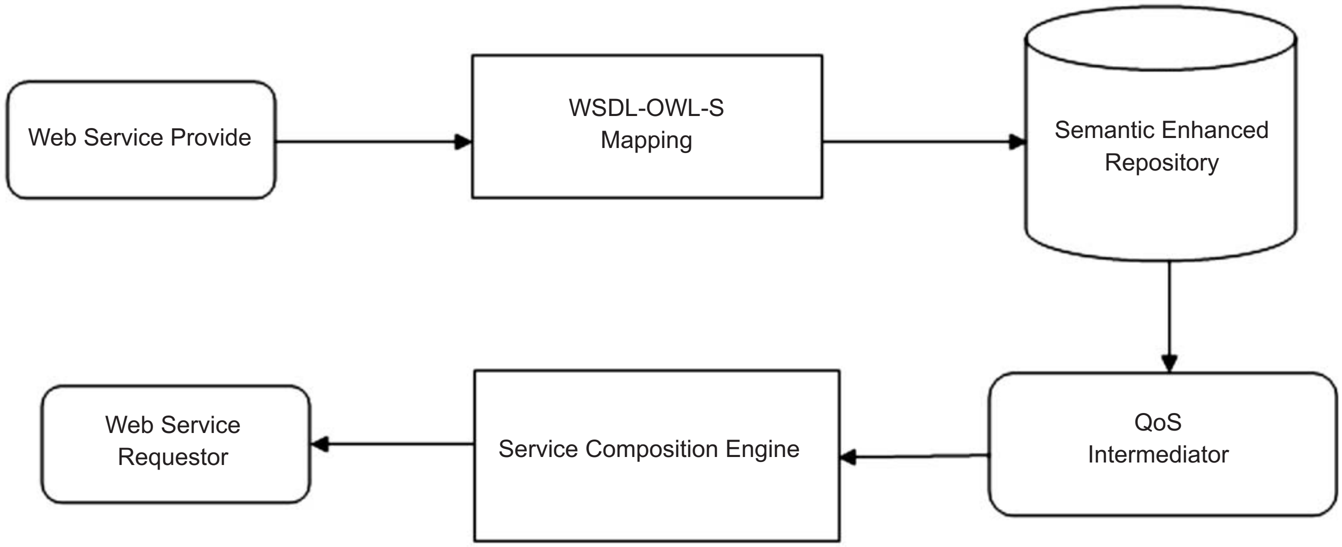

Figure 2: Proposed Framework for QoS execution for service composition

The Figure 2 illustrates about the execution of semantic web service composition through the consideration of QoS attributes. The service compositions engine in the framework composite the web services. First the Web service provider stores the service in semantic registry with the QoS values. Then Intermediate collects QoS attributes from the web service Repository. Then relevancy factor is calculated and updated in the semantic repository. The web service Requestor sends a request to the execution engine. It finds a set of composite services that match the client's requirements. After receiving the best service the users provide their feedback regarding the received service and these feedbacks are updated in the repository.

The semantic enhanced repository maintains the quality of service for each service and the relevancy factor is calculated thorough the parameters obtained from the semantic repository. So each and every time when the user request for a service, the QoS parameters are matched form the repository.

The QoS intermediator acts as an interface between the users and the service providers. The composition engine plays a key component in the framework. The suitable optimizer model needs to be implemented to fulfill the user's requirements

3.1. Composition plans

In our approach we have proposed a new composition model which is based on genetic algorithm. In general composition plans are formed from serial, cycle, XOR-parallel and AND-Parallel .In Serial patterns the web services are executed one after other and there is no chance for overlap during the execution .In cycle pattern, the web services are executed for a limited number of cycles. In XOR parallel pattern the execution is not determinant, so there is a need to find the aggregation for the QoS parameters. In AND-parallel pattern all the web services which are subsequent are executed continuously once the prior service executes. The composition optimizer model is based on genetic approach.

3.2. Genetic Approach

Genetic Algorithms (GAs) are evolutionary algorithms that produce solutions for the optimization problems using techniques on the principle of evolution through natural selection. The algorithm initially takes a population of individuals that undergo selection with the operators such as mutation and crossover. To evaluate individuals the fitness function is used by the algorithm and the success rate varies accordingly with the fitness value. The steps of the GA are as follows [22]:

- Initial population is created;
- Generate new offspring by applying genetic operators, namely selection, crossover and mutation, one after the other;

- Find the fitness value of each individual in the population;
- The process is completed if a desired solution was found or the execution time was expired. Otherwise, the process repeats steps 2 and 3.

3.3. Conditions possessed

We have provided two constraints, one is to select only one web service from the population (candidate web services).The second condition is to plan proper composition plan to fulfill the user requirements. To continue with the work, the aggregate values are obtained. There is a need to find the negative and positive QOS attributes. In the proposed approach cost is a negative QoS , so the aggregate values need to smaller than the user conditions. In the case of positive QoS, the aggregate values should be greater.

$$\text{Agg} = \text{User Constraints}$$

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4. PERFORMANCE EVALUATION

In this section we have verified the accuracy and performance of the proposed system through simulation and we have compared our results with other existing methods.

4.1. Simulated Results

The experiments have accomplished several experiments to evaluate the implemented algorithm. The programming language used to do the evaluation is Java and the algorithm is executed on desktop PC with Pentium 2.2 GHz dual core CPU and 3 GB of RAM. Table 1 lists the experimental environment at a glance.

Table 1

Environment of the experiments

Hardware	*Pentium 2.2 GHz dual core CPU and 3 GB of RAM*
Operating System	Windows 7
Programming language	Java 7.0
Service Domain	Telecommunication

Figure 3: Conversion of WSDL to OWL File

Figure 3 illustrates the semantic mapping *i.e.*, mapping WSDL to OWL-S document

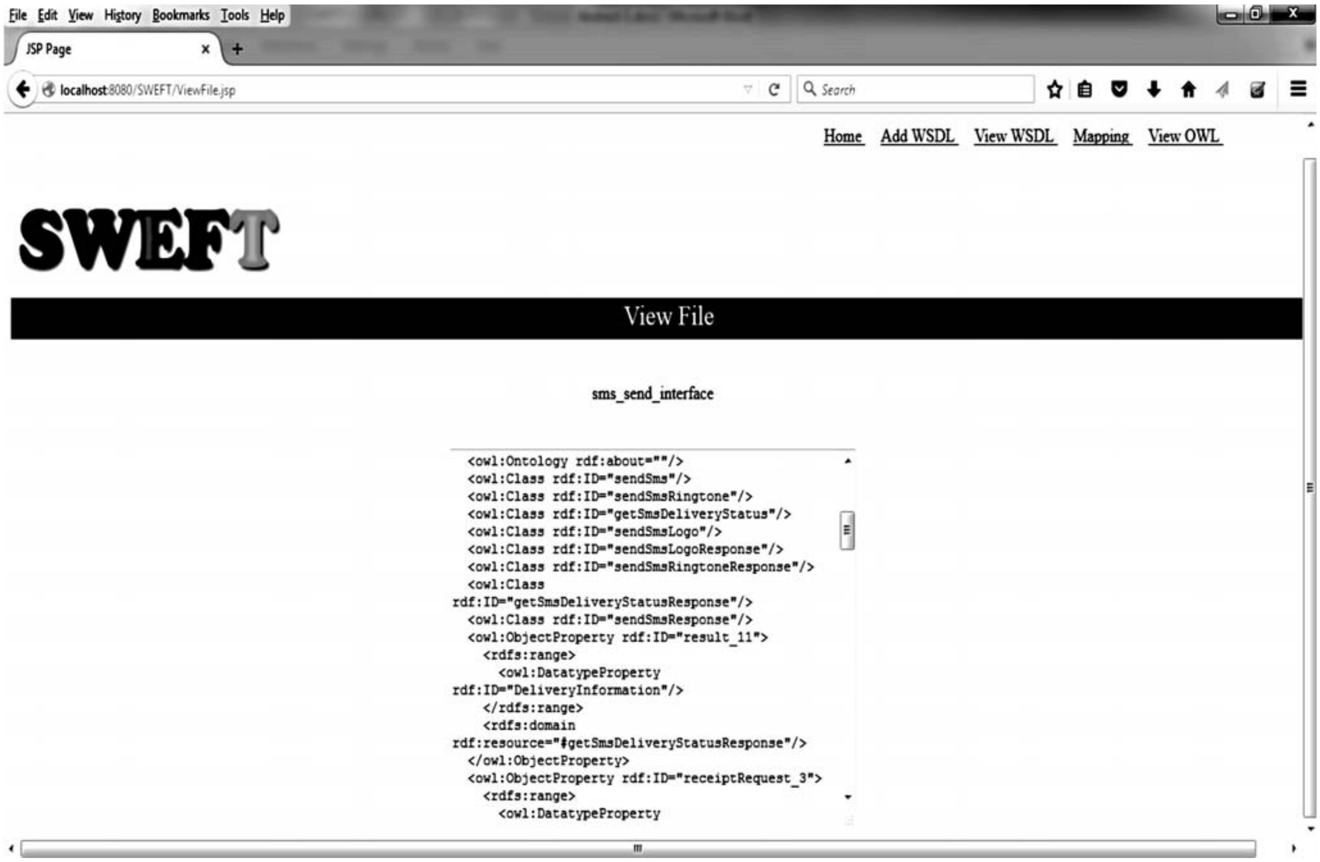

Figure 4: Mapped OWL File

Figure 4 shows the converted document (OWL-S). We have carried out number of experiments to find the relationship between local and global optimum. As there are numerous composition plans available, we need to find the optimized composition. So we have used an enumeration method to find the local and global optimum. We have formulated an experiment on the basics of below equation

$$\sum_{j=0}^{k} a(ij) = 1 \tag{3}$$

Where the condition should be $i <= j <= n$. From the equation only one service from the candidate services have to be selected. Initially we have conducted an experiment with n = 10 and k = 10, so the plans obtained will be 10 9 .The calculation of local value for the web service is based on normalizing the QoS parameters through the under mentioned equation

$$A_{norm} = A - A_{min} / A_{max} - A_{min}$$
$$A_{norm} = A_{max} - A / A_{max} - A_{min}$$

Where in both the equations the $A_{max} - A_{min} \neq 0$ and $A_{max} - A_{min} = 0$. If once the normalization is done, the local value is calculated for individual web service through the below equation

$$LV_{ij} = \sum_{i=0}^{A} \mathrm{W}i\mathrm{A}i \tag{4}$$

Where A represents the number of QoS parameters and LV represents the local value for each web service. After obtaining the local value, the candidate web services are sorted as per the local values .Then the population is generated with the best web services that has a high local value. The fitness function is calculated for each chromosome that is generated. The idea is to calculate the fitness function from the random chromosomes [23, 24, and 12]. If the fitness function is zero or smaller than zero, then the proposed model for composition satisfies the user requirements.

The experiment was conducted with 10 tasks where in each task the web services varies as 20,30,40,50,60 and 100 web services. Table 2 shows parameters of the genetic algorithm. The proposed approach changes the value for each execution. The population size is varied from 20 to 500. The crossover and mutation probability is varied from 0.1 to 0.9. Based on these parameters the execution time and fitness values are changed. The algorithm is executed number of times with different parameters.

Table 2
Initial GA Parameters

Crossover Probability	0.7
Mutation Probability	0.1
Population Size	20

Figure 5 gives the result of proposed method where the execution time increases when the number of tasks increases. Initially we have used 20,40,60,80 and 100 web services, each service are executed by considering its QoS parameters and the equivalent execution tine was measured when each task executes.

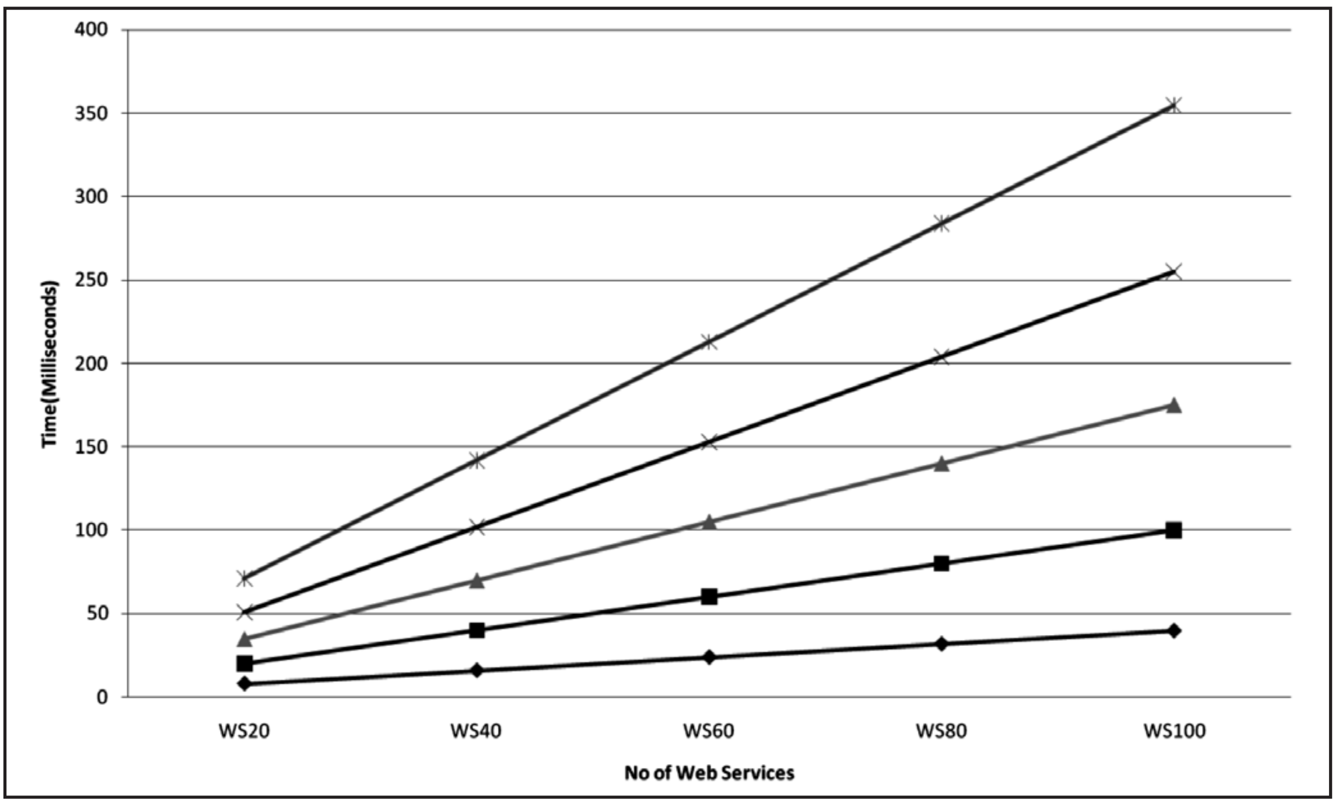

Figure 5: Performance of GA based algorithm

Figure 6 represents the total number of web services executed. We have performed 100 tasks to value the efficiency of our proposed system. It was proved that the proposed method gives better results than the Tabu search and other enumeration methods

5. CONCLUSIONS

In this paper, we have proposed a novel approach for semantic web service composition model for the telecommunication domain using genetic algorithms. The experimental results show that the execution time is much faster than other random search approaches. The obtained results demonstrate that the advantages of the new ideas are welcomed to overcome the local optimums. So applying genetic algorithms in telecommunications for handling thousands of users has a great effect on improving computation time. The proposed approach is different from conventional GA-based approaches because it contains four distinct fitness functions for addressing the modeled composition problem.

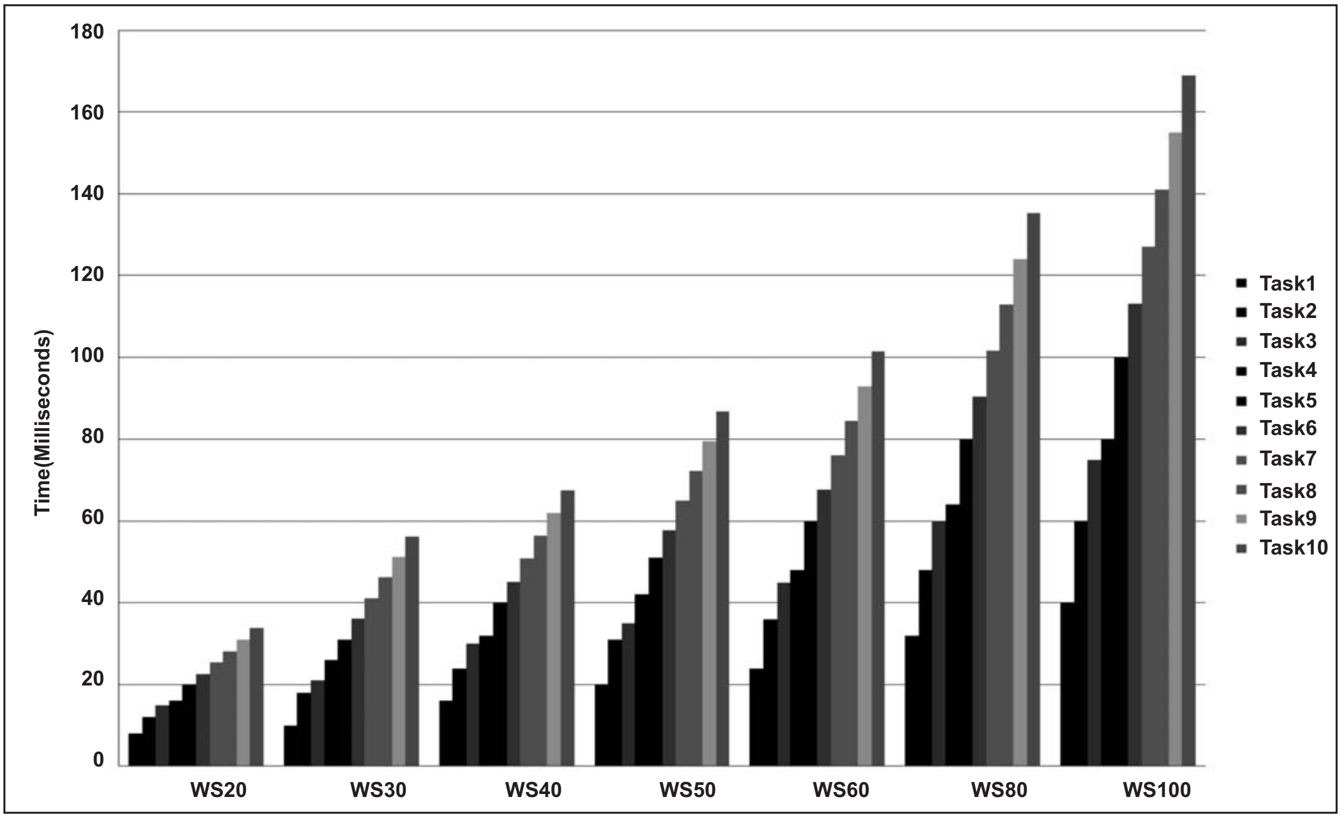

Figure 6: Performance of GA based algorithm with 100 tasks

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