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QoS Aware Services Selection for IOT

Naresh Teja
Electronics and Communication Department, Jawaharlal Nehru Technological University Anantapur, JNTUCEA, Andhra Pradesh, India

ABSTRACT

An important challenge is addressed in this paper for developing efficient services selection algorithm with the optimization of both quality and energy consumption in the context of IOT services composition. In a large scale IOT environment, the composition of thousands of entities becomes a crucial issue. In this paper, an EQSA algorithm is proposed for service composition. The proposed selection approach consists in the quality of the services in view of the satisfaction of the user through the use of a lexicographical optimization technique. In order to increase the energy conservation without decreasing the user's preferences, a most suitable service is selected among the pre candidate service ones are then Selected using the concept of relative dominance of services in the sense of Pareto. The relative dominance concept mainly depends on the energy profile and QoS attributes and users preferences.
Keywords : EQSA algorithm, IOT, QoS

I. INTRODUCTION

The internet of things is an interconnection of various objects with their capabilities like sensing, actuation communication and computation are rapidly developed to collect the data to create the applications the users requirements

In our everyday lives, the vision of iot is extended so number of connected devices and their innovative applications are rapidly increasing in many domains as possible.

The interconnected devices can communicate with each other through the various Communication protocols without human invocation. The IoT can be introduced in the fields of communication, e business applications. For example, a composite service would be a travel planning system that interconnects the multiple component services for flight booking, accommodation booking, car rental and itinerary planning are executed sequentially or concurrently

The composition of IOT services promotes the creation of complex applications. .i.e. composite services. This composite service is formed by aggregating the individual atomic services to provide new functionalities.

In this study, the term candidate service refers the invocable service, where as an abstract service is also called service classes. Each Abstract service, there may exist several concrete services which is having same functionality but different quality value. The composition plan describes how candidate services interact with each other by specifying the order of invocation.

A key issue in a composition process how effectively chooses the most relevant services that can match the user's requirements. interms of QoS, the services selection is still crucial task because dynamic and stochastic nature of IoT. In the energy model, the candidate services selected for a composition process which is hosted in devices are limited budget of energy. During the execution of composition plan, the services may fail due to intensive use of battery leading to unreliable of service. The mobility of devices new services are introduced but energy budget cannot be increased much more, the battery capabilities gradually increase per annum by only 5%. So, finally less energy consumption services may lead to high availability of services. In this paper, an EQSA algorithm proposed for iot services composition. The main aim of this algorithm is to reduce energy consumption by slightly reducing the QoS level without affecting the user's requirements. The services selection approach is carried out by 2 methods.

1) Pre-selection of services 2) Relative dominance method

In the first phase, services selection approach is solved by using the lexicographic optimization method. This method consists of solving the sequence of each QoS attribute (availability, reliability, response time etc). The QoS attributes are ranked in the order of user preferences. For each operation, finding the candidate services providing the best quality with respect to the QoS attribute q. A threshold value of best quality is defined from the best quality value and tolerance factor [0,1] represents the reduction of the quality allowed by the user.

The candidate services which do not satisfy the obtained threshold value are removed from the candidate services set. The first phase allows us reduce the search space along with selection time. The candidate services obtained in the pre selection phase are compared in the 2nd phase .i.e. dominance concept. An utility value which represents the relative dominance of each candidate service are selected for the services composition. The utility value mainly depends on energy profile, QoS attributes, user preferences.

II. METHODS AND MATERIAL

A. Service model description.

1) concrete versus abstract services: A concrete service(CSj) is described by its functional properties in the form of transformation function Action(CSj) that takes an input Input Data(csJ) to produce an Output data(CSj) and non functional attributes like QoS(CSj) and energy profile Eprof(CSj)

$$cs_j = \{InputData(cs_j), OutputData(cs_j), Action(cs_j), QoS(cs_j), EProf(cs_j)\}.$$

An abstract service ASi={CS1,CS2,……..CSn} is a class of 'N' concrete services having the similar functional properties.i.e. atleast the same input data and output data but differ by the non-functional properties.

2)Abstract versus Concrete Composite Service: An abstract composite service is represented by the aggregation of abstract services(services classes) with out representing the concrete services. A concrete composite service is example of an abstract composite service obtained by mapping the each abstract service (e.g., localization of an object) to one of its concrete services (e.g., RFID-based localization, vision-based localization).

B.Energy Profile Model:

The energy profile Eprof(CSj) of a concrete service is descibed by following parameters like Ecost(CSJ) and AutoS(CSj). The Ecost(CSj) represents the overall energy consumption during the execution of the service. The AutoS(CSj) represents Energy level of the device which hosting the service.

$$AutoS(cs_j) = EnergyDevice(cs_j) - EnergyThreshold(cs_j)$$

Energy device and Energy threshold represented as, the charge level of battery powered device hosting a service and threshold value under which device cannot provide a service anymore.

$$ECost(cs_j) = ConsRate(cs_j) \cdot ExecTime(cs_j)$$

ConsRate represents the consumption rate and Exec Time (CSj) represents the execution time of the service.

Finally, the energy profile of a service is defined as ratio of its energy cost and its autonomy is represented as

$$EProf(cs_j) = \frac{ECost(cs_j)}{AutoS(cs_j)}.$$

1) QoS Level Based Services Pre-selection:

The Qos aware services selection can be done by using the Lexicographic optimization. In this technique, ranking the each QoS attribute in an order based on the user's preferences. Let us consider 5 candidate services C1, C2, C3, C4, and C5.

C1={cost=100, AV=90%, RL=0.95}
C2={cost=90, AV= 85%,RL=0.90}
C3={cost=110,AV=85%,RL=0.85}
C4={cost=120,AV=88%,RL=0.90}
C5={cost=95,AV=86%,RL=0.88}

The user selects cost is his first priority. So, from the above 5 candidate services cost=90 is the best quality of service.

Here, we define a threshold value and tolerance factor which is characterizing the decrease of quality allowed by the user.

$$qos_q^{\text{Threshold}} = \begin{cases} qos_q^* - qos_q^{\text{Decrease}}, & \text{if } q \text{ is positive} \\ qos_q^* + qos_q^{\text{Decrease}} & \text{otherwise} \end{cases}$$

$$\text{with} \quad qos_q^{Decrease} = qos_q^* \cdot \delta_q$$

Where qos*q ,qosdecrease, del q represents best quality value, decrease the quality which allowed by the user, tolerance factor ranging from[0,1].

Algorithm 1 – QoS level-based services preselection

Inputs: Abstract service AS_i with n candidate services.
δ_q : the tolerance factor for each QoS attribute q.

Ranking the QoS attributes according to the user's preferences. The rank is $1 \dots k$. The attribute $q = 1$ has the highest priority.
$PCS = AS_i$.
for $q = 1$ until k **do**
  Find cs_j^i from PCS such as $qos_q^* = optimal(qos_{q,j}^i)$.
  Calculate $qos_q^{Decrease}$ using **(13)**.
  Calculate $qos_q^{Threshold}$ using **(12)**.
  Update PCS as follows:
  if q is a positive attribute **then**
    $PCS = \{cs_x^i \in PCS \cap AS_i / qos_{q,x}^i \geq qos_q^{Threshold}\}$
  else
    $PCS = \{cs_x^i \in PCS \cap AS_i / qos_{q,x}^i \leq qos_q^{Threshold}\}$
  end if
end for

Outputs: The Preselected Candidates Set (PCS).

2) Relative dominance based services selection:

In this phase, the pre selected candidate services are compared using the value which reflects their relative dominance. The dominance value mainly depends on its energy profile, QoS attributes and users preferences. Finally, the best services in terms of relative dominance are selected for the composition process.

The candidate services which are selected for PCS (CS) are given below

C1={cost=100, AV=90%, RL=0.95}

C2={cost=90, AV= 85%,RL=0.90}

C3={cost=110,AV=85%,RL=0.85}

C5={cost=95,AV=86%,RL=0.88}

2.1) QoS-BasedParetoDominance:

The paretodominance is defined as follows.

The COST (CS1)> COST(CS3) because cost is a negative attribute. The Av(cs1) greater than equal of Av(CS3). So CS1 strictly dominates the CS3 at least one one attribute (user preferred) strongly. Hence, the candidate service CS3 is removed from the set.

The COST(C2)>COST(CS1) and Av(C1)>Av(C2).in this case, the service C2 doesn't dominates the service C1. The remaining candidate services are does not a dominates each other. These 2 services are called nondominated or Pareto equivalents.

To overcome this difficult to compare the services which can be pareto equivalents in terms of QoS, a relative dominance concept is proposed.

2.2) Relative Dominance:

Let Eprof (cs1)=Ecost(cs1)/AutoS(cs1) and Eprof(cs2)=Ecost(cs2)/AutoS(cs2) be the energy profile of CS1 and CS2.

Definition1:

QoS Attribute based Dominance: It can be represented as how many number of candidate services are dominated with respect to its attributes like 'COST'. From the above candidate services, C2=90 dominates 3 candidate services (C1=100,C3=95,C5=95). But C3 and C5dominates only 1 candidate service C1. Finally, the Candidate service C2 dominates 3 services so it can be noted as Dom (csj,q).

Definition2: In the energy model description, the battery of each device has initial charge value "Cintial" chosen randomly in the interval [0.7Cmax to 1.0Cmax]. Where the Cmax represents the maximum battery charge. When a service is requested, a charge chosen randomly in the interval [100mA.S, 10000mA.s] is subtracted from the actual battery charge of the device hosting the service.

Cmax=1500 mA.h

Cthreshold=30% of Cmax

A device can stop providing a service when the battery level reaches its threshold level and the service considered to be failed in the selection view.

Algorithm 2 – Relative dominance-based services selection

Inputs: The PCS of abstract service AS_i

The set of user's preferences.

1: **for each** $cs_j^i \in PCS$ **do**

2: **for each** QoS attribute q **do**

3: Determine the $Dom(cs_j^i, q)$.

4: **end for**

5: Determine the $EP - Dom(cs_j^i)$.

6: Calculate relative dominance of cs_j^i using **(15)**.

7: **end for**

8: Find the cs_x^i having the maximal relative dominance value.

Outputs: The selected candidate service cs_x^i.

In the proposed selection approach, the added value can be shown by using the 3 algorithms.

1) EQSA: Here both energy profile and quality value can be considered for the services selection

2) EQSA-EP: Here the only the energy profile values can be considered .i.e. lower energy profile services are selected.

3) EQSA-QoS: Here the only quality attributes are considered for selection and composition process.

III. RESULTS AND DISCUSSION

Simulation Results:

- Selection time: it represents the computational time of the Selection algorithm.
- Optimality: it is defined as the ratio of quality value obtained in the case of EQSA to optimal value of composite service in EQSA-QoS algorithm.

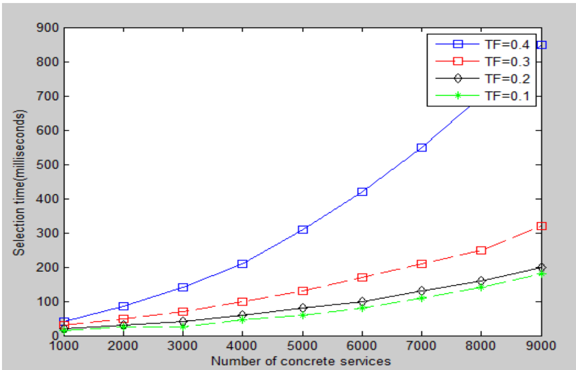
$$Optimality = \frac{\sum_{q=1}^{|QoS|} Optimality(qos_q)}{|QoS|}.$$

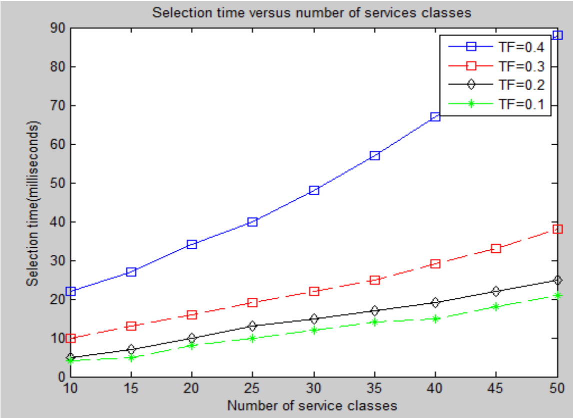
$$Optimality(qos_q) = \begin{cases} \frac{\frac{1}{qos_q(EQSA)}}{\frac{1}{qos_q(EQSA\sim QoS)}}, & \text{if } q \text{ is negative} \\ \frac{qos_q(EQSA)}{qos_q(EQSA\sim QoS)}, & \text{otherwise} \end{cases}$$

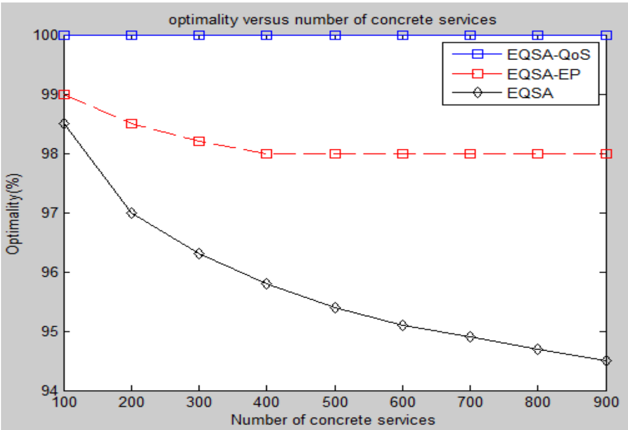
Where qos(q) is the qth QoS attribute and |QoS| is the number of QoS attributes. And qos (q) EQSA and qos(q)-EQSA-QoS are the Values of the qth QoS attribute of the composite service obtained using and algorithms, respectively.

1) Selection Time Versus Number of Services: The first simulation is intended to validate the scalability of the algorithm. The number of services classes is set to 10, which correspond to a typical structure of a composition plan in the ad dressed use-case. The number of candidate services for each class varies from 1000 to 10000. As shown in Fig. 1, the selection time increases with the tolerance factor as the number of candidate services satisfying the QoS threshold values increases. The average selection time taken by the algorithm is compatible with large scale IoT environments since it does not exceed 900 milliseconds for a number of concrete services equal to 10 000.

In the second simulation, the number of services classes varies from 10 to 50 classes whereas the number of concrete services is set to 1000 for each class .The bound of 50 services classes corresponds to an extreme but realistic case of services composition. As observed in Fig. the selection time increases with the number of services classes used in the composition Structure. Similarly to the first simulation, the selection time increases with the tolerance factor. In addition, when this factor becomes larger ( ), the number of preselected candidate services increases significantly as well as the selection time that does not exceed 90 ms for a number of services classes equal to 50.







IV. CONCLUSION AND PERSPECTIVES

In this paper, QOS aware services selection with reduced energy consumption approach for IoT environment is presented. It can be solved as a bi-objective optimization problem includes quality value and minimization of energy consumption which provides the high availability of services along with users satisfaction. A QoS based services selection can be achieved by using the Lexicographic optimization technique. In the next phase, a relative dominance concept is used for those candidate services which are Pareto equivalents. The pre selected candidate services are compared for best service selection and the relative dominance value can be calculated from the energy profile and QoS attributes. The posted simulation results promising performances of the proposed algorithm. The EQSA algorithm can be scalable in large IoT structures and gives the very optimal solution (98%). For the future work, the extension of EQSA algorithm can be handled with re-selection of services by predicting the QoS and Energy values changes.

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