

# Quality and Energy Aware Services Selection for IOT

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## ABSTRACT

In recent years, Internet of Things (IoT) has received massive attention from research and industry. Integrating and composing smart objects functionalities or their services is required to create and promote more complex IoT applications with advanced features. In a large scale IOT environment, but 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 :** Internet of Things, EQSA, 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 2<sup>nd</sup> 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. MODELS DEFINITION

### A. Service model description.

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

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

An abstract service  $AS_i = \{CS_1, CS_2, \dots, CS_n\}$  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  $Eprof(CS_j)$  of a concrete service is described by following parameters like  $Ecost(CS_j)$  and  $AutoS(CS_j)$ . The  $Ecost(CS_j)$  represents the overall energy consumption during the execution of the service. The  $AutoS(CS_j)$  represents residual 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 6 candidate services C1, C2, C3, C4, C5, C6.

- C1={EP=0.05,cost=10.3, RT=20, Av=90}
- C2= {EP=0.5, cost=9, RT= 21, Av=92}
- C3={EP=0.7,cost=10,RT=22, Av=91}
- C4={EP=0.15,cost=13,RT=18, Av=93}
- C5={EP=0.15,cost=8,RT=27, Av=95}
- C6={EP=0.1,cost=9.5, RT=25, Av=85}

The user selects *cost* is his first priority. So, from the above 6 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.

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

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

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

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**Algorithm 1 – QoS level-based services preselection**

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**Inputs:** Abstract service  $AS_i$  with  $n$  candidate services.

$\delta_q$  : the tolerance factor for each QoS attribute  $q$ .

1: Ranking the QoS attributes according to the user's preferences. The rank is  $1 \dots k$ . The attribute  $q = 1$  has the highest priority.

2:  $PCS = AS_i$ .

3: **for**  $q = 1$  **until**  $k$  **do**

4: Find  $cs_j^i$  from  $PCS$  such as  $qos_q^* = optimal(qos_{q,j}^i)$ .

5: Calculate  $qos_q^{Decrease}$  using (13).

6: Calculate  $qos_q^{Threshold}$  using (12).

7: Update  $PCS$  as follows:

8: **if**  $q$  is a positive attribute **then**

9:  $PCS = \{cs_x^i \in PCS \cap AS_i / qos_{q,x}^i \geq qos_q^{Threshold}\}$

10: **else**

11:  $PCS = \{cs_x^i \in PCS \cap AS_i / qos_{q,x}^i \leq qos_q^{Threshold}\}$

12: **end if**

13: **end for**

**Outputs:** The Preselected Candidates Set ( $PCS$ ).

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**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= {EP=0.05, cost=10.3, RT=20, Av=90}
- C2= {EP=0.5, cost=9, RT= 21, Av=92}
- C3= {EP=0.7, cost=10, RT=22, Av=91}

C.S	E.P	COST	R.T	Av	R.D
1)	3	1	3	1	3.6
2)	2	3	2	3	5.4
3)	1	2	1	2	3.4

Fig 1. EP and QoS dominances to calculate

2.2) Relative Dominance:

Let  $E_{prof}(cs1) = E_{cost}(cs1) / AutoS(cs1)$  and  $E_{prof}(cs2) = E_{cost}(cs2) / AutoS(cs2)$  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 CS1 dominated by remaining 2 services. so its value is  $Dom(cs1)=3$ . Remaining also follow the same rule.

Definition2:

*Energy profile based Dominance:*

In the energy model description, The candidate service providing the lowest energy profile value will have the highest energy profile-based dominance which is equal to the value 3.

Algorithm 2 – Relative dominance-based services selection

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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  $cs_x^i$ .
    
```

Relative dominance

The value which is having the highest relative dominance is selected for the service composition.

The Energy model is described below for how to calculate energy profile of a candidate service and then energy consumption. The battery of each device has initial charge value "Cintial" chosen randomly in the interval  $[0.7C_{max} \text{ to } 1.0C_{max}]$ . Where the  $C_{max}$  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.  $C_{max}=1500 \text{ mA.h}$   
 $C_{threshold}=30\% \text{ of } C_{max}$

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.

in the proposed selection approach, the added value can be compared by using the 2 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

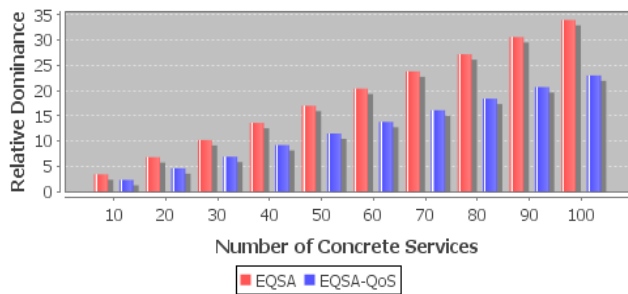
Simulation Results:

- **Relative Dominance:** it is sum of dominances of all the candidate services.
- **Energy Consumption:** it is sum of the energy consumed by individual components.
- **Composition life time:** The number of compositions are executed before the first concrete service failure. A service is failure when its residual energy no longer sufficient to be used.

1) Relative dominance Vs. no. of concrete services :

The relative dominance of a EQSA algorithm allows to selecting candidate services maximizing both EP-based & QoS-based dominance but in EQSA-QoS algorithm allows only considering QoS values alone, which leads to reduce the relative dominance.

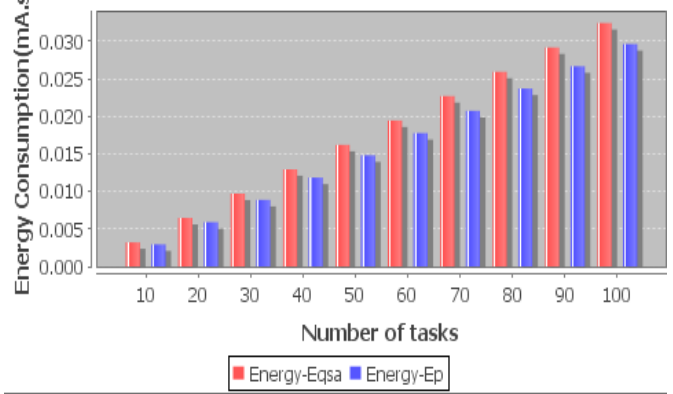
**Relative dominance versus number of concrete services**



2) Energy consumption Vs No. of Tasks:

The figure shows that the energy consumption of the composite path(EQSA) increases when the number of service classes(Tasks) increases. In fact, increasing the size of composite path will increase the number of selected services which causes more power consumption.

**Energy consumption versus number of tasks.**

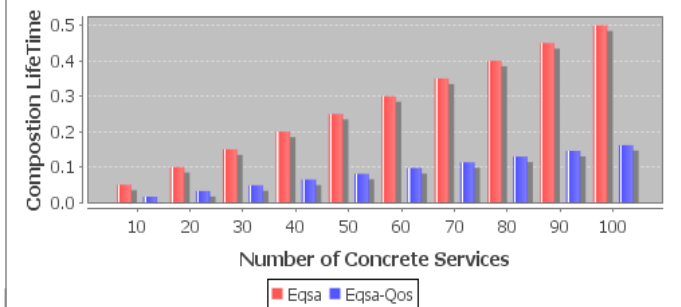


3) Composition life time Vs no. of concrete services:

Composition life time=Total initial energy/ energy per sec.

The composition lifetime of EQSA algorithm is more efficient than the EQSA-QoS. Because EQSA-QoS select the services with high energy profile which leads to reduce the composition life time

**Composition lifetime versus number of concrete services.**



### 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 EQSA algorithm.

## V. REFERENCES

- [1]. Y. Ngoko, A. Goldman, and D.Milojicic, "Service selection in web service compositions optimizing energy consumption and service response time," *J. Internet Services and Applicat.*, vol. 4, no. 1, pp. 1-12, Dec. 2013.
- [2]. D. Ardagna and B. Pernici, "Adaptive service composition in flexible processes," *IEEE Trans. Softw. Eng.*, vol. 33, no. 6, pp. 369-384, Jun. 2007.
- [3]. T. Yu, Y. Zhang, and K.-J. Lin, "Efficient algorithms for Web services selection with end-to-end QoS constraints," *ACM Trans. Web*, vol. 1 no. 1, pp. 6:1-6:26, May 2007.
- [4]. G. A. Garcia Llinas and R. Nagi, "Network and QoS-based selection of complementary services," *IEEE Trans. Services Computing*, vol. 8, no. 1, pp. 79-91, Feb. 2015.
- [5]. Q.Wu and Q.Zhu, "Transactional andQoS-aware dynamic service composition based on ant colony optimization," *Future Generation Comput. Syst.*, vol. 29, no. 5, pp. 1112-1119, Jul. 2013.
- [6]. M. Alrifai, T. Risse, and W. Nejdl, "A hybrid approach for efficient Web service composition with end-to-end QoS constraints," *ACM Trans. Web*, vol. 6, no. 2, pp. 7:1-7:31, May 2012.
- [7]. S. X. Sun and J. Zhao, "A decomposition-based approach for service composition with global QoS guarantees," *Inf. Sci.*, vol. 199, pp. 138-153, Sep. 2012.
- [8]. Furthmüller and O. P. Waldhorst, "Energy-aware resource sharing with mobile devices," *Comput. Networks*, vol. 56, no. 7, pp. 1920-1934, May 2012.

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