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Illustrative example of determining Quality of Service (QoS) using trustworthiness measurement methodology

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Abstract— In this paper we make use of a case study comprising of an interaction between a service provider and a service requestor to determine the quality of service (QoS) provided by the service provider. The trustworthiness measurement methodology is made use of to carry out the QoS assessment. The steps involved in the trustworthiness measurement methodology are discussed and illustrated by demonstrating the working of trustworthiness measurement methodology software that we have engineered.

I. INTRODUCTION

In this paper we present a software tool that makes use of the trustworthiness measurement methodology, which was proposed and explained in our earlier publications [1,2], to determine the Quality of Service (QoS) of a given service provider.

The user enters the identity of the trusting agent (service requestor) and the identity of the trusted entity (service provider) involved in the interaction, the context of the interaction, the criteria involved in the interaction and the numerical values for the metrics of Actual Behaviour Criterion Correlation ($ABCC_{\text{Criterion}}$), Mutually Agreed Behaviour Criterion Correlation ($MABCC_{\text{Criterion}}$), Clarity of Criterion ($Clear_{\text{Criterion}}$) and Importance of Criterion ($Imp_{\text{Criterion}}$). Finally, the software tool makes use of CCCI metrics that were proposed, explained and discussed in our earlier publications [1, 2] to determine the trustworthiness value of the trusted entity.

In the next section, Section 2, we present a case study involving an interaction between a service requestor and a service provider. Subsequently, in Section 3 – Section 7, we explain the steps in determining the QoS of service provided by the service provider, by utilizing the trustworthiness measurement methodology. The process of determining the QoS is supplemented and explained by demonstrating the working of our trustworthiness measurement methodology software. Finally, Section 8 concludes the paper.

II. TRUSTWORTHINESS MEASUREMENT METHODOLOGY FOR QUALITY OF SERVICE ASSESSMENT

In this section we give an overview of the process of trustworthiness measurement methodology and how it can be used to determine the Quality of Service (QoS) provided by a given service provider. Due to space constraints we are unable to carry out an in depth discussion and description of the trustworthiness measurement methodology, in this paper. Interested readers are requested to refer to [1, 2] for an in depth discussion and description.

The steps involved in the trustworthiness measurement methodology are as follows:

1. Determine the context of interaction between the trusting agent and the trusted entity.
2. Determine the criteria involved in the interaction between the trusting agent and the trusted entity.
3. Develop a criterion assessment policy for each criterion involved in the interaction.
4. Determine the trustworthiness value of the trusted entity in the given context and time slot corresponding to the time spot of interaction by making use of CCCI metrics.

The proposed methodology for determining the Quality of Service (QoS) is exactly similar to the above methodology with the exception that the terms are changed to reflect the service domain. The specialized methodology that determines the Quality of Service provided by a given service provider in an interaction comprises of four steps as follows:

1. Determine the context of interaction between the service requestor and the service provider.
2. Determine the criteria involved in the interaction between the service requestor and the service provider.
3. Develop a criterion assessment policy for each criterion involved in the interaction.
4. Determine the Quality of Service of the service provider in the provided service and time slot corresponding to the time spot of interaction by making use of CCCI Metrics.

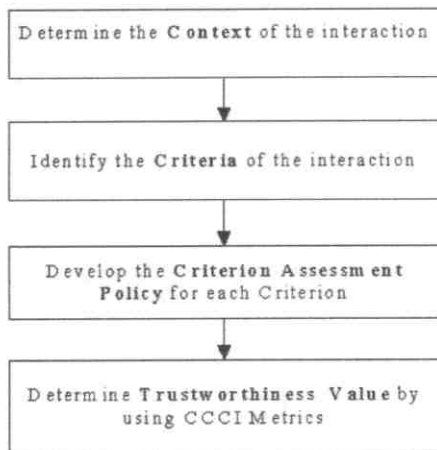


Figure 1: Flow Chart of the Trustworthiness Measurement Methodology

III. CASE STUDY FOR ILLUSTRATION PURPOSES

In this section, we will explain how the Quality of Service (QoS) provided by a given service provider can be determined by making use of the trustworthiness measurement methodology. The case study that we use is as follows:

Assume that there are two logistic companies namely, East Field and West Field which are located in Sydney and Perth respectively. Let us further assume that they have their areas of operation specific to the area that they are located in. Let us furthermore assume that East Field wants to store some of its consignment of goods in the warehouse belonging to West Field. It sends a request to West Field asking for warehouse space of say 6000 sq feet for a duration of 6 days.

This constitutes the initial service proposal from East Field to West Field. Let us further assume that West Field is unable / unwilling to provide the service requested by East Field and proposes an alternative service proposal. Let us assume that the alternative service proposal from West Field is to provide East Field with a warehouse space of 5500 sq ft for duration of 6 days. Let us furthermore assume that East Field agrees to the alternative service proposal which as a result becomes the mutually agreed service.

Let us assume that East Field was allocated a warehouse space of 5000 sq ft for a duration of 6 days by West Field when the actual interaction between them took place.

In the following sections, we will explain the step-by-step procedure for determining the Quality of Service (QoS) provided by West Field in its interaction with East Field, by

making use of the trustworthiness measurement methodology.

IV. DETERMINING THE CONTEXT OF INTERACTION

As mentioned previously, the first step that East Field in its capacity as the service requestor, in determining numerically and semantically the Quality of Service (QoS) by making use of the trustworthiness measurement methodology needs to take is to find out the context of interaction. It was additionally pointed out that the context of interaction where the trusted entity is a service provider is derived from the mutually agreed service.

Based on the above description, the mutually agreed service between East Field and West Field is as follows:

- 1) West Field would provide a warehouse space of 5500 sq feet to East Field (and)
- 2) This warehouse space would be provided for duration of 6 days.

Based on the above mutually agreed service, the context of interaction between East Field and West Field can be referred to as 'provide warehouse space for a specified duration of time'.

Figure 2, below shows the trustworthiness measurement methodology software prompting the user to input whether the trusting agent is a service requestor or a buyer, and the identity of the trusting agent. In this case, we select the trusting agent as a service requestor and enter the identity as East Field.

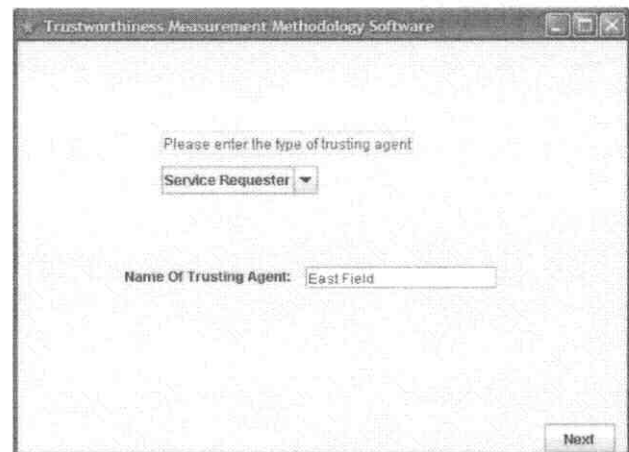


Figure 2: The Trustworthiness Measurement Methodology software prompting the user to enter the trusting agent in the interaction along with its identity

Figure 3, below shows the trustworthiness measurement methodology software prompting the user to input whether

the trusted entity is a service provider or a product, and the identity of the trusted entity. In this case, we select the trusted entity as a service provider and enter the identity as West Field.

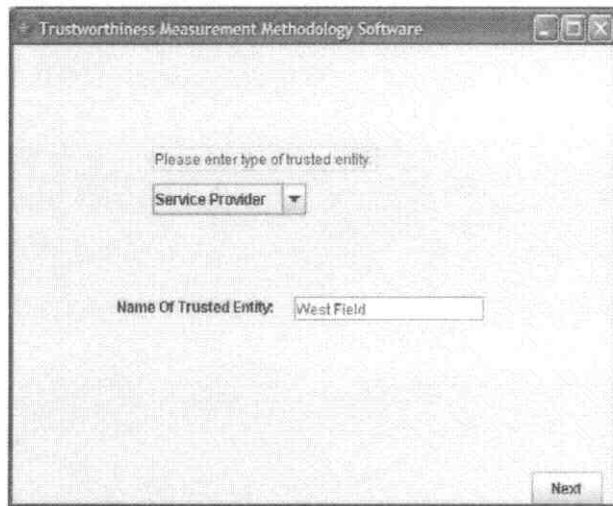


Figure 3: The Trustworthiness Measurement Methodology software prompting the user to enter the trusted entity in the interaction along with its identity.

Figure 4, below shows the trustworthiness measurement methodology software prompting the user to input the context of interaction between East Field and West Field. In this case, we enter the context of interaction as 'provide warehouse space for a specified duration of time'.

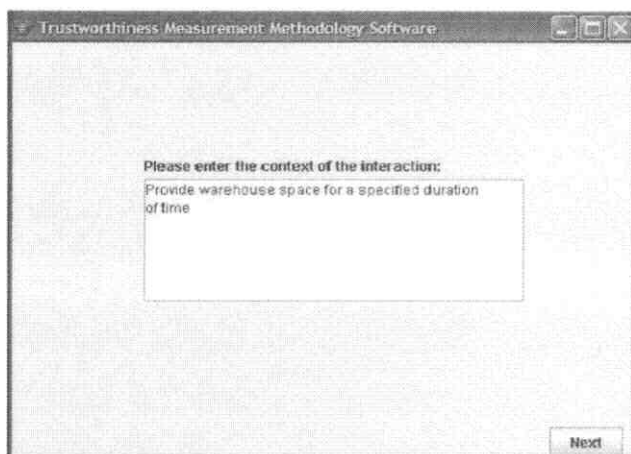


Figure 4: The Trustworthiness Measurement Methodology software prompting the user to enter the context of the interaction

V. DETERMINING THE CRITERIA OF INTERACTION

The second step that East Field in its capacity as the service requestor needs to take in order to determine the Quality of

Service (QoS) provided by the service provider (West Field), by making use of the trustworthiness measurement methodology is to determine all the criteria in the interaction.

From the above mutually agreed service between East Field and West Field, it is clearly evident that the two decisive activities that East Field is looking for in its interaction with West Field are as follows:

1. Warehouse space of 5500 sq ft (and)
2. Should be provided with the above warehouse space for a duration of no less than 6 days.

Figure 5, below shows the trustworthiness measurement methodology software prompting the user to input all the criteria involved in the interaction between East Field and West Field. In this case, we enter the two criteria as discussed above.

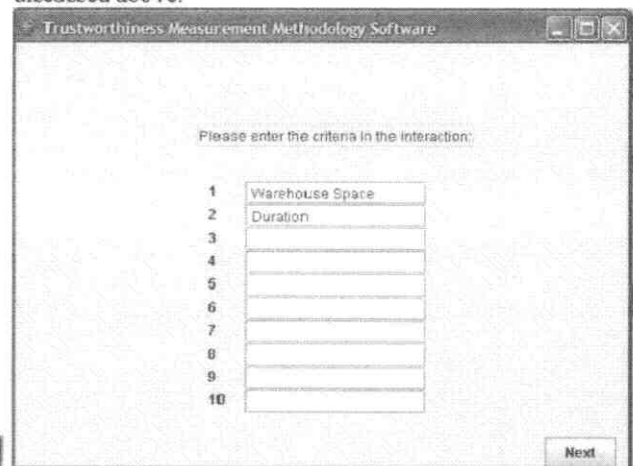


Figure 5: The Trustworthiness Measurement Methodology software prompting the user to enter the criteria of the interaction

VI. DEVELOP CRITERION ASSESSMENT POLICIES

The third step in the trustworthiness measurement methodology is to develop criterion assessment policies for each of the above two criteria.

Let us assume for discussion purposes that West Field has developed the following criterion assessment policies:

Criterion Assessment Policy for 'Size of Warehouse Space Allocated':

If West Field allocates a warehouse space of greater than or equal to 5500 sq ft then this criterion has been met by the West Field, else not.

Criterion Assessment Policy for 'Duration of Warehouse Space Allocated' or 'Duration':

If West Field allocates the warehouse space for a duration of greater than or equal to 6 days then this criteria has been met by the West Field, else not.

We will now present a step-by-step procedure of how East Field can quantitatively and semantically determine the Quality of Service (QoS) provided by West Field using the CCCI metrics.

VII. USE CCCI METRICS TO DETERMINE QoS IN THE GIVEN CONTEXT AND TIME SLOT

The final step in the trustworthiness measurement methodology that East Field needs to take in order to determine the QoS provided by West Field in the context of 'provide warehouse space for specified time' and at the time slot of interaction is to apply CCCI metrics that were proposed in our earlier research work [1,2]. We explain the stepwise procedure of the working of CCCI metrics in this scenario to determine the QoS provided by West Field.

Step 4(a): Determine the ABCC_{crit} and MABCC_{crit} values of both the criteria in the interaction.

As can be seen from the above description, the actual service of the West Field in the interaction is as follows:

- It provided East Field with a warehouse space of 5000 sq feet (and)
- This warehouse space was provided for a duration of 6 days.

From the above description of the mutually agreed service and the actual service we can see that:

- 1) Actual Behaviour Criterion Correlation for the criterion 'Warehouse Space' (ABCC_{WarehouseSpace}) would be '0', since West Field had agreed to provide a warehouse space of 5500 sq ft to East Field but in the interaction provided it with a warehouse space of 5000 sq ft only. In other words, since West Field did not deliver on the mutually agreed service for the given criterion the value of ABCC_{WarehouseSpace} would be '0'.
- 2) Actual Behaviour Criterion Correlation value for the criterion 'duration for which the warehouse space has been allocated' or 'duration'(ABCC_{Duration}) would be '1', since West Field had agreed to provide the warehouse space for a duration of 6 days and in the interaction provided it with a warehouse space of 6 days. In other words, since West Field delivered fully on the mutually agreed service for the given criterion the value of ABCC_{Duration} would be '1'.

- 3) MABCC_{WarehouseSpace} and MABCC_{Duration} correspond to the mutually agreed service values for each of these two criteria. From Table 5.2 it can be seen that values for each of these would be '1'.

Step 4(b): Determine the clarity of all the individual criteria involved in the interaction

From the above description, we can see that both the criteria along with their output had been mutually agreed upon by East Field and West Field. Thus the clarity value for the criterion of 'Warehouse Space' (Clear_{WarehouseSpace}) would be '1' and the clarity value for the criterion 'Duration of Warehouse Space' or 'Duration' (Clear_{Duration}) would be '1'.

Step 4(c): Determine the importance of all the individual criteria involved in the interaction

Let us assume that the East Field considers both the criteria involved in the interaction to be 'very important'. Hence, the importance of the criterion 'Warehouse Space' (Imp_{WarehouseSpace}) would be '3' and the importance of the criterion 'Duration of Warehouse Space Allocated' or 'Duration' (Imp_{Duration}) would be '3'.

Figure 6 and Figure 7, below shows the trustworthiness measurement methodology software prompting the user to input numerical values of ABCC_{crit}, Clear_{crit} and Imp_{crit} for both the criteria in the interaction.

Figure 6: The Trustworthiness Measurement Methodology software prompting the user to enter numerical values for ABCC_{WarehouseSpace}, Clear_{WarehouseSpace} and Imp_{WarehouseSpace}

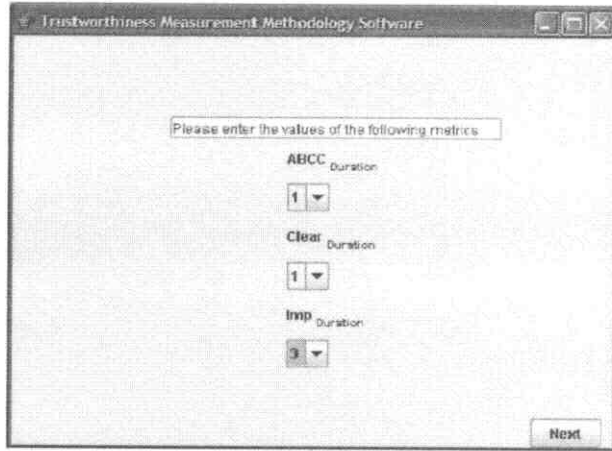


Figure 7: The Trustworthiness Measurement Methodology software prompting the user to enter numerical values for ABCC_{Duration}, Clear_{Duration} and Imp_{Duration}.

Step 4(d): Express Quantitatively the Actual Service Provided by West Field in its interaction with East Field

The actual service provided by West Field in its interaction with East Field is as follows [1, 2]:

$$\text{ActualService}_{\text{WestField}} = (\text{ABCC}_{\text{Corr WarehouseSpace}} + \text{Clear}_{\text{WarehouseSpace}} * \text{Imp}_{\text{WarehouseSpace}}) + (\text{ABCC}_{\text{Corr Duration}} + \text{Clear}_{\text{Duration}} * \text{Imp}_{\text{Duration}})$$

$$\text{ActualService}_{\text{WestField}} = (0*1*3) + (1*1*3) = 3$$

Step 4(e): Express Quantitatively the Mutually Agreed Service between East Field and West Field in their interaction

Quantitatively the mutually agreed service between East Field and West Field is as follows [1,2]:

$$\text{MutuallyAgreedService}_{\text{WestField}} = (\text{MABCC}_{\text{Corr WarehouseSpace}} * \text{Clear}_{\text{WarehouseSpace}} * \text{Imp}_{\text{WarehouseSpace}}) + (\text{MABCC}_{\text{Corr Duration}} * \text{Clear}_{\text{Duration}} * \text{Imp}_{\text{Duration}})$$

$$\text{MutuallyAgreedService}_{\text{WestField}} = (1*1*3) + (1*1*3)$$

- 6

Step 4(f): Express quantitatively and semantically the Quality of Service (QoS) in the given context and time slot of interaction

Using the quantitatively expressed actual service and mutually agreed service of West Field, the QoS provided by West Field, on a scale of [1-6] is as follows [1,2]:

$$\text{QualityofService}_{\text{WestField}} =$$

$$\frac{((\text{ActualService}_{\text{WestField}}) / (\text{MutuallyAgreedService}_{\text{WestField}})) * 6}{(3/6) * 6}$$

$$= 3$$

= 3

Hence numerically the QoS provided by West Field in the context 'provide warehouse space for specified time' and at the time slot of interaction with East Field is 3, which semantically corresponds to 'minimally reliable service' or 'minimally acceptable service' by making use of the trustworthiness scale proposed in our earlier publications [1,2].

Figure 8, below depicts the trustworthiness measurement methodology software showing quantitatively the Quality of Service provided by West Field to East Field.

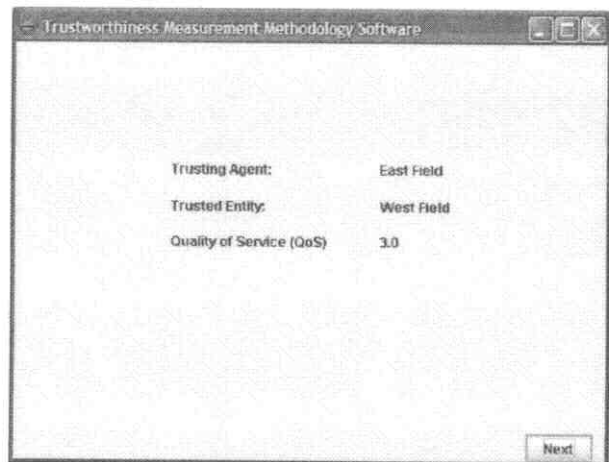


Figure 8: The Trustworthiness Measurement Methodology software showing the Quality of Service (QoS) provided by West Field

VIII. CONCLUSION

In the paper we illustrated with an example and case study how the trustworthiness methodology proposed in our

earlier research work [1, 2] can be used to determine the quality of service (QoS) provided by a given service provider. Using a case study of an interaction between a given service requestor and a given service provider, each of the steps in the trustworthiness measurement methodology were explained. Furthermore all the steps were illustrated and supplemented by demonstrating the working of our trustworthiness measurement methodology software that we have developed.

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Abstract

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