Semantic web service discovery for mobile web services

A. Bhuvaneswari*
IT Department,
Adhiparasakthi Engineering College,
Melmaruvathur, India
Email: bhuvan@adhiparasakthi.in
*Corresponding author

G.R. Karpagam
CSE Department,
PSG College of Technology,
Coimbatore, India
Email: grkarpagam@gmail.com

Abstract: The process of service discovery is the most important task in web services. But this service discovery process may degrade network performance due to the mobile environment. To overcome these issues, a new approach called ‘semantic mobile web services (SMWS)’ is proposed. This proposed semantic mobile web services is used for a better discovery process even in the high mobile environment. By using the query request (QRY REQ), response (RSP) packets, user can identify the location of the mobile node as well as discover the web services with the minimum utilisation of bandwidth resources. During the service discovery process, a service registrar is included between service requester and service provider to reduce overhead. The process of matchmaking produces the exact match responses for the respective requestor queries. This helps to increase the quality of performance and network efficiency. Simulation has analysed the performance of the proposed semantic mobile web services.

Keywords: semantic mobile web services; SMWS; service discovery; matchmaking; web service layered architecture; web service description language; WSDL.


Biographical notes: A. Bhuvaneswari is a Professor in the Department of Information Technology with expertise in Semantic Web Services. She received her Doctorate in Semantic Web Service Composition from Anna University. Her current interest is in mobile web services, service orchestration and cloud infrastructure.
1 Introduction

Web service is a type of technology which is used to create any software application. This application will be used in many industries based on their requirement and needs. This web service was generally described by using web service description language (WSDL) and that will be extracted using the simple object access protocol (SOAP). Discovery of web services is denoted as semantic web services and this was developed by using the ontology web language service (OWL-S). This helps to extend the process of discovery and routing process in the web services. Bluetooth service discovery protocol and service location protocol are used for the discovery process by using the location and Bluetooth. But these techniques are not suitable for the mobile applications. The web services are used in the mobile network architecture and that will be denoted as mobile services. The major drawbacks in the mobile services are mobility, link failure, node failure and lesser performance. To overcome these issues, many techniques have been introduced. Those techniques are group based discovery process, query based discovery process and web service discovery replication process. These techniques are used to discover with the help of group, query and replication data. But these approaches increase the complexity. The major process of semantic web services is as follows

- finding the information
- extract the information
- maintaining the information
- representing the information
- interpreting the information.

These five processes are the most important tasks in the semantic web services. This will help to extract the web services with full potential. Normal web services allowed doing the discovery process, selection and composition process. But the semantic web technology allows the interpretation as well as used the ontology for the data model. The semantic web service architecture (WSA) includes web services, semantic web services and agent. Web services are used to make the communication between the machines in the architectural network. Semantic will be placed on the top layer of web services and that will provide the language and logical support. Agent will act as users. By using the semantic web content, users will get their software with the high quality.
2 Related work

Shridevi and Raju (2016) suggest the solution of semantic web annotation and this technique is used for the software testing in the semantic web services. This will verify the behaviour of software before the installation. That helps to avoid the issues as well as increase the efficiency. He et al. (2016) explains the universal description discovery and integration (UDDI) technique is used to provide the security in the cloud computing through the semantic web services. By using the semantic queries, the description, discovery and integrity process will be done in the P2P structured overlay network. De Renzis et al. (2016) discuss the case-based reasoning model for the web searching and selection process. This helps to increase the efficiency and decrease the deficiency occurs in the web semantic services. Rahman and MacCaull (2016) introduced the service oriented architecture which is based on the service enabled workflow. This will allow some specific task to complete in the web semantic service area. This helps to analyse the quality enabled web service model for the quality purposes. Lemos et al. (2016) give the detail explanation about the web services in the different fields such as languages, tools, platforms and composition models. This helps to get the clear explanation of web services as well as understood the difficulties in the web services. Narayanan et al. (2016) suggest the auto-discovery logic condition for the discovery of web services. This will use the proper authentication scheme for both partially and fully premise condition. The protocol has been developed based on the clouds and enterprise computing environment. Huber et al. (2016) presents the semantic access method for the internet of things and this helps to make the communication between the web services and IoT devices. This technique uses the capability based scheme and for the resource allocation process used the context sensitive method. Ayad et al. (2016) suggest the new web services for mobile ad hoc network with the help of cross-layer techniques. This helps to reduce the issues occur in the mobile ad hoc network such as mobility and link failure. This cross-layer semantic web services help to improve the performance of the mobile ad hoc network such as bandwidth, throughput and network efficiency. As well as this approach used the discovery services in the limited diameter in the network. Van Woensel and Casteleyn (2016) discuss the mobile query services. Generally, web documents are the large integrated data sets and that will be in the form of RDF files. By using the novel cache replacement process, can allow the web service discovery process even in a large number of online web semantics. Du et al. (2016) explains about the service cluster net unit. Service discovery process will be limited in the particular clustered area. Through this web service clusters, can increase the efficiency and performance with the help of service substitution scheme.

3 Research issues

WSA (Khemaja and Taamallah, 2016) is used to enhance the communication from one application to another application. This has been developed by using the XML and web technologies. Web service layer is connected to the transport layer and application layer. In the web service layer includes, web description language, network type and protocol. By using these three forms, web service layer has been developed. Service-oriented architecture (SOA) (Liu et al., 2016) and this will be applicable for the mobile web
services. This SOA includes requesters, providers and brokers. Initially requestor will send the request to brokers for service discovery process. Before that, brokers will register all the services. Providers are used to publishing their services through the brokers. Requestors are used to request the service to providers, providers will response through the brokers to requestors. This may lead to high delay during the request and response rate. Mobile users interactions and tasks (MIUT) architecture (Luo and Feng, 2016) is used to increase the efficiency and reduce the computational cost. This helps to adapt the mobile users using the controller function. This controller function will combine the view and model. View state is used to interface the mobile users and model state is used to interface the web users. End-user programming for mobile services (EUPM) (Schobel et al., 2016) has been developed for the end users should achieve the quality in the mobile services. The providers will store their data in the web storage database and that will be compressed and executed. That will be evaluated by using the process aware evaluation. Web service architecture for supplier chain manufacturing system (WSCM) (Danila et al., 2016) is helping to increase the interoperability and context awareness services. This technique is mostly suitable for smart objects and internet of things. This helps to enable the flexibility and reusability process based on the web services architecture. These techniques have a lot of research issues such as high computational complexity, high delay, high response rate, lesser efficiency and high drop rate. These can be overcome by using the proposed approach.

4 Semantic mobile web services

The proposed semantic mobile web services (SMWS) are used to apply the semantic web discovery approach in mobile services. This mobile service has high mobility, due to which it is difficult to maintain the topology. To avoid the mobility issues in the web services, authors have proposed this new approach as SMWS. This proposed semantic mobile web service includes five steps as follows

- web service layered architecture
- bandwidth allocation
- resource selection
- service discovery process
- match-making.

By using these steps, the proposed SMWS have been designed. This technique is used to reduce the computational cost, overhead ratio, response rate, drop rate and increase the throughput, network efficiency.

In the first steps, layered architectures have been developed based on the requirement of proposed SMWS. The bandwidth will be allocated for the advertising, discovery and synchronisation process.

\[ B_{w} = \frac{A_{r}}{C} \] (1)
Equation (1) is defined as the bandwidth allocation process. Where, $Bw$ is bandwidth, $Ar$ is available resources and $C$ is capacity. Bandwidth allocation will be based on the available resources with respect to the capacity. Then resource selection has been introduced to make the routing table based on the routing protocol used in the proposed SMWS. After that introduced the services discovery process, it involves route request and route response in the routing format. Finally matchmaking, based on the output and input source file, matching process will be done. Based on the exact match, discovery, routing and allocation process will be successfully implemented. This proposed semantic mobile web service helps to increase the quality of services with the help of these different five steps involved in this method.

4.1 Web service layered architecture

In OSI layer architecture, by using the physical layer data will be collected from either wired or wireless medium. That data will be converted into segments by using the data link layer. The third layer of network layer will forward the data segment by using the IP address. Transport layer will move to the session layer and make the data segments into session. Presentation layer will compute and combine all the data, which will be forwarded to the application layer. By using the seventh layer of the application layer, data will be forwarded to the destination user or client. But in this proposed web service layered architecture, it goes to add the new layer between the transport layer and application layer. This will allow applying the web services in the mobile communications. It includes protocol layer, messaging layer, web service layer and discovery layer. Figure 1 shows that the web service layered architecture.

![Figure 1 Web service layered architecture](see online version for colours)

Protocol layer is used to access the file transfer protocol or hypertext transfer protocol. Messaging layer used the XML language for transferring the messages between one application to another application services. Web service layer is allowed to support the web services, semantic web services and mobile web services. Discovery layer is used to discover the services.
4.2 Bandwidth allocation

Here the proposed SMWS help to reduce the utilisation of bandwidth. Generally, in semantic web services uses the more channel bandwidth for the service discovery process. To discover the services, it uses advertising packets, synchronisation packets, query packets and response packets. Generally, advertising packets broadcast the advertising messages for the discovery process. This will utilise the more bandwidth resources. Likewise, synchronisation packets are only used between the two discovery layers. This also utilises more bandwidth resource. Query packets are used for the discovery process and these packets are broadcast, multicast and unicast to a particular node based on the user requirement. Response packets also the same process of query packets. Based on the query packets, response packets will be generated. These two packets are used for the discovery process and also it utilises the bandwidth resources. But this proposed SMWS use only query packets and response packets. These query packets will be multicast to the neighbour nodes and response packets will response as unicast to the respective query packets.

4.3 Resource selection

Resource selection is the process of creating the routing table format as per the requirements of the proposed SMWS. Here AODV ad-hoc on the demand distance vector routing table is used. Based on the requirements of the proposed SMWS, this AODV routing table has been modified. Figure 2 shows that the Routing table for SMWS. Here included the two formats as QRY REQ is (query request) and RSP is (response). And these two format structures are used for the discovery process in the proposed SMWS.

![Routing table](see online version for colours)

<table>
<thead>
<tr>
<th>Source</th>
<th>Destination IP Address</th>
<th>Next hop</th>
<th>Hop Count</th>
<th>RREQ</th>
<th>RREP</th>
<th>QRY REQ</th>
<th>RSP</th>
<th>Sequence</th>
</tr>
</thead>
</table>

Here, RREQ is route request and RREP is route response. These are used to find the route between the source and destination.

4.4 Service discovery process

In the service discovery process includes the service provider, service registrar and service requestor. Here service providers will register their services in the service registrar. Service requestor will send the query request to the service registrar and that will be a response to the service requestor. After that the service requestor invokes to the service provider.

Figure 3 shows the flow chart of service discovery process, initially user node generates query request (QRY REQ) to the neighbour nodes. Initially it checks whether the source node. If it is source node, that will be dropped. Each node checks this query request already received. If it is already received, forward to the next node. Otherwise, it will add to the cache memory. By using this can verify the already received query request. This helps to reduce the delay and overhead. Then that will be appropriate service or best service, generate response and that will be given to the user. That user will
intimate to the source node. Here user will act as service registrar, source will be the service requester and the best service node is the service provider. Otherwise, repeat the process. This helps to increase the overall network performance in the SMWS.

**Figure 3** Flow chart of service discovery process

4.5 **Process of matchmaking**

The purpose of matchmaking includes increasing the network efficiency. During the service discovery process, in the best service selection is based on the process of matchmaking. Sometimes, for the QRY REQ (query request) the proper response will not be achieved. That proper response and then the correct service has to be fixed to the particular service requestor.

Figure 4 shows the process of matchmaking. Initially, service requester will send the QRY request to the neighbour node. After finding the services, matchmaking process will be included for the quality improvement. This will check the QRY REQ and RSP, if both the services are same it will be considered as perfect match. And that response will be given to the service requester.
Figure 4  Process of matchmaking (see online version for colours)

Algorithm  Matchmaking process

Let I(sr) is the input QRY request generated by the service requester.
O(sr) is the expected output of the service requester.
I(sp) is the input generated by the service provider.
I(sp) is the output RSP (response) produced by the service provider.

Condition 1: Exact match:
If O(sr) = O(sp)
Exact match
High priority

Condition 2: Partial match:
If O(sr) > O(sp)
Service provider is available
May satisfy
Else if O(sr) < O(sp)
Week relationship
Low priority

Condition 3: NULL match:
If O(sr) ≠ O(sp)
Fail
Zero priority
End
After this process of matchmaking, sort the results based on the priority and that was shown in Figure 4. Based on the priority level, query response will be forwarded to the requester. In this proposed SMWS, included the web service layered architecture and then to utilise more bandwidth used only the QRY REQ and RSP packets for the discovery process. In the discovery process, the service registrar avoids the overhead. Finally, matchmaking process gives the quality and increase the network efficiency by allocating the proper response to the QRY REQ generated by the service requester.

5 Simulation results

The simulation results were analysed by using the network simulator NS2.42., the simulation time is assigned as 200 seconds. Table 1 shows that the simulation parameters used for the proposed SMWS.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simulation time</td>
<td>200 seconds</td>
</tr>
<tr>
<td>Simulation area</td>
<td>1000 * 990</td>
</tr>
<tr>
<td>Number of nodes</td>
<td>500</td>
</tr>
<tr>
<td>Mobility</td>
<td>20 m/s</td>
</tr>
<tr>
<td>Number of service requester</td>
<td>25</td>
</tr>
<tr>
<td>Number of service providers</td>
<td>100</td>
</tr>
<tr>
<td>Number of registrars</td>
<td>50</td>
</tr>
<tr>
<td>Propagation model</td>
<td>Two ray ground model</td>
</tr>
<tr>
<td>Antenna type</td>
<td>Omnidirectional</td>
</tr>
<tr>
<td>Channel type</td>
<td>Wireless MAC 802.11</td>
</tr>
<tr>
<td>Routing protocol</td>
<td>AODV</td>
</tr>
</tbody>
</table>

The proposed SMWS is compared with the existing approaches are WSA, MIUT architecture and EUPM. To analyse the performance, the following parameters are used.

- network throughput
- network efficiency
- overhead ratio
- request and response rate.

Network throughput states that the number of successfully received files with respect to the simulation time. The proposed SMWS achieves high throughput compared to the existing architectures such as WSA, MIUT architecture and EUPM. The WSA has reduced the throughput without the service registrars. MIUT architecture has lesser throughput and EUPM has low throughput due to the high utilisation of bandwidth that was shown in Figure 5.
Network efficiency states that the response should be appeared to their respective query request generated by the service requesters. The existing architectures are WSA, MIUT architecture and EUPM have lesser network efficiency due to the responses are not generated properly for the service requesters queries. But in proposed SMWS increases the network efficiency compared to the existing WSA, MIUT architecture and EUPM this was shown in Figure 6.

**Figure 6** Analysis of network efficiency
Overhead ratio states that the high utilisation of channel with high resources with respect to the simulation time. High utilisation of channel, increases the overhead and that was high in these existing WSA, MIUT architecture and EUPM techniques. The proposed SMWS reduce the utilisation of channel bandwidth as well as reduce the overhead ratio and this was shown in Figure 7.

Figure 7  Analysis of overhead ratio

![Figure 7](image)

Figure 8  Analysis of request and response rate

![Figure 8](image)
Request rate states that the number of request generated by the service requesters with respect to simulation time. Response rate states that the number of responses generated by the service providers with respect to the simulation time. The increasing of request rate, response rate will be increased in the proposed SMWS. But in the existing WSA, MIUT architecture and EUPM techniques have lesser response rate by increasing the request rate. This shows that the existing approach degrades the network performance and this was shown in Figure 8.

6 Conclusions

The proposed SMWS helps to increase the network performance with the help of semantic web layered architecture, resource allocation, lesser utilisation of bandwidth, service discovery process and matchmaking performance. This will intimate about the node mobility to their clients. The location will be identified by using the service discovery process. Matchmaking performance makes the exact response generated by the service providers and that will forward to the service requestors through the service registrars. Due to this process, overhead ratio will be reduced as well as network efficiency and network performance has been improved. In simulation section, the proposed SMWS are used to increase the throughput, network efficiency, response rate by increasing the request rate.

References


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