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Modelling Mobile Service-Oriented Applications

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Abstract: From small service providers to large enterprises a need to collaborate and share expertise and resources, as well as costs and risks on-the-fly exists. This need arises from the challenge to remain competitive in an aggressive global market. Service Oriented Architecture (SOA) is the most prominent attempt to realize this cooperation and collaboration through both, dynamic service invocation and selection and their use in workflows. The current technologies are enabling novel and innovative businesses never possible in traditional setting, such as on demand composition of offerings from distinct providers to address a customers needs. This is already being investigated in numerous approaches under the heading ”Mashups” which are concerned with users combining services. In this paper we propose a model to compose a service dynamically to address an arising opportunity for which no service is available assuming that simple or complex services exit to provide the functionality

Keywords: Mobile Service-Oriented

1. INTRODUCTION

High speed data switching wireless networks such as 2.5G GPRS, EDGE, 3G UMTS, 3.5G HSPA and 4G Mobile WiMax have made services ubiquitous. Service-oriented architecture (Erl, 2004; Erl, 2005) which is architecture for web service; there is not support for mobility of a requester and a provider. Here a requester and a provider are static nodes. If we want to give mobility support to a requester and a provider then we have to add mobility standards in between a requester and a provider that will manage and control the flow of data between a mobile requester and a mobile provider. This will enable a mobile requester and a mobile provider to communicate with each other irrespective of their physical locations. We are interested to model mobility support in SOA by using some mobility standards.

The increased popularity and usage of mobile services (Keshav, 2005) have given birth to many issues related to location management and mobility of service provider (host mobility). Therefore we want to address issues related to location management and mobility of a service provider and model mobility complexities through AGG (visual environment for graph transformation). We have developed meta model (type graph) and semantic model through AGG. Graph transformation rules are used to give meaning to our diagrams/models.

The benefit of such a model, apart from illustrating the operation of these standards, lies in the ability to test and validate them. Sequences of reconfigurations corresponding to application scenarios can be tested for their realizability even without an actual implementation. Graph transformation models like the one presented here can therefore be used for protocol design and prototyping.

2. MATERIAL AND METHODS

Background

We are giving here a brief introduction about SOA, mobility standards. Mobility standards that deal with micro mobility or macro mobility are mobile IP (Perkins, C.E., 1996; Ruidong, *et al.*, 2008; Perkins, 1997), cellular IP (Valko, 1999; Junn-Yen, and Chun-Chuan 2005 and Akyildiz, *et al.*, 204), intradomain mobility management protocol (IDMP), HAWAII (Gunasundari, *et al.*, 2008); but we are interested in macro mobility because we are using it in SOA and SOA is architecture for web services and web service are accessed throughout the internet that's why we have used Mobile IP in our case study.

Followings are SOA and some mobility standards.

Service-Oriented Architecture (SOA) Service-oriented architecture (Erl, 2004; Erl, 2005 and Huhns, *et al.*, 2005) was given by IBM, when they were working on web services. They found that it is quite suitable to implement web service in this architecture. SOA is not only architecture; but a programming model that supports loosely coupled applications. It gives a

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new approach for developing software systems. Services (Alonso, *et al.,* 2004 and Barry, 2003) are exposed through interfaces (Service Descriptions) which are implemented in XML-based languages. Service description can be located through registry by clients/requesters. SOAP is a standard protocol for communication of web services (Butler, M., 2001 and Papazoglou, M.P., 2008). Services help integrate applications that were not written with the intent to be easily integrated with other distributed applications and define architectures and techniques to build new functionality while integrating existing application functionality (Papazoglou, M.P., 2003). A Provider, a requester and a registry are three components of SOA and their operations are publish, find and bind.

Mobile IP We want to extend service-oriented architecture (SOA) for mobility support. One way of doing this is to use Mobile IP in between a requester and a provider.

The Mobile Internet Protocol (Mobile IP) (Perkins, , 1996; Ruidong, *et al.,* 2008; Perkins, 1997) was proposed by Charles Perkins; it is actually the extension of the Internet Protocol. It was approved as a Mobile IP protocol by IETF-RFC 2002. It enables mobile computers to stay connected to the Internet regardless of their location and without changing their IP address. Mobile IP has two IP addresses one is home address/permanent IP address and other is care-of-address/temporary IP address which shows current connectivity of a mobile node with a network. A care-of-address changes at each new network and thus indicates the mobile node's point of attachment with respect to network topology. A mobile node needs to keep its IP address the same while moving to maintain existing TCP connection; changing its IP address will loose TCP connection. That's why Mobile IP has one permanent IP address. When a correspondent node wants to communicate with a mobile node it sends IP packets to a mobile node's permanent IP address/home address. Then home agent (HA) encapsulates IP packets and tunnels them to foreign agent (FA). Foreign agent decapsulates datagrams and forwards IP packets to a mobile node (MN) for processing; When mobile node receives a request from FA it processes it and then sends a reply to a FA. Foreign agent then transfers this reply to correspondent node.

Cellular IP Cellular IP (Valko, 1999; Junn-Yen, and Chun-Chuan 2005 and Akyildiz, *et al.,* 204) is a protocol for local mobility and it can be interwove with Mobile IP for wide area mobility. Cellular IP is an optimal solution for local mobility as in Mobile IP when a mobile host changes its location from one base station (access network) to another base station (access network) in a foreign network it needs to send location update message to a remote home agent if mobile host changes its location frequently then it becomes inefficient to send location update messages frequently to a distant home agent which overburdens a network transmission and increase latency. Therefore to optimize local mobility of a mobile host Cellular IP is a good option to control and manage local mobility of a mobile host. Cellular IP keeps distributed cache for location management and routing of the data.

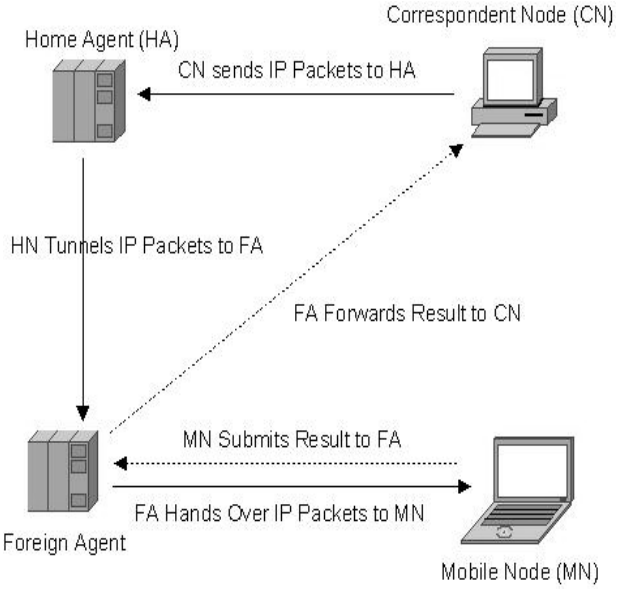


Fig.1 Triangle Routing in Mobile IP.

HAWAII Protocol The Handoff-Aware Wireless Access Internet Infrastructure (HAWAII) (Gunasundari, *et al.,* 2008) is actually protocol for intradomain (micro-mobility). HAWAII protocol uses Mobile IP for macro mobility (interdomain mobility). This is alternative option for controlling and managing local mobility of a mobile host in a foreign network; which reduce latency and network overburden caused by location update message in mobile IP. In this protocol when a mobile node (MN) travels to a foreign network it is assigned a collocated care-of-address. Thus movement of an MN in different base stations of the same foreign network is transparent to a home agent. Mobility of an MN is processed locally in a foreign network. This protocol uses path set up message mechanism to update routing entries for an MN. A CN sends IP packets (addressed to an MN) to the MN's home agent. Then HA tunnels the IP packets to a domain root router (foreign network) which is currently serving the MN. The domain root router then encapsulates datagrams and sends them (by using host-base routing entries) to a base station to which an MN is currently visiting. Then BS decapsulates the packets and finally delivers them to the MN.

3. RESULTS AND DISCUSSION

A Case Study.

In this case study, we have modelled mobility support in service-oriented architecture. We have extended service-oriented architecture for mobility by using Mobile IP in SOA. Mobile IP is used as a intermediatery protocol between a requestor and a provider. In Mobile IP, the home address is permanent address of a mobile node and care-of-address changes at each new network and thus indicates the mobile node's current point of attachment with respect to network topology. Mobile Node (MN), provider, publishes a service in a registry and correspondent node (CN), requester, matches his requirements against all available services and if its requirements are satisfied then he gets binding information of a service which is actually a permanent address of a mobile node (service provider).

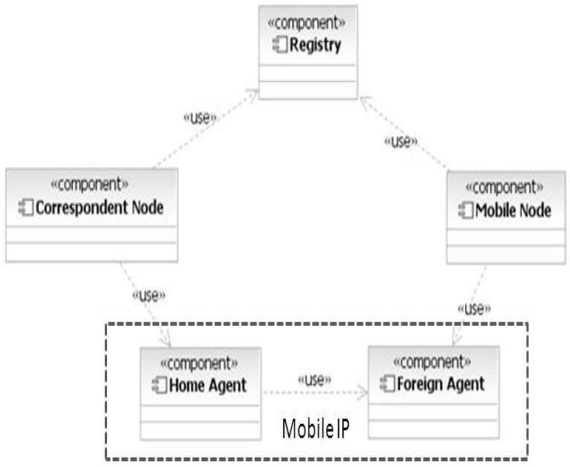


Fig.2 A Component Diagram of Mobile IP in Service-Oriented Architecture

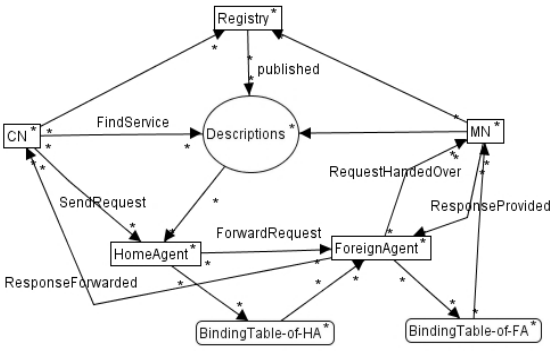


Fig.3 A Type Graph of Mobile IP in Service-Oriented Architecture

In type graph **(Fig.3)** a mobile node (MN)/provider publishes a service in a registry where a client finds the service. A correspondent node (CN)/requester matches its requirements against all available services in a registry; if all the requirements are satisfied then client gets binding information/interface information of the service. After getting binding information client sends a request to a home agent (HA)/home network of a mobile node (MN) where an MN is permanently registered. When an HA receives a request for a mobile node, then it forwards it to a foreign agent (FA)/foreign network where an MN is currently visiting. When a message/request arrives at a FA then it hands over the request to an MN for processing. After processing the request an MN submits the result to a FA for further transmission. Finally a FA transmits the result to a CN/requester without sending the result to a home agent for route optimization.

In graph, **(Fig.3)** we have used two types of edges labelled and unlabelled. The labelled edges show operation/rule and unlabeled edges show static reference between nodes. Following are graph transformations' rules, which explain how service is provided in mobile service-oriented architecture.

We are giving here the start graph **(Fig.4)** of our model before applying any rules. Here unlabeled edges show static reference between nodes of the graph.

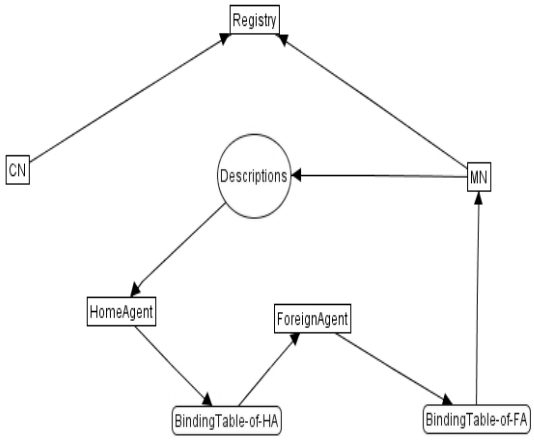


Fig.4 Start Graph of the Model

Fig.6 shows the graph of the model after applying publish operation/rule. In this rule, **(Fig.5)** a service provider publishes a service in a registry.

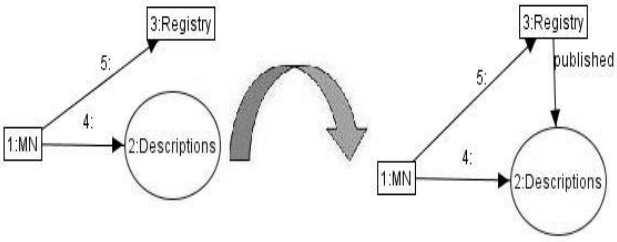


Fig.5 Publish Operation

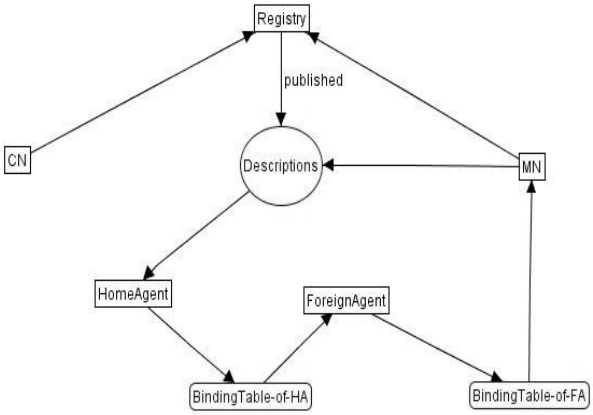


Fig.6 Graph of the Model after applying "Publish Operation/Rule"

In find operation client matches his requirements against all available services. If requirements are satisfied then he will get binding information of a service **(Fig.7).** Fig.8 shows the graph of the model after applying find operation/rule

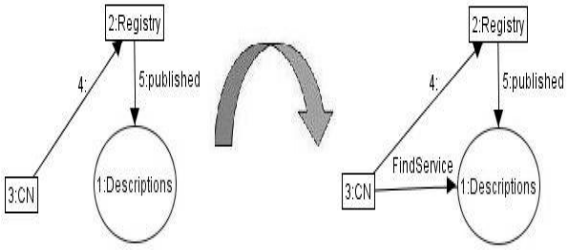


Fig.7 Find Operation

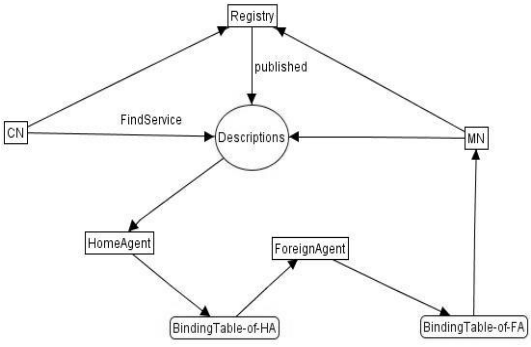


Fig.8 Graph of the Model after applying "Find Operation/Rule"

Fig.9 shows a client sends a request to the home agent to which a mobile node is permanently registered for getting the service.

- In **(Fig.10)**, a home agent forwards a client's request to the foreign agent to which a mobile node is currently visiting for sending it to the service provider/mobile node.
- In **(Fig.11)**, a foreign agent hands over a request to a mobile node/provider for processing.
- After processing a client's request the mobile node provides a result to a foreign agent for further transmission to the requester **(Fig.12)**.
- Finally a foreign agent forwards the result to a requester/client **(Fig.13)**.
- **Fig.14** shows the graph of the model after completion of all rules/operations

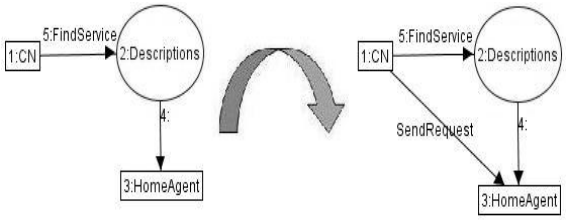


Fig.9 Send Request Operation

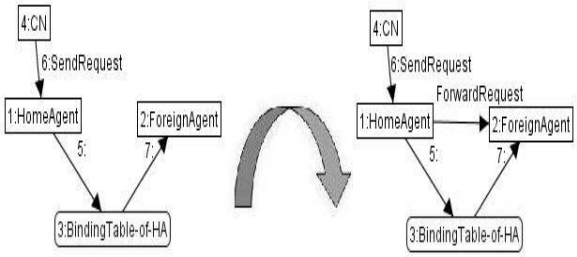


Fig.10 Forward Request Operation

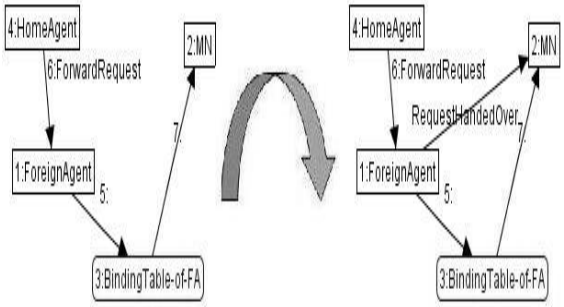


Fig.11 Request Handed over to a Provider Operation

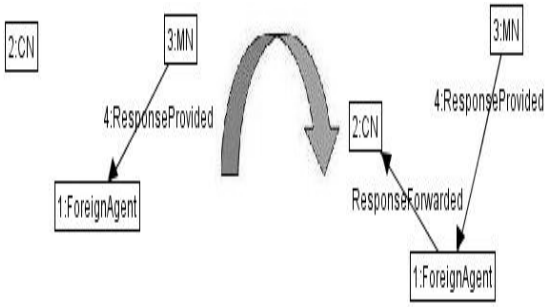


Fig.12 Response Provided to a Foreign Agent Operation

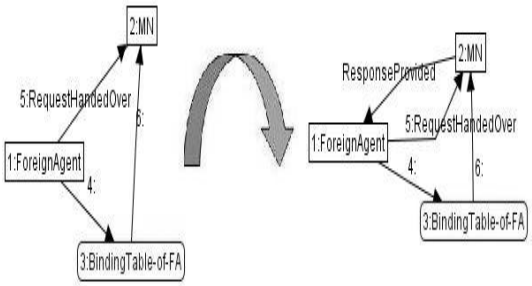


Fig.13 Response Provided to a Requester Operation

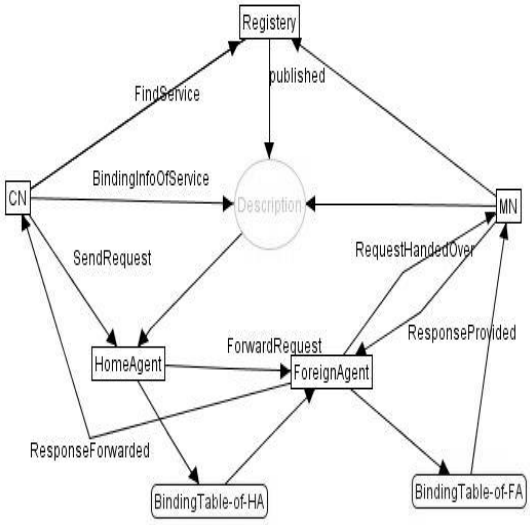


Fig.14 Graph of the Model after applying all rules/operations

4. CONCLUSION

In this paper we have modeled mobility of a requester and a provider in service-oriented architecture. We have used AGG (visual language for graph transformation) to create meta model and semantic model for mobile SOA.

In future we are interested to define a UML profile for modeling and analyzing mobile services in service-oriented architecture. Which will be used to model and analyze mobile services. In this UML profile meta models (type graphs) and semantic models for SOA and mobility will be developed. Graph Transformation rules will be used to give meaning to our meta models (type graphs). Syntactic models will be mapped to semantic models through mapping.

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