Extending the Open Grid Services Architecture to Intermittently Available Wireless Networks

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Abstract

The EQUATOR e-Science program is developing techniques for placing sensing devices on the grid. One such project, *wearable medical devices*, aims to expose mobile sensing devices via wireless networks to facilitate remote patient monitoring. The current grid model assumes a permanently available network connection between client and service, however there is a clear need for mobile clients/ services to whom network availability cannot be guaranteed. This paper introduces a framework for supporting both mobile grid clients and service in a wireless network environment.

Introduction

The EQUATOR e-Science program is developing techniques for placing sensing devices on the grid. There are three parts to the program: Wearable medical devices for remote patient monitoring [1]; Remote sensing of a fresh water lake in the Antarctic to facilitate environmental modelling [2]; Mobile pollution sensors designed to record pollution levels in urban areas [3].
Exposing sensing devices as grid services allows them to make use of a range of grid services, such as a database service to archive sensor data or a computational service to process/ model the data e.g. modelling carbon cycles in fresh water Antarctic lakes. Further, a grid interface could be used to manage and control a sensing device remotely. These techniques make it considerably easier to share both sensing devices and their associated data between multiple interested organisations.

All the above projects share the characteristic of involving remote and intermittently available sensor services, as well as mobile client applications. The present approach to grid computing (OGSI [4]) is designed to support synchronous, always connected services and cannot easily be used to facilitate the placement of asynchronous, intermittently connected services on the grid. Tools, such as the globus toolkit assume the availability of a permanent connection to a grid service.

This paper introduces a framework for supporting both mobile grid clients and services in a wireless network environment. The paper also examines ways to support the various distinctive aspects of grid applications in a mobile environment, such as support for state management, handle resolution, etc.

Normal Grid Service Invocation

A typical grid service invocation makes use of a fixed network infrastructure to provide communication between clients and services. The Grid idiom uses factory services to create service instances. A client (or clients) then interacts with the service instance, which is able to maintain state data for the duration of the client(s) interaction(s). OGSI defines the use of a *Grid Service Handle* (GSH) and a *Grid Service Reference* (GSR). A GSH is a persistent handle to the service, but does not contain protocol or location information. The GSR is a transient network pointer with an associated lifetime, which can be used to locate and invoke the grid service. The GSH can be resolved to a GSR using a *Handle Resolver Service*. OGSI also provides some additional functionality, for example, service groups and a notification service. Figure 1 shows a typical grid service invocation.

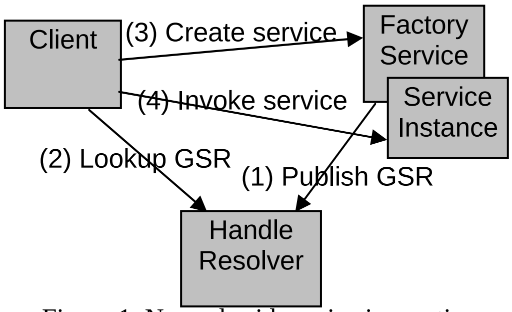

Figure 1, Normal grid service invocation

Mobile Grid Service Framework

This framework aims to allow grid service invocations to persist in the presence of intermittent network failure. Stalled invocations should be completed when network reconnection occurs, where these periods of disconnection may be of the order of minutes or hours or sometimes longer. The framework also aims to minimise the necessary modifications required to clients and services, minimise the performance overhead involved in using the mobility framework and be scalable to large numbers of clients and services.

This mobility framework makes use of intermediary SOAP Routers to queue messages during periods of network disconnection as well as providing finer grained retransmission (i.e retransmission from SOAP Router rather than complete end-to-end retransmission).

Figure 2 shows a simplification of how the framework can be used to support a mobile grid service. The complete framework supports both mobile clients and services by routing requests from client to service via a number of intermediary SOAP Routers. This routing information is embedded in a Mobile-GSR and published by the mobile grid service to a handle resolver on a fixed network. Mobile grid clients contact the handle resolver and retrieve the Mobile-GSR. Routing information in the Mobile-GSR is mapped to header information in a SOAP request message, allowing the message to route itself to the mobile service. Wireless network hops can be invoked using a reliable messaging protocol to ensure that packets are not lost when the network is unavailable. Further optimisations can be made to minimise packet wastage on low bandwidth or pay per use networks by only allowing senders to send information when they think the receiver is available. Support for roaming services and ad-hoc networking can be provided by allowing services to dynamically discover intermediary routers.

Conclusion

This paper has shown that current Grid implementations cannot be used to support clients and services that exist in intermittently available wireless network environments. In addition the paper has reported a clear need for mobility support in grid computing from a number of motivating eScience applications. A framework for supporting mobile clients and services through the use of SOAP level intermediaries has been described. An implementation of the framework has been produced and tests have shown the framework to support continued operation in the presence of temporary network failure.

References

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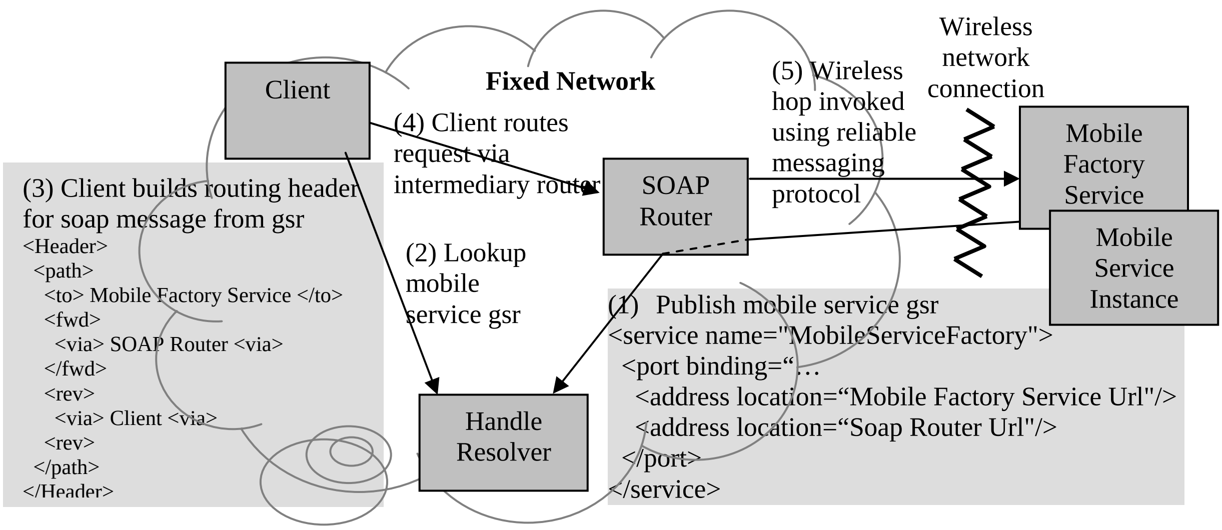

Figure 2, Mobile grid service architecture