

# Execution Management for Mobile Service- Oriented Environments

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## ABSTRACT

*This paper presents an Execution Management System (EMS) for Grid services that builds on the Open Grid Services Architecture (OGSA) while achieving "mobile awareness" by establishing a WS-Notification mechanism with mobile network session middleware. It builds heavily on the Session Initiation Protocol (SIP), used for managing sessions with mobile terminals (such as laptops and PDAs) where the services are running. Although the management of mobile services is different to that of ubiquitous services, the enhanced EMS manages both of them in a seamless fashion and incorporates all resources into one Mobile Dynamic Virtual Organization (MDVO). The described EMS has been implemented within the framework of the Akogrimo EU IST project and has been used to support mission critical application scenarios in public demonstrations, including composite and distributed applications made of both ubiquitous and mobile services within multiple domains.*

*Keywords: Execution Management System, Grid, Mobile Dynamic Virtual Organization, Service-Oriented Mobile Grid, Virtual Organization*

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## INTRODUCTION

The development of more robust mobile communication networks and more powerful

portable computing devices has encouraged the emergence of a wide range of mobile distributed computing applications. These applications use services that reside on mobile devices presenting users with information derived from a variety of sources and localities. The applications that use

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these emerging services are the subject of much research and business models (Waldburger & Stiller, 2005). However bringing about the enhanced functionality associated with these advances presents a challenge (Forman & Zahorjan, 1994).

Supporting mobile devices in a service-oriented computing environment (Weissman, Kim, & England, 2005) requires specialist management capabilities to ensure the reliability and dependability of a single composite application. Services in these environments have not only to present predictable behaviour in terms of connectivity but collectively a framework to aid automated decision making based on a variety of information linked to location data. For example, as mobile devices are subject to physical connection changes as they move between networks and areas of coverage, the application may adapt its characteristics in order to accommodate such events. In the case of movement of a device onto another country's network, the data the device shares may be restricted by international legislation or in the case of lower bandwidth the device again may adapt not transmit certain types of data.

In addition, the management of fluctuating connection quality as devices roam across networks may create the need for live service reselection or replacement, as an application may reselect services using more efficient networks as they become available. All these changes require the application to make real-time automated decisions and this challenge is why critical service-oriented applications that use and support multiple mobile services are something of a rarity. To ensure that applications in critical environments are dependable, issues of cross-domain co-operation and dynamic service management have to be solved. The European IST project Akogrimo (2007) addressed these issues by integrating a Grid approach into web service management and creating a framework to support mobile network-aware services, users and service providers.

This paper focuses on some results of the Akogrimo project which are relevant to

this purpose. It describes how the Execution Management Service (EMS), enhanced in Akogrimo, supports distributed Grid applications that are mobile and dynamic and does this by supporting Mobile Dynamic Virtual Organizations (MDVOs). It establishes a notification to keep track of the changes that may occur in the location and availability of Grid services that reside in mobile resources. By doing so, the OGSA-compliant EMS achieves increased awareness of the changes that take place in the mobile network layer and adjusts them on the fly so that they remain transparent to the user.

## RELATED WORK

The use of mobile resources within distributed computing frameworks relies on strong communication, management and understanding between the network and service middleware (Tosic et al., 2005). A common approach to this has been the management of network derived mobile context. This context management has been a focus for work in the Akogrimo project using SIP (Rosenberg et al., 2002) to link the mobile network with the grid middleware. SIP was chosen due to the familiarity of the protocol with the Akogrimo developers and its wider user community than other similar standards. Other work in this area has investigated the use of other protocols such as IP Multimedia Subsystem (IMS) (Camarillo & Garcia-Martin, 2004) which was developed around the standardization of mobile devices in UMTS networks.

Management of mobile context in service based applications has been further enhanced by standards such as the Web Service Offerings Language (WSOL) (Tosic, Kruti, & Pagurek, 2002). This standard works with Web Service Description Language (WSDL) (Christensen et al., 2001) to better categorize and explain web service interfaces. Approaches to web service orchestration and specifically choreography enhance the use of WSOL and increase the amount of service level collaboration via the use of standards such as Web Services Choreography Description Language (WS-CDL) (Kavantzas,

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