Agents that possess the attribute of mobility are considered particularly useful for mobile and distributed applications. Mobile agents are typically light-weight processes that have the ability to migrate from host to host of their own accord. They have been shown to improve performance in terms of response time and bandwidth usage in data-intensive, distributed applications such as distributed data mining [3] and disconnection tolerance in pervasive computing applications [4]. Consequently, several mobile agent implementation environments or toolkits have been developed for both handheld and traditional devices (http://reinsburgstrasse.dyndns.org/mal/preview/preview.html, Accessed September 2004).

With the increasing uptake of this technology fuelled by the growth and widespread deployment of mobile and ubiquitous applications, the need to provide strategies for formal analysis and design of these applications to facilitate the systemic construction of mobile agent applications as a step towards mobile agent oriented software engineering is increasingly being recognized [1, 5, 7, 8]. While these research initiatives take a step in the direction of conceptual modelling of mobile agent applications, they are constrained by retention of a specific frame of reference or context as discussed in [6]. They are typically limited by specific implementation considerations and notational constraints imposed by the methodology that is used to represent the concepts. A more serious concern is that these approaches to modelling mobility of agents has thus far remained fragmented—in that different modelling approaches tend to focus on different concepts and that they have a non-orthogonal perspective of mobility. For example, they tend to associate mobility only with agents. However, it is often likely that it is the roles that an agent assumes that determines its mobility and therefore it is important to consider the mobility as an attribute that can be assigned to roles as well as agents. This in turn opens up a whole gamut of associations, such as itineraries that are formulated as a consequence of role mobility and so on.

There is clearly a need for a holistic approach to conceptual modelling of agent mobility— independent of a specific methodology, toolkit, implementation, or application domain. In this context, we have proposed and developed an ontology of concepts and their relationships that are essential and integral to modelling mobility in agent applications. We have formally compared our conceptual model of mobility to existing mobile agent modelling methodologies, namely AUML [1], mGAIA [7], SODA [5] and MASE [8], providing mappings between our concepts and the mobility concepts, whether equivalent or distinct, in these methodologies [6]. Our conceptual model clearly establishes the holistic and integrative perspective that our work provides as compared to the fragmented landscape of current mobile agent modelling methodologies. It is the first attempt to provide both (1) a comprehensive ontology for mobility as a sound basis for developing methodologies and tools to support mobile agent applications and (2) a comprehensive and cohesive comparison of current mobile agent modelling methodologies [6]. This fundamental work was supported by a Monash Small Grant and has resulted in 3 E1 conference publications, one seminal position paper that first raised this issue of conceptual modeling and engineering mobile agent applications, and 1 poster (Publications List Attached).

This project aims to take the next step towards realizing software engineering of mobile agent applications. Through our work, we have established a sound and comprehensive conceptual model for agent mobility. However, in order to facilitate the use of this model in formal analysis, design, and specification as pre- cursors to the implementation of mobile agent applications, it is essential to provide notations to represent the concepts and their inter-relationships. It is necessary to provide the means to represent the concepts that we have formally identified through our ontology. Thus, we aim to develop a language for facilitating representation of the concepts and their inter-relationships. We aim to investigate the appropriate formalisms for this language (e.g. graphical, logical or a
combination), both in the context of applications focusing only on agent mobility (i.e. using only mobile agents) and those applications having a broader scope including non-mobile agents and other general agent concepts such as reasoning. Typically, analysis and design of the latter class of applications is supported by traditional AOSE methodologies Therefore, we also intend to develop support for integration of the specification language with representative AOSE methodologies, e.g. as a separate extension for each type of methodology. This typically would require mapping our specification language to the notation and paradigm of a given methodology. To demonstrate integration with AOSE methodologies, we will choose one AOSE methodology from each of the three broad philosophies [9] – multi-agent (Gaia [9] or one of its extensions such as ROADMAP [2]), object-oriented (AUML [1]), and knowledge engineering (CoMoMAS [9]). Finally, the mobile agent conceptual model and specification language/extensions will be trialed for developing agent applications in teaching AOSE in two post-graduate units offered by the faculty (CSE5610—Intelligent Software Systems and CPE5010—Mobile Software Agents).

In summary, the aims of this project are to: (1) Formalize our conceptual model by developing a mobile agent specification language, (2) Integrate (map) this language into representative existing AOSE methodologies, and (3) Develop prototype applications and conduct user trials demonstrating and validating use of the specification language and extensions. These mappings will form the basis for general guidelines for integrating our model for mobility of agents (that consists of both the conceptual model and the formal specification language) with other existing AOSE methodologies and models.

Project Publications till Date - Please email Shonali.Krishnaswamy@infotech.monash.edu.au for any of these papers.

1. Price, R., Krishnaswamy, S., Loke, S, W., Chhetri, M, B., (2004), Towards an Ontology for Agent Mobility, Proc. of the Workshop on Conceptual Modelling for Agents (CoMoA 2004), to be held in conjunction with the 23rd International Conference on Conceptual Modelling (ER 2004), Shanghai, China, November 8 - 12, Lecture Notes in Computer Science (LNCS), Springer Verlag.
References

6. Price, R., Krishnaswamy, S., Loke, S, W., Chhetri, M, B., (2004), Towards an Ontology for Agent Mobility, Accepted for publication in the Proceedings of the Workshop on Conceptual Modelling for Agents (CoMoA 2004), to be held in conjunction with the 23rd International Conference on Conceptual Modelling (ER 2004), Shanghai, China, November 8 - 12, (LNCS), Springer Verlag.