# Mobile Software Agents for Network Monitoring and Performance Management

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# ABSTRACT

The rapid developments in the area of communication and data networks require high-performance and reliable Network and Systems Management (NSM). Due to the deficiencies of the traditional manager-agent paradigm and the resulting *scalability* and *flexibility* limitations of centralisation, it is now commonly agreed that a transition to *distributed management* is required. There are many new trends in NSM that try to address this requirement. In general, these trends make use of well-established techniques from other computing fields, e.g. distributed objects, Java and Web technologies, adapted to NSM problems. In addition, management distribution aspects have also been incorporated in both the Internet and OSI-SM management architectures. However, it has been shown that distribution alone is not enough. Due to the high frequency of changes in networking environments, it is imperative that management systems are flexible, i.e. they can dynamically adapt to those changes and allow on-the-fly customisation of management services. In that context, *Management by Delegation* (MbD) paradigm has been identified as the first promising approach towards management distribution and flexibility.

*Mobile Agents* (MA) represent a relatively new computing paradigm used in several domains as a means for structuring distributed applications. The term MA refers to a software entity identified by its code, persistent and execution state, with the ability to autonomously move from host to host, acting on behalf of a user or an application. The MA paradigm is part of the generic family of *mobile code* paradigms, which provide a mechanism to extend the capabilities of services through dynamically moving the components of a distributed application among the nodes of a network. In the context of NSM, MAs represent a relatively new trend that builds on the groundwork of MbD and involves the use of mobile objects as a tool to realise scalable and flexible distributed management systems. MA-based management has been a subject of intense research in the past few years, reflected on the proliferation of MA platforms (MAP) expressly oriented to distributed NSM. However, the applicability of MAs in management applications is still subject of ongoing debates, due to concerns related to the security, performance and scalability aspects of this technology. Namely, it is still unclear which problems of distributed management can be addressed by MAs and whether their use can offer performance benefits compared to alternative solutions.

A first objective of the research work described in this thesis has, therefore, been to assess the values and weaknesses of MA technology from the management viewpoint and identify ways for the effective use of this technology in distributed management applications. Based on this assessment, we have identified a set of requirements that MAPs tailored to management applications should meet. Following that, we have implemented an NSM-oriented MA framework, satisfying these requirements. Our framework addresses the scalability, flexibility and adaptability requirements related to the management of large-scale and dynamic networks. The performance of our prototype has been quantitatively and experimentally evaluated, demonstrating its competence against centralised management and distributed objects-based approaches.

In addition, three novel applications that exploit the ability of MAs for performing decentralised operations have been developed on the top of the introduced MA-based management framework. The application areas include the fields of *network monitoring* and *performance management*. In particular, the proposed applications include semantic compression of management data, efficient retrieval of bulk monitoring data and filtering of SNMP tables according to pre-defined, arbitrarily complex filtering criteria.

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*Στην οικογένεια*
*και τους φίλους μου*

*"Να υποφέρεις δεινά που ακόμα και η ελπίδα τα θεωρεί ατέρμονα*
*Να αψηφάς την εξουσία που μοιάζει παντοδύναμη*
*Να αγαπάς και να υπομένεις*
*Να ελπίζεις, εώς ότου η ελπίδα μέσα από την ίδια την καταστροφή της, να πραγματώσει το*
*σκοπό της*
*Να μην αλλάζεις, ούτε να διστάζεις, μήτε να μετανιώνεις*
*εδώ είναι η δόξα σου Τιτάνα: καλοσύνη, μεγαλείο, ευτυχία, ομορφιά και ελευθερία..,,*

"Προμηθέας λυόμενος"
Α. Σέλλευ