Telecommunications Management Network:
A Novel Approach Towards its Architecture and Realisation
Through Object-Oriented Software Platforms

George Pavlou
University College London

Thesis submitted for the degree of Doctor of Philosophy
December 1997
Abstract

The increasing sophistication of telecommunications infrastructures and, in particular, the introduction of broadband transmission and switching technologies together with advanced services that exhibit guaranteed Quality of Service characteristics, have necessitated the use of sophisticated management facilities. The Telecommunications Management Network (TMN) is being developed by the ITU-T as the framework to support the open management of telecommunications networks and services, exploiting the capabilities of emerging broadband technologies and harnessing their power. It projects a hierarchical distributed paradigm in which interactions are object-oriented (O-O) in information specifications terms. On the other hand, it is mainly a communications concept, and, as such, it does not address software realisation aspects. The TMN uses currently OSI Systems Management (OSI-SM) as its base technology.

The complexity of the combined OSI-SM/TMN architectural framework and the fact that non object-oriented approaches have been initially adopted for its realisation has resulted in doubts about its feasibility, implementability, performance and eventual deployment. This thesis proposes first a number of modifications and extensions to the TMN model and architecture. The modifications aim at the simplification of the overall framework and rely on the fact that this thesis shows that full scale OSI-SM/TMN technology is both feasible and performant. The extensions introduce distribution and discovery facilities through the OSI Directory and aim to support the TMN as a large scale distributed system.

The thesis subsequently shows that the inherent object-oriented aspects of the OSI-SM/TMN framework can be exploited through an object-oriented realisation model that hides protocol aspects, bears similarities to recently emerging O-O distributed systems frameworks and has good performance characteristics without requiring excessive computing resources. The environment in which these concepts were validated is known as OSIMIS (OSI Management Information Service) and can be used as a TMN distributed O-O platform that enables the rapid development and deployment of TMN systems. It predated similar products by some years and influenced a number of subsequent commercial developments.

Open Distributed Processing (ODP) has recently emerged as the theoretical framework for object-oriented distributed systems. The Object Management Group (OMG) Common Object Request Broker Architecture (CORBA) can be seen as its pragmatic counterpart. Since the appearance of CORBA, a lot of research has addressed its use in TMN environments, because of its generality, better distribution paradigm and potentially better performance. Despite the relevant efforts though, there is no complete solution as yet that retains the full OSI-SM expressive power. This thesis proposes a solution that will make possible the seamless replacement of the OSI SM and Directory with CORBA as the base technology for the TMN.
To my family and friends

for their encouragement and support.

Acknowledgements

The work presented in this thesis was carried out over a long period of time while I was working initially as Research Associate, then as Research Fellow and finally as Senior Research Fellow and Lecturer at the Department of Computer Science, University College London. During that period, I was given the opportunity, support and freedom to do all this exciting research.

I would like to thank in particular the following people: Graham Knight, my first supervisor, who introduced me to the field of network management ten years ago, kept me on the rails during the formulation of this thesis and contributed the initial idea of generic software management environments; Prof. Peter Kirstein, my second supervisor, for giving me the freedom to undertake this type of research in projects for which he was the principal investigator and also for keeping me on the rails during this thesis; David Griffin, for the endless discussions we had on related subjects over the years and for commenting on the thesis; Dave Lewis, for instilling gradually to me his enthusiasm for open distributed processing technologies and for commenting on the thesis; a number of colleagues at UCL and elsewhere who contributed to the software environment that validated the concepts presented in this thesis - they are acknowledged separately; and finally the people at the University of Surrey, and in particular Prof. Barry Evans, who trusted me by offering a senior academic position - this has been the strongest stimulus for completing this thesis!

Last but not least I would like to thank my family, and in particular Christine for her forbearance over the years while I was spending endless late evenings and weekends in front of a pile of papers and the computer.
Acknowledgements to OSIMIS Contributors

Most of the concepts presented in this thesis have been validated in the OSI Management Information Service (OSIMIS) TMN platform. A number of colleagues at UCL and elsewhere have contributed to OSIMIS. The most important contributors are acknowledged below.

Graham Knight of UCL, my first supervisor, contributed initially the idea of a Generic Managed System, influenced the concept of the event-driven coordination mechanism, implemented the first version of the example UNIX object class, directed the security research work and in general influenced the OSIMIS concepts and direction.

Saleem N. Bhatti of UCL designed and implemented the log control function, including the managed object persistency, implemented the string-based CMIS filter manipulation language, designed and implemented the native version of the OSI Internet MIB-II, designed and implemented the public key based security mechanisms, designed the private key based ones and provided early feedback on OSIMIS design.

James Cowan of UCL implemented the first version of the object-oriented manager infrastructure, designed and implemented the generic MIB browser and designed and implemented the ingenious platform-independent GDMO compiler.

Thurain Tin, formerly of UCL, designed and implemented the second version of the object-oriented manager infrastructure, designed and implemented the Tcl-based version of the latter, contributed to the implementation of the access control function and implemented the generic CORBA to OSI-SM gateway.

Kevin McCarthy, formerly of UCL, designed and implemented the generic OSI-SM to SNMP gateway, contributed to the directory access concepts and integration, designed and implemented the private key based security mechanisms and contributed feedback to the OSIMIS design.

Costas Stathopoulos, formerly of ICS, Crete, Greece, designed and implemented the directory access for location transparency.

George Mykoniatis, formerly of NTUA, Greece, designed and implemented the intelligent monitoring facilities.

Jim Reilly, formerly of VTT, Finland, designed and implemented the first version of the metric monitor objects. He also designed and implemented the SMIC SNMP SMI to GDMO translator, based on an SNMP SMI compiler by David Perkins of Synoptics, USA.