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Management of Telecommunication Systems and Services

Modelling and Implementing TMN-Based Multi-Domain Management

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Foreword

With the advent of broadband communications, new generations of communications systems and services are being conceived, responding to the ever growing demands of the market place. Additionally, under the new regulatory framework being established in Europe, new transnational service providers and network operators are emerging.

In parallel, effective global communications are becoming an essential enabler for successful business enterprises. With such importance being placed on communications, the management of these communication assets (the systems which provide the networks and the services) becomes a key issue both for the providers and the user.

Recognising this importance, the European research programme RACE has supported a number of projects in the area of communications management.

The challenge facing communications management lies in the complexity of the communications environment, comprising as it does a multiplicity of network technologies and competing and cooperating providers. The work done within the framework of TMN has laid the foundation for handling this complexity by recognising different domains of management, where a domain represents either an ownership domain or a particular network technology domain.

One of the RACE projects, PREPARE, has successfully investigated, developed, and demonstrated solutions for end-to-end management of communication systems and services, concentrating particularly on interworking between different domains of management. The project has adopted a sound approach to integrate an extensive set of hardware and software elements in order to provide a solution for inter-domain management, based on a complex scenario of heterogeneous private and public networks. The excellent results obtained by the project have been acknowledged by a diverse set of actors, ranging from standards bodies, manufacturers, operators, service providers, to academia.

To provide a wider dissemination of the topic, the PREPARE project team has written this book, with the goal of presenting in a coherent, integrated, and readable form the issues addressed by the project, the motivation for the work carried out, and the key results obtained. The results described in this book constitute a major contribution to the field of communications management which will be reflected in a better quality of service for the customer and a lower cost of ownership for the providers. As the name of the project suggests, the results of the PREPARE project enable European actors to become better *prepared* to address the challenges of an open market for the provision of communication services.

November 1995

Mario Campolargo

Project Line Coordinator

European Commission - Programme RACE

Preface

The telecommunications industry is changing rapidly. With the advent of broadband networks the worldwide interconnection of distributed system components becomes feasible. The challenges arising for service management from this environment, the issues involved in providing cooperative management between different organisations and their management systems in order to manage advanced teleservices on an end-to-end basis, and the approach adopted by the European RACE II research project PREPARE project in designing and implementing prototype management systems over real testbeds are the subject of this book.

In the future, cooperative service management needs to be given particular attention if the capabilities of broadband interconnection networks are to be utilised to their full extent for the realisation of the global information society. There is at present little information available on the relevant issues and even less on implementation experience. Prospective readers of this book include those concerned with the design, development, delivery, and maintenance of telecommunications services in the global service market as well as anyone with a general interest in multi-domain management issues.

The PREPARE project (1992-95) investigated the issues likely to arise in a future liberalised telecommunications market when managing services across networks belonging to different organisations. A specific objective was to verify this work by deploying and demonstrating systems managing telecommunications services and the broadband network testbeds over which they operate in a realistic multi-vendor multi-network environment. PREPARE used existing standards as far as possible and enhanced them where needed. It adopted the Telecommunications Management Network (TMN) framework [M.3010] for designing and implementing its management systems due to TMN's widespread recognition and acceptance by public network operators and transport network service providers. Standards are not always easy to interpret and do not necessarily cover every aspect required and so the work in PREPARE could, by testing many of the ideas in real demonstrators, show how the relevant management architecture and computational and information models should be designed to support the management of teleservices on an end-to-end basis in an open service market. PREPARE has not only implemented management systems based on the standards but as a result of its experiences in this area has contributed extensions to them and indicated to standards bodies and other practitioners the real problems involved and how to tackle them.

Structure of the Book

This book has been structured so that the reader obtains an understanding of the problem area and general information about the PREPARE project first. This is followed by more specific details about how the project proceeded in its work and the results that it attained in implementing management systems for managing the networks and services of its testbeds. A brief overview of the structure is given below.

Chapter 1 introduces the developments leading to the global information society and the characteristics of this environment that are creating new challenges for telecommunications management. The main problems that have to be resolved in

order to achieve multi-domain service management are discussed in order to highlight the issues in the PREPARE project's area of investigation.

In chapter 2 the background to the PREPARE project and the initial context in which the project was carried through is discussed. This relates to the RACE framework and to service management work in preparation for integrated broadband communications (IBC) in Europe. The aims of the project, its approach, its testbed configurations, and the management architectures it developed are described so that the reader obtains a good basis for understanding the work presented in the following chapters.

Chapter 3 presents the PREPARE development methodology adopted in the design phase in order to proceed from the conceptual work to a functioning system. The implementation of a multi-domain management system is not a trivial task and the various stages in the process that are discussed in this chapter show how the modelling work can be realised in an actual implementation.

Chapter 4 introduces multi-domain service management using examples from the PREPARE implementation work. This chapter provides an overview of what was actually managed in PREPARE with the examples showing in some detail how specific services were managed on an end-to-end basis. The services selected comprise an ATM Virtual Path service, a Virtual Private Network service, a Multimedia Mail service, and a Multimedia Conferencing service. Each service is discussed using a common approach. First a general overview of the service is given. Then the stakeholders for the service are introduced and the resources that are relevant to the service and its management are discussed. The management functionality is presented via the roles involved in the service and their responsibilities and obligations that require certain management functions to be carried out. As a result of the management function requirements, the information model, computational model, and information flows for each service are described in order to show how the management functionality was designed for each service. The interdependencies and interactions between the services are highlighted in order to demonstrate the complexities of managing multiple services in a multi-vendor multi-network environment.

During the period of the PREPARE project's work, promising developments were taking place in other areas of distributed computing that could usefully be investigated by those about to embark on developing management systems for the open service market. Chapter 5 evaluates these developments and their significance for future work on inter-domain service management. The particular relevance of each development to inter-domain management is emphasised in order to show what benefits each specific development can contribute to the area.

Chapter 6 provides a summary of the work undertaken by PREPARE and its achievements as well as a discussion of issues that are still open and requiring further investigation. This includes an evaluation of the TMN principles as experienced by PREPARE in its work, a view on how management in this area could evolve, and an overview of further work being carried out by the PREPARE partners.

The appendices provide additional information on certain aspects of the work referred to in the book. They are intended for readers who would like to know more about these aspects and aim to give a short introduction to the relevant concepts. Appendix A surveys the main principles behind the TMN recommendations. Readers less familiar with the TMN concepts are strongly encouraged to read this appendix as the work discussed in this book is based upon the TMN principles and a basic

understanding of them is assumed. Appendix B introduces the main ideas behind OSI Systems Management, focusing on the concepts relevant to the TMN principles. Appendix C provides details of the Inter-Domain Management Information Service, which was developed in the PREPARE project in order to provide a global repository for management information required in a multi-domain environment. Appendix D presents the work that PREPARE undertook in investigating how the IN standards work needs to develop to prepare for the challenges of inter-domain service management in the global service market. Having gained so much experience from its implementation work, PREPARE developed architectural solutions for managing IN networks and services which are described in this appendix. Appendix E provides examples of the information models developed in PREPARE for managing the public network ATM service and the PREPARE VPN service.

This book is based on the work of the PREPARE project and so published papers are not individually referenced in the text. Papers published about the work undertaken in PREPARE on inter-domain management are listed separately as a guide to further information about the project's work. The glossary contains a useful list of the most important terms and concepts together with definitions of how they are used in the book. It explains how a particular term is used in PREPARE and how it is to be understood in the context of the PREPARE work. This is important for readers who may have experience of some of the terms in the book from other contexts.

The PREPARE Consortium

The PREPARE project was part of the European RACE II research programme. The work of the project was carried out between 1992 and 1995. The following organisations were members of the PREPARE consortium throughout this period:

- Broadcom Eireann Research Ltd, Dublin, Ireland.
- DSC Communications A/S, Copenhagen, Denmark (formerly NKT Elektronik A/S).
- L.M. Ericsson A/S, Copenhagen, Denmark.
- GMD-Fokus, Berlin, Germany.
- Compagnie IBM France S.A., La Gaude, France; IBM European Networking Center, Heidelberg, Germany.
- MARBEN, S.A. (SLIGOS Group), Agence Sud-Est, France.
- Tele Danmark A/S, Copenhagen, Denmark.
- University College London, United Kingdom.

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critically about what we had done so far and to develop our ideas further. This book would never have come to fruition without the dedication of a few individuals who were concerned to see the results of PREPARE adequately recorded. They organised others to write for the book and contributed much input themselves. So although this book reflects the work of every member of the project, it could not have been produced without the particular efforts of Lennart H. Bjerring (L.M. Ericsson), David Lewis (University College London), Michel Louis (Marben), and Jürgen M. Schneider (IBM). To them, of course, the biggest thanks of all for such unwavering support and sheer hard work.

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Contributors

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