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Management of International Networks

Influence of Telecommunications Regulation and Telecommunications Services
on Cost-effective Management

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Influence of Telecommunications Regulation and Telecommunications Services
on Cost-effective Management

Proefschrift

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Preface

In recent years a giant telecommunications boom has emerged. The rise of the Internet, the liberalization of telecommunications regulation and the emergence of many new telecommunications companies are just a few of signs of a fast growing need for people around the globe to communicate.

As the science of management of networks is relatively new, very little research has been done in that area and most of the decisions on investments for networks are still made without knowledge of the management aspects of the network. As networks internationalize, an extra factor of complexity is added, that can have an enormous impact on the costs and the effectiveness of networks. Due to the lack of knowledge on management of international networks, organizations are often faced with high management cost. This combined with the fast rising demand for international communication by the users of the network, often results in costs getting completely out of control. The thesis explores international aspects that influence management of international networks

The research in this thesis was conducted as part of the research program of Information Strategy and Management of Information Systems of the Delft University of Technology. The research program has included several Doctoral projects, such as Modelling change management of evolving heterogeneous networks, Evaluation of information systems proposals, Management of distributed data in distributed environments and Information systems management in complex organizations. Management of international networks is a subject which had very little attention so far in scientific literature and that complementary to the research program in Delft.

The research proposes a model, the Cost-effective Management model, that helps us understand the relationship between Regulatory Environment, Telecommunications Services Offering and Cost-effective Management. The research was based on a survey, an explorative case and two test cases, as well as practical experience in large telecommunications companies in Europe and in the USA.

The process of research and writing of the thesis became international in itself, as part of the research conducted in the Netherlands and part in the United States, for I moved to New York in 1995. Thanks to the flexibility of my promotor, it was possible to continue the research based in the USA, which gained an extra international dimension.

An international network of people have helped me with the research for this thesis, both in the Netherlands and in the USA. First of all I would like to thank Maarten Looijen for his excellent support as promotor, even bridging the gap between the Netherlands and the USA and accommodating to my travel schedules. Eli Noam of Columbia University in New York gave me close guidance and was the advisor from the telecommunications regulations point of view as a second Doctoral advisor, in which area Willem Korthals Altes and Mike Botein of the New

York Law school made essential contributions. Theo Bemelmans helped with the application of the research methodology. Kornel Terplan, Wim Verdonck and Bruce Egan lent me their unique experiences from the management consulting practice. I thank Louis van Hemmen, Rob Mersel, Cees de Wijs and Marcel Spruit at the Delft University of Technology and Paul van der Velde of the University of Amsterdam for the intense and exciting academic discussions and Esther Rombaut of Columbia University for her key role in the test cases with Lawrence Yeung of the United Nations and John Stabrylla of Calvin Klein Cosmetics. The telecommunications industry input came from Jan Sander (KPN Telecom), Marc Hendrickx (INS), Dick Witstok, Mike Stoll (Lucent Technologies) Bob Baulch, Cathy Martine (AT&T) and Jo van Gorp (Level3). My wife Eva provided most continuous support, without which I would not have endured the endless evenings and weekends on this project.

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Table of Contents

1	MANAGEMENT OF INTERNATIONAL NETWORKS	15
1.1	INTRODUCTION	15
1.2	INTERNATIONAL NETWORKS	16
1.3	REASONS FOR THE RESEARCH (WHY?)	20
1.4	RESEARCH SUBJECT.....	22
1.5	RESEARCH QUESTION (WHAT?).....	25
1.6	RESEARCH APPROACH (HOW?)	26
1.7	NETWORK MANAGEMENT: CURRENT LITERATURE.....	32
1.7.1	<i>Service Level Agreements</i>	33
1.7.2	<i>Management Control and Maintenance Paradigm and related theories</i> 33	
1.7.3	<i>OSI network management framework</i>	35
1.8	SUMMARY	36
2	THEORETICAL DEVELOPMENT	37
2.1	GENERAL THEORIES: TELECOMMUNICATIONS MANAGEMENT NETWORK	37
2.2	THEORIES FOR INPUT PARAMETER REGULATORY ENVIRONMENT.....	38
2.3	THEORIES FOR INPUT PARAMETER TELECOMMUNICATIONS SERVICES OFFERING	41
2.4	THEORIES FOR OUTPUT PARAMETER COST-EFFECTIVE MANAGEMENT ...	43
2.5	CROSSING INTERNATIONAL BORDERS.....	44
2.5.1	<i>Management of links</i>	44
2.5.2	<i>Improving management of links</i>	45
2.6	LEGAL IMPLICATIONS OF CROSSING INTERNATIONAL BORDERS.....	47
2.7	SUMMARY	48
3	REGULATORY ENVIRONMENT.....	49
3.1	LEGAL FRAMEWORK FOR COMPETITION.....	49
3.2	REGULATORY BODY.....	52
3.2.1	<i>Purpose of a Regulatory Body</i>	53
3.2.2	<i>Categories of the Regulatory Body</i>	55
3.2.3	<i>Total overview of the scoring for the element Regulatory Body</i>	61
3.3	COMPETITION ACTIVE.....	63
3.4	OVERVIEW OF THE REGULATORY ENVIRONMENT	64
3.5	NEW DEVELOPMENTS IN REGULATORY ENVIRONMENTS	66
3.6	SUMMARY	67

4	TELECOMMUNICATIONS SERVICES OFFERING	69
4.1	TELECOMMUNICATIONS SERVICES.....	69
4.2	ECONOMICS OF SERVICES CROSSING INTERNATIONAL BORDERS.....	72
4.3	INTERNATIONAL ORGANIZATIONS AND TELECOMMUNICATIONS SERVICES 76	
4.4	DEVELOPING A TELECOMMUNICATIONS SERVICES OFFERING MATRIX ...	79
4.4.1	<i>Area of availability</i>	79
4.4.2	<i>Price of telecommunications services</i>	80
4.4.3	<i>Overview of the Telecommunications Services Offering matrix</i>	81
4.5	SUMMARY.....	84
5	COST-EFFECTIVE MANAGEMENT.....	85
5.1	OVERVIEW OF COST-EFFECTIVE MANAGEMENT	85
5.2	COST RELATIVE TO SIZE OF THE NETWORK.....	86
5.2.1	<i>The Cost of Ownership model</i>	86
5.2.2	<i>Determining the size of the network</i>	87
5.2.3	<i>Determining the Cost relative to size of the network</i>	88
5.3	PERFORMANCE OF THE NETWORK.....	88
5.4	CALCULATING THE COST-EFFECTIVE MANAGEMENT OF THE NETWORK .	89
5.5	SUMMARY.....	91
6	EXPLORATIVE CASE.....	93
6.1	AT&T NETWORK SYSTEMS / LUCENT TECHNOLOGIES.....	93
6.1.1	<i>Overview of the network</i>	94
6.1.2	<i>Organization of network management</i>	98
6.1.3	<i>Regulatory Environment of the countries</i>	99
6.1.4	<i>Telecommunications Services Offering in the countries</i>	101
6.1.5	<i>Total scores for the input parameters</i>	103
6.1.6	<i>Cost-effective Management of the net work</i>	103
6.2	INTERNATIONAL PARTICULARITIES IN PRACTICE.....	104
6.3	SUMMARY AND CONCLUSIONS FROM THE EXPLORATIVE CASE.....	108
7	THE COST-EFFECTIVE MANAGEMENT MODEL	111
7.1	REQUIREMENTS FOR A COST-EFFECTIVE MANAGEMENT MODEL	111
7.2	PROPOSITIONS FOR THE COST-EFFECTIVE MANAGEMENT MODEL.....	112
7.3	PROPOSITIONS EXPLAINED WITH HEURISTICS.....	115
7.3.1	<i>Explanation of Proposition 1</i>	115
7.3.2	<i>Explanation of Proposition 2</i>	117
7.3.3	<i>Total explanation with heuristics</i>	119
7.4	PROPOSITIONS TESTED WITH STATISTICS IN THE CASES.....	120
7.5	SUMMARY.....	120

8	DESCRIPTION OF THE TEST CASES.....	123
8.1	REQUIREMENTS, ACTIVITIES AND DESCRIPTION OF THE CASES.....	123
8.2	CASE 1; CALVIN KLEIN COSMETICS COMPANY (CKCC).....	128
8.2.1	<i>Overview of the network.....</i>	<i>128</i>
8.2.2	<i>Organization of network management.....</i>	<i>130</i>
8.2.3	<i>Regulatory Environment of the countries.....</i>	<i>131</i>
8.2.4	<i>Telecommunications Services Offering in the countries.....</i>	<i>132</i>
8.2.5	<i>Total scores of the input parameters.....</i>	<i>134</i>
8.2.6	<i>Cost-effective Management of the CKCC network.....</i>	<i>135</i>
8.3	CASE 2; UNITED NATIONS DEVELOPMENT PROGRAMME (UNDP).....	141
8.3.1	<i>Overview of the network.....</i>	<i>141</i>
8.3.2	<i>Organization of network management.....</i>	<i>144</i>
8.3.3	<i>Regulatory Environment of the countries.....</i>	<i>145</i>
8.3.4	<i>Telecommunications Services Offering in the countries.....</i>	<i>147</i>
8.3.5	<i>Total scores of the input parameters.....</i>	<i>149</i>
8.3.6	<i>Cost-effective Management of the UNDP network.....</i>	<i>149</i>
8.4	SUMMARY AND CONCLUSIONS.....	152
9	RESULTS OF THE STATISTICAL ANALYSIS OF THE CASES.....	153
9.1	STATISTICAL ANALYSIS METHODS AND STATISTICAL INDICATORS.....	153
9.2	RESULTS OF STATISTICAL ANALYSIS FOR THE CKCC CASE.....	156
9.3	RESULTS OF STATISTICAL ANALYSIS FOR THE UNDP CASE.....	159
9.4	SUMMARY.....	161
10	CONCLUSIONS AND FURTHER RESEARCH.....	163
10.1	CONCLUSIONS: RESEARCH RESULTS.....	163
10.2	FURTHER RESEARCH.....	167
10.3	SUMMARY OF THE RESEARCH.....	168

APPENDIX; NETWORK MANAGER SURVEY

GLOSSARY OF TERMS

REFERENCES

SAMENVATTING IN HET NEDERLANDS

AUTHOR BIOGRAPHY

INDEX

Table of Figures

Figure 1-1; Examples of an international networks with different topology.....	17
Figure 1-2; Process of determination of the research subject.....	25
Figure 1-3; Graphical depiction of the relationships sought in the research question	27
Figure 1-4; Research methodology	32
Figure 1-5; Telecommunications services in the international network value chain	33
Figure 1-6; The Network Management Paradigm.....	34
Figure 2-1; Example of a regulatory index table on Japan.....	40
Figure 2-2; OECD Liberalization index.....	41
Figure 2-3; The Service Value Model.....	42
Figure 2-4; Example of Management of a link that crosses an international border	45
Figure 2-5; Example of a Responsibilities matrix.....	46
Figure 3-1; Example of influences in an EU country. In a country, laws from different Legal Frameworks may be applicable	50
Figure 3-2; Starting values for the Legal Framework for competition.....	51
Figure 3-3; Example of a Legal Framework for competition for sample countries	52
Figure 3-4; Example: Universal service regulations in the USA	60
Figure 3-5; Regulatory Body scores for a sample country X (Y=yes, N=no).....	62
Figure 3-6; Regulatory Body scores in figure in 'condensed horizontal format'	63
Figure 3-7; Starting values for Competition active	64
Figure 3-8; Example of scores for the element Competition active	64
Figure 3-9; Example of scores in the Regulatory Environment model.	65
Figure 3-10; Example of 'offers' of a few countries in the WTO Basic Telecom Services agreement.....	66
Figure 4-1; Private networks, public networks and private networks based on public networks.	70
Figure 4-2; Example of supplier-customer relationships, described in terms of the Service Value Model.....	72
Figure 4-3; Price difference (multiple) of international versus national leased lines in 1997 and 1998 for selected countries	73
Figure 4-4; Monthly costs of 100km, 2Mb/s leased lines in several countries	74
Figure 4-5; Example of unbalanced traffic and settlement payments between countries A and B.....	75
Figure 4-6; Area of availability	80
Figure 4-7; Price of telecommunications services.....	81
Figure 4-8; Telecommunications Services Offering matrix for one country with sample scores	82

Figure 4-9; Telecommunications Services Offering matrix in condensed horizontal format, spread over two tables	83
Figure 4-10; Telecommunications Services Offering matrix totals	83
Figure 5-1; Cost-effectiveness principles as basis for Cost-effective Management	86
Figure 5-2; Example of use of the Cost of Ownership model.....	87
Figure 5-3; Cost relative to size of the network.....	88
Figure 5-4; Measuring cost -effective management.....	90
Figure 6-1; International services of the AT&T Network Systems/Lucent Technologies international network.....	94
Figure 6-2; Backbone and concentrator nodes of the international network.....	95
Figure 6-3; Links between the concentrator and backbone nodes	95
Figure 6-4; Evolution of the network between 1995 and 1996.....	97
Figure 6-5; Organization of network management for the international network...	98
Figure 6-6; The Legal Framework for competition element of the Regulatory Environment	99
Figure 6-7; The Regulatory Body element of the Regulatory Environment.....	100
Figure 6-8; The Competition active element of the Regulatory Environment.....	101
Figure 6-9; Telecommunications Services Offering matrix for the selected countries (Spread over two tables)	102
Figure 6-10; Telecommunications Services Offering matrix totals	102
Figure 6-11; Summary of the scores of the input parameters	103
Figure 6-12; Cost of Ownership	103
Figure 6-13; Cost relative to size of the network.....	104
Figure 7-1; Cost-effective Management model: determining the Process between Input and Output	111
Figure 7-2; Conceptual view of the input parameters, process and output parameter	112
Figure 7-3; Comparison of telecommunications prices in a competitive and non-competitive environments.....	117
Figure 7-4; Telecommunications services in the international network value chain.	118
Figure 7-5; Example of Influence of Area of availability on Cost-effective Management	118
Figure 7-6; The Cost-effective Management model	119

Figure 8-1; Case organizations and fulfillment of requirements	124
Figure 8-2; Flow of the activities for the cases	124
Figure 8-3; Questions of the questionnaire and purpose of each of the questions	125
Figure 8-4; Services on the international network of Calvin Klein Cosmetics Company	129
Figure 8-5; Graphical overview of the international network of CKCC	130
Figure 8-6; The Legal Framework for competition of countries in the CKCC network	131
Figure 8-7; The Regulatory Body of the countries in the CKCC network	132
Figure 8-8; The Competition active of the countries in the CKCC network	132
Figure 8-9; Telecommunications Services Offering matrix for countries of the CKCC network (VPN, ISDN and PSTN services)	133
Figure 8-10; Telecommunications Services Offering matrix for countries of the CKCC network (Leased lines and PSDN services)	133
Figure 8-11; Telecommunications Services Offering matrix totals	134
Figure 8-12; Summary of the scores of the input parameters	134
Figure 8-13; Cost of Ownership and Cost relative to size of the network	136
Figure 8-14; Performance indicators for the CKCC network	138
Figure 8-15; Cost-effective Management of the CKCC network	139
Figure 8-16; Services on the international network of the UNDP	142
Figure 8-17; Graphical overview of the international network of the UNDP	143
Figure 8-18; Capacity of the international links in the UNDP network	144
Figure 8-19; UNDP Network management organization	145
Figure 8-20; Legal Framework for competition of the countries of the UNDP network	146
Figure 8-21; Regulatory Body of the countries of the UNDP network	146
Figure 8-22; Competition active of the countries of the UNDP network	147
Figure 8-23; Telecommunications Services Offering matrix for countries of the UNDP network (VPN, ISDN and PSTN services)	147
Figure 8-24; Telecommunications Services Offering matrix for countries of the UNDP network (Leased lines and PSDN services)	148
Figure 8-25; Telecommunications Services Offering matrix totals	148
Figure 8-26; Summary of the scores of the input parameters of the countries of the UNDP network	149
Figure 8-27; Cost of Ownership and Cost relative to size of the network	150
Figure 8-28; Performance indicator for the UNDP	151
Figure 8-29; Cost-effective Management	151

Figure 9-1; Regression analysis example.....	154
Figure 9-2; Summary of the Input parameters of the CKCC network	156
Figure 9-3; R-square and correlation values of simple regressions of Average utilization and Availability of the network in the CKCC network.....	157
Figure 9-4; R-square and correlation values of simple regressions of Throughput time and MTTR in the CKCC network.....	158
Figure 9-5; Summary of the scores of the input parameters of the UNDP network	159
Figure 9-6; Results of regression analysis of the UNDP case.....	160
Figure 9-7; Results of multiple regressions with two variables in the UNDP case	161
Figure 10-1; Examples of an international network without hubbing and with hubbing	165

1 Management of international networks

International communications networks are becoming more and more part of our everyday lives. Whether we reserve an airplane seat through a central reservation agency, or get money from a banking machine in our holiday country; we are dependent on international networks. Airlines, banks, hotel chains and other international organizations consider international networks as the most vital part of their business. The rise of the Internet is an example of how individuals are reaping the benefits of direct access to an international network. Many people now find it normal to access information by means of a computer from the other side of the world, but would have considered that to be magic just a few years ago. International networks can consist of computers in different countries that are connected with each other, but can also be materialized by for example a telephone network, where a person in one country can call a person in another country and be connected by just typing a few buttons on a telephone set.

1.1 Introduction

International networks need to be designed, built and managed. Studies by the Index Group [Treacy1989][Gartner1994] show that the *management* of networks is the most expensive¹ one of these activities. One of reasons for this is the cost of international telecommunications services. Organizations are spending large and fast increasing amounts of money on international telecommunications services. The demand for international communications is growing rapidly with the introduction of new services and more and more people start to use the services of international networks. On the other hand, the cost per unit of information (whether expressed in minutes or bits or other units is going down quickly, because of technological advancements, such as the increasing capacity of fiber cables [Frieden1995]. Currently, the growth in demand for telecommunications services outpaces the price decrease and makes the average telecommunications bill for international organizations rise rapidly. International organizations are trying to manage the cost of international communications, but often find that the environment in many countries in which they operate, strongly limits their ability to do so. Another reason for the high cost may be the lack of availability of the right services in the (areas of) the countries where the network operates.

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¹ Research of Index group [Treacy1989] shows that over a 5 year period, the costs of management of a network account for two thirds of the total costs of the network. Only one third of the total costs of the network is spent for the purchase of the network equipment and software. Research of Index group [Treacy1989].

In countries with competition in telecommunications, market forces exist that can influence the prices, quality and the telecommunications services offering [Lamberton1997], but this is not always the case. In addition to market forces, also government measures can determine what services are offered and at what price. Price and quality of telecommunications services can be some of the factors that may influence the possibilities of international organizations to do their business or government activities and have an international network in that country. Right now, the telecommunications environment in many countries is changing or about to change drastically. Governments are liberalizing the offering of services for international networks, privatizing formerly government owned telecommunications operators and introducing competition. In the European Union, 1998 was a magical year, as it marks the opening of the telecommunications markets to competition in several of the member states with the other member states to follow before the end of 2002. On a worldwide scale, in 1997 the GATS (General Agreement on Trade and Services) agreement was signed, in which 69 member states of the World Trade Organization (WTO) ([Drake1997][Sisson1997][Oliver1998]), agreed to a time schedule to open their countries to competition in the market for telecommunications services. This means that the signatory countries of the GATS agreement will each open their markets at a predetermined time between the years 1998 and 2002. So the strong increase in demand for international network services on one hand and the rapid changes in the telecommunications environment in many countries on the other hand, call for a closer examination of international networks. This chapter will focus on the reasons, subject and approach (why, what, how?) in this research project and will also give a brief overview of current literature in management of networks in paragraph 1.7.

1.2 International Networks

An international network crosses international borders. International networks are often characterized as no different from a national network. This is particularly tempting in a world where country boundaries seem to disappear more and more. Indeed, some countries cooperate in a such a way, that the environments for the international networks appear a bit similar to their neighbor countries (some countries in the European Union for example are trying to create similar telecommunications laws), but in reality, differences, such as differences in the regulatory environment, language or dominant telecommunications services suppliers still exist and are sometimes getting more pronounced, because of the varied pace of regulatory change in various countries.

We should define what we mean by a network and an international network. There are several definitions for the word network in the area of electronic communications. The definition that is chosen for use in this book is: *A network is a composition of communication devices and links that connect at least two nodes that consist of hardware and software. These connected communications devices*

and links perform interactions between nodes using exact prescriptions, including protocols [VanHemmen1997].

In this research project an *international network* is defined as: a network that operates in at least 2 different countries, with a management organization (coordinating body) in each of the countries responsible for the management of that part of the network that lies in that country.

A topology of a network shows the locations of nodes and links of a network. Figure 1-1 shows two examples of international networks with different topologies. One of the differences between these two examples is the number of links crossing an international border (international links). The left network has four international links, whereas the right network only has two. The total number of links in these examples is equal. Even though designing a network topology is not the subject of this book, knowledge of cost-effectiveness of managing international links versus non-international links can influence the choice for a topology. Apart from different cost-effectiveness, the topologies may also have different performance and reliability characteristics and redundancies in case problems such as breaking a link because of cutting of a cable occur.

Figure 1-1; Examples of an international networks with different topology

The examples in Figure 1-1 show only links that connect nodes in neighboring countries. However, links in international networks may also connect nodes in countries that are not neighbors and the links may therefore skip a series of countries before ending at a node. The countries that are skipped (and that therefore not have a node) are, in this book, not being considered².

² Not considering the skipped countries is considered the most accurate method. Physical links that carry the information between the nodes can be e.g. satellite (which literally skips countries

Management

Management is defined to include the activities of control and maintenance' [Looijen1998] management is therefore also referred to as Management, Control and Maintenance (MCM). Here is chosen to just use the word *management* to represent all three of the activities and the control and maintenance activities should be considered included.

The definition of an international network suggests that there are different organizations (coordinating bodies) responsible for management in each of the countries. From an organizational point of view, this *can* mean that the coordinating bodies are logically in the same organization in the organization diagram. There are, however, always some management activities that are carried out separately on each side of an international border and that are therefore viewed as carried out by several coordinating bodies.

An example: There is a group of specialists in the IT department, which supports multiple countries, but who has on-site assistants in each of the countries.

Trends in International Networks

Four trends affecting international networks were found in practice and in literature [Frieden1995][Terplan1992][Ananthanpillai1997]. Increased scale and globalization, changing regulatory environments, a widening range of telecommunications services that are being offered and the trend to subcontract management outside the organization (outsourcing). These trends may affect the management of international networks. For the choice of the exact research subject, later in the book, the four trends will be taken into account.

a. Increased scale and globalization of networks

International networks are in rapid development and supply and demand for international communications has risen sharply recently. Consumers in various parts of the world are asking for more and more services across international borders. The number of countries that are connected to international networks increases drastically. When an organization starts building its international network in just in a few countries, the people in parts of the organization in the rest of the world often realize that they would also like access to the same information. A good example is the rise of corporate Intranets, which transport more and more internal reference information and messages (such as electronic mail) between offices of the same company. Working together effectively for different parts of the organization in different countries, will soon require access to an intranet (which is an international network) in all local offices of the organization.

b. A changing regulatory environment

Liberalization of telecommunications markets around the world currently is an important trend that helps change international networks. Liberalization usually

---

that lie in between) or fiber cable, which may or may not skip countries, depending if it is laid undersea or over land.

means that telecommunications services may be offered by multiple parties and not, as was traditionally the case, only by one monopolistic telecommunications company or ministry (Public Telecommunications Operator, shortened to PTO). Also, PTOs are increasingly privatized, which makes them independent of governments and gives them more freedom to determine their own market strategy [Noam1994].

c. A widening range of Telecommunications services that are being offered

Until recently, the choice of telecommunications services in many countries, in particular the services that were offered internationally (cross-border) was very limited. Public Switched Telephone Network, also called voice telephony, leased lines and some limited data services, such as low-speed packet-switched data services often comprised the total offering. These international services were (and still are today) much more expensive than similar services being offered within a country [Frieden1995][Zarley1997]. Currently, the array of available international services is expanding rapidly in most countries, including international ISDN (Integrated Services Digital Network), often used for video conferencing and fast/low-cost data transfer, Frame Relay, ATM (Asynchronous Transfer Mode) and TCP/IP (Transaction Control Protocol/Internet Protocol) connections for Internet traffic. Furthermore, a series of cross-border wireless services, such as GSM (Global System for Mobile telecommunications) with roaming has emerged. The prices for these services have also been lowered considerably and fixed-rate pricing of the Internet connections have helped to make international services through the Internet extremely popular. In the future, even a wider range of telecommunications services will be offered, as the distribution of the telecommunications services will become easier, because of new technology to deliver the services to the end-user, such as the use of coax cable, compression technologies and wireless technologies.

d. Outsourcing

Outsourcing is playing an increasingly important role in the information technology industry. Now outsourcing is also starting to become popular for management of networks [Zarley1997]. Whereas the international network is so essential for most of the larger international organizations that they have so far been very careful to maintain control over their network, outsourcing companies are now active in several activities for management of organizations international networks. Some of the trends (widening range of telecommunications services being offered and a changing regulatory environment), which result in more suppliers and services to choose from, have led to a need for specialized knowledge on the purchase of telecommunications services [Roussel1996].

These trends are not the only ones. Other trends that can be found in literature are e.g. standardization of communications protocols and convergence of networks into one technology. Standardization is often stimulated by governments and industry, but is sometimes also avoided as governments try to concentration of power.

1.3 Reasons for the research (Why?)

The overview in paragraph 1.2 assesses that managing an international network is different from managing a national network and that there are 4 trends influencing international networks. Why do we want to learn more about the management of international networks? Since an international network crosses borders and operates in various countries, particularities of the countries, such as the language, telecommunications services suppliers and the telecommunications regulations may influence the management of an international network. Understanding the particularities of management of international networks and their impact on the management of the network helps to organize the management of the network for maximum cost-effectiveness. Owning and managing an international network involves a considerable amount of resources, such as people, equipment and external facilities, which could be used in a more efficient and effective way when knowing what exactly influences Cost-effective Management. Many organizations that own and manage international networks can benefit from knowing what factors influence the Cost-effective Management of the network in order to improve performance and lower costs of their networks.

Developments in *society* as well as in *international organizations* also show a need for more understanding of what exactly influences management of an international network, as is shown in the following paragraphs.

Reasons for society: governments and regulatory organizations

Governments and regulatory organizations have as some of their main tasks to make and enforce regulations in order to improve quality of life and stimulate economic growth in their country or territory. By understanding how the regulatory environment would influence Cost-effective Management of a network, regulations can be made and the set of telecommunications services being offered can be adjusted. Doing so may benefit the users of telecommunications services in that country.

Governments and regulatory organizations can be supported by knowledge about the influence of their regulations on Cost-effective Management of networks in their country. This enables them to select regulations that have e.g. a positive influence on management of international networks and therefore the attractiveness for international organizations to establish a (regional) telecommunications headquarters, also called a hub. A hub is a node with a position in the network, such that it acts as a concentration point. Arnbak [Arnbak1999] stresses the importance of understanding the technical dynamics and characteristics for every body that makes policies and rulings.

Reasons for international organizations, expressed in strategic questions

International organizations, such as AT&T, MCI/WorldCom, Qwest and Level3 Communications, may both manage international networks for their own use, as well as manage international networks of other organizations. Political developments, in most of the world, are aimed towards ending many of the monopolies of telecommunications operators on the provision of telecommunication services. The environment of a manager of an international

network becomes much more complex. A timely insight in what influences multinational organizations managing their international networks and purchasing telecommunications services is essential for international organizations. The large international organizations together spend more than \$100 billion per year, which is growing at 15% annually [AT&T1997] on telecommunications services for their networks, that they buy from other parties, excluding equipment and in-house cost for management control and maintenance.

International organizations face *strategic questions* and the need to make strategic decisions, that could influence the Cost-effective Management of the network. Strategic questions are:

- Assuming the country choice is flexible. How to choose a country for establishing a new part of the international network?
- How to design an international network topology, including border-crossing links, such that the international network can be managed cost-effectively?
- How to choose a country as a location for a hub to concentrate international traffic between countries in the most cost-effective way?

A Real-life example of influence of international aspects on management of networks

Real-life situations offer examples of influences of international aspects on management of international networks, illustrated by examining experiences with communications managers of international companies as described in a consultant report [McKinsey1993]. In 1992, Wal-Mart, a large U.S. retailer of household goods wanted to expand its business into Europe. Wal-Mart uses a completely automated logistics system as its main differentiator in the market: it has super-efficient logistics, that result in few stockouts, meaning few disappointed customers and low inventory cost. One of the managers of its international network indicated that management of Wal-Marts network is more cost-effective (meaning in this case that it can be managed with lower costs) in the USA than in Europe. One reason is that the international leased line prices are much higher in Europe, which made the companys business plan look so negative that the company had to decide not to continue in the European market. The other main cost factor in the management of the network was *personnel*. Also, costs for personnel turn out to be higher in most European countries than in the USA, but the difference was by far not as big as the difference between the leased line prices in the countries. Wal-Marts main differentiator could not be achieved cost-effectively in Europe. Similar experiences and business applications can be found in other literature [Bartholomew1997]³.

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³ It could have been possible that the entry into Europe would have been eased by careful planning of the network, such as avoiding too many lines in the higher-price leased line

Another example can be found in Hewlett Packard. Hewlett Packard moved its European Headquarters from Brussels to London in the early 90s, because of the difficulties with obtaining high-quality, low-cost telecommunications services for its network.

1.4 Research subject

The research subject was chosen in a process whereby we took into account:

- Existing literature on international aspects of a country for management of an international network.
- The four trends mentioned in paragraph 1.2.
- The three strategic questions, mentioned in paragraph 1.3

These are explored in the remainder of this paragraph.

Existing literature on international aspects as basis for the research subject

There is only little literature that addresses management of an international network as Attention points [Liebmann1995]. The Attention points of Liebmann for managing an international network are described as follows:

1. geographical size of the network;
2. crossing of multiple time zones by the network;
3. different languages spoken in the countries where the network is operated;
4. different social cultures of the countries where the network is operated;
5. offering of international telecommunications services;
6. product politics influencing the choice of hardware and software as suppliers (choosing telecommunications equipment is in part determined by suppliers, which do not service/sell all equipment in every country).

Closer examination reveals that the first 4 of Liebmanns Attention points are not mentioned strictly because of the fact that the network is *international*, but because of other reasons, that can also exist *within* a country. E.g. Attention point 1: the geographical size of the network and Attention point 2: the crossing of multiple time zones by the network, are not particular for an international network, as for instance, networks exist in the USA that are not international but much larger than many networks in Europe that are international. Very often moving to a different country means that a different language is spoken as stated in Attention point 3, but the country and the language are not necessarily coupled. Also, cultures, stated in Attention point 4 may change when crossing country borders, but they may also be very different within a country.

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countries or too many lines crossing borders, using modern equipment that compresses information and saves capacity, but even those costs would have been too high.

Attention point nr. 5 in Liebmanns list: offering of international telecommunications services, has support in literature as Attention point ⁴ as it also includes price [Frieden1995] [OECD1997] [Van den Broek1997].

Attention point nr. 6: product politics is particularly important when the organization responsible for the management has standardized on certain types of equipment or if the presence of particular equipment is necessary at the foreign nodes to perform services correctly. Literature [Zarley1997] shows a strong increase in demand for delivery of the same equipment across borders. Network managers ask not only their standard equipment to be delivered in all international locations, but also ask for similar services from the equipment suppliers, such as help-desk, warranty support and system integration. Suppliers to organizations with international networks, establish equipment service offices, or cooperate with other equipment service vendors to be able to provide global support.

Recently, equipment suppliers become more and more global in their business approach and start offering the same products and services across borders, which decreases the importance of the sixth Attention point.

Liebmanns list shows a series of Attention points that is a selection of a series of aspects of management of international networks. As only a limited number of aspects can be studied in the book, a selection should be made. In an explorative case, that is to be covered in chapter 6, a longer list of international particularities will be found and examined. For the research subject here, one of the Attention points of Liebmann (offering of telecommunications services) is chosen as well as one other aspect (regulatory environment) for the research subject.

Trends as basis for the research subject

The trends, as addressed in paragraph 1.2 also help in the formulation of the research subject. First of all, trend a, increased scale and globalization of networks, directly implies that the subject of international networks is increasing in importance. Trend b is the changing regulatory environment, which is considered in literature to influence for instance the price of telecommunications services [vanCuilenburg1995] and may therefore also influence Cost-effective Management of a network. Also, the magnitude of the trend is so important, with 69 countries going through drastic changes between 1998 and 2002, that the changing regulatory environment trend is a candidate for the research subject. The regulatory environment is an aspect that is particular for a country, as it is directly related to applicable laws, which are often made by a country government or a Regulatory Body of the country. As a result, we will use the regulatory environment as an aspect for our research and will refer to it as Regulatory Environment. The Telecommunications Services Offering (trend c) is a country aspect that is changing rapidly as the choice is widening, which confirms our interest in this aspect. The fourth trend that concerns outsourcing (trend d) implies that international networks are more and more going to be managed by third

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⁴ It is not certain that the difference in price between a link that does not and a link that does cross international borders will remain applicable, but for the foreseeable future this is assumed applicable.

parties, which confirms the interest in increasing the knowledge base on the subject of management of international networks.

Developing the strategic questions as basis for the research subject

Two of the *strategic questions*, mentioned as the first and the last strategic question in paragraph 1.3, directly concern the selection of a country for placement of a network. The other, second strategic question concerns the design of a network topology for an international network and therefore indirectly also requires a choice of countries to establish links between.

With a total of more than 200 countries existing in the world, the number of possible choices could be large and therefore the strategic questions should be approached in a more structured way and *aspects* of countries should be considered, which may give structure to making a choice. Aspects of a country are also essential for the second strategic question on the design of an international network, which shows the need for knowledge of aspects of a country that influence the management of a border-crossing link.

This leads to the conclusion that a key strategic question can be formulated, which is fundamental to the above strategic questions: *how do aspects of a country influence Cost-effective Management of a network?* This question can form the basis for the research subject.

In order to explore possible answers to the strategic questions, this research project is defined. Learning more about the answers can save international organizations time and money, make more effective use of resources and provide more efficient communications between users of international networks in the world. The research subject is therefore approached from the point of view of an international organization, rather than from the individual consumer, although the conclusions should be applicable to consumers as well.

In addition a completely different reason to focus the research on *international organizations* and *international networks*, is that *international organizations* are more progressive [Grover1995]. Grover has found that international organizations have shown to be earlier adopters of new technologies, such as Wide Area Networks, videoconferencing and email. When new technologies are used, the learnings of examination of these organizations can be even more valuable, given they can act as a more useful learning experience for organizations that do not have the technology yet.

This results in the choice of two aspects for further study: the Regulatory Environment and the Telecommunications Services Offering.

Demarcation

We then need to do demarcation of the research subject to make the research manageable. We restrict the research subject to certain types of international networks: in particular private networks. Research on private networks may very well be applicable in public networks also, however this is to be verified. We do not use demarcation to restrict ourselves to a particular service or set of services. Both data services, voice services and other services may be provided by the

network. Figure 1-2 shows the process of determination of the research subject in a graphical format.

Figure 1-2; Process of determination of the research subject

The research subject will be approached with a model, which we will refer to as the *Cost-effective Management model*. The Cost-effective Management model explains influences of the aspects Regulatory Environment and Telecommunications Services Offering, which we will now call input parameters of the model, on the Cost-effective Management, which we will call output parameter of the international network. A country can be scored on the Regulatory Environment and Telecommunications Services Offering in the country. The research will then assess if the scores have a relationship with Cost-effective Management of a network in the countries. The described flow of thoughts can be formalized in a research question.

1.5 Research question (What?)

After having chosen the two input parameters, we consider their relationship with Cost-effective Management.

The research aims to show possible relationships between the:

Regulatory Environment and the *Telecommunications Services Offering* in a country on one hand and the *Cost-effective Management of the network* on the other hand.

The keywords are printed in italics and will further be defined in the book, but can be generally explained as follows:

- The *Regulatory Environment* is the set of applicable laws, regulations and jurisprudence regarding telecommunications that is applicable in a country.
- The *Telecommunications Services Offering* is the set of available telecommunications services in a country.
- The *Cost-effective Management* is the degree to which the performance of the network fulfills the requirements of the users.

In order to clarify the cause and effect to be researched, the words *input parameters* and *output parameter* can be used in the *research question*:

Research question

What heuristic relationships can be found between input parameters Regulatory Environment and Telecommunications Services Offering of a country in which part of the network operates and the output parameter Cost-effective Management of the network?

A note on types of relationships

Both the input parameters and the output parameter need to be quantified in order to alleviate comparisons between cases, however the type of relationships that are sought were chosen to be *qualitative*, rather than *quantitative*. For example: this means that a relationship should just show that there is a positive or inverse relationship between an element of an input parameter Price of telecommunications services and Cost-effective Management, but does not have to show e.g. that if input parameter price increases by x%, the Cost-effective Management will decrease by y%.

Also, we are looking for a heuristic relationship, rather than a causal relationship. In case of a causal relationship a proof of the relationship is necessary. When searching for a *heuristic* relationship, *cases* can be used to support the confidence in the relationship and the relationship does not have to be present with 100% certainty [Yin1984].

Even though our objective is to find a qualitative relationship, the input parameters and output parameter will be quantified with scoring models in order to do analysis on possible relationships with help of cases. Since the scoring models for the input parameters will use *nominal* values, their significance for quantitative analysis, such as statistical analysis, is limited.

1.6 Research approach (How?)

Research methodology; the use of cases

As stated in literature [Yin1984] a case study strategy is extremely useful for appraising a situation if the boundaries of the phenomenon are not clearly evident at the outset of the research and no experimental control or manipulation is used. Therefore case studies, in combination with literature studies are used as major sources of information. In addition, the experience in the international business of a major telecommunications operator creates ideas that are used in the project.

Case studies are used in *explorative case* form and in *test case* form. The difference between the two forms is that the explorative case is of much shorter duration than the test case and it does not test models or hypotheses for their validity. The explorative cases purpose is to *examine an existing situation* and *generate ideas*. The test case is a more lengthy procedure, that applies models that have been developed and has as main purpose to test and explain the relationships expressed in the propositions that the models suggest and create ideas for improvement of the models.

Relationships in the cases

In the cases, first a demarcation is done to select part of the network that can be studied. In order to study relationships, the *Regulatory Environment* and the *Telecommunications Services Offering* is scored for each country in which part of the network being studied is operational. Then statistical analysis is done to get insight in the existence and type of *relationships* between the input parameters and the *cost-effectiveness of management* of the part of the network in that particular country.

Figure 1-3 shows a graphical depiction of the relationships sought in the research question.

Figure 1-3; Graphical depiction of the relationships sought in the research question

Research methodology: 10 steps

A research methodology with 10 steps was developed and carried out⁵ that will be shown here in more detail.

Step 1; Literature study and research question

Step 1 in the research methodology has the purpose of clearly defining the research subject using literature and experience on management of networks and on international aspects, so the research question can be formulated. Outcome of step 1 is the research question, with a research methodology that clearly describes how the

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⁵ The steps were carried out between October 1994 and April 1998.

research methodology can be answered. Chapter 1 shows an overview of the research subject and the choice of the research question.

Step 2; Development of the theory for input parameters and the output parameter

With the research question and the research subject, several theories are studied and their value with respect to answering the research question is assessed. Even when a theory seems to have relatively little value towards answering the research question, a summary is made for further reference, as ideas that are used in the theory may be used in other steps of the research. Special focus is given to the theories on network management in general and on international aspects of countries.

Chapter 2 shows the result of this development of theories.

Step 3; Development of the input parameter Regulatory Environment

Using the existing literature found in step 1 and 2, the input parameters can be described in a systematic and quantitative way. An analysis should be done of what elements constitute a Regulatory Environment. A model should be developed to express the input parameter Regulatory Environment of a country in a quantitative way. The model may initially use starting values, which are values that are chosen using experience or estimates, that can later be fine-tuned. The result of the development of the Regulatory Environment is shown in chapter 3.

Step 4; Development of the input parameter Telecommunications Services Offering

Also, different elements of a Telecommunications Services Offering shall be determined. The elements that are to be included in the model that describes the Telecommunications Services Offering, should be selected after analyzing the level of importance of the various elements for international organizations by means of e.g. a survey. Result of this step is a model that describes the Regulatory Environment and is depicted in chapter 4.

Step 5; Development of the output parameter Cost-effective Management

After both the input parameters have been modeled and can therefore be quantified, the output parameter, Cost-effective Management needs to be researched in how it can be measured and quantified. For this research, it is essential to find a method of quantification that is both accurate enough to determine the existence of relationships as mentioned in the research question, as well as easy to use. If possible, Cost-effective Management should be expressed in one formula that comprises certain parameters of a network and its management. Chapter 5 shows the chosen formula to measure Cost-effective Management.

Step 6; Explorative case

The explorative case is used to examine a situation and generate ideas [Yin1984] and in this research primarily to examine the situation of applying the models that describe the

two input parameters, Regulatory Environment and Telecommunications Services Offering and the output parameter Cost-effective Management. The practical environment of the explorative case may show possible complications with the application of the models of the input and output parameters and can teach us about the circumstances in which the models should or should not be used.

Secondarily, however not as a direct contribution to the solution of the research question, the explorative case can be used to assess other experiences of management of international networks. These experiences may form a basis for a list of international particularities that should be considered for the management of international networks.

Result of this step is a series of experiences in the explorative case that can help refine or better apply the models of the input parameters and the output parameter. The second result is a list of several international particularities that are found in a practical situation of operating an international network. The explorative case is described in chapter 6.

Step 7; Development of a Cost-effective Management model

As Step 3 through 5 developed the input parameters, which are input to a process and the output parameter, which is the output of a process, we now consider the process itself. In addition, Step 6 helped obtain practical experience with input parameters and output parameter. Step 7, development of a Cost-effective Management model seeks to describe the Cost-effective Management model. Furthermore, literature studied in step 2 may be used.

The Cost-effective Management model gives an assessment of a relationship between the input parameters and the output parameter by stating *propositions*. Propositions are statements on the relationships, which can be tested with e.g. cases. The combination of propositions should embody an answer to the research question, which makes the Cost-effective Management model of prime importance in the research project. Where possible, propositions should be explained with help of literature or experience from earlier steps.

Result of this step is a series of propositions on relationships between the input parameters and the output parameter, as well as an explanation why these propositions could be valid. Development of a Cost-effective Management model is described in chapter 7.

Step 8; Two test cases

After the Cost-effective Management model is developed, two *test cases* should be carried out in international organizations. The first purpose of the test cases is to apply the Cost-effective Management model in practical situations and test the propositions that were developed in Step 4. Two case situations in international organizations with international networks should be identified with the following requirements:

1. Each case concerns an organization that operates in a different industry.
2. Each case has a considerable number of countries, such that the statistical analysis can be done with confidence. A minimum number of 5 countries is assumed for our cases.
3. Each case has a stable network environment that does not change drastically within the time frame of observation.
4. Each case operates in countries where data on the input parameters Regulatory Environment and Telecommunications Services Offering is available.

Due to the nature of the case method, the test cases can not *prove* the propositions of step 7 [Yin1984]. They can only strengthen or weaken confidence that a proposition is valid and the confidence that an actual relationship between input parameters and output parameter exists.

As mentioned in 1.4, there is no intention to show a *quantitative relationship* between the input parameters and output parameter, but rather a *qualitative relationship*.

Result of this step is a choice of two organizations where cases are to be done, a detailed description of the case situations and application of the models that score the input parameters and the output parameter for the networks in the case situations. The two test cases are described in chapter 8.

Step 9; Statistical analysis of the test cases

In this step, statistical analysis of the test cases is done with the quantitative representation of the input parameters and the output parameter. The use of statistical analysis may enable us to test the validity of the propositions and may reveal more of the nature of the relations between the input parameters and the output parameter.

The statistical analysis method to be used is *regression analysis*. Regression analysis is a method for showing a relationship between two series of data, in this case the input parameters and the output parameter. Both so called *simple regression*, which involves one input parameter and *multiple regression*, which involves multiple input parameters, can be used.

Regression analysis should be done for each of the input parameters, but it should also be done for individual elements of the input parameters, as this can reveal more detail on possible relationships that may exist just between elements of the input parameters and the output parameter. A limited series of multiple regressions should also be done to assess the potential for relationships between a combination of multiple input parameters and the output parameter. Cases may show the necessity for using multiple performance indicators, in order to adequately measure the performance of a network. In that case a regression analysis is done for each of the performance indicators separately and multiple indicators of Cost-effective Management are calculated as a result, which means that multiple output parameters are used.

Result of this step is a series of statistical indicators, including R-square and correlation that show the likelihood of a relationship between each of the input parameters and the output parameter. This step is depicted in chapter 9.

Step 10; Conclusion and further research

Using the Cost-effective Management model of Step 7 and the statistical indicators of the test cases of step 9, conclusions should be drawn on the validity of the propositions. Furthermore, potential refinements for the Cost-effective Management model or for the models describing the input parameters and output parameter can be suggested.

Result of this step is an assessment of the validity of the propositions, a suggestion for possible refinements and a proposal for future research. Step 10 is described in chapter 10.

Figure 1-4 shows an overview of the research methodology with all steps in one figure.

Figure 1-4; Research methodology

1.7 Network management: Current literature

Theories for management of international networks and for analyzing telecommunications services and regulatory environments exist in various areas of current research. Most common areas are *management science*, *legal and regulatory sciences*, *computer science* and to a lesser extent *organizational behaviour*. The current literature mentioned here is only a shortlist that is the basis for the theories to be developed. Overviews of literature of specific areas of network management can be found in [vanHemmen1997], [Verdonck1992] and [Terplan1992].

1.7.1 Service Level Agreements

A Service Level Agreement (SLA) is an agreement between the organization responsible for management of an information system, or more particular in this instance: a network and the organization using the network, regarding the management of the network, including level of performance. SLAs are not always in place in organizations and may have various forms, such as a written agreement, written departmental objectives or verbal agreements [Passmore1996] [Ananthanpillai1997][deLooff1996].

1.7.2 Management Control and Maintenance Paradigm and related theories

The Management Control and Maintenance Paradigm (MCM Paradigm) is the basis for a series of theories that help establish insight in Management of International networks [Looijen 1998]. The MCM paradigm and its use in this research can be understood by starting with the value chain model.

The value chain model, as developed by Porter [1998] gives the opportunity to look at an international network as an entity that uses (purchases) and delivers (performs) services. An international network may add value to services in many different ways. For instance it can deliver the same telecommunications services as it purchases, but with a different kind of billing, or it may even bring services across borders, add customer care services⁶ or help desks or add a single-point-of-contact for the users to interface with when there are problems with the network [Bishop1996].

The *International Network* as depicted in Figure 1-5, uses certain telecommunications services as its input and delivers certain services as its output. The reason for using this figure is that it forms a clear way to differentiate services *performed* for the users of the network and services that are *purchased* from other parties. It thus allows us to describe the network in terms of the value that it adds to purchased services.

Figure 1-5; Telecommunications services in the international network value chain

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⁶ Customer care services are the services that provide information to support the use of the telecommunications services. Customer care services can be provided by people, who assist the users with the use of the services and payment for them, but there are also other ways to provide customer service, such as the use of web sites or voice-response phone systems.

The Network Management Paradigm [Van Hemmen1997], shown in Figure 1-6, was developed out of the MCM Paradigm [Looijen 1998]. A network system is defined as the combination of network, network services, characteristics, users, requirements, preconditions and procedures. An international network system is a network system with a link that crosses an international border. For our research, when we will use the words International network, actually an international network system is meant. In other words: the elements of the network system, such as network services, characteristics, users, requirements, preconditions and procedures are considered included. When just considering arrows A and C, in the Network Management Paradigm, it shows that it embodies the value chain as depicted in Figure 1-5.

Figure 1-6; The Network Management Paradigm

The services denoted by the arrows A,B,C are generally categorized as telecommunications services. The Service Value Model, to be described in paragraph 2.3 will categorize them in more detail. Examples of influences from the outside world on the international network and its management are various and are categorized by Looijen [Looijen1998] as managerial, contractual, economic and technical.

1.7.3 OSI network management framework

A commonly used model for describing activities for management of networks is the OSI network management framework [Obsitnik1994][Terplan1992][Ananthanpillai1997]. The OSI network management framework identifies five functional areas:

- Configuration management;
- Fault management;
- Performance management;
- Security management;
- Accounting management.

A short description of the functional areas is as follows (see also [Terplan1992]):

Configuration management is a set of activities for controlling physical, electrical and logical inventories, maintaining vendor files and trouble tickets, supporting provisioning and order processing defining and supervising SLAs; ongoing changes and distributing software.

Fault management is a set of activities required to dynamically maintain the network service levels, such as pinpointing problems and performance degradation quickly and initiating controlling functions when necessary, which may include diagnosis, repair, testing, recovery and back-up.

Performance management is a set of activities required to continuously evaluate the performance of network operation, to verify how service levels are maintained, to identify actual and potential bottlenecks to establish and report on trends for management decision making and planning.

Security management is a set of activities for the ongoing protection of the network and its components such as the protection against entering the network, accessing an application and transferring information in a network.

Accounting management is a set of activities for collecting interpreting and reporting costing and charging-oriented information on resource usage, such as processing of accounting records, bill verification and carrying out charge-back procedures.

The functional areas of the OSI network management framework can be used in various ways. In this research the use is *categorization* of activities for network management, which will be used in the case situations. With a proper categorization of activities, organization diagrams of case organizations can be better understood and international aspects can be categorized in a standard way that can be recognized by people not familiar with the situation.

1.8 Summary

Managing an international network can consume as much as two thirds of the total budget for communications. Since an international network crosses borders and operates in various countries, aspects of the countries, such as the language, telecommunications operators, the offering of telecommunications services and the telecommunications regulations may influence Cost-effective Management of the network.

This research focuses on modeling two *aspects* called: *input parameters*, that may influence the management of an international network: The Regulatory Environment and the Telecommunications Services Offering in the countries in which the network is located. The research should develop a model (the Cost-effective Management model) that explains influences of the two *input parameters* on an *output parameter*.

The Cost-effective Management model is intended to support the strategic questions of international organizations; in particular related to the influence of country aspects, but the Cost-effective Management model also gives insight to international organizations and governments into what the influence of Regulatory Environment and Telecommunications Services Offering is on Cost-effective Management of a network, so governments can adjust their policies to improve their countrys attractiveness for international networks. Chapter 2 will develop a series of theories that can be used for further researching management of international networks.

2 Theoretical development

Chapter 1 (paragraph 1.7) addressed existing network management theories found in literature and addressed the research question. In this chapter, various theories are further developed for management of international networks, as required by step 2 of the research methodology. Theories for management of networks in general are discussed in paragraph 2.1, theories for the input parameter Regulatory Environment in paragraph 2.2, theories for the input parameter Telecommunications Services Offering in paragraph 2.3 and theories for the output parameter Cost-effective Management in paragraph 2.4. Theories for crossing international borders are addressed in paragraph 2.5.

2.1 *General theories: Telecommunications Management Network*

Telecommunications Management Network (TMN) is a standard that supports the management of telecommunications networks [Verdonck 1992][van Hemmen 1997]. The International Telecommunications Union, section Telecommunications Standardization, (ITU-T) is developing this standard during the 1990s. The architecture of the standard is complete as of 1998, but several details are still to be filled in⁷. The TMN architecture has four layers. The architecture is divided in four layers, according to the objects that are managed. The layers are: Network element management, Network management, Service management and Business management.

Each of the layers is shown in more detail:

Network element management

The network element management layer takes care of the management of a certain class of network elements, such as network elements of a particular vendor. The class of equipment may need to be controlled by a specific network management system. This layer takes care that the network management information is translated into standards that are used in the network management layer.

Network management

The network management layer manages the total network and has an overview of the network as well as the individual elements. MCM of network elements is now integrated and vendor specific issues are already taken care of in the network element management layer.

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⁷ Recommendations in M.3010 Principles for a TMN

Service management

MCM is carried out for specific services that are running on the network.

Management at this layer makes it possible to directly support users of the network that use a particular service. The functions of this layer can be divided in two groups:

Functions that support operational customer processes;

Functions that support service managers, that are responsible for the financial results of a certain service including e.g. sales, billing, service quality and capacity planning.

Business management

Business management is a layer that focuses primarily on the business associated with the services, including the cost-effectiveness of the services. The business management includes the management of the network at a strategic level with longer term trends, the planning of new services, security and quality.

2.2 Theories for input parameter Regulatory Environment

Literature has shown a few theories that show a categorization of the Regulatory Environment in a country. A theory found, for instance, is the Meta Telecom Maturity Model. The most detailed one found is the categorization by the Yankee group, called Regulatory index in their reports. Other models are the Liberalization index used by the OECD. Furthermore, there are various treaties and laws that have influence on a large number of countries. Those treaties and laws will also be addressed in this paragraph.

Meta Telecom Maturity Model

This theory, developed by the Meta Group [Johnson 1997] is based on a checklist, against which a country is evaluated. This checklist contains regulatory and infrastructure aspects of a country. Using the checklist, the Meta Group classifies countries as Class A (Advanced), Class B (Highly developed), Class C (developed) or Class D (growth). The items in the checklist are:

- Privatization: Is the telecommunications operator is privatized?
- Independent regulation: Is regulatory body affiliated with the main telecommunications operator?
- Foreign competition and ownership: Is investment in telecommunications operators allowed by foreign entities?
- Competitive interconnection and resale: Is connecting to the main carriers network permitted?
- Alternative infrastructure: Are multiple infrastructures for voice, data and wireless services available?
- Universal service: Is Universal service a mandatory offering?
- Enhanced services: Are telecommunications operators offering advanced services?

The categorization in classes is then roughly defined by checking what questions are answered affirmatively. If the first three answers are yes and the rest of the conditions are at least 90% met, the country can be placed in Class A. If a country fails one of the first three conditions it is placed in Class B or below. The differences between the classes B and C are mainly in the offering of infrastructure. Class B (e.g. Germany, Australia) offers ubiquitous infrastructure, but Class C (e.g. Malaysia) offers only infrastructure in major business areas. Class D shows the least amounts of regulatory freedom and infrastructure presence.

The Meta Telecom Maturity Model is fairly coarse and does not show detailed criteria for placing the countries in the classes, but does, at least give insight into what conditions should be satisfied for a deregulated country, in the opinion of the Meta Group. The model was developed with the purpose of making network managers aware of the different environment that they may encounter when doing business in different countries and to sensitize them to the need for different negotiation tactics when negotiating service agreements with their suppliers.

Yankee Group Regulatory Index

Another theory that is available in literature is the Regulatory Index of the Yankee group. This index is simply a matrix with services and a score. The score is expressed in a number, ranging from 1 to 5, where 1 indicates that regulations are highly restrictive, or that no reform has been implemented; a 5 indicates that regulations are very liberal, or that radical reform has been implemented [Yankee1996].

There is no strict assignment of the numbers to a specific regulatory situation, but many examples are given in the Yankee group reports.

Market	Score and Comments
Terminals	5: Terminal equipment markets for both fixed and wireless (mobile phone, cellular) services have been liberalized
Basic Services	4: Basic services using the public network can be provided only by so called Type 1 carriers
Value Added Services	5: The market is open
Independent regulator	3: Ministry of Post and Telecommunications (MPT) regulations (or wishes) have been generally vague, unwritten. However, recent communications by the MPT indicate that it will clarify rules and regulations pertaining to telecommunications.
Private network restrictions	4: Private networks are allowed
Mobile services	4: Currently pricing needs to be approved by MPT. According to recent announcements, pricing will be liberalized in 1997
Satellite services	2: Still heavily regulated

Figure 2-1; Example of a regulatory index table on Japan (Source: Yankee Group(1996))

Figure 2-1 gives an example of use of the Yankee group regulatory index for the country Japan. The left column shows various markets (as they are called in the Yankee Group literature). For each of the markets, a number is assigned to show the score on the 1-5 scale, but comments are added in almost every row, to show that the regulatory index can be different for different services, or the comment is used just in general as a more detailed description.

This regulatory index is considered not an adequate theory for our research, as its scoring is very unclear and it mixes services categories with other aspects, such as aspects of the regulatory body. The title market is very confusing; we would rather call it services categories and the entries independent regulator and private network restrictions would better fit in a separate table.

OECD liberalization index

The Organization of Economic Cooperation and Development (OECD) liberalization index [OECD1997] is comparable to the Yankee group regulatory index. It also takes groups of telecommunications services in a country and then lists the state of competition in the market for those services. An overview of the different values of the OECD Liberalization index is shown in Figure 2-2. The OECD uses letter codes to describe the state of competition in different kinds of services. Figure 2-2 shows the letter codes in the first column. They denominate a state of competition described in the second column and a liberalization index, stated in the third column. The 1993 report [OECD1993] gives an explanation of the codes and connects the index numbers with the codes. The later reports [OECD1995,1997] only use the codes and not the index numbers.

Code	Description	Liberalization index
C	Competition	2
PC	Partial Competition (in a particular geographic area)	1.5
D	Duopoly	1
RD	Regionalized Duopoly	1
B	Competition allowed at the border of concessions	0.5
M	Monopoly	0
N	No Service	0

Figure 2-2; OECD Liberalization index

The OECD adds up the scores per country for a set of 8 different services: Public Switched Telephone Network (PSTN) local within a city or region, PSTN domestic long-distance, PSTN international, Packet Switched Data Network (PSDN), leased lines, mobile analogue voice communications, mobile digital communications and mobile paging.

The resulting scores range from 0 to 16 and a higher number denotes a more competitive environment.

The OECD model does not apply much detail and the different states of competition are not described with criteria, but it is the most adequate model for is one of the more important building blocks for our Regulatory Environment model, to be developed in future chapters.

Concluding on theories for the Regulatory Environment, we assess that the theories found are not sufficiently detailed to function as input parameter for the relationships mentioned in the research question and they will therefore be further developed in chapter 3.

2.3 Theories for input parameter Telecommunications Services Offering

We developed a theory, named *Service Value Model*, with the purpose to get overview over and categorize the communications services. The communications services are delivered (or performed) by a network (arrow B and C in Figure 1-6) and used by a network (arrow A in that same figure). The model is based on the OSI (Open Standards Interconnection) model, developed by ISO (International Standards Organization)⁸. The OSI model [Tanenbaum1997][Black1993] includes layers for which protocols for communication were developed by the industry and

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⁸ Understanding the OSI model, is however, not necessary for the comprehension of the essence of the research.

standards organizations. The model is a bit similar to an existing model developed for mobile services by Arnbak [Arnbak 1997].

In our Service Value Model, the layers are grouped such that interfaces between the groups of layers can be expressed in common standards as much as possible and such that it matches with the way most present telecommunications regulations in countries are structured. The model identifies three Service Value Levels as shown in Figure 2-3.

Figure 2-3; The Service Value Model

Services are classified in the Service Value Model in *Service Value Levels*⁹.

A *Service Value Level* is a group of services that is determined by the levels in the OSI model. As the highest layers of the OSI model use interfaces that are still in the process of being standardized, the boundaries of the Service Value Levels may vary slightly, depending on the actual protocols and interfaces.

Value Added Services form the top layer of services and can be characterized as the services that are defined in protocols of OSI layers 5-7. They are services that the end-users actually use. In many countries, Value Added Services are the first services where competition between suppliers is allowed and the supervision of regulatory bodies is only minimally present.

Basic Data¹⁰ Transfer Services are services that provide the transport of data (which can mean various kinds of information) in a certain format and fit in the

⁹ Service Value Level should not be confused with a service level as commonly used in agreements to provide a set of services (Service Level Agreements). The services meant in the services level agreement are usually a much broader set of services

OSI model in layers 2-4. Protocols for these services are usually standardized in an international environment in order to facilitate connection to equipment on the network. An example is Packet switched data transfer service, which transports information in information packets. Another example is formed by international leased lines, which are dedicated lines between points in the network that can transport a specified bandwidth of data.

Infrastructure Services are services that consist of making available a physical connection with certain technical specifications between two locations and fits in the OSI model in layer 1. In most countries the provision of Infrastructure services still is the exclusive right of the PTO. There is not much standardization yet in Infrastructure services, as they have not been generally available until recently. An example of one of the Infrastructure services is *dark optical fiber service*. This service offers a fiber connection with certain specifications between two points e.g. point A and point B, where the user of the service gets access to the endpoints of a fiber in point A and point B.

2.4 Theories for Output Parameter Cost-effective Management

Measuring the output parameter Cost-effective Management of the network apparently is an extensive task, and very few models have been found in research that actually calculate a quantitative value for cost-effectiveness of the management of a network [Terplan1995] [Loe1994]. Terplan has developed a method for *benchmarking network* management, which consists of 4 phases. The phases are:

- Data Collection.
Data is collected on the management of the network through various means.
- Data Consolidation.
Comparisons of data are made with best practices, standards or industry averages.
- Gap Analysis.
Details are analyzed of the gap between the results of the previous two phases for all functions of network management.
- Elaborating the Recommendations.
The gap identified in the previous phase become the basis for improvement or for supporting the decision to outsource certain network management activities.

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¹⁰ Data is placed between brackets since data is a general term. So no specific choice for fax, voice, computer data or video is meant.

Terplans method and its phases are defined in detail and form an extensive basis to perform a thorough assessment of benchmarks. For the purpose of modeling the output parameter, Cost-effective Management, only a relatively small part of Terplans method will be applicable, as the purpose is not to compare Cost-effective Management of a network with industry standards and to do detailed analysis, but merely to get a high-level overview with some kind of quantification of the Cost-effective Management of an international network in different countries that results in numbers comparable among countries.

2.5 Crossing international borders

Lastly we examine a particularity that every international network has: the *international link(s)*. The management of the international link will be discussed first, while thereafter tools for support of management of the international links will be addressed. Both subjects are discussed from a theoretical background in these paragraphs. Practical experiences with this international particularity and other international particularities will be mentioned when the explorative case is discussed in paragraph 6.2.

2.5.1 Management of links

Using the Service Value model, the management of a link may be carried out by different parties, e.g. Telecom operators, such as Public Telecommunications Operators (PTOs) for certain Value Levels of the link. In Figure 2-4, an international link between nodes in countries A and B is a link that delivers Basic Data Transfer Services to the international organization, which uses its own information systems to provide Value Added Services to its customers.

Figure 2-4; Example of Management of a link that crosses an international border

When two different Telecom operators manage the link for the two Service Value Levels, that has important implications for the management of the total network. An example is *Fault Management*. Fault Management requires that, for example, if a user of a service calls the Help Desk, there should be a quick answer as to when the problem will be solved and appropriate action should be taken to solve the problem. If the is at the *Basic Data Transfer service* or *Infrastructure service* service value level, it may be possible that several PTOs need to be contacted before the problem is found. Dealing with the PTOs requires special procedures and possibly special clauses in the SLAs between the PTOs and the international organization to control these problems and to maintain an adequate level of support to the end-user [Passmore1996] [Ananthanpillai1997].

The need for special procedures or clauses is illustrated by the following example: An international organization with several border-crossing links has SLAs with PTOs to restrict outage times for the links over a time period to a predefined minimum. As a backup scenario, the organization may have SLAs with other Telecom operators to fulfill similar links between similar nodes. The other Telecom operators should have a clause in their contract that it does not rely on the same PTO for its infrastructure services as the organization already has a contract with. The extra clause may avoid that both links are physically being routed over the same infrastructure and therefore could fail at exactly the same time.

2.5.2 Improving management of links

Management of an International network can be supported by tools. As the presence of an international link, which is a link that crosses an international border, is the key difference between an international network and a non-international network, tools that help manage links that cross international borders are considered in particular.

Analysis of the principles of international networks and experiences mentioned by users in surveys, such a survey by DataComm [Heywood1997] resulted in the invention of the Responsibilities matrix. Apart from the Responsibilities matrix, two other tools are mentioned: *One-stop shopping* and the *Core skills model*.

Responsibilities matrix

A tool, developed in research project is the *Responsibilities matrix*. The Responsibilities matrix (see Figure 2-5) can serve as a tool to check if all responsibilities for management covered in the OSI management framework have been taken care of, which is necessity that has become clear after examination of Figure 2-4. All cells in the matrix need to be filled with the names responsible for particular functional areas to ensure that all responsibilities for management of an international link are taken care of. Essential is that the parties mentioned in a cell

together are responsible for the *complete* management of the Service Value Level in that functional area. So a cell can have one name or more names in it. In the case of multiple names in a cell, the responsibilities of the parties mentioned in the cell in total, should cover the management of that Service Value Level and that functional area of the link.

	Parties responsible for the functional areas				
Service Value Level	Configuration management	Fault management	Performance management	Security management	Accounting management
Value Added Service	Int. Org./ Technical dept.	Int. Org/ Consult dept.	Int. Org/ Technical dept.	PTO A	Int. Org / Security dept.
Basic Data Transfer Service	PTO A (part) PTO B (part)	PTO A (part) PTO B (part)	PTO A (part) PTO B (part)	PTO A (part) PTO B (part)	PTO A (part) PTO B (part)
Infrastructure Service	PTO A (part) PTO B (part)	PTO A (part) PTO B (part)	PTO A (part) PTO B (part)	PTO A (part) PTO B (part)	PTO A (part) PTO B (part)

Figure 2-5; Example of a Responsibilities matrix.

Writing down responsibilities has proven its value, even in relatively simple cases with few international links. It can for instance help focus PTO A during the negotiations between the organization and PTO A on what it will have to work out with PTO B or other service providers or operators in order to provide full coverage of particular functional areas for each layer in the Service Value Model.

One-stop shopping

One-stop shopping is a term generally used for the possibility to obtain various different services and products from one supplier, instead of from multiple suppliers. It may not look like a tool at first glance, but a supplier that offers One-stop shopping, is seen as offering a tool to its client [Tice1997]. The supplier may offer it as an option for which has to be paid separately

In case of One-stop shopping, one agreement between the Telecom operator and the international organization could be sufficient. For example, suppose the PTO A implements the One-stop shopping concept for Basic Data Transfer services [Elixmann1996].

In that case there may be an SLA between the international organization and a PTO in country A (who says to practice the One-stop shopping concept) for the Service Level to be maintained on that link. PTO A has an SLA (or other type of contract) with PTO B for the part of the link in country B. For all functional areas of management of the link, the SLA should cover what activities either party should perform and how the performance according to the SLA can be verified.

The core skills model

The third tool to be addressed here was found in literature [Allott 1997] and is called the core skills model. The core skills model shows that a Telecom operator can manage the network best by:

- Buying the right network.
- Running the network well.
- Filling up the capacity on the network.
- Competing effectively.

An explanation that Allott shows is:

- Buying the right network is interpreted as buying a network that exactly fits the needs in terms of types of services.
- Running the network well is a very ill defined term, that, according to Allott, includes remote management and managed network service provision and the use of new management for new technologies, such as the combination of voice and data in technologies like ATM. If a network is run well is mostly determined by what the users indicate in their SLAs.
- Filling up the capacity on the network is developed with the analogy of other industries, such as the airline industry in mind which also have very high fixed costs and relatively low variable cost. It shows the utilization factor as a prime indicator of their efficiency. As an illustrative example, past financial results of airlines have confirmed that airlines numbers shows a positive correlation between utilization factor and financial results.
- Competing effectively is considered the result of managing SLAs and the ability to customize management for certain customer requirements.

We considered the core skills model to be more focused on getting financial results and competing in the services market as a telecom operator, than on improving the management of the international network as such. We did not find an immediate application for them in this project, although we may use some of the conclusions of the core skills model for analyzing the networks in the case studies.

2.6 Legal implications of crossing international borders

A link that crosses an international border also has legal implications, such as the impact of import and export laws and tax laws in countries on both sides of the link that crosses the international border. Data that flows across a border (also called transborder dataflow) can be subject to taxes for import or export. An example of a situation where taxes are important is when software is developed in a low wage country and shipped to another country for sales. Some data may not be exported, for example confidential data of the government. Also, some data may not be imported, such as pornographic material in several Middle-Eastern countries. We just note these legal implications of crossing international borders, but will not

further research them. In the explorative case, we will search for various international particularities and will list the ones we find, among which may be these legal implications as well.

2.7 Summary

Whereas some theories have been developed for management of networks, literature on management of *international* networks is rare. This chapter shows a combination of existing theories like *Meta Telecom Maturity model* and the *core skills model*, that are adapted such as the *MCM Paradigm* and self- developed theories, such as *Management of links* with a Responsibilities matrix and the *Service Value Model* that can be used to model specific areas of the research subject.

The available tools to model the Regulatory Environment and the Telecommunications Services Offering in a country are not sufficiently detailed for immediate use in our research and the Regulatory Environment and Telecommunications Services Offering will therefore be further developed in Chapters 3 and 4.

Cost-effective Management is also an area with relatively underdeveloped tools, even though on the subject of benchmarking, detailed theories by Terplan are available. Cost-effective Management will further be modeled in Chapter 5

3 Regulatory Environment

Step 3 in the research methodology develops a model for the input parameter Regulatory Environment, which is covered in this chapter. The Regulatory Environment is one of the two aspects of the research question and should therefore be described in such a way that the description can be used as an input parameter for the Cost-effective Management model.

The Regulatory Environment can consist of various types of regulations that influence international networks, including regulations concerning secrecy of information flowing across international borders, privacy of citizens whose information is transported across international borders and regulations that concern parties that may compete in offering telecommunications services.

In this research, we describe the Regulatory Environment for a *country*, as is common in most literature. So, even though particular reference may be made to regulation for a different entity, such as European Union or a particular state or province, the entity for examination of the Regulatory Environment will be the *country*.

Literature [OECD1997] suggests that the Regulatory Environment plays a role in the management of a network. The OECD has done research to the influence of the presence of competition (which we will define as one element of the Regulatory Environment) on Price of telecommunications services and has found a relationship¹¹. The Regulatory Environment that we propose is divided into three elements: The Legal Framework for competition, shown in paragraph 3.1, the Regulatory Body, shown in paragraph 3.2 and Competition that is actually active, depicted in paragraph 3.3. The first two of the elements are prescriptive and the third one is descriptive. Furthermore, paragraph 3.4 gives an overview of the Regulatory Environment as a whole and paragraph 3.5 shows new developments that are taking place concerning the Regulatory Environment.

3.1 Legal Framework for competition

The first element we chose for modeling the Regulatory Environment is the Legal Framework for competition. For the purpose of this research, the Legal Framework for competition of a country consists of a series of laws regarding telecommunications competition. The applicable telecommunications laws in a country can be assessed in terms of the possibility that they create for telecommunications services suppliers to compete when offering their services. Laws may be enacted at the country level (e.g. by the country government), at a higher level, the so-called *supranational* level or lower level, e.g. the State level [Korthals Altes1999]. As we have taken the *country* as the unit of analysis, we look

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¹¹ Van Cuilenburg and Slaa [1995] have done research on the statistical correlation between liberalization and economic factors, in particular *innovation* (the introduction of new products or services). Their research shows a positive correlation between *liberalization* and *innovation*. This will be used in chapter 7, where propositions are developed and explained.

at applicable laws in the country. However the applicable laws in a country may have been made by *supranational* organizations, such as the European Union (EU) or lower level organizations, such as the Public Utility Commissions, that fulfill an important role in the legal framework of the individual states in the USA. Laws from the supranational organizations may or may not have direct effect on the citizens and companies in a country. For instance, in case of the EU, laws or other regulations only have direct effect if they are self-executing, which is usually defined in the laws or regulations themselves. An essential EU directive on the road to full competition in the European Union was the Open Network Provision (ONP) directive¹². The ONP directive mandated the opening of infrastructures that are controlled by a dominant or monopoly operator to the other operators. The World Trade Organization (WTO) is another example of a supranational organization. The WTO, however, does not make laws, but their meetings deliver commitments that, depending on the country, need to be by country governments that then implement regulation in laws. When we keep the unit of analysis the *country*, a mix of different laws can be applicable. In practice, national governments take care that laws at a country level do not contradict laws that have influence on that country at a supranational level. In Figure 3-1 an example of different Legal Frameworks is shown. In the example, assumed is that the country is in the EU.

Figure 3-1; Example of influences in an EU country. In a country, laws from different Legal Frameworks may be applicable

It is essential to know what government or body enacts a particular law or regulation as this has strong influence on the methods for enforcement of it. The Legal Framework for competition as we describe it is represented by a listing of telecommunications services categorized in Service Value Levels (see paragraph 2.3) in the country and symbols showing for each Service Value Level that the laws rule that the provision of the services of that Service Value Level is open to more than one supplier.

Service Value Levels are part of the Service Value Model, a model that we developed to categorize telecommunications services according to their place in the Value Chain for the provision of telecommunications services. Laws sometimes

¹² Framework directive for ONP, Established at the meeting of the Commission of the European Community, 28 June 1990, further detailed in meetings in 1992 and 1993 for four services: leased lines, packet switched data network, ISDN and PSTN.

differentiate between types of services. The Legal Framework for competition, however, does not address such differences between types of services. It only addresses differences between Service Value Levels of the services. The Legal Framework for competition is described here in terms of its actual state. Multiple aspects, such as political, social and economical aspects, may influence it.

Four categories are used to show the content of the laws with respect to allowing suppliers to offer the telecommunications service. The categories used are: M (Monopoly), D (Duopoly), PC (Partial Competition) and C (Competition)¹³. M means that there is only one supplier allowed that supplies telecommunications services of that Service Value Level, D means that there are two suppliers allowed that compete in supplying services of that Service Value Level. PC means that there is only competition in certain areas. C means that there are several suppliers of similar services and that there is competition in the whole country. Current literature [OECD1995] considers the order of liberalization from less liberalized to more liberalized as: M,D,PC,C.

In order to use the Regulatory Environment in a quantitative way, we would like to score the categories, with a higher score meaning a Legal Framework for competition that allows more freedom for parties to offer telecommunications services. We have chosen starting values for the scores as an assumption, using our experience and literature: M, D, PC and C are awarded 0, 1, 2 and 3 points respectively as starting values¹⁴. This results in the starting values as shown in Figure 3-2.

Legal Framework for competition	Score Starting value
M	0 points
D	1 point
PC	2 points
C	3 points

Figure 3-2; Starting values for the Legal Framework for competition

These starting value scores are used to quantify the Legal Framework for competition and do statistical analysis in future case studies.

The Legal Framework for competition is a *prescriptive* element, which means that it quantifies a situation that is prescribed. The use of laws, for instance, can

¹³ These categories are also used by the Organization for Economic Cooperation and Development (OECD) [OECD1997]

¹⁴ Starting values are used for the purpose of starting with the model somewhere. Columbia Institute of Tele Information (E. Noam) notes however that the difference in practice between M and D may be higher than the differences between D and PC.

prescribe a behavior, but does not give any feedback if the behavior actually occurs. Figure 3-3 gives an example of scores for the Legal Framework for competition for sample countries X, Y and Z.

	Legal Framework for competition						
	<i>Value Added Services</i>		<i>Basic Data Transfer Services</i>		<i>Infrastructure Services</i>		<i>TOTAL Legal Framework for competition</i>
	Code	Score	Code	Score	Code	Score	Total score
Country X	C	3	M	0	M	0	3
Country Y	C	3	C	3	C	3	9
Country Z	C	3	C	3	C	3	9

Figure 3-3; Example of a Legal Framework for competition for sample countries X, Y and Z

3.2 Regulatory Body

The second element of the Regulatory environment is the Regulatory Body, written with capital letters as the representation of the regulatory body in the input parameter is meant. Regulatory Bodies are organizations that are responsible for implementation of part of the regulation and, in some cases, are responsible for development of regulation. In EU legislation, they are also called National Regulatory Authorities (NRAs). Regulatory bodies exist in several countries. Usually, regulatory bodies are founded as soon as more than one telecom operator emerges, but even in a monopoly environment, a Regulatory Body can exist and e.g. control the offering of telecommunications services by the monopoly and handle the control of tariffs and quality of the telecommunications services. The regulations that the Regulatory Body is allowed to establish are within boundaries set by the laws and associated legal instruments, defined here in the Legal Framework for competition. There is no standard arrangement to determine if a regulation should be made by the Regulatory Body or by laws. Regulations from Regulatory bodies are, however, more flexible than laws, since laws usually have to be made in a formal process involving e.g. a majority vote by the representative of the population in a congress or senate, whereas Regulatory Body regulations usually do not have to pass these barriers. The laws of a country, however, usually must provide a legal basis for the Regulatory Body to issue regulation in the first place [Melody1997].

3.2.1 Purpose of a Regulatory Body

In practice, we observe that Regulatory Bodies exist in order to promote good competition in the telecommunications services market, such that the consumers in that country can benefit from low prices and more choice of telecommunications services. Therefore we describe good competition as competition where *unequal advantages of competition are neutralized*.

Two examples of the role of the Regulatory Body

The Regulatory Body can play an important role in the Regulatory Environment and can make or break the effects of the Legal Framework for competition. For instance in the United Kingdom (UK) during a period (1984-1992), the Regulatory Body in the UK (OFTEL) ruled that Mercury had to pay relatively high access charges, also called interconnection charges to British Telecom, for access to the local telephone lines, which were mostly owned by BT. The access charges were higher than British Telecoms cost and that were only on a per-minute-use basis and not on a per-call basis [Cave1997]. The given cost structure made it impossible for Mercury to compete effectively. When this changed by the Regulatory Body in 1992, Mercury gained a better cost basis and could start to capture significant market share. Another example; the Regulatory Body in New Zealand (the Ministry of Commerce), established very few regulations and no enforcement power after the market opening in 1987, which resulted in years of battles between the dominant telecommunications operator Telecommunications Corporation of New Zealand (TCNZ) and new Telecom operators on interconnection between networks. The first new telecommunications operator, Clear Communications, was connected with TCNZ more than 3 years after the first negotiations for interconnection started [Yankee1997]. Technically, such a process would only need to require 3 to 6 months, although the technology is almost never a real bottleneck, but rather stated by some incumbents as one. In a later stage, the Regulatory Body was assigned more enforcement power and established more regulations in order to speed up negotiations for interconnection and access to TCNZs other infrastructures.

Regulatory Bodies in various countries

Some examples of regulatory bodies and some of their regulation in various countries are shown below [Oliver1996, Clifford Chance1997, Melody1997, Noam1997].

AUSTEL The regulatory body of Australia, formed in 1989, that regulates the telecommunications environment. On 1 July 1997, the PSTN telecommunications market in Australia was fully opened and went from a Duopoly state to Competition state.

Ofkom The regulatory body of Switzerland, was founded in 1997 and developed regulation for interconnection of PSTN services, which opened for competition 1 January 1998.

CRTC (Canadian Radio-television and Telecommunications Commission), formed in 1996, chose a liberalization of national long-distance communications first. International traffic opened for competition later, in October 1998. There are special rules for traffic to and from the United States of America.

FCC (Federal Communication Commission) . FCC is the regulatory body of the United States and plays a key role in supervising competition in the United States. For instance, it carries the responsibility for implementing competition in local PSTN services, as described in e.g. the Telecom Act of 1996. Competition in long-distance PSTN services was introduced 1 January 1984 and in local PSTN service in 1996.

MF PTE (Ministere Fran aise de Poste, Tlcommunications et Espace) In France, the Ministry performs the regulatory body tasks until a regulatory body is founded. Competition in PSTN services was introduced on 1 January 1998.

OFTEL (Office of TELEcommunications) The regulatory body of the United Kingdom, founded 1982. OFTEL is in principle independent from the government. Opened the United Kingdom for one new telecommunications operator in voice services (PSTN) in 1982, resulting in a duopoly (Legal Framework for competition score D) and for competition by an unlimited number of suppliers in 1994.

OPTA (Onafhankelijke Post en Telecommunicatie Autoriteit)
The regulatory body of the Netherlands, founded in 1997, is charged with implementing the higher level directions, given by the office of the Ministry or HDTP (Hoofd Directie Telecommunicatie en Post, General Directorate on Telecommunications and Postal services). It opened the market for voice (PSTN) services in July 1997 [Tempelman 1997].

There is not yet a regulatory body that is called as such for the European Union, but a body may be formed in the future. So far the Directorate General IV and XIII of the European Commission have acted as a Regulatory Body. In the USA, the FCC is a regulatory body that enacts regulation for all states, but individual states often also have regulatory bodies as well, usually called a Public Utility Commission (PUC).

3.2.2 Categories of the Regulatory Body

Six categories of regulations have been identified for examining and quantifying the influence of the regulatory body in a country. Ideas for these categories came from practice¹⁵ and literature, such as the description of the Meta Telecom Maturity model [Johnson1997]. The categories were chosen to be as much as possible independent from each other, but not all categories are expected to be completely independent, which should be taken into account when the scores are used in an analysis. The starting values for the scores are mentioned in the categories. Each of the categories is scored to carry equal weight. The scores for each category will be added and result in a total score for the element Regulatory Body. The categories are numbered 1 to 6.

1. Regulations concerning regulatory body independence and enforcement power.

This is the only category that is not made BY the regulatory body, but made by the government FOR the regulatory body to be more effective. A regulatory body is considered usually a body that is independent of all telecommunications operators, with the responsibility of enacting telecommunications regulations that assure reasonable prices (usually by stimulating competition) and high quality of service in order to be effective¹⁶. The regulatory body should have the power to enforce the rules that it establishes. Starting values were chosen for the following sample answers to question a and b:

- a) Who is the regulatory body? One of the following answers is possible:
- The (dominant) telecommunications operator is the regulatory body: score 0 points.
  - The (dominant) telecommunications operator is privatized (independent of government) and the regulatory body is a government department: score 1 point.
  - The (dominant) telecommunications operator and the regulatory body are both independent of government: score 2 points.
- b) Does the regulatory body have *enforcement power*? One of the following answers is possible:
- Penalties or sanctions can be imposed for violation of regulatory body regulations¹⁷: score 1 point.
  - Penalties or sanctions can not be imposed for violation of regulatory body regulations: score 0 points.

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¹⁵ AT&T Law and Government affairs department spring 1998

¹⁶ Most regulatory bodies we encountered so far are government organizations.

¹⁷ It is noted that procedures can be lengthy before penalties can actually be imposed and they can therefore be of limited effectiveness.

For each of the two questions above, the scores are added to form the score of the category. This means that category 1, just like the other categories of the Regulatory Body may have scores ranging from 0 to 3 points.

2. Regulations concerning the licensing process . If there is a need for parties to obtain a license before they may offer telecommunications services in a country, the regulatory body can influence competition by influencing the process that regulates the awarding of telecommunications licenses to parties. The regulatory body can determine that the licensing process fulfills the following criteria:

- The licensing process is reasonably *short*. As a guideline we establish that the average length of the total licensing process is less than 6 months. This is the total licensing process including a public appeal process. This criterion gets 1 point if applicable and 0 points if not applicable.
- The licensing process is *open* to the public in its criteria and process (transparent). This is reflected in requirements of openness for e.g. hearing sessions or publications in newspapers. This criterion gets 1 point if applicable and 0 points if not applicable.
- The licensing process is *non-discriminatory*. The regulatory body treats all applicants in the same way. This criterion gets 1 point if applicable and 0 points if not applicable.

For each of the three criteria, the starting values chosen are 1 point and scores are added to get a score for this category ranging from 0 to 3. This means that, if the licensing process is reasonably short, open and non-discriminatory, the category scores 3 points and it scores less in other cases.

Literature [Cave1997] suggests active use of the licensing process by the Regulatory Body to influence competition considerably, such as: timing of competition on a per service basis. This can be done by making the possibility to offer services dependent on other parties in the industry. The U.S.

Telecommunications Act of 1996 allows local telecommunications operators (Regional Bell Operating Companies or RBOCs in the USA) to offer long-distance voice services, but only *after* the geographical market area of the RBOC has already encountered competition of new suppliers.

3. Regulations concerning equal access to infrastructure. With these regulations, the dominant telecommunications operator gives equal access to some of its facilities, including switches, cables, ducts, antennas to telecommunications operators, including to the service providing organization within its own company¹⁸. Equal access can be provided in various areas. We use three criteria,

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¹⁸ In order to carry out this regulation, often the dominant operator is split in terms of legal structure and accounting measures in a service provider and an infrastructure operator. This way cross subsidization can be avoided between the infrastructure operator, that operates in a monopoly environment as the only provider of infrastructure and the service provider, which operates in a competitive environment.

which are each scored with starting values of 1 point if they are applicable and 0 points if not applicable:

- a) Right to build a link/node infrastructure oneself. This includes the *right-of-way*, which means the right of a party (e.g. a new telecommunications operator), to lay cable in areas of land that the party does not own. Score is 1 point if applicable; 0 points if not applicable.
- b) Access to link/node infrastructure (equipment) of the (dominant)¹⁹ telecommunications operator is mandatory and based on internationally accepted technical standard interfaces²⁰. Score is 1 point if applicable; 0 points if not applicable.
- c) The dominant infrastructure service provider is obliged to accept co-location of equipment at its sites. Score is 1 point if applicable; 0 points if not applicable.

Under a) Right to build link/node infrastructure oneself, the criteria are used similarly for all different kinds of infrastructure, such as equipment at links/nodes, cables, but also the use of common media, such as frequency allocations for wireless and satellite applications. For fast provision of services, often wireless links are used in both networks for mobile operators as well as fixed infrastructure operators. Therefore access to frequency spectrum can be important, even when there is only competition allowed in wireline networks²¹. Adding the starting values of the three criteria in this category results in scoring for this category to range from 0 to 3 points.

4. Regulations concerning price of interconnection. The network for infrastructure services of the dominant telecommunications operator, or the entity that owns the infrastructure that provides the direct access to the locations of the subscribers in the country, should be open for connection (also called interconnection) with other telecommunications operators. The regulations concerning interconnection are identified in this category by the conditions a, b and c.

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¹⁹ Essential in practice is to have access to an operator of facilities that are a bottleneck, meaning facilities that are only in possession of that particular operator AND that are needed to realize the intended provisioning of the service.

²⁰ Access to this infrastructure is in regulation often referred to as unbundling of services, which means that the individual parts that make up a service of the dominant operator should be available to other operators.

²¹ Wireless and wireline (or fixed) services of operators are usually defined on basis of what the end-user sees. The end-user with a wireless handset that communicates directly with the operator (using e.g. GSM) considers himself on a wireless service (e.g. by a wireless operator). The end-user with a wireline handset considers himself connected to wireline service of a wireline operator. The actual transmission of the signal from user A to user B, can use various media to complete its path, e.g. including satellite, terrestrial wireless, fiber cable or copper cable. Access to all infrastructure (to both wireless frequency spectrums, as well as equipment and cables of the fixed network) is essential both kinds of operators to establish service.

- a) The price and conditions for access to infrastructure are cost-justified²². Starting value: 1 point if applicable or 0 points if not applicable.
- b) The price and conditions for access to infrastructure are known to the public. Starting value: 1 point if applicable or 0 points if not applicable.
- c) The price and conditions for access to infrastructure are exactly the same for all competing telecommunications operators, including the competing part of the dominant telecommunications operator that uses the network infrastructure. This criterion is referred to as non-discriminatory. Starting value: 1 point if applicable or 0 points if not applicable.

For each of the three regulations, the starting values chosen are 1 point and scores are added for the category, leading to a three point score if all regulations are present or less if some of them are not present and a total range of scores of 0 to 3 points.

The importance of these interconnection regulations is shown in various practical cases (see the BT/Mercury example shown earlier in this paragraph). Cost-justification (*condition a*) is an extensive subject that requires detailed accounting rules. Especially the allocation of fixed costs of a network (which are very high in a capital-intensive type of operation) is a detailed accounting process and is often challenged in court cases between existing telecommunications operators and new telecommunications operators. An example of such a challenge in New Zealand is listed in this paragraph under purpose of the Regulatory Body. Most literature on this subject is available in jurisprudence [Oliver1997].

5. Regulations concerning Fair competition . There are measures that can promote the fairness of competition, by establishing regulations aimed at particular parties. Depending on the nature of the competition, some of these measures can be used temporarily or permanently. The two kinds of regulations addressed here are: *price regulations*, listed under a) and *Universal service*, listed under b). Opinions vary widely on the effectiveness of price regulations [van Cuilenburg 1995][Cole1991]. There are opinions that price regulations stimulate competition, as they prevent the incumbent operator from dumping their services. Others indicate that the absence of price regulations gives all parties possibility to compete with complete freedom. We have chosen starting values, that increase when fewer regulations are imposed. Universal service is a regulatory criterion that has been estimated in literature to promote fair competition, as it equals the obligations for telecommunications operators that are offering services [Hammond 1998]. The two kinds of regulations concerning Fair competition:

a) Price regulations.

Either one of the following three situations may exist:

- prices for services are established with Government approval: score is 0 points.

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²² There are different ways to justify cost, among which are the justification based on historical cost and based on forward looking incremental cost.

- price regulations applicable (for instance minimum or maximum prices to be charged for certain services): score is 1 point.
- no price regulations: score is 2 points.

b) Universal service. Universal service means that telecommunications operators have to offer their services in all areas of a country at the same price and conditions (non-discrimination) and that they have to provide a basic service to everyone for a regulated, affordable price. Universal service may be a mandatory aspect of the service offering of an operator or may be realized by having operators pay into a Universal service fund to subsidize the provision of service to certain non-profitable customers or to customers that they don't provide service to. Universal service regulation is made because telecommunications operators would otherwise not offer service to low-revenue customers or customers in areas where there is a high cost of provisioning the service, with less profitability as a result. Starting values are as follows: 0 points if Universal service does not exist, 1 point if Universal service exists in some form in a country.

Difference between universal service in countries: USA and EU

There are significant differences in the implementation of universal service. In most European Union countries, universal service is depicted in non-discrimination regulations (based on Open Network Provision regulation)²³, as well as in basic service regulations, that provide a minimum service for everyone in the country²⁴. Non-discrimination regulations are often only applicable to a party that is dominant in the market as defined in the legislation.

Universal service currently exists in most countries for basic telephone service (Public Switched Telephone Network), but hardly exists for other telecommunications services. As Universal service often plays a role in lawsuits between telecommunications operators, we provide a more detailed example of how Universal service is implemented in the USA.

Universal service example in the USA

An example of an implementation of Universal service can be found in the USA. Universal service in the USA is regulated in various laws, including anti-discrimination laws, as well as the Telecom Act of 1996 in section 254 [US government 1996], which provides for special funds, financed by all telecommunications operators for maintaining Universal service for various types of services. Also, there are special programs with Government subsidies that can give access to basic services. Increasingly, access to PSTN (in the law described as Basic Telephony) is not considered sufficient anymore in United States politics. Access to Advanced Telecommunications services, such as the Internet, is seen as

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²³ For instance, in the Netherlands the non-discrimination aspect is implemented in article 7.4 of the Telecommunicatiewet of 19 October 1998.

²⁴ In the Netherlands Telecommunicatiewet, this is depicted in the Universele dienstverlening of Article 9.1 through 9.4

another service that all people need to be able to have [Oliver1997]. As regulations for Universal service for the Access to Basic Telephony, several programs exist, such as the Lifeline and Link-up programs, which are actually subsidies to the users of telecommunications services. For Access to Advanced Telecommunications services, a multitude of regulations exist, such as Anti discrimination laws, as well as specific programs to assure Universal service for certain groups in the population, such as members of schools and libraries. Figure 3-4 gives an overview of current Universal service regulations by the Federal government in the USA.

Universal service regulations in the USA	
Subject:	Applicable Regulation
Access to Basic Telephony	Lifeline and Link-up programs (subsidies for low-income households)
Access to Advanced Telecommunications services	Anti discrimination laws
	Regulation based on sec. 254 and 706 of the Telecom Act of 1996, Universal Service in all regions
	Regulations that arrange targeted subsidies for: • Schools and libraries • Rural Health care providers • Community Based Organizations

Figure 3-4; Example: Universal service regulations in the USA

The scores of category 5, fair competition regulations will be tracked both as an aggregate sum to represent the whole category, but also individually in order to be able to do more detailed statistical analysis in chapter 9. With the starting values chosen, the scores of the category range from 0 to 3.

6. Regulations concerning number portability

This category handles Regulations on number portability or subscriber identification and numbering. An important aspect of subscriber identification and numbering is *Number portability*, the possibility to keep ones current phone number, domain name or TCP/IP address while changing telecommunications operators or service providers.

Number portability exists in different forms. Meant here is to assess the local number portability, which concerns the possibility for a subscriber to keep ones own number or identification. Number portability has been shown an important criterion for subscribers and very few users would like to give up their number or identification, in order to get a lower price or better service from a different telecommunications operator [Terplan1999][Franx1998]. Number portability scores 3 points if it is implemented and 0 points if not implemented. The number

portability requirement is fulfilled only²⁵ when an independent body or department administers the numbering plan, in order to assure fair treatment of the new telecommunications operators that request identification numbers.

3.2.3 Total overview of the scoring for the element Regulatory Body

For each of the six categories of regulatory body, we are using the starting values as shown. The starting values were chosen to cover all categories with about the same weight and such that a higher score is expected (according to literature [VanCuilenburg1995] and experience) to result in *more, lower priced or faster provisioned* services. The weighting may be changed after the statistical analysis that we plan to do in case studies. The answers are scored and added per country in the rightmost column in Figure 3-5. The total score is the addition of the category scores and is expected to give an indication of the total regulations of the regulatory body, which means that the higher the score, the more the regulatory body is expected to promote good competition as referred to earlier in this paragraph. Each of the categories has a score ranging from 0 to 3, so the total score for the Regulatory Body should thus range between 0 and 18.

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²⁵ For practical use, requirement is independence. It could be possible that a company or operator administers the numbering plan, but in that case the government should closely supervise in order to ensure equitable treatment of operators.

Regulatory Body	Country X	
Categories (with in brackets the point scores)	Status (starting value)	Category (starting values)
1. Independence/Enforcement power 1a. Regulatory body independence. One of the following: = dominant telecommunications operator is regulatory body (0 points) = regulatory body is government department and telecommunications operator privatized (1 point) = independent telecommunications operator and regulatory body (2 points) 1b. Does regulatory body have enforcement power? (Y=1, N=0)	In-dependent (2) Y (1)	3
2. Licensing process Licensing process is: • short (Y=1, N=0). • transparent (Y=1, N=0). • non-discriminatory (Y=1, N=0).	N (0) Y (1) N (0)	1
3. Equal access to network infrastructure A new telecommunications operator is allowed to: • build network infrastructure (Y=1, N=0). • have access to network of a dominant (bottleneck) operator (Y=1, N=0). • require mandatory co-location from a dominant operator (Y=1, N=0).	Y (1) Y (1) Y (1)	3
4. Price of interconnection Access charges are: Cost-justified (Y=1, N=0) Published (Y=1, N=0) Non-discriminatory (Y=1, N=0)	Y (1) Y (1) Y (1)	3
5. Fair competition Price regulations set the following restrictions: = Services pricing only with Government approval (0 points) = Price caps (minimum/maximum prices) (1 point) = No price regulations (2 points) Universal Service or fund contribution is mandatory (Y=1, N=0).	no reg(2) N (0)	2
6. Number portability Number portability mandatory (Y=3, N=0)	Y (3)	3
TOTAL Regulatory Body score		15

Figure 3-5; Regulatory Body scores for a sample country X (Y=yes, N=no)

When the Regulatory Body of multiple countries is described, the format of Figure 3-5 can be difficult as only few columns fit on a page. Therefore, the figure can also be depicted in a way, mirrored across the diagonal, resulting in a figure in condensed horizontal format as depicted in Figure 3-6. The condensed horizontal format does not allow room for the scores of each of the individual bullet items (criteria) within the categories. An exception is made for category number 5, Fair competition regulations, since that category is built up of two very different criteria, Price regulations and Universal Service. Splitting the scores of category 5 makes it easier to do analysis of potential relationships between these criteria when applying the model in the cases in step 5 of the research methodology.

	Regulatory Body							TOTAL Regulatory Body score
	1. Inde- pendence/ Enforcement power	2. Licensing process	3. Equal Access to Infrastructure	4. Price of intercon- nection	5. Fair competition regulations		6. Number portability	
					Price Regula- tions	Universal service		
Country X	3	1	3	3	2	0	3	15
Country Y	2	3	2	3	1	1	0	12
Country Z	2	3	2	2	0	0	0	9

Figure 3-6; Regulatory Body scores in figure in 'condensed horizontal format'

3.3 Competition active

The third element of the Regulatory Environment is Competition active. Competition active, or the number of competitors for a telecommunications service in a country, differs from the other two elements in the sense that it is *descriptive* rather than *prescriptive*. This element is part of the Regulatory Environment merely in order to confirm that the two other elements actually result in competition or not. A high number of (legally operating) competitors in a country shows that the Regulatory Environment has created low barriers for entry, and is a sign of a competitive market. The number of competitors offering a service at a level in the Service Value Model are counted, which forms the basis for the score. A competitor is only counted as such, if its market share is above a certain percentage. We have debated whether a fixed percentage (1% or 3% for example) would suffice and we used 3% as a guideline. In order to be more accurate we have concluded that it would be preferable to take into account how the total market is divided [Theil1972][Fomby1997]²⁶. This literature shows ways to determine a

²⁶ Another way to measure the amount of competition is to measure the share of the incumbent operators, which is showing a trend from 100% downwards, as more competition is active.

good threshold depending on the relative market shares and number of parties in the market and uses an indicator called entropy to measure that. The market share number is essential as it often happens that many competitors are starting in a certain market, but in some cases competition is so tough that the new entrants get almost no market share. The starting values for the scores are chosen such that the number of points is in line with the experience of expected competitiveness. More than two competitors denotes a competitive market and is therefore awarded 3 points with lower scores for fewer competitors. This results in the scoring as shown in Figure 3-7.

Competition active	Code	Starting value
No competitor	0	0 points
One competitor	1	1 point
Two competitors	2	2 points
More than two competitors	>2	3 points

Figure 3-7; Starting values for Competition active

The competitors are counted for each of the three layers in the Service Value Level and the scores for all of the three layers in the Service Value Model is then added by country²⁷ Figure 3-8 shows an example for the scoring of the element Competition active.

	Competition active						
	Value Added Services		Basic Data Transfer Services		Infrastructure Services		TOTAL competition active
	Number	Score	Number	Score	Number	Score	
Country X	> 2	3	1	2	> 2	3	8
Country Y	1	2	1	2	> 2	3	7
Country Z	> 2	3	> 2	3	1	2	8

Figure 3-8; Example of scores for the element Competition active for country X, Y and Z

3.4 Overview of the Regulatory Environment

When the three elements described as part of the Regulatory Environment are taken together, a Regulatory Environment can be depicted as a combination of the tables shown in 3.3 and is shown with scores for sample countries X, Y and Z in Figure 3-9.

²⁷ Between the three Service Value Levels there could be a difference of weight, but this is not considered here as the scores are starting values. Competition in infrastructure services in particular is valued highly by experience of some researchers (Comment by E. Noam 1999).

	Legal Framework for competition						
	Value Added Services		Basic Data Transfer Services		Infrastructure Services		TOTAL Legal Framework
	Code	Score	Code	Score	Code	Score	Total score
Country X	C	3	M	0	M	0	3
Country Y	C	3	C	3	C	3	9
Country Z	C	3	C	3	C	3	9

	Regulatory Body						
	1. Independence / enforcement power	2. Openness and length of licencing process	3. Equal Access to Infrastructure	4. Price of interconnection	5. Fair competition regulations	6. Number portability	TOTAL Regulatory Body score
				Price Regulations	Universal service		
Country X	3	1	3	3	2	0	15
Country Y	2	3	2	3	1	1	12
Country Z	2	3	2	2	0	0	9

	Competition active					
	Value Added Services		Basic Data Transfer Services		Infrastructure Services	
	Number	Score	Number	Score	Number	Score
Country X	> 2	3	1	2	> 2	3
Country Y	1	2	1	2	> 2	3
Country Z	> 2	3	> 2	3	1	2

Regulatory Environment model

Figure 3-9; Example of scores in the Regulatory Environment model.

Each of the three elements fulfills a role in the Regulatory Environment model, which is probably best explained by viewing each of the three elements as fulfilling a role in a stage of competition active in a country. When a country opens markets of certain services for competition, often the *laws* are made to allow this, or the opening of the market is lead by decisions of judges in court cases, such as common in Anglo Saxon law. Then more detailed regulations are made (usually by a *regulatory body*) and finally *competitors* should start showing up that like to take advantage of the newly created opportunities.

The information needed to fill in the boxes in the Regulatory Environment model can be obtained from various sources. Examples are geographical area studies, such as done by Noam [1997, 1994, 1992] and high-level overviews that can be found in handbooks [Frieden1996][Terplan1999] or consultant reports and reports of official organizations [OECD97] The scores are added up on a per-country basis in order to arrive at a total score of the Regulatory Environment . In the example in Figure 3-9 the Country X would get the addition of all the Country X columns, $3 + 8 + 15 = 26$ points. The resulting total score of the Regulatory Environment per country can also be used as input parameter for the Cost-effective Management model, which will be developed in chapter 5.

3.5 New developments in Regulatory Environments

Many member countries of the World Trade Organization (WTO) signed an agreement called General Agreements on Trade in Services Concerning Basic Telecommunications, often referred to as the WTO Basic Telecom Services Agreement [Oliver1998] in February 1997 in order to commit each other to opening their telecommunications markets for competition.

Opening the markets for competition would happen according to a time schedule, that was proposed by each of the countries that signed the agreement. Each country had a so-called offer, which includes a series of plans, including a date, to open the market, categorized mostly by a Service Value Level or a similar description. The four main categories of services that are covered by the WTO Basic Telecom Services agreement are domestic Public Switched Telephone Network (PSTN), domestic long-distance PSTN, international PSTN and satellite services. The countries that signed the WTO Basic Telecom Services agreement represent 79 percent of the world economy²⁸. Figure 3-10 shows an example of offers of a few countries that were committed in the WTO Basic Telecom Agreement.

Situation regarding a service	Greece	Spain	Venezuela
Competition in domestic PSTN	in year 2003	in 12/1998	in 11/2000
Competition in international PSTN	in 12/1998	in 12/1998	in 11/2000
Possibility to own infrastructure	in year 2003	in 12/1998	in 11/2000
Allows bypass into country	in year 2003	in 1/1998	not planned

Figure 3-10; Example of offers of a few countries in the WTO Basic Telecom Services agreement

As shown, most offers contain commitments regarding competition for particular services. Countries state a date in their offer by which they commit competition to be allowed for that particular service. The WTO Basic Telecom Services agreement itself, then states requirements for when opening each of the services actually happens. For example, when a country declares that competition exists in PSTN services, the interconnection of competitive telecommunications operators to the PSTN network has to be non-discriminatory and cost-based. There are numerous developments in the Regulatory Environment of many countries and both country organizations as well as supranational organizations such as WTO and EU are developing regulation to implement in their countries or areas.

With so many developments in Regulatory Environments, the fact is stressed that the Regulatory Environment described in this chapter is always an assessment at a particular moment in time. One should realize that the effect of changes in the Regulatory Environment may be noticeable with a considerable time lag after the implementation of the changes.

²⁸ This is in terms of Gross National Product; however, in terms of world population, they only represent 19 percent of the population.

3.6 Summary

The Regulatory Environment has been described by modeling it in a way that determines three elements: *Legal Framework for competition*, *Regulatory Body* and *Competition active*. Each of the elements assesses the situation in a country and defined starting values are assigned to them to express the situation in a country in a quantitative set of scores. The combination of the scores filled in in the description of the elements is called the Regulatory Environment model. With the Regulatory Environment thus described, the regulatory environment of a country can be expressed in a quantitative way, so it can be used as input for the Cost-effective Management model, together with the Telecommunications Services Offering, that will be described in chapter 4.

4 Telecommunications Services Offering

Telecommunications Services Offering is the second input parameter for the Cost-effective Management model that is under study in step 4, which is depicted in this chapter. An international network may use and/or deliver telecommunications services, which are part of the Telecommunications Services Offering in a country. In this chapter, services will be categorized in different ways in paragraph 4.1, then aspects of telecommunications that are valued by international organizations are studied in paragraph 4.2. Services that are important for international organizations are selected in paragraph 4.3, after which a *Telecommunications Services Offering matrix* is developed in paragraph 4.4 in order to model the Telecommunications Services Offering in a country

4.1 Telecommunications services

History of telecommunications services

Bridging a distance of more than a few miles was made possible by the invention of electricity based telecommunications services by Samuel Morse in 1838. He invented the telegraph as a device, that used electrical signals, transported over a copper wire and he developed the Morse alphabet as a standard way of expressing our language in electric signals. Later the telegraph was also fitted to use radio waves for transmission. The telephone made it possible to communicate with normal voice and was invented by Alexander Graham Bell in 1879. The principle of operation of the telephone changed little between 1879 and today, but the technology for transmitting the electromagnetic signals from the telephone changed drastically. Initial communications was based on overhead wires, that all connected to a manually operated exchange, introduced in most countries around 1900. The first electromechanical switches appeared in 1930s. They could replace the telephone switch telecommunications operators and would allow for dialing of a number from by the subscriber himself. However it took until the 1960s in most Western countries for all the manually operated switches to be replaced by automatic switches and some countries in the world still rely on manually switched networks today. Since 1966, when the first telecommunications satellite was launched, telecommunications between continents grew enormously and international transmission of television images was made possible.

Introduction of multiple suppliers

Historically, creating telecommunications services in countries was a task of the government. The governments operated a ministry or public body, that would be responsible for offering telecommunications services. The services were seen as utilities and should be provided to everyone at the same price, usually regardless of the location where the user resides. There were also technical reasons to keep the complete network in hands of one party. The technical solutions had not been found to enable the use of a bottleneck resource, such as the infrastructure, by more than one party.

The offering of services consisted of a limited number of services that the government deemed necessary and beneficial for the users in the country. The government also controlled the quality of the services offered. If services were offered by a state owned company or a company that was not state owned, but considered monopolist, requirements for the telecommunications services were placed on the company. These one-supplier environments still created problems. In some countries where that situation still exists, the examination of a Telecommunications Services Offering in that country is an easy task, as only one information source is needed.

Only in the beginning of the 1980s, some governments started changing that situation and multiple suppliers emerged in some countries in the 1980s and 1990s.

Telecommunications services

Telecommunications services can be categorized in different ways. Distinctions that are often used are *public* services versus *private* services, *data* services versus *voice* services and *wireline* services versus *wireless* services. Most, but not all services can be categorized with these distinctions.

Figure 4-1 shows an overview of private networks and public networks and private networks based on public networks, which fit neither of the categories. Services of both public and private networks are commonly used by international organizations. The difference in essence stems from the ownership of and access to the network, which can be public (a body owns it and everyone has access to the same network) and private (only the party that leases or buys the network may access it). In practice, there are also services which are private, but are implemented on public facilities. They are called Virtual Private Networks. In that case the telecommunications operator usually implements the technological measures on a public network in order to give the virtual private network user access to a seemingly private network.

Figure 4-1; Private networks, public networks and private networks based on public networks.

Service Value Levels and supplier-customer relationship

Telecommunications services may be categorized in Service Value Levels as described in paragraph 2.3. Main purpose for categorizing services in such a way is that regulation in many countries uses a similar distinction to categorize services. In reality, there may be multiple parties (and supplier-customer relationships) at each layer of the Service Value Model. Figure 4-2 shows an example of actual supplier-customer relationships, described in terms of the Service Value Model in a two-country situation. Infrastructure operators at the bottom of the Service Value Model are for the actual owning and managing of the border crossing links. Some Value Added Services providers try to become international by offering managed services at e.g. the Value Added Services value level, such as Value Added Service Provider (d), that is operating both in country A and country B and therefore maintains relationships with both operators (e) and (f), that each obtain their services from infrastructure operators (g) and (h). Infrastructure operators (g) and (h) do not have a network individually that crosses international borders. They do have so called bilateral relationships with each other. In case of a bilateral relationship, usually the international link is owned by both infrastructure operators together, with each of the infrastructure operators responsible for management of half of the link; the part of the link that is on their country's soil. The Service Value Model here helps in creating an understanding of the relationships between the parties that enable the operation of the international network. In Figure 4-2, this is shown where both the end user (the multinational organization (b)) and Value Added Service Provider operate across international borders. Multinational organization (b) also obtains Internet services from the Internet Service Provider (i), that is obtaining TCP/IP services from operator (f), which on its turn is connected with other operators using infrastructure operator (h).

Figure 4-2; Example of supplier-customer relationships, described in terms of the Service Value Model

Standardization

Telecommunications Services Offering can be categorized by the types of services, that can include for example video services, voice services and data services. Some services are standardized and named, such that a wide audience can understand the service and use it with standardized equipment and peripherals that connect well with the networks [Tanenbaum1997][Looijen1998]. Examples of standard services are: X.25; a packet switched service, ETSI EURO ISDN Q931; a digital circuit switched service according to the standards of ETSI (European Telecommunications Standards Institute).

4.2 Economics of services crossing international borders

An important difference between the management of a network *with* or *without* international links, is the price for telecommunications services that the international organization has to pay²⁹. There are two main observations that were

²⁹ Leasing is the most common way of acquiring capacity for international links. If the regulatory environment allows it, there is a possibility to buy (parts of) links of infrastructure that crosses international borders. This can be done in form of IRU's (indefeasible rights of usage) or in form of actually buying (a share of) a cable facility or satellite. It may be possible that buying instead of

made: firstly an international link is much more expensive than a national link and secondly the price of a link varies very much per country.

On the first observation, currently everywhere in the world³⁰, the prices for services that cross an international border are a multiple of that of the same service when it would not cross an international border. In international leased lines services, the international line of a certain distance is usually 3-5 times³¹ [Molony1999] more expensive than a similar leased line of the same distance, that does not cross an international border. This may render certain applications for the end-user impossible from an economic point of view to implement internationally, whereas those applications could have been cost-effective when implemented without crossing international borders, such as in the large countries like the United States.

A graphical depiction of this multiple for a set of countries is shown in Figure 4-3 [Molony1999]. For each country, the left bar shows the multiple of international versus national leased lines in the year 1997 and the right bar shows the multiple for 1998. In most cases, the multiple is still between 2 and 5 and it is not decreasing, but rather increasing, except for Belgium and Denmark. This shows that international networks seem to become more and more 'different' from non-international networks, in terms of costs of telecommunications services.

Figure 4-3; Price difference (multiple) of international versus national leased lines in 1997 and 1998 for selected countries (source: Molony [1999], INTUG)

leasing decreases the difference in costs between international and national links. Since buying is only possible for a very select few companies (because of regulatory constraints and/or capital constraints), it is not considered as an alternative.

³⁰ Some improvements may be expected from international alliances of telecommunications operators. So far, however, they have not been able to force major changes in international tariffs.

³¹ Cost comparison by BTG, The Telecom User group, The Netherlands, 1999. E.g. a 2Mb/s leased line that crosses a border between The Netherlands and Belgium is 2.5 times the cost of a leased line with same capacity and same distance within The Netherlands. International leased lines pricing overview of Eurodata foundation.

Regarding the second observation, there are big differences in price in different countries. An example is shown in Figure 4-4, that shows the market prices of leased lines within various countries.

Figure 4-4; Monthly costs of 100km, 2Mb/s leased lines in several countries (source: Eurodata [1998])

The data in Figure 4-4 is a comparison of tariffs *within* a country [Eurodata1998]. The most expensive country for leased lines (Italy) is 15 times more expensive than the cheapest country (Sweden).

Infrastructure operators pricing

There are multiple reasons for the differences in prices that infrastructure operators demand for international leased lines and other international services. Many infrastructure operators in the world still don't pass on the benefits of lower cost technology to the consumer of the service, but decrease their prices at a much slower pace. Even though there may be multiple suppliers of services at the VAS-level or BDTs-level, infrastructure services are still a resource offered by only one party in many countries. The owners of the infrastructure are therefore often still in a position to charge higher prices. Infrastructure services crossing international borders is a scarce good in many countries as laying cable requires *rights of way* (the right to dig and lay a cable in a piece of land) in separate countries up to the international border. The actual land close to the border is often owned by the state and rights of way can be difficult to obtain. Transmission by radio waves across an

international border is also possible, but requires licenses for use of radio spectrum in countries on both sides of the international border.

International settlements

Another background, which may explain the high prices for international services is that the international arrangements between Infrastructure operators in different countries still include high reimbursements, also called settlements, between Infrastructure operators of different countries for the completion of each others telecommunications services in the terminating country. These international settlements could, in theory be close to zero, if there are as many leased lines or as much traffic from country A to country B as from country B to country A. In that case, it doesn't matter how high the per minute or per capacity charge for cross border traffic is. In reality, however, the balance of originating and terminating traffic between most pairs of countries in the world is tilted towards one side. The country with the lowest prices of services to the users often generates more originating traffic/request for capacity and ends up paying the terminating country for the difference between the amount of traffic/capacity sent and the amount of traffic/capacity received [Frieden1995][Sandbach1996]. Graphically settlement payments are shown in Figure 4-5. The leftmost bar shows 50 million minutes of traffic sent per year from country A to country B and the rightmost bar shows 30 million minutes of traffic incoming from country B to country A. The difference, also called unbalanced traffic, triggers a settlement payment for 20 Million minutes from Infrastructure operator(s) in country A to Infrastructure operator(s) in country B. Note that this is an example and the numbers of minutes have been chosen arbitrarily.

Figure 4-5; Example of unbalanced traffic and settlement payments between countries A and B

Non-traditional international traffic

Non-traditional international traffic is a euphemism often used in telecommunications for new ways for telecommunications operators to avoid paying the high international settlement cost. Important methods are bypass into the domestic network and refile or reorigination. Usually, this practice is used by Infrastructure operators, but could even be done by anyone with the right telecommunications equipment.

Bypass into a domestic network

Bypass into a domestic network uses an international leased line (or an other international means of transport, such as the Internet) to bring traffic from a foreign country into the termination country and terminate it in the domestic network at local rates. Termination can be done through organizations with high capacity links into the local network, such as hotels or large organizations with relatively large volumes of traffic and private exchanges. The traffic can then be disguised such that it looks as if it comes from the hotel, but in reality it is foreign originated traffic, that avoids the international settlements payments. A difficulty with bypass is that quality is often less than if traffic would be given to an official telecommunications operator. Also, this method can be easily detected when the telecommunications operator in-country realises that the hotel suddenly sends a lot more traffic than it usually sends. Other methods of bypass are for instance based on Voice-over-Internet technology.

Refile or reorigination

Refile or reorigination entails sending international traffic to the destination country via a detour, a third country, which cooperates by labeling the traffic like it originated in the third country and forwarding it to the termination country. The quality is usually higher than with bypass, but depending on the length of the detour and the communications technology (satellite, microwave or fiber cable), this method can introduce propagation delays. *Reorigination* is the same activity as refile, but then viewed from the third party. So for example: party A *refiles* traffic to party B via party C, which is *reoriginating* this traffic to party B. More details on Non-traditional traffic is available in literature [Scheele1998].

4.3 International organizations and telecommunications services

International organizations use telecommunications services at a rate growing by 15% per annum and spent more than \$100 billion in 1997 on telecommunications services [AT&T1997]. In this paragraph, telecommunications services for international organizations are examined in more detail as a preparation for the creation of the matrix, that we will call the *Telecommunications Services Offering*

matrix. The examination is done with a survey carried out for this research. It is called the Network managers survey.

Network managers survey

The network managers survey for this research project was carried out among the network managers of 17 international organizations in Europe^{32 33}. The network managers survey shows which services are most important to international organizations and what aspects of the services are most important. It furthermore focuses on the use of VPN services for purposes beyond the scope of this research [vanDalen1995]. The survey resulted in the following services being considered most important:

- Public Switched Telecommunications Network services (PSTN).
- Integrated Services Digital Network services (ISDN).
- Services many organizations use to establish a private network, such as:
  - Leased lines 64kbps.
  - Leased lines 2 Mbps.
  - Packet Switched Data Network (PSDN). There are various standards, primarily X.25, but this may in the future grow to TCP/IP or Asynchronous Transfer Mode (ATM).
- Virtual Private Network services, asked for by the respondents, primarily to combine some of the services mentioned above on one network and reduce costs of operators.

The results of the survey also show the most important aspects of these services for the network managers. The most important aspect was *price of the services*. Listed in order of decreasing importance are:

- Price of the services.
- Geographical coverage area of the services.
- Time, including: Time of provisioning, Mean-Time-To-Repair (MTTR), Mean-Time-Between-Failures (MTBF), Availability time of the network.
- Reliability, indicated in particular for Virtual Private Network services.
- Security, indicated in particular for Virtual Private network services.

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³² Demand by multinational corporations survey among 17 international organizations, conducted in 1995 by means of interviews and paper inquiries, AT&T/Lucent Technologies Netherlands, Edwin van Dalen. Organizations: Philips, DuPont, ING Netherlands, Shell, Nedlloyd lines, Netherlands postoffices, Hewlett-Packard, IBM, DSM, Monsanto, Akzo Nobel, Dutch railways, Schiphol Telematics, PTT post, AT&T, Ministry of Health and Environment, Unilever meat group.

³³ It should be noted that most of the respondents operate networks that cover many countries, but about half of the networks had more than 50% of the links concentrated in Western Europe.

Concerning this list of aspects, some remarks were made in the surveys by the network managers that were combined with our observations. For example, the *security* aspect was mentioned in particular concerning Virtual Private networks and Wide area networks, but it is difficult to measure. An explanation given by one of the respondents was that Virtual Private Networks and ISDN networks are seen as a new technology and the fact that physical resources are shared with other users may introduce an initial fear for security problems. *Reliability* and security were not an aspect that were of high priority, but some network managers indicated that they just assume it as a given that reliability and security are provided adequately by the telecommunications operators. Other network managers simply indicate that they have adequate measures in place to guarantee reliability and security (such as redundant routing for reliability and encryption for security) and that they don't expect problems in those areas. An overview of the survey questions can be found in appendix A.

Developing a Telecommunications Services Offering matrix

The Telecommunications Services Offering matrix that is to be developed, should be easy to use and therefore include a limited set of aspects and services. The aspects that were mentioned by the network managers most often in the survey, Area of availability and Price, were taken and quantified, so they can be used as input for a model that describes the Telecommunications Services Offering in a country.

Area of availability

- Coverage, or the percentage of villages/cities of country where the service is offered. This aspect is detailed in paragraph 4.4.1.

Price of telecommunications services, consisting of:

- One-time price of the service, such as installation fee, and
- Usage price of the service per unit of information.

This aspect is detailed in paragraph 4.4.2.

We will express the geographical coverage in a numeric value, based on the percentage of the geographical area. For price, we compare a standard set of services and usage, as defined in the OECD report [OECD1997].

Other aspects and their representation

Apart from the two chosen aspects, Area of availability and Price of telecommunications services, a third aspect, time, is not directly represented in the Telecommunications Services Offering matrix. It plays a minor role and is only considered if the time aspect is much different from a normal situation. This is explained as follows: we will consider a service as simply *not available* if the time aspects of the service are so much worse than average that the average international organization cannot use them. Time aspects are e.g. *downtime*, *provisioning time*, *Mean Time Between Failures (MTBF)* and *Mean Time To Repair (MTTR)*. Downtime is the time the service is not available per month and

provisioning time is the time it takes to provide a service to a new user. MTBF is the average time between two failures in a network. MTTR is the average time it takes to repair a failure.

For downtime, we consider a service unavailable in that geographic area if it is available less than 90% of the time or if the provisioning of such a service takes more than 4 times the average provisioning time for those services in other countries. Area of availability and Price of telecommunications services together form the Telecommunications Services Offering matrix.

4.4 Developing a Telecommunications Services Offering matrix

The *Telecommunications Services Offering matrix* is used to quantify the Telecommunications Services Offering in the countries where the network operates. In order to fill the Telecommunications Services Offering matrix we give the countries a score, depending on the Area of availability and the Price of telecommunications services.

The main source for selecting the services that would be represented in the matrix were services used by the 17 multinational organizations that were surveyed. The following services of paragraph 4.3 were selected:

- International Virtual Private Network service (VPN).
- International Public Switched Telecom Network (PSTN) Voice, fax and modem service.
- International Integrated Services Digital Network (ISDN).
- International Leased line (digital) 64Kbps speed.
- International Leased line (digital) 2 Mbps speed.
- International Packet Switched Data Network (PSDN).

An optional service to be selected could be International Dark fiber service. This service will only become part of the Telecommunications Services Offering matrix when a sufficient number of countries offer the service. Currently, the number of suppliers of this service is so small that it was not a candidate for the Telecommunications Services Offering matrix. The service is only mentioned here, because it represents the Service Value Level Infrastructure service. The use of dark fiber services requires a license in many countries.

4.4.1 Area of availability

The geographical area in a country where the service is available can roughly be measured by determining in what cities and rural areas the service is offered compared to the total size of the country. Apart from PSTN services, for which often Universal Service regulations exist, most services are not offered ubiquitously in the country. If service is available only in a particular (e.g. the capital) city, it can have strong repercussions on the cost of management of the

network. This means that for expansion into other cities, different services would need to be used that can be more expensive or deliver lower quality. An example is leased line service that may not exist in part of a country. Instead an international organization then may have to use Very Small Aperture Terminals (VSAT) that are used for setting up a leased line via satellite. Starting values were chosen to represent three categories of Area of availability as depicted in Figure 4-6, such that a high score is expected to have a positive effect and thus lower the cost, as the services would be available in more areas, so more freedom of choice is available for choosing the type of service with the lowest cost.

Area of availability	
	Score
+ = the service is available in almost all populated areas (80%-100% of the populated area)	3 points
0 = the service is available in limited areas only (20%-80% of the populated area)	2 points
- = the service is available in very limited areas or is not available (<20% of the populated area or requires an unusually long provisioning time)	1 point

Figure 4-6; Area of availability

The starting values were chosen, such that points range between 1 and 3. The very limited or not available category receives one point, as it represents very little or no availability.

4.4.2 Price of telecommunications services

The Price of the telecommunications services is measured relative to the prices of the services offered in other countries in the world. For each of the six services that are part of the Telecommunications Services Offering matrix, the countries in the world are divided according to price into three groups.

One group represents the 20% highest priced countries for that service, one group represents the 20% lowest priced countries for that service and the middle group represents the remaining countries. It is not always possible to use this division accurately, because it implies that all the countries in the world must be examined for their Price of telecommunications services. In the test cases, the 25 OECD countries were taken as a group representing the world, which means that for instance the 20% lowest priced countries for a service means the 5 lowest priced OECD countries for that service. Starting values were chosen as 1 point for the highest priced group, denoted with an H, 2 points for the middle priced group, denoted with an M and 3 points for the lowest priced group, denoted with an L. The scoring of price of telecommunications services is shown in Figure 4-7.

Price of telecommunications services	
	Score
L = Low price (lowest priced 20 % of telecommunications operators on world market)	3 points
M = Medium price (average priced group of telecommunications operators on world market) The middle group of operators that are not in H or L categories.	2 points
H = High price (highest priced 20 % of telecommunications operators on world market)	1 point

Figure 4-7; Price of telecommunications services

Similar to *Area of availability* the total score of *Price of telecommunications services* ranges from 1 to 3.

In the current starting situation, all six services are counted with the same weight, however, depending on the type of organizations that actually use the services, the importance of the services may differ.

4.4.3 Overview of the Telecommunications Services Offering matrix

Using the scoring in the previous paragraphs, Figure 4-8 shows an overview of an example of the total Telecommunications Services Offering matrix, which is the combination of the Price of telecommunications services, using Figure 4-7 as a reference and the Area of availability scores, using Figure 4-6 as a reference. The scores of Area of availability and Price of telecommunications services are added for each type of service depicted on one row and then the rows are added to get to the total Telecommunications Services Offering score per country. We did not consider any weighting or further fine tuning of the starting values in this stage, even though there may be different weight that some international organizations place on several services. Weighting can be applied in a later stage, after several cases have been done, such that a calibration can be made.

For each country a matrix as in Figure 4-8 can be developed. Multiple columns can be used to show several countries in one matrix.

Type of Service	Country X				
	Area	Score	Price	Score	Total
International VPN service (VPN)	+	3	H	1	4
International Voice, Public Switched Telecom Network (PSTN)	0	2	H	1	3
International Integrated Services Digital Network (ISDN)	0	2	M	2	4
International Leased line (digital) 64Kbps speed	+	3	H	1	4
International Leased line (digital) 2 Mbps speed	+	3	M	2	5
International Packet Switched Data Network (PSDN)	0	2	M	2	4
Area of availability and Price of telecommunications services scores and total Telecommunications Services Offering score per country	15		9		24

Legend:

Area = Area of availability, Price = Price of telecommunications services

Area

+ = >80%

o = 20%-80%

- = < 20%

Price

L =the lowest 20%

M =the middle group

H =the highest 20%

Figure 4-8; Telecommunications Services Offering matrix for one country with sample scores

Both the Area of availability and Price of telecommunications services and the Telecommunications Services Offering score per country will be used in the Cost-effective Management model that will be described in chapter 7. The Cost-effective Management model will be used to determine the relationship between the score and Cost-effective Management, using the input parameter values and output parameter values for each of the countries.

There are numerous sources of information to help filling in the Telecommunications Services Offering matrix. As mentioned, in case of a single telecommunications operator situation, there is usually one source: the single telecommunications operator. There are publications by the telecommunications operator or by the government. In case of multiple telecommunications operators, often the regulatory body in the country can provide an overview. In most cases, however, we have to rely on other sources that provide the services of collecting the data, such as consulting organizations like Eurodata, Analysys and OECD [OECD1997] and a combination of observations of the local offering brochures of telecommunications operators. Reports of consulting companies should be

assembled in a very short time window in order to obtain comparable results and timing the measuring of the Cost-effective Management of a network with the measurement of the Telecommunications Services Offering, so the statistical analysis of the relationships will not be disturbed. The matrix can also be depicted in condensed horizontal format to allow for showing multiple countries as shown in Figure 4-9. Two tables are necessary to depict all selected services.

	Telecommunications Services Offering matrix														
	VPN					ISDN					PSTN				
	A	S	P	S	Total VPN	A	S	P	S	Total ISDN	A	S	P	S	Total PSTN
Country X	+	3	M	2	5	-	1	M	2	4	+	3	M	2	5
Country Y	0	2	M	2	4	+	3	H	1	4	+	3	H	1	4
Country Z	o	2	H	1	3	+	3	L	3	6	+	3	L	3	6

	Telecommunications Services Offering matrix														
	Leased lines 64kbps					Leased lines 2 Mbps					PSDN				
	A	S	P	S	Total VPN	A	S	P	S	Total ISDN	A	S	P	S	Total PSTN
Country X	-	1	H	1	2	-	1	H	1	2	o	2	H	1	3
Country Y	+	3	M	2	5	+	3	M	2	5	+	3	M	2	5
Country Z	-	1	H	1	2	-	1	H	1	2	o	2	H	1	3

Figure 4-9; Telecommunications Services Offering matrix in condensed horizontal format, spread over two tables

The addition of Area and Price in the Telecommunications Services Offering matrix in condensed horizontal format, requires a separate table, which is depicted in Figure 4-10.

	Telecommunications Services Offering matrix Totals	
	Total Area	Total Price
Country X	11	9
Country Y	17	10
Country Z	12	10

Figure 4-10; Telecommunications Services Offering matrix totals

4.5 Summary

Most international organizations use various telecommunications services for their networks. A survey was done to determine what network managers considered the most important telecommunications services and aspects of the telecommunications services. The set of available services in a country is called the

Telecommunications Services Offering.

Telecommunications Services Offering may vary significantly between countries. Six services listed in the network managers survey as most important were selected to become part of the Telecommunications Services Offering matrix on one axis and the two aspects listed in the network managers survey as the most important (Area of availability and Price of telecommunications services) were chosen to become part of the matrix on the other axis, so a comparison between countries can be made in a Telecommunications Services Offering matrix. The matrix will be used to compare the countries when the relationship between Telecommunications Services Offering and Cost-effective Management will be examined. The next step is to model the output parameter Cost-effective Management in a quantitative way, which we will do in chapter 5.

5 Cost-effective Management

In the following paragraphs we will develop an approach that allows us to quantify the output parameter Cost-effective Management. We will address a methodology that can determine Cost-effective Management, such that it can be quantified in any network. Paragraph 5.1 gives an overview of Cost-effective Management. Paragraph 5.2 addresses Cost relative to size of the network. Paragraph 5.3 addresses the performance of the network and how to measure that and finally paragraph 5.4 shows the total calculation for Cost-effective Management.

5.1 Overview of Cost-effective Management

As explained in paragraph 1.5, the research question asks for a qualitative relationship³⁴ between the input parameters and output parameter, but in order to establish a qualitative relationship, quantitative research is used, that will allow us to use statistical analysis to help assess qualitative relationships between input parameters and output parameter. Measuring the output parameter Cost-effective Management in a quantitative way is necessary for use in the statistical analysis. Cost effective Management can be calculated for the complete network or for a part of the network e.g. the part in a particular country. As with the input parameters, the output parameter is used primarily per country in this research. The main problem with measuring Cost-effective Management is the lack of established methods to measure it. Most of the formulas in this chapter are based on taking several pieces of literature and combining them into one measurement methodology. Developing a methodology requires finding a balance between the accuracy of a measurement and the ease of application of the methodology. In order to make a start, first a definition of Cost-effective Management should be established.

Cost-effective Management is defined here as: *the degree to which the performance of the network fulfills the requirements of the users.*

Requirements of the users consist of e.g. performance indicators, size of the network and costs of the network. With help of the definition, Cost-effective Management can thus be split in the following principles, which we call *Cost-effectiveness principles*: (shown graphically in Figure 5-1)

- Cost relative to size of the network.
- Performance of the network (vs. required performance by the users in SLAs)

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³⁴ An example of a Qualitative relationship: Cost-effective management increases as costs of the telecommunications services used decrease

Figure 5-1; Cost-effectiveness principles as basis for Cost-effective Management

Cost relative to size of the network will be worked out and is further addressed in paragraph 5.2 and performance of the network will be covered in paragraph 5.3.

5.2 Cost relative to size of the network

Cost relative to size of the network is a Cost-effectiveness principle that, as the name suggests, is built of the measurements *cost of the network* and *size of the network*. We will analyze this, using as much as possible existing, universally applicable theories.

The measurement cost of the network is calculated with the Cost of Ownership model of Treacy [Treacy 1989], described and refined in literature [Eekeren 1996][Kind1996]. The measurement *size of the network* is measured in terms of the number of nodes, links or the total capacity of the links. An explanation of the Cost of Ownership model will be provided in paragraph 5.2.1. Paragraph 5.2.2 addresses the size of the network and paragraph 5.2.3 relates the cost of the network to the size of the network.

5.2.1 The Cost of Ownership model

The Cost of Ownership model (COO model) is developed by Treacy at the Index Group [Treacy1989][Looijen1998] and has shown its value for doing calculations on costs of information systems and networks. Cost calculations can be useful in various situations, such as for requesting proposals from suppliers, comparing alternative deployment options and for budgeting network projects.

A few basic steps have to be taken before the COO model can be applied. In particular the *demarcation* of the network should be done. The demarcation can be a source of ambiguities if not properly defined before the Cost of Ownership model is applied. For instance, the nodes of the network contain equipment (such as computers, routers and servers) that could either be considered part of the network or could be considered as peripheral equipment to the network. A personal computer (PC), for instance, contains a network adapter card, which could be considered part of the network, but the additional equipment in the PC, such as sound cards and hard disk, could be considered separate and not part of the network, depending on the chosen demarcation.

The Cost of Ownership model uses 3 sorts of costs:

- Hardware and software costs
- Personnel costs
- External facilities costs

Hardware and software costs are lumped together in one sort of costs, because in practice, there is a vanishing difference between hard- and software from a perspective of functionality. A particular functionality can often be implemented either in hardware or software. Hardware and software costs includes e.g. cabling, network equipment, servers. Personnel costs includes cost related to personnel, e.g. administrative cost, as well as costs for personnel for network operations. The External facilities costs include telecommunications services purchased from telecommunications operators, such as leased lines as well as costs paid for other, outsourced, services. Hardware and Software costs are split in the COO model in purchasing cost and maintenance cost and purchasing cost are then spread over a certain period, which is usually 5 years in form of depreciation.

When cost is calculated for individual countries, the cost of centrally located management that can be attributed to certain countries, is allocated to the countries and added to the cost of the management in the country.

	Costs of Ownership (In thousands of US\$ per year)			
	Hardware and software costs (1)	Personnel costs (2)	External facilities costs (3)	Total costs (1)+(2)+(3)
Country X	5	23	43	71
Country Y	4	32	23	59
Country Z	7	45	12	64

Figure 5-2; Example of use of the Cost of Ownership model

The Cost of Ownership model, shown in Figure 5-2 is calculated using the cost data for hardware/software related to the network (includes depreciation and maintenance), personnel cost and actual cost of the external facilities, such as leased lines.

5.2.2 Determining the size of the network

No standard method for determining the size of a network has been found in literature. It is possible to use the number of nodes or the number of links or the total capacity of the links to determine the size of the network. In this research, we have chosen to determine the size of the network as the *sum of total capacity of all links in the network or in the part of the network that is selected in a demarcation*.

The use of the measurement of size in terms of capacity of the links makes that all services are included in that measurement. Some service use more capacity of a link than others, but the capacity used by a service is usually in relation to its functionality. For instance, a 2 Mbps leased line uses much more capacity than a 64kbps leased line, but this is compensated by the fact that it also offers more functionality. For example, a 2Mbps leased line can be used to make more than 30 simultaneous phone conversations, whereas a 64kbps leased line allows only one simultaneous phone conversation.

5.2.3 Determining the Cost relative to size of the network

The Cost of Ownership can be related to size, by dividing the size of the network by the cost. In the example this results in the overview of Figure 5-3. It is also possible to relate the cost to size by using the reciprocal value, dividing cost by the size of the network. But in our total calculation for Cost-effective Management, the size-divided-by-cost representation of cost relative to size of the network is chosen because we prefer that a higher number indicates more Cost-effective Management and a lower number indicates less Cost-effective Management.

Country	Size of the network (1) (kbps)	Cost of Ownership (2) (US\$/year)	Cost relative to size of the network (1)/(2) (kbps/US\$/year)
Country X	3456	71	48.7
Country Y	883	59	14.9
Country Z	2880	64	45

Figure 5-3; Cost relative to size of the network

Figure 5-2 and Figure 5-3 may also be combined in one figure by creating one figure with multiple columns.

5.3 Performance of the network

The second Cost-effectiveness principle *Performance of the network* is measured with performance indicators, that are listed in the SLA or, if there is no SLA available, indicators that are measured and reported to the users [McGee1996].

When an SLA is available, performance indicators are usually specified and tracked and the required values as specified by the users in the SLA as well.

Performance indicators that are associated with required values can be expressed in a percentage value that shows to what extent the performance indicator meets or exceeds the requirements in the SLA. If no required level is available, because e.g. there is no SLA, the performance indicator value itself can be used. The performance indicator should be used in such a way that a higher numeric value of the indicator means a higher level of performance. Therefore, if the performance

indicator number is lower when a higher level of performance is measured, the reciprocal value of the performance indicator should be used instead. Such a performance indicator we will call an *inverse* performance indicator.

Research has been done on how to measure the performance of a Public Switched Telephone Network (PSTN) [Cole1991], usually by a regulatory body, often with help of a research institute, with the purpose of determining that the effects of competition in telecommunications stay within previously set boundaries. For example; the regulatory body monitors that calls to emergency services should not be blocked more than an agreed percentage of the time.

Xavier [Xavier1996] has shown several indicators that are being used in Australia. Examples are: *Percentage of calls not completed on the PSTN*, *Percentage of faults that are cleared within 24 hours*, *Availability of itemised billing*, *Quality of transmission of mobile telecommunications on the GSM network*.

User surveys for evaluation of performance of the network

User surveys are a method that can be used to evaluate performance of the network. The user survey asks questions on performance of the network, which users can answer by showing their opinion on a scale e.g. ranging from 1 to 5. An example of a survey in industry is Data Comms *Annual User Survey of international service providers* [Heywood1997]. This survey focuses on telecommunications operators and Value Added Service Providers and performance indicators to meet their installation dates, minimize outages and report and repair faults. The survey also asks users to rank the importance of the categories, so the weighted average result of the survey can actually give some idea of the level of satisfaction of the network services users.

Indicators from management systems for evaluation of performance of the network

Management systems are information systems that are used to support the activities of managing a network. Management systems can for instance keep track of the status of network elements and register when a network element becomes unavailable, a situation that is often indicated when the network element is down. As management systems register the time that a network element is down, they can also calculate the number of users that is affected and for what length of time. Registration of such information is a way to obtain performance indicators.

5.4 Calculating the Cost-effective Management of the network

The approach described here for calculating the Cost-effective Management is shown in a chart depicted in Figure 5-4. Using the numbers from the Cost relative to size of the network calculation and from the performance of the network together, we can assess Cost-effective Management of a network. In the case studies of this research, Cost-effective Management of a network is also measured

on a per-country or a per-region basis. Therefore information on cost, size and performance of the network needs to be available on a per-country or per-region basis, depending on how detailed the analysis of Cost-effective Management should be.

Figure 5-4; Measuring cost -effective management

Since it is easiest to work with one number to express Cost-effective Management in practice, a pro-forma formula was invented, such as shown in formula 5-1.

$$\text{Cost - effective Management} = \frac{\text{Performance of the network}}{\text{Cost of Ownership} / \text{Size of the network}}$$

(formula 5-1)

However, care must be taken not to interpret the outcome of the formula for Cost-effective Management as an absolute number that can be compared between networks, but rather as an indication of relative cost-effectiveness, given that all of the other circumstances are equal. With use of a mathematical rule, the formula 5-1 equals to the formula for Cost-effective Management in simplified format (formula 5-2), which provides for easier calculation from the numbers in the earlier paragraphs.

$$\text{Cost effective Management} = \text{Performance of the network} * \frac{\text{Size of the network}}{\text{Cost of Ownership}}$$

(formula 5-2)

When the SLA describes multiple performance indicators to measure Performance of the network, also multiple Cost-effective management calculations will be necessary. Due to the nature of performance indicators, they can often not simply be added or combined into one single number. There may be different ways to combine different performance indicators in one number, but this is outside of the scope of this research. If multiple performance indicators are used or asked for by the users of the network, we will therefore do separate calculations for each of the performance indicators.

5.5 Summary

Even though there is a lot of literature on Cost-effective Management and measuring performance of a network, there is little theory that provides actual measuring methods that are easy to apply. This chapter developed a formula for calculating an estimate of Cost-effective Management. Using an existing model for determining cost of a network, the Cost of Ownership model, cost of a network can be calculated and related to the size of the network, which results in the cost relative to size of the network. This is one of the two defined cost-effectiveness principles that together are defined to make up Cost-effective Management. The other cost-effectiveness principle is performance of the network, which is preferably expressed with help of an SLA between the organization that manages the network and the users of the network. The SLA shows which performance indicator(s) should be used in the calculations for Cost-effective Management. The result is a series of numbers that indicate Cost-effective Management for a particular country or region that the numbers were based on.

In chapter 6, step 6 of the research methodology will be covered. We will apply the input parameters Regulatory Environment, the Telecommunications Services Offering of the countries in which the network operates and the output parameter Cost-effective Management in an explorative case, according to step 6 of the methodology, listed in chapter 6.

6 Explorative case

Step 6 of the research methodology is an explorative case. After having modeled the input parameter Regulatory Environment in chapter 3, the input parameter Telecommunications Services Offering in chapter 4 and the output parameter Cost-effective Management in chapter 5, an explorative case is done to determine how applying the models works in practice. The explorative case also provides a source of ideas for the Cost-effective Management model in step 7 of the research methodology and generates experiences in practice on what other international particularities managing an international network can involve. The chapter is organized as follows: Paragraph 6.1 gives an overview of the explorative case for which the input parameters and output parameter are calculated and experiences with the calculation formulated. Paragraph 6.2 shows the experiences in practice on International Particularities that were encountered in the explorative case. Conclusions are drawn in paragraph 6.3.

6.1 *AT&T Network Systems / Lucent Technologies*

According to Yin, an explorative case study does not need to have a proposition but it does need a purpose and unit of analysis [Yin1984]. Here the purpose is to discover what issues are important in practice with the application of the Regulatory Environment Model and Telecommunications Services Offering matrix of step 3 and 4 as described in chapters 3 and 4. The unit of analysis is a particular organization, which was at the time of the explorative case study a business unit of AT&T, called AT&T Network systems. After 1996, the organization split from AT&T is called Lucent Technologies.

AT&T is an international telecommunications company that has its headquarters in New York, NY, USA. The company employs about 120.000 people world-wide and has sales of \$ 50 Billion annually.

The main products of AT&T are telecommunications services of all kinds. The main products of Lucent Technologies are: telecommunications switching systems for public and private use, long-distance transmission systems, network management systems, wireless systems, micro-electronic components and consumer products, such as telephones and answering machines. We will refer to the organization that we researched as AT&T Network systems/Lucent Technologies.

The international network plays a role in processes for development, manufacturing and sales of these products in the different countries in which the company operates. The international network is a network spanning the world, with management represented in several countries.

Various services are being delivered over the international network, such as electronic mail, file transfer (including Internet and Intranet traffic), and terminal session traffic.

The following subparagraphs will give an overview of the network and an assessment of the entries in both models that we use as input for the Cost-effective Management model.

6.1.1 Overview of the network

The international network is operational in 42 countries. It covers the majority of the countries in which the company operates. The other countries may be connected by means of dial-up connections with modems over regular phone lines, or not have data connection at all.

International services offering

The services that are provided by the AT&T Network systems/Lucent Technologies international network, are listed here with the corresponding Service Value Level in Figure 6-1.

<i>Service Value Level</i>	<i>Services</i>	<i>Locations</i>
VALUE ADDED SERVICES	E-Mail Internet Access	All locations All locations
BASIC DATA TRANSFER SERVICES	TCP/IP Asynchronous terminal session traffic	All locations All locations
INFRASTRUCTURE SERVICES	Not available	

Figure 6-1; International services of the AT&T Network Systems/Lucent Technologies international network

Lay-out of the network

The network is built up in 3 layers, which are called backbone (5 nodes), concentrator (16 nodes) and endpoints (105 nodes). The nodes of the backbone are in the following locations: Hong Kong, Allentown (Pennsylvania USA), Denver (Colorado USA), Indian Hill (Illinois USA), Hilversum (The Netherlands). The concentrator nodes are each connected to one of the backbone nodes as shown in Figure 6-2.

Figure 6-2; Backbone and concentrator nodes of the international network

Figure 6-3 gives a more detailed description of the backbone and concentrator nodes and the links between them.

Locations of the concentrator nodes	Connected with backbone node	Capacity (kbps)	Region
Sydney (Australia)	Hong Kong	128	Asia
Shanghai (China)	Hong Kong	64	Asia
Beijing (China)	Hong Kong	128	Asia
Singapore	Allentown	307	Asia
Tokyo (Japan)	Hong Kong	256	Asia
Munich (Germany)	Hilversum	64	Europe
Malmesbury (UK)	Hilversum	512	Europe
Hilversum (The Netherlands)	Allentown	1024	Europe
Hilversum (The Netherlands)	Allentown	1024	Europe
Nuremberg (Germany)	Hilversum	512	Europe
Plessis (France)	Hilversum	128	Europe
Bydgoszcz (Poland)	Hilversum	256	Europe
Madrid (Spain)	Hilversum	384	Europe
Reynosa (Mexico)	Denver	128	Americas
Lima (Peru)	Denver	64	Americas
Caracas (Venezuela)	Denver	64	Americas
Zafiro (Mexico)	Denver	128	Americas
Allentown-Indian Hill-Denver ring	3 times 1024 kbps	3072	Americas
TOTAL		8243	

Americas = North America, Central America and South America

Figure 6-3; Links between the concentrator and backbone nodes

Demarcation of explorative case research

The backbone nodes handle the most traffic and have the most connected links in the network. As this is an explorative case, we do a first assessment using just a limited number of countries. The three countries in which the backbone nodes lie are chosen as for application of the Regulatory Environment model and Telecommunications Services Offering matrix.

Evolution of the network

Every description of a network is only a momentary description and is bound to change regularly [vanHemmen1997]. The fast evolution of the network in terms of capabilities, number of nodes and type of equipment in the network surprised us. This resulted in the recommendation to assemble all information for the input parameters in a very short timeframe. As a reference for the impact of changes over a longer period, some important changes in the network during the year from 1995 to 1996 are listed in Figure 6-4.³⁵

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³⁵ Also, Lucent Technologies was spun off from AT&T in that period, but that event in itself did not influence the network being examined, because in case of the year 1995, the network was separated in one business unit as well.

Changes in the international network between June 1995 and December 1996	
June 1995	December 1996
Not all international links encrypted	All international links encrypted
Backbone all leased lines	Backbone all Frame Relay connections
Voice and Data transported completely separately	Voice and Data integrated on the higher speed links. Lower speed links are still separate for voice and data services
Much asynchronous terminal traffic and little TCP/IP	Mostly TCP/IP services and little asynchronous traffic
Low volume data transfer over leased lines	Low volume data transfer over ISDN
Number of international links: 39	Number of international links: 67
Total number of links: 76	Total number of links: 114

Figure 6-4; Evolution of the network between 1995 and 1996

Management of the network

Studying management of the network is a way to explore if a Cost-effective Management indicator can be used at all and it can also be a way to learn some of the International Particularities that are applicable to using an international network. Knowing International Particularities can help establishing checklists for use when an organization is expanding its network in a new country. See also paragraph 6.2 for a list of International Particularities encountered in this explorative case. Management of the international network is done from the network management centres. Two network management centres have been established in the following locations:

- Maitland (Florida USA)
- Hilversum (The Netherlands)

and a third centre is going to be established in Singapore. The organization currently responsible for management of the network does not see it as a necessity to manage the network from the same location as where a backbone node is present. The choice for these locations was made on basis of availability of telecommunications services, availability of trained people and locations in convenient time zones.

Three network management centres are used to adequately follow the sun [Ananthanpillai 1997], which means that the network most often has a group of telecommunications operators with a dayshift that can provide their full attention to problems. Apart from that, the network management centres are still manned 24 hours a day with basic operations staff right now, in order to maintain a high service level for the total network.

The follow the sun principle does not cover the world completely; Singapore is 5-6 hours ahead of continental Europe, depending on daylight savings time, and Maitland is 6 hours behind continental Europe, so there is a 2 hour overlap between business days. Some areas in the world such as Hawaii, dont have the coverage of a fully staffed network management centre during all of their business day, but have to operate during 4 hours a day with partly staffed network management centre at their disposal. Follow the sun also requires that trouble tickets have to be handed off to the centre located in the time zone where the time is earlier in the day if the problems were not solved during the working day of the centre that handled the trouble ticket.

6.1.2 Organization of network management

The organization that manages the international network, the Global Network Services Center (GNSC), reports to the Chief Information Officer (CIO) of the company and has the structure as depicted in Figure 6-5.

Figure 6-5; Organization of network management for the international network

The functions of network management (Configuration management, Performance management, Security management, Accounting management and Fault management) are all represented in the GNSC organization. Physically, the organization is spread around the world, exchanging information between the people in the organizations primarily by means of electronic mail.

6.1.3 Regulatory Environment of the countries

In this paragraph, the model of the Regulatory Environment is applied to the situation of the explorative case of the international network.

The Regulatory Environment of the countries of the in the demarcation of the network are determined on the basis of publications, particularly in the journals on telecommunications policy³⁶ and the descriptions of the legal situations of countries in reports of consulting companies such as Analysys (www.analysys.co.uk) and Eurodata (www.eurodata.com). For these three countries, there is also a good source of information on the Internet, which gives possibility to access up-to-date information directly from consultants, the regulatory body or ministry of communications. Figure 6-6 gives an overview of the situation of the Legal Framework for competition in the selected countries.

	Legal Framework for competition						
	<i>Value Added Services</i>		<i>Basic Data Transfer Services</i>		<i>Infrastructure Services</i>		<i>TOTAL Legal Framework for competition</i>
	Code	Score	Code	Score	Code	Score	Total score
USA	C	3	C	3	C	3	9
Hong Kong	C	3	C	3	M	1	7
The Netherlands	C	3	C	3	D	2	8

Figure 6-6; The Legal Framework for competition element of the Regulatory Environment

Figure 6-7 gives an overview of the status of the regulations of the Regulatory Body of the selected countries. For the country USA, the sources for filling in the matrix were primarily the FCC website (www.fcc.gov). For the country Hong Kong, similar information was found on www.oftel.hk and the information on the Netherlands on www.opta.nl.

³⁶ Journals such as Telecommunications Policy and Global Telephony; see references.

Regulatory Body						
Categories (point scores)	USA		Hong Kong		The Netherlands	
		To- tal		To- tal		To- tal
1. Independence/Enforcement power						
1a. Regulatory Body independence	(2)		(2)		(1)	
1b. Does Regulatory Body have enforcement power?	Y (1)	3	N (0)	2	Y (1)	2
2. Licensing process						
Licensing process is:						
• Short	N (0)		N (0)		Y (1)	
• Transparent	Y (1)		Y (1)		Y (1)	
• Non-discriminatory	N (0)	1	N (0)	1	Y (1)	3
3. Equal access to network infrastructure						
A new telecommunications operator is allowed to:						
• Build network infrastructure	Y (1)		Y (1)		Y (1)	
• Have access to network of a dominant (bottleneck) telecommunications operator	Y (1)		Y (1)		Y (1)	
• Require mandatory co-location from a dominant telecommunications operator	Y (0)	2	Y (1)	3	N (0)	2
4. Price of interconnection						
Access charges are:						
• Cost-justified	Y (1)		Y (0)		Y (1)	
• Published	Y (1)		Y (1)		Y (1)	
• Non-discriminatory	Y (1)	3	Y (1)	2	Y (1)	3
5. Fair competition						
a. Price regulations	Price caps (1)		No (2)		Price caps (1)	
b. Universal Service	Y (1)	2	N (0)	2	Y (1)	2
6. Number portability						
Number portability mandatory	Y (3)	3	N (0)	0	N (0)	0
TOTAL Regulatory Body		14		10		12

Figure 6-7; The Regulatory Body element of the Regulatory Environment

Figure 6-8 gives an overview of the Competition active element, with the appropriate scores. Counting the number of competitors is done with help of official publications of the Regulatory Body, or, if official publications are not available, with help of market research documents from consultants.

	Competition active						
	<i>Value Added Services</i>		<i>Basic Data Transfer Services</i>		<i>Infrastructure Services</i>		<i>TOTAL</i>
	Number	Score	Number	Score	Number	Score	
USA	> 2	3	>2	3	> 2	3	9
Hong Kong	> 2	3	>2	3	0	0	6
The Netherlands	> 2	3	0	0	0	0	3

Figure 6-8; The Competition active element of the Regulatory Environment

All the input parameters in the models in this explorative case is provided as of July 1996.

6.1.4 Telecommunications Services Offering in the countries

For assembly of the data, research by Eurodata and Analysys were used. The H, M and L designations have been chosen on the basis of comparison of a typical mix of usage and monthly subscription prices.

Figure 6-9, the Telecommunications Services Offering matrix, shows the Telecommunications Services Offering for the selected countries, spread over two tables.

	Telecommunications Services Offering matrix														
	VPN					ISDN					PSTN				
	A	S	P	S	Total VPN	A	S	P	S	Total ISDN	A	S	P	S	Total PSTN
USA	+	3	M	2	5	-	1	M	2	4	+	3	M	2	5
Hong Kong	0	2	M	2	4	+	3	H	1	4	+	3	H	1	4
The Netherlands	o	2	H	1	3	+	3	L	3	6	+	3	L	3	6

	Telecommunications Services Offering matrix														
	Leased Lines 64 Kbps					Leased Lines 2 Mbps					PSDN				
	A	S	P	S	Total	A	S	P	S	Total	A	S	P	S	Total PSDN
USA	+	3	L	3	6	+	3	L	3	6	+	3	L	3	6
Hong Kong	+	3	H	1	4	+	3	H	1	4	+	3	M	2	5
The Netherlands	+	3	M	2	5	+	3	M	2	5	o	2	M	2	4

Legend:

Area = Area of availability, Price = Price of telecommunications services

Area

Price

+ = >80%

L =the lowest 20%

o = 20%-80%

M =the middle group

- = < 20%

H =the highest 20%

Figure 6-9; Telecommunications Services Offering matrix for the selected countries (Spread over two tables)

Figure 6-10 shows the totals of Area and Price of the Telecommunications Services Offering matrix in a separate figure.

	Telecommunications Services Offering matrix Totals	
	Total Area	Total Price
USA	16	15
Hong Kong	17	8
The Netherlands	16	13

Figure 6-10; Telecommunications Services Offering matrix totals

6.1.5 Total scores for the input parameters

Now all the input parameters for the chosen countries of this network have been filled out, the total scores of the countries can be calculated by adding all numbers per column and listing the totals on the bottom row. The bottom row of the Telecommunications Services Offering matrix then shows the total score for each country for Area of availability and Price of telecommunications services, as well as the sum of the Area of availability and Price of telecommunications services. Figure 6-11 shows a summary of all scores of the input parameters of the explorative case.

	Input parameters						
	Legal framework for competition (1)	Regulatory Body (2)	Competition active (3)	Total Regulatory environment (1) + (2) + (3)	Area of availability (4)	Price (5)	Total Telecommunications Services Offering (4) + (5)
USA	9	16	9	34	16	15	31
Hong Kong	7	9	7	23	17	8	25
The Netherlands	8	12	5	25	16	13	29

Figure 6-11; Summary of the scores of the input parameters

6.1.6 Cost-effective Management of the network

The number of people in each department and the activities of the department is essential as an input for the Cost-Of-Ownership model to measure the output parameter: Cost-effective Management³⁷. Interviews with people in the various departments in the GNMC revealed details as to how many people were assigned to and sometimes physically working in a particular region. The cost of personnel was then calculated per region using US\$60k as average cost per person per year. All information is current as of the date of the case study (July 1996).

	Costs of Ownership (In thousands of US\$ per year)			
	Hardware-software costs (1)	Personnel costs (2)	External facilities costs (3)	Total costs (1)+(2)+(3)
USA	3200	4560	192	7952
Hong Kong	1500	1440	1324	4264
The Netherlands	2300	1620	3168	7088

Figure 6-12; Cost of Ownership

³⁷ It turned out that activities of different people were not tracked. Detailed tracking of the activities of personnel can give a good idea of the cost of management activities.

The total Cost of Ownership (shown in Figure 6-12) was calculated using actual cost data for hardware/software related to the network (includes depreciation and maintenance) and actual cost of the external facilities (leased lines).

The Size of the network was determined and Cost relative to size of the network was calculated, by dividing the Size of the network by the Cost of Ownership as explained in paragraph 5.2. This results in the overview of Figure 6-13.

	Size of the network (1) (kbps)	Cost of Ownership (2) (kUS\$/year)	Cost relative to size of the network (1)/(2) (kbps/kUS\$/year)
USA	3456	7952	0.436
Hong Kong	883	4264	0.207
The Netherlands	2880	7088	0.406

Figure 6-13; Cost relative to size of the network

After calculating Cost relative to size of the network, the formula for Cost-effective Management describes a calculation with performance indicators. It turned out to be difficult to choose the performance indicators. In total, five performance indicators were tracked by the network management organization. The indicators were: *Network faults per 1000 nodes*, *Mean Time to Repair*, *Rate of unsuccessful changes in the network relative to the total number of changes*, *On-time completion of provisioning* and *Utilization of the network*. A problem was that these performance indicators were not available for the regions or countries individually, but were only tracked for the complete network. Also, there was no SLA between the network management organization and the users of the network. Due to the lack of an SLA, it was not certain that the five performance indicators that were tracked, were actually the indicators that are most important for the users of the network. This leads to the conclusion that it is necessary that the indicators should be tracked regularly on a per-country or per-region basis. If there is no SLA, at least a confirmation should be obtained that the performance indicators that are tracked are relevant for the users. This can for instance be done by means of a survey.

6.2 International particularities in practice

As addressed in paragraph 1.4, international particularities found in literature [Liebmann1995] were of various nature and many of them were not exclusively tied to a country. They did, however, provoke interest in other particularities. Furthermore, knowledge on international particularities is essential for a network manager that has the task of expanding a network internationally. They could e.g. be included in a checklist that an international organization may use for the expansion of a network into a new country. The explorative case gives a practical situation in which international particularities are found. Interviews with the people that manage the network were used to generate the list of international

particularities in this paragraph. The particularities are organized using the functional areas of network management.

International particularities and functional areas of network management

This paragraph uses the activities of the system management functional areas, a part of the OSI Management Framework that is explained in paragraph 1.7.3. There are several different interpretations of what activities are part of the functional areas. We use a description by Terplan [1992] to clarify the activities of the functional areas. The particularities differ also in their reason for being a particularity. We identify three categories of reasons. The categories are:

- Country
- Language
- Telecommunications operator
- Other reason

In brackets, the category of particularity is denoted by a C (reason for particularity is the different Country) if it is actually dependent on the country. Two other categories depicted here are L (reason for particularity is the different Language), T (reason for particularity is the different Telecommunications operator) or O (reason particularity is for Other differences).

Configuration management carries out middle and long range activities for controlling physical, electrical and logical inventories, maintaining vendor files and trouble tickets, supporting provisioning and order processing defining and supervising SLAs; ongoing changes and distributing software .

International particularities for Configuration management

- SLAs are governed by different legal regulations in the countries (C); this is country dependent, because legal regulations are usually applicable for a particular country.
- Some services to be delivered to other parties or to the Real System (arrow B and C in the Network management paradigm; see paragraph 1.7) cannot be of adequate quality and should therefore not be performed. Example: Provide only store-and-forward services in countries with lower quality Basic Data Transfer services (T); this is dependent on the operator in the country that offers the services.
- Internet domain name (for electronic mail) addresses should be standardized (C); every country has a standard for Internet domain name addresses, usually supervised by an Internet domain name supervising body.

Fault management is a collection of tasks required to dynamically maintain the network service levels.

These tasks ensure high availability of computing resources by pinpointing problems and performance degradation quickly and by initiating controlling functions when necessary, which may include diagnosis, repair, testing, recovery and back-up.

International particularities for Fault management

- Information for surveillance of the status of a link should be carried on a link separate from the link that transports the information (T); this is dependent on the operator, as different operators will have different policies on transport of information for surveillance of status.
- Information regarding the status of the network, including trouble tickets should be multilingual in some countries (L); depends on what languages are commonly used in the country, or what language(s) the international organization has chosen to use.
- Help desks should be available during the users working hours [Bishop1996], due to time zone differences (O) and the celebration of different holidays in different countries (C); depends on the country in case of holidays and mostly on the country for time zones, however in some countries multiple time zones exist. Examples of countries with multiple time zones are: Russia with 11 time zones and the United States with 4 time zones.
- Help desk employees should have the language skills to support everybody in the Real System (L); depends on the languages that are used in the Real System.
- If we use standard equipment throughout the network; equipment suppliers don't always support a particular type of equipment in every country (C); equipment suppliers usually choose a country as an area for marketing, aiming their support organizations and advertising for use throughout a country, and usually not across international borders.

Performance management is a set of activities required to continuously evaluate the principal performance indicators of network operation, to verify how service levels are maintained, to identify actual and potential bottlenecks to establish and report on trends for management decision making and planning.

International particularities for Performance management

- Use of performance indicators should be defined such that performance can be measured across borders. (T); performance indicators are related to the operator(s) providing the service. An example of performance indicators:
  - Availability of agreed bandwidth
  - Quality of the connection (also called line transmission quality)
  - Outage time (also called Mean Time to Repair)
- Compression effects come into play as international links are compressed because of high costs. This introduces extra *propagation delay* in the transport of information that can have a service deteriorating effect on certain

applications. For example propagation delay for applications such as terminal sessions and for voice transmission should be below 150 milliseconds, so compression possibilities are limited for those applications. (T); it is common to compress information on international links and not to compress information on domestic links, but it is entirely a decision of the operator or group of operators that are providing the service.

Security management is the ongoing protection of network and its components such as the protection against entering the network, accessing an application and transferring information in a network. It includes:

- protecting network management tools by analyzing risks and minimizing risks
- developing and implementing a network security plan
- monitoring results of the network security plan

International particularities for Security management

- When multiple telecommunications operators are suppliers of services, this introduces extra risks of fraudulent entry into the international network (T); depends on the telecommunications operator that delivers the services and if it uses multiple operators at a lower level in the Service Value Model.
- Different legal systems in countries have different possibilities for prosecuting (and thus deterring) criminal activities on an international network (C); depends on the country, as laws are usually applicable in a country.
In some countries, slight differences in laws exist between states or provinces, but on this subject, if there are laws governing the security of an international network, most countries have laws that are applicable in the whole country.
- Determination in which country the crime is committed is important for criminal law, but may be difficult due to the international nature of the network. In most countries the criminal law states that in principle the criminal law is applicable of the country in which the criminal activity has been conducted. If the physical location of the activity is not clear, this introduces extra difficulties in pursuing legal action. It may even be possible that the activity was conducted from a country where the activity is not considered illegal (C); depends on the country as this is tied to the laws of a country.
- Encryption of information is illegal in certain countries. For reasons of control, some countries prohibit the sending of encrypted information across networks (C); depends on the country as this is tied to the laws of the country.
- Encryption algorithms may not be exported to certain countries. In particular the United States Department of Defense has mandated that only certain types of encryption algorithms may be exported outside of the United States. Depending on the country where the encryption algorithm is exported to, the encryption algorithm may have a certain level of security against cracking (C); depends on the country to which the encryption algorithms are exported.

Accounting management is the process of collecting interpreting and reporting costing and charging-oriented information on resource usage. In particular, processing of accounting records, bill verification and charge-back procedures

International particularities for Accounting management

- Identification of cost components is necessary per country for fiscal authorities of the country and local assets that are part of the international network should be booked on local balance sheets and on local income statements. (C); depends on the accounting principles that are applicable in the country and on the tax system of the country, which is usually governed by laws and therefore specific for the country.
- Splitting of bills has to be done with right local currency for each of the countries. This is also for the identification of the cost components as mentioned in the previous point (C); depends usually on the country, as different countries usually have different currency, even though some countries have a common currency.

Conclusions on international particularities

The explorative case shows that international particularities do exist, albeit that some of the international particularities are not just caused by the fact that a link crosses an international border, but may also exist regardless of the existence of a country border. Many of the international particularities have only been discovered recently, as networks have started to become more and more international, as explained in the trends in paragraph 1.2. As one may encounter any of these (and more) international particularities when expanding a network internationally, attention should be given to these international particularities and procedures should be developed to handle them.

A few observations from the study of international particularities in this explorative case are:

- International particularities that are dependent on language come into play in particular in fault management activities.
- Performance management particularities are mostly caused by the difference in telecommunications operator.

Since this is data based on an explorative case, combined with literature research, conclusions may not be universally applicable, but may for instance be used as a basis for development of a checklist. The checklist contains items that could be important to review and that can support the expansion of a network in a new country.

6.3 Summary and conclusions from the explorative case

The Regulatory Environment, Telecommunications Services Offering and the formula for Cost-effective Management, described chapters 3, 4 and 5, were applied in the international network of AT&T Network systems/Lucent Technologies. The explorative case shows that applying and entering numbers in

the Regulatory Environment model and the Telecommunications Services Offering matrix is generally feasible, but in specific situations, the data may not be available. Because of the high speed of evolution of the network, the recommendation was made to gather information for filling out the Regulatory Environment model and the Telecommunications Services Offering matrix in a very short time window. The Cost-effective Management (output parameter) was only in part calculated. Even though capacity and cost information was available on a per-country basis or per-region basis, the performance indicators were not tracked on a country or region specific basis and the Cost-effective Management calculation could therefore not be fully completed. This led to recommendations to improve the measurement of performance indicators. An other conclusion is that the use of time by employees of the organization be tracked per activity of support people in the network management department and that the tracking of indicators be studied in order to ascertain tracking of country-specific performance information. In the next step in the research methodology, step 7, which concerns the development of a Cost-effective Management model is described in chapter 7.

7 The Cost-effective Management model

Step 7 of the research methodology is the development of a Cost-effective Management model, which is addressed in this chapter. First, however, the position of a Cost-effective Management model should be clear in terms of the process theory. After having determined Input and Output in step 3 through 5 of the research methodology, we consider the Process, which takes place between Input and Output as depicted in Figure 7-1.

Figure 7-1; Cost-effective Management model: determining the Process between Input and Output

The Process between Input and Output, expressed respectively with input parameters and an output parameter is considered in terms of relationships, as mentioned in the research question. Those relationships and their expression in a Cost-effective Management model are the main subject of this chapter

We will address the requirements for a Cost-effective Management model in paragraph 7.1, after which we will show a proposal for a Cost-effective Management model and we discuss the various ways to test it, based on propositions in paragraph 7.2. Paragraph 7.3 explains propositions with help of heuristics and paragraph 7.4 addresses a possible testing method through statistical analysis.

7.1 Requirements for a Cost-effective Management model

There are various requirements for a Cost-effective Management model. Apart from the fact that it should help answer the research question and thus help to show the relationships between input parameters and output parameter, the model should also be easy to apply. Applying it should require only a reasonable amount of time, such that it can adequately help to support the answering of the *strategic questions* mentioned in paragraph 1.3 when applied on a daily basis in practical situations.

The *Regulatory Environment model*, combined with the *Telecommunications Services Offering matrix* form the input parameters of the Cost-effective Management model. The output parameter of the Cost-effective Management model is *Cost-effective Management*. Both the input parameters and the output parameter have been modeled and described in step 3 of the research methodology. Figure 7-2 depicts the input parameters, process and output parameter in a conceptual view, which, with relationships added, that detail the process, would form the Cost-effective Management model.

Figure 7-2; Conceptual view of the input parameters, process and output parameter

The arrows marked relationship show the relationships that we are seeking to describe in order to answer the research question. However, in order to learn more detail of the relationships, we consider the use of *propositions*. A proposition is described in literature as *a statement about the causal connections between abstract concepts* [Knoke 1991]. The abstract concepts translate into the input parameters and the output parameter. The causal connections are the relationships.

7.2 Propositions for the Cost-effective Management model

As explained, propositions are statements about the relationships between input parameters and output parameter. In order to develop propositions, we analyze the input parameters. Models for the input parameter Regulatory Environment and

Telecommunications Services Offering have been developed in step 3 , 4 and 5 of the research methodology, in such a way that they represent higher scores when one of the following situations is applicable in a country, as supported by the description of the Regulatory Environment in paragraph 3.4:

- Legal Framework for competition shows a relatively high number of Service Value Levels in which competition is allowed.
- Regulatory Body shows a relatively high number of categories with high scores, which means that relatively many measures to promote good competition have been implemented.
- Competition active shows a relatively high number of competitors actually competing with services in various Service Value Levels.

Literature [Noam1997] [Frieden1995] leads us to the suggestion that when the situations mentioned above are applicable in a country and thus the score for the Regulatory Environment is relatively high, relatively good conditions have been created for organizations to manage their networks in that country. Cost-effective Management has been defined such that a relatively high score for Cost-effective Management would represent one or more of the following situations:

- the Cost of Ownership the network is relatively low.
- the size of the network is relatively large.
- the performance of the network is relatively high.

As a result, we formulate a Proposition that ties a high score for the Regulatory Environment, to a high score for Cost-effective Management:

Proposition 1

An increase in the score of the Regulatory Environment in a country results in an increase of Cost-effective Management of the network in that country.

A similar approach can be taken for the input parameter Telecommunications Services Offering, as described in paragraph 4.4. A high score in the Telecommunications Services Offering matrix indicates one of the following situations:

- *Area of availability* shows a relatively large area of the country where relatively many telecommunications services are available.
- *Price of telecommunications services* shows a relatively low price for telecommunications services in the country.

No literature has been found that gives suggestion for the influence of the Telecommunications Services Offering on Cost-effective Management, but the presence of cost of external facilities in the Cost of Ownership model generates a suggestion. The explorative case suggests that a considerable part of the cost of external facilities is made up of telecommunications services, purchased from telecommunications operators. When Price of telecommunications services increases, which is shown by a *lower* score in the Telecommunications Services Offering matrix, the cost of external facilities increases, resulting in a higher Cost of Ownership, which results in a lower score of Cost-effective Management, as supported in paragraph 5.4. Likewise an increasing score for Price of telecommunications services could result in an increasing score of Cost-effective Management.

We therefore have obtained a suggestion to formulate a Proposition that ties an increase in the score for the Telecommunications Services Offering, to an increase in score for Cost-effective Management, as shown in Proposition 2:

Proposition 2

An increase in the score of the Telecommunications Services Offering in a country results in an increase of Cost-effective Management of the network in that country.

Using the Propositions for further research

We will explore two methods to assess the propositions. The first method is by using heuristics, here called Heuristic Intermediate Factors to help explain the relationship. Heuristic Intermediate Factors do not use calculations or process quantified information but rather use reasoning and relations obtained from literature. This method is addressed in paragraph 7.3.

The second method to learn about the relationships is to do a statistical analysis as shown in paragraph 7.4. A statistical analysis uses quantified information from the input parameters as calculated in the Regulatory Environment model and the Telecommunications Services Offering matrix of case studies.

7.3 Propositions explained with heuristics

Each of the propositions shown in paragraph 7.2 is examined and possibly explained with heuristics. This means that heuristics are used to find a reasoning that confirms the relationship. For proposition 1, Heuristic Intermediate Factors are used as help. Heuristic Intermediate Factors (HIF) are ideas that help bridge the mental gap between input parameters and the output parameter when thinking about the relationships.

7.3.1 Explanation of Proposition 1

Proposition 1 relates the Regulatory Environment in a country to Cost-effective Management. This relationship can be explained by introducing two HIFs. The first HIF shows a relationship between the Regulatory environment and innovation, as well as between innovation and Cost-effective Management. The HIF (HIF1) is expressed as listed below.

Regulatory Environment *relates to* innovation and innovation *relates to* Cost-effective Management (Proposition 1, HIF 1)

The first HIF assumes that Regulatory Environment relates to Innovation, which relates to Cost-effective Management. Both Regulatory Environment and Cost-effective Management are terms that are defined, but innovation should still be defined. The way HIF 1 is formulated, it consists of two statements: one concerning the relationship between Regulatory Environment and Innovation and one concerning the relationship between Innovation and Cost-effective Management.

As described in chapter 3, the score of the Regulatory Environment is higher, if there is more competition allowed. Van Cuilenburg and Slaa [1995] have showed the relationship to be: *the more competition allowed, the more innovation*. The literature makes a difference between various kinds of innovation and mentions in particular the product innovation, which means more choice of services³⁸. This shows the likelihood of the first half of HIF1.

As more innovation includes that there is more choice of services, then this is expected to result in lower cost of managing the network, as more services become available to choose from for purchase. The cost of services that are purchased for the network can be found in the COO model under external facilities and are shown in the explorative case to be a considerable part of the Cost of Ownership of an international network. Lower cost in the COO model, results in higher scores for Cost-effective Management, according to the formula for Cost-effective Management of paragraph 5.4.

There is a second reason why HIF 1 could be explained, which is a researched relationship between the Regulatory Environment and a performance indicator, often marked in literature as named Quality of service. In order to explain the

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³⁸ Van Cuilenburg and Slaa examine two different kinds of innovation: Process innovation is more of the same (just a lower price); Product innovation means the creation of new products that did not exist before

second reason, we need a measurement of *Quality of service* [Frieden1996] [Cole1991]. For example: a few common performance indicators for PSTN services are: *system response time or speed of dial tone*, *the number of trouble reports compared to the number of users* and *call completion*. The indicators differ according to the type of service. The overviews of Frieden and of Cole show that three to four years after a change in the Regulatory Environment that resulted in more competitors for each of the telecommunications services, there was a measurable improvement in quality of service³⁹. These indicators are used for investigation of a relationship between the Regulatory Environment and the performance of the network. A higher performance of the network filled in in the formula of Cost-effective Management of paragraph 5.4 means that Cost-effective Management of the network increases.

In order to create an explanation that is as thorough as possible, a second HIF (HIF2) was generated, that uses Price of telecommunications services. HIF2 can be stated as follows:

Regulatory Environment *relates to* Price of telecommunications services and Price of telecommunications services *relates to* Cost-effective Management (Proposition 1, HIF 2)

HIF 2 concerns the relationship between the Regulatory Environment and Price of services as well as the relationship between Price of telecommunications services and Cost-effective Management. Research of the OECD [1995] compared several countries telecommunications services prices and showed that more competition (which is a higher score in the Regulatory Environment model) means lower prices for telecommunications services. Figure 7-3 gives an overview of the changes in prices for telecommunications services in 15 OECD countries compared to the year 1990. Prices in competitive environments turn out to be lower than in non-competitive environments.

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³⁹ The performance indicator Quality of service in the study of Cole is expressed in transmission quality, average PSTN dial tone delay, percentage of service orders completed on-time, percentage of calls completed, customer perception surveys [Cole 1991] p. 261.

Figure 7-3; Comparison of telecommunications prices in a competitive and non-competitive environments [OECD1997]

Lower prices of telecommunications services can result in a higher score of Cost-effective Management, because prices of telecommunications services are represented in the Cost of Ownership model and therefore in the calculation of Cost-effective Management.

7.3.2 Explanation of Proposition 2

Proposition 2 relates the Telecommunications Services Offering in a country to Cost-effective-Management. Proposition 2 can be split in two statements that each form one half of the proposition, one regarding Area of availability and one regarding Price of telecommunications services. The relationships of these two statements are explained in this paragraph. The explanation could be made without help of HIFs.

Area of availability relates to Cost-effective Management (First half of Proposition 2)

The first half of proposition 2 relates the Area of availability to Cost-effective Management. The Area of availability of services is expected to correlate with the Cost-effective Management of the international network. The type of influence is dependent on what type of service the network should perform for its users. In order to explain the expected influence, we view the network with the services it performs and the services it purchases in the value chain [Porter1998] as explained in paragraph 1.7.2 and depicted again in Figure 7-4.

Figure 7-4; Telecommunications services in the international network value chain.

Figure 7-5 shows an example of how availability of services to be purchased, may influence Cost-effective Management. The middle and left columns show services that can be purchased to perform services in the right column. The Basic Data Transfer service that is shown in the left column is the less expensive service that can be purchased that can be used in order to perform the Value Added Service in the right column. If that Basic Data Transfer service is not available in a part of the country, a more expensive service, such as shown in the middle column will have to be purchased.

Services purchased		Services performed
More Cost-effective when these Basic Data Transfer services are available for purchase. (Less expensive services)	Less Cost-effective when these Basic Data Transfer services are available for purchase (More expensive services)	
Leased lines (if volume of voice services is high)	Public Switched Telecom Network (PSTN)	Voice services between nodes in a network
Packet Switched Data Network (PSDN)	Leased lines	Terminal connections
ISDN or Frame Relay	Leased lines	File Transfer Services
Frame Relay or ATM	Leased lines	High volume file transfer

Figure 7-5; Example of Influence of Area of availability on Cost-effective Management

An additional insight is that with help of overviews like in Figure 7-5 it is possible to improve Cost-effective Management of the network by selecting the service to be purchased for the delivery of a service by the international organization.

Price of telecommunications services *relates to* Cost-effective Management (Proposition 2)

Secondarily, the second half of Proposition 2 concerns the relationship between Price of telecommunications services and Cost-effective Management. The

assumption that Price of telecommunications services has influence on Cost-effective Management of the network, is shown in the definition of Cost-effective Management and the Cost-of -Ownership model in paragraph 5.4 and is therefore trivial.

7.3.3 Total explanation with heuristics

The Cost-effective Management model with HIFs is shown in Figure 7-6. A dotted arrow shows the expected correlation. A complete relationship between input parameter, Heuristic Intermediate Factor and output parameter is identified by HIF 1 and HIF2.

Correlation can be a positive relationship or a inverse relationship. In other words, when, e.g. *innovation* (HIF 1) increases, Cost-effective Management increases, denotes a *positive* relationship, when Cost-effective Management increases.

Figure 7-6; The Cost-effective Management model

It is possible to explain the propositions with heuristics, however, the heuristics can per definition not accept a proposition as true and there may be other situations that give results that could contradict the assumed propositions.

Heuristics, however, may lead us to a better understanding of what may influence the Cost-effective Management and therefore can show relationships. The statistical research goes a step further and gives the possibility to analyze the individual

elements of the input parameter and help further understand possible relationships between input parameters and the output parameter. However, before getting into statistical analysis we have to realize the following constraints.

- The values chosen for the models of the Regulatory Environment and the Telecommunications Services Offering are starting values and were chosen using general qualitative knowledge from literature and experience. Scores that were determined are therefore nominal scores and cannot be used for detailed statistical analysis
- Cases with relatively few data points will be used, which limits the significance of the outcome of the statistical analysis

7.4 Propositions tested with statistics in the cases

The second method to test the propositions is a statistical analysis of the relationships between the Regulatory Environment model and Telecommunications Services Offering matrix on one hand and the Cost-effective Management of the network on the other hand. The method using statistics also goes a step further than the method with heuristics, since it looks at the individual elements of the Regulatory Framework and Telecommunications Services Offering.

A statistical method that assesses the relationship between two series of data points is called regression analysis. Regression analysis shows the likelihood of a relationship between input variable(s) and an output variable. Regression analysis can be applied with single input variables or with multiple input variables, but the amount of calculations increases rapidly when many input variables are used. The result of the regression analysis is a series of *statistical indicators* that give an indication of how the input parameters and output parameter could be related. Regression analysis does not result in statements with 100% certainty about the relations and, just like with heuristics, cannot be used to accept the propositions of paragraph 7.2, but can only strengthen our confidence of the relationships if the propositions do not get rejected. Chapter 8 will show a detailed overview of the approach of the cases.

7.5 Summary

The *Cost-effective Management model* as developed in this chapter intends to describe the Process, which takes place between Input and Output, exemplified by the input parameter and output parameter respectively. The Process is expressed in relationships between the input parameters and output parameter.

Two *propositions* were developed that show assumptions on the relationships. Two methods are proposed to assess the validity of the propositions. One method is with heuristics, which gave a high-level explanation why the propositions might be applicable. For the high-level explanation, so called Heuristic Intermediate Factors were used. The first method strengthened the confidence in the

propositions. This led to decision to analyze the models in further detail and do case studies in the second method.

The second method assesses the relationships between all elements of the input parameters and the output parameter with statistical analysis. The method of statistical analysis that will be used is Regression analysis. Cases will be studied and detailed quantitative information on cases will be obtained for the Regression analysis in chapter 8, after which the actual statistical analysis will be done in chapter 9.

8 Description of the test cases

Step 8 of the research methodology consists of carrying out two test cases. The purpose of the test cases, hereafter called the cases is to test the heuristically found qualitative relationships between the input parameters Regulatory Environment in the country and Telecommunications Services Offering in the country and the output parameter , Cost-effective Management of the network. First we will address the requirements for the cases in paragraph 8.1, after which the two test cases follow in paragraph 8.2 and paragraph 8.3. As a recapitulation, the propositions are formulated and that the cases seek to support are depicted below.

Proposition 1

An increase in the score of the Regulatory Environment in a country results in an increase of Cost-effective Management of the network in that country.

Proposition 2

An increase in the score of the Telecommunications Services Offering in a country results in an increase of Cost-effective Management of the network in that country.

As the propositions call for an examination of the scores on a per-country basis, one of the requirements for the cases will be that the input parameters and output parameter are discernable on a per country basis. Further requirements are developed in paragraph 8.1.

8.1 Requirements, activities and description of the cases

The following four requirements for cases were formulated before the cases were chosen. Cases should:

1. Each concern an organization that operates in a different industry.
2. Have a considerable number of countries, such that the statistical analysis can be done with confidence. A minimum number of 5 countries is assumed for our cases.
3. Have a stable network environment that does not change drastically within the time frame of observation. As many measurements are taken over a period of time, rather than as a snapshot, it is necessary that there are no big changes in network or the managing organization in the observation period.
4. Operate in countries where data on the input parameters Regulatory Environment and Telecommunications Services Offering is available.

Two organizations were chosen that fulfill the requirements and were also willing to provide the detailed information needed for a case study.

The Calvin Klein Cosmetics Company (CKCC) is a commercial organization in the cosmetics industry, that manufactures, markets and sells cosmetics. CKCC is based in 7 countries. The United Nations Development Programme (UNDP) is an international governmental organization that is based in 143 countries. Figure 8-1

gives an overview of both case organizations regarding fulfillment of the requirements.

Requirement	CKCC	UNDP
Industry	Commercial organization in cosmetics industry	International governmental organization
Number of countries of organization	7	143
Stable network environment	Yes	Yes
Operates in countries where data is available for input parameters	Yes	Yes

Figure 8-1; Case organizations and fulfillment of requirements

With the case study organizations selected, we start the process of the carrying out the case study and then describing it. Therefore a series of activities was established that support a systematic approach to the case studies.

The flow of activities for the cases is shown graphically in Figure 8-2.

Figure 8-2; Flow of the activities for the cases

The people interviewed were network managers and managers of the Information Technology departments. Experience has shown that several interviews are necessary to get the adequate information and often the performance information has to be calculated from system reports.

The information from the answers to the questions of both the questionnaire and the interviews is then combined with separate research on country data and entered in Regulatory Environment model and Telecommunications Services Offering matrix and the Cost of Ownership model and the scores were analyzed with statistics.

Activity 1

Choose people in the case organization. After identifying the organizations that fulfill the requirements for the cases, people that are working in the organization need to be selected to provide us with information. A start can be to contact the

Chief Information Officer (CIO) of the organization or the person responsible for management of the network. That person can then identify which other people are necessary to provide information.

Activity 2

Develop and send out a questionnaire, that precedes the interviews with the people selected in activity 1, with the purpose to obtain as much information needed in the cases as possible and to guide the interview process. Also the questionnaire can help make the selected people in the organisation aware what questions are asked from them and should prompt them to assemble the right information, reports or colleagues, in order to be able to answer in an interview any unanswered questions from the questionnaire.

Figure 8-3 shows the questionnaire and the purpose of the questions in the questionnaire.

Question	Purpose
What is the primary process of the international organization?	Used to determine if performance indicators used in the network are relevant.
Which services does the network deliver/what applications does it support?	Used to check if cases are comparable.
In which countries is the international network located?	Used as basis for the scoring of the Regulatory Environment model and Telecommunications Services Offering matrix.
What is the topology? (links, nodes, capacities)	Used to determine the size of the network; essential for Cost-effective Management.
What is the content of the SLA or any other established objectives? (indicators and benchmark values) if applicable	Used to determine the reference levels of the indicators.
To what extent are the performance indicators in the SLA being attained? (what are values of the performance indicators?)	Used to calculate Cost-effective Management.

Figure 8-3; Questions of the questionnaire and purpose of each of the questions

Activity 3

Make an overview of network and goals of the organization. In this activity, a total overview of the network is made. This is done both to understand the organization better, so the importance of the network for the organization to obtain its goals can be judged, as well as to assemble information about the network that will be needed in the calculation of cost-effective management. This activity also should include a

demarcation of the network in the study, in case that not the complete network can be studied.

Activity 4

Match interview subject and the people as a preparation for the interview. The preparation helps to ascertain that the right people are interviewed and that the right subjects are asked of the particular individuals.

Activity 5

Conduct interviews and fine-tune information from the interviews. Interviews should bring all the required information on the network and management. With help of the interviews, the answers to the questionnaire can be completed and quantitative information of the case study assembled for the calculations in activity 6.

Activity 6

Determine the data per country for filling in the Regulatory Environment model, the Telecommunications Services Offering matrix and for the calculation of Cost-effective Management.

The Regulatory Environment model and Telecommunications Services Offering matrix are filled with data from consultant reports, or if not available, by contacting a regulatory body or government organization in the countries. The calculations are then made as described in chapter 3 and 4.

For the calculation of Cost-effective Management, the model indicated in paragraph 5.4 will be applied in the case study in order to calculate Cost-effective Management. Below is the formula of Cost-effective Management (formula 5-2) as described.

$$\text{Cost effective Management} = \text{Performance of the network} * \frac{\text{Size of the network}}{\text{Cost of Ownership}}$$

Cost of Ownership, Size of the network and Performance of the network are the measurements that need to be assembled in the cases. Cost of Ownership is calculated using cost information obtained in the questionnaire and interviews for each of the countries. The Size of the network is measured by taking the totals of the capacity of the links for each of the countries in the case. As described in paragraph 5.3, for Performance of the network, performance indicators are assembled, preferably based on the content of an SLA, or if not present, we may also use requirements expressed by users in the interviews.

After the six activities are carried out, the case is described and the data can be analyzed statistically, which will be done in chapter 9.

In the following paragraphs, the cases will be described. The CKCC case study in paragraph 8.2 and the UNDP case study in paragraph 8.3. The description of the cases within these paragraphs will have the following structure:

1. Overview of the network.
  - International services offering, including services offered to the users of the network and the locations.
  - Lay-out of the network, shown in a graphical format with the capacities of the links.
  - Demarcation of the case research, including a list of countries that is chosen for analysis.
2. Organization of network management, showing primarily the size and location of the organization that is responsible for managing the network.
3. Regulatory Environment of the countries, showing the Regulatory Environment scored in the Regulatory Environment model.
4. Telecommunications Services Offering of the countries, showing the Telecommunications Services offering in the matrix.
5. Total scores for the input parameters, showing a summary of the scores for the Regulatory Environment and the Telecommunications Services Offering.
6. Cost-effective Management of the network, including:
  - Cost of Ownership.
  - Cost relative to size of the network.
  - Performance of the network.
  - Cost-effective Management calculations.

With this structure, the CKCC case study will be described in paragraph 8.2 and the UNDP case study will be described in paragraph 8.3.

8.2 Case 1; Calvin Klein Cosmetics Company (CKCC)

Calvin Klein Cosmetics Company (CKCC) is a 100% daughter company of Unilever North America and manufactures, distributes and sells cosmetics, fragrances and personal care products and is co-marketed with the clothing brand of Calvin Klein all over the world. The organization for manufacturing and distribution is in North America and Europe. CKCC has an international network with about 1000 users.

8.2.1 Overview of the network

International services offering

The CKCC international network is primarily a network that performs data services. In particular, the connections between the United States headquarters and the affiliate offices in Europe carry exclusively data. A number of Value Added Services are available on the network. Value Added services are *electronic mail applications* (cc Mail), *groupware applications* (Lotus Notes) and both *Internet* and *Intranet* access through the backbone network of the parent company Unilever. Typically, the network is also used for exchanging transactional information in Electronic Data Interchange (EDI). At the Basic Data Transfer Services Value Level, the services performed for the users are: TCP/IP⁴⁰ File Transfer and terminal session connections over leased lines.

The network exists exclusively of leased lines and ISDN connections used as a back up to the leased lines. The only addition to the network is the T-1 (1.544Mbps) connections between Mount Olive and New York. Figure 8-4 presents the services used on the international network of CKCC in the Service Value Model (services in the middle column and the locations where they are available in the right column).

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⁴⁰ TCP/IP (Transaction Control Protocol/Internet Protocol) is a packet switched data protocol, commonly used in the Internet and Intranets.

Service Value Level	Services	Locations
VALUE ADDED SERVICES	Voice Public Switched Telecom Network (PSTN)	All locations
	E-Mail	All locations
	Internet Access	All locations
	International Integrated Services Digital Network (ISDN)	All locations
BASIC DATA TRANSFER SERVICES	TCP/IP	All locations
	International leased lines:	All locations
INFRASTRUCTURE SERVICES		Not available

Figure 8-4; Services on the international network of Calvin Klein Cosmetics Company

The leased line bandwidth is generally 64 Kbps, with the exception of the connections to from U.S. to Germany and U.S. to Canada which have a bandwidth of 56 Kbps.

Lay-Out of the CKCC international network

The companys international network covers North America and Europe. The main hub is located in Paris, France where Calvin Klein facilities are located on the premises of France TØIØcom. The network backbone consists in two 64 Kbps leased lines between the main hub in France and a smaller hub in Mount Olive, New Jersey.

The hub in Paris, France establishes links to the manufacturing and distribution facilities with 2 nodes in Evreux (France) and connections to the rest of the affiliate offices in Neuilly-sur-Seine (France), Wiesbaden (Germany), Milan (Italy), Barcelona (Spain), and London (United Kingdom). Similarly, the US hub in New Jersey connects with the offices in Toronto (Canada) and the headquarters in New York City. The connection between Mount Olive and New York City is a T-1 connection, that has a capacity of 1.544 Mbps. Figure 8-5 shows a graphical overview of CKCCs international network.

Figure 8-5; Graphical overview of the international network of CKCC

The network's e-mail service is used by approximately 800 e-mail account holders approximately 25 users per country office, 400 users in Mount Olive and 200 users in New York. The e-mail application uses TCP/IP file transfer as Basic Data Transport service, which is switched by 11 routers in the nodes that are connected with the international leased lines.

Demarcation of the case research

As demarcation of the network in the case, the total network of CKCC is chosen. The number of countries that the network is located in (seven), is manageable for analysis and taking the complete network makes it easier to obtain performance indicators.

8.2.2 Organization of network management

The organization of network management of CKCC is located in Mount Olive, New Jersey. There are three people directly involved in the management of the international network. The staff responsible for information technology management in *country offices* do not directly monitor network performance, but signals problems with international lines to the network management center in the United States that functions 24 hours a day, 7 days a week.

France TØIØcom has been contracted by CKCC to perform maintenance on pieces of equipment on the international network of CKCC. France TØIØcom is also responsible for the equipment used to back up the leased lines in the European affiliate offices. On these sections, France TØIØcom performs functions of network management and collects a series of performance indicators.

8.2.3 Regulatory Environment of the countries

As the demarcation of the case study includes all the countries of the international network of CKCC, the countries to be examined are: Canada, France, Germany, Italy, Spain, United Kingdom and the United States. All scores were determined in July 1997.

The scores of the Regulatory Environment are calculated and presented. These include:

- *Legal Framework for competition* (Figure 8-6)
- *Regulatory Body* (Figure 8-7)
- *Competition active* (Figure 8-8)

	Legal Framework for competition						
	<i>Value Added Services</i>		<i>Basic Data Transfer Services</i>		<i>Infrastructure Services</i>		<i>TOTAL Legal Framework for competition</i>
	Code	Score	Code	Score	Code	Score	
Canada	C	3	C	3	C	3	9
France	C	3	C	3	PC	2	8
Germany	C	3	C	3	PC	2	8
Italy	C	3	M	0	PC	2	5
Spain	C	3	PC	2	PC	2	7
United Kingdom	C	3	C	3	C	3	9
USA	C	3	C	3	C	3	9

M = Monopoly = 0 point

D = Duopoly = 1 point

PC = Partial Competition = 2 points

C = Competition = 3 points

Figure 8-6; The Legal Framework for competition of countries in the CKCC network

	Regulatory Body							TOTAL Regulatory Body score
	1. Inde- pendence/ Enforcem ent power	2. Licen- sing process	3. Equal Access to network Infrastruct ure	4. Price of intercon- nection	5. Fair competition regulations		6. Number portability	
					Price Regu- lations	Universal Service		
Canada	3	2	2	1	0	1	0	9
France	3	3	3	2	0	0	0	11
Germany	2	2	3	1	0	0	0	8
Italy	2	2	0	2	0	0	0	6
Spain	2	2	2	0	0	0	0	6
United Kingdom	3	3	1	1	1	0	3	12
USA	3	3	2	3	1	1	3	16

For scoring legend, see paragraph 3.2, where a description of the Regulatory Body is given.

Figure 8-7; The Regulatory Body of the countries in the CKCC network

	Competition active						
	Value Added Services		Basic Data Transfer Services		Infrastructure Services		TOTAL Competition active
	Number	Score	Number	Score	Number	Score	
Canada	> 2	3	> 2	3	> 2	3	9
France	> 2	3	> 2	3	> 2	3	9
Germany	> 2	3	> 2	3	> 2	3	9
Italy	> 2	3	0	0	> 2	3	6
Spain	> 2	3	> 2	3	> 2	3	9
United Kingdom	> 2	3	> 2	3	> 2	3	9
USA	> 2	3	> 2	3	> 2	3	9

Figure 8-8; The Competition active of the countries in the CKCC network

8.2.4 Telecommunications Services Offering in the countries

The selected countries were then examined, so the Telecommunications Services Offering matrix could be made as represented in Figure 8-9 and Figure 8-10. Codes to read the table are available in the legend. The total on each row, for each

country, is added up and shown in Figure 8-11, to give a total overview of the Telecommunications Services Offering.

	Telecommunications Services Offering matrix														
	VPN					ISDN					PSTN				
	A	S	P	S	Total VPN	A	S	P	S	Total ISDN	A	S	P	S	Total PSTN
Canada	+	3	L	3	6	-	1	M	2	4	+	3	M	2	5
France	o	2	M	2	4	+	3	M	2	5	+	3	M	2	5
Germany	o	2	M	2	4	+	3	M	2	5	+	3	M	2	5
Italy	o	2	M	2	4	+	3	M	2	5	+	3	M	2	5
Spain	o	2	M	2	4	o	2	M	2	4	+	3	M	2	5
UK	+	3	L	3	6	+	3	L	3	6	+	3	L	3	6
USA	+	3	M	2	5	-	1	M	2	4	+	3	M	2	5

Figure 8-9; Telecommunications Services Offering matrix for countries of the CKCC network (VPN, ISDN and PSTN services)

	Telecommunications Services Offering matrix														
	Leased Lines 64 Kbps					Leased Lines 2 Mbps					PSDN				
	A	S	P	S	Total	A	S	P	S	Total	A	S	P	S	Total PSDN
Canada	+	3	M	2	5	+	3	M	2	5	+	3	M	2	5
France	+	3	M	2	5	+	3	M	2	5	-	1	M	2	4
Germany	+	3	M	2	5	+	3	M	2	5	+	3	H	1	4
Italy	+	3	M	2	5	+	3	H	1	4	-	1	M	2	4
Spain	+	3	M	2	5	o	2	M	2	4	o	2	H	1	3
UK	+	3	M	2	5	+	3	M	2	5	+	3	L	3	6
USA	+	3	L	3	6	+	3	L	3	6	+	3	L	3	6

Legend:

A = Area of availability; P = Price of telecommunications services; S = Score

For Area of availability:

- Wide Area of availability (80-100% of populated area) = + (3 points) ;
- Limited Areas of availability (20-80% of populated area) = o (2 points);
- Little Area of availability (less than 20% of populated area) or wait over 12 months for service = - (1 point)

For Price of telecommunications services:

- Among the 20% cheapest countries = L (3 points) ;
- Not among the 20% cheapest or 20% most expensive = M (2 points);
- Among the 20% most expensive = H (1 point)

Figure 8-10; Telecommunications Services Offering matrix for countries of the CKCC network(Leased lines and PSDN services)

Figure 8-11 shows the additions of the respective Price and Area values.

Telecommunications Services Offering matrix		
Totals		
	Total Area	Total Price
Canada	16	13
France	15	12
Germany	17	11
Italy	15	11
Spain	14	11
UK	18	16
USA	16	15

Figure 8-11; Telecommunications Services Offering matrix totals

8.2.5 Total scores of the input parameters

The total scores that measure the Regulatory Environment and the Telecommunications Services Offering for the countries of the CKCC network are reproduced in Figure 8-12. The total scores for both the Regulatory Environment (fifth, shaded column) and the Telecommunications Services Offering (rightmost, shaded column) and individual column scores will be used as input data for the statistical analysis in chapter 9.

	Input Parameters						
	Legal Framework for competition (1)	Regulatory Body (2)	Competition active (3)	Total Regulatory Environment (1) + (2) + (3)	Area of availability (4)	Price (5)	Total Telecommunications Services Offering (4) + (5)
Canada	9	9	9	27	16	13	29
France	8	11	9	28	15	12	27
Germany	8	8	9	25	17	11	28
Italy	5	6	6	17	15	11	26
Spain	7	6	9	22	14	11	25
United Kingdom	9	12	9	30	18	16	34
USA	9	16	9	34	16	15	31

Figure 8-12; Summary of the scores of the input parameters

8.2.6 Cost-effective Management of the CKCC network

Cost of Ownership

Most of the costs paid by Calvin Klein Cosmetics are recurring charges such as external facilities or maintenance expenses. Capital costs such as the purchase of the network equipment are counted in the depreciation cost, although much of the equipment was purchased more than 5 years ago and is already fully depreciated.

In an overview, the costs of ownership for Calvin Klein Cosmetics Company, classified into the main categories of the COO model are:

- Hardware/software, consisting mainly of depreciation on routers in the network
- Personnel (headcount numbers were identified and industry average personnel cost were used to calculate costs)
- External facilities including in this case:
  - Rental and connection fees to several service providers for its international leased lines.
  - Outsourced services. These charges include the leasing and maintenance fees for the ISDN connections, fees paid to the Customer Support Center of France TØIØcom and maintenance costs.⁴¹

Cost relative to size of the network

Figure 8-13 is a summary of the costs incurred by each country office in the left five columns. In order to calculate the Cost relative to size of the network, the total capacity of the network in the various countries, is divided by the Cost of Ownership of the network in each of the countries as shown in the rightmost column.

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⁴¹ The costs of the international network of CKCC exclude expenses associated with the leased lines and other network equipment in place on the French facilities of Evreux, and the office in Neuilly-sur-Seine.

While the service charges associated with the leased lines are clearly identifiable as expenses linked to a specific country office, the fees that are paid for the maintenance of equipment under France TØIØcom responsibility and for the maintenance of the routers have been equally divided between the nodes based upon the type of equipment they contain.

	Costs of Ownership (In thousands of US\$ per year)				Size of network (kbps) (5)	Cost relative to size of the network (In Kbps per thousands of US\$) (5)/(4)
	Hardware/ software costs (1)	Personnel costs * (2)	External facilities costs (3)	Cost of Ownership (4)= (1)+(2)+(3)		
Canada	10.91	10	0	20.91	56	2.678
France	48.15	10	122.20	180.35	624	3.459
Germany	16.33	10	23.43	49.76	112	2.250
Italy	16.33	10	50.85	77.18	128	1.658
Spain	16.33	10	32.61	58.94	128	2.171
UK	16.33	10	22.05	48.38	128	2.645
USA	21.82	200	215.59	437.41	3272	7.480

* Personnel outside the USA is on an allocated basis. Yearly personnel costs are based on industry average in USA, source: information systems departments.

Figure 8-13; Cost of Ownership and Cost relative to size of the network

Performance of the network

As shown in paragraph 5.1, the assessment of performance of the network uses preferably an SLA (described in paragraph 1.7.1) established between the network managers and the users [McGee1996]. No written SLA was in place between the users of the network and the management of the network of Calvin Klein Cosmetics. However, some performance indicators are regularly collected for network management purposes, and targets have been set by the management team for the network management organization to monitor the level of performance on the network.

Performance indicators ⁴² that were tracked are: *Average utilization*, *Peak utilization*, *Network availability*, *Throughput time*, *Mean Time To Repair (MTTR)*, and *Number of trouble tickets per month*. Peak utilization and Number of trouble tickets per month were not used for further analysis, so four performance indicators are used in the case.

Note that the depiction of values in several decimals or numbers can create the image of accuracy that may not be justified, but the use of many decimals will avoid accumulation of rounding due to calculating with rounded numbers.

⁴² Due to the fact that the element management of the European nodes is outsourced to France TØIØcom, a number of indicators are not collected on the connection established to Canada. The statistical analysis is done with the data presently available and excludes the link to Canada from the USA.

Definitions for the performance indicators are established by CKCC as follows:

$$\text{Average utilization} = \frac{\text{Total number of bytes transported per month}}{\text{Available capacity per month}} * 100\%$$

$$\text{Peak utilization} = \frac{\text{Total number of bytes transported in busy hour}}{\text{Available capacity per hour}} * 100\%$$

$$\text{Network availability} = 100\% - \left(\frac{\text{downtime hours per month}}{720\text{hrs (month duration)}} * 100\% \right)$$

Throughput time = Average time it takes for a TCP/IP packet to travel round trip between 2 nodes

$$\text{MTTR} = \frac{\text{Down time hours per month}}{\text{Number of trouble tickets per month}}$$

$$\text{Number of trouble tickets per month} = \frac{\text{Number of trouble tickets opened in a year}}{12}$$

With the exception of *Average utilization* and *Peak utilization*, performance indicators can be directly related to cost-effective Management. For bandwidth utilization, the value of the performance indicators depends on the technology used in the network. While certain technologies allow a network to work efficiently when links are almost entirely filled, other technologies need to reserve additional links in case of a burst⁴³ in traffic.

In the case of the CKCC network, no connection is ever utilized at more than 45-50%, which leaves enough margin to handle peak demands without loss of data. Therefore, we consider that high utilization on the links is an indication of efficient use of the capacity and therefore positive. A positive relationship between bandwidth utilization and Cost-effective Management of the network can be expected. Only average utilization is used for exploring the relationships. Peak utilization is only used to verify that there is no overload in the network that could impact the quality of the data.

Cost-effective Management can be considered to increase when *availability* of the network increases and when *throughput time* decreases.

MTTR is calculated using the *Number of trouble tickets per month* and provides information on how problems and failures are managed. The interpretation for Cost-effective Management is that MTTR and Throughput time are expected to have an inverse relationship with Cost-effective Management of the network. The

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⁴³ Burst: an unexpected large amount of data that is to be transported

performance indicators used and their scores per country are presented in Figure 8-14. In Figure 8-13 the second line shows the relationship between the indicator and Cost-effective Management. Network availability, as an indicator signifies more Cost-effective Management when its value is higher and therefore has a positive relationship. MTTR, on the other hand has an inverse relationship, since a lower value means more Cost-effective Management of the network. Later the calculations will be done and the indicators with inverse relationship will be converted to ones with positive relationship by taking the reciprocal value.

	Average utilization (*1) (*2) (In %)	Network availability (*3) (*4) (In %)	Throughput time (*3) (*4) (In milliseconds)	MTTR (*5) (In hours per month per trouble ticket)
Relationship	positive	positive	inverse	inverse
Canada	26	n.a.	n.a.	n.a.
France	23.75	99.93	191	2.4767
Germany	26	99.83	200	3.7167
Italy	22	99.99	200	0.030
Spain	19	99.94	230	5.0167
UK	28	99.91	200	2.5
USA	28.5	99.99	125	1.15

Figure 8-14; Performance indicators for the CKCC network.

NB: All indicators are a yearly average of monthly indicators collected over the period from June 1996 through June 1997.

(*1) Data for Paris, France are obtained by taking an average of utilization levels on connections to European nodes, excluding the French facilities in Evreux and Neuilly-sur-Seine. Data on the utilization levels between the US and France are not available.

(*2) Data for the US are obtained by taking an average of the utilization levels on links to Canada and New York. This does not include the utilization level on the US-France connections, since the data are not available.

(*3) Data for France is an average of the indicators collected on all the connections coming in the Paris hub: this includes all leased lines with Wiesbaden, Milan, Barcelona, London, and Mount Olive. It does not include data collected on the national sections of the network such as the connections between Paris and the other French facilities in Evreux and Neuilly-sur-Seine.

(*4) Data for the United States concerns only the leased line between Mount Olive and Paris and does not include performance on the connections to Toronto and New York.

(*5) Data for France is an average of the indicators collected on all the connections coming in the Paris hub: this includes all leased lines with Wiesbaden, Milan, Barcelona, London, and Mount Olive. It does not include data collected on the national sections of the network such as the connections between Paris and the other French facilities in Evreux and Neuilly-sur-Seine.

n.a. = not available because of outsourcing to an organization that does not report these indicators.

Cost-effective Management calculations

In order to make the performance indicators comparable to one another, the indicators with an *inverse* relationship are calculated with their reciprocal value⁴⁴, such that for all performance indicators, a higher value means a better performance. The absence of SLAs made it impossible to weigh the performance indicators or even compare them with existing requirements. The performance indicators are therefore used in their existing fashion, to calculate the Cost-effective Management.

The calculation is based on the formula 5-2 of paragraph 5.4, depicted in the formula below.

$$\text{Cost effective Management} = \text{Performance of the network} * \frac{\text{Size of the network}}{\text{Cost of Ownership}}$$

The formula shows that Cost-effective Management can be calculated by taking the performance indicator, or its reciprocal value in case of inverse related performance indicators, and multiply that by the Cost relative to size of the network, which is the same as Size of the network divided by Cost of Ownership. In the CKCC case, this means the use of the Size of the network or total capacity of the links, depicted in Figure 8-5 divided by Cost-Of-Ownership data of Figure 8-13 and multiplied by the performance indicators of Figure 8-14. The resulting Cost-effective Management is gathered in Figure 8-15.

	Average utilization	Network Availability	Throughput time	MTTR
	(% * Kbps per US\$)	(% * kbps per US\$)	(1/sec.*kbps per US\$)	(1/Hours * kbps per US\$)
Canada	63	n.a.	n.a.	n.a.
France	82.2	345.7	18.11	1.40
Germany	58.5	224.6	11.25	0.61
Italy	36.5	165.8	8.29	165.80
Spain	41.2	217.0	9.44	0.43
UK	74.1	264.3	13.23	1.06
USA	213.2	747.9	59.84	6.50

n.a. = not available

Figure 8-15; Cost-effective Management of the CKCC network

⁴⁴ Reciprocal value is 1 divided by the value

Now for each country, the output parameter is to be related to the input parameters for each country of the Cost-effective Management model: the Regulatory Environment and the Telecommunications Services Offering. The relationships are tested with help of statistics, that can give us an indication of the validity of the propositions, as is shown in chapter 9.

8.3 Case 2; United Nations Development Programme (UNDP)

The United Nations Development Programme (UNDP) is an organization affiliated with the United Nations and is responsible for granting multilateral aid to developing countries. Its main objectives are to promote sustainable human development, eliminate poverty, protect the environment, create jobs and advance women in society.

The United Nations Development Programme has a network of 143 offices worldwide, and its headquarters are located in New York. The description of the case reflects the situation in May 1997.

8.3.1 Overview of the network

International services offering

The UNDP network is a network that offers data communications services such as electronic mail and Internet access (Value Added Services), and TCP/IP File Transfer between country offices (Basic Data Transfer Service). Those services use different kinds of Basic Data Transfer Services such as leased lines, PSDN and Very Small Aperture Terminal (VSAT) satellite connections. Figure 8-16 illustrates the different services available to the international network locations of the UNDP.

<i>Service Value Level</i>	<i>Services</i>	<i>Locations</i>
VALUE ADDED SERVICES	Voice Public Switched Telecom Network (PSTN)	Over 100 country offices
	E-Mail and Internet Access	Tunisia, Chile, Colombia
	International Virtual Private Network (VPN)	Not available
	International Integrated Services Digital Network (ISDN)	Not available
BASIC DATA TRANSFER SERVICES	Packet Switched Data Network (PSDN)	Netherlands, El Salvador and Malaysia
	International leased lines	Switzerland Malaysia, Bolivia, Denmark, United States
	Satellite leased line services (VSAT)	Albania, Belarus, Bulgaria, Latvia, Lithuania, Moldova, Poland
INFRASTRUCTURE SERVICES		Not available

Figure 8-16; Services on the international network of the UNDP

Lay-out of the UNDP international network

The international network of the UNDP revolves around the headquarters in New York City. All the connections are between New York and an end point or regional hub. The network of the UNDP is characterized by the existence of only two other regional hubs from which traffic gets redirected to other local country offices. Both of these hubs are operated by the telecommunications operator SITA⁴⁵, that provides data services to the UNDP, including the frame relay and the X.25 connections. SITA has two regional hubs that interconnect with the UNDP network: one is located on the East Coast of the United States in Long Island, and another one is located in the Netherlands (Batum).

⁴⁵ SITA (Societe Internationale Telecommunications Areene) is a telecommunications operator that was created to operate airline reservation systems and their terminals all over the world. SITA merged in 1998 with Equant communications.

The layout of the network has evolved as such because of two reasons: first, the existence of individual communications budgets for each country offices has meant that decisions over the type of connection were taken directly by the local offices based upon their needs and resources; second, this particular architecture has enabled the agency to isolate a problem on the network, without affecting communications of other country offices. A description of the network is shown in Figure 8-17.

Figure 8-17; Graphical overview of the international network of the UNDP

The various capacities of the main international links are described in Figure 8-18.

Link	Capacity
New York - Bolivia (leased line)	64 Kbps
New York - Denmark (leased line)	64 Kbps
New York - El Salvador	9.6 Kbps (X.25)
New York - Malaysia (leased line)	64 Kbps
Internet Connection through T-1 leased line to Country Offices	1.544 Mbps From 9.6 Kbps to 64 Kbps
New York - Malaysia (back-up to the leased line)	9.6Kbps (X.25)
New York - Switzerland	32 Kbps CIR ⁴⁶ Frame Relay
New York - The Netherlands	64 Kbps (X.25)

Figure 8-18; Capacity of the international links in the UNDP network

Demarcation of the case research

Demarcation of the case research was done by selecting a mix of countries. The selection of the countries was guided by the need to select countries where a significant amount of traffic (communication) is routed to.

We decided to select the countries with major traffic streams, due either to the importance of the UNDP office in certain countries e.g. Denmark, Switzerland, and the United States; or to the importance of the country as a hub in the network e.g. the Netherlands, and the United States. The selection led to a total of seven countries - Bolivia, Denmark, El Salvador, Malaysia, the Netherlands, Switzerland and the United States.

8.3.2 Organization of network management

The organization of network management is located in New York and is responsible for monitoring the UNDP network. The organization, which is organized in five units, some of which have an international focus, as is indicated.

- E-mail/Country Office Network Unit (international focus).
- Mainframe Access Control Unit.
- Internet Support Unit (international focus).
- LAN Information Unit.
- Telephone Unit (international focus).

All units together carry out different activities of network management, which are categorized in OSI functional areas of network management framework. Figure 8-19 presents the organization managing the network and the number of persons

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⁴⁶ CIR (Committed Information Rate) indicates a minimum rate of capacity that is guaranteed on the Frame Relay service

involved in the management of the UNDP network. A description of responsibilities is enclosed only for the units that have international focus.

Figure 8-19; UNDP Network management organization

In addition to the network management organization in New York, each UNDP country office has in average one person that is responsible for managing the network connections with the headquarters in New York. Most of the network management problems encountered by local offices, such as engineering problems, advisory or clearance services relating to network operations, are forwarded to the Network management organization in New York. SITA provides Basic Data Transfer Services as an international operator. SITA is responsible for managing the performance on the Basic Data Transfer services it delivers to the UNDP.

8.3.3 Regulatory Environment of the countries

The score of the Regulatory Environment is determined according to the Regulatory Environment model described in chapter 3.

All the information is provided as of the period January to June of 1997, which is also the period covered by the performance indicators obtained from the UNDP network management organization. Figure 8-20 shows the scores for the Legal Framework for competition of the countries.

	Legal Framework for competition						
	<i>Value Added Services</i>		<i>Basic Data Transfer Services</i>		<i>Infrastructure Services</i>		<i>TOTAL Legal Framework for competition</i>
	Code	Score	Code	Score	Code	Score	
Bolivia	M	0	M	0	M	0	0
Denmark	C	3	C	3	C	3	9
El Salvador	C	3	C	3	C	3	9
Malaysia	C	3	C	3	PC	2	8
Netherlands	C	3	C	3	PC	2	8
Switzerland	C	3	M	0	M	0	3
USA	C	3	C	3	C	3	9

Legend:

M = Monopoly = 0 point

D = Duopoly = 1 point

PC = Partial Competition = 2 points

C = Competition = 3 points

Figure 8-20; Legal Framework for competition of the countries of the UNDP network

Information about the Regulatory Body was available on the Internet for the Netherlands, United States, Switzerland and Denmark. Malaysia and El Salvador information came from local employees in the telecommunications businesses in these countries.

Figure 8-21 shows the scores for the countries for the Regulatory Body.

	Regulatory Body							TOTAL Regulatory Body score
	1. Independence/ Enforcement power	2. Licensing process	3. Equal Access to network Infrastructure	4. Price of interconnection	5. Fair competition regulations		6. Number portability	
					Price Regulations	Universal Service		
Bolivia	2	2	1	2	0	0	0	7
Denmark	2	3	2	3	1	1	0	12
El Salvador	2	3	2	2	0	0	0	9
Malaysia	2	1	1	1	0	1	0	6
Netherlands	2	3	2	3	1	1	0	12
Switzerland	0	2	0	1	2	0	0	5
USA	3	3	2	3	1	1	3	16

Figure 8-21; Regulatory Body of the countries of the UNDP network

Figure 8-22 shows the scores for Competition active in the countries.

	Competition active						
	Value Added Services		Basic Data Services		Infrastructure Services		TOTAL Competition active
	Number	Score	Number	Score	Number	Score	
Bolivia	> 2	3	0	0	0	0	3
Denmark	> 2	3	> 2	3	0	0	6
El Salvador	0	0	1	1	0	0	1
Malaysia	> 2	3	> 2	3	0	0	6
Netherlands	> 2	3	> 2	3	> 2	3	9
Switzerland	> 2	3	0	0	0	0	3
USA	> 2	3	> 2	3	> 2	3	9

Figure 8-22; Competition active of the countries of the UNDP network

8.3.4 Telecommunications Services Offering in the countries

Each country selected from the UNDP network was scored in the Telecommunications Services Offering matrix as shown in chapter 4. Scores were derived from the Tarifica [Tarifica1997] reports and OECD [OECD97] reports. These scores are presented in Figure 8-23 for VPN, ISDN and PSTN services and Figure 8-24 shows the scores for leased lines and PSDN services. The information was relatively easy to obtain, but just turned out to be more difficult for Bolivia, Malaysia and El Salvador, because of the less frequent study by the consulting firms. Having less frequent reports means that it is more difficult to find reports on all countries that report data on the same period.

	Telecommunications Services Offering matrix														
	<i>VPN</i>					<i>ISDN</i>					<i>PSTN</i>				
	A	S	P	S	Total VPN	A	S	P	S	Total ISDN	A	S	P	S	Total PSTN
Bolivia	-	1	H	1	2	-	1	H	1	2	o	2	H	1	3
Denmark	+	3	M	2	5	+	3	M	2	5	+	3	M	2	5
El Salvador	-	1	H	1	2	-	1	H	1	2	o	2	H	1	3
Malaysia	-	1	H	1	2	o	2	H	1	3	+	3	H	1	4
Netherlands	o	2	H	1	3	+	3	L	3	6	+	3	L	3	6
Switzerland	o	2	H	1	3	+	3	H	1	4	+	3	M	2	5
USA	+	3	M	2	5	-	1	M	2	4	+	3	M	2	5

Figure 8-23; Telecommunications Services Offering matrix for countries of the UNDP network (VPN, ISDN and PSTN services)

	Telecommunications Services Offering matrix														
	<i>Leased lines 64 Kbps</i>					<i>Leased lines 2 Mbps</i>					<i>PSDN</i>				
	A	S	P	S	Total VPN	A	S	P	S	Total ISDN	A	S	P	S	Total PSTN
Bolivia	o	2	H	1	3	o	2	H	1	4	-	1	H	1	1
Denmark	+	3	L	3	6	+	3	M	2	5	+	3	M	2	5
El Salvador	o	2	H	1	3	o	2	H	1	3	o	2	M	2	4
Malaysia	o	2	M	2	4	o	2	M	2	4	o	2	M	2	4
Netherlands	+	3	M	2	5	+	3	M	2	5	o	2	M	2	4
Switzerland	+	3	M	2	5	+	3	M	2	5	+	3	M	2	5
USA	+	3	L	3	6	+	3	L	3	6	+	3	L	3	6

Legend:

A = Area of availability; P = Price of telecommunications services; S = Score

For Area of availability:

- Wide Area of availability (80-100% of populated area) = + (3 points) ;
- Limited Areas (20-80% of populated area) = o (2 points);
- Little Area of availability (less than 20% of populated area) or wait over 12 months for service = - (1 point)

For Price of telecommunications services:

- Among the 20% cheapest countries = L (3 points) ;
- Not among the 20% cheapest or 20% most expensive = M (2 points);
- Among the 20% most expensive = H (1 point)

Figure 8-24; Telecommunications Services Offering matrix for countries of the UNDP network (Leased lines and PSDN services)

Figure 8-25 shows the totals of Area and Price of the Telecommunications Services Offering matrix.

	Telecommunications Services Offering matrix	
	Total Area	Total Price
Bolivia	9	6
Denmark	18	13
El Salvador	10	7
Malaysia	12	9
Netherlands	16	13
Switzerland	17	10
USA	16	15

Figure 8-25; Telecommunications Services Offering matrix totals

8.3.5 Total scores of the input parameters

The total scores of the Regulatory Environment and Telecommunications Services Offering matrix of the selected countries were compiled. Figure 8-26 shows the total scores. The scores of the Regulatory Environment and Telecommunications Services Offering matrix as a whole are shown in the shaded columns.

	Input Parameters						
	Legal Framework for competition (1)	Regulatory Body (2)	Competition active (3)	Total Regulatory Environment (1) + (2) + (3)	Area of availability (4)	Price (5)	Total Telecommunications Services Offering (4) + (5)
Bolivia	0	7	3	10	9	6	14
Denmark	9	12	6	27	18	13	31
El Salvador	9	9	1	19	10	7	17
Malaysia	8	6	6	20	12	9	21
Netherlands	8	12	9	29	16	13	29
Switzerland	3	5	3	11	17	10	27
USA	9	16	9	34	16	15	31

Figure 8-26; Summary of the scores of the input parameters of the countries of the UNDP network

8.3.6 Cost-effective Management of the UNDP network

The calculation of the output parameter Cost-effective Management of the network should be done similar to the CKCC network, but posed a complication with the tracking of performance indicators in the UNDP network as will be shown later in this paragraph.

Cost of Ownership

The categories of costs are measured in the UNDP according to the Cost of Ownership model:

- Hardware/software, consisting of: depreciation, rental and the maintenance of the equipment. The cost are relatively low for the UNDP, as most of the equipment has already been depreciated and maintenance cost are relatively low.
- Personnel, consisting of costs incurred by the New York headquarters. The headquarters does most network management tasks.
- External facilities, consisting of: leased lines for data services and voice services.

Costs relative to size of the network

The Costs of Ownership of the network for each country are now related to size of the network. Size of the UNDP network is expressed as total capacity of the links. The overview of Cost of Ownership and Cost relative to size, which equals Size of the network divided by Cost of Ownership is reproduced in Figure 8-27.

	Costs of Ownership (In thousands of US\$ per year)				Size of network (kbps) (5)	Cost relative to size of the network (In Kbps per thousands of US\$) (5)/(4)
	Hardware/ software costs (1)	Personnel costs (2)	External facilities costs (3)	Cost of Ownership (4) = (1)+(2)+(3)		
Bolivia	8	15	47.2	70.2	64	0.9803
Denmark ⁴⁷	13	15	72.3	100.3	64	0.6856
El Salvador	4	15	22.5	41.5	14.4	0.3471
Malaysia	6	15	98.5	119.5	78.4	0.6562
Netherlands	9	15	46	70	64.0	0.9143
Switzerland	7	15	41.8	63.8	32	0.5769
USA	36	820	1143.2	1999.2	1788	0.8947

Figure 8-27; Cost of Ownership and Cost relative to size of the network

Performance of the network

In the case of the UNDP network, no SLA was available and the organization did not establish internal standards to monitor the activity on the network. Only a limited amount of performance indicators was regularly collected. The type of performance indicators available were utilization indicators and a record of the incoming and outgoing email traffic for each UNDP country office.

The indicator *Average utilization* enabled the study of the link capacity and the effective level of utilization of the network connections, which we used as a performance indicator. Average utilization was the only performance indicator available for this study, while the CKCC case had four performance indicators available. Even though multiple performance indicators are preferred, this single performance indicator turned out to be adequate. Figure 8-28 shows the calculation of the Performance of the network, indicated by the performance indicator Average utilization.

⁴⁷ The leased line between New York and Copenhagen is a donation of the Danish government to the UNDP. However, in order to avoid introducing a bias in the calculations, the cost of an international leased line between Denmark and the United States was based on the tariffs published by Tele Danmark as of October 1996.

	Average utilization (1)/(2)	Total number of kbytes transported per minute (1)	Capacity of the network in kbytes per minute (2)
Relationship	positive		
Bolivia	0.066	248	3840
Denmark	0.736	2825	3840
El Salvador	0.806	387	480
Malaysia	0.139	533	3840
Netherlands	0.057	219	3840
Switzerland	0.048	184	3840
USA	0.537	48683	90597

Figure 8-28; Performance indicator for the UNDP network with on the right the calculation

Cost-effective Management calculation

Figure 8-29 shows the calculation of Cost-effective Management, by multiplying the Cost relative to size and the performance indicator Average utilization, according to the formula of Cost-effective Management.

	Cost relative to size of the network (1)	Average utilization (2)	Cost-effective Management (1)*(2)
Bolivia	0.9803	0.066	0.0647
Denmark	0.6856	0.736	0.5046
El Salvador	0.3471	0.806	0.2798
Malaysia	0.6562	0.139	0.0912
Netherlands	0.9143	0.057	0.0521
Switzerland	0.5769	0.048	0.0277
USA	0.8947	0.537	0.4805

Figure 8-29; Cost-effective Management

The output parameter Cost-effective Management has now been calculated and for each country the output parameter will be related to the input parameters in chapter 9.

Another performance indicator available was a turnaround time for e-mail traffic. On a monthly basis, the UNDP monitored the amount of time it took country offices to receive a message sent from the New York headquarters. Percentages of country offices having received the message on the same day, the following day or a number of days after were compiled. However, no numbers were recorded for the

individual turnaround time of each country office, which resulted in the decision not to use this data as a performance indicator.

8.4 Summary and Conclusions

The cases were done in two organizations, the Calvin Klein Cosmetics Company (CKCC) and the United Nations Development Programme (UNDP) according to a standardized approach, consisting of 6 activities. The use of a standardized approach with a predetermined set of activities called for preparation by selecting people in the organization, using questionnaires to get information, using interviews to complete the information and carry out the calculations of the Regulatory Framework model and Telecommunications Services matrix to obtain the input parameters. In each of the cases, a network covering 7 countries was selected and the input parameters on the two sets of 7 countries were determined. The output parameter, Cost-effective Management, was calculated after obtaining information on the networks for Cost-of-Ownership, size of the network and performance indicator of the network. The performance of the network turned out to be best calculated if an SLA is present between the users of the network and the organization managing the network. In none of the two cases, however an SLA was applicable, so performance indicators that were available were used.

In the CKCC case, the four performance indicators were used and as a result four separate calculations of Cost-effective Management were done. In the UNDP case, one performance indicator was used, resulting in one set of calculations. This availability of performance indicators turned out to be the most essential difference between the two cases and could make the statistical results of the CKCC case study more significant than the results of the UNDP case study.

Now, for each country, the output parameter is to be related to the input parameters for in the Cost-effective Management model: the Regulatory Environment and the Telecommunications Services Offering and their respective elements. The relationships are tested with help of statistics, which can give us an indication of the validity of the propositions, as is shown in chapter 9.

9 Results of the statistical analysis of the cases

Step 9 of the research methodology addresses the statistical analysis of the cases, which may show a relationship between the input parameters and output parameter. The propositions of chapter 7 are tested by doing a number of analyses. Paragraph 9.1 gives an overview of the analysis methods and statistical indicators. Paragraph 9.2 shows results for the CKCC case and paragraph 9.3 then shows the results for the UNDP case.

9.1 Statistical analysis methods and statistical indicators

In order to test the relationship between the input parameters and the output parameter, an analysis was used on the data obtained in the case studies. The analysis aims at finding a relationship between an *independent variable*, in this case the input parameter; and a *dependent variable* that is the output parameter. Each of the countries in the cases forms a set of numbers for input parameters and output parameter. We do not only analyze the total scores of Regulatory Environment and Telecommunications Services Offering as independent variables, but also scores of the individual elements or categories that make up the Regulatory Environment and Telecommunications Services Offering.

As a byproduct, the analysis can give insight in the impact of different elements of the Regulatory Environment and Telecommunications Services Offering on Cost-effective Management.

A number of regression analyses was done with different independent variables or groups of variables and the explanatory power of each of them on the output parameter was calculated. A regression analysis with one independent variable is called simple regression and a regression with multiple variables is called multiple regression. Each case study presents the results of the regressions and makes statements on the relations of the Cost-effective Management model as shown in chapter 7. Regression analysis can be explained graphically, using a chart with dots that represent the data points as shown in Figure 9-1.

The points represent combinations expressed in coordinates such as (1,20), (2,28) and (4,41). Then a line is drawn through the points to approximate the dots. The line can be straight, in which case it is called a linear regression line, or have other shapes such as logarithmic, in which case it will be called logarithmic regression line. The regression line approximates the datapoints to a certain extent, which can be expressed by statistical indicators, which essentially give a measure for the level of approximation of the data points by the regression line.

In this research, each of the dots in the graph represents a country, such as country UK. The dots are placed at the points where the x-value of the matrix equals the value of the input parameter (here Regulatory Environment) for that country (for UK it is 8). The y-value of the location of that dot represents the output parameter, Cost-effective Management, with average utilization as indicator (for part of the

network that is in the UK, the value is here 77). Dots are placed for each of the countries in the case.

Figure 9-1; Regression analysis example

Out of a common set of statistical indicators of which we selected two: the R-Square and the Correlation. We describe below how each of them can be interpreted and used.

a. R-Square

R-square, also called Coefficient of Determination, gives the percentage of total variation of the independent variable that are explained by one or a group of variables, for a simple or a multiple regression respectively. The value of R-square is between 0 and 1. It is also referred to as the *explanatory power* of the variable or group of variables used in the input.

b. Correlation

The correlation expresses the strength and the nature of the relationship between the independent and the dependent variables. Comprised between -1 and +1, it shows a strong relationship when it is a high absolute number. Thus a correlation of 0 shows no linear association between the input and the output. The negative sign indicates that when the independent variable increases, the dependent variable decreases or vice versa. The positive sign signals that the independent and the dependent variables move in the same direction. In the case of multiple regressions, the multiple correlation explains the overall strength of the relationship between all the independent variables and the dependent variable.

The statistical analysis was done on a Toshiba Tecra 7300 Pentium computer, with Microsoft Excel 97. The Tools/Data analysis function of the spreadsheet has a series of statistical analyses, among which regression analysis. Regression analysis gives several outputs, including R-square and Correlation. The rest of the output is depicted in an ANOVA (ANalysis Of VAriance) table, which includes several indicators of the variance of the regression analysis. Examples of these indicators are: lower and upper confidence limits, significance value F and the so-called t-stat. Explanation of these indicators can be found in [Knoke 1991].

Statistical analysis and the propositions

The propositions are shown here again as a reference for interpretation of the analysis.

Proposition 1

An increase in the score of the Regulatory Environment in a country results in an increase of Cost-effective Management of the network in that country.

Proposition 2

An increase in the score of the Telecommunications Services Offering in a country results in an increase of Cost-effective Management of the network in that country.

9.2 Results of statistical analysis for the CKCC case

The relationship between input parameters and the output parameter in the CKCC network was tested by doing regression analyses (regressions) for each of the input parameters, as well as for the individual elements of the input parameters. Results of the regressions are presented in Figure 9-3 and Figure 9-4.

In paragraph 8.2.6, the Cost-effective Management of CKCC was expressed in four values for each country. These are Cost-effective Management expressed in *Average utilization*, *Availability of the network*, *Throughput time* and *Mean-Time-To-Repair* (MTTR). The performance indicators have each different dimensions and are not additive or combinable into one value. So four output parameters exist that cannot be combined into one output parameter and therefore separate regression analyses are done for each of the four. The input parameters are shown summarized in Figure 9-2.

	Input parameters						
	Legal Framework for competition (1)	Regulatory Body (2)	Competition active (3)	Total Regulatory Environment (1) + (2) + (3)	Area of availability (4)	Price (5)	Total Telecommunications Services Offering (4) + (5)
Canada	9	9	9	27	16	13	29
France	8	11	9	28	15	12	27
Germany	8	8	9	25	17	11	28
Italy	5	6	6	17	15	11	26
Spain	7	6	9	22	14	11	25
United Kingdom	9	12	9	30	18	16	34
USA	9	16	9	34	16	15	31

Figure 9-2; Summary of the Input parameters of the CKCC network

Results of simple regressions

The results of the simple regressions are determined for each of the Cost-effective Management values that were used to run the regressions. Figure 9-3 shows the R-square and Correlation values for the regressions of the performance indicators Average utilization and Availability of the network. The shaded fields show a relatively high R-square and correlation of more than 0.75.

Input parameters			Relationship with the output parameter for each of the performance indicators			
			Average utilization R-Square	Average utilization Correla- tion	Availability of the network R-Square	Availability of the network Correlation
Regulatory Environment			0.64	0.80	0.63	0.79
	Legal Framework for competition		0.29	0.54	0.34	0.59
	Regulatory Body	Total Regulatory Body	0.82	0.90	0.77	0.88
		1. Independence/ enforcement power	0.32	0.57	0.40	0.63
		2. Licensing process	0.40	0.63	0.40	0.63
		3. Access to network infrastructure	0.03	0.19	0.05	0.24
		4. Price of Interconnection	0.53	0.73	0.51	0.71
		5. Fair competition regulations	0.72	0.84	0.41	0.64
		Price regulations	0.48	0.69	0.92	0.96
			Universal service	0.45	0.67	0.75
		6. Number portability	0.48	0.69	0.41	0.64
	Competition active		0.11	0.33	0.13	0.36
Telecommunications Services Offering			0.07	0.26	0.03	0.19
	Area of availability		0.03	0.18	0.00	0.08
	Price of telecommunications services		0.09	0.30	0.06	0.25

Figure 9-3; R-square and correlation values of simple regressions of Average utilization and Availability of the network in the CKCC network

The regressions for the performance indicators Average utilization and Availability of the network show a high correlation and R-Square value for the Regulatory Body, of which the category Fair competition regulations shows a significant R-square value and correlation. Other categories of the Regulatory Body also have a relatively high correlation. The Telecommunications Services Offering does not show high values of R-square and correlation for the performance indicators Average utilization and Availability of the network. Figure 9-4 shows the regression analysis for the performance indicators Throughput time and MTTR.

Input parameters			Relationship with the output parameter for each of the performance indicators			
			Throughput time R-Square	Throughput time Correlation	MTTR R-Square	MTTR Correlation
Regulatory Environment			0.91	0.95	0.50	0.71
	Legal Framework for competition		0.88	0.93	0.73	0.85
	Regulatory Body	Regulatory Body	0.82	0.90	0.20	0.45
		1. Regulatory Body independence and enforcement power	0.71	0.84	0.18	0.43
		2. Licensing process	0.71	0.84	0.18	0.43
		3. Access to network infrastructure	0.06	0.24	0.59	0.77
		4. Price of Interconnection	0.10	0.32	0.06	0.26
		5. Fair competition regulations	0.61	0.78	0.06	0.26
		Price regulations	0.74	0.86	0.08	0.29
		Universal service	0.26	0.51	0.02	0.16
		6. Number portability	0.74	0.86	0.08	0.29
Competition active		0.42	0.65	0.99	0.99	
Telecommunications Offering			0.68	0.82	0.10	0.32
	Area of availability		0.48	0.69	0.07	0.27
	Price of telecommunications services		0.67	0.81	0.10	0.32

Figure 9-4; R-square and correlation values of simple regressions of Throughput time and MTTR in the CKCC network

Regression analysis for the performance indicators Throughput time and MTTR shows a strong relationship of the Regulatory Environment with the output parameter. Of the Regulatory Environment, the element Legal Framework for competition shows strong correlation and R-square values. The Regulatory Body, also which shows a strong relationship in Figure 9-3 is strong in relationship with Throughput time, but not so much in relationship with MTTR. Regressions analyzed for different output parameters provide us with a wide variety of results that require caution when interpreting them for general conclusions. There are, however, some observations that we would like to make for further reference, They are:

- All the input parameters have a positive correlation with the output parameters, which confirms our confidence in the propositions.

- The Regulatory Environment has a stronger relationship with Cost-effective Management than the Telecommunications Services Offering has with Cost-effective Management. This is indicated by the higher R-square and Correlation values for Regulatory Environment than for Telecommunications Services Offering in Figure 9-3 and Figure 9-4.
- Out of the elements of the Regulatory Environment, the Regulatory Body shows the strongest relationship with Cost-effective Management and Legal Framework for competition is secondary, but still relatively strong. They both are depicted in a gray area in Figure 9-3 and Figure 9-4.
- Regulatory Body categories that show strong relationships are category 1; Regulatory Body independence and enforcement power, category 2; Speed and openness of the licensing process and category 5; Fair competition regulations.
- Category 4 of the Regulatory Body, Access to network infrastructure, shows the weakest relationship, with lower values for the statistical indicators.
- Out of the Telecommunications Services Offering, Price of telecommunications services shows a stronger relationship than Area of availability.

9.3 Results of statistical analysis for the UNDP case

Just like in the statistical analysis of the CKCC case, the relationship between input parameters and the output parameter in the UNDP network was tested doing statistical analysis for each of the input parameters. The input parameters are summarized again in Figure 9-5.

	Input parameters						
	Legal Framework for competition (1)	Regulatory Body (2)	Competition active (3)	Total Regulatory Environment (1) + (2) + (3)	Area of availability (4)	Price (5)	Total Telecommunications Services Offering (4) + (5)
Bolivia	0	7	3	10	9	6	14
Denmark	9	12	6	27	18	13	31
El Salvador	9	9	1	19	10	7	17
Malaysia	8	6	6	20	12	9	21
Netherlands	8	12	9	29	16	13	29
Switzerland	3	5	3	11	17	10	27
USA	9	16	9	34	16	15	31

Figure 9-5; Summary of the scores of the input parameters of the UNDP network

The output parameter, Cost-effective Management is, for this case study, based on one performance indicator, Average utilization. The results of the regressions are presented in Figure 9-6.

Input parameters			Relationship with the output parameter for each of the performance indicators		
			Average utilization R-Square	Average utilization Correlation	
Regulatory Environment			0.34	0.65	
	Legal Framework for competition		0.37	0.61	
	Regulatory Body	Regulatory Body Score	0.55	0.74	
		1. Regulatory Body independency and enforcement power	0.32	0.57	
		2. Licensing process	0.35	0.59	
		3. Access to network infrastructure	0.34	0.65	
		4. Price of Interconnection	0.39	0.62	
		5. Fair competition regulations	0.06	0.24	
			Price regulations	0.00	0.02
			Universal service	0.16	0.40
			6. Number portability	0.32	0.56
Competition active		0.06	0.25		
Telecommunications Services Offering			0.18	0.43	
	Area of availability		0.15	0.39	
	Price of telecommunications services		0.21	0.46	

Figure 9-6; Results of regression analysis of the UNDP case

The regressions that we analyzed and that are shown in Figure 9-6, show that some of the variables have a strong relationship with Cost-effective Management. However, there are no R-square values or correlations of more than 0.75, indicated by the absence of shaded cells in Figure 9-6.

The total score for Regulatory Environment, the scores for Legal Framework for competition and Regulatory Body and the categories of the Regulatory Body Access to network infrastructure and Price of interconnection have the strongest relationship with the output parameter.

Similar to the statistical analysis of the CKCC case, the analysis in this case shows that the Telecommunications Services Offering has less explanatory power than the Regulatory Environment. When taken as a total score, the Telecommunications Services Offering produces an R-square of 0.18 and a correlation of 0.43. Studied individually, Area of availability and Price of telecommunications services

respectively have R-square values of 0.18 and 0.21 with correlations of 0.39 and 0.46.

All together, even though just like with the CKCC case, the number of data points used in the case is relatively low, the values for R-square and correlation show that there is significant explanatory power, which supports the presence of a relationship between some of the input parameters and the output parameter.

Results of multiple regressions

Multiple regressions, as discussed in paragraph 9.1 perform analysis combinations of input parameters, which may result in many calculations as many combinations of input parameters are possible. As a trial, one multiple regression calculation was done for the UNDP case study. Figure 9-7 shows a multiple regression that was done using a combination of the two input parameters. The combination of the scores for Regulatory Environment and Telecommunications Services Offering, which is the combination of the two propositions, explained about 0.75 (R-square) of the output, with a correlation of 0.86, which is relatively high.

Number of input parameters	Input parameters	Relationship with the output parameter for each of the performance indicators	
		Average utilization R Square	Average utilization Correlation
2	(The propositions 1 and 2) - Regulatory Environment - Telecommunications Services Offering	0.75	0.86

Figure 9-7; Results of multiple regressions with two variables in the UNDP case

Case conclusions

As in the CKCC case, the results of the statistical analysis are based on seven countries and should be treated with care. Cases may be studied with more data points in order to get a more confident assessment. From the available results, we make the following observations:

- Regulatory Environment shows a relatively strong relationship with Cost-effective Management, Regulatory Body is the element with the strongest relationship,
- All the input parameters have a positive correlation with the output parameter, which confirms that an increasing input parameter relates to an increasing output parameter.

9.4 Summary

Analyzing two cases using statistical analysis has given us insight into possible relationships between input parameters and output parameter.

Conducting the case studies, we encountered the importance of a strict demarcation of the network to be studied. This includes establishing exactly what hardware and software is part of the network and what are e.g. to be considered peripherals. The calculation of the input parameters did not pose many difficulties, as long as consistent data sources are used. The sources should also be up-to-date to the date of the case study. Some sources, such as consulting companies, do surveys of different countries at different times of the year, which could make the data less comparable. The calculation of the output parameter posed more problems. Cost-effective Management was calculated as stated in chapter 5 using the Cost of Ownership model, but actually obtaining the performance indicators proved to be challenging. The calculation requires performance indicators, which are prescribed in an SLA. An SLA, however, was not present in any of the cases under study⁴⁸. The CKCC case study shows that the company uses four performance indicators, which the users had indicated were essential, but with no predetermined, required performance level. The performance indicators were used in the formulas exactly as they were tracked, but with calculating the reciprocal value of the indicators that have an inverse relationship with performance. Use of the four performance indicators, with no required level, made it necessary to do four individual calculations of Cost-effective Management, which resulted in four different sets of regression analyses.

In the UNDP case study, some countries proved more difficult for obtaining information on the Regulatory Environment and Telecommunications Services Offering. Only one performance indicator was used by the users, the *utilization of the network*. This resulted in one set of regression analyses.

In both cases, the correlation values are positive and therefore show all positive relationships, which strengthens us in our confidence in the propositions.

R-Square and correlation values of 0.75 or more, were considered to show strong relationships and in particular in the CKCC case study, several of these strong relationships appeared.

The score for the Regulatory Body and in particular several categories of the Regulatory Body show particularly high R-square and correlation. The categories are Regulatory Body independence and enforcement power, Speed and openness of the licensing process and Fair competition regulations. We should, however, caution the interpretation of these results, as they based on a limited sample.

Further research, as addressed in step 10 of the research methodology, depicted in chapter 10, may be done in this area to develop a more detailed analysis.

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⁴⁸ It appears many international organizations that have internal network management organizations have not reached the point where they would formalize the relationship between the departments responsible for network management and the users.

10 Conclusions and further research

In the earlier steps of the 10-step research methodology, the research project started with developing the research question and ended with a series of conclusions on application of a Cost-effective Management model. This chapter depicts step 10 of the research methodology, combines the research results of earlier steps and derives conclusions in paragraph 10.1 for answering the research question and the strategic questions of chapter 1. Also, areas for future research are determined in paragraph 10.2 and the total research project is summarized in paragraph 10.3.

10.1 Conclusions: Research results

The research question

In order to analyze the research results, we start from the research question evaluate in which way we answered it.

The research question defined in paragraph 1.5 states the following about the What?:

Research question

*What heuristic relationships can be found between **input parameters** Regulatory Environment for Telecommunications and Telecommunications Services Offering of a country in which part of the network operates and the **output parameter** Cost-effective Management of the network?*

The research question was approached with the 10-step methodology, which we have come to know in a fairly detailed way.

In step 3, step 4 and step 5 of the research methodology, the input parameters and output parameters were developed and depicted such that they could be quantified. In step 7, heuristic relationships were proposed and formulated in *propositions*, which were then supported by explanation with heuristics and by a statistical analysis of findings in cases. We recapitulate the propositions below:

Proposition 1

An increase in the score of the Regulatory Environment in a country results in an increase of Cost-effective Management of the network in that country.

Proposition 2

An increase in the score of the Telecommunications Services Offering in a country results in an increase of Cost-effective Management of the network in that country.

The propositions are analyzed with heuristics, as well as with statistical analysis in step 7 and 9 of the research methodology. Analysis with heuristics, included the invention of Heuristic Intermediate Factors, that help explain the relationships in

the propositions with existing literature. The analysis with heuristics did confirm the propositions.

Statistical analysis, depicted in chapter 9, confirmed the propositions as well, although it should be stated that it was based on only two case studies with seven countries each and does therefore not include sufficient data points for a thorough analysis. The statistical analysis is therefore particularly useful as a practical application of a methodology, that can be used in future cases to create a more confident assessment of the relationships between the input parameters and the output parameter. The statistical analysis did give more insight in the relationships than just the confirmation of the propositions. Further detail will be given in the subparagraph conclusions from the statistical analysis.

The strategic questions

The basis for the research question were the following strategic questions for an international organization, that were developed in paragraph 1.3:

1. How to choose a country for establishing a new part of the international network; assuming the country choice is flexible?
2. How to design an international network topology with border-crossing links, such that the international network can be managed cost-effectively?
3. How to choose a country as a location for a hub to concentrate international traffic between countries in the most cost-effective way?

As steps 8 and 9 confirmed our confidence in the validity of propositions 1 and 2, the answers to the strategic questions should be:

Question 1. How to choose a country for establishing a new part of the international network; assuming the country choice is flexible?

Answer to question 1: do an analysis of the potential countries where the new part of the network can be established according to the business needs of the international organization. The analysis should be done with the models described for the input parameters: Regulatory Environment and Telecommunications Services Offering in all applicable countries. Choose the country with the highest score on each of the input parameters.

Question 2. How to design an international network topology with border-crossing links, such that the international network can be managed cost-effectively?

Answer to question 2: using the observations in paragraph 4.2, international links are more than 3 times as expensive as comparable non-international links. Therefore the number of international links should be minimized in the topology of an international network. One way to achieve this is to use hubbing to concentrate international traffic. Hubbing is the methodology that provides for concentration points with the purpose of minimizing the number of links and in particular the number of international links, as is shown examples in Figure 10-1.

Figure 10-1; Examples of an international network without hubbing and with hubbing

The topology without hubbing is shown on the left and has 6 links that cross international borders, which are relatively expensive, resulting in a high level of costs for external facilities. The topology on the right has only 2 links crossing international borders and therefore saves cost on international facilities.

Question 3. How to choose a country as a location for a hub to concentrate international traffic between countries in the most cost-effective way?

Answer to question 3: hubbing provides for concentration points in a country.

When a country is chosen as a hub, relatively many telecommunications services are purchased in that country, because more traffic is coming into and leaving the hub-country than other countries. When many services are purchased in a country, per definition the Telecommunications Services Offering in the country is important. An answer to this question is therefore: Choose therefore the country with the highest score for the input parameter Telecommunications Services Offering.

Conclusions from the statistical analysis

- All the input parameters have a positive correlation with the output parameters, which confirms our confidence in the propositions.
- The Regulatory Environment has a stronger relationship with Cost-effective Management than the Telecommunications Services Offering has with Cost-effective Management. This is indicated by the higher R-square and Correlation values for Regulatory Environment than for Telecommunications Services Offering in Figure 9-3 and Figure 9-4.
- Out of the elements of the Regulatory Environment, the Regulatory Body shows the strongest relationship with Cost-effective Management and Legal

Framework for competition is secondary, but still relatively strong. They both are depicted in a gray area in Figure 9-3 and Figure 9-4.

- Regulatory Body categories that show strong relationships are category 1; Regulatory Body independence and enforcement power, category 2; Speed and openness of the licensing process and category 5; Fair competition regulations.
- Category 4 of the Regulatory Body, Access to network infrastructure, shows the weakest relationship, with lower values for the statistical indicators.
- Out of the Telecommunications Services Offering, Price of telecommunications services shows a stronger relationship than Area of availability.

Practical recommendations for international organizations

Analysis of the cases suggests that a series of practical recommendations that can help managers of an international network. The practical recommendations are not based on statistical analysis or quantitative research, but practical findings during our study:

- Understand International Particularities. They do influence management of the international network (see paragraph 6.2) and since they differ in various countries, they should be assessed for every country in the network.
- Have a small number of parties manage as many of the Service Value Levels as possible for the international links (see paragraph 2.5)
- A high score for the Regulatory Environment and a high score for Telecommunications Services Offering are likely to have a positive influence on Cost-effective Management (see paragraph 9.2 and 9.3).
- Avoid a high number of international links as they are more expensive than non-international links and usually involve more parties for management of the links, which means less control over the quality of the link (see paragraph 4.2).
- Taking these points together in one recommendation for expansion of an international network, leads to the following: Choose countries with high scores for Regulatory Environment and Telecommunications Services Offering *and* plan for the right topology of nodes and links, which may reduce the number of international links and/or locate hubs for international links in countries with high scores on the input parameters

Practical recommendations for governments

As depicted in paragraph 1.3, governments are charged with making regulations for telecommunications and usually try to provide reliable and low-cost communications for everyone and at the same time making their country as attractive as possible for international organizations to invest in. Making a country attractive for international organizations, according to the propositions, would be helped by influencing the Regulatory Environment and Telecommunications Services Offering such that the scores of both are as high as possible. The Regulatory Environment is usually better to influence by governments than the Telecommunications Services Offering. The government should in particular enact regulation that has the strongest relationship with Cost-effective Management and

which therefore has the highest impact in improving the attractiveness of the country for international organizations to buy services in the country, to situate hubs and potentially to situate headquarters when the organization is strongly dependent on communications.

The statistical analysis, although it is not completely equivocal, shows that establishing a powerful, high quality Regulatory Body is particularly important for a high score. The categories Independence and enforcement power (category 1), speed and openness of the licensing process (category 2) and Fair competition regulations (category 5) should obtain the highest priority for implementation. We therefore formulate the following practical recommendations:

- Open as many services for competition as is possible, given the country can afford a decline in income to the state from telecommunications services.
- Establish a regulatory body with a quick and transparent licensing process and give it enforcement power and independence.
- Let the regulatory body enact regulation that corresponds with the highest scores in the categories.

10.2 Further Research

Further research on international networks is highly recommended, as the subject is of fast growing importance and very little research has appeared in literature (see paragraph 1.7). Some research is found in literature concerning limited areas of the research subject. The Regulatory Environment, for instance, is subject to more research recently, but there is no research known yet that relates the Regulatory Environment to management of networks, whereas a prime motivation of governments to change the Regulatory Environment in a country is to attract international organizations, that will invest. As this research indicates, they may make their choice for the country in which they invest, dependent on a Regulatory Environment or the Telecommunications Services Offering. A second, separate area where research is being conducted is in developing a more accurate way to determine indicators for Cost-effective Management. The driver there, however, comes from a completely different background: the recent popularity of providing voice services using data networks, with data services as Basic Data Transfer Services. These data networks use protocols, such as the Internet Protocol (IP). For the transmission of voice, the voice is translated into packets of data, to be transported over an IP network, such as for example the Internet (Voice over IP). Voice over IP is being adopted by many telecommunications operators and is claimed to result in more Cost-effective Management of their network. As telecommunications operators are about to make big investments in new technology, research for more facts is necessary to guide what type of technology they should implement.

With research being conducted to the Regulatory Environment and in Cost-effective Management, the research on input parameter and output parameter of this research is getting more developed, which is a step in the right direction. Apart

from developing the input parameters and output parameter, further and more detailed research is necessary to relate the input parameters and output parameter to each other.

While conducting this research, we have encountered certain limitations, as well as areas where more research could be done, but that fell outside of the scope of this research.

- Data used for the statistical analysis in the case studies is based on relatively few observations and therefore the confidence level of the statistical indicators is relatively low. An action for further research is:
Do more cases to provide for more data points that increase the reliability of the results. This will allow the starting values to be refined also.
- The type of telecommunications service used in an international network is not a factor in our examination of the Regulatory Environment, described in paragraph 3.4, as Service Value Levels are used to categorize telecommunications services. However, several Regulatory Environments have been found that do discriminate between different telecommunications services, even when they are in the same Service Value Level. An action for further research is:
Refine the model of the Regulatory Environment to include scores for several different telecommunications services in every Service Value Level.
- The output parameter Cost-effective Management was measured using a formula developed in paragraph 5.4. This formula is developed because there formula or method found in literature that was concise and easily applicable. The formula, however, only takes three variables into account, which are each expressed in one numeric value: the size of the network, the Cost of Ownership of the network and the performance of the network. Using this way to measure Cost-effective Management, we realize that there are several other factors that could be taken into account, which would help make calculations of Cost-effective Management for different networks more comparable among each other. An action for further research is:
Develop a more detailed way to measure the output parameter Cost-effective Management.

10.3 Summary of the research

International networks fulfill a more and more important role in our society. We use international networks for instance when we get cash from an automated teller machine abroad or when we send someone in another country an e-mail, or simply when we surf on the Internet.

An international network is a network that is operational in at least two countries and that has a management organization for each of these countries, that is responsible for the part of the network that is located in that country.

Managing an international network demands special attention because of the international nature of the network. As the network is in various countries, where environments may be different, it should be verified what influence these different environments have on the management. Examples are the different dominant telecommunications services providers in different countries, the fact that there are usually different regulations applicable for offering telecommunications services and the fact that in different countries a different language may be spoken and understood.

The subject of management of international networks is studied using a 10-step approach.

In the first step, the questions are formulated that should be answered by the study. Literature, trends and strategic questions, heard in international organizations form the basis. Two aspects are chosen and formulated in a research question

- (1) the regulation for telecommunications (Regulatory Environment) in the countries where the network is located, and
- (2) the offering of telecommunications services (Telecommunications Services Offering) in the countries where the network is located.

The research question researches the relationship between these aspects and the Cost-effective Management of an international network.

Research question

Which heuristic relationships can be found between the input parameters, Regulatory Environment of a country and Telecommunications Services Offering of a country in which part of the network is operational and the output parameter, Cost-effective Management of a network?

We will search for qualitative relationships between the input parameters and the output parameter. Here is chosen to collect quantitative details of the input parameter and the output parameters, such that, with help of statistical models, as much insight as possible can be obtained into possible relationships. Answering the research question will increase our insight in possible effects of these aspects on Cost-effective Management, such that better decisions can be made for the design and management of international networks. The heuristic relationships and input parameters found, will together also be called the Cost-effective Management model.

In chapter 2 we further developed the theory based on the research question. An inventory is made about existing theories on management and international aspects and a couple of theories will be judged on their usefulness for modeling input parameters and the output parameter.

Chapter 3 further develops the Regulatory Environment. A subject that is in many current discussions as countries are revising their Regulatory Environment and international organizations are watching the changes closely to see where their next best expansion area may be. The Regulatory Environment is quantified for a country using 3 different elements, including

- the Legal framework for competition, which identifies the legal possibilities for competition in different sets of services
- the Regulatory Body, which is the set of regulations issued by a regulatory body in the country
- the real state of competition in the country, called Competition active. This last element is a descriptive element, whereas the first two elements were prescriptive.

The third element actually shows how competition has worked in reality and if competitors have been able to obtain any significant market share.

Furthermore, in chapter 4, the Telecommunications Services Offering in a country is described and quantified. The quantification of the Telecommunications Services Offering includes an analysis of seven telecommunications services in the country. The telecommunications services are judged for price and availability in particular geographic areas of the country and are depicted in a Telecommunications Services Offering matrix.

After the quantification of the input parameters, chapter 5 then modeled the output parameter Cost-effective Management. So far, there are no easy-to-use and adequate measurement methods that were found in theory or practice, so a new model had to be developed. Cost-effective Management was defined to include three factors:

1. Cost of management of the network (which can be calculated by an existing method, called the Cost-of-Ownership method),
2. Size of the network (which can be measured in terms of capacity of all links of the network) and
3. Performance of the network (which can be measured with various performance indicators)

Performance indicators are preferably defined in the SLA, which would assure that the users of the network have chosen performance indicators that they consider relevant. In reality, however, many instances have been found where no SLA existed and performance indicators were produced by the organization that managed the network, without regards for the requirements of the users.

The following formula was used to calculate a single value for Cost-effective Management using the three factors:

$$\text{Cost effective Management} = \text{Performance of the network} * \frac{\text{Size of the network}}{\text{Cost of Ownership}}$$

Cost-effective Management of a network can be calculated for a part of the network (such as the part in a particular country) or for the network as a whole.

Then in chapter 6 an explorative case was described, which had as objectives to assess the management of an international network in practice and to apply the models for the input parameters in a practical situation. The explorative case was done in AT&T network systems, that changed its name in 1996 to Lucent Technologies. The result of chapter 6 is a list of attention points from practice that are also used in a checklist in chapter 10.

Chapter 7 then described the Cost-effective Management model. This model relates the input parameters to the output parameter. Two propositions were formulated in order to show the relationships. Also a more detailed analysis is done with case studies and statistical analysis. By means of logical deduction (heuristics) and literature, we conclude that a higher score on each of the input parameters leads to more Cost-effective Management.

The propositions are listed below:

Proposition 1

An increase in the score of the Regulatory Environment in a country results in an increase of Cost-effective Management of the network in that country.

Proposition 2

An increase in the score of the Telecommunications Services Offering in a country results in an increase of Cost-effective Management of the network in that country.

Chapter 8 shows case studies that are used as a second method to test the propositions. The case studies are done in two international organizations: Calvin Klein Cosmetics Company (CKCC) and United Nations Development Programme (UNDP). In these case studies the international network of the organizations is studied and the Cost-effective Management model is applied to (part of) the international network of the case situation. In both cases, 7 countries were chosen for the research. Application of the models for the input parameters and the output parameter was straightforward. We should note, however, that an adequate number of performance indicators should be available on the network of the case studies. The CKCC case study had a higher number of indicators at its disposition, which makes for a higher reliability of the outcome of the CKCC case study compared to the UNDP case study, which was just based on one set of performance indicators. Chapter 9 shows the statistical analysis of the cases with help of linear regression. Linear regression delivers outputs in terms of statistical indicators correlation and R-square. The case studies did not show any reason to contradict the propositions, which confirmed our confidence in the propositions.

Therefore our assumption is strengthened that a higher score of the input parameters relates to a higher Cost-effective Management of a network. Specific elements of the input parameter that show a strong relationship with Cost-effective Management are the element Regulatory Body in general and the Regulatory body independence and enforcement power, Speed and openness of the licensing process and Fair competition regulations in particular.

Conclusions

The last chapter, chapter 10 shows conclusions, recommendations and ideas for further research. The Cost-effective Management model is developed to learn more about how aspects of international networks influence the management of the network and therefore how we can improve Cost-effective Management of the network by means of influencing the aspects or choosing the countries with the most favorable aspects. For this book, models of the Regulatory Environment in a country and the Telecommunications Services Offering in a country were made that can quantify such aspects. The models of these aspects result in a quantification of the aspects in a particular country in such a way that a higher score for Regulatory Environment and Telecommunications Services Offering, while other aspects are kept the same, was expected to result in more Cost-effective Management. Heuristics and statistical analysis have strengthened the confidence in this expectation. Statistical analysis has also shown that particular elements of the Regulatory Environment and Telecommunications Offering are particularly indicative for high Cost-effective Management of a network in a country with high scores. The elements are Regulatory body independence and enforcement power, Speed and openness of the licensing process and Fair competition regulations .

Knowledge of these relationships can help to support strategic decisions for management of international networks. Examples of these decisions are the choice of the countries where the network will expand into and the choice of the topology of the network and the countries where the concentration points (hubs) of the network may best be placed.

Knowledge of the influence of the Regulatory Environment on Cost-effective Management is also particularly valuable for governments. With a number of 69 countries that will admit competition in the period 1998-2004, the creation of an adequate Regulatory Environment can be an important way for governments to make their country more attractive for foreign investment in industries such as high technology, that are high users of international networks. Also a good Regulatory Environment will be attractive for a government as it creates lower prices of services for the benefit of consumers in the country and may increase communication between people in a society.

Further research may focus for instance on getting more reliable and more detailed data and about the relationships by means of more case studies. The models developed in this book should form a standard for the analysis of those case situations.

Appendix; Network manager survey

A network manager survey was done among 17 network managers of international organizations. The organizations are: Philips, DuPont, ING Netherlands, Shell, Nedlloyd lines, Netherlands postoffices, Hewlett-Packard, IBM, DSM, Monsanto, Akzo Nobel, Dutch railways, Schiphol Telematics, PTT post, AT&T, Ministry of Health and Environment and the Unilever meat group. The survey is depicted in the following paragraphs.

Survey

In this survey we would like to ask you about the telecommunications services your international organization purchases and which general decision criteria you consider to be important in the buying process of telecommunications services.

A model of buying criteria

In order to illustrate an example of a buying process, we have found a model as depicted in A-1 from theory [Easterby-Smith 1993] which gives an overview of the perceived value and possible purchasing criteria for a product or service. The shaded areas are the areas that we consider applicable for telecommunications services. In your buying process you will perceive a certain kind of value of the service you want to purchase. This perceived value depends on a trade-off between on the one hand five groups of qualities and on the other hand the price.

Figure A-1; Model of purchasing criteria based on perceived value

We would like to ask you to rate how important the following variables are for your telecommunications network. You have 10 possibilities to rate: from one (totally not important) to ten (very important).

*Example: If you want to rate the importance of a variable with *totally not important*, you encircle the first number:*

totally not important   →   *very important*

1 2 3 4 5 6 7 8 9 10

After finishing the questionnaire you can fax the two next pages and the prepared fax cover page to us.

<i>important</i>	<i>totally not important</i>	<i>very</i>
Technical quality (overall):	1 2 3 4 5 6 7 8 9 10	
• Maintainability:	1 2 3 4 5 6 7 8 9 10	
• Features:		
• Standard features:	1 2 3 4 5 6 7 8 9 10	
• Bells and whistles features:	1 2 3 4 5 6 7 8 9 10	
• Convenience (overall):	1 2 3 4 5 6 7 8 9 10	
• Billing options:	1 2 3 4 5 6 7 8 9 10	
• Outsourcing	1 2 3 4 5 6 7 8 9 10	
• Reliability:	1 2 3 4 5 6 7 8 9 10	
• Security (overall):	1 2 3 4 5 6 7 8 9 10	
• Authorized access security:	1 2 3 4 5 6 7 8 9 10	
• Security against private use	1 2 3 4 5 6 7 8 9 10	
• Durability:		
• Technical durability	1 2 3 4 5 6 7 8 9 10	
• Economical durability	1 2 3 4 5 6 7 8 9 10	
• Performance (overall):	1 2 3 4 5 6 7 8 9 10	
• Availability (location):	1 2 3 4 5 6 7 8 9 10	
• Availability (time):	1 2 3 4 5 6 7 8 9 10	
• Capacity:	1 2 3 4 5 6 7 8 9 10	
• Speed:	1 2 3 4 5 6 7 8 9 10	

<i>totally not important</i>	→	<i>very important</i>
Price (overall):	1 2 3 4 5 6 7 8 9 10	
• Purchase price/investment:	1 2 3 4 5 6 7 8 9 10	
• Ownership costs (overall):	1 2 3 4 5 6 7 8 9 10	
• Training costs:	1 2 3 4 5 6 7 8 9 10	
• Start-up costs:	1 2 3 4 5 6 7 8 9 10	
• Maintenance costs:	1 2 3 4 5 6 7 8 9 10	
• Scrapping costs:	1 2 3 4 5 6 7 8 9 10	
• Usage costs:	1 2 3 4 5 6 7 8 9 10	
• Depreciation costs:	1 2 3 4 5 6 7 8 9 10	

Other variables:

totally not important

very important

- _____ : 1 2 3 4 5 6 7 8 9 10
- _____ : 1 2 3 4 5 6 7 8 9 10
- _____ : 1 2 3 4 5 6 7 8 9 10
- _____ : 1 2 3 4 5 6 7 8 9 10

Personal Information

1. What is your function and what are your main responsibilities?

Function: _____

Responsibilities: _____

Configuration of your companys network

2. We use the ☐ public network ☐ private network ☐ WVPN (world-wide VPN) network (*2)
3. How many end-users are connected approximately? _____
4. My current operator(s) /PTO(s) is/are: _____
5. How many sites of your company are connected ? In NL: _____ World-wide _____
6. Can you please fill in the following table?

Kind of traffic	Percentage of total traffic	Yearly expenses
Voice	± %	±\$
Fax	± %	±\$
Data	± %	±\$
Video	± %	±\$

7. Which are the most urgent problems with your current telecommunications network in order of importance(1=Most important, 8=less important)?

- 1 _____
- 5 _____
- 2 _____
- 6 _____

3 _____
7 _____
4 _____
8 _____

8. What is the most important function of the international network for your organization ?

_____

9. Are you familiar with national VPN ? Yes/No (*1)
10. Are you familiar with VPN ? Yes/No (*1)

(*1) Cross out what does not apply.
(*2) Fill in which does apply.

Glossary of Terms and Abbreviations

Accounting management - Process of collecting interpreting and reporting costing and charging-oriented information on resource usage.

Area of availability - Element of Telecommunications Services Offering that indicates in what area of a country telecommunications services are available

Basic Data Transfer Services (BDTS) - Telecommunications services that are between layers 5 and 7 of the OSI model and usually part of a set of services that is *not* identified as enhanced services or Value Added services and not as infrastructure services in Regulatory Environments.

Competition active - Element of the Regulatory Environment that describes how many competitors actually appeared when a market is opened for competition

Configuration management - Network management activity for controlling physical, electrical and logical inventories, maintaining vendor files and trouble tickets, supporting provisioning and order processing

Cost of Ownership model (COO model) - Model, developed by the Gartner Group, to measure the cost of ownership of information systems

Cost-effective Management - The management of a network in a cost-effective way. I.e. offering a specified set of services/capacities with specified performance requirements for a particular (preferably lowest possible) cost.

Cost-effective Management indicator - Indicator for the management of a network in a cost-effective way.

Cost-effective Management model - Model that relates the cost-effective management of a network to the *Regulatory Environment* and the *Telecommunications Services Offering* of the countries in which it operates.

Equal access to infrastructure - The right for telecommunications operators to access to infrastructure of another (usually dominant) telecommunications operator

Fair competition - Competition that does not unreasonably favour a particular party

Fault management The set of tasks required to monitor and restore faults in order to dynamically maintain agreed network service levels

Infrastructure services - Set of services that operates at layers 1-4 of the OSI model and that are usually the making available of fiber cables, radio spectrum or wires.

Integrated Services Digital Network (ISDN) - a value added service that is a digital and enhanced version of PSTN. The Basic Rate ISDN service carrier two 64kbps channels and one 16kbps channel.

Legal Framework for competition (element of the Regulatory Environment) - the Legal Framework element gives an overview of the laws that exist in a country that regulate the offering of telecommunications services.

Licensing process - Process of obtaining a telecommunications license in a country

Management, Control and Maintenance (MCM) - The set of activities performed to ensure the continuous fulfillment of the performance characteristics of an information system or network

One Stop Shopping - Possibility to obtain multiple services or products from a single supplier

Packet Switched Data Network (PSDN) - A public network that offers the services of transporting data in form of packets, often using a protocol called X.25. Other possible protocols are TCP/IP or Frame Relay.

Performance management - Activities required to continuously evaluate the principal performance indicators of network operation, to verify how service levels are maintained, to identify actual and potential bottlenecks to establish and report on trends for management decision making and planning

Performance of network - Extent to which the network performs according to the performance criteria agreed between the users and management organization of a network

Price of telecommunications services - (element of Telecommunications Services Offering) This element of the Telecommunications Services Offering indicates the level of prices offered

Private networks - Networks that are structured such that no facilities are used that are accessible for the general public.

Private Line - (or leased line) Dedicated capacity designed to link a single user with requirements in two locations.

Public networks - Networks that are accessible by multiple parties of the general public.

Public Switched Telephone Network (PSTN) - The publicly available local and long-distance facilities of telecommunications operators

Public Telecommunications Operator (PTO) - A telecommunications operator that is all or in part owned by a government

Regional Bell Operating Company (RBOC) - An operator that was established after the liberalization of the United States market on 1 January 1984, by breaking AT&T into smaller companies.

Regulatory Body (element of the Regulatory Environment) A body that may exist in a country to control the competitive scene of telecommunications operators by issuing and enforcing regulation.

Regulatory Environment - The set of telecommunications regulations applicable in a country

Regulatory Environment model - model that describes and quantifies the Regulatory Environment in a country

Security management - a set of activities for the ongoing protection of the network and its components such as the protection against entering the network, accessing an application and transferring information in a network.

Service Level Agreement (SLA) - Agreement between the management organization of a network and the users of a network, that stipulates the required services and performance of the network.

Service Value Level - A classification of a set of services that has a similar level in the OSI model

Service Value Model - A model that describes three different service value levels

Size of the network - A measurement of the scale of the network, for which various measurement methods can be used. A common measurement method is to sum the total capacity of all links in the part of the network or network of which the Size of the network is to be determined.

Subscriber identification and numbering (Number Portability) - The possibility for a user to keep the same subscriber identification (e.g. telephone number) when switching service providers or when moving within a certain area of a city.

Telecommunications operator - an operator that provides telecommunications services and is often licensed to do so in a particular area (country or region)

Telecommunications Services Offering (one of the two input parameters for relationships in research question) - The set of telecommunications services that are

offered in a country, expressed in measurements for price and Area of availability of the services

Telecommunications Services Offering matrix - A matrix that shows the quantification of the Telecommunications services offering

Telecommunications Services Offering score - The score in the matrix that shows the quantification of the Telecommunications services offering

Transaction Control Protocol/Internet Protocol(TCP/IP) - A protocol for the transport of packets of information, which is e.g. used in the Internet

Universal service - The offering of telecommunications service at any point in a country at the same commercial conditions (price and installation time)

Value Added Services (sometimes called *enhanced services*)- Set of services (or Service Value Level) that is available directly to end-users or organizations, that is upward of layer 5 of the OSI model and that is usually performed using the -more strictly regulated- Basic Data Transfer Services.

Very Small Aperture Terminal (VSAT) - A satellite terminal that is easily portable and suitable for establishing e.g. leased line service at any location covered by a special satellite.

World Trade Organization (WTO) - Organization of countries that was established to promote trade with the fewest possible restrictions, between the countries

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Samenvatting in het Nederlands (Summary in Dutch)

Management of International Networks

Floris van den Broek, 21 september 1999

Communicatienetwerken vervullen een belangrijke rol in de samenleving. Wij maken gebruik van internationale netwerken als we bijvoorbeeld geld opnemen in het buitenland, een e-mail sturen naar een verre vriend, of gewoon bij het surfen op het Internet.

Gaandeweg zijn netwerken steeds internationaler geworden, wat vragen oproept over welke invloeden het internationaal zijn van een netwerk heeft op het beheer van dat netwerk. Eerder onderzoek heeft aangetoond dat het beheer van een netwerk een aanzienlijke en vaak onderschatte kostenpost is. Organisaties die netwerken beheren blijken in de praktijk nauwelijks inzicht te hebben in de invloed van het internationaal zijn op het beheer van het netwerk.

Daarnaast is de *omgeving* van internationale netwerken in veel landen aan sterke veranderingen onderhevig. In de periode 1999-2004 zijn er grote veranderingen gaande in de regulering van telecommunicatie in 69 landen, die de WTO-overeenkomst hiervoor in 1997 ondertekend hebben. Ook is er in veel landen sterke verandering in het aanbod van telecommunicatiediensten: diensten belangrijke bouwstenen zijn voor internationale netwerken. Naast deze veranderingen in de omgeving, spelen in veel organisaties veranderingen betreffende de organisatie van het beheer. Vooral uitbesteding van het beheer aan een andere organisatie is daarbij populair. Inzicht in de invloed van deze veranderingen, is nodig voor een goed beheer van een internationaal netwerk.

Deze veranderingen, verder trends genoemd, vormen een basis voor de onderzoeksvraag en worden in een puntsgewijs overzicht als volgt samengevat:

- een snel groeiende schaalgrootte van internationale netwerken;
- een veranderende regulering van telecommunicatie;
- een veranderend aanbod aan telecommunicatiediensten;
- het steeds meer uitbesteden van het beheer van netwerken.

Een gebrek aan inzicht in internationale aspecten van het beheren van een netwerk, kan grote problemen opleveren voor organisaties bij het implementeren van hun bedrijfsstrategie. Een voorbeeld uit de praktijk is het Amerikaanse bedrijf Wal-Mart, dat enkele jaren geleden zijn activiteiten naar Europa wilde uitbreiden, maar dit uiteindelijk niet deed vanwege de hoge beheerskosten die het internationale netwerk in Europa met zich mee zou brengen. Wal-Mart is namelijk in grote mate afhankelijk van een speciaal computersysteem dat de logistiek van goederenstromen tussen de vestigingen ondersteunt en continu in alle vestigingen beschikbaar moet zijn. In de Verenigde Staten (VS) wordt daarvoor gebruik gemaakt van goedkope, nationale verbindingen. Dergelijke verbindingen die tussen de geplande vestigingen in Europa zouden moeten worden gehuurd, zijn 10-15

maal duurder dan de verbindingen tussen de vestigingen in de VS, terwijl de afstanden tussen de vestigingen in de VS zelfs groter zijn.

Dit voorbeeld en praktijkervaring in andere organisaties leren dat een groot aantal vragen over beheer onbeantwoord blijft. Belangrijke vragen die daarbij aan de orde komen zijn:

- Hoe kiezen we een land waarin het netwerk aangelegd of uitgebreid moet worden, als deze keuze beïnvloedbaar zou zijn?
- Hoe kunnen we een topologie ontwerpen van een internationaal netwerk, zodanig dat het netwerk het best beheerd kan worden?
- Is het verstandig om internationaal verkeer te concentreren en hoe kiezen we een land waarin een knooppunt geplaatst kan worden om internationaal verkeer te concentreren?

Bestudering van literatuur duidt aan dat internationale aspecten van netwerken tot nu toe zelden zijn onderzocht en nog weinig geschreven is over de complexiteiten van het beheer van internationale netwerken.

Het combineren van trends, vragen en literatuur en ontwikkelt het inzicht in het probleemgebied ontwikkeld. Tenslotte is er een keuze gemaakt voor het onderzoeken van invloeden van enkele aspecten van een netwerk op het beheer.

Als aspecten zijn gekozen:

- (1) de Regulering van telecommunicatie (in het Engels genaamd: Regulatory Environment) waar het netwerk zich bevindt en
- (2) het Aanbod van telecommunicatiediensten (Telecommunications Services Offering) in de landen waar het netwerk zich bevindt.

Om de kwaliteit van beheer te meten wordt het begrip Kosten-effectief beheer geïntroduceerd. Om de relatie te onderzoeken, kunnen aspecten als invoerparameters en Kosten-effectief beheer als uitvoerparameter van een model gezien worden.

Samenvattend resulteert dit in de volgende onderzoeksvraag:

Onderzoeksvraag

Welke heuristische relaties kunnen worden gevonden tussen de invoerparameters, Regulering van telecommunicatie en Aanbod van telecommunicatiediensten van een land waarin een deel van het netwerk opereert en de uitvoerparameter Kosten-effectief beheer van het betreffende deel van het netwerk?

Op grafische wijze is de onderzoeksvraag als volgt weer te geven, waarbij de pijlen de gevraagde relaties vertegenwoordigen:

Het onderwerp wordt benaderd met behulp van een 10-stappenplan. Elk van de 10 stappen wordt weergegeven in een hoofdstuk.

De eerste stap is reeds in het voorgaande toegelicht. Hierin worden met behulp van aandachtspunten uit praktijk en literatuur, trends en vragen, twee aspecten gekozen en in een onderzoeksvraag geformuleerd.

Om inzicht te verkrijgen in het beheer van internationale netwerken, wordt een kwalitatieve beschrijving van relaties tussen invoer- en uitvoerparameters geacht een belangrijke stap vooruit te zijn naar een antwoord op de onderzoeksvraag.

Gekozen is om de aspecten zelf kwantitatief te beschrijven en dus kwantitatieve gegevens over de invoer- en uitvoerparameters te verzamelen, zodat met behulp van bijvoorbeeld statistische methoden zoveel mogelijk inzicht in de relaties kan ontstaan.

Voor de kwantitatieve beschrijving van invoer- en uitvoerparameters kunnen scoringsmodellen uit de literatuur dienen. Bij het ontbreken daarvan kunnen ook nieuwe modellen ontwikkeld worden.

De combinatie van gevonden relaties en invoerparameters en uitvoerparameter wordt ook wel het Kosten-effectief beheer model genoemd.

In stap 2 wordt, uitgaande van de onderzoeksvraag, de theorie verder ontwikkeld. Een inventarisatie wordt gemaakt van bestaande theorieën over beheer van internationale netwerken en enkele theorieën worden beoordeeld op hun nut voor het modelleren van de invoerparameters en uitvoerparameter. Enkele theorieën zijn het Telecommunications Management Network model, dat activiteiten voor het management van een telecommunicatienetwerk beschrijft en het hier ontwikkelde Service Value Model, dat telecommunicatiediensten indeelt op grond van hun positie in een waardeketen.

In stap 3 komt de invoerparameter Regulering van telecommunicatie aan bod. Voor het kwantificeren van de Regulering van telecommunicatie wordt een model ontwikkeld, dat bestaat uit 3 elementen en voor ieder een kwantificering (scoring)

1. de wetten die concurrentie regelen (Wettelijk framework voor concurrentie),
2. een regulerend orgaan (Mededingingsautoriteit, ofwel Regulatory Body) en
3. de werkelijke toestand van concurrentie (Concurrentie actief) in het betreffende land.

Elk van de elementen is weer in categorieën verdeeld. Er worden startwaarden voor scores gekozen, zodanig dat verwacht wordt (op basis van literatuur) dat een hogere score correspondeert met een meer geliberaliseerde regelgeving. De startwaarden zijn gekozen op basis van de praktijk en voor elke categorie worden scores van hele getallen van 0 tot 3 genomen. Dit zijn dan nominale waarden. Ze zijn niet vantevoren getoetst of geïkt. Dit betekent dat bij latere toepassing van statistische analyse rekening gehouden moet worden dat er afwijkingen kunnen zijn. Voor het doen van uitspraken over kwalitatieve relaties behoeft dit geen probleem te zijn, daar niet de exacte analysewaarden zelf worden gebruikt, maar alleen het feit of ze onder of boven een bepaalde grens liggen.

In stap 4 wordt de tweede invoerparameter beschreven, het Aanbod van telecommunicatiediensten. Eerst wordt een survey gedaan onder netwerk managers van 17 multinationale organisaties om de belangrijkste telecommunicatiediensten

en hun aspecten te leren kennen. Een zestal telecommunicatiediensten wordt met behulp van de survey als belangrijkste geselecteerd. Het zijn de diensten Public Switched Telephone Network (PSTN of in dagelijks spraakgebruik: telefonie), ISDN, Virtual Private Network (VPN), huurlijnen met capaciteiten van 64 kilobits per seconde (kbps) en 2 Megabit per seconde (Mbps) en Packet Switched Data Network (PSDN).

Wat betreft aspecten van telecommunicatiediensten, komen Gebied van beschikbaarheid en Prijs van telecommunicatiediensten als belangrijkste naar voren. Voor het kwantificeren van het Aanbod van telecommunicatiediensten wordt dit zestal beoordeeld op beschikbaarheid in verschillende delen van het land (Gebied van beschikbaarheid) en op prijs (Prijs van telecommunicatiediensten). Ook hier worden startwaarden gekozen en het Aanbod van telecommunicatiediensten kwantitatief bepaald. De resultaten worden weergegeven in een matrix.

Nadat de invoerparameters beschreven zijn, modelleert stap 5 de uitvoerparameter Kosten-effectief beheer. Daarvoor wordt eerst een meetmethode ontwikkeld, omdat een representatieve en tegelijkertijd eenvoudig toe te passen methode nog niet voorhanden is.

De meetmethode maakt voor het berekenen van de kosten van beheer van een netwerk gebruik van het reeds bestaande Cost-of-Ownership model. Bovendien gebruikt de meetmethode informatie over de capaciteit van het netwerk en over Prestatie indicatoren. Kosten-effectief beheer kan worden berekend voor elk individueel land waar het netwerk nodes heeft, of voor het netwerk als geheel.

In stap 6 wordt een exploratieve case uitgevoerd, die tot doel heeft, het beheer van een internationaal netwerk in de praktijk te bekijken en de invoerparameters toe te passen in een werkelijke situatie. De exploratieve case is uitgevoerd bij AT&T Network Systems dat sinds 1996 Lucent Technologies heet.

Resultaat van deze case is een lijst met aandachtspunten uit de praktijk en enkele ervaringen bij het toepassen van de modellen voor de invoerparameters en uitvoerparameter. Een van de ervaringen is bijvoorbeeld dat scores van de invoerparameters onderhevig zijn aan snelle veranderingen. De invoerparameters moeten daarom in zo kort mogelijk tijdsbestek geobserveerd worden om nauwkeurigheid te garanderen. Ook is een ervaring dat om Kosten-effectief beheer goed te kunnen meten, verscheidene gegevens, zoals kosten en prestaties van een netwerk per land afzonderlijk moeten worden bijgehouden.

In stap 7 wordt met behulp van de eerder beschreven invoer- en uitvoerparameters en de ervaringen in de exploratieve case, het Kosten-effectief beheer model beschreven. Dit model relateert de invoerparameters aan de uitvoerparameter. Er wordt een tweetal proposities geformuleerd, die de relaties weergeven tussen invoerparameters en de uitvoerparameter.

Propositie 1

Een toename van de score van de Regulering van telecommunicatie in een land resulteert in een toename van Kosten-effectief beheer van het netwerk in dat land.

Propositie 2

Een toename van de score van van het Aanbod van telecommunicatiediensten in een land resulteert in een toename van Kosten-effectief beheer van het netwerk in dat land.

De proposities worden met twee middelen geanalyseerd. Ten eerste worden ze aannemelijk gemaakt met behulp van heuristieken. Ten tweede wordt een gedetailleerder analyse van de relaties gedaan door middel van case studies en statistische methoden.

Een heuristiek is een bewering over de invoerparameters en geeft daarbij aan dat bij een hogere score van $\emptyset\emptyset n$ van de invoerparameters, er sprake is van verbetering van $\emptyset\emptyset n$ van de volgende factoren: *meecoinnovatie*, een groter *gebied van beschikbaarheid* van de diensten, een lagere *prijs* van de diensten of een combinatie van deze factoren. Door middel van logische afleiding en literatuur wordt geconcludeerd dat een hogere score voor $\emptyset\emptyset n$ van de invoerparameters leidt tot meer Kosten-effectief beheer.

In stap 8 wordt een tweede middel beschouwd om relaties te vinden en om de Propositions te testen in een tweetal case studies: Calvin Klein Cosmetics Company (CKCC) en United Nations Development Programme (UNDP). In deze case studies wordt het internationale netwerk van de organisaties bestudeerd en het Kosten-effectief beheer model toegepast op (een deel van) het internationale netwerk in de case situatie. In beide cases zijn 7 landen gekozen voor het onderzoek. Toepassing van de scoringsmodellen voor de invoerparameters verliep zonder grote complicaties. Een kanttekening is dat er verschil is in de hoeveelheid werkelijk gemeten prestatie indicatoren, die nodig zijn voor de berekening Kosten-effectief beheer. Een groter aantal prestatie indicatoren in de CKCC case heeft daarbij tot meer materiaal voor statistische analyse geleid, wat de betrouwbaarheid van de uitkomsten van de CKCC case iets groter maakt dan die bij de UNDP case.

Statistische analyse van de cases wordt in stap 9 gedaan met behulp van lineaire regressie, waarvan de resultaten weergegeven worden in de statistische indicatoren correlation en R-square. Hierbij moet de kanttekening worden gemaakt dat het toepassen van statistische analyse op nominale waarden tot beperkt bruikbare resultaten leidt. De statistische indicatoren moeten dan ook als indicatief gezien worden. Er wordt hier alleen bepaald of de waarden voor correlation en R-square boven of onder een standaard grenswaarde liggen (wij hebben gekozen voor een grenswaarde van 0.75).

De case studies gaven geen aanleiding de Propositions te verwerpen. De aanname blijft dus dat een hogere score van de invoerparameters relateert aan een hogere kosten-effectiviteit van beheer van het netwerk.

Conclusies en aanbevelingen voor verder onderzoek volgen in de tiende en laatste stap. Kennis over hoe de Regulering van telecommunicatie en Aanbod van telecommunicatiediensten het beheer van netwerken beïnvloedt, helpt bij het beheer van een internationaal netwerk door een organisatie. De kennis kan bovendien zeer waardevol zijn voor overheden. Met een aantal van 69 landen, dat concurrentie in telecommunicatie gaat toelaten in de periode 1999-2004, is de creatie van een Regulering van telecommunicatie die voor ondernemingen en personen in een land zo voordelig mogelijk is, van groot maatschappelijk belang. Enkele conclusies die zijn afgeleid:

- Minimaliseer het aantal grensoverschrijdende verbindingen door middel van een topologie waarin verkeer wordt geconcentreerd.
- Betrek zo min mogelijk diensten van verschillende partijen voor het beheer van grensoverschrijdende verbindingen.
- Kies een land met hoge scores voor de invoerparameters als locatie voor de concentratie van verkeer. In concentratiepunten worden de meeste diensten afgenomen en het is beter die diensten af te nemen in een omgeving die Kosten-effectief beheer ondersteunt.

Verder onderzoek kan worden verricht met het oog op het verkrijgen van meer inzicht in andere internationale aspecten van het beheren van een netwerk. Ook is er behoefte aan meer betrouwbare informatie over de relaties, bijvoorbeeld door middel van meerdere case studies en door het eerst ijken van de invoerparameters door ander vergelijkend onderzoek. Tevens kan de meetmethode voor de uitvoerparameter Kosten-effectief beheer in meer detail ontwikkeld worden, zodat meer betrouwbare kwantitatieve gegevens over het Kosten-effectief beheer in de analyse gebruikt kunnen worden. Uiteindelijk kan dan met de kwantitatieve beschrijving van zowel de invoer- als de uitvoerparameters de invloed van ieder van de onderdelen van de Regulering van telecommunicatie en het Aanbod van telecommunicatiediensten afgewogen worden, waardoor er een prioriteitenlijst kan worden gemaakt die het nemen van strategische beslissingen voor beheer van het internationaal netwerk nog meer vergemakkelijkt.

Author Biography

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Together with professor Looijen, he has written articles on Management of International networks, two of which appeared in the International Journal of Network Management in Spring and Summer 1997. He is also associate editor of the Telecommunications Handbook, to be published in 1999 by CRC/Times Mirror publications.

Floris van den Broek is married to Eva Crebolder.

INDEX

A

Accounting management	28
AUSTEL.....	47

B

Bakom-Ofkom	47

C

Calvin Klein Cosmetics Company.....	117
CKCC.....	117
Co-location	50
Competition	56
Configuration management	28
Core skills model	40
Correlation.....	143
Cost of Ownership model	79
Cost-effective Management.....	77
Cost-effective management model.....	101
Cost-effectiveness of management.....	20
CRTC	47

D

Dark fibre service.....	36

E

Enforcement power	48
Evolution	87
explorative case.....	84

F

Fair competition	51
Fault management	28
FCC.....	47

H

Heuristics.....	105

I

Imbalance	67
Infrastructure services.....	36

Innovation.....	109
Integrated Services Digital Network.....	71
Integrated Services Digital Network services.....	69
Interconnection.....	50
International Standards Organisation	34

L

Leased line.....	71
Legal Framework.....	42
Licencing process.....	49
Link.....	37

M

Management Information Systems Paradigm	27
Management of a link	See Link
Meta Telecom Maturity Model	31

N

Network Management Paradigm	27
Network managers survey.....	69
Non-traditional international traffic	68
Number portability	53

O

OECD liberalization index.....	33
OFTEL	47
OPTA	47

P

Packet Switched Services	71
Particularities	97
Performance management.....	28
Private network	62
Public Switched Telecom Network.....	71
Public Switched Telecommunications Services.....	69

R

Refile.....	68
Regression analysis	142
Regulatory Body	45
Regulatory environment	19, 29, 102
Regulatory Environment18, 31, 44, 57, 58, 84, 87, 90, 105, 106, 110, 113, 120, 123, 134, 148, 150, 152, 154, 155	
Reorigination	68
Research methodology.....	20

Research methodology.....	20
the research flow.....	20
Research question.....	19, 152, 158, 177
Research Question.....	18
Responsibilities matrix	38

S

Security management	28
Service Value Level	35
Service Value Model.....	27, 34, 35, 43, 56, 57, 63, 64, 117
Settlements	67
Starting values.....	44

T

Telecommunications Services Offering 9, 11, 12, 18, 20, 23, 60, 61, 62, 70, 71, 73, 75, 76, 84, 92, 109, 112, 121, 123, 129, 136, 141, 142	

U

UNDP.....	112
United Nations Development Programme.....	112
Universal service.....	51
Universal service fund	51

V

Value Added Services Value-added-services.....	35
Value chain model.....	26
Virtual Private Network service	71
Virtual Private network services.....	69

W

World Trade Organization	59
WTO.....	See World Trade Organization

Y

Yankee Group Regulatory Index.....	32