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PREFACE

The Centre for Telematics and Information Technology (CTIT) has concluded its third year of operation. If we assess the last three years in light of the initial expectations, and what we have learned from our experiences, we can conclude that steady progress has been made towards achieving the goals spelled out in the mission of the CTIT: multidisciplinary research in the design of complex telematics and information technology systems, explicitly taking into account the embedding in user environments.

Achieving synergy between the disciplines present in the CTIT has been and still is a learning process. It is a process of change in which researchers with an established track record in their own field, have to go beyond their familiar environment and enter a dialogue with researchers from other fields with quite different perspectives. A multimedia database expert has to interact with a cognitive ergonomist, a mathematician has to work with a researcher in optical technology and people in education have to engage in a dialogue with computer scientists designing middleware platforms.

The benefits are often not perceived directly. Effort has to be invested by researchers which detracts from their estabished path, and worse, may even lead to a temporary dip in the rate of publication, the measure by which researchers are conventionally judged.

A long term perspective is needed and a conviction that one will perform more effectively in one's particular research discipline if one's personal goals are derived from a wider multidisciplinary context. The CTIT has learned that a continuous and sustained effort is needed from all involved to make it work, and it has proven to work! The process is however being accelerated by the fact that this awareness for the need of multidisciplinary research is growing in society and is reflected in the research funding at a national and at a European level.

CTIT has grown in 1996, both in quantitative and qualitative terms. The number of externally funded projects increased to 14. A highlight of 1996 was the successful conclusion of PLATINUM, a high visibility project, which created and demonstrated a platform for ATM-based advanced multimedia applications. This in turn led to the start-up of a new national project, MESH, concentrating on applications in the realm of tele-education and tele-medicine.

This year the university awarded CTIT a grant of 1 MFl per year for a period of five years in order to bolster the position of telematics research as a spearhead activity. An important event in 1996 was the participation of CTIT together with other institutes in a successful bid for a national Telematics Institute. This institute, which will start operating in 1997, will be strongly driven by the needs of industry and society. The impact on CTIT will be considerable and will amplify the opportunities for doing research.

The future looks promising. One cloud is the worsening problem of human resources. Due to the success of the ICT sector and the decrease of students in the technical fields, it is increasingly difficult to staff projects. A major effort and international recruiting will be needed to alleviate this problem.

Once again the members of the Board of the CTIT have played a critical and inspiring role. Their involvement and genuine interest in CTIT matters have been a strong support and have guided us in navigating through sometimes difficult waters. I would like to express my gratitude for this.
Last but not least I would like to thank all the CTIT researchers, Scientific Council members and support staff. Their dedication is crucial for reaching the ambitious goals that CTIT has set for itself.

Prof. dr. ir. I.G. Niemegeers
Scientific Director

Part I: The CTIT in 1996

1 Telematics Research at the CTIT

To respond to the challenges posed by the rapid developments taking place within the combined areas of communications, information technology, and related social, business and management sciences, the Centre for Telematics and Information Technology (CTIT) began operation in 1994. The research within the CTIT is focused on the design of complex telematics and information technology systems. Not only technical apects of these systems are investigated, but at the same time the complex issues are addressed of how to successfully introduce and use these systems in organizations, businesses and private lives. The institute is well equipped to meet the challenges, since it combines expertise of technical and non-technical disciplines from seven departments of the University of Twente. This has proven to work: at the end of 1996 a wide diversity of disciplines collaborated in a growing number of multidisciplinary projects.

1.1 Telematics: a spearhead of research at the University of Twente

In recent years, telematics has become one of the spearheads of research at the University of Twente. To strengthen the UT's position within the telematics research area, the Board of the University granted in 1996 for a period of five years an incentive of 1 Mdfl per year to the CTIT. Consequently, the CTIT will be in a good position to participate in a national initiative for a Leading Technological Institute on Telematics (LTIT)[1] (see Section 1.3.1).

The incentive is spent on reinforcement of the CTIT's research organization, by appointing senior staff members responsible for key disciplines. Crucial areas that are to be reinforced are:

- Architecture of Telematics Systems and Applications
- User Environments

1. Leading Technological Institutes are large research institutes, to be established by the Ministry of Economic Affairs, in order to improve the competitiveness of Dutch industry, by improving and intensifying knowledge transfer between academia and industry.

- Telematics Application Systems
- Communication Networks
- Operational Aspects and Management of Telematics Systems

These disciplines are of vital importance for participation in a future LTIT. The first senior staff member started his work on January 1, 1997.

Next, the CTIT will introduce a "Distinguished Visitors Programme", through which leading scientists within the field of telematics will be invited to visit the CTIT on a temporary basis, in order to give an impulse to specific research areas. The "Distinguished Visitors Programme" is especially meant to strengthen research areas that are at present inadequately represented within the CTIT, e.g., legal aspects and techno-economic aspects of telematics.

The remaining part of the incentive is used for the funding of the IDYLLE project, one of the larger multidisciplinary projects within the CTIT.

1.2 1996: A quick overview

Research Programme

In 1996, efforts continued to bring about coherence in multidisciplinary research activities and the acquisition of projects. The CTIT Research Programme will, in fact, provide a framework for all these activities. The Programme has a scope of five years, and defines the main research areas within the CTIT. An outline of the programme is given in Section 2. The descriptions for a number of research areas have been produced in 1996. The CTIT plans to cover the remaining research areas by mid 1997.

Research Projects

The number of externally funded projects increased in 1996 to 14. By the end of 1996, more than half of the budget of the autonomous part of the institute originated from external funding. This led to an increase of personnel from sixteen to twenty-three within the autonomous part of the institute (see Appendix 5).

In 1996, also the first projects were concluded, e.g., the PLATINUM project, which has resulted in a protocol architecture for application platforms, enabling multimedia services, such as video-conferencing and cooperative document editing. Together with a number of partners, we succeeded in acquiring a follow-up project to the PLATINUM project: the MESH project (start: November 1996).

Multidisciplinary research

Although bringing together technical and non-technical disciplines in joint projects is not an easy task, all personnel presently involved in multidisciplinary projects have developed a very positive attitude towards such collaboration. The added value of multidisciplinary research becomes clear!

1.3 Opportunities

1.3.1 Leading Technological Institutes

In 1995 the Minister of Economic Affairs issued a report "Kennis in Beweging"[1] in which he disclosed his views on increasing and improving the economic growth in the Netherlands by forming five Leading Technological Institutes in areas closely linked to Dutch industrial interests. These institutes will be funded by three parties: the government (about 11 Mdfl per institute per year), industry and the participating institutes.

Within the area of telematics, an initiative for a Leading Technological Institute (LTIT) was started by the Telematics Research Centre (TRC). The TRC succeeded in building a strong consortium of companies and research institutes. The plan of the Telematics Consortium successfully passed all selection rounds, resulting in a positive decision by the Ministry of Economic Affairs in April 1997. The institute will start operating by October 1997.

For the CTIT it is of major importance to be part of this initiative; participation in a LTIT is a unique opportunity to better fulfil our mission. Besides firmly

1. "Kennis in Beweging: over kennis en kunde in de Nederlandse economie", Report Ministry of Economic Affairs (24R58), 1 June 1995.

establishing the CTIT as the centre of academic expertise in the field of telematics in the Netherlands, it will also give access to substantial sources of funding for telematics research. On the other hand, the CTIT is an attractive partner to the LTIT, due to its unique combination of expertise from various disciplines.
The CTIT will participate in the LTIT as a partner of the TRC. Other partners are CWI, TNO and the University of Delft. The University of Twente has committed a contribution of 1Mdfl per year to the Consortium, to be spent through the efforts of the CTIT in LTIT projects.

Research within a Leading Technological Institute Telematics
The CTIT, as part of the LTIT, will have to adapt its way of working according to the requirements of the LTIT. This has quite a few consequences for the research and the researchers that will operate within the LTIT context. The Research Programme of the LTIT will be determined by the Programme Council of the LTIT; the same holds for the daily research management. LTIT research will be divided in *basic research*, which is of a generic nature, generally of long-term duration with a strategic character, and *market driven research*, which is closely linked to the needs of industry, mostly of short-term duration. Basic research must always be at least 50%. There will be a matching volume of market research. This 50/50 balance basic/market research is based on the philosophy, that effective knowledge transfer from universities to companies requires a substantial amount of market driven research carried out jointly with industry. With its relative high participation in external projects with industry, the CTIT is expected to meet this requirement. However, a substantial amount of CTIT research will remain outside the LTIT, and will be managed directly by the CTIT.

The CTIT, as other academic partners, will have direct influence on the research programme of the LTIT via membership of the Programme Council. This allows us to harmonize the research programmes of both organizations as much as possible.

1.3.2 Graduate Schools

In 1996 the research and educational programme of a Telematics Graduate School were defined. Principle partners in this graduate school are the CTIT, the Technical University of Delft, and the Telematics Research Centre. It formally started in March 1996 with a joint Workshop, and will apply for official recognition by the Dutch Academy of Sciences in 1997.
Besides a major participation of CTIT research groups in this graduate school, some groups are involved in other graduate schools: IPA (software algorithms), SIKS (knowledge-based systems), BETA (business engineering and technology application), MRI (mathematics) and COBRA (communication technology / opto-electronics).

1.3.3 Telematics Degree Programme

In 1995, initiatives were started to an undergraduate telematics degree programme. At first a ’telematics annotation’ of the existing Master’s exam has been introduced in 1996 for students of Computer Science, Electrical Engineering and Business Information Technology. In 1997, the Telematics Degree Programme will take further shape: a separate telematics curriculum, combining technological, as well as business, legal and social sciences courses in a coherent framework. The programme will thus be multidisciplinary. Although the CTIT is not the initiator of this academic programme (which is the department of Computer Science), it is clearly based on the concepts of the CTIT research.

1.4 Regional activities

The CTIT also intends to expand its regional function. In 1996 it has been invited to join working groups, which intend to promote the deployment of telematics and technology in the Twente Region and the "Three Cities Triangle" (Deventer, Apeldoorn and Arnhem). The first working group recently issued the "Regional Technology Plan Twente", in which the CTIT, together with the TRC, plays a role.

1.5 Knowledge and Demonstration Centres

The CTIT plans to create expertise centres: one on Advanced Networks and Applications (ATM technology, measurements, and management), one on the use of Object Oriented Technology, and one on Information and Communication Technology for Education.

The objective of establishing these centres is twofold: to advance the dissemination of knowledge, available at the university, as well as to inspire the research through new (practice-based) questions. To this end, the CTIT collaborates with suppliers of equipment and potential users, and participates in the University's Demonstration Centre 'Da Vinci'. These centres will provide demonstration facilities and courses, expertise on relevant scientific research, applications and future developments, and information on telematics standards, telematics products, and experiences with the introduction and use of telematics.

2 Developments in Research

'Integration' is the key-issue in characterizing the CTIT research. In 1996, efforts continued to bring about this integration between technical and nontechnical disciplines. The CTIT adopted the philosophy to chart a *research perspective* in the form of a research programme with a scope of 5 years. This programme forms the reference point for projects, such as for example ACTS and ESPRIT projects, individual PhD projects and other externally funded projects.

2.1 Research Programme

The research programme (which is still under development) is divided in the following areas:

1. Use of Telematics and Information Technology

- Business and Telematics
- Public Administration and Telematics
- Tele-Education
- Transport and Logistics

2. Telematics Systems

- Telematics Services
- Communication Networks (including Optical Networking and Broadband Networking)
- Network Applications
- Systems Management

3. Methodology

- Design Methodology and Architectural Concepts
- Performance, Measurements and Design of Telematics Systems
- Software Engineering for Telematics/Telecommunication Systems
- Language Speech and Information Engineering
- Software Tools for Telematics Systems
- Formal Methods

4. Multimedia

- Multi-Media
- Mobile Computing

Part of the research programme has been formulated in 1996; by mid-1997 the programme will be completed.

2.2 Overview of 1996 Research

The research programme forms a framework and reference point for the CTIT projects. Projects vary widely: they can be funded by the European Union, national or local government, university etc., and be of different sizes, e.g., large national or international projects versus individual PhD-projects. Projects address research issues, identified in one or more research areas described in the programme.

The projects started at the end of 1995 produced their first major results in 1996. This concerns the *INSIGNIA, TOBASCO* and *WIDE* projects, the *Optical Networks* project and the PhD project on *User Interfaces for a Multimedia Database*.

In the first half of 1996 new projects started: *Twenty-One* (language engineering, *IDYLLE* (Tele-learning), a PhD project on *Evaluation of Performance and Quality of Service*, and *Testbed* (Business Process Re-design). Two projects were concluded: the project *Implementation of tools for monitoring the status and utilisation of the network and distributed services* (April 1996) and the *PLATINUM* project (June 1996).

Mid-1996 the *MobyDick* project began, as well as a PhD project on *Desktop Tele-learning Environments*, the project *OL2000* (Overheidsloket 2000, Information Services for Citizens), and two projects for SURFnet, the Dutch Academic Network (*SURFnet IV Infrastructure* and *Management of SURFnet IV*). Finally, mid-November the follow-up of the PLATINUM project, *MESH* (Multi-Media Services on the Electronic Superhighway) was launched.

All projects together have led to an annual turnover in 1996 of 1.635 Mdfl direct funding and of 1.167 Mdfl external funding in the autonomous part of the institute. In 1997, the direct funding will decrease a little, because one of the centrally funded projects ends (the project: *Societal effects of Scientific Re-*

search relating to the 'Telematicastad Twente'). The external funding, however, is expected to increase to at least 1.912 Mdfl. Figure 1 illustrates the funding history and projections for 1997.

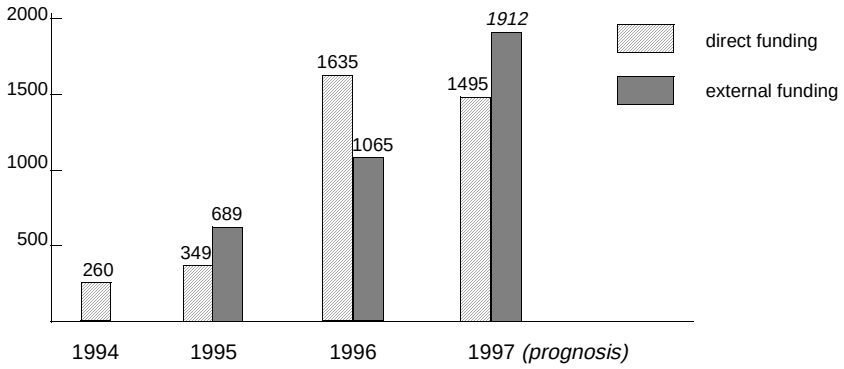

Figure 1: Annual turnover CTIT 1994 - 1997 (in Kdfl)

The acquisition of projects led to a substantial growth in the number of employees (scientific staff and support), from fourteen to twenty-five at the beginning of 1997. This number is expected to increase further in 1997, since the procedures started for the appointment of senior researchers (see Section 1.1), vacant positions in projects have to be filled in, and new projects are about to start. Finding qualified people will be a major concern in 1997.

In the following sections, an overview will be given of the projects which are running at present. A more detailed progress report on these projects is given in Part II. The (mainly internal) projects within the federative part will be accounted for in internal reports of the participating departments

2.3 Research Projects

2.3.1 PLATINUM (1995-1996)

The **PLATINUM** project (PLATform providing Integrated services to New Users of Multimedia) aimed at developing innovative multimedia applications, supported by advanced broadband network technology. Both user and technology perspectives have been taken into account. The PLATINUM project ended on June 30, 1996.

2.3.2 MESH (1996-1998)

The MESH (Multi-Media Services on the Electronic Superhighway) project is a follow-up of the PLATINUM project. The overall goal is to accelerate the introduction of advanced, relevant and flexible telematics services.

2.3.3 TESTBED (1996-2001)

The Testbed project (Test Environment for the Off-line Analysis and Re-design of Business Processes) aims at the development, application and dissemination of knowledge, methods and tools for off-line analysis and redesign of business processes.

2.3.4 IDYLLE (1996-2000)

'IDYLLE' (Innovative Distributed Learning Environments): the main target of the project is the development of distributed learning environments in order to improve the quality of the instructional process and reduce its costs through the use of telematics. The focus is on higher education.

2.3.5 ACTS/INSIGNIA (1995-1998)

INSIGNIA (IN and B-ISDN Signalling Integration on ATM Platforms) focuses on the definition, implementation and demonstration of an architecture for network control functions involving Intelligent Network support.

2.3.6 ACTS/TOBASCO (1995-1998)

TOBASCO (Towards Broadband Access Systems for CATV Optical networks) explores ways to introduce broadband interactive services in a fibre-coax CATV network with high splitting ratio, by using a high-density wavelength multiplexing upgrading strategy in combination with conventional TDMA techniques. The CTIT contribution in this project is the study and design of wavelength assignment techniques and their integration into the network management and control system.

2.3.7 ACTS/RAINBOW (1996-1999)

The ACTS/RAINBOW (Radio Access Independent Broadband On Wireless) project investigates the architectural and integration issues related to UMTS (Universal Mobile Telecommunications Service) access to B-ISDN networks. The project will implement a radio access system and the mobility control functions for UMTS in order to provide a proof of concept for these architectural ideas.

2.3.8 Twenty-One (1996-1998)

The Twenty-One project (Development of a Multimedia Information Transaction Tool) aims at improving the distribution and use of multimedia documents, and facilitates access to them by supporting cross-language retrieval. Users can retrieve documents in any of the languages covered by the project, irrespective of the language they prefer to use for their queries. The project focuses on the domain of sustainable development and ecology, but the technology developed in the project will be domain independent.

2.3.9 Pop-Eye (1997-1998)

Pop-Eye is a pilot application project, aiming at the needs of professional producers of video productions, such as broadcasting companies. The project objective is to facilitate the disclosure of video documents by using subtitles as a basis for multilingual indexing. Both indexes and scripts will be made available via Internet and/or CD-ROM, thus providing users with very rapid access to the corresponding video sequences.

2.3.10 ESPRIT/WIDE (1995-1998)

WIDE is focused towards the development of advanced database technology for workflow management (WFM) systems, and methods and techniques for the design of workflow management applications related to this technology. In 1996, results were achieved in three main areas: advanced transaction management, database and workflow system architecture, and workflow methodology.

2.3.11 MobyDick (1996-1997)

In this project the architecture of a new generation of hand-held computers, so-called Pocket Companions, is developed and defined. These devices are resource-poor, i.e., they have a small amount of memory, limited battery life, low processing power, and they are connected with the environment via a network with variable connectivity. The system is designed for daily use applications, such as: guided tours, electronic payment, ticket payment, information retrieval, etc. In 1996, the CTIT researchers have mainly worked on two subjects: wireless communication and security.

2.3.12 BELSIGN (HCM Network Behavioural Design Methodologies for Digital Systems) (1994-1997)

The BELSIGN network is a human capital and mobility network, aiming at advances in the fields of VLSI processor architecture, high-level synthesis, testability and verification of digital circuits, functional simulation, and protocol specification and synthesis. CTIT research concentrates on methodologies for hardware synthesis of protocol functions, in particular those design and implementation aspects having major impact on the speed.

2.3.13 CEO project: Implementation of tools for monitoring the status and utilisation of the network and distributed services (1995-1996)

The CTIT, together with ESYS ltd. have performed a 'proof of concept' study on the design and implementation of tools that allow status and utilisation monitoring of networks and distributed information servers.

2.3.14 SURFnet IV (1996-1997)

The CTIT participates in two subprojects: '*Management of ATM Networks*' and '*SURFnet IV Infrastructures*' of the SURFnet IV (future dutch academic network) programme.

Management of ATM networks

The research on management of ATM networks has a strong practical orientation, and is particularly focusing on the management problems of the dutch

ATM research net (SURFnet4), which is connected to the 34-Mbit pan-european JAMES network.

SURFnet IV Infrastructures

Within the SURFnet IV infrastructure project, 3 mini-projects started:

- the *SVC tunnelling project:* to test the ability of local ATM switches to set up switched virtual circuits through permanent virtual circuits;
- the *provision of VBR service over the SURFnet4 ATM network:* to test the VBR service profiles for SURFnet using a device which inherently generates VBR traffic;
- *Cell Delay Variation Tolerance (CDVT) and Burst Tolerance (BT),* traffic parameters of the underlying ATM network. The task for this project was to investigate, in both the national network and an international network, the changes in the CDVT/BT for cell streams as they passed through various switches and subnetworks.

2.3.15 Optically Circuit and Packet Switched Networks (1995-1999)

This project on multi-access, multi-dimensional optical networks addresses aspects of an optical fibre core transport network as well as a local area network for business communication, emphasizing their interworking and aiming at proving the feasibility by conducting experiments on a laboratory scale.

2.3.16 Tele-loket / Civic Service Center 2000 (1995-1998)

Tele-loket is an internal CTIT research initiative, which fits in a national programme initiated by the Dutch Home Department (Civic Service Center 2000). The aim is to increase the accessibility of governmental information and services by electronic means and telematics applications.

2.3.17 Societal Effects of Scientific Research relating to the "Telematicastad Twente" (MEWO) (1996)

In this project attention has been given to a variety of aspects related to a "virtual city" that is connected to the Electronic Superhighway. It deals with the societal effects primarily to be found within the context of regional telematics

applications initiatives (e.g., TwenteWeb). The project was funded by the University of Twente, and ended December 1996.

2.3.18 Desktop Tele-learning Environments (1996-2000)

This PhD-project has recently been incorporated in the 'IDYLLE' project. The output will be an advanced high-speed network-based environment that can be used in project-based learning that supports more effective and more efficient employment of this instructional form. The results will be reported under 'IDYLLE'.

2.3.19 Methods and Techniques for Simulation of Telecommunication models (1996-2000)

Recent research on rare event simulation of telecommunication models has focused on importance sampling. In this project we are looking for alternative approaches which may be applicable to broader or a disjoint class of models. One such approach is the RESTART method. Exact results have been obtained mainly for Markov chains. It is now tried to extend the method to classes of problems which are not Markovian.

2.3.20 User Interface for a Multimedia Database (1995-1999)

This PhD-project focuses on the application of database technology to multimedia data. To allow users to share and retrieve multimedia data, we need a way to combine evidence from different representations of the multimedia data and incorporate relevance feedback. The database has to 'talk' with the user about his information need. It is investigated how the application of probabilistic networks enables a powerful query interface to the multimedia database.

2.3.21 Next generation Hospital Information Systems (1994-2000)

In this project, two PhD-students cooperate. The focus is on application of compression and security techniques in a variety of medical data transfer applications. Unfortunately, the progress of this project has been hampered in 1996, due to the leave of one of the PhD-students.

2.3.22 DAMD project

DAMD (Design de Aplicacoes Multimidia Distribuidas) is a project of the Brazilian ProTeM-CC phase III program, founded by the Brazilian Ministry of Education. The participation of the CTIT consists mainly of consultancy. The objectives are the development and evaluation with practical case studies of a methodology for the development of distributed multimedia applications on top of high speed networks.

2.3.23 TeleCoach (1996-1998)

TeleCoach is a so-called BVE-project (dutch: Beroeps- en Volwassenen Educatie - Vocational and Adult Education), aiming at the development of a flexible learning-environment that will be used in adult education. A number of tools is being developed in order to give concrete shape to the TeleCoach- concept. CTIT's contribution concerns the evaluation of the project itself, and the development of a manual that can be of help in implementing the TeleCoach concept in practice.

3 CTIT Organization

3.1 Research Staff

The institute consists of so-called "federative" and "autonomous" parts. The federative part consists of the contribution of the participating departments (research staff and related budgets remain under the control of the departments, but are assigned to the institute; the director of the CTIT is only authorized to *manage* this research manpower); this contribution has been allocated for a period of 5 years. The autonomous part comprises the personnel appointed by the CTIT itself, as well as budgets acquired from incentives and external funding.

The institute's manpower for 1996 is shown in Table 1. The units are fte's (full time equivalents, i.e., manyears).

department	1st (direct) funding	2nd (indirect) funding	3rd (external) funding	total
Computer Science	34.75	5.7	21.15	61.6
Electrical Engineering	15.15		1.0	16.15
Applied Mathematics	1.8			1.8
Educational Sciences	1.02			1.02
Business & Management Sciences	0.9			0.9
Public Administration	1.0		1.0	2.0
Philosophy and Social Science	1.2			1.2
subtotal	55.82	5.7	23.15	84.67
CTIT-autonomous	9.53		9.31	18.84
total	65.35	5.7	32.46	103.51

Table 1: Contribution in manpower per department in 1996

3.1.1 CTIT personnel

The number of people employed by the CTIT steadily increased in 1996. Contracts concluded for personnel in projects are generally on a temporary basis (between 2 and 4 years), except those of the management staff. The total number of personnel employed per 1-1-1996 amounted to 16, per 31-12-1996 it was 23 persons. In 1996, six employees left the CTIT and fourteen new ones were appointed[1].

By January 1997, there are a few vacant positions in projects. The procedure has started to fill in the senior staff member positions for strengthening CTIT's 'backbone'.
By the time the senior staff member positions are filled in, the internal organization of the CTIT can be structured according to plans formulated early in 1996. Senior staff members have a responsibility in defining the research strategy, leading multidisciplinary projects, acquiring external projects, project reviewing, management tasks and guiding PhD-Students.

3.1.2 Exchange of researchers

One of the CTIT researchers, J.T. van der Veen, visited the Hewlett Packard Laboratory in Bristol from November 1, 1995 through June 30, 1996 to start up CTIT research on the role of measurements and monitoring in network management and control.

Within the BELSIGN project (Human Capital and Mobility), Miss M.A. Anton Gil from the University of Cantabria, Spain, visited the CTIT from March-June 1996. Another exchange of researchers within the BELSIGN network is planned for 1997.

3.1.3 Starting entrepreneurs

The University of Twente has a funding programme (TOP) to stimulate young entrepreneurs in starting up a new business. This business should have a link with research at the University. One CTIT researcher, Dr. A.N. Ladhani, succeeded in acquiring this grant. His business *"3D Interfaces"* provides Human Computer Interaction consultancy for commercial and business applications. A second young entrepreneur, H.C. Theisens, has acquired a grant per February 1997. His business is linked to the research of the Multimedia Database Group.

3.2 Institute's finances

The institute's budget in 1996 largely consisted of the capitalization of the input of the participating departments of the Institute. This 'federative' budget

1. See Appendix 5

remains under the formal control of these departments. In addition to this budget, the CTIT has its own 'autonomous' budget.

The total budget of 1996 is shown in Table 2. The units are Kdfl.

				(in Kdfl)
Department	1 st (direct) funding	2 nd (indirect) funding	3 rd (external) funding	total
Computer Science	7.991		2.200	10.191
Electrical Engineering	2.879		159	3.038
Applied Mathematics	192			192
Educational Science	68			68
Technology & Management	103			103
Public Administration				
Philosophy and Social Science	115 138	75		190 138
Total federative part	11.486	75	2.359	13.920
Autonomous part	1.635		1.065	2.700
Total CTIT	13.121	75	3.424	16.620

Table 2: The CTIT budget in 1996 (in Kdfl)

The estimated budget for 1997 is shown in Table 3:

direct funding	external funding	total autonomous budget	total federative budget	total budget 1997
1.495 [a]	1.912 [b]	3.407	15.000	18.407

Table 3: The CTIT budget 1997 (in Kdfl)

a. central budgets and contribution TIOS-group
b. including estimation Testbed project, excluding part of the SURFnet project (1996 part: 92.5 Kdfl is included in the results of 1996)

Figure 1 represents the growth of the budget in the period 1994-1997 (in Kdfl):

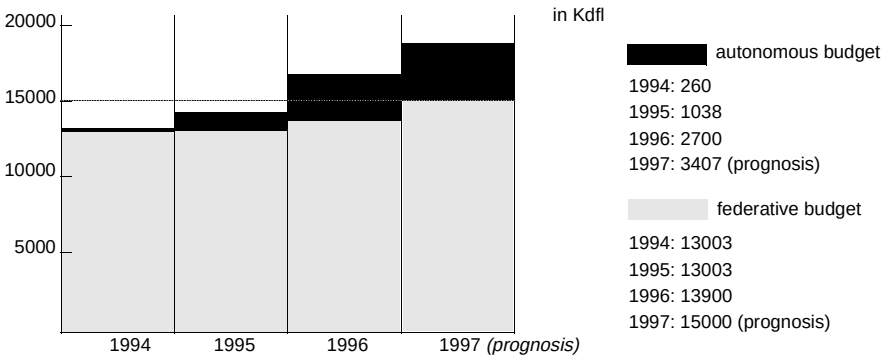

Figure 1: CTIT budget 1994-1997

3.2.1 Autonomous budget

In 1996, the following budgets have been allocated by the University of Twente to the CTIT: 200 Kdfl central allocation, 245 Kdfl allocation for innovative research (3 PhD projects), 250 Kdfl for the IDYLLE (=Tele-Learning) project, 750 Kdfl for strengthening the CTIT within the framework of a Technological Topinstitute Telematics (sections 1.1 and 1.3), and 100 Kdfl for the MEWO project. The Tele-Informatics and Open Systems (TIOS) group of the departments of Computer Science and Electrical Engineering contributed with 90 Kdfl to the salary costs of the management staff. See Table 4 for an overview of the autonomous budget in 1996[1].

1996		Autonomous part (in Kdfl)	
expenditures		budgets	
direct funding (1)			
salaries	603.5	central budget	200.0
travel / meeting costs	64.6	innovative research	245.0
equipment / software	20.7	strengthening CTIT	750.0
maintenance	38.2	IDYLLE	250.0
comm. facilities	17.4	MEWO	100.0
general expenses	28.7	contribution TIOS	90.0
network	6.8		
housing, etc.	36.0		
library	2.8		
reservation salaries			
senior researchers [a]	750.0		
result [b]	66.3		
total	1635.0		1635.0
external funding (3)			
salaries	584.4	*national projects*	
travel / meeting costs	92.0	-PLATINUM	378.9
equipment / software	92.5	-SURFnet	92.5
maintenance	29.6	-IOP Optically Networks	57.9
comm. facilities	1.5		
general expenses	13.0	*European projects*	
network	6.0	-CEO: Impl. of tools etc.	33.9
housing, etc.	32.0	-Insignia	220.1
library	2.5	-Tobasco	84.8
result [b]	211.2	-HCM/BELSIGN	46.9
		-MobyDick	31.9
		-Twenty-One	87.6
		-KPN/Rainbow	30.2
	1064.7		1064.7
total budget CTIT	2699.7		2699.7

Table 4: Autonomous budget 1996 (in Kdfl)

a. vacancies are expected to be filled in early 1997
b. including salary reservations for 1997 and reservations for finishing PhD studies in later years

1. These are updated figures, in comparison to the Annual Financial Report 1996 of the University of Twente. Overhead contributions to the department of Computer Science have been settled.

3.2.2 Justification

Direct funding

Travel and meeting costs include the costs for the Annual CTIT Workshop (5 Kdfl), the IDYLLE Workshop (on Tele-Education - 1 Kdfl), the Graduate School on Telematics Workshop (6.5 Kdfl) and sponsoring of the IEEE 802 meeting (7.5 Kdfl). Equipment concerns mainly the purchase of personal computers for newly appointed CTIT personnel. Maintenance refers to maintenance contracts with suppliers, as well as the maintenance performed by the technical staff of the department of Computer Science.

External funding

Travel and meeting costs concern mainly the travel costs for European projects. Equipment includes the purchase of personal computers for newly appointed CTIT personnel, as well as special equipment (a.o. a spectrum analyser, 48 Kdfl) for the Optically Networks project.

Results

As well in the direct funding, as in the external funding, there is a positive result. These results are fully committed for salary reservations in 1997 (management staff and research staff), and for extensions of contracts. The CTIT has made arrangements with three PhD-students to extend their contract with one year, in order to finish their PhD-thesis (a reservation of 186 Kdfl).

3.3 Public Relations

3.3.1 CTIT Publications

In 1996 three Ph.D.-Theses were published in the "CTIT Ph.D.-Thesis Series" and forty-nine Technical Reports[1]. It is expected that these numbers will show a growing tendency in the coming years.

3.3.2 Workshops and Conferences

CTIT Workshop

The Annual CTIT Workshop was held on April 19, 1996, in Boekelo near Enschede, The Netherlands. Presentations were given on CTIT projects, such as PLATINUM, Tele-learning, the CEO-project and WIDE. The workshop was closed with a panel discussion on "Multimedia", led by Peter M.G. Apers. Members of the panel were: Han Albers (KPN Research Multimedia), Alexander Peek (Lucent Technologies), Maurice Houtsma (TRC) and Jef Moonen (University of Twente).

IDYLLE Workshop

On August 28, 1996, the IDYLLE project (on tele-learning) had its first workshop. The project and all its subprojects were presented. It is the intention to organize IDYLLE workshops on a regular basis, once per half year. This first workshop was mainly an official kickoff of the project, intended for CTIT members, but the coming workshops will have a national scope. The second workshop is planned on January 31, 1997.

Graduate School on Telematics Workshop

The Graduate School started in March 1996 with a joint workshop of the CTIT, the Technical University of Delft and the Telematics Research Centre in Enschede. Presentations have been given on key-projects in these institutes, to learn more about each other’s research.

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1. See Part II I: Scientific Results 1996

IEEE 802 Conference

From 8-12 July, 1996, the CTIT hosted the IEEE 802 Summer Conference. It was the first time after a long period that this Conference has been organized outside the North American continent. IEEE 802 is the main standardization body within the field of local networking, and meets in about 14 subgroups. Around 380 delegates visited Enschede. The University offered a wide variety of meeting locations, Océ Nederland B.V excellent printing and copying facilities and the CTIT, together with the Department of Computer Science, provided a special cluster of workstations and internet access to the attendants. The CTIT management took care of the local organization.

3.3.3 The CTIT Web Server

The information on the CTIT server has expanded in 1996. At the server information is available on the institute itself, its qualifications, research projects, calendar of events, newsletters and publications, as well as pointers to information on participating groups. A lot of projects now have their own project information, which is kept up-to-date in a 'distributed' way by the project members (see for example IDYLLE, TOBASCO, Twenty-One, Teleloket 1). In this way, the web functions as a real WEB!

3.4 Scientific Council

The Scientific Council of the CTIT is an advisory body to the executive committee and the scientific director of the CTIT on matters of research strategy. It formulates new ideas on future programmes, and it acts as a scientific reviewing board for programmes and projects. In the reviewing process, it may ask advice from the Research Committees of the respective departments, in case specific expertise is required. The Council meets in general once per six weeks.

In 1996, besides the regular agenda, the Scientific Council meetings have been devoted to present new CTIT research programmes. These proved to be very informative meetings, with fruitful discussions, in which a lot of information could be exchanged.

Part II: CTIT Research Projects in 1996

1 PLATINUM (1995-1996)

(Projectleaders CTIT: Prof. dr. ir. I.G.M.M. Niemegeers and Ir. J. van de Lagemaat)

The PLATINUM project (PLATform providing Integrated services to New Users of Multimedia - partially funded by the Dutch Ministry of Economic Affairs) aimed at developing innovative distributed Multimedia applications, supported by advanced broadband network technology. By taking into account both user and technology perspectives, the proper environment to foster advanced applications of the electronic superhighway is created. An important aspect of the project is that the user requirements are taken into account right from the start of the design and implementation of the applications and the system. This is crucial for the introduction and acceptance of these services. The project started on January 1995 and ended on June 30, 1996. The PLATINUM project was the start of a strategic cooperation between the partners, AT&T (NSI and GIS both now called Lucent Technologies), TRC, CTIT and Deutsche Telekom, a cooperation that continues in the MESH project.

The results of the project are:

- a working prototype of multimedia applications and the underlying ATM network for computer supported cooperation;
- shared document editing of multimedia documents, desktop video conferencing and a shared whiteboard allowing multiple users to be involved;
- a multimedia framework that can be extended with additional applications;
- specific instantiations of the framework for specific usage for, e.g., telemeeting, tele-education and co-authoring.

The total project involved 80 fte. The CTIT participated with 9 fte and contributed to the:

- architecture of multimedia applications, middleware and network;
- design of signalling and control functions;
- quantitative analysis and measurement of network functions and multimedia applications;

- design and implementation of middleware, multimedia applications and human-computer interfaces;
- assessment of usability and user requirements for tele-education.

PLATINUM Software

In the PLATINUM project a conferencing platform has been developed. CTIT mainly worked on the following two parts of this software: Conference Management and Human-Computer Interface. Conference management is responsible for the control of the conference containing group meetings, participants and media. The methods of control are the creation and deletion of these components and the control of the connection between the participants and the media that are connected to it (the so called 'floor control'). The Human-Computer Interface was designed by taking into account the user requirements as well as technical constraints resulting from the underlying middleware software. They were balanced in solving the design problem. A design solution was chosen in which the HCI was made pluggable in such a way that different HCI styles and views for different (human) user types and task context could be easily placed and exchanged on top of the middleware software.

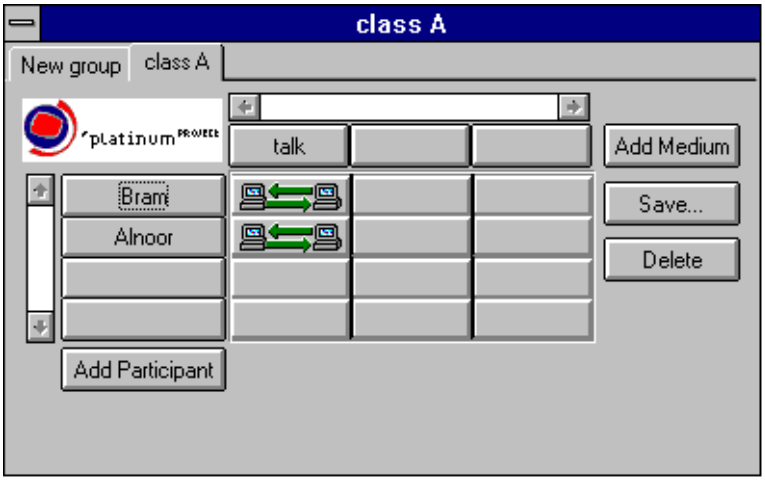

Figure 3: PLATINUM Human Computer Interface

Deliverables:

[1] H. van der Lugt, E. Heeren, A.N. Ladhani, *Scenarios for the educational settings of phase II*, Deliverable D2.2/08, PLATINUM/N018/V00.

[2] Ph. Chimento, V. Jones, L. Ferreira Pires, M.J. van Sinderen, I. Widya, *Integrated Protocol Reference Architecture (IPRA)*, Deliverable D2.3.9, PLATINUM/N020/V00.

[3] H.M. Franken, H. Jonkers, M.K. de Weger, *Development aspects of business processes*, Deliverable D3.5, PLATINUM/N021/V00.

[4] D.A.C. Quartel, *A taxonomy of models, methods, techniques and tools for application service engineering*, Deliverable D3.7, PLATINUM/N023/V00.

[5] L. Ferreira Pires, *A design methodology for application service engineering*, Deliverable D3.8, PLATINUM/N024/V00.

[6] H. Boekhorst, P. Chimento, J. Moerkerken, S. Ombre, J.A. Peek, O. Tettero, F.E.W. Vervuurt, B. van der Waaij, *Functions and algorithms used in the network*, Deliverable D4.1.2, PLATINUM/N025/V00.

[7] H. Boekhorst, P. Chimento, J. Moerkerken, S. Ombre, J.A. Peek, O. Tettero, F.E.W. Vervuurt, B. van der Waaij, *NNI requirements and functional model*, Deliverable D4.1.1, PLATINUM/N026/V00.

[8] E. Veldkamp V. Nicola, Performance Aspects of the PLATINUM Signalling System, Deliverable D4.1.3, PLATINUM/N027/V00.

Relation with CTIT research areas:

PLATINUM has been part of the areas: Telematics Services, Communication Networks, Network Applications, Design Methodology and Architectural Concepts.

2 MESH (1996-1998)

Projectleaders CTIT: Ir. J. van de Lagemaat and Prof. dr. J. C.M.M. Moonen

The MESH project (partially funded by the Dutch Ministry of Economic Affairs) is a follow-up of the PLATINUM project. It started on November 18, 1996 for a duration of 2 years. The overall goal is to accelerate the introduction of advanced, relevant and flexible telematics services in order to provide a strong competitive advantage to national industry and service providers. The objectives of this project are:

- to demonstrate the possibilities and potentials of multimedia applications for education and in the medical sector;
- to improve working practices in these sectors;
- to validate and adapt the PLATINUM technology to support improved working practices and potential commercial use;
- to develop an integrated set of multimedia services and underlying infrastructure which are tested by future users and service providers, and are tailored to their wishes;
- create and increase awareness by actively promoting results, and facilitate the introduction and use in other sectors;
- to promote and actively engage in cooperation with similar (inter-) national projects;
- to support standardization by supplying knowledge and hands-on experience.

For this project, the PLATINUM consortium (Lucent Technologies, TRC, CTIT and Deutsche Telekom) was extended with KPN, SURFnet, Roessingh, Academic Hospital of the Free University Amsterdam and the Technical University of Delft, in order to include partners from all parties concerned: application and infrastructure suppliers, users, service providers and knowledge institutes.

The project is centred around pilot experiments for tele-consultation in the medical sector, tele-education, tele-meeting and tele-cooperation. Methods are developed to help sectors to assess the value and applicability of advanced telematics services for their business processes and to disseminate these methods towards other sectors.

The total project involves 72 fte. The participation of the CTIT is 9 fte; it will contribute on:

- development of multimedia applications, architectures and supporting protocols;
- relation between protocol architecture and software architecture;
- compliance to standards, such as CORBA;
- architecture, design, implementation and evaluation of human-computer interfaces;

- effectiveness and efficiency of tele-education in higher education and modelling the educational processes and the use of advanced communication and information systems in these;
- design of the tele-cooperation and tele-learning pilots including the criteria, measurements and evaluation of effectiveness and efficiency;
- participation as a user in pilot experiments for tele-education and tele-meeting.

Relation with CTIT research area:
The MESH project is part of the research areas Telematics Services and Tele-Education.

3 TESTBED (1996-2000)

Projectleader CTIT: Dr. L. Ferreira Pires

TESTBED (Test environment for the off-line analysis and redesign of business processes) started on April 1, 1996.

Experience with the introduction of information technology and telematics to support the automation of business processes has shown that the potential benefits of automating these processes are not exploited as expected. Automation can even have a negative influence on the quality of the services or products provided to the customers. Negative results of automation can sometimes be blamed on the quality of the software or equipment utilized. However, the main problem is often that business processes are not properly designed to cope with evolution. Business processes can be jeopardized by the following factors, amongst others:

- out-of-date procedures that are poorly aligned with the opportunities generated by information technology and telematics;
- changes in customers' expectations and requirements;
- growing in costs to unforeseeable levels;
- growing competition;
- changes in legislation.

Over the past years, these factors have largely motivated the need for continuous renewal of business processes. On the one hand, this renewal allows anticipation for changes in the environment of the business processes (customers, suppliers, legislation, competition, etc.), and on the other hand offers the opportunity to fully exploit modern information technology and telematics. The need for structural renewal of business processes demands knowledge, methods and tools to test and redesign these processes in a systematic fashion. This research area is called Business Process Redesign (BPR).

Objectives

The Testbed project aims at the development, application and dissemination of knowledge, methods and tools for off-line analysis and redesign of business processes. This general objective is pursued by addressing the following issues:

- creating a learning environment for thinking in terms of customer-oriented business processes;
- developing and applying a user-oriented arsenal of knowledge, methods and tools for the (re)design of (data-intensive) business processes;
- designing a 'framework of building blocks' to allow clear modelling of the essential characteristics of business processes at various levels of detail and from different viewpoints;
- developing methods for thorough and reliable analysis and optimization of business processes in advance, separately from the existing processes;
- developing software tools that simplify the application of the developed knowledge and methods;
- stimulating the full exploitation of modern information technology and telematics in new business processes;
- disseminating the results, e.g., by publishing these results in specialized conferences.

Consortium

The Testbed project has been set up by the Telematics Research Centre (TRC), in Enschede, the Netherlands, in cooperation with ABP (a large Dutch pension

company), ING Group, the Dutch tax department and IBM. Testbed is also partly subsidised by the Dutch Ministry of Economic Affairs. CTIT participates in the Testbed project as a subcontractor of TRC.

Expected results

Four main results are expected from the Testbed project:

- an inventory of real-life needs in business processes modelling. This inventory guides the gradual application of the knowledge, methods and (software) tools that are developed in the project;
- a modelling framework consisting of building blocks, building rules and structuring principles for making models of business processes;
- a powerful design language that supports the modelling framework. This language supports unambiguous modelling of business processes and unambiguous communication between designers. Statements written in this language can be automatically processed for analysis purposes;
- dedicated knowledge, methods and powerful (software) tools for the modelling, analysis and redesign of business processes based on the modelling framework and the design language.

Results in 1996

The Testbed project is planned in cycles of six months, starting from April 1996.

The first cycle concentrated on the requirements for the modelling of business processes, the inventory of available techniques and tools, and the development of a modelling framework. Much effort has been spent on the systematic development of a modelling framework from the requirements of its users, and the adjustments found necessary after the application of the initial versions of the modelling framework on realistic case studies.

The main deliverables produced in the first cycle are:

- Deliverable 1.2.5: General needs and functional requirements
- Deliverable 1.2.6: Requirements and needs for the architectural framework for business processes modelling

- Deliverable 2.1: State-of-the-art in modelling languages and tools
- Deliverable 2.2: Business process re-engineering: trends, theory, trajectory, tools and transformation
- Deliverable 3.1: Principles for BPR modelling
- Deliverable 3.2: AMBER, an architectural modelling building-box for business processes

Since the Testbed project aims at directly communicating with the designers of business process (business managers) in the field, these deliverables have been written in Dutch. Publication [1] (in English) presents some ideas that have been applied in Testbed. The theoretical basis for the Testbed modelling framework, language and tools will be published (in English) in forthcoming deliverables, scientific papers and PhD theses.
The Testbed second cycle concentrates on the design language and the implementation of some simple tools for the analysis of business processes. Deliverables are officially issued at the end of each cycle.

References

[1] H.M. Franken, M.K. de Weger, D.A.C. Quartel, L. Ferreira Pires. "On engineering support for business process modelling and redesign". *Proceedings of the International Workshop on Modelling Techniques, Business Process Re-Engineering and Benchmarking*. Bordeaux, France, pp. 81-98, 1996.

Relation with CTIT research area:

The Testbed project is part of the research areas Business and Telematics, Tools for Telematics Systems, and Design Methodology and Architectural Concepts.

4 IDYLLE (1996-2000)

(Projectleader CTIT: Prof. dr. J.C.M.M. Moonen)

In October 1995 the project "Tele-Learning: Better and More Efficient Learning via New Paradigms and Tools" was approved for funding by the Universi-

ty of Twente from a special budget on innovative research. The project was renamed in 'IDYLLE': Innovative Distributed Learning Environments, expressing the main target of the project: the development of distributed learning environments in order to improve the quality of the instructional process while controlling the costs. The focus is on higher education. The project is part of the research programme 'Tele-Learning'.

Aim of the project

The major research question of IDYLLE relates to relationships among tele-learning processes, activities and tools, and output variables relating to the quality of education, student throughput, and costs. It is hypothesized that if learning can be offered in more flexible ways, the effectiveness and efficiency of the educational system will improve. However, large cutbacks in the budgets of universities are a serious obstacle for this kind of improvement in their instructional services. Improving the throughput of students, therefore, cannot be discussed independently of the available time that instructors can spend on instruction and the money made available by the institution on facilities for the instructional purposes.

The aim of the project is to develop and test tele-learning tools that can potentially solve the needs described above, making use of the latest developments in the field of Information and Communication Technologies. During the first year of the project, design-criteria have been specified in more detail, and a start has been made with the development of different tele-learning tools. For example, a prototype of a tool has been constructed that can be used by instructors in designing and coordinating courses. Also, an inventory has been made up of telematics-support environments for project-based education that are already in use. Output of the project will be knowledge about how tele-learning tools can be used in supporting the throughput of students in higher education and reduce its costs through the use of telematics.

This research question is being addressed in a multidisciplinary manner whereby educational, technological and ergonomical perspectives and approaches are employed.

IDYLLE consists of five PhD-projects:

- *Studying effectively and efficiently using tele-learning*

  The focus of this sub-project is the overall investigation of the relationship of tele-learning to the effectiveness and efficiency of higher education. An instrument will be developed that can be used in designing tele-learning environments and diagnosing existing education with respect to effectiveness and efficiency.

- *Modelling, design and quality analysis of tele-informatic embedded educational information infrastructures*

  A flexible way of organising course environments by means of which interactions, tasks, and resource utilisation can be integrated, will be developed, designed and tested. This educational information infrastructure will be embodied by means of a "human-computer interface" to support the flexible representation, organisation, and realisation of course material.

- *Distributed educational multimedia databases: design, production and application*

  "Rich learning environments" give users access to distributed digital libraries in which text, sounds, still pictures and moving pictures are combined. Methods for structuring and presenting information for these kinds of databases to support users who differ with respect to information needs will be developed.

- *Facilitating distributed collaborative learning by means of interaction modelling*

  The output of this project will include interaction guidelines for tele-learning situations. Through the development of an Interaction Modelling Theory for the analysis and representation of interaction in a self-regulating learning community, essential aspects of interaction will be identified.

- *Project-based tele-learning: analysis, modelling, design and evaluation*

  The output of this project will be an advanced high-speed network-based

environment that can be used in project-based learning that supports more effective and more efficient employment of this instructional form. The research is conducted on the basis of existing problems relating to the effectiveness and efficiency of collaborative learning and working in problem-based project-oriented learning tasks.

All PhD-students work closely together and interact frequently with the involved researchers of the departments of Instrumentational Education, Tele-Informatics and Open Systems, Information Systems and Cognitive Ergonomics. IDYLLE has thus become in practice a real CTIT-integration project

In its first year, IDYLLE achieved a real central position within the CTIT, with links to the 'Educational Centre' (Onderwijskundig Centrum, which advises departments of the university on improvement of curricula) and other tele-learning activities in- and outside the university. IDYLLE has also strong connections with the MESH project.

IDYLLE members are active in regularly organizing presentations, and once per half year an IDYLLE Workshop (28 August, 1996 and 31 January, 1997).

More information:

http://wwwtios.cs.utwente.nl/ctit/projects/osf-TL/IDYLLE.htm

Relation with CTIT research area:

The IDYLLE project is part of the research areas Tele-Education, Multimedia and Telematics Services.

5 ACTS/INSIGNIA (1995-1998)

Projectleaders CTIT: Prof. dr. ir. I.G.M.M. Niemegeers and Dr. Ph. Chimento

INSIGNIA (IN and B-ISDN Signalling Integration on ATM Platforms) focuses on the definition, implementation and demonstration of an advanced architecture for network control functions involving Intelligent Network support.

The project started September 1, 1995, for a three-years period.

Partners in the INSIGNIA project are: ATEA, CORITEL, CSELT, Fondazione Ugo Bordoni, GPT, GEC Research, GMD Fokus, Italtel, NTUA, RWE Telliance, Siemens Germany, Siemens-Albis Switzerland, Telefonica S.A.

INSIGNIA Project in 1996

Within the CTIT a number of people are contributing a total of about 2 person-years per year to the INSIGNIA project. In 1996, a number of things were achieved: Deliverables D1103 and I3101 as well as contributions to D3101 were completed and delivered to the EC on time. These were major milestones and CTIT personnel coordinated a number of partners to produce them, as well as having supplied major contributions themselves.

Within activity A.1.1.4, the CTIT contributed simple and detailed performance models of the SSF and CCF functional elements of the B-SSP and performed initial simulation runs with these models. In addition, we contributed an extensive study of IN congestion and overload control mechanisms as preparation for evaluating these schemes and proposing new ones. Further, the CTIT contributed leadership of A.1.1.4 and coordinated the activity with the design activities of the whole project and coordinated with the activities of A.3.1.2.

Within A.1.1.4, the CTIT has also run more extensive simulations of the B-SSP (SSF and CCF models) attempting to give the design activities of WPG1 meaningful information about system performance. Furthermore, performance models for the other IN functional entities (SCF, SDF and SRF) were implemented and evaluated. In addition, the CTIT defined experiments for the evaluation of the scalability of the INSIGNIA system. Finally, the CTIT is evaluating the congestion and overload control schemes already studied and will compare their effectiveness. Our leadership and coordination activities will be continued.

The CTIT has contributed to activity A3.1.2 as the activity leader and coordinator with the A.1.1.4 performance modelling activities. The CTIT has worked within WP 3.1 to develop a realistic performance measurement plan that can be executed during the first field trial. The CTIT has developed measurement configurations, measurement scenarios, and has defined performance measurements and measurement points for the video-on-demand (VOD) service in terms of basic events obtained from the system descriptions produced by WP 1.2. These performance measures were defined for the network, and the physical network elements of the INSIGNIA system (i.e. the B-SSP, B-SCP, B-IP).

The CTIT is presently developing measures, measurements and measurement-points for the broadband video conferencing (B-VC) and broadband virtual private network (B-VPN) services, as was done for VOD. The CTIT will contribute to the development of measurement scenarios using the ATS measurement tool. Furthermore, the CTIT is investigating, with the partners, the possibility of performing measurements within the B-SCP, using internal measurement points, in order to measure the performance of the functional elements residing in the B-SCP.

The CTIT is contributing to the identification and development of performance measurement analysis and processing procedures. The actual processing and analysis of the results and the interpretation and reporting are scheduled for 1997.

Deliverables:

[1] B.J. van Beijnum, Ph. Chimento, G. Karagiannis, and V.F. Nicola, *Deliverable I3101: Planning of Performance Evaluation for the Trials*, No. AC068-A3.1.2-UOT-95001-TC-CC/a2, February 1996, 60 pp.

[2] G. Karagiannis, D.S. de Graaf, eds., *Deliverable D1103, Node-based signalling traffic models and performance parameters*, No. AC068/UOT/114/DS/P/003/b0, May 1996, 111 pp.

[3] F.J. Herrera, ed., *Deliverable D3101, First trial: scope, nature, partici-*

pants and configuration, No. AC068/TES/310/DS/L/001, July 1996, 94 pp.

[4] F.J. Herrera, ed., *Deliverable I3102, First trial: planning for services and CPE deployment*, No. AC068/TES/310/PI/I/002/b1 (*to appear in 1997*).

Relation with CTIT research area:

The INSIGNIA project is part of the research area: Communication Networks.

6 ACTS/TOBASCO (1995-1998)

Projectleader CTIT: Dr. ir. S.M. Heemstra de Groot

The European Union ACTS project TOBASCO (Towards Broadband Access Systems for CATV Optical networks) explores ways to introduce broadband interactive services in a fibre-coax CATV network with high splitting ratio, by using a high-density wavelength multiplexing upgrading strategy in combination with conventional TDMA techniques. It features flexible network reconfiguration via wavelength reassignment at the fibre terminating network units, a high interactive services capacity per user, and improved network scalability. The CTIT contribution is this project is the study and design of wavelength assignment techniques and their integration into the network management and control system.

In 1996, the work focused on the study of those management functions that relate specifically to the interactive services part of the multi-wavelength system, which is the innovative aspect of TOBASCO. Three evolution stages have been discerned in the TOBASCO architecture: the field trial system providing Ethernet to the user, the fully-fledged system providing Ethernet to the user with dynamic wavelength reconfiguration at the ONUs, and a fully-fledged system providing this reconfigurability with primarily connection-oriented (ATM, MPEG) services to the user. Various switching scenarios as well as operation and management of the multi-wavelength aspects of the IS have been examined to achieve optimal performance for each of these evolution stages, focusing on wavelength allocation and bandwidth assignment. The assignment of ONUs to wavelengths and the management of the bandwidth per

wavelength is based on bandwidth demand, bandwidth availability, and external events, e.g., faults and maintenance. If spare capacity is available on some of the wavelength channels, certain faults can be resolved by the management system, namely those where one or a few wavelength channels go out of order.

Deliverables

D5.1.1 Options for Network Control and Management (31/08/96). This deliverable explores options for implementation of the NM&C system, and identifies wavelength assignment strategies.

Relation with CTIT research area:

The TOBASCO project is part of the Communication Networks research area.

7 ACTS/RAINBOW (1996-1999)

Projectleader CTIT: Dr. Ph. Chimento

RAINBOW is an ACTS project funded by the European Union. RAINBOW stands for Radio Access Independent Broadband On Wireless. The CTIT participates together with KPN Research in Leidschendam and DT Mobil Münster. Rainbow is a continuation of studies performed in the RACE II framework concerning UMTS. MONET is the main reference project; w.r.t. the radio interface, it uses the outcomes of the CODIT and ATDMA RACE II projects.

The main objective of RAINBOW is to investigate the architectural and integration issues related to UMTS (Universal Mobile Telecommunications Service) access to B-ISDN networks. The project will implement a radio access system and the mobility control functions for UMTS in order to provide a proof of concept for these architectural ideas.

More specifically the objectives are:

1. to demonstrate the feasibility and estimate complexity of a UMTS access infrastructure, which is able to cope with different 'innovative' radio access techniques, and must offer a solution for migration of 2nd generation mobile systems (DECT, DCS1800, GSM);

2. to contribute to UMTS standardisation (in ETSI/SMG{35} and ITU;
3. study the integration of the UMTS radio access structure into B-ISDN (ATM) and IN, for transport and control procedures;
4. study the impact of multimedia services and variable bit-rate techniques on the transport and control procedures.

The long term view is to build a basis for a UMTS access system that is independent of the particular radio access techniques used in the access network. The shorter term view of the project is to demonstrate how second generation mobile communication systems such as GSM and DECT can be migrated to UMTS.

The CTIT personnel in this project are working on design aspects, rather than programming aspects of the project. They are concentrating their efforts in the workpackages relating to call control and intelligent networking functions. In particular, these workpackages focus on functions and related protocols for call control, handover, multicast, and interworking of UMTS and B-ISDN functions. Another aspect of this project of interest to us is the design of the signalling network layer which concerns the routing of signalling messages through the network.
Currently CTIT personnel are studying:

- (application requirements of / interface definition of) the signalling network layer;
- Why one would want to use B-ISDN (ATM) for transport and control protocols as opposed to what goes on in GSM now, i.e. use one GSM net and one (or two for redundancy) gateway to a regular PSTN or N-ISDN net.

This project offers the opportunity to extend CTITs' work in signalling systems and network control functions to the mobile communications area. Through the INSIGNIA project knowledge is already acquired of IN systems; this can be applied to RAINBOW.

CTIT members already participated in the MONET project (1992-1995)

which also dealt with UMTS and mobile communications. The participation in the RAINBOW project increases that expertise and spreads it further in the organization. It also brings the CTIT in contact with the important practical issues in mobile communications which is important to the future of the networking research group.

Relation with CTIT research area:
The RAINBOW project is part of the Communication Networks research area.

8 Twenty-One (1996-1998)

Projectleader CTIT: Prof. dr. F.M.G. de Jong

Twenty-One (Development of a Multimedia Information Transaction Tool - IE 2108, sector Information Engineering, Telematics Applications Programme) aims at improving the distribution and use of multimedia documents, and facilitates access to them by supporting cross-language retrieval. Users can retrieve documents in any of the languages covered by the project, irrespective of the language they prefer to use for their queries.

The project focuses on the domain of sustainable development and ecology, but the technology developed in the project will be domain independent. The project runs from January 1996-December 1998. By the end of 1996 the user needs were specified, plus the global functional design and the detailed functional design of the software demonstrator. A monolingual prototype version for English is already operable.

Project partners
Project partners are: University of Tübingen, DFKI GmbH, TNO/TPD, Getronics (coordinator), Xerox Research Centre France, Highland Software Limited, The MOOI Foundation, Friends of the Earth Europe, Environ Trust Limited, Climate Alliance and VODO.

CTIT Contribution
The CTIT was involved in the inventory and selection of software tools, and the design of the demonstrator, with a major accent multilinguality.

Deliverables

Substantial work has been done on the following deliverables: deliverable D2.2 "The Demonstrator Tool Overview", deliverable D2.3a "The Demonstrator Extended Tool Information Overview", deliverable D2.3b "The Demonstrator Tool Selection", deliverable D2.4 "The Detailed Functional Design". In the scope of the project a software tool was developed for the automatic extraction of translation lexicons from bilingual corpora.

Publications

Hiemstra, D. "Using statistical methods to create a bilingual dictionary", Master's Thesis University of Twente, 1996

Relation with CTIT research area:

The Twenty-One project is part of the research area Language Speech and Information Engineering.

9 Pop-Eye (1997-1998)

Projectleader CTIT: Prof. dr. F.M.G. de Jong

Pop-Eye (Subtitle: a Multilingual Continuous Video Disclosing Tool, based on Subtitle Indexing and Partial Translation) is a pilot application project within the sector Language Engineering of the Telematics Applications Programme, aiming at the needs of professional producers of video productions, such as broadcasting companies. The project objective is to facilitate the disclosure of video documents by using subtitles as a basis for multilingual indexing. Both indexes and scripts will be made available via Internet and/or CD-ROM, thus providing users with very rapid access to the corresponding video sequences. By the application of proven natural language processing and partial translation, queries can be entered in the language preferred by the user.

The CTIT (PARLEVINK-group) will be involved in the design and development of lingware and partial translation tools. On January 1, 1997, the project will start.

Relation with CTIT research area:

The Pop-Eye project is part of the Language Speech and Information Engineering research area.

10 ESPRIT/WIDE (1995-1998)

Projectleaders CTIT: Prof. dr. P.M.G. Apers and Dr.ir. P.W.P.J. Grefen

The WIDE (Workflow on Intelligent Distributed database Environment) started in November 1995 and is scheduled to be finished by April 1998. Participants in the project are Sema Group (Spain) as main contractor, Politecnico di Milano (Italy) and University of Twente as technology providers, and ING Bank Nederland and Hospital General de Manresa (Spain) as end users. The total investment in the project is about 4 MECU.

WIDE is focused towards the development of advanced database technology for workflow management (WFM) systems, and methods and techniques for the design of workflow management applications related to this technology. In 1996, substantial research effort has been spent on the project, leading to the first project results. For the CTIT, these results are in three main areas: advanced transaction management, database and workflow system architecture, and workflow methodology.

In the area of transaction management, an advanced two-layer transaction model has been designed that offers support for both process-oriented global transaction semantics and database-oriented local transaction semantics. The model caters for the requirements of complex workflow applications, but is usable in other process-oriented environments as well. The detailed architecture of an orthogonal two-layer transaction management subarchitecture has been defined. A start has been made with the implementation of this subarchitecture. The work has been reported in a main milestone deliverable. External publications are in preparation.

The overall WIDE system architecture has been defined in detail in tight cooperation between Sema Group, Politecnico di Milano, and University of

Twente. The architecture consists of an orthogonal combination of workflow engine, transaction management module, active rule management module, and commercial database management system. Distribution is a main issue in the architecture, obtained by a CORBA distributed object model, client/server interfaces, and a hierarchical workflow server configuration. A paper on the architecture has been accepted for an international workshop in 1997.

In the methodology work package, the WIDE conceptual workflow model and workflow specification language have been defined. A first step has been made towards workflow specification techniques and methods. Model and language design have been documented in CTIT technical reports. External publications are in submission and preparation.

Relation with CTIT research area:
The WIDE project is part of the Multimedia research area.

11 ESPRIT LTR/MobyDick (1996-1997)

Projectleaders CTIT: Prof. dr. S.J. Mullender and Dr. ir. G. Smit

In this ESPRIT Long Term Research project the architecture of a new generation of hand-held computers, so-called Pocket Companions, is developed and defined. These devices are resource-poor, i.e. they have a small amount of memory, limited battery life, low processing power, and they are connected with the environment via a network with variable connectivity. The system is designed for daily use applications, such as: guided tours, electronic payment, ticket payment, information retrieval, etc. In 1996, CTIT researchers have mainly worked on two subjects: wireless communication and security. The project started mid-1996 for a period of one year.

Together with Nedap N.V. in Groenlo work has been done on a wireless ATM communication network based on near-field RF coupling. Near-field RF exhibits a more rapid spatial decay of field strength then far-field RF systems. It permits close packing of small cells, all of which may operate on a common carrier frequency. A low carrier frequency is used and the wavelength is long

enough that standing wave problems are eliminated. It is expected that the near-field RF hardware has low cost and consumes little power. The objective of this project is to design a wireless link that delivers a bandwidth of 1 to 10 Mbps per cell. Cells have the size of a single office room. A mobile user can use this network for running multimedia applications, such as high quality teleconferencing, video on demand etc.

In November 1996 it was possible to demonstrate a prototype in which video information was transmitted over a 1 Mbps wireless link. Multimedia applications require not only high bandwidth, but also a small end-to-end latency with little variation (low jitter) and a guaranteed throughput. Therefore a MAC protocol was designed and analysed, called Request-TDMA. The results were presented at the 3rd workshop on mobile multimedia communications.

In the field of security a minimal syntax with semantics for delegation tokens in a distributed file repository was developed. It was showed that this can be exploited in the implementation of one-time access rights. Delegations can occur off-line, and the practical implementations have been investigated. The ideas were presented in the DIMACS96 Workshop on Trust Management in Distributed Systems.

A survey of electronic payment methods and systems was written, which was presented at the Euromedia96 conference. Work was also done on a security mechanism for executing foreign programs, called helpers, on a Pocket Companion. A helper program, is a program or service that can migrate once from a server to a Pocket Companion or vice-versa. In this way a Pocket Companion can receive services relevant to its environment. By migrating to the location of a resource, a helper can access the resource more efficiently. This is particularly attractive for mobile computing, where the network conditions can be poor and unreliable, and because it does not require a permanent connectivity. Security is a significant concern for helpers, as a Pocket Companion receiving a piece of code for execution may require strong assurances about the helper's behaviour.

Partners in the project are: University of Pisa and University of Tromsø.

Relation with CTIT research area:

The MobyDick project is part of the Mobile Computing research area.

12 BELSIGN (HCM Network Behavioural Design Methodologies for Digital Systems)(1994-1997)

Projectleader CTIT: Dr. ir. S.M. Heemstra de Groot

The BELSIGN project is a human capital and mobility network, including laboratories and research groups with complementary profile. It aims at advances in the fields of VLSI processor architecture, high-level synthesis, testability and verification of digital circuits, functional simulation, and protocol specification and synthesis.

Partners in the project are: University of Cantabria, Fraunhofer Gesellschaft, University of Duisburg, INESC, Polytechnical University of Madrid, EERIE, GMD.

CTIT Contribution in 1996

In the area of research on protocol design and synthesis, the work concentrated in 1996 mainly on design alternatives for high-speed end-to-end communications and high-performance architectures for lower layer protocols.

Several types of end-to-end protocols were studied in the context of reliable communications in high-speed networks. Formal verification and analysis was carried out in order to determine the conditions for the correctness of these protocols which are essential for planning complex communication systems. The classification of the techniques used in different transport protocols provided better understanding of reliable communication.

High-speed network architectures for processing time-critical protocol functions and in particular several ATM adaptation layers have been investigated. A subnetwork project between the University of Cantabria and the University of Twente on design of a high-performance architecture for processing the ATM adaptation layer was successfully carried out.

Besides the above mentioned activities, there was active research on design and synthesis methods to support correct and optimal design of digital systems (CTIT-SPA) as well as on combinatorial optimization problems related to low-power design (CTIT-BSC). Some of the results were presented at network workshops and subnetwork meetings complemented with short visits to Twente.

There has been an exchange (for training purposes) of network members from Twente and Cantabria (Miss Arantza Anton, University of Cantabria, March-June 1996 in Twente, and Mr. Harold Teunissen, University of Twente, June-September 1996, at the University of Cantabria).

Relation with CTIT research area:
The BELSIGN project is part of the Communication Networks research area.

Publications

[1] Olah, A. and Heemstra de Groot, S.M. "Alternative Specification and Verification of a Periodic State Exchange Protocol", *CTIT Technical Report* No. 96-02, ISSN 1381-3625, January 1996, Submitted to IEEE/ ACM Transactions on Networking, 5 pp. (accepted for publication).

[2] Teunissen, H.W.A., de Vries, D.B. and Heemstra de Groot, S.M. and Anton, A. and Villar, E., "Design of a Flexible Architecture for Processing ATM Adaptation Layer Protocols", October 1996, *CTIT Technical Report No. 96-40*, ISSN 1381-3625, 8 pp.

[3] Olah, A.L. and Heemstra de Groot, S. M, and Bliek, R., "Connection Management in Reliable Transport Protocols", *Proceedings of Ericsson HSN'96*, Budapest, Hungary, June 4 1996.

[4] Olah, A. and Heemstra de Groot, S.M. Comments on ‘’Minimum-Latency Transport Protocols with Modulo-N Incarnation Numbers", *IEEE/ ACM Transactions on Networking*, August 1996, pp. 660-666.

[5] Teunissen, H.W.A. and de Vries, D.B. and Heemstra de Groot, S.M. and Anton, A. and Villar, E., "A Flexible Architecture for Processing ATM Adaptation Layer Protocols", *Proceedings of the 4th BELSIGN Workshop*, Santander, Spain, October 30-31, 1996.

[6] Anton, A. and Villar, E., and Teunissen, H.W.A. and de Vries, D.B. and Heemstra de Groot, S.M. "Hardware/Software Co-design of the AAL 5 Protocols", *Proceedings of the 4th BELSIGN Workshop*, Santander, Spain, October 30-31, 1996.

[7] Teunissen, H.W.A. and de Vries, D.B. and Heemstra de Groot, S.M. and Anton, A. and Villar, E., "Design of a High-Performance Programmable Architecture for Processing ATM Adaptation Layer Protocols", (to be published in the) *Proceedings of the IEEE Benelux and ProRISC 7th Annual Workshop on Circuits, Systems and Signal Processing,* Mierlo, The Netherlands, November 27-28, 1996.

13 CEO project: Implementation of tools for monitoring the status and utilisation of the network and distributed services (1995-1996)

Projectleader CTIT: Dr. ir. A. Pras

The CTIT together with ESYS Limited (Guildford, UK) have performed a `proof of concept' study within the research programme 'Centre for Earth Observation' (CEO) which was coordinated by the Joint Research Centre (JRC) of the EC (Ispra, Italy). The subject of the study was the design and implementation of tools that allow status and utilisation monitoring of networks and distributed information servers. In the specific case of the CEO programme, the information servers contain large quantities of earth observation data (e.g., satellite pictures), that are accessible through the World-Wide-Web. CTIT was primarily responsible for the design and implementation of the management agents.

The work division within the project was that ESYS primarily investigated the management applications which run on top of HP-Openview, and the CTIT investigated the design and implementation of the management agents. These agents include a number of Management Information Bases (MIBs); an important part of the work has therefore been the definition of dedicated MIBs for WWW.

The project resulted in:

- Three new MIBs, which were presented as internet-drafts to the IETF. These MIBs are the HTTP-MIB, the Retrieval Service (RS) MIB and the Information Store (IS) MIB. Of these, the HTTP-MIB is currently being further developed by a special IETF mailing list group.
- WWW agent prototypes, which were implemented as subagents of the EMANATE extensible agent package. The prototypes have been successfully tested in a number of field trials. A public domain variant of these prototypes is currently under development by Martin Toet. This variant, which uses the public domain SCOTTY package, is based on the latest version of the HTTP MIB, as being developed by the IETF.
- An article, which was published in the May issue of the Polytechnisch Tijdschrift (a dutch technical magazine).
- A CTIT technical report, which describes the ins-and-outs of the project.
- A presentation, which was held at the CTIT workshop in Bad Boekelo in the Netherlands (19/04/96).

The results of the project are also being used by a follow-up study, which takes place within the EC's fourth framework TELEMATICS programme, called DESIRE/MUSIQ.

Publication

[1] H. Hazewinkel, E. van Hengstum and A. Pras "Results of the CEO project; WWW management" [*CTIT Technical Report series No. 96-18*], ISSN 1381-3625, 9 pp.

For more information: see the Web-page of this project:

http://wwwsnmp.cs.utwente.nl/~nm/projects/ut-ceo.

Relation with CTIT research area:

The CEO project has been part of the Systems Management research area.

14 SURFNET IV (1996-1997)

The CTIT participates in the SURFNET IV project, a collaborative pilot project of the "Stichting SURF" (Dutch Academic Network), the KPN (Dutch PTT), and the Dutch Universities for the introduction of a high speed network based on ATM.

Within the second phase of the SURFnet IV programme, the CTIT participates in two subprojects: '*Management of SURFnet IV*' and '*SURFnet IV Infrastructures*'. Both projects have a duration of six months and will conclude early 1997. A continuation of these projects is expected in 1997 for phase 3 of the SURFnet IV programme.

14.1 Management of ATM Networks

Projectleader CTIT: Dr. ir. A. Pras

The CTIT currently performs a research project on management of ATM networks. The research has a strong practical orientation, and is particularly focusing on the management problems of the dutch ATM research net. This net, called SURFnet4, is operated by SURFnet b.v. and is connected to the 34-Mbit pan-european JAMES network.

The CTIT has performed the following research activities in 1996:

- The existing ATM Management Information Base (MIB) standards have been studied. These standards are the versions 3.0, 3.1 and 4.0 of the Interim/Integrated Local Management Interface (ILMI) of the ATM Forum, and AToMMIB (RFC 1695) of the Internet Engineering Task Force (IETF).
- For all switches that were accessible via our ATM lab, the ILMI and AToMMIB support was investigated. The available switches were: ASX 200WG (FORE), GeoSwitch 155 (UB Networks) and LS 100 (Cisco).
- A number of vendor specific ATM MIBs were investigated. In particular those switches were investigated that are commonly being used within the SURFnet4 (e.g., Cisco, FORE, UB Networks, GDC).
- A report describing which MIB objects should be used to derive network usage figures was produced.
- A tool was made which gathers and collects management information from

ATM switches. Communication between tool and switch takes place via SNMP. The information is being processed and stored by the tool and subsequently presented to the user via HTTP as web pages.

Since the results of some research activities are confidential, reports have not yet been published. A publicly available report is expected to appear soon.

The following research activities are planned for 1997:

- Determine which management information should be exchanged between the various management domains of the interconnected ATM network;
- Improve the tool mentioned above;
- Investigate the problems, in particular bandwidth management and accounting, that may be associated with the introduction of Switched Virtual Connections (SVCs).

These activities will be carried out in a follow-up of the project. For more information on this project, *see the Web-site*:
http://wwwsnmp.cs.utwente.nl/~nm/projects/ut-atm.

Relation with CTIT research area:
The 'Management of ATM networks' project is part of the Systems Management research area.

14.2 SURFnet V Infrastructures

Projectleader CTIT: Dr. Ph. Chimento

In 1996 the CTIT began a number of mini-projects with SURFnet B.V. On the infrastructure side, there were 3 mini-projects started. There were several staff members and some MSc students involved in these projects.

The first mini-project is the *SVC tunnelling project.* The purpose of this project was to test the ability of certain local (workgroup) ATM switches to set up switched virtual circuits through permanent virtual circuits already provided.

The second mini-project concerns the provision of *VBR service over the SURFnet4 ATM network.* The purpose was to test the VBR service profiles for SURFnet using a device (the AVA-300 multimedia encoder) which inherently generates VBR traffic (instead of generating the traffic artificially).

The third mini-project concerns *Cell Delay Variation Tolerance (CDVT) and Burst Tolerance (BT),* two traffic parameters whose behaviour has to do with the underlying characteristics of the ATM network. The task for this project was to investigate, in both the national network and an international network, the changes in the CDVT/BT for cell streams as they passed through various switches and subnetworks.

Relation with CTIT research area:
The 'SURFnet IV Infrastructures' project is part of the Communication Networks research area.

15 IOP Electro-Optics cluster 1, project IEO94100 Optically Circuit- and Packet-switched Networks (1995-1999)

Projectleader CTIT: Prof. ir. A.M.J. Koonen

In the IOP Electro-Optics Phase 3 Cluster 1 a study of "Multi-Access, multi-dimensional optical networks" is performed. The research in this cluster is addressing aspects of an optical fibre core transport network as well as a local area network for business communication, emphasizing their interworking and aiming at proving the feasibility by conducting experiments on a laboratory scale. The work involves a large variety of topics in multi-wavelength all-optical networking. Seven research groups of three universities (TUD, TUE, and UT) and KPN Research interact with each other to exchange expertise, components and results. The project achieved in 1996 an additional grant.

The CTIT studies the design and performance of the interconnection of BCPNs (Business Customers Premises Networks) to a core transport network by means of all-optical add/drop nodes employing dynamic multiwavelength

routing and wavelength converters.

In 1996, after studying Wavelength Division Multiplexing communication, an architecture for the proposed network on laboratory scale has been chosen. The architecture contains a self-healing local ring with 2 local nodes and an interconnection node which connects the ring to a core network. The data channels in this network will use the 1550 nm window, and the control and management system will use a 1300 nm overlay network. Crosstalk analysis has led to specifications for the component-oriented groups.

To compensate for the losses in the network caused by the optical components an optical amplifier is needed. Therefore the behaviour of EDFAs (Erbium Doped Fiber Amplifiers) in a WDM system is being investigated, and an EDFA suitable for the use in WDM systems is being designed and realized.

The next subject of research is the control and management system (C&MS) for the proposed network. The C&MS will contain an access mechanism, a detection mechanism for link- and transceiver-failures, a healing mechanism for link- and transceiver failures, and component control.

A proposal has been made for the last phase of the IOP project, aiming at a multiwavelength core network - access network demonstrator in cooperation with the other IOP-EO cluster 1 partners. The CTIT's responsibility will be the access network part, and the interfacing to the core network.
Ton Koonen (professor at the Electrical Engineering department and senior staff member CTIT) has been elected as chairman of the IOP-EO cluster 1 activity, succeeding Ad Labrujere of KPN Research Leidschendam.

Relation with CTIT research area:
The IOP-project is part of the Communication Networks research area.

16 Teleloket, Civic Service Center 2000 (1995-1998)

Projectleaders CTIT: Prof. dr. H.M. de Jong and Prof. dr. ir. A. Nijholt

Since 1995 these titles cover an internal CTIT research initiative and a national programme initiated by the Dutch Home Department respectively. The aim of both projects is to increase the accessibility of governmental information and services by electronic means and telematics applications.

The year reported here was mainly devoted to provide ourselves some entrances in concrete work to be done within the national project. The intention to do this, is to become involved not in academic considerations solely, but in the real research issues that result immediately from the very first attempts to introduce information and communication technology in the interaction between average citizens and the local administration.

The CTIT has been involved in the pilotproject that is in execution in the city of Enschede, and obtained some research projects initiated and coordinated by the Executive Bureau of the national Civic Service Center 2000 Programme. With respect to the Enschede pilot the full proposal was written, and in the last quarter of 1996 this has been worked out towards a system concept that will be published in the beginning of 1997. With respect to the national programme, the researchers are heavily involved in writing a handbook on user-orientation and the analysis of structure patterns within questions.

It is to be expected that in 1997 these activities will be continued; the involvement will extend to some other pilot projects and other research questions.

Relation with CTIT research area:
This project is part of the Language Speech and Information Engineering research area.

17 Societal Effects of Scientific Research relating to the 'Telematicastad Twente' (MEWO project)[1]

Projectleader CTIT: Prof. dr. ir. A. Nijholt

In January 1996 the research project on Societal Effects on Scientific Research with respect to telematics (Dutch acronym: MEWO) started for a duration of one year. This project is founded by the board of the University of Twente and it dealt with the societal effects primarily to be found within the context of regional telematics applications initiatives (e.g., TwenteWeb).

Based on the spearheads among these initiatives (introduction among wide public, education, recreation, business to business, local administration) related societal effects, strategic research projects and fundamental scientific research issues have been identified. Subsequently a selection of actual interactions between initiatives and (strategic of fundamental) research projects or initiatives and societal effects has been made, such, that these processes of interaction between scientists and representatives of society can be investigated in depth.

The results of these case studies and some general conclusions will be published in 1997.

Relation with CTIT research area:
This project is part of the Public Administration and Telematics research area.

18 Multidisciplinary PhD-projects

In 1994 -1996 four PhD-projects on nuclei of multidisciplinary research have started. All projects have or will be incorporated in larger multidisciplinary research areas. Coaching is done by senior researchers of at least two different departments.

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1. MEWO is an organization within the University of Twente which intends to bridge the gap between the technical sciences on the one hand and the social sciences on the other hand. MEWO means: 'Maatschappelijke Effecten van Wetenschappelijk Onderzoek' (=Societal Effects of Scientific Research)

It concerns the following PhD-projects:

18.1 Desktop Tele-learning Environments (1996-2000)

This PhD-project has recently been incorporated in the 'IDYLLE' project.It has been renamed in: *Analysis, modelling, design and evaluation.* The output of this project will be an advanced high-speed network-based environment that can be used in project-based learning that supports more effective and more efficient employment of this instructional form. The research is conducted on the basis of existing problems relating to the effectiveness and efficiency of collaborative learning and working in problem-based project-oriented learning tasks. The results will be reported under 'IDYLLE'.

This project is a collaboration between Educational Instrumentation and Telematics. The project started in July, 1996, with the appointment of Jan van der Veen as PhD-student.

Relation with CTIT research area:
This project is part of the Tele-education research area.

18.2 Methods and techniques for simulation of telecommunication models (1996-2000)

Recent research on rare event simulation of telecommunication models has focused on importance sampling. In this project we are looking for alternative approaches which may be applicable to broader or a disjoint class of models. One such approach is the RESTART method. Exact results have been obtained mainly for Markov chains. It is now tried to extend the method to classes of problems which are not Markovian.

This project is a collaboration between Educational Instrumentation and Telematics. The project started in April, 1996, with the appointment of Marnix Garvels as PhD-student, and is a collaboration between Applied Mathematics and Telematics.

Relation with CTIT research area:
This project is part of the Performance, Measurements and Design of Telematics Systems research area.

18.3 User Interface for a Multimedia Database (1995-1999)

This research project focuses on the application of database technology to multimedia data. To allow users to share and retrieve multimedia data, we need a way to combine evidence from different representations of the multimedia data and incorporate relevance feedback. The database has to 'talk' with the user about his information need. It is investigated how the application of probabilistic networks enables a powerful query interface to the multimedia database. This project has also connections with the 'IDYLLE' project. The PhD-student Arjen de Vries started to work at the end of 1995.

Research activities in 1996

A paper was published on feasibility of audio retrieval at the IDMS'96 workshop in Berlin. Arjen de Vries co-authored the second chapter of the forthcoming book *Multimedia databases in perspective.* Also an article was written about HCI for the popular magazine Automatiseringsgids. Finally, work has been done on defining the research tasks to be performed the next three years. This resulted in an extended abstract on new requirements for multimedia databases, submitted for publication.

Arjen de Vries became a grant recipient in the Engines of Innovation Research Grant program with Informix, a commercial database vendor. Together with some students and a special prototype television acquired from Philips, a testbed environment to store and index television material was designed. Arjen gave talks on various topics, including speech retrieval, new requirements for multimedia databases, and Java. He also set up Multimedia colloquia at the CTIT, and participated in several teaching activities.

Planned research activities in 1997

Investigate the Bayesian inference network paradigm in depth to conclude whether to use it or not. It is the intention to extend the designed testbed, using the new database software to receive from the Informix research grant. A collaboration with Digital CRL in Boston is planned, to incorporate speaker identification algorithms in a database environment.

Deliverables (see also Part II, Scientific Results)

- Full paper on requirements for multimedia databases
- Testbed for multimedia information retrieval (paper)
- Inference networks to meet new requirements (report/software)
- Incorporate speaker identification algorithms in multimedia database (report/software)

Relation with CTIT research area:
This project is part of the Multi Media research area.

18.4 Next generation Hospital Information Systems (1994-1998)

This is a nucleus, defined in 1994, between Electrical Engineering and Computer Science, where two Ph.D.-students cooperate. The focus is on application of compression and security techniques in a variety of medical data transfer applications. Unfortunately, the progress of this project has been hampered in 1996, due to the leave of one of the PhD-students. The resulting vacancy will be filled in soon.

This project is part of an internal project on Tele-medicine, in which there are collaborative links with Roessingh Research and Development, an R&D company associated with 'Het Roessingh' rehabilition centre in Enschede. 'Het Roessingh' treats patients with movement disorders. The aim of this collaboration is how to process, store, retrieve and distribute multimedia information including audio, video and biosignals. The biosignals include ground reaction force readings and EMG (electromyography) signals, and need to be synchronized with audio and moving images, which may be 3D moving images or video.

Relation with CTIT research area:
This project is part of the research area Telematics Services.

19 DAMD project

Projectleader CTIT: Dr. L. Ferreira Pires

DAMD (Design de Aplicacoes Multimidia Distribuidas) is a project of the Brazilian ProTeM-CC phase III program, founded by the CNPq (section of the Brazilian Ministry of Education). CTIT participation is mainly consultancy.

Objectives:

The development and evaluation with practical case studies of a methodology that allows the supervised development of distributed multimedia applications on top of high-speed networks. Partners are five Brazilian universities.

Relation with CTIT research area:

This project is part of the research area Design Methodology and Architectural Concepts.

20 TeleCoach (1996-1998)

Projectleader CTIT: Prof. dr. J.C.M.M. Moonen

TeleCoach is a so-called BVE-project (dutch: Beroeps- en Volwassenen Educatie, Vocational and Adult Education), funded by the participating partners (DAC, PTT TeleCom, Malmberg, Q-multimedia, CINOP, RBO) and the Ministry of Education, Culture and Sciences. Purpose of the project is the development of a flexible learning-environment that will be used in adult education. A number of tools is being developed in order to give concrete shape to the TeleCoach- concept. CTIT's contribution concerns the evaluation of the project itself, and the development of a manual that can be of help in implementing the TeleCoach concept in practice. The project is executed by several partners (a.o. CINOP, Uitgeverij Malmberg, ECABO, ROC Eindhoven, PTT Telecom) and has a duration of three years.

More information: http://www.telecoach.net/

Relation with CTIT research area:

This project is part of the Tele-education research area.

Part III - 1996 Scientific Results

1 CTIT PhD-Thesis Series

Heeren, E. *Technology Support for Collaborative Distance Learning* [CTIT PhD-Thesis Series No. 96-08], ISSN 1381-3617 / ISBN 90-365-0798-7, 28 March 1996, 272 pp.

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9 Public Administration

PhD-thesis

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Scientific Publications

Jong, H.M. de, and Denters, S.A.H. "De staatsvorm van het koninkrijk" in: W. Derksen, and W.G.M. Salet (Eds.). *Bouwen aan het binnenlands bestuur*, Den Haag, Sdu. ISBN 90 39910790, pp. 15-48.

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Technical Publications

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Presentations

Jong, H.M. de, "Bestuurlijke arrangementen in de regio Eindhoven" [presentations in Son, Eersel and Deurne].

Jong, H.M. de, "Gemeentelijke herindeling in West-Overijssel. Genemuiden [Presentation *VNG conferentie West Overijssel en bestuurlijke vernieuwing*].

Jong, H.M. de, "Informatisering, kanalen graven tussen overheid en burger" [Presentations *Lustrum University of Twente*, Almelo and Deventer].

Jong, H.M. de, "Twente bestuurt" [Presentation of the report *'Twente bestuurt'*, Enschede].

Jong, H.M. de, "Universiteit en lokaal bestuur" [Presentation "Van Poelje lezingen", Enschede].

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10 Philosophy and Social Sciences

Scientific Publications

Nardi, B.A. and Veer, G.C. van der, "Technical Program Overview" in: *Common Ground CHI '96*, Vancouver, ISBN 0-201-94687-4, pp. 1.

Nardi, B.A. and Veer, G.C. van der, "Retrospective on Pre-Conference Activities" in: Tauber, M.J., Nardi, B.A. and Veer, G.C. van der (Eds.), *Common Ground, CHI '96*, Vancouver, ACM Press, ISBN 0-89791-832-0, pp. 435.

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Veer, G.C. van der, Lenting, B.F. and Bergevoet, B.A.J. "GTA: Groupware Task Analysis - Modelling Complexity", *Acta Psychologica*, Vol. 91, ISSN 0001-6918, pp. 297-322.

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Veer, G.C. van der, Hoeve, M. and Lenting, B.F. "Modelling Complex Work Systems - Method meets Reality" in: *Eight European Conference on Cognitive Ergonomics*, Granada, ISBN 2-9510412-0-9, pp. 115-120.

Veer, G.C. van der, "Section Introduction: Requirements and Principles for Groupware Design" in: Shapiro, D., Tauber, M. and Traunmüller, R., *The Design of Computer Supported Cooperative Work and Groupware Systems*, Amsterdam, Elseviers, ISBN 0-444-81998-3, pp. 69-76.

Veer, G.C. van der and Spenkelink, G.P.J. "Ergonomie" in: *Handboek voor Elektrotechniek*, Alphen aan de Rijn, Samsom, ISBN 62-398-004, pp. 1-51.

Vertegaal, R.P.H. and Eaglestone, B. "Comparison of Input Devices in an ISEE Direct Timbre Manipulation Task". *Interacting with Computers*, Vol. 8, Nr. 1, ISSN 0953-5438, pp. 13-29.

Vertegaal, R.P.H. and Ungvary, T. "Towards a Musician's Cockpit: Transducers, Feedback and Musical Function" in: *ICMC '96*, Hong-Kong, ISBN 962-85092-1-7, pp. 308-311.

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Spenkelink, G.J. "De ontwerpprojecten van de postdoctorale Beroepsopleiding Ergonomie", *Ergonomie in uitvoering*, Garderen.

Vertegaal, R.P.H. "GAZE: Visual-spatial Attention in Communication", *CHI '96*, Vancouver.

11 Visiting scientists

J.R. Abrial (March 1996; Information Systems Group / Tele-Informatics and Open Systems Group)

A. Anton, University of Cantabria, Santander, Spain (April - June, 1996, Tele-Informatics and Open Systems Group)

Dr. C. Baier, University of Mannheim , Germany (November 1996; Tele-Informatics and Open Systems Group)

P. Domosi, University of Debrecen, Hungary (April -June 1996; Software Engineering and Theoretical Informatics)

Prof. Dovgiallo, Institute for Cybernetics, Academy of Sciences of Ukraine, Kiev, Ukraine (Instrumentation Technology Group)

Prof. D. Ely, Syracuse University, USA (September - December 1996; Instrumentation Technology Group)

Dr. R. Gail, IBM T.J. Watson Research Center, USA (April 1996; Tele-Informatics and Open Systems Group)

Prof.dr. G.G.E. Gielen , University of Leuven, Belgium (March, 1996 - Network Theory Group)

Dr. G. Holzmann, Lucent Technologies (Bell labs), Murray Hill, USA (May 1996; Tele-Informatics and Open Systems Group)

Prof. D.H. Jonassen, Penn State University, State College, Pennsylvania (March 1996, Instrumentation Technology Group)

Dr. Y. Kato, Sendai National College of Technology, Japan (May 1995 - February 1996; Tele-Informatics and Open Systems Group)

Dr. June Hyoung Kim, Duksung W. University, Seoul, Korea (July 1994 - July 1996; Systems Programming and Architecture Group)

Dr. L. Lamport, DEC Research (March 1996; Information Systems Group / Tele-Informatics and Open Systems Group)

F. Marcelloni, University of Pisa, Italy (11 months and 2 weeks; Software Engineering and Theoretical Informatics)

J. M. Mendias Caudros, Universidad Complutense Madrid, Spain (July 1996; Systems Programming and Architecture Group)

M. Minski, MIT, USA (September 1996; Software Engineering and Theoretical Informatics)

Dr. Dongsu Seo, SERI, Korea (September 1996; Tele-Informatics and Open Systems Group)

Prof. Wanderley Lopes de Souza, Universidade Federal de Sao Carlos, Brazil, (October 1996; Tele-Informatics and Open Systems Group)

J.A. Paulos, Temple University, USA (September 1996; Software Engineering and Theoretical Informatics)

L. Peng, China, (October 1996 - October 1997; Tele-Informatics and Open Systems Group)

Dr. G.R. Ribeiro-Justo, University of Westminster, UK (April - May 1996; Tele-Informatics and Open Systems Group)

Prof. dr. A. Rodriguez-Vazques, University of Sevilla (March, 1996, Network Theory Group)

Dr. M. Saeki (March - August 17, 1996; Information Systems Group)

Dr. M. Thomas, University of Glasgow, UK (March 1996; Information Systems Group / Tele-Informatics and Open Systems Group)

Professor J. Walrand, University of California at Berkely, USA (May 1996; Tele-Informatics and Open Systems Group)

Dr. H. Wehrheim, University of Hildesheim (February 1996; Tele-Informatics and Open Systems Group)

12 International cooperation

Major international cooperation of the CTIT:

Industry

Alcatel Bell Telephone Antwerpen, Belgium

ATEA Telecom, Herentals, Belgium

Bellcore, Redbank NJ, USA

Bell Laboratories, USA

Bosch GmbH, Hildesheim, Germany

British Telecom plc, Ipswich, UK

Coritel

CSELT, Turin, Italy

Detecon, Bonn, Germany

Ericsson, UK

ESYS Ltd., Guildford, UK

France Télécom - CNET, Lannion, France

FORE, USA

Fujitsu Laboratories of America, Inc., Santa Clara, USA

GPT

Hewlett Packard Laboratories, Bristol, UK

IBM T.J. Watson Research Center, USA

IBM Research, Zürich, Switzerland

ICL, International Computers Ltd., UK

ITF, IT Focus, UK

LC, Logic Control, Spain

MITRE Corporation, USA

MTG, Media Transfer, Denmark

Norcontel, Dublin, Ireland

ODS, USA

Philips, Aachen, Germany

Rank Xerox, Palo Alto, USA

Rank Xerox Research Centre, Meylan, France

SEMA group, Spain

Siemens, München, Germany

Siemens-Albis, Switzerland

SNMP Research, Knoxville, Tennessee, USA

Telefónica S.A., Madrid, Spain

NTIHL, Nine Tiles Information Handling, Ltd., UK

Steve Price Consultancy Limited, UK

Telematica, Ofimatica y Comunicaciones, S.L., Spain

Universities and Research Institutes

Cambridge University Computer Laboratory, UK

CNR Instituto CNUCE, Pisa, Italy

Department of Health Sciences, University of York, UK

DFKI, Saarbrücken, Germany

Fondazione Ugo Bordoni, Italy

GMD Darmstadt, Germany

GMD Fokus, Berlin, Germany

GMD, St. Augustin, Germany

Health Services Research Unit, School of Medicine, University of Aberdeen, Scotland

INRIA, Paris, Nancy and Sophia Antipolis, France

Institut National des Télécommunications, France

IRST, Trento, Italy

Joint Research Centre, Ispra, Italy

MIT, Boston, USA

National Technical University of Athens, Greece

Polytechnical University of Madrid, Spain

Polytechnical University of Catalunya, Spain

Polytechnical University of Milan, Italy

Purdue University, USA

RWTH Aachen, Germany

Technical University of Braunschweig, Germany

UFSC, Universidade Federal de Santa Catarina, Florianopolis, Brazil

UFMG, Universidade Federal de Minas Gerais, Belo Horizonte, Brazil

UNICAMP, Universidade Estadual de Campinas, Brazil

Universidad de La Republica, Montevideo, Uruguay

University of Aberdeen (Department of Computing Science, School of Medicine), Scotland

University of Athens (Medical Physics Laboratory, School of Medicine), Greece

University of Augsburg

University of Bucharest, Romania

University of Dublin, Ireland

University of Duisburg, Germany

University of Edinburgh (Edinburgh Telemedicine Group), Scotland

University of Essen, Germany

University of Genoa (Faculty of Engineering, Department of Informatics, Systems and Telematics), Italy

University of Hildesheim, Germany

University of Iowa, USA

University of Karlskrona-Ronneby, Sweden (Department of Business Administration and Computer Science)

University of Kiel, Germany

University of Lund, Sweden (Department of Business Administration, Department of Computer Science)

University of Massachusetts at Lowell, USA

University of Oldenburg, Germany

University of Ottawa, Canada

University of Pennsylvania, USA

Universtiy of Pisa, Italy

University of Reims, France

University of Rennes, France

University of Stuttgart, Germany

University of Tarragona, Spain

University of Tromsoe, Norway

University of Tübingen, Germany

University of Columbia, USA

VERIMAG, Grenoble, France

Part IV - Participating Groups

The following departments and research groups within the departments are participating in the CTIT:

Department of Computer Science:
Tele-Informatics and Open Systems group (interdepartmental group with the Department of Electrical Engineering)
Information Systems group (Databases, Knowledge-based Systems, Design Methodology)
Software Engineering and Theoretical Informatics group (Language Engineering)
System Software and Computer Architecture group (Distributed Systems, Multimedia and Security; Architecture and Implementation of Digital Systems)

Department of Electrical Engineering
Tele-Informatics and Open Systems group (interdepartmental group with the Department of Computer Science)
Laboratory for Network Theory

Department of Applied Mathematics
Stochastic and Operations Research group

Department of Educational Sciences
Educational Instrumentation

Department of Philosophy and Social Sciences
Cognitive Ergonomics

Department of Business and Management Sciences
School of Management Studies

Department of Public Administration
Management and Finance

Part V - CTIT Personnel

name	*function*	*project(s)*	*start of contract period*	*end of contract period*
Management Staff				
M.G.M. Castañeda	Secretary		1-8-1994	
W.G. Hiddink	Assistant Manager		1-1-1994	
J. van de Lagemaat	Institute Manager		1-1-1994	
F.H. Scholten	Secretary		1-12-1996	
J. Volbers (0.5 fte)	Staff member Public Relations		1-8-1995	15-3-1996
Research Staff				
M.A. Anton Gil	Ph.D.-student	HCM/BELSIGN	1-3-1996	1-6-1996
B.J. van Beijnum	Senior Researcher	ACTS-Insignia	1-10-1995	1-10-1998
M.J.J. Garvels	Ph.D.-student	Evaluation of Performance and Quality of Service	15-4-1996	15-4-2000
S. de Graaf	Researcher	ACTS-Insignia	1-10-1995	1-9-1996
H. Hazewinkel	Researcher	CEO-project	15-9-1995	15-3-1996
G.W. Hiddink	Ph.D.-student	IDYLLE	15-7-1996	15-7-2000
D. Hiemstra (0.8 fte)	Researcher	Twenty-One	1-11-1996	1-5-1997
F.M.G. de Jong (0.2 fte)	Senior Researcher	Twenty-One	1-1-1996	1-1-1999
I.N. van de Kamp	Researcher	IDYLLE	15-1-1996	15-1-2000
G. Karagiannis	Researcher	ACTS-Insignia	15-12-1995	15-12-1998
A.N. Ladhani	Researcher	Platinum	1-4-1995	1-10-1996
B.F. Lenting	Ph.D.-student	IDYLLE	1-2-1996	1-2-2000
J. Schaake (0.8 fte)	Researcher	MEWO	1-1-1996	1-3-1997
E.O. Schol	Researcher	Twenty-One	1-3-1996	1-10-1996

A.M.R. Slingerland	Ph.D.-student	KPN / ACTS-Rainbow	15-7-1996	15-7-2000
F. Slothouber	Ph.D.-student	ACTS-Tobasco	1-10-1995	1-10-1999
R.A.M. Sprenkels	Researcher	SURFnet IV	1-8-1996	31-12-1997
J.T. van der Veen	Researcher	Platinum /PhD	1-1-1995	31-12-1997
J.T. van der Veen	Ph.D.-student	IDYLLE	1-8-1996	1-8-2000
D. van Veen	Ph.D.-student	IOP- Optical Circuit and Packet Switched Networks	15-10-1995	15-10-1999
C.J.A.M. Volman	Ph.D.-student	IDYLLE	15-2-1996	15-2-2000
A.P. de Vries	Ph.D.-student	User interface for a multi-media database	1-12-1995	1-12-1999
R.G. de Vries	Researcher	MESH	1-11-1996	1-11-1998
B.D. van der Waaij	Researcher	Platinum SURFnet IV	15-3-1995	31-12-1997
Associated Positions				
A.N. Ladhani		TOP	1-10-1996	1-10-1997