

ANNUAL REPORT 1995

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PREFACE

In January 1994 the Centre for Telematics and Information Technology (CTIT) began operation. It was authorized by the University of Twente in order to respond to the challenges posed by the rapid developments taking place within the combined areas of communications and informatics. The development of technology, both hardware and software, has caused dramatic increases in the capabilities of IT systems. We have taken the first few steps toward the Information Society which is now within our capabilities. However, the introduction of these technologies into society across a broad front will cause even more radical changes. The economic impact of these services can be expected to be huge and the social effects of new working practices, operating procedures and even social relations will be revolutionary. The new modes of interaction that are possible via Internet and the World Wide Web are, in a sense embryonic. At this time, no one knows in which ways they will develop, but even in these embryonic forms, broad societal effects are evident. In the next decade we can expect telematics and IT to play an even bigger role as new applications, and the services that they enable, develop. From every point of view, that of education, business and indeed society at large, we can expect increased demand for knowledge and expertise in this area.

The growing impact of these fields on society leads to the belief shared by many that an academic institution which wants to contribute significantly to building the information society, must go beyond the traditional ways of doing research and teaching. It will have to take into account not only the technical aspects but more and more the complex issues of how to successfully introduce these systems into organizations, businesses and private homes. CTIT was specifically created to face that challenge. It is structured in a way that crosses the traditional boundaries between faculties and research areas. It combines the relevant expertise which is present in the various departments of the University of Twente. The result is a research organization which is able to cover a substantial part of telematics and information technology and its embedding

in user environments. The scope ranges from basic technology to systems and applications, from fundamental research on design concepts and methods to practical software tools.

The first two years of CTIT have been an exciting time. We have passed through an initial period of starting up and organizing. We are now in the phase of exploring new ways of working, and trying to encourage the synergistic effects which come from real cooperation between groups and that make the whole more than the sum of its parts. A number of interdisciplinary projects will thus be presented in this Second Annual Report.

This Annual Report presents an overview for the year 1995 of:

- developments in telematics research at the CTIT (Section 1)
- the CTIT organization and finances (Section 2)
- the research in projects (Section 3)
- other initiatives in which the CTIT is involved (Section 4).

There are five appendices which contain:

- a progress report of the CTIT projects (Appendix 1)
- the scientific results (Appendix 2)
- the members of the Scientific Council (Appendix 3)
- the participating groups and a list of federative projects (Appendix 4)
- an overview of CTIT personnel in 1995 (Appendix 5).

Finally I would like to take this opportunity to thank the Board of Directors for the support and guidance they have provided in determining the course of CTIT.

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

1. Developments in Telematics Research at the CTIT

1.1 CTIT research

The CTIT research addresses the design of complex telematics and information technology systems, explicitly taking into account the embedding of these systems in the user environment. Characteristic for the CTIT is its multidisciplinary approach, combining technical and non-technical disciplines. The CTIT covers a wide spectrum of research topics. There is a close cooperation and strategic alignment with the Telematics Research Centre (TRC)¹, also located in Enschede. The CTIT research (more focused on long term strategic issues) is complementary in many aspects to the TRC research, which is more aimed at short term, national and market-oriented issues. As such CTIT and TRC are each others' natural partners.

1.2 Present state

The CTIT started its activities in January 1994, with the contribution of seven departments of the University of Twente. Many policies, for which preparatory work was done in 1994, were put into effect in 1995, both in the area of research and management. The shaping of the organizational structure of the CTIT was completed, the Scientific Council was installed and started its work. Furthermore, a lot of effort was spent on the acquisition of projects and bringing about coherence in multidisciplinary research activities. In 1995 the first major results were achieved.

Compared to the original "Institute's Plan", a further selection, refinement and reinforcement of areas of special interest has taken place, especially with respect to the telematics research. Integration projects were started: the Platinum project, the "Tele-learning" project, some Ph.D. projects, and, very recently, the project "Societal effects of research on the Telematicstad Twente". Multi-

1. The Telematics Research Centre (TRC) is an independent research institute, founded by IBM, KPN (Royal PTT Netherlands NV), Philips and the Ministries of Economic Affairs, and of Education, Culture and Sciences. AT&T became partner in January 1995. The TRC concentrates on multidisciplinary research within the area of telematics systems, application of telematics in user environments and the social preconditions for large scale application of telematics.

disciplinary cooperation between the technical and non-technical departments starts to blossom.

The CTIT was also successful in the acquisition of external projects, thus extending its national and international position. This has led to an increase of personnel within the autonomous part of the institute from three to fourteen at the end of 1995, with a projection of around thirty by the end of 1996.

The integration of technical and non-technical disciplines has turned out to be a time and effort consuming process. There are large differences in research approach, interpretation of concepts, and culture. All these have to be overcome gradually. Good intentions and expertise are not sufficient. Experience over the last two years has taught us, that although especially in the beginning a lot of time has to be spent on overcoming these differences, understanding and respect for each other's viewpoints increases and eventually leads to a result with added value for the involved parties.

1.3 New developments

1.3.1 Topotechnological Institutes

In 1995 the Minister of Economic Affairs issued a report "Kennis in Beweging"² in which he disclosed his views on increasing and improving the economic growth in the Netherlands. He expressed the intention to form five Topotechnological Institutes in areas closely linked to Dutch industrial interests. Funding of these institutes will be partly by the government (about 11 Million DFL per institute per year) and partly by industry. At the beginning of 1996, the top one hundred Dutch companies in terms of R&D spending will be invited to propose areas in which Topotechnological Institutes need to be established; telematics is considered to be a strong candidate.

A Topotechnological Institute in the area of telematics will most probably be concentrated around the TRC, with close links to the relevant Dutch academic partners. These are the CTIT, DITSE (= Delft Institute of Telematics based

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

Systems Engineering, a newly formed initiative at the Technical University of Delft) and the graduate school OTI. Participation in this institute would be a unique opportunity. Besides firmly establishing the CTIT as the centre of academic expertise in the field of telematics in the Netherlands, it would also give access to an important source of funding of telematics research.

1.3.2 Graduate School OTI

In 1995 the research and educational programme of the Graduate School OTI (= Onderzoekschool Telematica en Informatietechnologie) was further specified; initiators and principle partners in OTI are the University of Twente and the Technical University of Delft; there is a strong liaison with the Telematics Research Centre. The focus of OTI has now shifted more to telematics than originally planned. OTI will start in March 1996; in the course of 1996 OTI will apply for official recognition by the Dutch Academy of Sciences.

Besides a major participation of CTIT research groups in OTI, some groups participate in other graduate schools as well, such as IPA (software algorithms), SIKS (knowledge-based systems), BETA (business engineering and technology application) and COBRA (communication technology / opto-electronics).

1.3.3 Telematics Degree Programme

In 1995, initiatives have started to formulate a first phase telematics degree programme. The CTIT research will form the research basis for this academic programme. There will be a step-wise introduction starting with a 'telematics annotation' of the Master's exam in 1996-1997 for students of Computer Science, Electrical Engineering and Business Information Technology. In the same time a separate telematics curriculum will be developed, combining technological, as well as business, legal and social sciences courses in a coherent framework. The Telematics degree programme will thus be multidisciplinary.

2. CTIT Organization

2.1 Board and Scientific Council

Board

Members of the Board of the CTIT are: Prof. Dr.-Ing. P.J. Kühn (Chairman, University of Stuttgart, F.R.G.), Prof. Dr. E.J. Neuhold (GMD-IPSI, Darmstadt, F.R.G.), Prof. ir. M. Antal (director of Eurescom, Heidelberg, F.R.G.) and Prof. ir. W. Zegveld (Rathenau Institute, Den Haag, NL).

The Board of the institute meets at half-yearly intervals. One meeting is devoted to the formal tasks of the Board, e.g., the approval of policy documents and annual reports. A second meeting will be dedicated to discussions on the research policy of the institute, and future trends in the telematics domain.

Scientific Council³

In June 1995, the Scientific Council of the CTIT has formally been established. It meets five times per year. Senior researchers, representing all disciplines of the CTIT are member of this Council. Two external members have been nominated, as well as a student representative. The council advises the executive committee and the scientific director on matters of research strategy and formulates new ideas on future projects. Furthermore, it acts as a scientific reviewing board.

2.2 Contribution of Research Staff

The institute consists of so-called "federative" and "autonomous" parts. The federative part consists of the contribution of the participating departments; this contribution has been allocated for a period of 5 years. The autonomous part comprises the personnel appointed by the CTIT itself.

The contribution in manpower for 1995 is shown in Table 1. The units of manpower are fte's (full time equivalents, i.e., manyears).

3. Members of the Scientific Council: see Appendix 3

department	1st (direct) funding	2nd (indirect) funding	3rd (external) funding	total
Computer Science	34.75	3.2	21.15	59.1
Electrical Engineering	15.15	4.5	1.6	21.25
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	7.7	23.75	87.27
CTIT-autonomous	3.5		10.0	13.5
total	59.32	7.7	33.75	100.77

Table 1: Contribution in manpower per department in 1995

2.2.1 CTIT personnel

In 1995 eleven employees were appointed by the CTIT in the autonomous part of the institute: one senior researcher, three Ph.D-students, six researchers and one public relations staff member. The total number of employees amounted to fourteen at the end of 1995⁴. The prognosis for the end of 1996 is thirty researchers. All contracts are on a temporary base, except those of the management staff.

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

4. See Appendix 5

management and control.

With the planned growth of activities, the internal organization of the CTIT will have to be evaluated in 1996 and, if necessary, adapted to cope with the growth.

2.3 Institute's finances

The institute's budget in 1995 largely consisted of the capitalization of the input of the federative parts of the Institute. This 'federative' budget remains under the control of the participating departments. Since January 1st, 1995, the CTIT has become an autonomous administrative unit, for which the director is fully authorized. This unit has its own 'autonomous' budget.

The total budget 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	5.828	409	2700	8.937
Electrical Engineer- ing	2.845	104	426	3.375
Applied Mathemat- ics	192			192
Educational Sci- ence	68			68
Business & Man- agement Sciences	103			103
Public Administra- tion	115	75		190
Philosophy and Social Science	138			138
total federative part	9.289	588	3.126	13.003
total autonomous part	349		689	1.038

(in kDFL)				
Department	1 st (direct) funding	2 nd (indirect) funding	3 rd (external) funding	total
total CTIT	9.638	588	3.815	14.041

Table 2: The CTIT budget in 1995 (in kDFL)

The estimated budget for 1996 is shown in Table 3.

direct funding	external fun- ding	total autono- mous budget	total federative budget	total budget 1996
885 ¹	900 ²	1.785	13.900	15.685

Table 3: CTIT budget 1996

1. deviation w.r.t. originally estimated budget: including OSF Tele-learning project + MEWO project "Telematicastad Twente"
2. deviation w.r.t. originally estimated budget: including project Twenty-One

Figure 1 represents the growth of the budget in the period 1994-1996 (in kDFL).

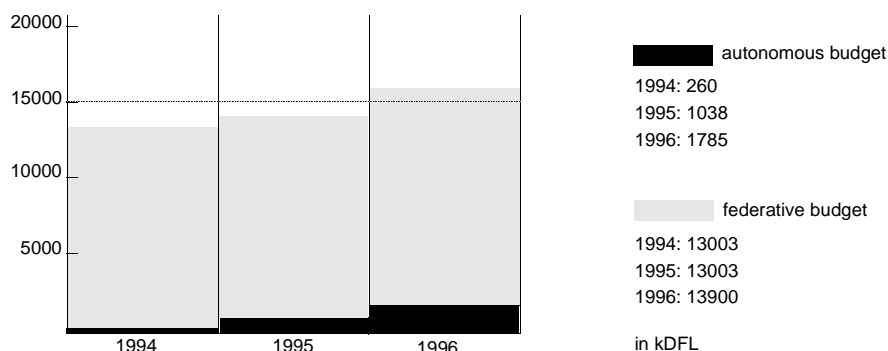


Figure 1: CTIT budget 1994-1996

Autonomous budget

For 1995 a central budget of 200 kDFL has been allocated to the institute. The department of Computer Science contributed with 27.4 kDFL and the Tele-Informatics and Open Systems (TIOS) group of the departments of Computer Science and Electrical Engineering contributed with 122 kDFL to the salary costs of the management staff. Moreover, the TIOS group supported the

project acquisition of the institute with 25 kDFL travelling costs out of their own budget. See Table 4 for an overview of the autonomous budget in 1995.

Autonomous part (in kDFL)			
expenditures		budgets	
direct funding (1)			
salaries	249.8	central budget	200.0
travel costs	23.0	contribution Dept. of Computer Science	27.4
general expenses	21.6	contribution TIOS	122.0
result	55.0		
total	349.4		349.4
external funding (3)			
salaries	279.2	Platinum	500.0
travel costs	40.0	Impl. of tools etc.	70.0
equipment	45.0	Insignia	60.0
general expenses	45.0	Tobasco	30.0
result	280.2 ¹	Bosch	15.0
		IOP	8.0
		HCM/BELSIGN	6.4
	689.4		689.4
total budget CTIT	1038.8		1038.8

Table 4: Autonomous budget 1995 (in kDFL)

1. incl. salary reservations for 1996

2.4 Public Relations

CTIT Publications

In 1995 six Ph.D.-Theses were published in the "CTIT Ph.D.-Thesis Series" and twenty-five Technical Reports⁵. It is expected that these numbers will show a growing trend in the coming years. Early 1996 a book based on the results of the Computer Supported Cooperative Work seminars of 1994 will be published.

5. See Appendix 2: Scientific Results 1995

Newsletters

On December 1, 1995, the first external Newsletter (in English) was issued. This Newsletter is distributed to all external relations of the institute at a three monthly interval. Information is given on research activities within the CTIT. In every issue one or two currently running projects are discussed in depth, and information is given on coming events (workshops, conferences), and publications.

Beside this external Newsletter, the internal Newsletter (in Dutch) will continue to appear. This publication is particularly intended to inform all researchers of the institute and the participating departments on what is going on within the CTIT.

Both Newsletters are accessible through our World-Wide-Web server (<http://www.tios.ctit>).

Workshops

In 1995 two workshops and one course were organized. In the first half of 1995 a series of seminars on the Electronic Superhighway were held with speakers from outside the University. One session was devoted to a panel discussion on "Telematics in the Twente Region". This series of seminars attracted a large number of attendants.

From 19 through 21 April 1995 the Seventh European Workshop on Dependable Computing (EWDC-7) on "Dependable Computing for Telematics" was organized by the CTIT.

On June 8-9, 1995 a course was organized by the Information Systems group on "Multimedia Databases in Perspective".

IEEE 802

The CTIT has been selected to host the IEEE 802 Summer Conference in 1996. The Conference will be held from 7-12 July, 1996. It is the first time af-

ter a long period that it will be organized outside the USA. The expected attendance is 400 persons.

WWW Server

The information on the CTIT server has been extended in 1995. At present, a new lay-out is being prepared to give a better overview on all the activities within the institute. 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 the information on the participating groups.

3. Overview of 1995 Research

In 1995 the CTIT proved to be successful in the acquisition of projects under the Fourth Framework Programme of the European Union: within ACTS two projects were approved (Insignia and Tobasco), within ESPRIT and the Telematics Applications Programme both one project (ESPRIT: WIDE - within the federative part of the CTIT; TAP: Twenty-One). Beside these projects, a European 'proof of technology' project has been acquired.

At a national level the Platinum project started, and a project under the IOP (= Innovatieve Onderzoeksprojekten / Innovative research projects)-Electro-optics programme was approved, as well as three research projects funded by the University of Twente within their research incentives programme (OSF: Tele-learning, MEWO: Social Effects of Scientific Research relating to the de Telematicastad Twente, Integration project CTIT: 3 Ph.D.-projects on focal points of multidisciplinary research).

All projects together will lead to an annual turnover in 1996 of 885 kDFL direct funding and of 900 kDFL external funding.

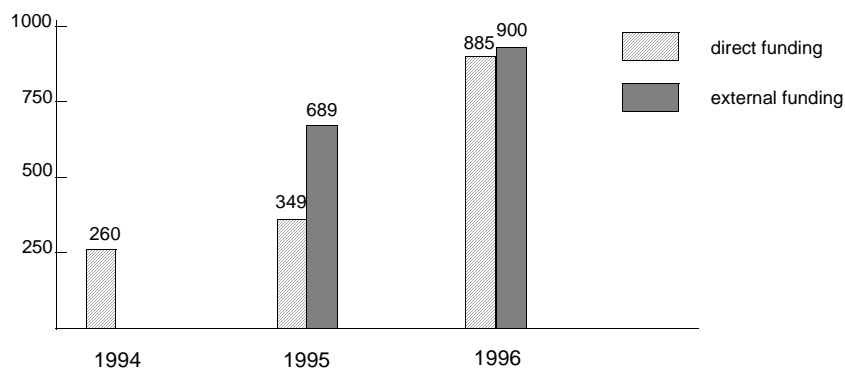


Figure 2: Annual turnover CTIT 1994 - 1996 (in kDFL)

There are also some new project initiatives in the pipeline, which wait for approval. The acquisition of projects lead to a substantial growth in the number of employees, from three to fourteen. This number will increase in

1996, since four of the new projects were approved at the end of 1995⁶.

In 1995 six Ph.D.-Students received their Doctoral degree under the auspices of the CTIT, three Ph.D.-Students of the Department of Computer Science and three Ph.D.-Students of the Department of Electrical Engineering. These theses have been published in the CTIT Ph.D.-Thesis Series (see Section 8, Scientific Results).

In Chapter 3 a brief overview will be given of the projects which are currently running within the CTIT. A more detailed progress report on these projects, as well as an overview of external partners involved, is given in Appendix 1. The (mainly internal) projects within the federative part will be accounted for in the reports of the participating departments.

3.1 Integration Projects

The CTIT will advance multidisciplinary research by means of 'integration projects'. These integration projects can be achieved in different ways:

- participation in external projects around a pre-defined theme, hereby combining the expertise of different disciplines (for example the Platinum project);
- clustering of multidisciplinary research around a pre-defined research theme (Tele-Learning project and 'Telematica Stad Twente' project);
- definition and growth of nuclei of multidisciplinary research (Ph.D.-projects in interdisciplinary areas).

The **Platinum** project (= PLATform providing Integrated services to New Users of Multimedia - partly funded by the Ministry of Economic Affairs) aims at developing innovative multimedia applications, together with the underlying advanced broadband network architecture. Both user and technology perspectives are taken into account. The first phase of the Platinum project ends

6. The Tele-Learning project, the MEWO project, the Integration project for 3 Ph.D. students and the Twenty-One project.

on June 30, 1996. By then the first demonstrable systems will be available. In the meantime goals are set for continuation of the project in a second phase.

In October 1995 the programme "**Tele-Learning: Better and More Efficient Learning via New Paradigms and Tools**" was approved for funding by the University of Twente from a special budget on innovative research. The Tele-learning programme will develop a coherent overall vision how new communication and information technologies can improve the studying itself, as well as methods for studying, by using tele-learning. This project is a good example of combining the research of different disciplines around a pre-defined theme. It strongly supports the university's policy of stimulating the collaboration between the technical sciences and the social sciences. With this project, Tele-learning becomes one of the strategic domains within the CTIT.

January 1996 the project: **Societal Effects of Scientific Research relating to the 'Telematicstad Twente'** will start. This project is also funded by the University of Twente. In this project attention will be given to a wide range of aspects related to a "virtual city" connected to the Electronic Superhighway.

At the end of November, a proposal for three **Ph.D.-projects on nuclei of multidisciplinary research** has been approved for funding by the University of Twente. It is the intention to let these nuclei grow, by adding other Ph.D.-projects to these nuclei. The supervision will be done by senior researchers of at least two different departments. These first three Ph.D.-Students will closely cooperate; two of them have links with the research of the "Tele-learning" project.

The following Ph.D-projects have been approved for funding:

- Desktop Telelearning Environments (Educational Instrumentation and Telematics)
- Evaluation of Performance and Quality of Service (Applied Mathematics and Telematics)

- User Interface for a Multi-media Database (Ergonomics and Information Systems)

Another nucleus has been defined already in 1994 around "Next generation Hospital Information Systems", between Electrical Engineering and Computer Science. At this moment two Ph.D.-students cooperate in this project.

3.2 National Projects

The CTIT also succeeded in attracting national funding for research projects. Beside the Platinum project (see 3.1), partly funded by the Ministry of Economic Affairs, two more projects were approved for funding.

SURFNET IV

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. This Dutch pilot project is part of a European ATM pilot, which will be carried out by KPN together with 14 European PTTs. As such it will also be possible to test European ATM traffic. The CTIT received funding to set up a local ATM infrastructure, in order to carry out experiments.

Optically Circuit and Packet Switched Networks

In the IOP (= Innovatief Onderzoeks-project / Eng.: Innovative research project, funded by the Dutch Ministry of Economic Affairs) Electro-Optics Phase 3 Cluster 1 a study of "Multi-Access, multi-dimensional optical networks" will be 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. In this project the three technical universities cooperate, together with KPN Research. The project started on October 1st, 1995, with the appointment of a Ph.D.-student.

3.3 European Technology Programmes

3.3.1 ACTS

INSIGNIA

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 and has a duration of three years.

TOBASCO

TOBASCO (TOWards Broadband Access Systems on CATV Optical networks) aims at upgrading existing CATV networks with high splitting counts, with broadband interactive services by applying High-Density Wavelength Division Multiplexing (HDWDM). The project started on September 1, 1995 and has a duration of three years.

3.3.2 Telematics Applications Programme

Twenty-One

Twenty-One (Development of a Multimedia Information Transaction and Dissemination Tool - IE 2108, Information Engineering) aims at improving the distribution and use of multimedia documents, and facilitates access to them by readers who are not native speakers of the language in which they are written. The project will focus on the domain of sustainable environmental development and ecology, but the technology developed by the project will be domain independent. The project starts by January 1996, with a duration of three years.

Another proposal within the Telematics Applications Programme: **DEMOCRAT** (on hospital information systems, together with the rehabilitation centre "het Roessingh") has been shifted to a next round for "Elderly and Disabled".

3.3.3 ESPRIT

WIDE

The WIDE (Workflow on Intelligent Distributed database Environment) project started in November 1995 and is scheduled to be finished by April 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. The project is placed under the federative part of the institute.

3.3.4 Human Capital and Mobility Programme

BELSIGN (HCM Network Behavioural Design Methodologies for Digital Systems)

The BELSIGN network, which includes laboratories and research groups with complementary profiles, is aimed to achieve advances in the fields of VLSI processor architecture, high-level synthesis, testability and verification of digital circuits, functional simulation, and protocol specification and synthesis. The project started in 1994, with a duration of three years.

3.3.5 European 'Proof of Technology' programme

Implementation of tools for monitoring the status and utilisation of the network and distributed services

The CTIT together with ESYS Limited (Guildford, UK) perform a 'proof of concept' study for the Institute of Remote Sensing Applications (the Centre for Earth Observation) of the Joint Research Centre of the EC (Ispra, Italy). The subject of the study is the design and implementation of tools that allow status and utilisation monitoring of networks and distributed information servers. The project started on July 1, 1995 and has a duration of 10 months (until May 1, 1996).

4. Other initiatives

4.1 Telematicastad Twente

The CTIT also intends to expand its regional function. At the end of 1994 the CTIT was invited to participate in the "Telematicastad Twente" initiative, a joint project between the University of Twente, the cities of Enschede, Hengelo and Almelo, PTT Telecom (Hengelo), Hogeschool Enschede, the "Kamer van Koophandel", the Overijsselse Ontwikkelingsmaatschappij (OOM/EFRO), Kabel Oost, Teleport Twente and the Telematics Research Centre.

The "Telematicastad Twente" has created its own web-site: "Twenteweb" (<http://twenteweb>). The CTIT assisted in designing and establishing the usability of this site. Twenteweb can be considered as a basis for future projects with regional partners.

4.2 Demonstration Centre

Together with suppliers of network equipment, workstations and applications, the CTIT is investigating the possibility to establish a demonstration centre, in order to be able to demonstrate advanced telematics systems and applications. The aims of this centre are:

- to introduce and demonstrate telematics to potential users and user organizations
- to obtain feedback on the usability of advanced telematics systems and applications at an early stage of development
- to improve the telematics profile of the CTIT and the University of Twente for attracting potential students.

This centre may be complemented with:

- courses on topics addressed in telematics research
- an expertise centre on:
 - management aspects of telematics networks
 - introduction, use and evaluation of telematics in identified sectors, e.g.,

education and consultation

- future developments

This demonstration centre is also intended to improve the links and cooperation with both suppliers and manufacturers of telematics systems and with (potential) users.

For 1996 the board of the University of Twente allocated resources to investigate whether interested parties can come to a common definition and realization of a demonstration center, in which telematics is an important element.

APPENDIX 1 - Progress Report of CTIT projects

Integration Projects

1.1 PLATINUM

(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) aims at developing innovative multimedia applications, together with the underlying advanced broadband network architecture. Both user and technology perspectives are taken into account.

Partners in the project are AT&T, the Telematics Research Centre (TRC), the Centre for Telematics and Information Technology (CTIT) and Deutsche Telekom. The CTIT is subcontractor of AT&T.

The 'Platinum' project (partly funded by the Ministry of Economic Affairs) started on January 1st, 1995. This is a strategic project for the CTIT, not only for the collaboration with AT&T, the TRC, and Deutsche Telekom, but also in view of the innovative aspects of the systems developed. It is the first CTIT project where a number of non-technical and technical disciplines cooperate. General objectives of the project are:

- demonstrate a working application of dynamic multimedia conferencing and other groupware applications;
- define, analyse and implement an innovative broadband network architecture that supports the multimedia applications;
- develop a tele-education pilot application based on the application mode that is defined for the broadband network architecture, taking into account both technology and user perspective;
- evaluate this tele-education application in a geographically distributed graduate school environment, taking into account the technical perspective and the organizational consequences of broadband technology;

- provide the basis for Asynchronous Transfer Mode (ATM) trials with systems developed in the project;
- test the feasibility and the timescale for the introduction of multimedia services into the network;
- develop and document the methods, tools and techniques that support the design and implementation of multimedia tele-services and networks.

In 1995 the Platinum project partners have cooperated well. The project is on schedule, and, what is more important, the partners really appreciate each other's expertise, thereby generating better overall results.

The first phase of the Platinum project ends on June 30, 1996. By then, the first demonstrable systems will be available. In the meantime goals are set for continuation of the project in a second phase.

Deliverables:

[1] P. Chimento, H. Eertink, L. Ferreira Pires, D. Quartel, and M. van Sinderen. *Shared whiteboard application design. Protocol and software architectures*. Technical Report PLATINUM/T2.3/N032/V01.

[2] L. Ferreira Pires, D. Quartel, M. van Sinderen, M. de Weger, and H. Franken. *Deliverable 3.1: General design aspects of telematics applications*. Technical Report PLATINUM/N004/V00.

[3] B. van Driel, J. van den Broecke, P. Chimento, H. Eertink, H. ter Hofte, M. van Sinderen, and J. Verhoosel. *Middleware software architecture*. Technical Report PLATINUM/T2.1/N035/V06.

[4] M. van Sinderen, P. Chimento, L. Ferreira Pires, and H. van der Veen. *Deliverable 2.1.1: Middleware protocol reference architecture (MPRA)*. Technical Report PLATINUM/T2.1/N021/V03.

[5] H. Bakker, H. ter Hofte, H. van der Lugt, A.N. Ladhani, W. Teeuw, H. Voordenhout, D. Velthausz, *User requirements*, Technical Report PLATINUM, PLATINUM/N006/V00.

[6] F.W. Hoeksema, *Performance annotation of the SDL-specified UNI protocol*, Deliverable D1.1.4, Technical Report PLATINUM/N009/V00.

[7] Huis in't Veld, R., E.F. Michiels, E. van Rijssen, J. Verhoorsel, I. Widya,

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1.2 Tele-learning

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

In October 1995 the programme "Tele-leren: Studeren en studeerbaarheid via nieuwe paradigma's en tools" (Tele-Learning: Better and More Efficient Learning via New Paradigms and Tools) was approved for funding by the University of Twente from a special budget on innovative research. This project strongly supports the university's policy of fostering the collaboration between the technical sciences and the social sciences. With this project, *Tele-learning will become one of the strategic domains within the CTIT*. It is a unique opportunity to strengthen the multidisciplinary research, which already existed at a small scale, between the less 'technical' disciplines Educational Sciences and Cognitive Ergonomics on the one hand, and Computer Science and Electrical Engineering on the other hand. The project has a duration of four years.

The Tele-learning programme will develop a coherent overall vision how new communication and information technologies can improve the studying itself, as well as methods for studying, by using tele-learning. Fundamental and applied research on advanced types of organization and processes within the framework of distance learning will be carried out, as well as the identification of the telematics systems and applications needed.

One researcher and three Ph.D.-Students will be appointed on hinges of multi-disciplinary research and be supervised by senior researchers of at least two different departments. There are also links with Ph.D.-Students working on related subjects within the participating departments. Early 1996 the first appointments have been made.

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

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

In this project attention is given to the a wide range of aspects related to a "virtual city" connected to the Electronic Superhighway. It is the intention of MEWO to let its views on research influence the direction of telematics research within the University of Twente: societal requirements and preconditions should be taken into account already from the beginning in this research. This approach fits exactly into the philosophy of the CTIT and will in this project be demonstrated by the design of the 'Telematica-stad Twente'. Research will be concentrated on the following issues:

- state of the art of technical and policy scenario's with respect to the physical and informative infrastructure, as well as the services and user-interface to offer;
- to get insight in the societal effects connected to the different scenario's, especially the general accessibility, the user orientation, privacy aspects and ergonomic aspects, etc.;
- evaluation of the outcome of these analyses and recommendations for further improvement of the different parts of a system design.

The project starts January 1996 and has a duration of one year.

1.4 Multidisciplinary Ph.D.-projects

Recently, a proposal for three Ph.D.-projects on nuclei of multidisciplinary research have been approved for funding by the University of Twente. With re-

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)

spect to the supervision, the same policy is adopted as with the Ph.D.-Students of the "Tele-learning" project: coaching by senior researchers of at least two different departments. These Ph.D.-Students will closely cooperate and two of them have links with the research of the "Tele-learning" project.

The following Ph.D-projects have been defined:

- Desktop Telelearning Environments (Educational Instrumentation and Telematics)
- Evaluation of Performance and Quality of Service (Applied Mathematics and Telematics)
- User interface for a multi-media database (Ergonomics and Information Systems)

All projects have a duration of four years. For the last project, a candidate has been appointed in December 1995, for the other projects candidates will be appointed early 1996.

Another focal point has been defined around "Next generation Hospital Information Systems", between Electrical Engineering and Computer Science, where two Ph.D.-students cooperate. In 1995, collaboration between both Ph.D.-students has focused on the following issues:

- *compression techniques*; The usability of the MPEG standard for various applications has been investigated. MPEG is a very complex standard, which can be used for both storage and networking applications (or a combination thereof). In order to obtain a good understanding of all its features, a number of sessions have been held (presentations followed by discussions).
- *security issues*; The focus was on secure transfer of data over unprotected networks. A couple of presentations/discussion sessions have been held (with participation from the TRC, who is also interested in the subject).

The results of these investigations will be published in a couple of Technical Reports. In 1996, the project will focus on application of compression and security techniques in a variety of medical data transfer applications.

National Projects

1.5 SURFNET IV

(Projectleader CTIT: Ir. J. van de Lagemaat)

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. KPN provides the national backbone network, as well as local ATM equipment.

This Dutch pilot project is part of a European ATM pilot, which will be carried out by KPN together with 14 European PTTs. As such it will also be possible to test European ATM traffic.

In collaboration with Surfnet the CTIT performed five application pilots to assess the usefulness of ATM networks and applications. Within the pilots experiments were performed to:

- send and receive audio and video over ATM using standard hardware and software
- send and receive audio and video using dedicated protocols, cameras and displays
- investigate ways to manage ATM networks and switches
- investigate the signalling used for ATM to set-up and release connections
- support tele-education with ATM-based audio and video conferencing.

For this purpose an ATM infrastructure has been realized, consisting of 9 connected workstations using 3 local ATM switches, partly supplied by Surfnet. This infrastructure was connected to the Surfnet 34 Mbit/s pilot ATM network. Experiments were performed locally, with the University of Delft over the Surfnet network and with the University of Cambridge over the Surfnet network, the PNO ATM trial network and the SuperJanet network in Great Britain.

The cooperation with Surfnet will be continued and intensified in 1996 in the

following areas:

- management of the Surfnet ATM network, which is operational at that time;
- signalling and control for ATM, based on measurements to assess the quality of connections, the utilization of network resources etc.;
- one or two "appealing" multi-media applications that clearly demonstrate the benefits for users of ATM based multi-media applications.

1.6 IOP Electro-Optics cluster 1, project IEO94100 Optically Circuit- and Packet-switched Networks

(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" will be 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 CTIT will study 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. The Ph.D.-student involved (D.T. van Veen) started on Oct. 15, by investigating literature about the aspects related to data communication using wavelength division multiplexing techniques, and about broadband data communication networks in general. Contacts have been made with the component-oriented group TUD-TTT, which will supply key components needed for the realisation of the interconnection. Studies of the Ph.D.-student will result in draft specifications for these components shortly, based on the system requirements identified. The project has a duration of four years.

European Technology Programmes

ACTS

1.7 INSIGNIA

(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, CTIT, Fondazione Ugo Bordoni, GPT, GEC Research, GMD Fokus, Italtel, NTUA, RWE Telliance, Siemens Germany, Siemens-Albis Switzerland, Telefonica S.A.

In spite of the fact that the CTIT is one of the smaller partners, CTIT has an important role in the project, leading two activities and is responsible in the first year for two deliverables. Our activities address two aspects of the performance of the INSIGNIA system.

First, we lead a performance modelling activity. The purpose of this activity is to build performance models at different levels of detail which will provide a good insight into the performance of various IN functions for the designers of the IN network elements. Associated with this activity also is the task of designing congestion and overload controls for the experimental system and then analyzing the effects of these controls. Finally, there is an important issue of system scalability which must be addressed if the INSIGNIA system is to be commercially exploited.

The second activity that CTIT leads deals with performance measurements. Here we are leading an effort to define a new methodology for defining and obtaining performance measures from working systems. This has a two-fold

purpose: One is to try to characterise the behaviour of the system, the other is to provide values for the models developed in the modelling activity and to validate the models themselves by comparing their results (with realistic parameter values) to the operation of the real system.

In both these activities, CTIT is attempting to break new ground. In performance modelling, we are trying to give early feedback to designers and developers in order to make performance evaluation part of the development process. In the measurement activity, we are trying to bring a clear and systematic approach to an important technique for studying systems.

Deliverables:

Beijnum, B.J. van., Chimento, Ph., Karagiannis, G. and Nicola, V.F.N., *Deliverable I3101: Planning of Performance Evaluation for the Trials*, Nr. AC068-A3.1.2-UOT-95001-TC-CC/a2, 61 pp. (to be finished January 1996).

1.8 TOBASCO

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

TOBASCO (TOwards Broadband Access Systems on CATV Optical networks) aims at upgrading existing CATV networks with high splitting counts, with broadband interactive services by applying High-Density Wavelength Division Multiplexing (HDWDM). The project started on September 1, 1995 and has a duration of three years. Partners in the project are: AT&T Network Systems Nederland, CTIT, ANT Nachrichtentechnik, Corning Europe, KPN Research, Norcontel, Philips Optoelectronics Centre en het Optoelectronics Research Centre.

TOBASCO's main objectives are:

- to develop a strategy to upgrade partly optical CATV networks for provisioning interactive broadband services to subscribers' homes
- to develop HDWDM techniques to offer 2 Mbit/s (ATM-oriented) connection capability via a partly fibre, partly coaxial-cable based CATV network

- to develop strategies for flexible allocation of wavelengths, yielding an optimum Quality of Service
- to develop cost-effective HDWDM optical components to demonstrate the viability of the system in a field trial of a commercial cable operator.

CTIT Contribution

The CTIT participation in TOBASCO is via its contribution in the design and implementation of the network management and control (NM & C) system.

The NM&C system of TOBASCO is aimed at the demonstration of the feasibility and advantages of HDWDM for offering interactive services. The NM&C concepts developed need to be flexible, modular, and scaleable.

The implementation and design of the NMC system concentrates on the support of:

- functions which are essential for the demonstration of the TOBASCO concept
- features necessary for the integration of TOBASCO into a commercially operating CATV network without jeopardizing the operation of the system.

The work carried out under D1.3.1 and the initial phase of WP 5.1 has resulted in the definition of a NM & C Scenario, in determining its scope, deciding what functions to implement in a field trial and those to be implemented in a commercial trial.

Deliverables

Work has been done on *Deliverable D5.1.1 Options for Network Control and Management System*, to be finished in the course of 1996.

Telematics Application Programme

1.9 Twenty-One

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

Twenty-One (Development of a Multimedia information Transaction and Dissemination Tool - IE 2108, Information Engineering) aims at improving the

distribution and use of multimedia documents, and facilitates access to them by readers who are not native speakers of the language in which they are written. The project will focus on the domain of sustainable environmental development and ecology, but the technology developed by the project will be domain independent.

The project starts by January 1996 for a period of three years. Partners are: CTIT, Getronics, TNO/TPD, Eolas, University of Tübingen, DFKI GmbH, de MOOI-Foundation en Rank Xerox Research Centre France, Friends of Earth Europe, VODO, Environ Trust Limited, Climate Alliance.

ESPRIT

1.10 WIDE

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

The WIDE (Workflow on Intelligent Distributed database Environment) is an ESPRIT project in the 4th framework. The project 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. The project has been placed under the federative part of the CTIT.

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. To achieve this goal, the project is structured in five main work packages:

- 1 - development of extended transaction support for WFM,
- 2 - development of active database rule support for WFM,
- 3 - development of design methods, techniques and tools for WFM,

4 - integration of new technology into an advanced WFM system,

5 - development of end user applications and WFM system test.

The University of Twente is mainly involved in the first and third work packages mentioned above. The 'local branch' of the project is managed by prof.dr. Peter M.G. Apers and dr.ir. Paul W.P.J. Grefen of the Information Systems division, and employs two full-time researchers. Several staff members are also involved with the project.

Currently, the first phase of the project is being performed, which focuses on the selection of the technology platforms to be used in the project and the definition of a unified model for specifying workflow management applications.

Human Capital and Mobility Programme

1.11 BELSIGN (HCM Network Behavioural Design Methodologies for Digital Systems)

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

The BELSIGN network, which includes laboratories and research groups with complementary profiles, is aimed to achieve 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 and CTIT.

CTIT Contribution

CTIT participation in the BELSIGN HCM network is via the research carried out in the area of methodologies for hardware synthesis of protocol functions. The work on synthesis of protocols has concentrated on those design and implementation aspects having major impact on the speed.

On one hand, we focus on design alternatives of end-to-end protocols for reliable high-speed communications. Formal verification and analysis of several representative data-transfer and connection-setup protocols were carried out. Besides the detection, in some cases, of malfunctioning situations or unnecessary performance limitations, the analysis yields to a set of conditions involving real-time parameters of the network as well as parameters of the protocol that must be fulfilled. Results of these verifications will be used to create a common framework for comparison of the different end-to-end protocol mechanisms.

On the other hand we investigate possible architectures for hardware implementation of protocols. Given the dramatic increase in processor speed as well as the improvements in software implementation, the interest shifted from transport protocols to lower layer protocols. Besides the study of applicability of scheduling techniques for control-dominated applications in high-level synthesis of protocols, we concentrated on architectures for high-speed processing of the several ATM adaptation layers. A common project with our HCM partners of University of Cantabria was defined and has recently been initiated. The subject is on the analysis and design of a high-performance architecture for processing of ATM-adaptation layer protocols.

European 'Proof of Technology' programme

1.12 Implementation of Tools for Monitoring the Status and Utilisation of the Network and Distributed Services

(Projectleader CTIT: Dr. ir. A. Pras)

The CTIT together with ESYS Limited (Guildford, UK) perform a 'proof of concept' study for the Institute of Remote Sensing Applications (the Centre for Earth Observation) of the Joint Research Centre of the EC (Ispra, Italy). The subject of the study is the design and implementation of tools that allow status and utilisation monitoring of networks and distributed information servers. In

our case these information servers contain large amounts of earth observation data (e.g. satellite pictures) and are accessible via the WWW. The work division within the project is that ESYS primarily investigates the management applications which run on top of HP-Openview, and that the CTIT is primarily responsible for the design and implementation of the management agents. These agents include a number of Management Information Bases (MIBs); an important part of our work has therefore been the definition of dedicated MIBs for the WWW. As a result of this work we have produced a HTTP-MIB, a service MIB and an information retrieval MIB. Some of these MIBs will be presented to the IETF and provide a good starting point for subsequent standardization activities. The agents have been implemented as subagents of the EMANATE extensible agent package and will soon be tested in a number of field trials.

The project started on July 1, 1995 and has a duration of 10 months (until May 1, 1996).

APPENDIX 2 - Scientific Results

2.1 CTIT PH.D.-Thesis Series

Pras, A. *Network Management Architectures*, [CTIT Ph. D.-thesis series No. 95-02], ISSN 1381-3617 / ISBN 90-365-0728-6, 17 February 1995, 195 pp.

Heijenk, G.J. *Connectionless Communications using the Asynchronous Transfer Mode*, [No. 95-03], ISSN 1381-3617 / ISBN 90-365-0733-2, 3 March 1995, 242 pp.

Sinderen, M.J. van, *On the Design of Application Protocols*, [No. 95-04], ISSN 1381-3617 / ISBN 90-365-0730-8, 10 March 1995, 220 pp.

Kremer, H. *Protocol Implementation - Bridging the Gap between Architecture and Realization*. [No. 95-05], ISSN 1381-3617 / ISBN 90-365-0743-X, 5 October 1995, 221 pp.

Hou, X. *A Network Control Architecture for Advanced B-ISDN Services*. [No. 95-06], ISSN 1381-3617 / ISBN 90-365-0748-0, 15 June 1995, 220 pp.

Laarhuis, J.H. *Multichannel Interconnection in All-Optical Networks*. [No. 95-07], ISSN 1381-3617 / ISBN 90-365-0762-6, 8 September 1995, 332 pp.

2.2 CTIT Technical Reports Series

Baumann, F. *Design and Evaluation of Location Management Strategies in UMTS*, [CTIT Technical Report series No. 95-01], ISSN 1381-3625, TWAIO - Final Report, January 1995, 88 pp.

Lenoir, P. *Design of an ATM (de)multiplexer*, [No. 95-02], TWAIO - Final Report, 23 January 1995, 48 pp.

Veen, J.T. van der, (editor) *B-ISDN Signalling Performance: Issues and Analysis*, [No. 95-03], Final Deliverable RACE-MAGIC project, January 1995, 257 pp.

Hou, X. and Niemegeers, I.G. *A Simulation Study of Channel-Switching Response Times in On-demand Television Broadcasting (OTB)*, [No. 95-04], May 1995, 40 pp.

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Quartel D.A.C, Ferreira Pires L., Sinderen M.J. van, Franken H.M., Vissers C.A. *On the Role of Basic Design Concepts in Behaviour Structuring*, [No. 95-08], October 1995, 31 pp.

Kenter, H.J.H.N. *Research Issues in Wavelength Assignment and Routing in Wavelength Division Multiplexed Networks*, [No. 95-09], October 1995, 24 pp.

Nicola, V.F., Hagesteijn, G.A. *Efficient Simulation of Consecutive Cell Loss in ATM networks*, [No. 95-10], October 1995, 22 pp.

Rijssen, E. van, Widya, I., Michiels, E.F. *Multimedia Tele-services Modelled with the OSI Application Layer Structure*, [No. 95-11], October 1995, 20 pp.

Weger, M.K. de, Franken, H. and Vissers, C.A. *A Development Model for Distributed Information Systems*, [No. 95-12], October 1995, 13 pp.

Oláh, A. and Heemstra de Groot, S.M. *Assertional Verification of a Connection Management Protocol*, [No. 95-13], November 1995, 32 pp.

Ladhani, A.N., De Diana, I. and Widya, I. *Combining Desktop Tele-classroom and Distributed Multimedia Databases for Tele-tutoring*, [No. 95-14], November 1995, 18 pp.

Oláh, A. *Formal Verification and Analysis of PAWS*, [No. 95-15], November 1995, 33 pp.

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Wilschut, A.N., By, R.A. de and Quak, W. *From a Formal Model to an Implementation of Spatial Data*, [No. 95-24], 19 pp.

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Dikker F. *A Knowledge-based Approach to Evaluation of Norms in Engineering Design*. 30/06/95, ISBN: 90-9008420-7, 221 pp.

Drossaers M.F.J. *Little Linguistic Creatures: Closed Systems of Solvable Neural Networks for Integrated Linguistic Analysis*. 19/05/95, ISBN: 90-75296-02-9 (373 pp.).

Kremer H.H.C. *Protocol Implementation - Bridging the gap between Architecture and Realization*. See: *CTIT Ph.D. Thesis Series*.

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2.4 Educational Sciences - Instrumentation Technology

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2.5 Electrical Engineering - Network Theory Group

Ph. D. Theses

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Bentum, M.J. *Interactive Visualization of Volume Data*. 15/12/95, ISBN 90-008788-5, 199 pp.

Books

Veelenturf, L.P.J. *Analysis of Artificial Neural Networks*. (Prentice Hall International) London, U.K., ISBN 0-13-489832-X, 259 pp.

Publications

Arendsen, R.G.J., A.C. Brombacher, B. Habraken, O.E. Herrmann, "Process Maturity Grids used a Decision Support Tool" in: *Proceedings of the Fifth European Symposium of Electron Devices, Failure Physics and Analysis*, Glasgow, Scotland, pp. 321-326.

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Rooijen, J.A. van, G.O. Glentis, C.H. Slump, O.E. Herrmann, "System Identification Algorithms for Sparse Systems with Application to TV Ghost Cancelling" in: *Proceedings of the Pro-RISC & IEEE-Benelux Workshop on Circuits, Systems and Signal Processing*, Mierlo, The Netherlands, ISBN 90-73461-08-1, pp. 259-267.

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Terwisscha van Scheltinga, J., J. Smit, M. Bosma, "Design of an On-Chip Reflectance Map" in: *Proceedings of the Eurographics Hardware Workshop*, Maastricht, The Netherlands, 5 pp.

Veelenturf, L.P.J. "Neural Networks (Computer Science)" in: *Analysis and Applications of Artificial Neural Networks* (Prentice Hall International), London, U.K., ISBN 013-489832-X.

Veelenturf, L.P.J. "De werking en toepassing van neurale netwerken" in: *Aan de slag met Neuro Fuzzy, toepassing van neurale netwerken en fuzzy systemen*, Hengelo, The Netherlands, 19 pp.

Veelenturf, L.P.J. "Handwritten Digit Recognition with a Neural Network" in: *Themadag 'Egotronica', ontwikkelingen van lichtnetonafhankelijke producten*, Ede, The Netherlands, 16 pp.

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Wal, J. van der, *Safety Analysis of ProSafe's Logic Solver using the Random Internal Failure Injection Technique*, TWAIO Report, University of Twente, 81 pp.

2.6 Applied Mathematics

Ph. D. Thesis

Schrijner P. *Quasi-Stationarity of Discrete-Time Markov Chains*. 22/10/95, ISBN: 90-9008502-5, 107 pp.

Publications

Chaudry M.L., J.C.W. van Ommeren, "Analytically Explicit Results for the Transient Solutions of $M(n)^X(n)/M(n)/1/N$ queues" in: *Memorandum University of Twente*, Department of Applied Mathematics, no. 1268, ISSN 0169-2690, (1995), 28 pp.

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Schrijner P., E.A. van Doorn, "Weak Convergence of Conditioned Birth-death Processes in Discrete Time" in: *Memorandum University of Twente, Department of Applied Mathematics*, no. 1278, ISSN 0169-2690, (1995), 12 pp.

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2.7 Philosophy and Social Sciences

Publications

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Eaglestone, B., Vertegaal, R.P.H., "Intuitive Human Interfaces for an Audio-Database" in Proceedings: *User interfaces to Databases*, Ambleside, UK. ISBN 3-540-19910-1, pp. 315-328.

Spengelink, G.P.J., Besuijen, J., "Brightness: Highest Luminance or Background lu-

minance?" In: *Work with Display Units 94*, North Holland, Amsterdam. ISBN 0-44482145-7, 6 pp.

Veer, G.C. van der, "User Interface Design from the Viewpoint of Human Learning" in: *Organizational learning and technological change*. C. Zuccheromaglio, S. Bagnara en S.N. Stucky (eds.), ISBN 3-540-58917-1, Springer, Berlin, pp. 138-164.

Veer, G.C. van der, "The User Interface - Concepts and Design" in: *Informatie*, Vol. 37, Nr. 3, ISBN 0-201-54441-5, pp. 212-213.

Veer, G.C. van der, "Mentale processen en mentale modellen" in: *Tijdschrift voor Ergonomie*, Vol. 20, Nr. 6, ISBN 0921-4348, pp. 3-6.

Vertegaal, R.P.H., *Eudora Announcer. Op CD-Rom: Tout pour Internet - version MacIntosh, CD Rom*. ISBN 90-6789-641-1. Enschede.

Veer, G.C. van der, Vliet, J.C. van, Lenting, B.F., "Designing Computer Systems - a Structured Activity" in: *DIS 95, Symposium on Designing Interactive Systems*. G.M. Olson en S. Schnon (eds.), ISBN 0-89791-673-5, pp. 207-217.

Veer, G.C. van der, "Prospettive nella progettazione di interface uomo-computer" in: *Convegno internazionale di ergonomia cognitiva*, Padova, Itali. pp. 3-5.

Vertegaal, R.P.H., Leenes, R., "Eudora Announcer" in: *Using the Internet with your Mac*, ISBN 0-78797-0212-6. Ed. M.A. Pike, 1 pp.

Vertegaal, R.P.H., Ungvary, T. "The Sentograph: Input Devices and the Communication of Bodily Expression" in: *International Computer Music Conference*, Banff, Canada. pp. 235-256.

Vertegaal, R.P.H., "The Standard Instrument Space Libraries: Demonstrating the Power of ISEE" in: *International Computer Music Conference*, Banff, Canada. pp. 573-574.

Vertegaal, R.P.H., Quest, S. "Network Issues in the Growth and Adaption of Networked CSCW Services" in: *SIGCHI Bulletin*, Vol. 27, Nr. 4, ISBN 0736-6906, pp. 63-67.

3. Visiting scientists

Prof dr. D.J. Amit, University of Jerusalem, Israel and University of Rome Italy, (18-20 May 1995, Software Engineering and Theoretical Informatics Group)

Prof dr. R Berwick, MIT, USA (6-8 December 1995, Software Engineering and Theoretical Informatics Group)

Dr. Ph.F. Chimento, IBM Network Analysis Centre, Durham, USA (October 1994- October 1996, Tele-Informatics and Open Systems Group)

Dr. Sohrab Daadat, Cheltenham & Clouster College, UK, 14 November 1995, Cognitive Ergonomics Group)

M. Dyer, Leeds, UK, (Stochastic and Operations Research Group)

Prof dr. N.E. Fenton, City University London (22-23 June 1995, Software Engineering and Theoretical Informatics Group)

R. Grübel, Hannover, Germany (Stochastic and Operations Research Group)

Dipl.-ing. U. Hannemann, University of Kiel, Germany (1-7 March 1995, Software Engineering and Theoretical Informatics Group)

Prof. G. Hartvigsen, University of Tromsø, Norway (5 months, Systems Programming and Architecture Group)

Prof. dr. Tom Hewett, Drexel University, USA. (12 - 18 April 1995, Cognitive Ergonomics Group)

Dr. S. Hong, Georgia State University, Atlanta, USA (May - June 1995, Information Systems Group)

Dr. Y. Kato, Sendai National College of Technology (15 May 1995 - 1 March 1996, Tele-Informatics and Open Systems Group).

Dr. June Hyong Kim, Duksung W. University, Seoul, Korea (July 1, 1994 - July 1, 1996; Systems Programming and Architecture Group)

M. Kijima, Tokyo, Japan (Stochastic and Operations Research Group)

G. Latouche, Brussels, Belgium (Stochastic and Operations Research Group)

Dr. Paivi Makirinne-Crofts, Cheltenham & Clouster College, UK, 14 November 1995, Cognitive Ergonomics Group)

Dr. F. Marcelloni, University of Pisa, Italy (1 January - 30 September 1995 and 12-20 November 1995, Software Engineering and Theoretical Informatics

Group)

P. Marttiin, University of Jyvaskyla, Finland (6 September - 20 December 1995, Information Systems Group)

P.K. Pollett, Brisbane, Australia (Stochastic and Operations Research Group)

Prof. dr. F. Popentiu, University of Bukarest (1 July - 1 October 1995; Telematics and Open Systems Group)

Dr. S. Quest, Loughborough University of Technology, UK (21 December 1995, Cognitive Ergonomics group)

M. Rutkowski, Krakow, Poland (Stochastic and Operations Research Group)

A. Srivastar (Berlin, Germany, Stochastic and Operations Research Group)

Dr. P. Venkataram, Indian Institute of Science, Bangalore, India (1 September - 1 October 1995, Systems Programming and Architecture Group)

E. Welzl (Berlin, Germany, Stochastic and Operations Research Group)

4. International cooperation

Major international cooperation of the CTIT:

Industry

Alcatel Bell Telephone Antwerpen, Belgium (cooperation on individual basis)

Algosystems, Athens, Greece (new ACTS proposal)

ATEA Telecom, Herentals, Belgium (ACTS/Insignia project)

Bellcore, Redbank NJ, USA (student exchange, MAIN project)

Bell Laboratories, USA (cooperation on individual basis)

Bosch GmbH, Hildesheim, Germany (Valide project)

British Telecom plc., Ipswich, UK (previous RACE II projects)

Coritel (ACTS/Insignia project)

CSELT, Turin, Italy (Insignia project)

ESYS Ltd., Guildford, UK (Implementation of Tools project)

GPT (ACTS/Insignia project)

Hewlett Packard Laboratories, Bristol, UK (1st and 2nd phase student exchange, visit J.T. van der Veen)

IBM Watson Yorktown Heights, USA (cooperation on individual basis)
IBM Zürich Research Laboratory, Switzerland (cooperation on individual basis)
Norcontel, Dublin, Ireland (ACTS/Tobasco, new ACTS proposal)
SEMA group, Spain (WIDE project)
Siemens, München, Germany (ACTS/Insignia project)
Siemens-Albis, Switzerland\ (ACTS/Insignia project)
Telefonica S.A., Madrid, Spain (ACTS/Insignia project)

Universities and Research Institutes

Cambridge University Computer Laboratory, UK (Pegasus project)
Centre for Earth Observation, Ispra, Italy (Implementation of Tools project)
CNR Istituto CNUCE, Pisa, Italy (Formal Methods)
Fondazione Ugo Bordoni (ACTS/Insignia project, previous RACE II projects)
Fraunhofer Institut, Stuttgart, Germany (cooperation on individual basis)
GMD Darmstadt, Germany
GMD Fokus, Berlin, Germany (new ACTS proposal / previous ESPRIT projects)
INRIA, Paris, Nancy and Sophia Antipolis, France (new proposals, previous ESPRIT projects)
National Technical University of Athens, Greece (ACTS/Insignia project, previous RACE II projects)
Polytechnical University of Madrid, Spain (HCM/Belsign project, new ACTS proposal, previous ESPRIT/LOTOSPHERE project)
Polytechnical University of Milan, Italy (WIDE project)
RWTH Aachen, Germany (cooperation on individual basis)
Technical University of Braunschweig, Germany (TMR/TEAM project - proposal)
University of Duisburg, Germany (HCM/Belsign project, CINEMA project - proposal)

University of Essen, Germany (CINEMA project - proposal)
University of Hildesheim, Germany (cooperation on individual basis)
University of Lancaster, UK (new ACTS proposal)
University College London, UK (new ACTS proposal)
University of Massachusetts at Lowell, USA (cooperation on individual basis)
University of Ottawa, Canada (student exchange, Formal Methods)
University of Pennsylvania, USA (cooperation on individual basis)
University of Tromsø, Norway (cooperation on individual basis)
University of Tübingen (TAP/Twenty-One project)
University of Turin, Italy (cooperation on individual basis; previous RACE II projects)

APPENDIX 3 - Scientific Council and Executive Committee

Scientific Council:

P.M.G. Apers (Computer Science)
C. Bakker (Computer Science/Electrical Engineering)
S. Brinkkemper (Computer Science)
H. Brinksma (Computer Science)
W.C. van Etten (Electrical Engineering)
U. Faigle (Applied Mathematics)
O.E. Herrmann (Electrical Engineering)
F. de Jong (Computer Science)
A.M.J. Koonen (Electrical Engineering)
J. Krabbendam (Business and Management Sciences)
Th. Krol (Computer Science)
N.J.I. Mars (Computer Science)
E.F. Michiels (Electrical Engineering)
J. Moonen (Educational Sciences)
S.J. Mullender (Computer Science)
D. Nauta (Philosophy and Social Sciences)
I.G.M.M. Niemegeers (Computer Science - Chairman)
A. Nijholt (Computer Science)
J.H.A. de Smit (Applied Mathematics)
C.H. Slump (Electrical Engineering)
R. Stamper (Business and Management Sciences)
G. van der Veer (Philosophy and Social Sciences)
C.A. Vissers (Computer Science)
H. Pot (student).
H. Thielmann (GMD-Darmstadt)
H. Johansson (Eurescom, Heidelberg).

Executive Committee:

P.M.G. Apers

I.G.M.M. Niemegeers (Director CTIT, Chairman)

J.H.A. de Smit

APPENDIX 4 - 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

Federative projects within the CTIT:

Departments of Computer Science and Electrical Engineering:

- 1 ARCH: Design and Structuring Techniques for Open Distributed Systems Development (INF/EL: TIOS)
- 2 ISE: Integrated Service Engineering (ISE) (INF/EL: TIOS)
- 3 MAIN: Management Architectures and Implementations (INF/EL: TIOS)
- 4 BONMA: High Speed Broadband Optical Networks for real-time multimedia applications (INF/EL: TIOS)
- 5 BROADBAND: Protocols, Signalling and Control in B-ISDN (INF/EL: TIOS)
- 6 Mobile Networking (INF/EL: TIOS)
- 7 VALIDE (INF: TIOS)
- 8 Knowledge Based Systems (INF: IS) (ISKANDAR; STEVIN; PARETO; PLINIUS)
- 9 Databases for Object-Oriented and Logical Languages (INF: IS) (DOLLS and TWIST)
- 10 Methods Engineering (INF: IS)
- 11 Architecture and Implementation of Digital Systems (INF: SPA)
- 12 Huygens (INF: SPA)
- 13 Sparta (INF: SPA)
- 14 Parlevink: Linguistic Engineering (INF: SETI)
- 15 Reliability and Quality of (VLSI) Systems and Circuits (EL: BSC-NT)
- 16 Computer Supported Design Methodology for VLSI Systems (EL: BSC-NT)
- 17 Algorithms and Systems for Digital Signal Processing (EL: BSC-NT)

Department of Applied Mathematics / Departments of Computer Science and Electrical Engineering:

- 18 Performance, Measurements and Design of Telecommunication Systems (INF/EL: TIOS and TW: STOR)
- 19 Computational Complexity of Allocation Problems in Network Structures (TW: STOR)

Department of Educational Sciences:

- 20 On-line learning: The Instrumentation of Telecommunications-mediated Learning Environments (TO: ISM)

Department of Business & Management Sciences:

- 21 Situation-Dependency of the Analysis- and Design Process (TBK: BIK)
- 22 DECO: Design Concepts for CSCW-systems (TBK: BIK)
- 23 Law and Information Technology in a Managerial Context (TBK: Bedrijfsrecht)

Department of Public Administration:

- 24 Scenarios for "Smart Cards" in Health Care (BSK: MF)

Department of Philosophy and Social Sciences:

- 25 Modelling the Presentation Interface (WMW: Ergonomics)
- 26 Legibility and readability of modern flat-panel displays (WMW: Ergonomics)
- 27 Application of Cognitive Ergonomic Methods for Human-Computer Interaction (WMW: Ergonomics)
- 28 Formal Task Models (WMW: Ergonomics)
- 29 Models for Cooperation Technology (WMW: Ergonomics & COST 14)

APPENDIX 5 - CTIT Personnel²

<i>name</i>	<i>function</i>	<i>project(s)</i>	<i>start of contract period</i>	<i>end of contract period</i>
Management Staff				
J. van de Lagemaat	Institute Manager		1-1-1994	
W.G. Hiddink	Assistant Manager		1-1-1994	
M.G.M. Castañeda	Secretary		1-8-1994	
J. Volbers	Staff member Public Relations		1-8-1995 (part-time)	15-3-1996
Research Staff				
J.T. van der Veen	Researcher	Platinum	1-1-1995	1-7-1996
B.D. van der Waaij	Researcher	Platinum	15-3-1995	15-9-1996
A.N. Ladhani	Researcher	Platinum	1-4-1995	1-9-1996
H. Hazewinkel	Researcher	Implementation of tools for monitoring the status and utilisation of the network and distributed services	15-9-1995	15-3-1996
B.J. van Beijnum	Senior Researcher	ACTS-Insignia	1-10-1995	1-10-1998
S. de Graaf	Researcher	ACTS-Insignia	1-10-1995	1-10-1996
G. Karagiannis	Researcher	ACTS-Insignia	15-12-1995	15-12-1998
F. Slothouber	Ph.D.-student	ACTS-Tobasco	1-10-1995	1-10-1999
D. van Veen	Ph.D.-student	IOP- Optical Circuit and Packet Switched Networks	15-10-1995	15-10-1999
A.P. de Vries	Ph.D.-student	User interface for a multi-media database / UT Innovative Research	1-12-1995	1-12-1999

2. All staff members are employed on a full-time basis, 1.0 fte, except for the Public Relations Staff member: 0.5 fte.