



Annual Report 1995

F. J. Rammig
B. Steinmüller
Editors

cadlab

THE JOURNAL OF THE

AMERICAN SOCIETY OF

1995

W. J. Bennett, B. Bennett, &
J. J. Bennett, B. Bennett

1995

1995

C-LAB Report 7/96

Cadlab Annual Report

1995

F. J. Rammig, B. Steinmüller (editors)
compiled by: P. Hielscher

C-LAB

Fürstenallee 11, D-33102 Paderborn, GERMANY

THE JOURNAL OF THE

AMERICAN SOCIETY OF

1995

W. J. Bennett, B. Smith, &
J. J. Bennett, B. Smith, &
J. J. Bennett, B. Smith, &

1995

W. J. Bennett, B. Smith, &
J. J. Bennett, B. Smith, &
J. J. Bennett, B. Smith, &

Contents

Preface	vii
I Overview	1
1 Goals and Objectives	1
1.1 Principal Goals	1
1.2 Objectives of the Report Period	1
1.3 Vision and Strategic Frame for the Future	2
2 Organization	3
2.1 Overview	3
2.2 Board Members	4
3 Summary of Progress	5
II Project Group Reports	9
4 Information Technology	9
4.1 Introduction and Baseline	9
4.2 Consultancy	10
4.2.1 PDMS Project	10
4.2.1.1 Project Overview	10
4.2.1.2 Subproject Board Integration (TIBET)	10
4.2.1.3 Subproject Information Retrieval and Library System (ABS)	11
4.2.2 Open Technology, OT, Framework Support	11
4.2.3 Product Management in China	11
4.2.4 Database Federation Pilot Project	12
4.2.5 STEP	12
4.3 (Database) Middleware	13
4.3.1 OpenDM Overview	13

4.3.2	OpenDM Development	14
4.3.3	Research Activities	14
4.3.4	EXPRESS	15
4.4	System Engineering	16
4.4.1	Mechatronic Systems	16
4.4.1.1	Hybrid Model	17
4.4.1.2	Pre-configuration of the METRO Operating System	18
4.4.1.3	Integrated Database Access	18
4.4.1.4	Further Research	18
4.4.2	Hardware/Software Codesign	19
4.4.3	Tool Integration and Design Assistance	19
4.5	Multimedia and Networking	21
4.5.1	Intelligent Search and Service Agents	21
4.5.2	Usability in the Development of User Interfaces	22
4.5.3	Global Engineering Networks, GEN	22
4.5.4	EDIFACT	23
4.5.5	Graphical User Interfaces	23
4.5.5.1	Gesture-Based Editing	24
4.5.5.2	User Interface Specifications	24
4.5.5.3	Multimedia Extensions	26
4.5.5.4	Pictorial Janus	26
4.6	Summary and Outlook	27
4.6.1	JCF and SYDIS	27
4.6.2	Consultancy	27
4.6.3	(Database) Middleware	27
4.6.4	System Engineering	27
4.6.5	Multimedia and Networking	28
4.6.6	Scientific Achievements and Contributions to Standardization Bodies	28
4.6.7	Outlook	29
5	Analog System Engineering	31
5.1	Introduction	31
5.2	Baseline	31

5.3	Work During the Report Period	31
5.3.1	Characterization of Lossy Transmission Lines Through a Hybrid FEM/BEM Approach	32
5.3.2	A new Approach for Time Domain Simulation of Lossy Transmission Lines	32
5.3.3	Fast Signal Integrity Analysis by a Distribution of Simulation	33
5.3.4	Fast Reflection Analysis Through Transformation of Subnets	36
5.3.5	Delta-I-Noise of Digital CMOS Circuits	39
5.3.6	Design Support for Digital Components Through a Signal Integrity Test Process	42
5.3.7	Influence of Finite Ground Planes on the Transmission Line Current Distribution	44
5.3.8	Lean Integration Platform	50
5.4	Summary and Outlook	52
6	Computing Centre	55
6.1	Move to a new building	55
6.2	New equipment	56
6.3	Operating System Software and Tools	56
6.4	Parallel Computing	57
6.5	Outlook	57
III	Publications, Funded Projects and Scientific Collaborations	59
7	Publications and Major Documents	59
7.1	Cadlab Reports	59
7.2	Major Software Documents	60
7.3	Technical Reports	61
7.4	Books, Conference and Journal Papers	61
7.5	PhD Theses	64
7.6	Master Theses	64
7.7	External Talks, Lectures, Tutorials, Panels	65
7.8	Exhibitions	68

8	Funded Projects	69
8.1	Nationally Funded Projects	69
8.2	European Funded Projects	70
8.3	Reports on Funded Projects	71
9	Collaboration in Technical-Scientific Bodies	73

Preface

This year Cadlab, the joint R&D institute of Universität-Gesamthochschule Paderborn and Siemens Nixdorf Informationssysteme AG, celebrated its 10th anniversary. Cadlab's unique approach to effectively bridge the traditional gap between academia and industry by deeply integrating university research and industrial development turned out to be very successful. Traditionally, due to the different major driving forces of these two cultures, there is a lack in transforming research results from university to industry and a lack in centering university research at industrially relevant topics. To overcome the separation of cultures and to close the gap of communication, in Cadlab engineers and scientists, although hired from both sides, work together day by day under one roof. They jointly search for innovative solutions in mixed project groups and share problems and visions. For an entire decade of collaborative work Cadlab has proven that its founders' ideas did not remain a dream and experiment but became reality and daily practice. This dream has not lost any impetus but it has been continuously adapted to the partners' needs and to the requirements of the scientific world.

From the beginning Cadlab's work has been inspired by visionary and demanding problems to be solved using innovative scientific approaches in leading edge industrial environments. One of the first demanding problems was the lack of integrated design environments for hardware design. The problem to be attacked in this context was to provide smoothly integrated environments and workbenches to the user instead of isolated tools. Cadlab initiated and successfully managed during the first half of its runtime the JESSI project AC-1 "JESSI COMMON FRAME", the most challenging project to develop leading edge framework technology. With excellent technical results including substantial contributions to the scientific state of the art, Cadlab performed a major technology transfer to its industrial partner in 1992 and shifted its focus to advanced techniques for complex concurrent engineering problems. This includes the design of workbenches that combine various engineering aspects. The most sophisticated workbench developed at Cadlab up to now is the EMC Workbench, an integrated toolset to support PCB design in compliance with EMC restrictions. As for concurrent engineering, the following areas may serve as examples for the work performed: modelling of heterogeneous systems, information exchange via standardised formats (STEP/EXPRESS), product data management (PDMS), development of an open database middleware toolkit, support of knowledge based engineering techniques, realization of an operating system independent advanced editing toolkit, and the support of distributed engineering via global engineering networks.

Now after a decade of successful work where Cadlab earned an excellent scientific reputation on areas with high relevance to the industry's needs Cadlab is focusing on new challenges. Today and in the near future the integration of computing and communications will continue to make substantial progress. In this context multimedia will gain special importance. By addressing various human senses concurrently, information can be transferred much more efficiently. This implies novel communications and working structures, opening new horizons for people to act in space and time.

Cadlab's focus in the next years will be cooperative computing and communication. As a

consequence it has been decided to change Cadlab's name to C-LAB. This stands for Cooperative Computing and Communication Laboratory.

One area of interest will be multimedia assisted communication and cooperation. In this context Cadlab will concentrate on technical topics but always considering human aspects. The usability of multimedia information and the social aspect of making use of this technology are of particular concern. An additional important aspect to be tackled by Cadlab will be telecooperation, i.e. computer supported human interaction over arbitrary distances. 1995 Cadlab started important projects in this area. Activities in the context of the Global Engineering Network (GEN) initiative have been started with the goal to provide a worldwide multimedia-based network of engineering workplaces. Base technologies for multimedia also have been investigated, including novel pictorial programming paradigm.

A second focus of Cadlab is given by the necessity to support computer-based cooperation and communications within heterogeneous and distributed environments by an adequate computerized infrastructure. Cadlab will address computing, transport and storage services needed in this field. Domain neutral and reusable solutions are a general objective for this task. In this area Cadlab already made substantial contributions during the reporting period. The European Project TALENT has been started offering Cadlab the opportunity to enhance its leading edge database federation system OpenDM.

The third focus of Cadlab's future work will be the engineering of computer-assisted cooperative systems. Cadlab will concentrate on complex technical systems with the goal to support the environment preserving and resources saving design of such systems using advanced computer and communications technology. Heterogeneous systems with their challenging interaction of very different components are of special interest. Cadlab earned competence in this area in recent years and continued its efforts during the reporting period.

Finally, based on its unique scientific standing in this field and the increasing demand from industry the design for electromagnetic compatibility will constitute Cadlab's forth focus. After having solved a remarkable part of problems concerning printed circuit boards the new challenge now is system design under EMC restrictions. Cadlab will concentrate on this demanding question and will also cope with the interactions of this aspect with other, and sometimes contradicting, objective functions of optimising an entire electronic system.

The following annual report gives an overview of Cadlab's activities and achievements in 1995. Part I of the report details Cadlab's objectives, describes Cadlab's organisational structure and gives a general overview of the progress made. Part II contains technical details from the project groups. Part III provides supplementary information on publications, funded projects, and cooperations.

F. J. Rammig and B. Steinmüller
Cadlab Executive Board
Paderborn, June 1996

I Overview

1 Goals and Objectives

1.1 Principal Goals

Cadlab, the joint research and development institute of Universität-Gesamthochschule Paderborn and Siemens Nixdorf Informationssysteme AG (SNI) has been founded in 1985 with the backing of the federal state of North-Rhine-Westphalia.

Ever since the vision behind this unique endeavour has been to deeply integrate university research and industrial development within a joint centre of excellence for the synergistic benefit of the partners as well as the public.

The mission is to provide innovative computer-based solutions for challenging industrial problems and to support bi-directional technology and know-how transfer from academy to industry.

Cadlab's mission materializes in the following tangible R&D results:

- reports,
- publications and PhD theses,
- software prototypes,
- software components with industrial quality standard.

Moreover, it is Cadlab's objective to supply high-quality R&D services in the following areas

- consultancy,
- education and training,
- coordination and support of complex R&D projects.

1.2 Objectives of the Report Period

The sources for the objectives of this report period were twofold:

On the one hand work programmes and projects defined in the recent report periods were to be continued, while on the other hand a strategic redirection of Cadlab's future work was to be initiated to take up new challenges in information technology and new strategic requirements of Cadlab's industrial partner as becoming apparent in the respective baselining processes.

Consequently the following key objectives were derived:

- to continue and finish existing projects and to start strategic redirection in the area of information engineering; for the latter multimedia and networking were anticipated as major fields,
- to apply and evaluate Cadlab pilot software in the areas of data base federation, advanced editing systems, and product modelling in order to prepare for transfer into commercial and non-commercial exploitation,
- to intensify consultancy work in order to gain deeper insight into existing and future industrial needs while at the same time securing the financial basis,
- to consolidate a new work organization and work topics in the area of Analog System Engineering ASE - as required after the successful commercial spin-off of a major part of ASE at the end of the previous report period,
- to complete the transfer of results to the new commercial company,
- to intensify work in the future ASE direction of system design under electromagnetic compatibility ('EMC') constraints,
- and finally, to define a new Cadlab vision and strategic framework for the upcoming years.

A special objective of particular importance for Cadlab's future work basis was:

- the gain of funds for a new improved Cadlab infrastructure, in particular for the acquisition of more spacious, computer-friendly premises,
- to gain a long-term extension of the Cadlab cooperation contract such as to provide a stable planning and working baseline for the future.

1.3 Vision and Strategic Frame for the Future

New challenges in information technology and new strategic requirements of Cadlab's industrial partner as becoming apparent in the respective baselining processes necessitates the redirection of Cadlab's future work. Consequently a new strategic frame has been created during the report period (cf. chapter 3), whereby the proven collaboration principles described in sections 1.1 and 2.1. essentially remained unchanged.

The new strategic direction acknowledges the fact that the integration of computing, communication and 'tele-X' technologies and the transition to a future information-oriented society plays an ever increasing role. Thus, Cadlab will therefore be active in computing and communication technology with the general task of making significant contributions to the integration of both technologies into truly cooperative applications. Consequently, Cadlab's general field of work will be entitled "Cooperative Computing & Communication".

Under this general heading the four main subject areas have been defined for future work:

- Multimedia-assisted communication and cooperation,

- Infrastructures for cooperative applications,
- Engineering of computer-assisted cooperative systems,
- Engineering of environmentally constrained and EMC-compliant systems.

Details will be found in forthcoming documents.

2 Organization

2.1 Overview

Cadlab is a joint venture of Universität-Gesamthochschule Paderborn and Siemens Nixdorf Informationssysteme AG. Each partner provides scientific staff and corresponding financial resources to about equal parts. The cooperation is regulated by a contract made between the two partners in agreement with the state of North-Rhine-Westphalia in 1985. It is open for new interested partners.

According to the guiding vision of deeply integrating university research and industrial development, a joint organization has been established, which enables Cadlab to act as one uniform organizational entity in a similar manner as an independent enterprise (see Figure 1). In formal external relations (e.g., in contracts with third parties), however, Cadlab does not act as a legal entity, but is formally represented by its two partners.

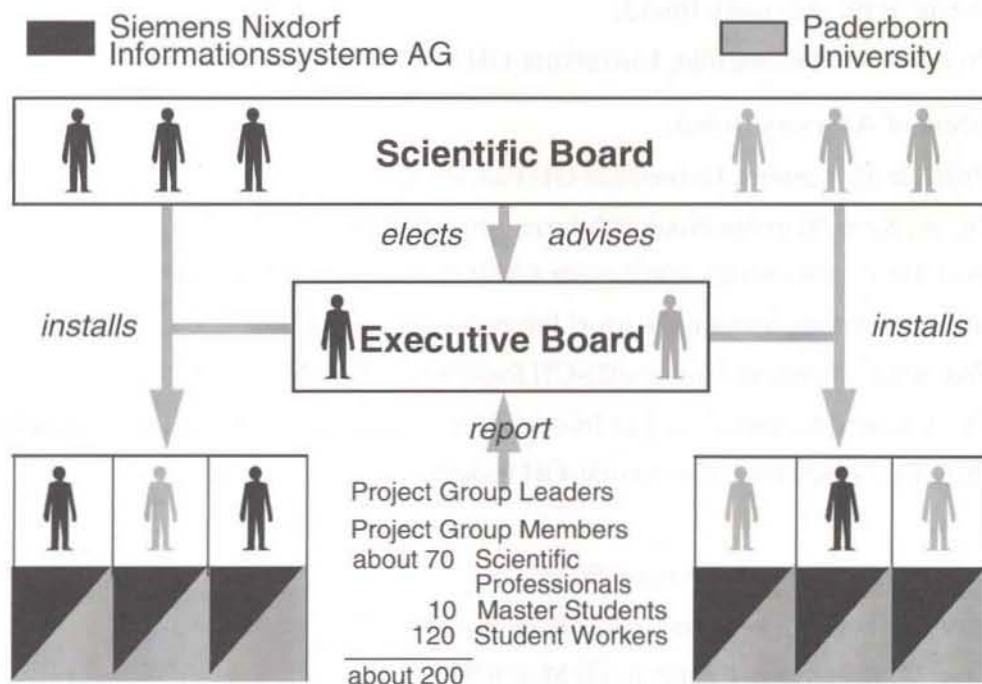


Figure 1: Cadlab, Principal Organisational Structure

Cadlab is headed by an executive board of two directors, one from the university and one from SNI. The executive board of directors is assisted and controlled by a scientific advisory board, in which the interests of the partners are balanced.

All technical work is carried out in mixed project groups irrespective of the employment contract (industry or university) of the individuals. These mixed project groups are headed by project group leaders. Depending on the specific needs, these principal entities can be combined into larger "super project groups" or further sub-structured into smaller working groups. In particular, the project groups in the domains of "Information Technology" and "Electrical Engineering" have been combined into the corresponding super project groups "Information Technology, IT" and "Analog System Engineering, ASE" respectively.

2.2 Board Members

During the reporting period the following members were assigned to the Cadlab Executive and Advisory Board, respectively.

Executive Board of Directors:

- Prof. Dr. F. J. Rammig, Universität-GH Paderborn
- Dr. B. Steinmüller, Siemens Nixdorf Informationssysteme AG

Chairman of the Advisory Board:

- Prof. Dr. W. Hauenschild, Universität-GH Paderborn

Members of Advisory Board:

- Prof. Dr. U. Kastens, Universität-GH Paderborn
- Dr. W. Kern, Siemens Nixdorf Informationssysteme AG
- Prof. Dr. G. Mrozynski, Universität-GH Paderborn (until March 95)
- Mr. U. Rethfeld, Siemens Nixdorf Informationssysteme AG
- Prof. Dr. U. Rückert, Universität-GH Paderborn (since March 95)
- Dr. A. Sauer, Siemens Nixdorf Informationssysteme AG (vice chair Advisory Board)
- Prof. Dr. G. Szwillus, Universität-GH Paderborn

Associated Members of Advisory Board:

- Prof. Dr. F. Belli, Universität-GH Paderborn
- Mrs. M. Brielmann, Cadlab (until March 95)
- Prof. Dr. J. Gausemeier, Universität-GH Paderborn
- Prof. Dr. G. Hartmann, Universität-GH Paderborn (until March 95)

- Prof. Dr. W. Hauenschild, Universität-GH Paderborn (chair of Advisory Board)
- Mr. H. Heckl, Siemens Nixdorf Informationssysteme AG
- Prof. Dr. H. Kleine Büning, Universität-GH Paderborn
- Prof. Dr. T. Lengauer, GMD (until March 95)
- Prof. Dr. K. Meerkötter, Universität-GH Paderborn (since March 95)
- Prof. Dr. B. Monien, Universität-GH Paderborn (until March 95)
- Prof. Dr. G. Mroczynski, Universität-GH Paderborn (since March 95)
- Prof. Dr. F. J. Rammig, Universität-GH Paderborn
- Prof. Dr. W. Schäfer, Universität-GH Paderborn (since March 95)
- Dr. B. Steinmüller, Siemens Nixdorf Informationssysteme AG
- Mr. J. Stroop, Cadlab (since March 95)
- Mr. H. Vogt, Siemens Nixdorf Informationssysteme AG

3 Summary of Progress

Work in the reporting period was driven by the mission and goals summarized in chapter 1. On the one hand work programmes and projects defined in the recent report periods were to be continued, while on the other hand a strategic redirection of Cadlab's future work was to be initiated to take up new challenges in information technology and new strategic requirements of Cadlab's industrial partner. In both aspects considerable progress was made. In particular, decisive steps were taken for safeguarding and strengthening Cadlab's strategic position and value.

To begin with, Cadlab's infrastructure and contractual situation were greatly improved by gaining a grant and a contract from the federal state North-Rhine Westphalia, which - in conjunction with the aid given by the city of Paderborn - allowed the acquisition of spacious, computer-friendly premises in the former headquarters of Nixdorf Computer. Here, too the Heinz Nixdorf Institute for information technology and the computer science department of Universität-Gesamthochschule Paderborn found their new home, so that an optimum scientific environment and community was created. With regard to the Cadlab cooperation contract, both partners agreed to extend the contract for another ten years, thus confirming their high interest in the cooperation and providing a stable, long-term basis.

As far as the strategic orientation for Cadlab's future work is concerned, an intensive discussion was started at the beginning of the reporting period involving the Cadlab staff and all major stakeholders of Cadlab's partners. The discussion was raised to an official level, when the top representatives of Cadlab's partners visited Cadlab in May 1995 encouraging the ongoing redirection of Cadlab's future work. In the sequel a systematic evaluation of requirements, strengths and interests was performed and cast into a new strategic framework as summarized in section 1.3 above. This framework was in principle agreed upon by the partners in December 1995. It will be refined and put into action in the forthcoming reporting period.

While all Cadlab project groups contributed to the new strategic framework, at the same time specific project work was carried out, which partially could already be redirected in line with the anticipated new goals. Other projects were finished as planned.

In the area of information technology IT (see chapter 4), three funded projects were finalized and results transferred for exploitation.

To begin with, the European ESPRIT project 'JESSI Common Framework JCF' was finished. This project had been initialized in 1990 under the leadership of Cadlab. It successfully contributed to international framework research and development as well as to international standardization. While Cadlab had handed over most of its development activities together with JCF version 2.0 to its industrial partner for further commercialization in 1992, subsequent contributions focused on applied research and advanced development aspects relevant to Computer Aided Concurrent Engineering. These activities were prepared for further exploitation. Advanced Editing Services (AES) were used in the construction of various new editors, which are available on the market (SCALOR, EXPREME). The results on Database Federation (DBF) were made use of in the project on 'Open Database Middleware OpenDM'. The scientific exploitation led to an interesting dissertation in October 1995, the industrial work resulted in a successful piloting at SNI finished in November 1995. At the same time an external industrial pilot test was started with a German CASE vendor and the further internal applications were prepared. As far as tool integration is concerned, insights gained in JCF resulted in another dissertation on object-oriented integration concepts. The 'Intelligent Framework Services IFS' investigated in JCF will be of benefit for knowledge-based applications and projects foreseen in the next work periods.

Besides JCF, the closely related 'European Standards and Integration project ESIP' came to an end. Here parts of the Cadlab STEP/EXPRESS Data Modelling Environment was developed, partially using results of JCF. In particular, one of the most complete and advanced checking tools, named 'ICE' and an interactive graphical editor for EXPRESS-G, named 'EXPREME' were finished and made publicly available via Internet. On the other hand a STEP-interface was built as an external adapter for the OpenDM System. The know-how acquired was also exploited in a number of customer projects with Daimler-Benz as well as the German ProSTEP group and in consultancy work.

As far as consultancy is concerned, substantial support was given to the SNI unit for midrange systems, to conceive and develop a new system for product data management ('PDMS'). Furthermore, PC and Windows-based framework development activities at SNI profited from Cadlab's framework expertise.

In system engineering, the national project SYDIS on synthesis of digital systems was finished. Here Cadlab developed intelligent design assistance tools based on extended predicate transition nets (PRT). While the SYDIS results have raised major interest in several industrial companies, the PRT technology will play a major role in future Cadlab projects. A dissertation on chip assembly and compaction rounded off Cadlab's scientific achievements on integrated circuit design.

New challenges for IT and Cadlab are given by the upcoming "information society", which will also revolutionize the way complex information contents is exchanged by using the emerging super information highways. In the reporting period, Cadlab estab-

lished the subject of 'networked multimedia' as a new subject and working area. Here a number of new projects were initialized. In this context Cadlab also assisted in launching projects for the "GEN"-initiative on "Global Engineering Networks and supported the foundation of the "GLENet e.V.", which promotes the GEN vision and its realization for large and small scale enterprises.

The activities in the domain of "Analog System Engineering ASE" (see chapter 5) are focused on the research and development of tools, methodologies and advanced measuring techniques for the design of electronic systems under EMC-constraints. EMC stands for "Electromagnetic Compatibility" and addresses a problem area, which has become ever more critical with the advent of high speed electronic systems.

After the successful commercial spin-off of a major part of ASE at the end of the previous report period into the newly founded company INCASES Engineering GmbH, the transfer of results was rounded off by the new version of the EMC Workbench 2.0. In particular a new tool for treating electromagnetic radiation and irradiation of/on to printed circuit boards was supplied as well as enhanced graphical input facilities. Moreover, the company INCASES was supported in its starting up phase by general consultancy and advice.

Apart from the technology transfer task, the re-orientation of the ASE-group towards future topics was continued. Here, the development and application of EMC-technology to full systems on the micro- as well as the macro-level is of primary interest. On the macro-level 'cabeling' became a new area of attention. Moreover, a new organization was set-up within ASE.

As far as ongoing project work is concerned, major progress was made in the European JESSI project AC5 on the development of a EMC-Workbench. This project is led by Cadlab. The second project phase was successfully finished and the excellent work was honoured by a 1995 JESSI recognition award. The third phase, which focuses on system design, was started consecutively.

As far as consultancy of SNI and Siemens factories is concerned, a new staff member was installed for EMC-consultancy related to system design.

Efficient support for the ongoing R&D work was provided by the Cadlab staff and the "Computing Centre, CC" (cf. chapter 6). The latter successfully managed to plan and realize the relocation to our new premises in such a smooth way, that normal work was hardly affected. This is remarkable considering the fact, that a totally new network infrastructure was erected. Besides the technical support work, scientific activities in the area of parallel computing were continued.

As already indicated above, most of Cadlab's work again was carried out in the context of collaborative projects (see chapter 8). Concerning nationally funded collaborations, Cadlab has participated in six government projects (BMBF), one project supported by the Deutsche Forschungsgesellschaft DFG, one supported by the AiF (Arbeitsgemeinschaft industrieller Forschungsvereinigungen e. V.) and one by GF_aI (Gesellschaft zur Förderung angewandter Informatik e. V.). Four projects are funded by ESPRIT.

Publications and dissemination of technical/scientific results again are a major result in this reporting period (see chapter 7). Cadlab's work is documented in about 80 public

reports and papers. Cadlab software was demonstrated on 10 fairs all over the world. More than 40 formal presentations, talks and tutorials were given on a large number of international events. At the same time internal technology transfer, education and training of young talent in application oriented engineering was actively promoted. This is reflected by eight master theses written under the supervision of Cadlab members and 120 student assistants integrated in a large number of Cadlab software projects.

II Project Group Reports

4 Information Technology

4.1 Introduction and Baseline

In the second year of its existence, one of the major objectives of the project group "Information Technology, IT" during the report period has been to consolidate its work on investigating methods, tools and infrastructures needed for the engineering of heterogeneous, hybrid systems and to provide middleware services as a basis for building engineering environments.

Besides continuing and/or completing work in various German national or European funded projects (e.g., SYDIS, METRO, JCF, ESIP¹), in which Cadlab participates/participated, especially in the area of data integration and data modelling continued industrialization efforts have been performed in the context of both the "Database Federation Services" project, which is now called "Open Database Middleware, OpenDM", and the EXPREME (EXPRESS Model Editor) project.

Previous IT efforts on employing the extended Predicate Transition Net, Pr/T-NET, paradigm together with knowledge representation means have been continued towards integrating both paradigms. Especially the project "METRO" dealing with mechatronic systems is representing an opportunity to further enhance the system modelling and evaluation support of Cadlab in providing additional requirements for this by applying it in the mechatronic system domain. The focus of this project is the use of massively parallel computers during design and realization of mechatronic systems.

It was expected, that the participation of Cadlab in the "Global Engineering Network, GEN" initiative together with other efforts dealing with "networked multi-media" and the acquisition of related projects will give Cadlab's "traditional" work in the area of engineering environments for supporting collaborative work in general and in the area of "Human-Computer-Interaction, HCI" a new push. This should be achieved by combining Cadlab's existing middleware and integration technology with multi-media means for better (tele-)engineering and/or collaboration support in distributed environments.

In addition to these activities it was intended to increase Cadlab's consultancy efforts by way of the "Product Data Management System, PDMS, Integration Project" in cooperation with the SNI Line of Business "Midrange Systems" in Paderborn, which started at the beginning of the report period. Rationale for this is to get input for further research activities for Cadlab by gaining deep insight into industrial practice and needs, to give Cadlab employees the opportunity to experience work outside Cadlab and to provide help to the industrial partner of Cadlab, SNI, in urgent and important projects with limited resources.

The report on work done and results achieved by IT in 1995 is structured as follows:

1. SYDIS = Synthese digitaler Systeme; METRO = Mechatronic; JCF = JESSI-Common-Frame; ESIP = European CAD Standards and Integration Project

After describing IT's "Consultancy" efforts (Section 4.2) the advances in the area of "(Database) Middleware" (Section 4.3) are described. Section 4.4 deals with IT's "System Engineering" work, whereas Section 4.5 contains the information on "Multimedia and Networking" followed by Section 4.6 "Summary and Outlook".

4.2 Consultancy

During the report period, Cadlab in general increased the level of direct participation in development projects run at sites of the industry partner of Cadlab, SNI. In particular, members of IT provided consultancy to the following project at SNI.

4.2.1 PDMS Project

4.2.1.1 Project Overview

The SNI Line of Business Midrange Systems (LoB MR) has set up a large project to replace the different product data administration tools in use today by a comprehensive Product Data Management System, PDMS¹. The rationale for the project is to optimize the complete process of computer development with respect to time, effort, maintainability, and flexibility, in order to meet the challenges of the ever-shorter product life-spans. The PDMS has to integrate all the tools and data involved in the development process of LoB MR's computer systems. This results in a uniform working environment for product managers, designers, fabrication supporters etc. Therefore, the existing workflows have to be identified and re-engineered and a common data schema has to be defined. The re-engineering follows the object-oriented paradigm. The integration framework is the product Metaphase from Metaphase Technology, Inc.

The PDMS project is run by the departments OI and PD1 of LoB MR. The actual project implementation started at the beginning of 1995. Cadlab is supporting LoB MR by assigning a small team with expertise in tool-integration, object-orientation, and UNIX-programming for the concept and prototype phases of the project. Cadlab staff is working at the MR site in two subprojects described below.

4.2.1.2 Subproject Board Integration (TIBET)

The subproject TIBET covers the design process for printed circuit boards (PCB's) from logic design to the generation of manufacturing data for the production. The logic design and layout tools used here concurrently have complex data dependencies. Therefore, the objective of TIBET is to relieve the designers from checking data and invoking converter tools whenever that can be done automatically, while making the current status of a PCB project transparent to all participants. A data model, tool encapsulation and a simple work-flow ("life-cycle") have been realized with the Metaphase tool. A first prototype will be available at the beginning of 1996. The Cadlab participation will continue until March 1996. The pilot version is planned for July 1996.

1. "CAI-Rahmenkonzept der SU MR", Editor: Siemens Nixdorf Informationssysteme AG, System Line of Business Midrange Systems, OI, 1994

4.2.1.3 Subproject Information Retrieval and Library System (ABS)

Most activities in the processes of computer manufacturing imply the handling of components. Thus, handling information about the parts is crucial. Currently, there are several disjoint administration tools in use for the different business processes. The ABS subproject is to replace these tools by an integrated information retrieval system which administers all classification data about parts and products and provides interactive access to them for all participants in the different business processes. In a later version, this will include the part libraries for the various CAD/CAE tools in use. A first prototype with real data has been realized mainly by Cadlab representatives participating in this subproject until the end of 1995.

4.2.2 Open Technology, OT, Framework Support

For a period of five months, one member of IT worked as a developer in the OT Framework project for SNI ASW IHD. The goal of this project is to provide a comfortable and easy-to-use programming environment for the business software ALX Comet 3.0.

The OT Framework is mainly implemented in Visual Basic 4.0, running under Windows NT and Windows95. It consists of two object-oriented database layers on top of Microsoft's Open Database Connectivity (ODBC) interface, basic user interface forms and classes, and a set of tools - so called wizards - which are integrated into the Visual Basic Integrated Development Environment (VBIDE).

The following wizards were developed with the support of Cadlab:

- **SetupWizard** to support a convenient installation of the framework;
- **ProjectWizard** to create new projects; it also provides a library and component management;
- **FormWizard** to automatically create forms according to the ALX Style Guide; creation includes all user interface objects as well as the underlying code;
- **BmWizard** to modify and enhance application specific business management classes.

Furthermore, the following modules and components were developed:

- system logging (concept and implementation);
- customization (concept and implementation);
- access management (concept).

4.2.3 Product Management in China

SNI is setting up a large investment program for the growing business in the Asia pacific region, specially in the people's republic of China. Within this program an IT member has been assigned to SNI China in the Line of Business Banking (LoB Banking) as a product manager, since October 1995.

During the report period (from October to December), the following main activities were carried out:

- preparing and presentation of the LoB Banking part within the computer exhibition "EXPO'95" in Beijing;
- building and leading the group of software development for automatic teller machines, ATM, and support team;
- analysing the Chinese market and basic requirements of ATM and banking solutions;
- getting into with major, potential customers in the QingDao and TaiYuan Branch;

- providing coordination and support to demonstrate SNI ATMs at exhibitions;
- introducing the standard ATM software developed by SNI in Paderborn into the Chinese market;
- support the local software development project for a large bank in Guangdong.

4.2.4 Database Federation Pilot Project

For the SNI Line of Business Midrange Systems a database federation pilot project was realized. The goal of this project was the integration of the databases of the systems EMC (ElectroMagnetic Compatibility) Workbench and CDV (Component Data View). The integration was performed using the OpenDM software (see Section 4.3.1), the CoSIO (Component Structure Input Output) interface of the EMC workbench, and the DDB/4 SQL interface to the CDV data. The pilot project showed that OpenDM was able to perform the required integration.

4.2.5 STEP

Cadlab is SNI's competence centre for STEP. STEP is the international Standard (ISO 10303) for the representation and Exchange of Product model data. STEP provides standardized data schemes, called Application Protocols (APs), for a number of application domains, like automotive design, building and construction, etc. For defining data schemes, STEP provides the language EXPRESS (see Section 4.3.4 for an overview of Cadlab's EXPRESS-based data modelling software). Furthermore STEP provides a file format for data exchange and a standard database interface called SDAI. During the report period, an SDAI interface on top of the database middleware OpenDM was realized (see Section 4.3).

In addition to the software development, Cadlab actively participated in the STEP standardization and supported other SNI departments when they needed STEP know-how during the report period.

For Siemens ANL (Anlagentechnik), an SMS-STEP processor which transforms STEP files into SMS files and vice versa was developed. SMS is a simulation system of Siemens ANL.

For the SNI department introducing Metaphase at Mercedes Benz, a tool translating STEP files into Metaphase files was developed. Subsequently, work was started on an extension of Metaphase that will enable Metaphase to import/export STEP files. This work was/is performed in co-operation with the companies Control Data and SDRC within the STEP/PDMI project of ProSTEP.

4.3 (Database) Middleware

The access to and modelling of data gains increasing importance, since most database applications are no longer restricted to single data sources. An increasing number of database applications is therefore confronted with problems in the area of

- data access to and manipulation of multiple heterogeneous databases;
- integration and modelling of data crossing multiple data bases;
- migration of data and migration of applications between databases.

For solving these problems, Cadlab works on solutions for federating heterogeneous databases, standardized database interfaces, data modelling, data exchange, data migration, etc. The basis of this work is a software layer between applications and data handling systems (database systems, file systems, etc.) called OpenDM (Open Database Middleware). OpenDM provides the standardized data access interfaces ODMG'93 and SDAI, and features for integrating existing databases and data migration. OpenDM allows to reduce the efforts and costs for designing and implementing database applications.

4.3.1 OpenDM Overview

OpenDM is a toolkit supporting solutions for problems like database-independent development of applications, migration or federation of heterogeneous data handling systems. OpenDM is realized as a generic and configurable software layer built on top of heterogeneous database systems (DBS) as shown in Figure 2.

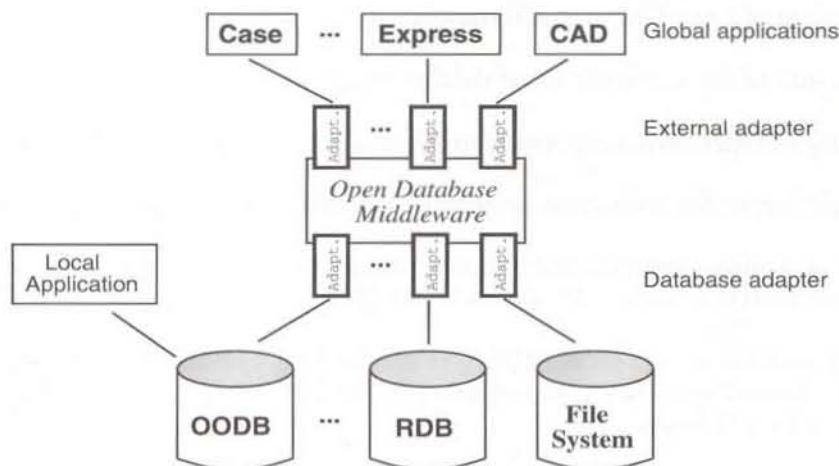


Figure 2: Open Database Middleware Overview

Support of a very large range of DBS is provided by OpenDM allowing dynamic extension with new DBS by way of so-called database adapters. These database adapters convert the DBS specific data models and languages to the OpenDM object-oriented data

model and languages. The adapters can couple a DBS in such a way that local applications have furthermore access to the DBS. By way of the database adapters most common DBS can be coupled to OpenDM, e.g., RDBS, OODBS or a file system. Actually supported DBS include Entire 3.1.1, Adabas-D, Oracle, OMS and the UNIX file system. Further adapters are being developed. For global applications different interfaces are provided by so-called external adapters. In OpenDM 1.0 external adapters of ODMG-93 and SDAI are provided whereas other standard interfaces like SQL are planned in future versions. These adapters convert the external data models and languages to the OpenDM ones. Apart from the adapters also modules of the OpenDM kernel are configurable and replaceable like the modules for object management, data storage/caching, process/user administration, or identifier mapping.

One key feature of the OpenDM approach is to use and to provide standards whenever possible which also underlines the openness of the approach (e.g., SQL, ODMG, STEP, or TCP/IP).

4.3.2 OpenDM Development

In the years 1993 to 1994 a basic version of OpenDM within the DBF project was developed. In 1995 the development was concentrated on enhancing the quality as well as the functionality of OpenDM in details. This went along with activities to bring OpenDM in use in pilot applications and extend the awareness of OpenDM in the database community, the STEP community, as well as object-oriented community. The highlights were as follows:

- realization of an ODMG-93 front-end (C++ ODL/OML) to OpenDM;
- realization of an SDAI front-end (C++ early binding) to OpenDM;
- extension of OpenDM kernel functionality by inheritance;
- extension of the available set of database adapters;
- porting of OpenDM components to other platforms (Solaris, SINIX, Win32);
- completion of the federation pilot project within SNI, see Section 4.2.4;
- start of a pilot application on database integration and migration with external partner (MID) as part of EU project TALENT (ESPRIT Project EP 20.545);
- software demonstrations at SIGMOD (USA), Object World (Frankfurt), GI Workshop "Grundlagen von Datenbanken" (Bad Salzdetfurt), and ESIP (ESPRIT Project EP 8370) reviews.

4.3.3 Research Activities

In addition to the development of OpenDM, the following research topics were addressed during the report period:

- migration within federated databases;

- schema evolution within federated databases;
- transaction management in design environments;
- object-oriented environment for the integration of tools into a design environment;
- a rule meta model for active database systems;
- structural definition of views.

4.3.4 EXPRESS

Cadlab provides several tools for data modelling with EXPRESS (ISO 10303-11). The EXPRESS-G editor EXPREME was developed on the basis of EOS (see Section 4.5.5). In 1994, the delivery of EXPREME 1.0 was started. Since 1995 EXPREME 1.2 is marketed by SNI. Over 40 licenses have been installed world-wide.

In 1993, the EXPRESS syntax and semantics checker ICE was developed. Since November '93, ICE 1.0 is available free of charge on the Internet for Sun-4, SGI, HP9000, Apollo, IBM RS6000, OS/2, and Linux. ICE 1.0 checks against the ISO 10303-11 Draft International Standard. In 1994, ICE was adapted to the ISO 10303-11 International Standard. Since April '95, ICE 2.0 is available free of charge for Sun-4. The ICE software can be retrieved from the ftp server of Paderborn University via anonymous ftp. Figure 3 shows the total number of versions of ICE 1.0 and 2.0 that were downloaded.

For integrated process and data modelling, Cadlab defined EXPRESS-P. EXPRESS-P is an extension of EXPRESS by the process modelling concepts of SDL and GRAPES-86. Cadlab contributes these concepts to the standardization of EXPRESS Version 2 as a member of the EXPRESS Ad-hoc Group of DIN NAM 96.4.4 - the German national standardization body for EXPRESS Version 2. An EXPRESS-P syntax and semantics checker for Sun-4 has been implemented and is available free of charge via anonymous ftp since March 1995. The ftp server statistics in Figure 3 as well as the application of EXPRESS-P within a modelling project¹ at the Rutherford Appleton Laboratory, UK, indicate a growing interest in EXPRESS-P.

1. Brian Matthews, Juan Bicarregui: "Process Modelling in Control Systems Design", 5th EXPRESS User Group, Grenoble, France, October 1995

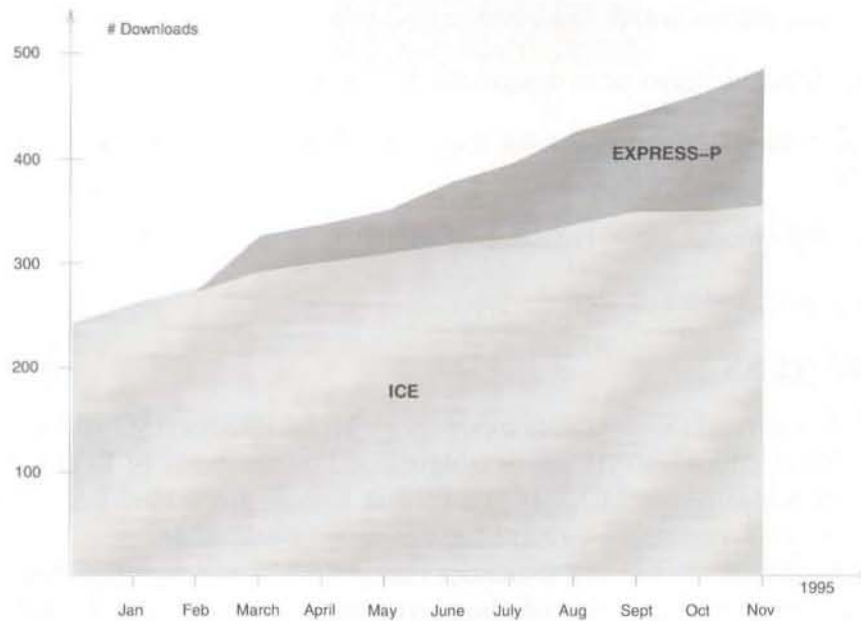


Figure 3: Total Number of Downloads of ICE and EXPRESS-P

4.4 System Engineering

The work on system engineering done during the report period can be roughly classified into two areas:

On the one hand methods and tools were developed for the engineering tasks themselves. The focus laid on system modelling and simulation in the two application domains mechatronic and hardware/software (co-)design, that will be described in more detail below. First ideas for system modelling, simulation and optimization were also developed in the transport domain.

On the other hand methods and tools for process support were provided. This work concentrated on tool integration and design assistance in a hardware/software co-design environment, and on distributed project planning.

4.4.1 Mechatronic Systems

System engineering for mechatronic systems is mainly performed in the scope of the BMBF funded project METRO that started in 1995. The overall aim of this project is to provide services for the development and realization of mechatronic systems. METRO promotes a design methodology that starts with a simulated model of the system and then replaces step-by-step components of this inherently parallel simulation model by real components (hardware-in-the-loop) until the final realization is accomplished. This transformation is supported by a set of modular and seamless degradable services. Parallelism plays an important and twofold role. It is used for the acceleration of the design

steps and services and it also determines the architecture of the system.

The project is organized in three layers (see Figure 4). The bottom includes a de-gradable and real-time capable operating system. Degradation ranges from comfortable services compared to standard operating systems features down to basic real-time scheduling and communication facilities. Further services are the control of design processes and access to a database in a real-time environment.

The next layer covers two simulation platforms (off-line and real-time) for the analysis and optimization of complex digital controllers. These platforms support a combined and closed simulation of models of heterogeneous mechatronic system parts expressed in different but commonly used description languages.

For the top layer partial models of the mechatronic application (hybrid engine) are provided through different tools. The cooperation of these parts is specified by the top level topology. As a common intermediate language for simulation a meta-language to be defined by the project or the C programming language are provided.

Cadlab contributes to the project in different areas that are explained below. General activities in the report period have been the definition of interfaces between the above mentioned layers. Furthermore, Cadlab is responsible for the overall project management.

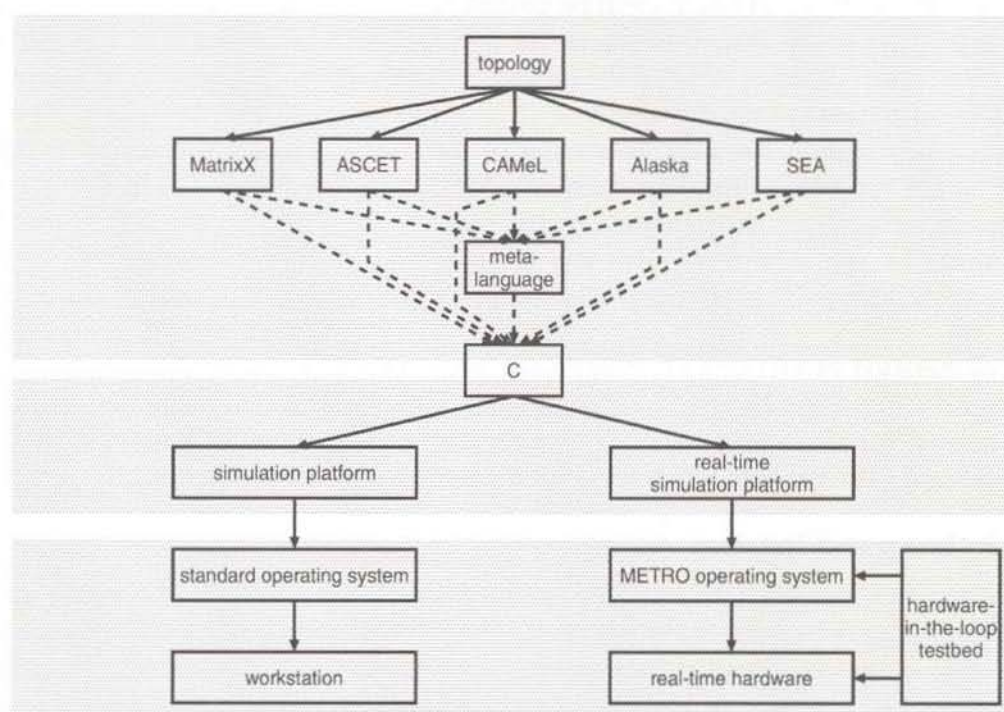


Figure 4: METRO Architecture

4.4.1.1 Hybrid Model

One task of the METRO Project is to develop a specification method which allows the description of the mechanical parts of a mechatronic system as well as the information technology parts. This method has to consider the energy, mass, data, and control flows

of a mechatronic system in a uniform way. As a first step towards such a specification method the characteristics of mechatronic systems have been investigated. The continuous parts of such systems are usually represented by differential equations. But the formats of the different tools used in the METRO project differ to such an extent that for the combined simulation of these equations the programming language C has to be used. The specification tool to be developed at Cadlab on the one hand has to support the coupling of continuous system parts developed with the partner specific tools. On the other hand methods for coupling of continuous and discrete system parts have to be provided. Based on an evaluation of the project requirements a first approach for such a specification method was elaborated. It is based on extended Predicate/Transition nets as they have been developed in Cadlab in the previous years and allows the seamless treatment of discrete and continuous systems. A modular and hierarchical composition helps to reduce the complexity of mechatronic systems.

4.4.1.2 Pre-configuration of the METRO Operating System

Real-time scheduling is based on a system for run-time analysis in the hardware domain. All periodic hard real-time tasks (= tasks with known computations times, hard deadlines, and bounded communications) are statically mapped to the processor network, such that all real-time conditions will be guaranteed. The mapping (allocation) will take into account operating system overhead for dynamic scheduling decisions. To achieve this the approach declares some of the processors to be SD (schedule driven) and others to be OD (operating system driven).

SD processors exploit the static behaviour of the considered set of tasks by avoiding overhead for dynamic scheduling decisions. SD processors simply run a precomputed scheduling table. Their disadvantage is that they do not allow to access free schedule slack times for dynamic tasks. This can be overcome by OD processors which allow access of slacktimes by performing scheduling dynamically with the trade-offs of overhead.

The combination of OD and SD processors is the best way of exploiting slack with a minimum of overhead. Hence, the allocation algorithm provides not only the actual task assignments, but also a processor type partitioning in OD and SD processors. The result is considered to be the preconfiguration of the parallel operating system.

4.4.1.3 Integrated Database Access

A third area in which Cadlab contributes to the project is the provision of database access in a real-time environment. Such a database can be configured both for the management of simulation models as well as for simulation inputs and results. Therefore, an automatically generated coupling of the simulation environment to the database management system is required. As this again means a coupling to discrete information processing tools, results of the specification methods for the combination of hybrid models can be incorporated. As initial activities requirements for this database access were gathered and interfaces to the METRO design system and to a database system were defined.

4.4.1.4 Further Research

Besides this work in METRO the research work on the modelling of heterogeneous, hybrid systems has been continued. For the application of the modelling technique

developed in previous years a design methodology for heterogeneous systems has been elaborated. This design methodology is based on approaches well known in the hardware engineering domain. Similar abstraction levels and views can be identified and similar methods and algorithms can be used for the transition between the levels. This design methodology together with the modelling technique was evaluated on the design of a production cell well known as a case study on specification.

4.4.2 Hardware/Software Codesign

The work in this area concerned standardization activities in the context of system specification, VHDL, and system validation as well as research work on these topics.

Within the ESIP (EDA Standards and Integration) Project, that finished in October, Cad-lab (in cooperation with its Swedish project partner Synthesia) evaluated the SDDL (System Design and Description Language) prototype proposal of the SDDL study group (of the DASC). On the basis of the evaluation results a specification framework based on the Z notation was introduced. It allows the designer to specify systems on the highest level of abstraction using VHDL specific application packages.

A research work will complement this specification framework. It will define correctness preserving methods to transform the specification into VHDL and other programming languages. This enables the validation of the specification by simulation.

In order to specify the VHDL'93 semantics unambiguously a formal definition of the complete VHDL'93 simulator was elaborated in cooperation with the Heinz-Nixdorf-Institut and Pisa University.

Further standardization activities included the participation in VHDL-A (IEEE/DASC P1076.1) standardization as well as in Verilog-HDL (IEEE 1364) standardization.

System specification was investigated in 1995 by the GI/ITG/GMM Fachgruppe 3.5.7 / 5.2.2 / 5.7 "Description Languages and Modelling of Circuits and Systems". This group coordinates the German (V)HDL activities and the German VHDL User's Group.

A further research activity concerns the formalization of distributed backplane-based simulation employing a modelling methodology based on extended Pr/T Nets is being developed and used to model a distributed simulation environment in an unambiguous way. A special feature of the methodology is its ability to express explicitly the dynamic semantics of each part of the model.

4.4.3 Tool Integration and Design Assistance

The work on tool integration and design assistance was mainly performed in the BMBF funded project SYDIS (SYNthesis of Digital Systems). The SYDIS project was successfully completed at the end of 1995. The results were presented at a final workshop in November 1995.

In this project a set of tools for hardware/software co-synthesis was developed. As integration platform for these tools the database middleware OpenDM (Section 4.3.1) with its STEP (ISO 10303) compliant interface OpenDM/SDAI was used.

An intelligent design assistant on the basis of extended Predicate Transition Nets (Pr/T Net) was realized and integrated with OpenDM/SDAI. The design assistant consists of a Predicate Transition Net editor to specify and simulate arbitrary design flows as nets. Furthermore, an editor for specification of abstract, user defined graphics representing

the Pr/T Net and its actual state is provided. The Pr/T Net environment is also used in the scope of mechatronic system modelling and simulation (see above).

As an example the APPlaUSE-Tools¹ for high level synthesis and floorplanning were integrated on top of the integration platform OpenDM/SDAI. For these tools a workflow was specified as extended Pr/T Net. According to this workflow a designer was guided during the development of several designs using the simulation facilities of the design assistant.

Furthermore, during the report period a first prototype of Cadlab's project PLANer CaPlan has been accomplished. This CSCW tool especially allows simultaneous editing of the same project plan by different users, and analysing the plan with respect to important dates (timing analysis). Its graphical user interface provides enhanced possibilities about critical path analysis, and concepts of hierarchy.

1. Elof Frank: Placement-Driven High-Level Synthesis; Dissertation, Universität GH Paderborn, August 1995

4.5 Multimedia and Networking

The work done during the report period in the domain of multimedia and networking as one of the future strategic orientation within IT is mainly characterized by an analysis of the application domain to investigate existing software and concepts and to identify technology gaps. With the existing technologies the following application domains have been addressed that will be described in more detail below:

- intelligent search and service agents,
- usability in the development of user interfaces,
- global engineering networks (GEN),
- electronic data interchange,
- graphical user interfaces.

The work on intelligent search and service agents will make use of experiences gained with the development and use of the Intelligent Framework Services (IFS).

4.5.1 Intelligent Search and Service Agents

The concept of agency has been used widely in computer science. Agent-oriented programming as a computer-science field reaches from distributed AI, distributed programming to the field of computer communications. A mobile agent is an encapsulation of code, data, and execution context that is able to migrate autonomously and purposefully within computer networks during execution.

The most obvious agent application domain seems to be information gathering. Other rationales for agent activities are the provision of added value, work support/notification services, or learning. Besides the application domain agents may be classified in agents which do not directly provide their services to a user and the so called user interface agents. The major characteristic of the latter is that they carry out missions delegated by the user, e.g. filtering incoming electronic mails according to user's needs or priorities.

To perform the described activities agents have to rely on a number of active features like triggers, rules and stored procedures. Further, agents have to be incorporated into existing environments. This leads to the use of experiences and software obtained in the reporting period in the Intelligent Framework Services (IFS). IFS is a knowledge representation and evaluation system, that is based on two concepts which have already been proven as an expressive means of dealing with knowledge, namely frames and rules.

Contrary to other hybrid knowledge representation systems, the frames and rules components of IFS are deeply integrated into the object management system of the JESSI Common Framework. This is due to the fact, that IFS was also developed within the same project. To evaluate the suitability of IFS to different application domains application examples for transportation domain, for EMC advice and optimization of predicate transition nets have been developed during the report period.

4.5.2 Usability in the Development of User Interfaces

Within the future strategic domain of multimedia and networking an important topic is usability which reflects the user needs for intuitive interfaces. This does not only address end user's interfaces but also developer's interfaces.

To cover this topic a master thesis has been produced during the report period which provides an easy textual specification of graphical dialogues. Those dialogues, which refer to objects and their dialogue components, which are related to attributes, are automatically connected to an object-oriented database system (OMS). To enhance the usability of this dialogue description, a graphical user interface builder was implemented. This graphical tool permits easily to define dialogue forms. The motivation to provide this graphical tool in addition to the textual description was, to permit a more generic possibility to develop user interfaces and to connect them to different databases. A further requirement for this graphical tool was to provide interfaces for applications which run on PC platforms as well as UNIX workstations.

4.5.3 Global Engineering Networks, GEN

The goal of the Global Engineering Network (GEN) is to provide a world-wide infrastructure for knowledge distribution to realize the "electronic marketplace". Besides the semantic framework for the systematization of engineering knowledge, a set of toolkits for acquisition, retrieval and presentation of knowledge is planned. To foster this process available technologies shall be used where possible.

Within the report period work was started on the realization of the so-called "GEN Basic Toolkit" in collaboration with the Heinz-Nixdorf Institut, HNI. The GEN Basic Toolkit provides a set of basic mechanisms and services enabling users to get access to GEN. It focuses on the establishment of the GEN network infrastructure. This includes services for net-connection, a WWW-server, authentication, administration, basic user management and basic business services.

The underlying hardware infrastructure of the GEN Basic Toolkit is heterogeneous. In particular, PC stations as well as (UNIX based) workstations may be used as platforms at customer site. Information about customers of GEN and their products are presented as html-pages via WWW. All information is distributed. Therefore a network gateway as well as WWW-servers at different sites are required. The central GEN server focuses on the management of the various suppliers' servers based on "meta" data.

The GEN Basic Toolkit forms the technological basis for other GEN projects like PROCAT-GEN, GENIAL, etc.

Together with some of the partner organizations of the GEN initiative and under the auspices of the GLENnet e.V. Association, which has been founded in 1995 for promoting the GEN vision and its commercialization, two major project proposal submission efforts, PROCAT-GEN and GENIAL have been coordinated by IT. Both projects have been approved by the European Commission and will start in 1996. Whereas PROCAT-GEN deals with user needs and market analysis aspects of multimedia-based product catalogues GENIAL will investigate and develop a common basic infrastructure, the corresponding logical framework and toolkits for the intelligent structuring and retrieval of so-called GEN engineering objects.

4.5.4 EDIFACT

During the report period, Cadlab worked on a concept for engineering data exchange by EDIFACT and EDIFACT-oriented messages, i.e., ENGDAT resp. CONDRA messages exchanging STEP data via the World Wide Web protocol HTTP. Cadlab started to implement a system in the context of a diploma thesis that ensures a complete transmission of trade and product data, and - in the case of STEP - the pertaining data model specified in EXPRESS. This HTTP extension is denoted as EDIFACT Transfer Protocol (ETP). The system is configurable by means of a structural description of EDIFACT messages which is given by the ISO data modelling language EXPRESS¹. Figure 5 outlines the system architecture and the application of EXPRESS specification (EDIFACT-Schemes).

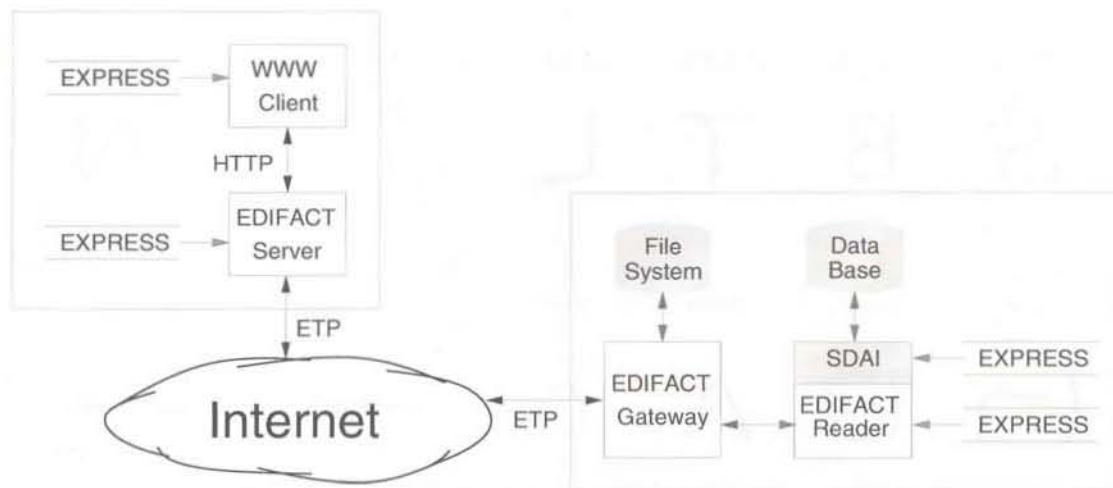


Figure 5: System for Engineering Data Interchange

4.5.5 Graphical User Interfaces

Within the report period, the human-computer interaction group developed applications and extensions on top of the object libraries, which were developed in earlier years. The main libraries are those of the editor framework EOS (Editor Object System) and the gesture-based toolkit HANDI.

HANDI is a framework for building hand-sketch-based diagram editors and has been designed for reducing the efforts required by building gesture-based diagram editors. HANDI was extended to support user defined gestures, which are interactively specified. Experiments with different mapping strategies of gestures and symbols were realized on different hardware platforms.

EOS was enhanced in various ways. A couple of master theses were started to develop graphical specifications of editors. First extensions for the usage of EOS in the multimedia area as well as for visual programming were realized. The individual EOS applica-

1. H. Aisch, M. Joosten, W. Müller, F. Buijs, "Interaktiver Produktdatenaustausch mit EDIFACT", Proceedings of the CAD'96, March 7-8, Kaiserslautern, Springer, Berlin, 1996

tions in 1995 cover the implementation of EXPREME (EXPRESS-G), SCALOR (Board Layout), JIM (Janus In Motion), editors for user interface specification and multimedia applications.

4.5.5.1 Gesture-Based Editing

Gesture-based input was integrated in the graphical Editor EXPREME. EXPREME is an easy-to-use graphical editor for the rapid development of EXPRESS-G models. Different strategies for the rapid prototyping of EXPRESS-G models, i.e., user-defined, pre-typing, post-typing, for HANDI applications have been developed. The software was successfully demonstrated on PC platforms and electronic whiteboards.

Figure 6 shows an example for the mapping of EXPRESS-G objects to gestures.

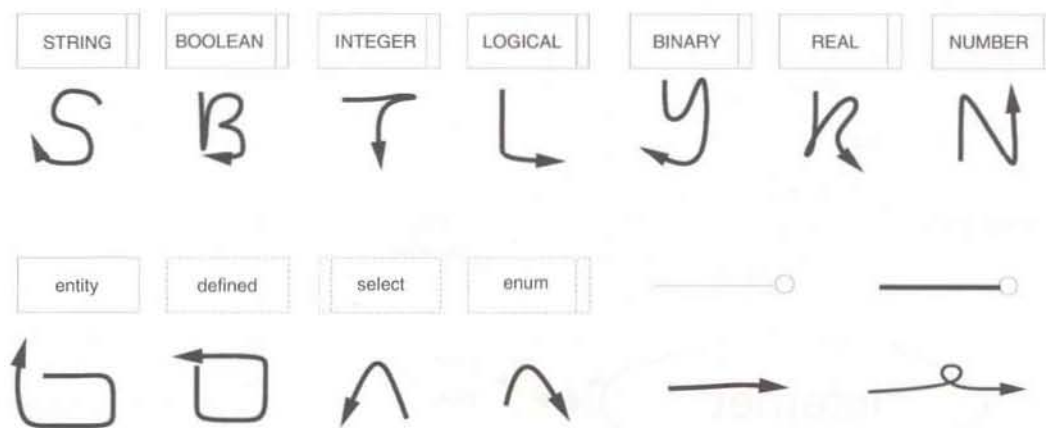


Figure 6: User-defined Gestures for EXPREME

4.5.5.2 User Interface Specifications

Based on EOS and EXPREME, a model-based specification of editors was designed and implemented. The construction of an editor starts with existing EXPRESS-G data descriptions and is annotated with specifications for the presentation. These specifications are defined by meta descriptions (templates) which are defined for a special class of editors. Figure 7 shows a specification of an editor and Figure 8 the generated result.

Two further diploma theses were started which develop concepts and implementations for graphical specifications of control flows and symbols descriptions in the context of model based specification.

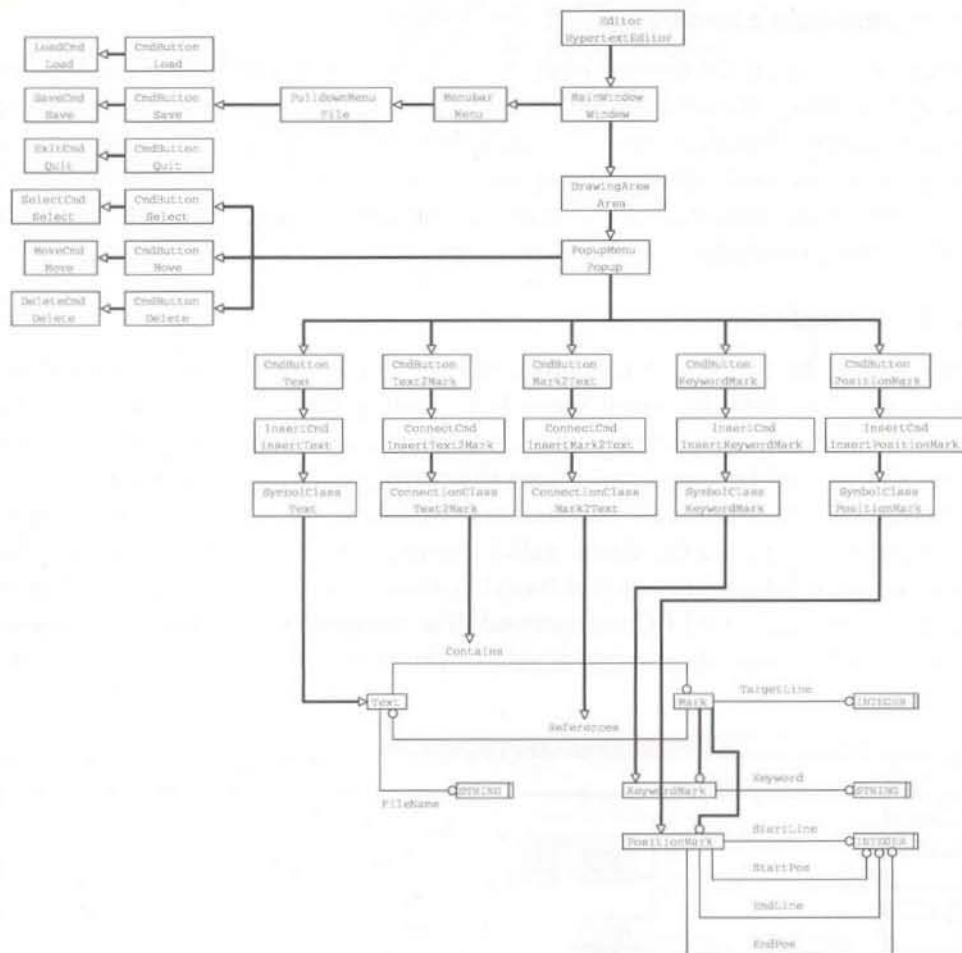


Figure 7: Specification of a Simple Hypertext Editor

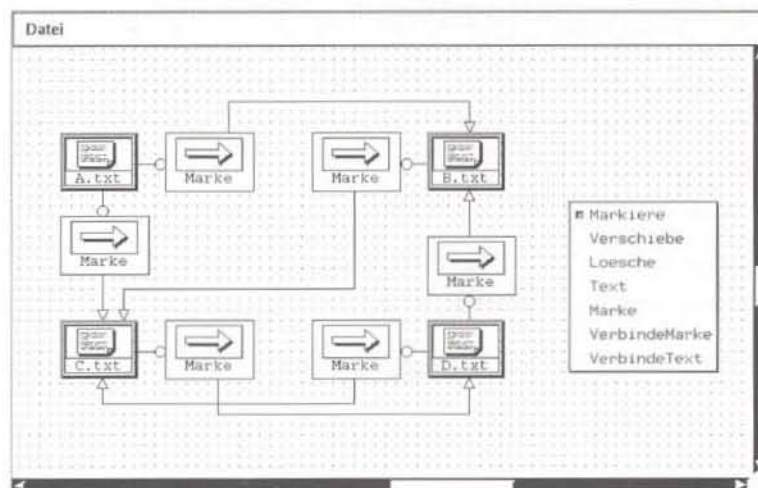


Figure 8: Generated Editor

4.5.5.3 Multimedia Extensions

Some first extensions to EOS were made to support audio output and picture output. An existing JPEG library was integrated and some prototype applications were developed in order to evaluate the interface. One of these applications supports the graphical programming of picture and sound display depending on time constraints. This kind of authoring tool can support presentations in the domain of teaching. Another application supports the graphical programming of a full screen application (kiosk applications).

4.5.5.4 Pictorial Janus

The prototype of the first interactive programming and animation environment for Pictorial Janus (PJ), i.e., JIM, has been successfully demonstrated at the 1995 IEEE Symposium on Visual Languages (September 5-8, Darmstadt, Germany). The environment covers an EOS-based PJ editor and interactive animation tool including a visual debugger. Several diploma theses were initiated in the context of these tools. The theses on the animation interface and on the visual gallery were finished. The thesis on visual debuggers as well as the thesis on constraint-based layouts will be finished in early 1996. A PJ extension for timing (Timed PJ) was defined. The application of Timed PJ in the context of high-level SDL protocols and low-level bus protocols was investigated in details.

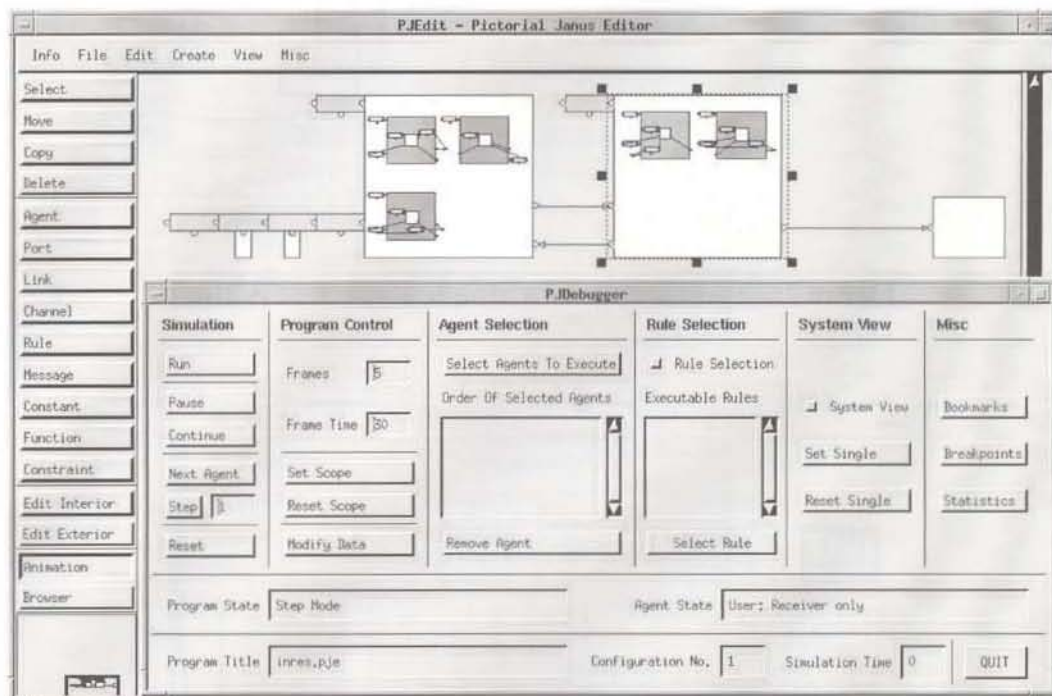


Figure 9: JIM - Interactive Debugging Environment for Pictorial Janus

4.6 Summary and Outlook

As stated in the introduction to Chapter 4 major objectives of the IT group during the report period have been the consolidation/finishing of existing activities and projects and the definition/establishment of promising new ones, especially in the area of multimedia and networking.

4.6.1 JCF and SYDIS

After six years the ESPRIT project JCF was terminated in the spring of '95. At the final review especially the work of SPI on "Applied Framework Research", where Cadlab contributed efforts on "Intelligent Framework Services, IFS" has been appreciated by the reviewers. At the end of the year, the BMBF project SYDIS was finished with a final workshop, where Cadlab successfully demonstrated work done in the context of intelligent design assistance employing Pr/T Nets, which was integrated with tools of other SYDIS partners using OpenDM/SDAI.

4.6.2 Consultancy

In addition to the PDMS project, which had been agreed upon in 1994 and started early 1995 in cooperation with SNI LoB MR, IT members participated in the SNI LoB ASW OT project and in establishing the sales department in Beijing, SNI China. A number of customer projects have been performed in the context of STEP/EXPRESS.

In addition, courses, mainly for students of Paderborn University, were given on C/C++ and ODMG.

4.6.3 (Database) Middleware

The project OpenDM, Open Database Middleware, made major progress towards software components of product-like status, which were in part evaluated and demonstrated in a pilot project with the SNI LoB MR. In addition, OpenDM was successfully subjected to the baselining process of SNI SU ASW. Within the Trial Application ESPRIT project TALENT, which was started during the report period, components of OpenDM have been further developed in order to provide a transparent database layer for the MID CASE tool INNOVATOR.

The work on the development of the two OpenDM frontends satisfying the ODMG-93 and STEP/SDAI standards was supplemented by further industrialization efforts in the context of Cadlabs Data Modelling Environment centred around STEP/EXPRESS.

4.6.4 System Engineering

The development of methods and tools for system modelling and simulation has been focused on mechatronic systems. Within the METRO project a first approach was developed for the integration of different specification methods contributed by the project partners. For the application of the integrated specification approach a design methodology for heterogeneous systems has been developed. Furthermore, a method for the pre-configuration of the METRO operating system was elaborated.

The work on methods and tools for process support was mainly performed within the

SYDIS project, which was successfully finished by the end of 1995. A design assistant for the hardware/software co-design environment developed in SYDIS was realized and successfully demonstrated at the project closing workshop. The design assistant and the tools were integrated on the basis of SDAI. Furthermore, a first prototype of Cadlab's project Planner CaPlan has been accomplished, which supports the simultaneous editing of project plans and timing analysis of the created plans.

4.6.5 Multimedia and Networking

During the report period "Networked Multimedia" was established as working area. First results of these activities are the GEN Demonstrators and the GEN Basic Toolkit, which have been developed in cooperation with the Heinz-Nixdorf-Institut, HNI. IT's activities on networked multimedia has additionally started to influence the direction of its "Human-Computer-Interaction, HCI" efforts. This was mainly reflected by acquiring relevant know-how and by evaluating existing tools and technologies in the context of multi-media front-ends.

During the report period Cadlab participated in the successful proposal submission of the MATES project as co-ordinating partner. MATES deals with Multi-media Assisted Tele-engineering Services and will provide, among others, multi-media frontends for all the projects related to the Global Engineering Network initiative.

Additionally with regard to HCI aspects, applications and extensions on top of the editor framework EOS and the gesture-based toolkit HANDI, which were developed in recent years, have been implemented. They cover the implementation of EXPREME (EXPRESS-G), SCALOR (Board Layout), JIM (Janus In Motion), editors for user interface specification, and multimedia applications.

4.6.6 Scientific Achievements and Contributions to Standardization Bodies

From a scientific point of view, IT results have been reported in numerous conference and workshop papers. Contributions to books and journals have been made.

Besides a number of master theses the following PhD theses have been completed within IT during the report period:

- B. Burkert: "Ein Framework generischer objekt-orientierter Basiskonzepte zur Werkzeug-Integration in unterschiedliche konzeptionelle Datenmodelle";
- M. Pape: "Chip Assembly mit topologischer Kompaktierung";
- E. Radeke: "Federation and Migration Among Database Systems";

IT members actively participated in DIN and ISO STEP/EXPRESS standardization bodies. In addition, IT contributed to the Verilog-HDL IEEE Standard 1364 as a balloting member.

4.6.7 Outlook

Whereas the participation of Cadlab in the PDMS project will terminate in spring further consultancy activities are expected and/or needed for OpenDM in order to contribute to its commercialization. Apart from further developing the OpenDM technology in end-user driven projects (e.g., TALENT), the latter will comprise intense (customer) project acquisition and the development of business plans.

Various emerging GEN related projects (MATES, PROCAT-GEN, GENIAL) will start during the next report period. These projects will mainly contribute to the “networked multimedia” topic in Cadlab. In addition, Cadlab’s HCI efforts will face new challenges provoked by the networked multimedia front-end needs.

Within the context of METRO the simulation platform for mechatronic systems will be provided during the next report period. Regarding the general modelling and simulation approach based on Pr/T Nets the approach will be enhanced to provide further analysis and transformation facilities.

சென்னை நகராட்சி நிர்வாகம்

சென்னை நகராட்சி நிர்வாகம் என்பது சென்னை நகரில் உள்ள பகுதிகளை நிர்வகிக்கும் ஒரு நகராட்சி ஆகும். இது 1994 ஆம் ஆண்டு சென்னை நகராட்சி சட்டம் (சென்னை நகராட்சி சட்டம், 1994) கீழ் உருவாக்கப்பட்டது. இது சென்னை நகராட்சி நிர்வாகம் மற்றும் சென்னை நகராட்சி நிர்வாகம் ஆகிய இரண்டு பகுதிகளாகப் பிரிக்கப்பட்டுள்ளது. சென்னை நகராட்சி நிர்வாகம் என்பது சென்னை நகரில் உள்ள பகுதிகளை நிர்வகிக்கும் ஒரு நகராட்சி ஆகும். இது 1994 ஆம் ஆண்டு சென்னை நகராட்சி சட்டம் (சென்னை நகராட்சி சட்டம், 1994) கீழ் உருவாக்கப்பட்டது. இது சென்னை நகராட்சி நிர்வாகம் மற்றும் சென்னை நகராட்சி நிர்வாகம் ஆகிய இரண்டு பகுதிகளாகப் பிரிக்கப்பட்டுள்ளது.

5 Analog System Engineering

5.1 Introduction

The mission of the Analog System Engineering group (ASE) is research and development of software tools, methodologies, strategies, and advanced measurement techniques for the design support of electronic systems with respect to their Electromagnetic Compatibility (EMC).

5.2 Baseline

During the design of electronic systems physical effects of thermal, climatic, mechanical, as well as of electromagnetic origin have to be taken into account in order to be sure that the system to be developed meets all requirements after manufacturing. Especially the ongoing complexity, miniaturization, integration density, and processing speed of any electronic equipment necessary to provide the required performance and low production costs lead to an increasing sensitivity with regard to electromagnetic interference. All effects and disturbances of this origin and all measures necessary to reduce or minimize the effects or their consequences, are covered by the term Electromagnetic Compatibility (EMC). EMC-effects (e.g. reflection, crosstalk, current spikes, delta-I-noise, electrostatic discharge, radiation, etc.) may cause malfunctioning on component-, subsystem-, and system level. These interference effects must not be interpreted as separately occurring phenomena, but they have to be taken into account as significant properties of a particular design and therefore, EMC-effects are design relevant subjects. Targeting at a sufficient functionality of the entire system, the development and design process has to consider EMC-aspects and given EMC-standards. Among these functionality aspects the security and quality of electronic products may strongly be influenced by EMC-effects and national as well as international regulations (e.g. European Community Council Directive 89/336/EEC) were set up. Moreover, European EMC-requirements (CE-conformity) will force designers to apply EMC-adequate design and analysis methods to the various design stages as early as possible. EMC-problems cannot be solved by conventional design methods because the already increasing integration densities at all design levels lead to difficulties in detecting EMC-effects by measurement taking into account general restrictions of measurement procedures due to costs, possibilities as well as development time constraints.

5.3 Work During the Report Period

Taking into account the technical and economical requirements mentioned above, the development of software tools, methodologies, and strategies for the EMC-adequate design of electronic systems becomes very important. In the following sections some technical and scientific results covering important problem areas are described in more detail. They have to be interpreted as parts of the overall objective, to develop methodologies, algorithms, tools, novel measurement techniques for the support of an EMC-compliant design of components and systems.

5.3.1 Characterization of Lossy Transmission Lines Through a Hybrid FEM/BEM Approach

For the calculation of electromagnetic fields of transmission lines and waveguides, several well-known techniques are available, for example the finite element (FEM), finite difference (FDM) and boundary element (BEM) methods. None of these methods is superior to the others in every respect, but when focusing on configurations with special geometrical or electrical properties, the performance of the methods can differ significantly. For instance, the application of the FDM to configurations with rectangular domains can be highly efficient if the field does not exhibit singularities or sharp peaks due to conducting edges. If this behaviour occurs, local mesh refinement will be necessary, and in this case, the FEM will usually be preferred. On the other hand, to avoid dealing with absorbing boundary conditions when applying FDM or FEM to unshielded structures, it may be advantageous to use the BEM.

Therefore, a hybrid method allowing the simultaneous application of FEM and BEM has been implemented. The method computes the electric and magnetic field distribution and the propagation constants for uniform transmission lines and waveguides, that is, structures with a constant cross section in the axial direction. The configuration can contain anisotropic and lossy media. The cross section has to be separable into homogeneous domains with polygonal boundaries. Number and shape of the polygons are arbitrary. Each homogeneous domain can be treated with either the FEM or the BEM, independent from the methods chosen for the other domains. The BEM especially is useful for the treatment of free space and media with high conductivity, that is, media with a very small skin depth. Anisotropic domains can only be handled using FEM. Thus, unshielded anisotropic waveguides can be treated by using FEM for the anisotropic part while using BEM for the free space surrounding the waveguide.

For each homogeneous domain, a system of equations is set up. These equation systems are then coupled by requiring the tangential components of the electric and magnetic fields to be continuous across dielectric interfaces. In case of anisotropic media, an equation system is set up by discretizing the double-curl equation in terms of the magnetic field. This formulation can also be used for the FEM treatment of isotropic media, but in this case, it is preferable to discretize the two-dimensional Helmholtz equation in order to reduce runtime and memory requirements. Both formulations are applied simultaneously, if the configuration contains isotropic as well as anisotropic media.

5.3.2 A new Approach for Time Domain Simulation of Lossy Transmission Lines

The investigation and rating of the signal integrity on transmission lines, printed circuit boards, and multichip modules can be based on conventional transmission line theory if quasi-transverse electromagnetic wave propagation (quasi-TEM Wave Propagation) can be assumed. This well-known theory allows the development of fast methods and algorithms which can be used to support the design of electronic equipment with respect to EMC-constraints. Also in case of lossy lines the transmission line theory can be applied if the losses are sufficiently low and therefore, quasi-TEM wave propagation can be assumed further.

As a lot of integrated circuits - especially digital ones - have a nonlinear input and output behaviour, time domain simulation of the signal integrity is required. The transmission line simulator FREACS, also developed at Cadlab, is based on the 'model of delayed current components', where a system of homogeneous transmission lines is represented by a multi port. The computation of the delayed current components $I_{TA}(p)$ and $I_{TB}(p)$ requires the determination of the current transfer matrix $G_{Ltg}(p)$, the characteristic admittance matrix $Y_L(p)$, and the transfer matrix $\exp(\Gamma(p)l)$, where p is the complex frequency and l the length of the corresponding transmission line system. If lossless transmission lines can be assumed, the matrix $Y_L(p)$ does not depend on the frequency and the matrix $\exp(\Gamma(p)l)$ describes a delay system. Therefore, the required convolution operations can be simplified significantly.

In case of lossy transmission lines the elements of these matrices are frequency dependent, even if the primary transmission line parameters R' , L' , C' and G' are assumed to be constant and independent from the frequency. As for the elements of $G_{Ltg}(p)$, $Y_L(p)$, and $\exp(\Gamma(p)l)$ no analytical expression can be given, the required time domain quantities can solely be obtained by approximative or numerical methods (e.g. Inverse Fast Fourier Transformation, IFFT) where the ones mentioned at last require an enormous numerical effort and do not give any information about important system properties (e.g. delay of the transmission lines) on a direct way.

To overcome these problems, the elements of the corresponding matrices can be approximated in frequency domain by appropriate functions which can be transformed analytically into time domain. Therefore an approach based on a Padé approximation was developed. All elements of the corresponding matrices are approximated by fractions of polynomials. By an appropriate choice of the matrix factors the information about the transmission line delay is explicitly conserved. Especially the current transfer matrix is decomposed into an appropriate matrix product. After the expansion of each factor into a Maclaurin series the Padé coefficients of the nominator and denominator polynomials are determined. After the computation of the corresponding poles and residue an expansion into partial fractions by the application of Heaviside's theorem is performed. The transformation of the partial fractions into time domain can be performed easily by the application of the inverse Laplace transform. Thus, all required time domain functions are given by a sum of weighted and delayed exponential functions and Dirac impulses.

5.3.3 Fast Signal Integrity Analysis by a Distribution of Simulation

The EMC analysis of complex systems results in a huge amount of simulations and other time consuming calculations. With regard to the use of the EMC-Workbench such processes can be identified during the radiation and irradiation simulation as well as the transmission line simulation within the signal integrity analysis. In future more complex proceedings, like an extensive signal integrity analysis of entire systems and modules (e.g. printed circuit boards), logic fault analysis considering reflection and crosstalk effects and optimization processes like parameter variation will increase the computational effort.

Most research and development departments have access to a large number of powerful workstations. It is common practice to attach every workstation to a single research engi-

neer who holds the exclusive right to access the workstation's resources as its owner. The exploitation of unused or seldom used workstations for public work can enhance the overall productivity by a significant factor.

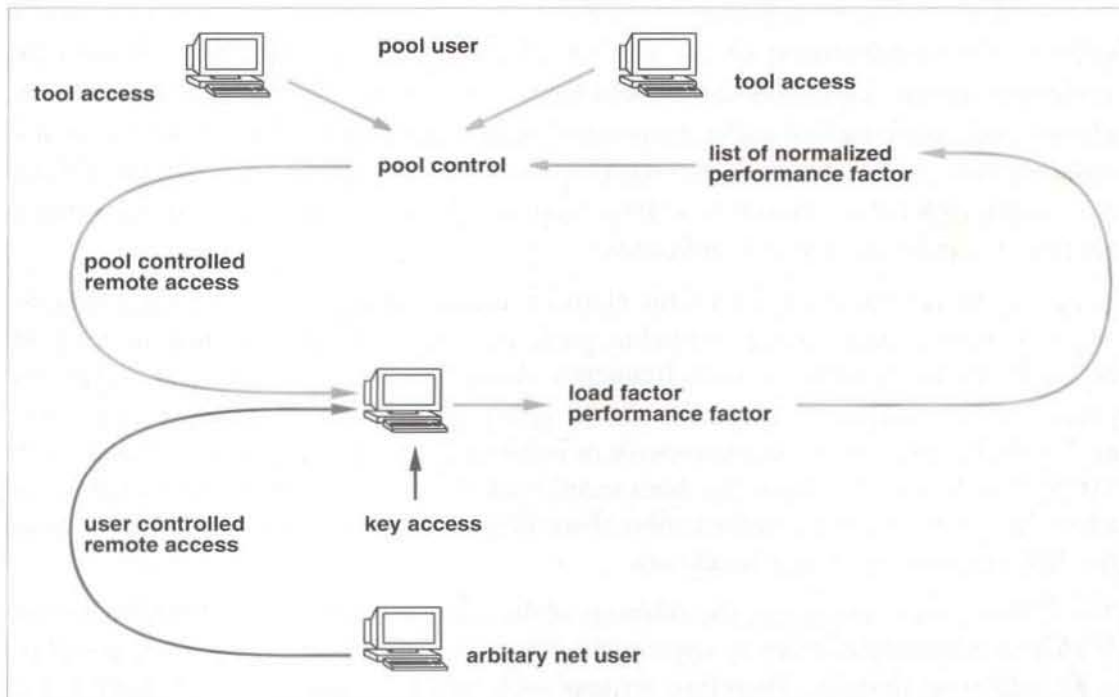


Figure 10 : Resource Management

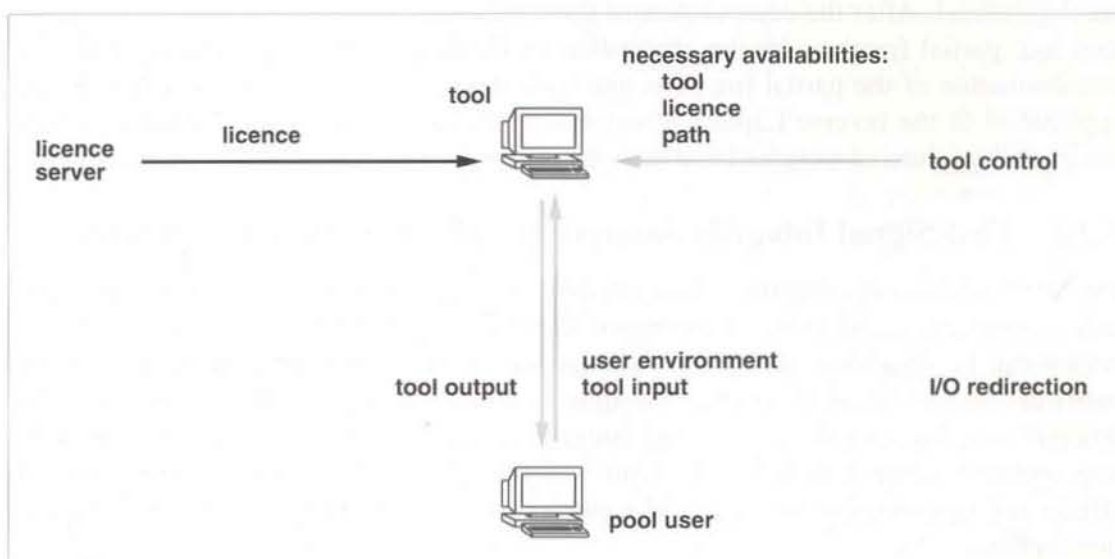


Figure 11 : Tool Management

This intrusion of time consuming processes to the privacy of other users should be hidden or should not affect the local work, respectively. Therefore, the actual load level, the number of running processes, and the last keyboard access of every pool workstation must be identified. Based on this information a dedicated server can decide where and whether a new process can be started or not.

Usually a computer network consists of different, heterogeneous computers distinguishing in architecture, operating system, capacity, capability, etc. To start a tool across the network means to know if it is accessible to this selected computer and where to find it. A second hint is that in complex and expensive environments used in the field of electronic design automation the different tools are licensed. These licences can be attached to special computers (flock licence) or they can limit the number of simultaneously running instances of the tool (floating licence). From this fact a licence management seems to be unavoidable. In addition to this, most tools allow to create user specific environments for tool control, library access, etc. This environment and the tools I/O have to be redirected by the management process.

To handle more complex interacting proceedings of processes running across different computers control, communication, and synchronisation mechanisms are needed. These mechanisms have to consider heterogeneous aspects and a recovery after a crash.

For the reduction of time used for urgent projects the necessity of a prioritisation of the addressed requests as well as an access control for users to well chosen resources is required. This can be done by an access handling management which is illustrated in Figure 12.

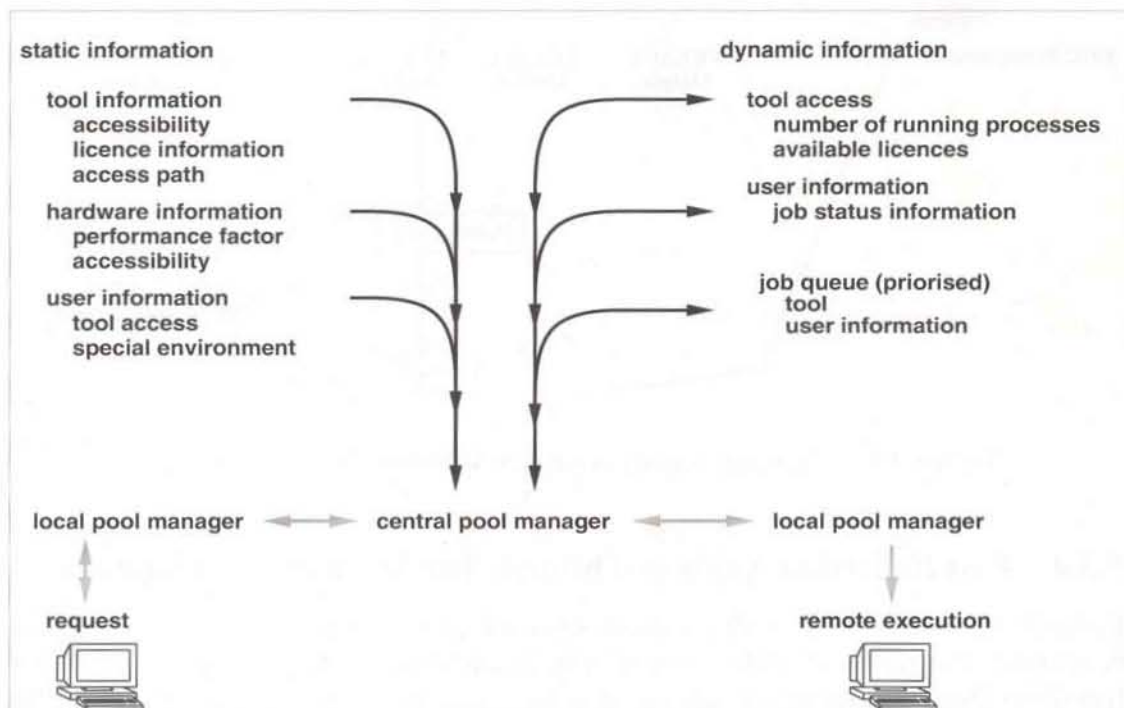


Figure 12 : Access Handling

A first prototype, which covers the basic functionality of load control, remote execution, and tool access has been built. A first evaluation of this approach in a test environment shows that the time for administration can be neglected. Actually, it is integrated into the scenario shown in Figure 13 to speed up the signal integrity analysis of complex printed circuit boards.

Here a first pre-analysis step of the EMC-Workbench classifies all transmission line networks on a printed circuit board considering reflection and crosstalk effects. Actually, the number of critical transmission line networks is rising due to fact of faster technologies. This means a high number of simulations using FREACS can be done with the aid of the proposed approach.

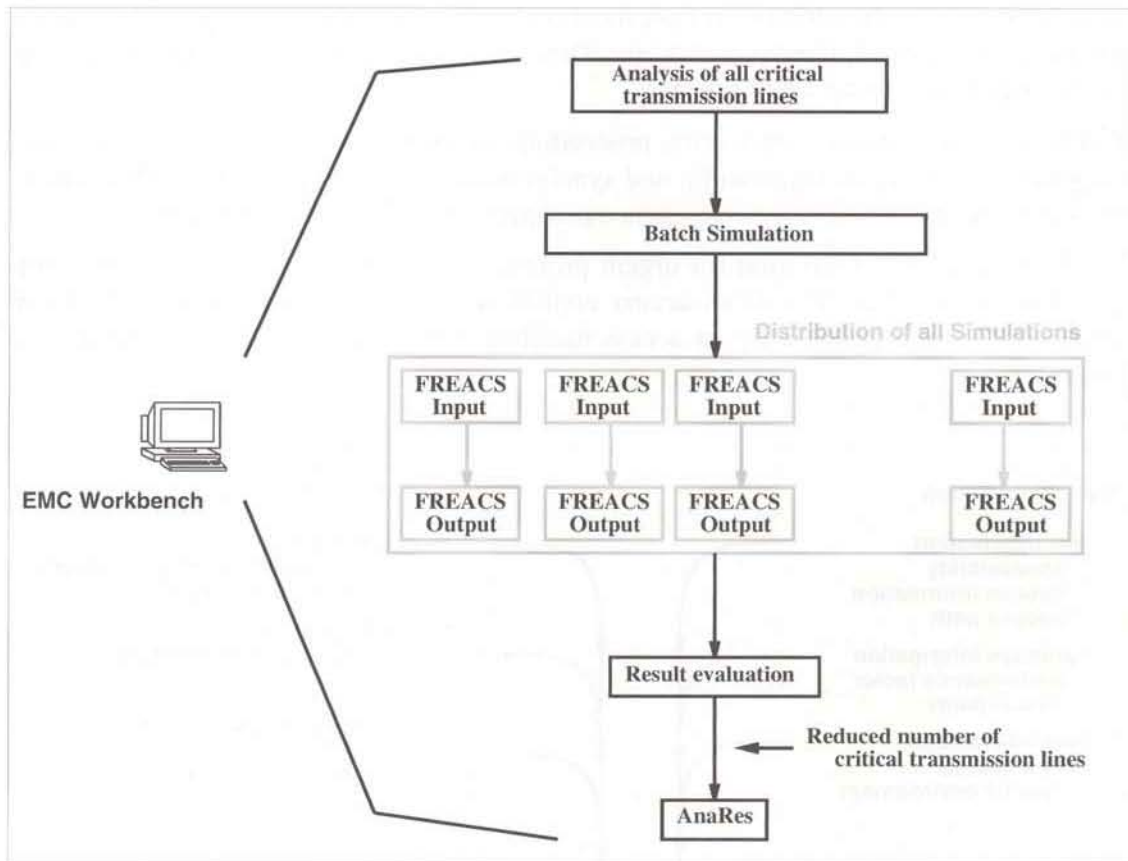


Figure 13 : Signal Integrity Analysis of Printed Circuit Boards

5.3.4 Fast Reflection Analysis Through Transformation of Subnets

Recently the concept of an EMC advisory system based on an EMC-review-process was developed. The review-process consists of different phases. The first one is the 'Transformation Phase' where the complexity of subnets on printed circuit boards is reduced by well known partitioning strategies. In the following sections the main ideas and the most important transformation methods of this phase are described.

Characteristic Impedances

The purpose of the first transformation method is to collect several homogeneous transmission line areas from the layout data set represented by so-called vectors which have got identical or reasonably similar characteristic impedances in order to represent the transmission line by only one single-virtual vector.

The definite assignment of the scope each transformation method has to deal with is important for the call of complex transformation runs. Therefore, the successful application of transformation methods rely on the results of the method 'Characteristic Impedances' in case of a non homogeneous transmission line, because all other methods described below, transform only single-vector transmission lines. Since the collection is only possible for direct vector-to-vector transitions where no other transmission lines are connected in between, all lines of the signal net can be treated independently. So, a depth-first search is performed through the net to get all vectors and transmission lines. In a first pass transition nodes are committed for each transmission line and each pair of adjacent vectors. Each node is sorted into a list ordered from best-vector-match to least-vector-match. In the second pass, always the first list node is removed from the list and its two vectors are collected into a single virtual one. The next step is to rebuild the two adjacent vector-to-vector transitions (as one of their vectors was just replaced by the new one) and resorting them. Then, the new best-matching transition node is selected. This transformation of vector pairs continues as long as there are transformable transition nodes in the list.

The key point to avoid effects where a previously non-transformable transition would become incorrectly transformable during the procedure is to ensure that always the best-matching transition is selected next. The sorted list is optimized due to the aspect that typically many adjacent vectors have got an identical characteristic impedance.

The transformation time depends on the number n of vectors. It varies from worst case $O(n^2)$ in a net consisting of a single long transmission line due to the various $O(n)$ effort transition list resortings which are necessary, to best case $O(n)$ for a widely structured and distributed net with only single- or two-vector transmission lines in between.

Stubs

This method links component pins directly to transmission lines if they are connected to the lines via short stubs. The transformation is possible if the reflection coefficient and the propagation delay of the stub are reasonably small. The determination of the reflection coefficient at the end of a stub depends on the characteristic impedances of the three connected vectors. To separate this method from 'Characteristic Impedances', only single-vector stubs are regarded here. To separate this method from 'Accumulation Groups' described later, only single-pin stubs are considered here. Furthermore, the local net (consisting of the stub and the two adjacent vectors) is examined whether there is another transformable stub adjacent to the current stub connection point or not. In this case the local net is part of the 'Accumulation Groups'.

A reflection analysis of the stub relies on various attributes of the stub, the component pin, and the adjacent vectors. The user can adjust transformability of stubs through a

method specific parameter file.

Since for each stub only a constant part of the adjacent net has to be visited, transformation time is restricted by the number p of component pins of the net $O(p)$. Typically a net has got much less component pins than vectors, so this method tends to be very fast.

Accumulation Groups

This method has been developed to collect groups of component pins which are connected to the same point of the signal net by reasonably short vectors into a single virtual component pin. In a first pass all zero-distance component pin groups of the net are collected. All transformable pins are collected into a single virtual pin. It is possible that these pins become part of a stub group in the second pass.

A depth-first search through the net is performed and at each net junction a search for transformable stubs is initiated. To separate this method from the 'Characteristic Impedances', only single-vector stubs are considered here, and the search is completely local. While the list of suitable stubs is built up during the search, a main stub is determined where the collected component pins are to be appended to, later. The main stub itself may be non-transformable though. Then, all transformable stubs are collected in a single virtual pin, which is linked to the net at the position of the main stub's previous component pin. If the main stub's component pin is non-transformable, it is left untouched and the remaining stubs are collected into a virtual pin which is connected directly next to the non-transformable pin. Whether a detected stub is suitable for transformation, depends on various vector/pin attributes and can be user-adjusted by a method-specific parameter file as usual.

Transformation time is $O(p)$ for the first pass, where p is the number of net component pins. For the second pass, considering that net junctions may consist of three one-vector stubs at maximum, integration of the affected net parts goes in constant time. Therefore, transformation time for this pass is equivalent to the effort of the depth-first search through n vectors, $O(n)$.

Distributed Capacitance

This method replaces component pins, adding their input capacitance value to a segment of adjacent vectors. Regarded as transformable are all pins which are placed inside a vector line, i.e. not at a vector junction, which are not marked as non-transformable and which have got a minimum input resistance value, adjustable through a method specific parameter file.

The segment into which an input capacitance is transformed, is calculated using a parameter dependent ideal propagation delay for the segment half to the left and to the right of the pin. If two pins are placed so near to each other, that their distance is too small to split two segment halves from it, the line between them is split exactly in the middle. Otherwise, segment halves with the ideal propagation delay are selected. Then, the pin's input capacitance value is added proportionately to all the segment vectors' capacitance attributes. Finally, the pin is removed from the net. Note that it may be necessary to split

line vectors in-between to achieve exact segment lengths. Therefore, the total number of vectors of a net is usually increased by this method.

General purpose of this method is to draw component pins, connected to a main signal-net line via short stubs, into the line using the "Stubs" method, then remove the pins, adding their input capacitances to the adjacent vectors using the "Distributed Capacitances" method, and finally unite the resulting vector line into ideally a single vector, using the "Characteristic Impedances" transformation method.

The transformation time depends on the number n of vectors. The algorithm proceeds through the net in a single depth-first search through all nets, to find the appropriate transformation segments. To add the component pin capacitance portions, each vector may be visited a second time only. Therefore, total the transformation time is restricted by $O(n)$.

5.3.5 Delta-I-Noise of Digital CMOS Circuits

In state-of-the-art integrated circuit technology, the trend is toward higher clock rates and higher densities. This trend reflects an increasing number of chip-to-chip connections and I/O's on the chip. To increase the speed of operation of the chips, the drive strengths of the output drivers need to be increased. Higher drive strengths combined with a larger number of I/O's may cause a large amount of noise in the power/ground connections of the output buffers. These noise pulses may be transmitted to their signal outputs and propagated through the package and board traces to connected receiving inputs. This can lead to false switching of the remote receivers.

Time efficient methods for the estimation of the simultaneous switching noise are very useful for various reasons. On the one hand this estimation method based on closed form equations can be used for a pre-analysis to detect probably critical parts of a digital system regarding the appearance of simultaneous switching noise (or delta-I-Noise, respectively). On the other hand this method offers a very good understanding of the behaviour of simultaneous switching noise with respect to various circuit and layout parameters. Based on this knowledge the simultaneous switching noise can be reduced by changing signal net topologies connected to the driver outputs or the fan out of output drivers prior to the final layout design stage.

Modeling of CMOS-Buffers for SSN Determination

Off-chip drivers in digital circuits have to provide large output currents to charge external loads in order to achieve the desired signal rise/fall times. Thus simultaneous switching of off-chip drivers located at the same chip may be the most important source of switching noise. Figure 13 shows the coupling of the output drivers of chip 1 through their common inductances L_{gnd} and L_{pwr} that represent the inductive behaviour of the package. Noise pulses occurring at L_{gnd} or L_{pwr} , respectively, may propagate through the outputs of quiet drivers to input circuits of chip 2 and may cause false switching of the logic inputs. Figure 15 shows the modelling process for both output transitions $H \Rightarrow L$ and $L \Rightarrow H$ of N simultaneous switching CMOS off-chip drivers.

The analysis of switching noise of simultaneous switching drivers will be performed in

two steps. The first step contains the calculation of the simultaneous switching ground noise caused by the switching drivers, that appears across L_{gnd} .

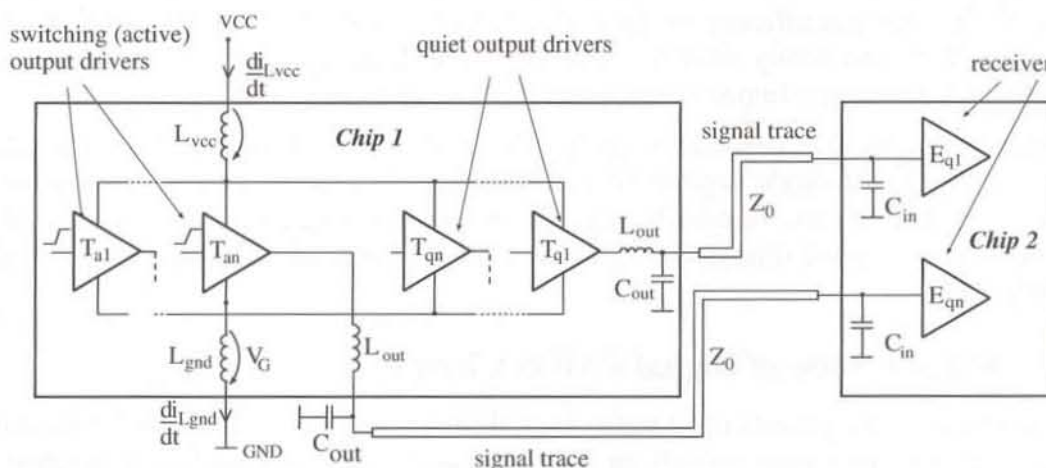


Figure 14 : Coupling of Active and Quiet Output Drivers Through Common Power/Ground Connections Represented by L_{pwr} , L_{gnd}

The determination of the power supply noise across L_{pwr} will be performed in a similar fashion thus the following refers only to the ground noise. As a second step the determination of the simultaneous switching noise at the outputs of the quiet drivers is discussed in the following section.

The simultaneous switching ground noise V_G appears at both the switching and the quiet drivers that are coupled through L_{gnd} . V_G will be transmitted to the output of the quiet driver only in the case if its NMOS is initially 'on' and the driver output is low, respectively. V_G can be treated as a voltage source changing in time where the waveform is known up to its maximum. This voltage source charges the load (for this example assumed as capacitive load) and the voltage V_{SSN} that applies across C_L is the simultaneous switching noise (or delta-I-Noise) at the observed quiet driver output.

The relation between V_G caused by simultaneous switching drivers and V_{SSN} that appears at a quiet driver output depends on the elements of its load circuit. The larger C_L at the output of the quiet driver the smaller the maximum of V_{SSN} at a given 'on' resistance of the NMOS. Similar relations exist for driver outputs with transmission line loads. With increasing characteristic impedance of the signal line the ratio V_{SSN}/V_G will increase as well. Simultaneous switching noise measurements will substantiate these dependencies.

Further investigations have to be performed in order to determine the simultaneous switching noise of quiet drivers analytically.

A test chip has been developed in cooperation with an ASIC vendor. The core of the chip contains two groups of 10 CMOS off-chip drivers each. Each group is provided with

power supply by separate power/ground pins of the single chip package and completely separated power ground/systems on the chip to maintain well defined power/ground currents flowing only through the pins belonging to their buffer group. Both buffer groups are identical in their circuit parameters, while their numbers of power and ground pins are different. The driver outputs are connected through the package pins to signal lines of different lengths on the test board loaded with a various capacitance to ground.

The clock signal of the external clock generator will be distributed and delayed on the test board (figure 6). This clock distribution and delay system allows the independent enabling or disabling of each driver input as well as the skewing of driver input signals (0, 200ps, ..., 8ns).

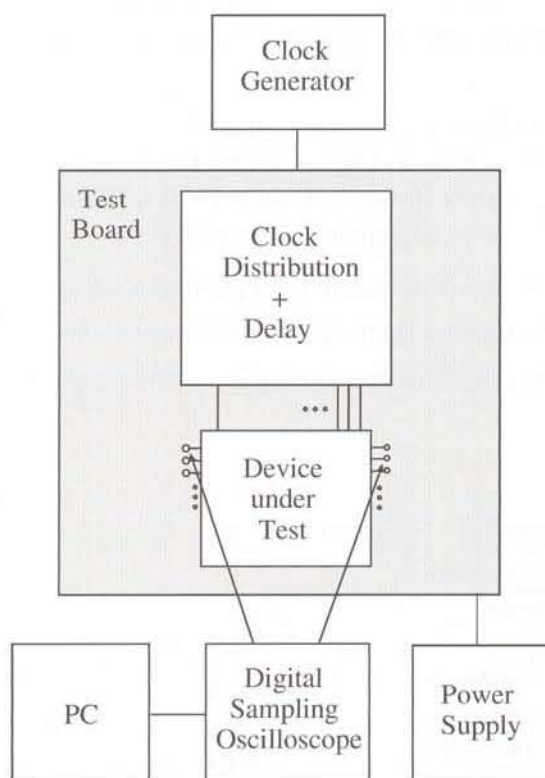


Figure 15 : Test Setup

Summarizing it can be pointed out that an analytical method for the estimation of the simultaneous switching noise of CMOS off-chip drivers has been developed. With this approach the conditions for the closed form solutions of the differential equation that describes the behaviour of the simultaneous switching ground noise can be given. Various loading conditions of both the switching and the quiet drivers can be taken into account. Based on the determined ground noise the influence of loading conditions on the simultaneous switching noise of quiet driver outputs can be described. A test chip along with an appropriate test environment has been developed for simultaneous switching noise measurements. Selected measuring results show the influence of the loading parameters of both the switching and the quiet CMOS output drivers on the power/ground noise as well as the simultaneous switching noise.

5.3.6 Design Support for Digital Components Through a Signal Integrity Test Process

A well-known problem arising during the layout design phase of digital high speed components (e.g. PCB, MCM, IC) is to avoid violations of the signal integrity due to electromagnetic interference (EMI). Unfavourably chosen routing of transmission lines leads to reflection-, crosstalk-, and switching noise. Later on, this noise may cause malfunctions of realized prototypes of the component or system.

To obtain short periods of development as well as to reduce costs for redesigns it is necessary to locate and analyse such critical areas in interconnection-networks during early design phases (post layout) by simulation (signal integrity validation by simulation). The intention of this work is, to develop a method allowing to analyse the dependencies between EMI and its effects with regard to the correct function of a digital component from an overall view.

Therefore, a so called 'failure occurrence mechanism' which includes a view to circuit level (electrical level) as well as to higher abstraction levels (S-, G-, RT-level) is taken into account. The mechanism is shown in Figure 16. It is based on the definition of 'fault, error and failure' from the area of dependability analysis:

- A 'fault' is a deviation in a system from its intended function.
- An 'error' occurs, when a fault causes an incorrect change in machine state.
- A 'failure' means a malfunction caused by errors propagating throughout a system.

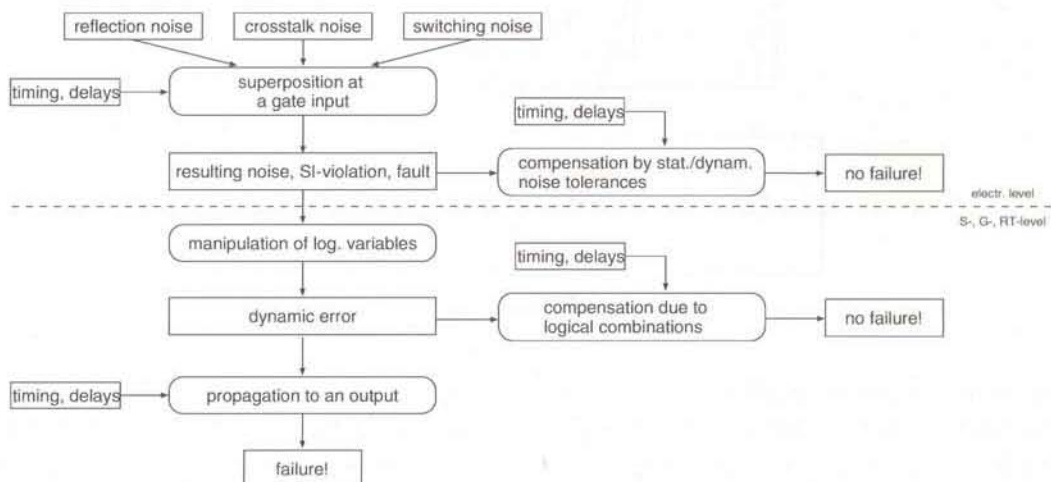


Figure 16 : Failure Occurrence Mechanism

The superposition of reflection-, crosstalk- and switching noise at a gate input leads to a signal integrity violation or fault. This fault may be compensated by static or dynamic noise tolerances of the interpreting receiver and no error/failure occurs. If a fault is not rectified, a manipulation of the value of a logic variable happens and a dynamic error occurs. Also there may be a compensation of this error due to logical combinations. That

means, that there is no error propagation to an output and there will also be no failure.

A failure is only arising, if a propagated error can be observed at an output. Of course the signal/noise timing is very important in fault- and error-compensation as well as in its propagation. Today's signal integrity validation mainly looks after noise compensation by static noise tolerances. Compensation faults by dynamic noise tolerances, compensation of dynamic errors by logical combinations and timing aspects are ignored.

From this state the goal is to validate layout designs of digital components with full inclusion of the described failure occurrence mechanism. To reach this goal, the failures triggered by SI-violations may be detected with adapted methods of conventional test of digital circuits and dependability analysis.

Further development of this idea leads to the Signal Integrity Testprocess (SIT-Process). Figure 17 shows the concept of the SIT-Process (OtbT = Object to be Tested).

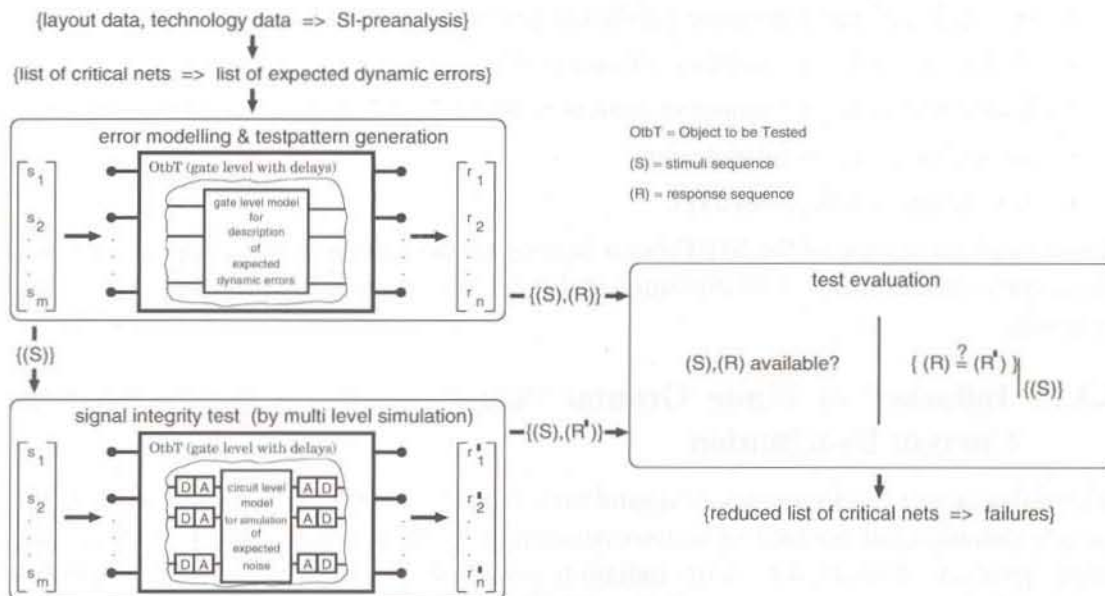


Figure 17 : Concept of the SIT-Process

The result of a conventional SI pre-analysis is a list of critical nets. These nets are the sites of expected faults which may cause dynamic errors and failures. In the first step of the SIT-Process a critical net is projected back into a gate level description of the digital component. Then a logic model of the expected dynamic error is injected at the site of the corresponding connections in the high level description. With this error model a set of test patterns for the detection of the modelled error is generated.

In the following step the logic model is replaced by an analog transmission line model for simulating the expected noise (fault). For that purpose the dynamic I/O-behaviour of the connected drivers and receivers is modelled by parameterizable D/A- and A/D-signal converter modules. After that a multi level simulation of the whole configuration is started with stimuli given by the former generated test pattern.

With the simulation result it is possible to analyse the functional behaviour of the whole component with regard to the influences of the modelled transmission line effects, the dynamic properties of the connected drivers and receivers and timing aspects.

Recapitulating, the main benefit of this method will be:

- Superposition of different disturbance-effects is taken into account.
- Inclusion of dynamic noise-tolerance mechanism on circuit level.
- Inclusion of natural error-tolerance due to logical combinations on high levels.
- Inclusion of signal/noise timing.
- Valuation of critical nets under more realistic working conditions inside a digital component.
- Exploration of error propagation and failure-occurrence mechanism is provided.

This leads to:

- Reception of more accurate validation results.
- Avoidance of too pessimistic valuation of digital component designs.
- Broad reduction of number of critical nets to be evaluated 'by hand'.
- Reduction of costs for redesign.
- Reduction of time-to-market.

A first implementation of the SIT-Process in a signal integrity test environment (research prototype) for the analysis of crosstalk problems in combinational circuits works successfully.

5.3.7 Influence of Finite Ground Planes on the Transmission Line Current Distribution

Due to the increasing frequency of digital and/or analog signals the problem of high frequency radiation has become of serious concern to manufacturers and designers of electronic products. Compliance with radiation constraints is one of the most important aspects of electromagnetic compatibility (EMC). The electromagnetic coupling between objects mounted on a PCB generates unwanted noise, which may lead to a malfunctioning of the electronic circuits. For example, on the one hand crosstalk signals are generated due to the strong coupling of parallel traces, on the other hand any scattering object in the near field region may change the radiation of electromagnetic energy greatly. Often finite ground planes have a significant influence on the coupling between interconnects on PCBs. Simplifying techniques such as the use of the Image Theory (IT) to consider the GND-planes can lead to an incorrect calculation of the current distribution and therefore to an incorrect prediction of the radiation, especially if traces located near an edge of a conducting plane are considered. In order to deal with the problem of analysing the radiation of electromagnetic fields by using an integral description for the electrical field strength, the tool COMORAN (COMputation Of RAdiationN) has been developed. COMORAN is able to analyse the electromagnetic field behaviour of arbitrary three-dimensional transmission lines. This includes the description of noise effects like radiation/irradiation, crosstalk, reflections, ground noise, etc. The excitation can be given by

periodic (e.g. clock signal) and/or aperiodic signals. Boxes (cabinets) and screens, which are fitted with several slots (apertures), can also be taken into consideration. In this contribution the influence of finite ground planes on the current distribution on PCBs will be shown.

The overall electric field strength in the ambient of a homogeneous body within a volume of different but homogeneous constitutive parameters being excited by an incident field, can be described by a field integral, where the integration is performed over the entire surface of the body excluding an infinitely small sphere around the singularity of the Green's function.

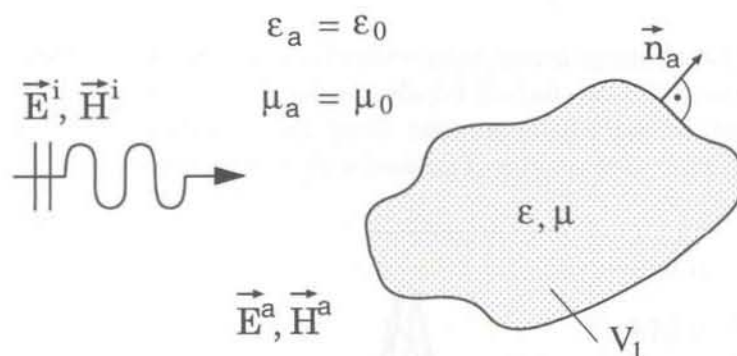


Figure 18 : Scatterer of Piecewise Homogeneous Constitutive Parameters

If the body is a very good conductor, that means it can be assumed to be perfectly conducting, no equivalent magnetic sources have to be considered. Enforcing the boundary condition for the electric field strength, and using the equation of continuity an Electric Field Integral Equation (EFIE) is obtained. Via the Method of Moments this equation may be transformed into a system of linear equations which can be solved by standard linear algebra methods. Hence, the unknown surface current density can be obtained by solving a matrix equation with the right hand side (inhomogeneous part) representing the excitation which could be either an impinging electric field and/or a set of lumped equivalent sources.

Figure 18 shows the geometrical model used in the MoM-solver COMORAN to discretize the finite ground planes. The set of rectangular subdomains is arranged to cover each flat section of the ground plane completely. The surface current is represented by rooftop functions which are a product of triangle functions along the direction of current flow and of pulses in the orthogonal direction. The discretization of the planes which can be situated arbitrarily in the three-dimensional space is performed automatically.

In order to show the effects of a finite ground plane on the current distribution of thin-wires located above the plane, a PCB-like arrangement ($a = 10$ cm, $b = 4$ cm, $l = 5$ cm, $h = 1$ mm, $f = 1.0$ GHz, $U_0 = 1$ V, $R_i = 50$ Ω , $R_l = 50$ k Ω , above a finite ground plane) as presented in Figure 19 is examined.

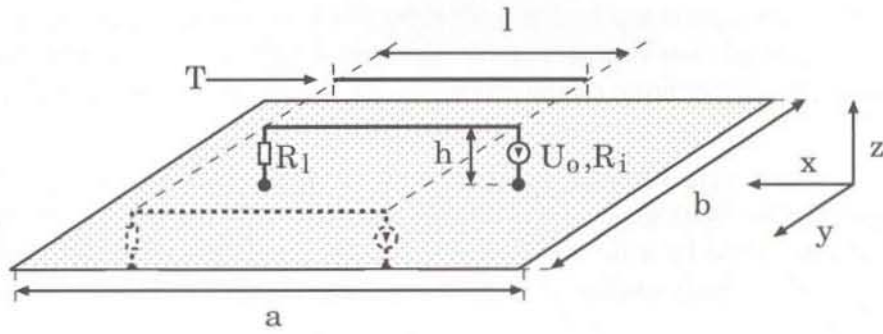


Figure 19 : PCB-Like Configuration

The terminations of a voltage driven interconnect are attached to the finite ground plane. Two different geometries are studied: Firstly, the wire is running along the centre of the ground plane, and secondly, it is situated along the boundary $y=b/2$. At the opposite boundary ($y=-b/2$) a passive scatterer (marked with T in Figure 19) is placed.

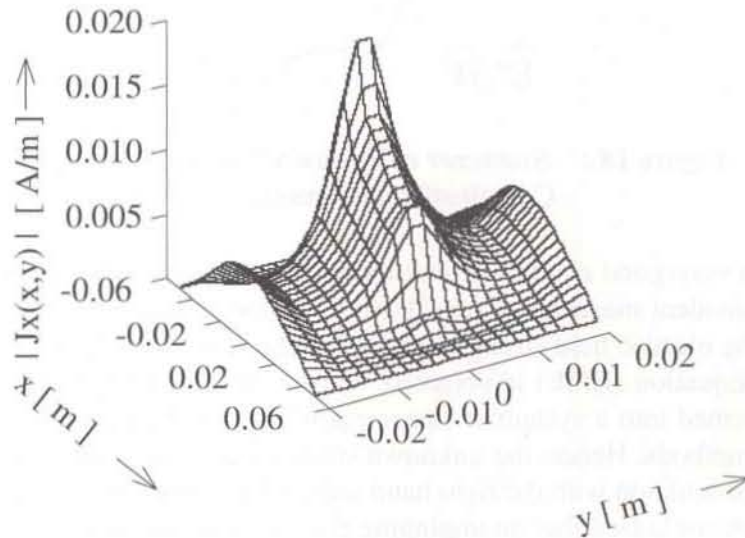


Figure 20 : Magnitude of the X-Component of the Calculated Surface Current Density, Active Line at Centre

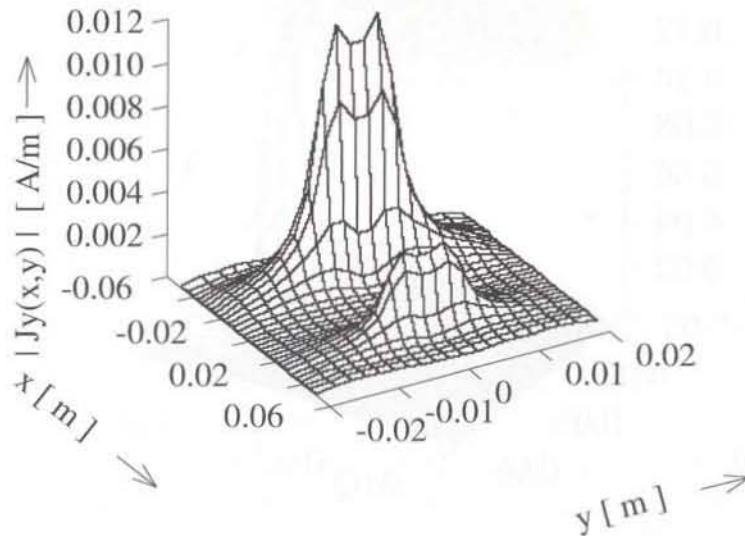


Figure 21 : Magnitude of the Y-Component of the Calculated Surface Current Density, Active Line at Centre

In Figure 20 the x-component of the magnitude of the surface current density on the plane is shown, Figure 21 depicts the y-component. The connection points between wire and plane can be recognized easily from the local maxima of the y-component of the current density. Due to the high frequency of 1GHz the return path can be seen directly below the active wire. Additionally, there is also a current along the boundary of the plane.

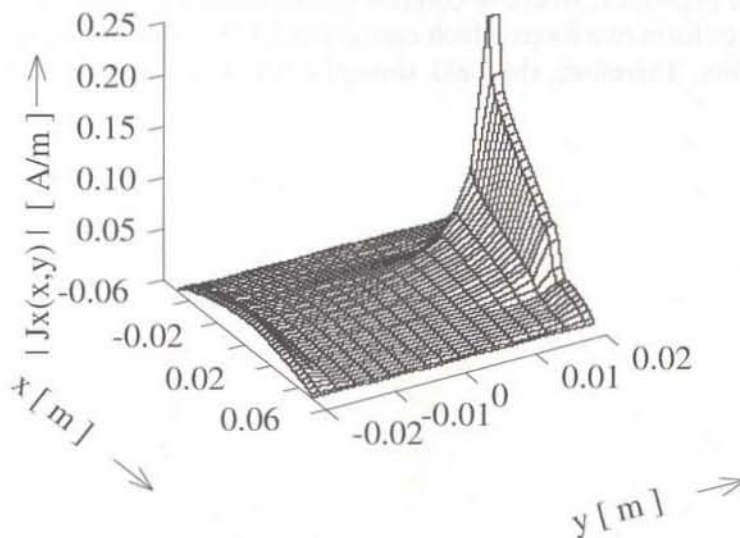


Figure 22 : Magnitude of the X-Component of the Calculated Surface Current Density, Active Line Close to Edge

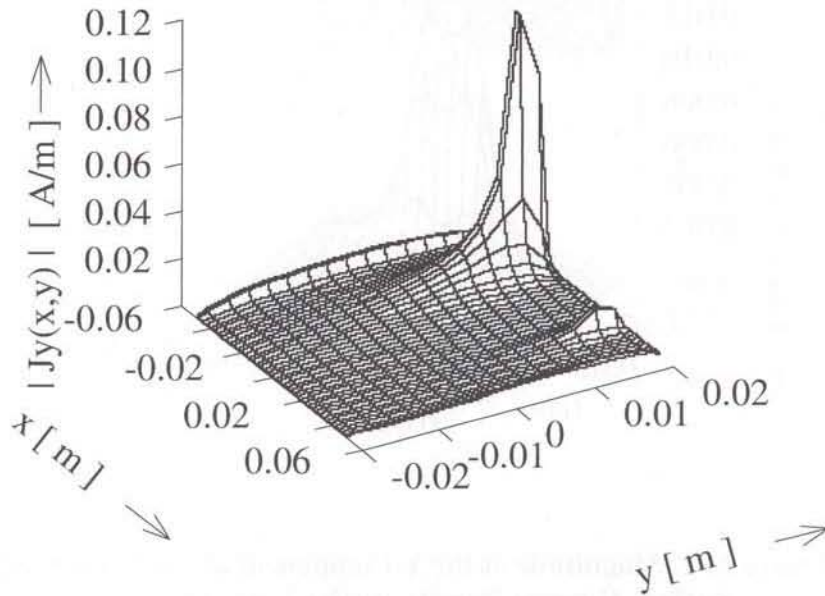
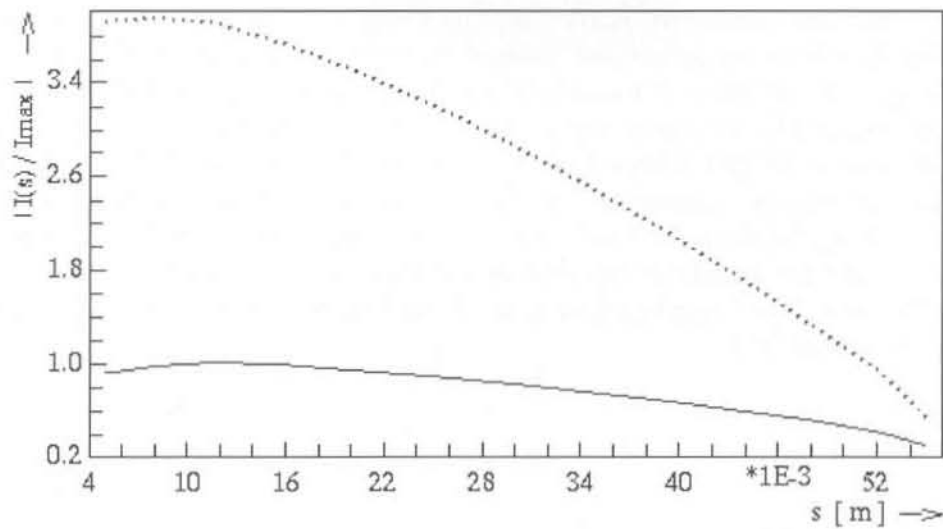
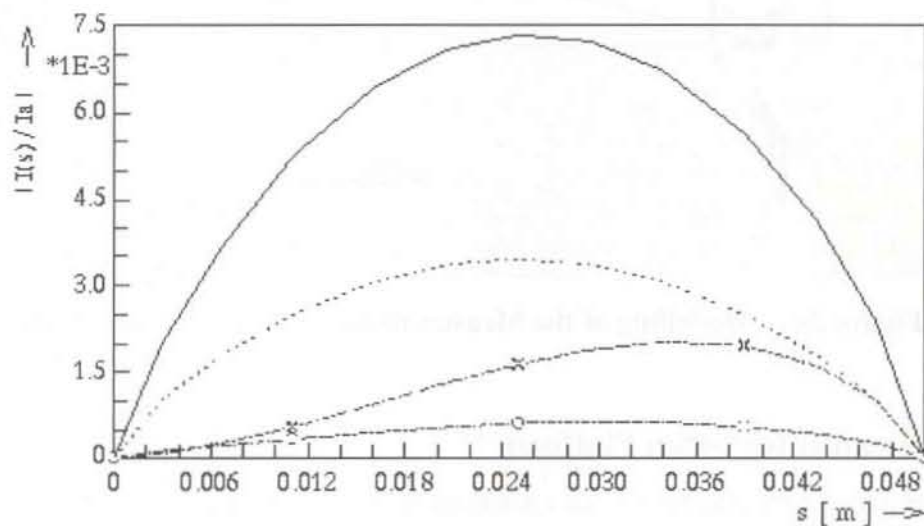


Figure 23 : Magnitude of the Y-Component of the Calculated Surface Current Density, Active Line Close to Edge

Figure 22 and Figure 23 depict the y-component of the surface current density for the second case. Here, the current directly below the trace is more distinctly, but due to the finite dimensions of the conducting plane a current is flowing along the boundaries, too. Therefore, the central area of the plane becomes almost current free and a current loop is generated. This leads to strong radiated field strengths which differ from the case shown in Figure 20 and Figure 21, where in contrast to the present geometry, the currents flowing near the edges form two loops which can be interpreted as two magnetic dipoles with opposite moments. Therefore, the field strengths are decreasing fast within short distances.



**Figure 24 : Current distribution on the active wire
(dotted line trace near edge)**



**Figure 25 : Current distribution on the passive wire
(dotted line trace near edge, marked lines obtained
via image theory)**

In Figure 24 the current distribution normalized to the maximum value of the first case on the active wire for the two positions is seen, s denotes the axial coordinate along the trace. Figure 25 shows the magnitude of the current distribution on the passive wire T for

both cases. In order to emphasize the coupling between the active and the passive wire the amplitudes refer to the maximum value of the current on the active wire, respectively. Additionally, the currents calculated with the image theory are depicted. In the case of infinite ground plane, corresponding to image theory, the surface current density on the infinite plane is small, which leads to a weak coupling between the active and the passive wire. The computation considering the finite dimensions of the ground plane yields a stronger coupling between the wires in both cases. Due to the boundary current below the passive scatterer the maximum current decreases only by a factor of two, approximately. This reveals the significant influence of finite dimensions to the current distribution of transmission lines.

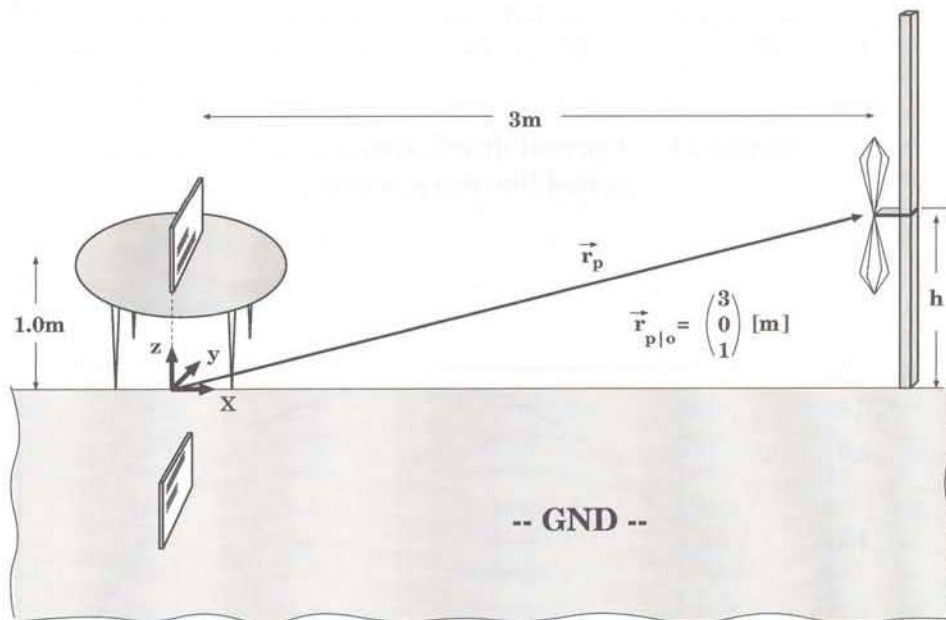


Figure 26 : Modelling of the Measurement Environment ($h = 1.0\text{m}$)

5.3.8 Lean Integration Platform

The lean integration platform is an environment for integrating different activities by building a complex flow. It is meant to be a lean replacement of a full-fledged framework as it concentrates on the workflow-view of design processes. Workflows are a very suitable notation to describe dependencies between single working steps in order to manage a complex task. Usually certain tasks are delegated to certain qualified persons, which have to or are used to follow well-defined procedures to handle them. In the lean integration platform these procedures are called workflows and each of these flows is owned by an individual that is qualified by its role.

Workflows describe designs from the activity driven viewpoint. Some activities in such a flow provide input data for others that eventually become executable if all their needed inputs are present. The lean integration platform conceals the - most of the time - com-

plex dataflow and presents only a configurable graph of activities to the user. The execution of activities itself is only triggered by the so-called workflow-engine that cares about activities and the states they are in. As there are two types of activities two models of execution are implemented in the lean integration platform:

The first type of an activity is a tool-activity. In this case a tool-server handles all aspects like tool-invocation, data-transfer or monitoring. Tool-execution is asynchronous by nature and can be distributed transparently across workstations in a network. The integration of tools uses a tool encapsulation specification proposed as a standard by CFI. In case short synchronous activities are acceptable they can be executed by the workflow-engine directly through system-calls. However, the asynchronous execution allows the user to work on independent activities in the workflow while for instance a simulation is running.

The second type of activity is a placeholder for a complete workflow itself. These "complex" activities offer the key-concept for hierarchical structured task and delegation of work. In the proposed multi-user environment the workflow-manager is supposed to handle the data-transfer from and two workflows even for different users.

The architecture of the lean integration platform is depicted in Figure 27. Its persistent data will be stored in an object database. It has to be noted that the lean integration platform makes no further requirements as a ODMG-compliant database interface which will make it compatible with different commercial database systems like Objectivity or ObjectStore.

For communication between different components the lean integration platform currently relies on the inter-tool communication environment bases of the ITC standard proposed by CFI.

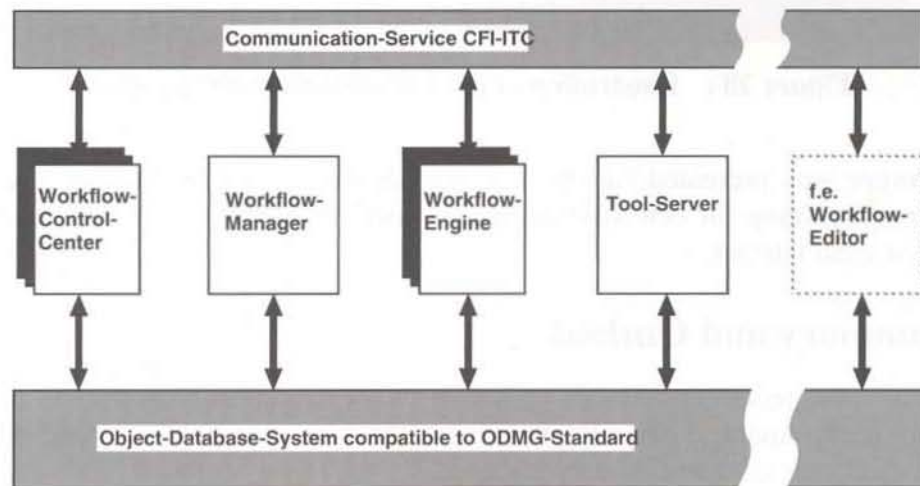


Figure 27 : Illustration of the LIP-Architecture

A working prototype has been implemented successfully and realizes the components workflow-engine, a single user workflow-manager, workflow-control-centre and tool-

server. The control-centre builds the instrument two create a user's workflows from a repository of available flow-types and start or delete them. A context sensitive help system based on HTML and Mosaic is available, too. Figure 28 shows the screen dump of a workflow-engine with a flow for macromodelling.

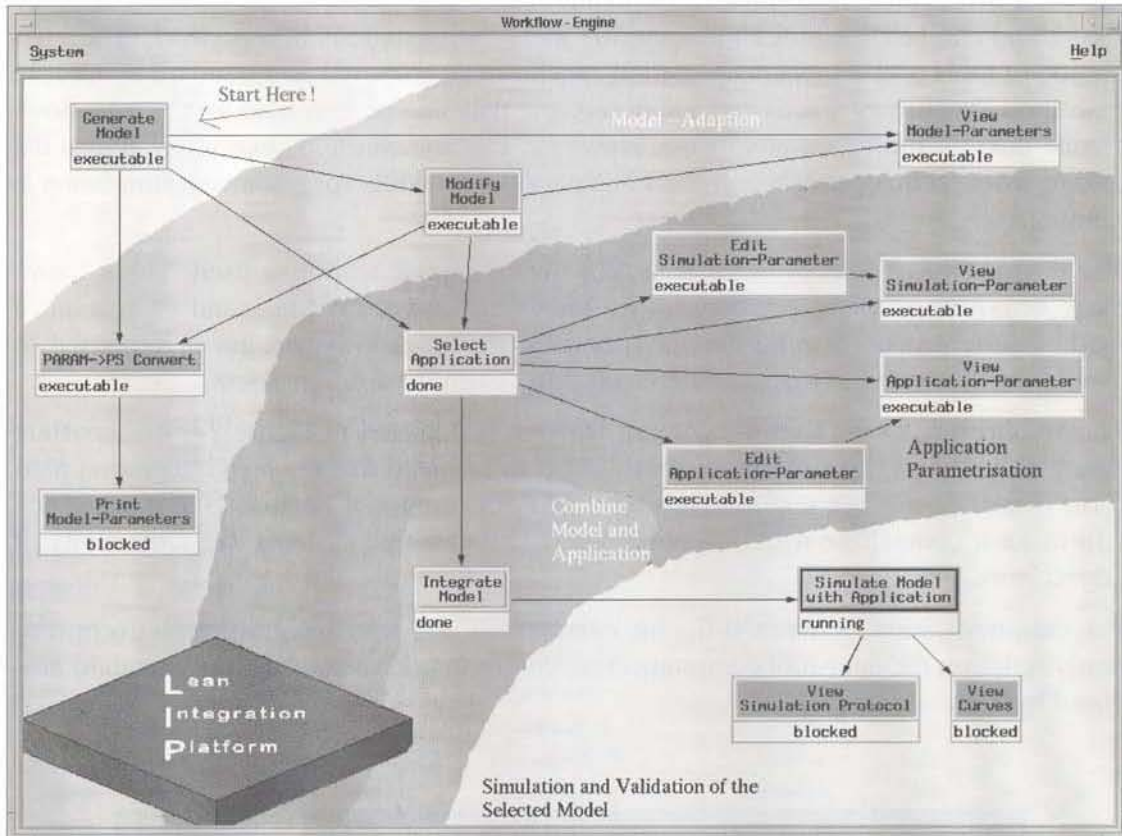


Figure 28 : Illustration of the LIP-Makromodelling Flow

The prototype was presented for the first time at the "2. Workshop Methoden- und Werkzeugentwicklung für den Mikrosystementwurf" in Karlsruhe, in November 1995 and created great interest.

5.4 Summary and Outlook

During the report period, considerable research and development progress was achieved by Cadlabs group Analog System Engineering in the context of its work 'EMC-adequate design of electronic components and systems'.

In the first year after the founding of INCASES Engineering GmbH and the transfer of the EMC-Workbench for PCB application from Cadlab to INCASES, the available knowledge and experience was used to start afresh and to continue existing basic research activities in order to develop methodologies and software tools for EMC applications. Besides the new objectives in the area of system design, still running activities

for PCB applications were also continued.

Significant results were among others:

- the development of a novel hybrid FEM/BEM approach for the characterization of lossy transmission lines,
- the development of a new and fast method for the simulation of lossy transmission lines and cables,
- a concept to distribute simulation tasks within a local area network,
- the realization of the transformation phase of the EMC advisory system for printed circuit board application,
- an analytical method for the estimation of simultaneous switching noise of CMOS off-chip drivers,
- the development of a signal integrity test process for supporting the design of digital components,
- fundamental investigations in the influence of finite ground planes on printed circuit boards,
- and a prototype of a lean integration platform (LIP) for the integration of different activities driven by the workflow.

The scientific success was documented by a large number of publications and talks given at important national and international conferences like

- 11th International Zurich Symposium and Technical Exhibition on Electromagnetic Compatibility, Zurich/Switzerland, March 1995,
- Progress in Electromagnetics Research Symposium 1995 (PIERS 1995), Seattle/USA, July 1995,
- 10th COMPUMAG Conference on the Computation of Electromagnetic Fields, Berlin/Germany, July 1995,
- European Design Automation Conference with EURO-VHDL '95, Brighton/UK, September 1995.

The research activities were supported by the European but nationally funded JESSI projects AC-5 'Development of an EMC-Workbench for Microelectronic Application' and the 3rd phase of AC-12 'Analog Expert Design'. Phase 2 of AC-5 with a total run time of 3 years was successfully finished in the middle of 1995. Phase 3 of AC-5 could be started nearly continuously. The overall project is led by Cadlab/Analog System Engineering and received in November 1995 a 'JESSI recognition': The project provides ground breaking tools novel EDA environments and methodologies, to take into account EMC-effects in the design process of advanced electronic systems and components, and facilitated market introduction through numerous tests, an intensive training programme, promotion of the project results and support for a start-up company.

Apart from these projects, the work of the Analog System Engineering group is also significantly supported by projects in the frame of the Microsystem Technology initiative of the German Government and the AiF (Arbeitsgemeinschaft industrieller Forschungsvereinigungen).

With regard to the recent and future industrial needs, the main objectives of the Analog System Engineering group for the near future are the development of methodologies,

algorithms, tools, and novel measurement techniques for the support of the EMC-compliant design at systems level. The work will consider EMC-effects due to radiated as well as conducted mode.

6 Computing Centre

The main task of the group "operating" of the Computing Centre is the support and maintenance of an efficient programming environment for all Cadlab employees. This particularly includes the assistance of the employees and student assistants, the acquisition and installation of additional hardware and software tools, the improvement of the existing network and the task to keep all systems operational.

To concentrate and coordinate Cadlab's activities in the field of parallel computing a new working group named "Parallel Computing" was formed within the Computing Centre.

6.1 Move to a new building

A main proposition was the planning and realization of Cadlab's move to a new building. The task of the Computing Centre was to organize the move of the computer equipment and to insure the full operability of the systems at the new building within a few days. Before and along with the removal a completely new computer infrastructure was planned and installed.

With the help of a local government funding new equipment was installed:

- The building was equipped with a state of the art passive network technology, consisting out of 300 twisted pair (shielded TP, Cat 5, 200MHZ) and 100 fiber optic connection lines, both arranged in a star topology.
- Active network components (16 Ethernet 10BaseT Hubs, 4 16-Port Ethernet-FDDI Switches) were installed and configured to operate within a network management system. In addition an ATM-based net with two 16-Port ATM Switches and four 12-Port Ethernet-ATM Switches was installed and is currently tested, with the aim to replace the Ethernet-FDDI backbone. The Cadlab LAN which is part of the University of Paderborn LAN was connected to the FDDI backbone of the university by attaching to a newly installed monomode fibre optic line to the university campus via a gateway. Other cooperating institutes were connected by ISDN lines and modem connections were installed.
- The existing file and software servers were replaced by five new SparcStation 20 servers.
- The hard- and software for backups was updated by three new Exabyte-Jukeboxes and licenses for "Budtool", a tool for automatic backups in a heterogeneous network.
- The servers and active network components were equipped with independent, battery buffered power supplies.
- In addition four true color SGI workstations and a portable Sun workstation were installed.

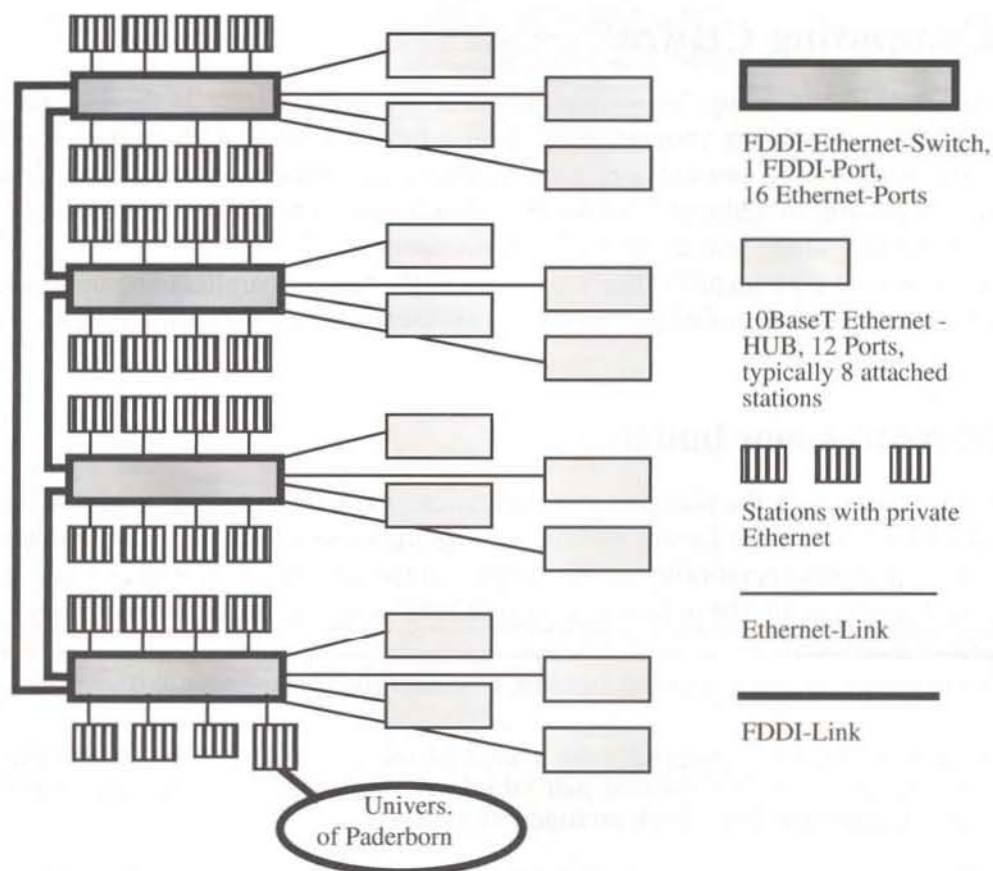


Figure 29 : Structure of Cadlabs LAN

6.2 New equipment

The existing hardware equipment, mainly Sun and Silicon Graphics workstations and PC's was expanded and updated with additional workstations and Personal Computers. Some Workstation were expanded with main memory and local disk capacity. To increase the printing capacity an additional laser printer and a colour laser printer were installed. For presentations a high resolution LCD-Projector was acquired.

6.3 Operating System Software and Tools

One of the main tasks of the Computing Centre group is to build up and preserve a homogeneous programming environment which, at best, is available on all different hardware respectively operating systems platforms.

With the support of experts from the other Cadlab project groups the installation of locally used tools like TeX, FrameMaker, printer spooler, gnu tools, as well as net-

work services like WWW were improved.

Along with the installation of new servers commonly used tools were updated and as far as possible unified cross the platforms.

Some more Sun workstations were installed with the operating system Solaris2 to gain experience. As the new version Solaris2.4 turns out to be stable and comes up with sufficient performance, in contrast to the older versions, a general change to Solaris2.4 is planned.

6.4 Parallel Computing

In fall 1994 a small project group named "Parallel Computing" was formed to concentrate and coordinate Cadlab's activities in this field. The first proposition was to evaluate software tools for load balancing and parallel programming on workstation clusters as well as parallel computer hardware. These tasks are ongoing.

Another project within this group aims at the extension of Predicate-/Transition-Nets by dynamical aspects through adaptive creation and annihilation of sub nets - based on a sound theory. These extensions support the specification of dynamical and parallel process systems. If coupled with a code generation system any explicit programming of parallelism and use of communication and process libraries is then substituted through an integrated and seamless approach. In the report period the activities were centred around the definition of dynamical extensions and the implementation of a code generating system.

6.5 Outlook

For next year it is planned to streamline the services for the different Unix platforms by freezing older versions of operating systems (Sun-OS-4.x, IRIX5.x).

Windows NT will become an additional main platform in Cadlab, thus know how and support for WindowsNT has to be offered by the Computing Centre group.

The FDDI-Ethernet LAN will be replaced by an ATM-Ethernet LAN and additional security features like firewalls will be installed.

A significant portion of the existing workstations will reach the end of their durability, so we will have to replace 30-40 workstations by new systems.

We plan to install a parallel computer of modest size in 1996, thus the work in the group parallel computing can become more practical.

III Publications, Funded Projects and Scientific Collaborations

7 Publications and Major Documents

7.1 Cadlab Reports

- "Information and Process Modelling Approaches for the Engineering of Heterogeneous Systems", M. Brielmann, B. Planken, H. Schmidt, F.-J. Stewing (Cadlab Report 01/95)
- "Rule Termination Analysis based on a Rule Meta Model", D. Zimmer, A. Meckenstock, R. Unland (Cadlab Report 02/95)
- "Operational and Structural View Models in OODBS: Differences, Fields of Application and Integration", W. Heijenga (Cadlab Report 03/95)
- "Unterstützung der 5-Ebenen-Schemaarchitektur durch Kontexte", G. Kachel (Cadlab Report 04/95)
- "Anwendung und Einsatz von DBF", B. Burkert, S. Bublitz, D. Nolte (Cadlab Report 05/95)
- "Implementierungsaspekte der Database Federation Services (DBF)", R. Böttger, G. Kachel (Cadlab Report 06/95)
- "Modelling Differential Equations by Basic Information Technology Means", M. Brielmann (Cadlab Report 07/95)
- "Complete Visual Specification and Animation of Protocols", W. Müller, G. Lehrenfeld, C. Tahedl (Cadlab Report 08/95)
- "Transforming SDL Diagrams into a Complete Visual Representation", G. Lehrenfeld, W. Müller, C. Tahedl (Cadlab Report 09/95)
- "Überblick zum Projekt DBF - Database Federation Services", S. Kolmschlag, R. Böttger, B. Burkert, Y. Engel, G. Kachel, D. Nolte, E. Radeke (Cadlab Report 10/95)
- "Annual Report 1994", F. J. Rammig, B. Steinmüller (Cadlab Report 11/95)
- "Persistent Object Migration in FDBS Enhanced by Schema Extension", E. Radeke, M. H. Scholz (Cadlab Report 12/95)
- "Allocation of Periodic Hard Real-Time Tasks", P. Altenbernd, C. Ditze (Cadlab Report 13/95)
- "The SEA Environment for System Engineering and Animation", B. Kleinjohann, E. Kleinjohann, J. Tacke (Cadlab Report 14/95)

- "Interaktiver Produktdatenaustausch mit EDIFACT", H. Aisch, M. Joosten, W. Müller, F. Buijs (Cadlab Report 15/95)
- "Support of Building Different Intelligent Applications with JCF Intelligent Framework Services (IFS)", P. Drescher, M. Holena, R. Kruschinski, G. Laufkötter (Cadlab Report 16/95)
- "On the False Path Problem in Hard Real Time Programs", P. Altenbernd (Cadlab Report 17/95)
- "Signal Integrity Test-Prozeß zur Unterstützung des Entwurfs digitaler Schaltungen", J. Schrage (Cadlab Report 18/95)
- "BF_to_EDIF-ein Übersetzer von Booleschen Funktionen nach einer EDIF-Netzliste auf Transistorebene", R. Milczewski, A. Rettberg (Internal Report 1/95)
- "Interaktive Konstruktion von graphischen Editoren auf der Basis von EXPRESS/G", A. Dangberg (Internal Report 2/95)
- "Prolog Benchmark-Tests (Version 1.2)", D. Ley (Internal Report 3/95)
- "Zum Testen von Software", D. Ley (Internal Report 4/95)
- "CADLAB: Strategischer Rahmen", F.J. Rammig, B. Steinmüller (Internal Report 5/95)

7.2 Major Software Documents

- "EXPREME 1.2 - EXPRESS-G Editor - User's Manual", S. Bublit, F. Buijs, Edition January 1995
- "The SDAI Interface to EXPRESS Models", ESIP/UPAD/001.1, S. Bublit, F. Buijs, B. Burkert, W. Müller, Cadlab, Paderborn, March 1995
- "HyKL 1.0 - Reference Manual", JCF SP1 Deliverable, P. Drescher, M. Holeña, R. Kruschinski, G. Laufkötter, April 1995
- "IFS Knowledge Evaluation Component, User Handbook", JCF SP1 Deliverable, M. Holeña, G. Laufkötter, April 1995
- "Evaluation and Demonstration of the IFS 1.0 Prototype", JCF SP1 Deliverable, P. Drescher, M. Holeña, R. Kruschinski, G. Laufkötter, April 1995
- "System Overview", OpenDM / ODMG-93 Prerelease 0.8, 1st Edition, Project Group Data Integration and Modeling, Cadlab, Paderborn, December 1995
- "Installation Guide", OpenDM / ODMG-93 Prerelease 0.8, 1st Edition, Project Group Data Integration and Modeling, Cadlab, Paderborn, December 1995
- "First Steps to Build an Application", OpenDM / ODMG-93 Prerelease 0.8, 1st Edition, Project Group Data Integration and Modeling, Cadlab, Paderborn, December 1995

- "Short Reference Manual", OpenDM / ODMG-93 Prerelease 0.8, 1st Edition, Project Group Data Integration and Modeling, Cadlab, Paderborn, December 1995
- "User Guide", OpenDM / ODMG-93 Prerelease 0.8, 1st Edition, Project Group Data Integration and Modeling, Cadlab, Paderborn, December 1995
- "System Overview", OpenDM / ODMG-93 Prerelease 1.0, 1st Edition, Project Group Data Integration and Modeling, Cadlab, Paderborn, December 1995

7.3 Technical Reports

- ISO (TC184/SC4/WG5) Documents: "The Process Modelling Language EXPRESS-P", ISO TC184/SC4/WG5, W. Müller, W. Felser, F. Buijs, Cadlab, Paderborn, March 1995.
- CENELEC Technical Reports: "Validation of EXPRESS Models", CENELEC Technical Report R117-003:1995, W. Müller, G. Lehrenfeld, N. Wiechers, 1995

7.4 Books, Conference and Journal Papers

- P. Altenbernd: "Deadline-Monotonic Software Scheduling for the Co-Synthesis of Parallel Hard Real-Time Systems" in Proceedings of the European Design and Test Conference (ED&TC), Paris, 1995
- P. Altenbernd, C. Ditzel: "Allocation of Periodic Hard Real-Time Tasks" in 20th IFAC/IFIP Workshop on Real Time Programming (WRTP), Fort Lauderdale, 1995
- E. Börger, U. Glässer, W. Müller: "A Formal Definition of an Abstract VHDL'93 Simulator by EA-Machines", in Semantics of VHDL, C. Delgado Kloos and Peter T. Breuer (eds.), Kluwer Academic Publishers, Dordrecht, 1995, pp. 107-140.
- R. Böttger, G. Kachel: "Implementierungsaspekte der Database Federation Services", GI-Workshop "Grundlagen von Datenbanken", June 6-9, Bad Salzdetfurth, Germany, 1995
- M. Brielmann, B. Planken, H. Schmidt, F.-J. Stewing: "Information and Process Modelling Approaches for the Engineering of Heterogeneous Systems", in Proceedings of the International Symposium and Workshop on Systems Engineering of Computer Based Systems, Tucson, March 1995, IEEE Press, 1995, pp. 218-225.
- M. Brielmann: "Modelling Differential Equations by Basic Information Technology Means", in Proceedings of the Euro-CAST'95, Innsbruck, May 1995, Springer Verlag, pp. 163-174
- F. Buijs, W. Käfer: "STEP Technology for ECAD Databases", in: F. J. Rammig, F. R. Wagner (eds.): Electronic Design Automation Frameworks Volume 4, ISBN 0 412 71010 2, Chapman & Hall, London, 1995, pp. 221-230.
- B. Burkert, S. Bublit, D. Nolte: "Beispiele für die Anwendung und den Einsatz von DBF", GI-Workshop "Grundlagen von Datenbanken", June 6-9, Bad Salzdetfurth, Germany, 1995

- P. Drescher, M. Holeña, R. Kruschinski, G. Laufkötter: Support of building different intelligent applications with JCF intelligent framework services (IFS). In L. Faria, editor, International Workshop Concurrent / Simultaneous Engineering Frameworks and Applications, pages 41-47, 1995.
- P. Drescher, M. Holeña, R. Kruschinski, G. Laufkötter: Uncertainty processing in a knowledge-support system for CAD/CAE frameworks. In Proceedings of the 2nd International Workshop on Artificial Intelligence Techniques AIT'95.
- E. Gries: "Diffraction Analysis of Dielectric Periodic Gratings Using Conventional Transmission Line Theory", Proceedings of PIERS Progress in Electromagnetics Research Symposium 1995, Seattle, USA, July 1995, p. 704
- E. Gries: "Equivalent Network Representation of Planar Gratings with Periodic Distribution of Dielectric Constant", Proceedings of the 10th COMPUMAG Conference on the Computation of Electromagnetic Fields, Berlin (Germany), July 1995, pp. 277-282.
- E. Gries: "Anwendung der Leitungstheorie zur Behandlung der vektoriellen Beugung elektromagnetischer Wellen an dielektrischen Gittern", Tagungsband zur Kleinheubacher Tagung 1994, Kleinheubach/Main (Germany), Kleinheubacher Berichte Band 37, 1995, pp. 255-262.
- M. Holeña: Exploratory data processing using a fuzzy generalization of the GUHA approach. In Applied Decision Technologies. Stream 3: Fuzzy Logic, pages 139-144, 1995.
- W. John: "Electronic Design under EMC Constraints", Proceedings of 11th International Zurich Symposium & Technical Exhibition on Electromagnetic Compatibility, Zurich (Switzerland), March 7-10, 1995, pp. 541-548.
- W. John, R. Brüning, H.-T. Mammen, W. Thronicke: "Generierung, Parametrisierung und Validierung von Makromodellen für analoge Funktionselemente", GME-Fachtagung 'Mikroelektronik', Baden-Baden (Germany), March 1995, pp. 277-282.
- G. Kachel: "Unterstützung der 5-Ebenen-Schemaarchitektur durch Kontexte", GI-Workshop "Grundlagen von Datenbanken", June 6-9, Bad Salzdetfurth, Germany, 1995
- H. -J. Kaufmann, T. Kern, A. Leventis, R. Zhao: "Chained Controllers in Object-Oriented User Interface Software", in Proceedings (poster session) of 6th Human-Computer Interaction International, Tokyo, July 9-14, Elsevier, Amsterdam, 1995.
- S. Kolmschlag, R. Böttger, B. Burkert, Y. Engel, G. Kachel, D. Nolte, E. Radeke: "Überblick zum Projekt 'DBF - Database Federation Services'", GI-Workshop "Grundlagen von Datenbanken", June 6-9, Bad Salzdetfurth, Germany, 1995
- G. Lehrenfeld, W. Müller, C. Tahedl: "Transforming SDL Diagrams Into a Complete Visual Representation", in Proceedings of the IEEE Symposium on Visual Languages '95, September 5-8, Darmstadt, Germany, 1995.
- D. Ley, J. Müller: "Schnelle Analyse von Reflexionen in digitalen Schaltungen durch Netztransformation", Tagungsband zum 1. Paderborner EMC-Forum, Paderborn, Germany, December 1995

- H.-T. Mammen, R. Scholz, R. Brüning, V. Geneiß, U. Kemper: "Wissensbasierte Entwicklung von Makromodellen für den analogen Schaltungsentwurf", 7th E.I.S.-Workshop, Chemnitz (Germany), November 1995, pp. 31-40.
- A. Meckenstock: "Recoverykonzepte in einem konfigurierbaren Transaktionsmodell für Entwurfsumgebungen", in Datenbank-Rundbrief GI-Fachgruppe 2.5.1, 6. GI-Workshop Transaktionskonzepte 1995, Bad Honnef, May 1995
- W. Müller, W. Felser, F. Buijs: "Guide to EXPRESS-P", Fourth Annual EXPRESS User's Group - EUG '94 - Conference Notes, U. S. Product Data Association, 1995
- W. Müller, G. Lehrenfeld, C. Tahedl: "Complete Visual Specification and Animations of Protocols", in Proceedings of the CHDL'95, August 30 - September 1, Tokyo, Japan, 1995.
- S. Öing, M. Künne, U. Keller, F. Sabath, M. Bucker: "Controlling EMI with an Extended EMC-Workbench", Proceedings of the 11th International Zurich Symposium & Technical Exhibition on Electromagnetic Compatibility, Zurich (Switzerland), 1995, pp. 573-578.
- E. Radeke, R. Böttger, B. Burkert, Y. Engel, G. Kachel, S. Kolmschlag, D. Nolte: "Efendi: Federated Database System of Cadlab", in: Proc. Int'l Conference Management of Data (SIGMOD), San Jose, USA, 1995
- E. Radeke, M. H. Scholl: "Functionality for object migration among distributed, heterogeneous, autonomous database systems", in: Proc. Int'l WS Research Issues on Data Engineering - Distributed Object Management (RIDE-DOM), Taipei (Taiwan), 1995
- F. J. Rammig, F. R. Wagner (eds.): "Electronic Design Automation Frameworks", Vol. 4, Chapman & Hall, 1995
- F. J. Rammig: "Models and Tools for Integrated System Design", in: Proc. of the 10th Congress of the Brazilian Microelectronics Society and 1st Ibero American Microelectronics Conference, pp. 191-210, 1995
- W. Rissiek, H. Holzheuer, O. Rethmeier: "Multiprocessor Solution for a Signal Integrity Analysis on Printed Circuit Boards", SAMS - System Analysis, Modelling, Simulation, Vol. 21, 1995, pp. 203-214.
- F. Sabath, M. Bucker, S. Öing: "Distribution of the Transmission Line Current Due to the Influence of Infinite and Finite Ground Plane", Proceedings of the Cost 243 Workshop, Hamburg, 1995, pp. 23-28.
- F. Sabath, M. Bucker, S. Öing: "Influence of Finite Ground Planes on the Transmission Line Current Distribution", Proceedings of the 10th COMPUMAG Conference on the Computation of Electromagnetic Fields, Berlin (Germany), July 1995, pp. 168-169.
- H. Schmidt, D. Theune, R. Thiele, T. Lengauer: "EMC-driven midway routing on PCBs", Proceedings of the European Design and Test Conference, Paris (France), March 1995, IEEE Press, 1995, pp. 486-491.

- J. Schrage: "Signal Integrity Test-Prozess zur Unterstützung des Entwurfs signalverarbeitender Mikrosystemkomponenten", Tagungsband zum 2. Workshop 'Methoden- und Werkzeugentwicklung für den Mikrosystementwurf', Karlsruhe (Germany), November 1995, pp. 85-93.
- J. Schrage: "Entwurfsunterstützung digitaler Komponenten durch einen Signal-Integrity-Testprozeß", Tagungsband zum 1. Paderborner EMC-Forum, Paderborn (Germany), December 1995.
- H.-G. Stark, G. Laufkötter: "Image Indexing and content based access to databases of medical images with wavelets", in Proceedings of the SPIE Meeting '95, Vol. 2569 "Wavelet Applications in Signal and Image Processing III", San Diego, July 1995
- W. Thronicke, R. Scholz, J. Lessner, B. Planken, W. John: "Workflow-orientierte Umgebung für den Systementwurf", Tagungsband zum 2. Workshop 'Methoden- und Werkzeugentwicklung für den Mikrosystementwurf', Karlsruhe (Germany), November 1995, pp. 143-150.
- D. Wagenblaß, W. Thronicke: "An Approach for Classification of Integrated Circuits by a Knowledge Conserving Library Concept", Proceedings of European Design Automation Conference with EURO-VHDL '95, Brighton (UK), September 1995, pp. 40-45.
- R. Zhao, H. J. Kaufmann, T. Kern, W. Müller: "Pen-based Interfaces for Engineering Environments", 6th Human-Computer Interaction International, Tokyo, July 9-14, Elsevier, Amsterdam, 1995
- R. Zhao, W. Müller, H. J. Kaufmann, T. Kern, F. Buijs: "An Editor for the Rapid Prototyping of EXPRESS_G Models", in Proceedings of the 5th EXPRESS User's Group, Grenoble, October, 21-22, 1995.
- D. Zimmer: "Regelterminierungsanalysen auf Basis des Regelmetamodells Vampire", in Datenbank-Rundbrief GI-Fachgruppe 2.5.1, 6. GI-Workshop Transaktionskonzepte 1995, Bad Honnef, May 1995

7.5 PhD Theses

- B. Burkert: "Ein Framework generischer objekt-orientierter Basiskonzepte zur Werkzeug-Integration in unterschiedliche konzeptionelle Datenmodelle", March 1995
- M. Pape: "Chip Assembly mit topologischer Kompaktierung", June 1995
- E. Radeke: "Federation and Migration Among Database Systems", October 1995

7.6 Master Theses

The following master theses have been completed at Paderborn University under the responsibility of Cadlab.

- C. Tahedl: "Entwurf eines schnittstellengesteuerten Animationswerkzeuges für eine vollständig visuelle Programmiersprache zur Animation von SDL-Spezifikationen", May 1995

- C. Schmidt: "Parallelisierung eines Simulators für verlustbehaftete Leitungssysteme", July 1995
- K. Benndorf: "Entwicklung eines Visualisierungssystems zur zwei- und dreidimensionalen Darstellung von Daten aus dem EMV-Bereich", September 1995
- B. Hoischen: "Entwurf eines Editors für eine visuelle Programmiersprache mit integriertem Bibliothekskonzept", September 1995
- D. Völlmecke: "Mixed-Mode-Simulation zur Unterstützung der Behandlung von Signal-Integrity-Problemen beim Entwurf schneller digitaler Signalverarbeitungskomponenten", December 1995
- M. Ramme: "Entwicklung eines Verfahrens zur Simulation verlustbehafteter Leitungen im Zeitbereich", December 1995
- A. Dangberg: "Interaktive Konstruktion von graphischen Editoren auf der Basis von EXPRESS/G", December 1995
- T. Peck: "Entwurf eines erweiterbaren Schemas zur Definition feldtheoretischer Probleme", December 1995

7.7 External Talks, Lectures, Tutorials, Panels

- M. Holeña: "Fuzzy hypotheses testing and GUHA implicational quantifiers." Presented at the Fuzzy Workshop in Kocovce, February 1995.
- E. Radeke, M. H. Scholl: "Functionality for object migration among distributed, heterogeneous, autonomous database systems" RIDE-DOM'95 (Int'l WS on Research Issues in Data Engineering - Distributed Object Management), Taipei (Taiwan), March 6-7, 1995
- W. John: "Electronic Design under EMC Constraints", 11th International Zurich Symposium & Technical Exhibition on Electromagnetic Compatibility, Zurich (Switzerland), March 7-10, 1995.
- D. Nolte, E. Radeke: Presentation of OpenDM, Arbeitskreis Verbindungstechnologie (SNI ASW QT), Munich, March 1995
- R. Kruschinski, G. Laufkötter, P. Drescher, M. Holeña: "Support of building different intelligent applications with JCF Intelligent Framework Services (IFS)" Poster at International Workshop on Concurrent/Simultaneous Engineering Frameworks and Applications, Lisboa, April 5-7, 1995
- W. Heijenga: "Klassifikation von object-orientierten Sichten", University Magdeburg, April 11, 1995
- W. John, J. Müller, S. Öing, F. Sabath, H. Schmidt, M. Vogt: "EMV-gerechter Leiterplattenentwurf", EMV Dresden, Workshop, April 25, 1995
- M. Vogt: "Berechnung des Feldes von Leitungssystemen auf verlustbehafteten, anisotropen Substraten mit einem hybriden FEM/BEM-Verfahren", Kolloquium zur Theoretischen Elektrotechnik, TU Ilmenau, Ilmenau, Germany, May 1995

- B. Steinmüller: "Cadlab - Projekterfahrungen in Europäischen Projekten", EUROPATAGE at Universität-GH Paderborn, May 9, 1995
- G. Kachel: OpenDM-Presentation, Efendi/OpenDM-Workshop in Munich, May 16, 1995
- S. Bublit: Software Demo SDAI, Open Day, Cadlab, Paderborn, May 18, 1995
- E. Radeke: Software Demo Efendi, Open Day, Cadlab, Paderborn, May 18, 1995
- E. Radeke: "Efendi: Federated Database System of Cadlab", paper and demo at SIGMOD95, San José, USA, May 1995
- J. Tacke: Werkzeugintegration/Integrierte Entwurfsführung at SYDIS-Workshop, FZI, Karlsruhe May 29-30, 1995
- E. Gries: "Equivalent Network Representation of Planar Gratings with Periodic Distribution of Dielectric Constant", 10th COMPUMAG Conference on the Computation of Electromagnetic Fields, Berlin (Germany), July 10-13, 1995.
- E. Gries: "Diffraction Analysis of Dielectric Periodic Gratings Using Conventional Transmission Line Theory" (Invited Lecture), 1995 PIERS Progress in Electromagnetics Research Symposium, Seattle/WA (USA), July 24-28, 1995.
- D. Wagenblaß: "An Approach for Classification of Integrated Circuits by a Knowledge Conserving Library Concept", European Design Automation Conference with EURO-VHDL '95, Brighton (UK), September 18-22, 1995.
- U. Keller: Erasmus summercourse: "Application of numerical techniques in EMC", KHBO, Oostende, Belgium, September 1995.
- E. Gries, H. Holzheuer, M. Ramme, F. Sabath: "Modellierung verlustbehafteter Leitungen im Frequenzbereich mit Hilfe der Padé-Approximation", Kleinheubacher Tagung 1995, Schloß Kleinheubach/Main (Germany), October 2-6, 1995.
- B. Burkert: "A Framework of Generic, Object-oriented Base Concepts to Support Tool Integration in Conceptual Data Models", Kolloquiumsvortrag, TU Delft, October 6, 1995
- F. Buijs: "An Editor for the Rapid Prototyping of EXPRESS-G Models", 5th Annual EXPRESS User Group International Conference, Grenoble (France), October 1995
- W. John, E. Gries, J. Müller, S. Öing, D. Theune: "EMV-gerechter Leiterplattenentwurf - Simulation, Analyse Meßtechnik", EMV-Seminar Düsseldorf, October 25, 1995.
- M. Holeña: Fuzzy hypotheses for implicational quantifiers. Presented at the Workshop "Thirty years of the general unary hypotheses automaton method" in Prague, November 1995.
- F. J. Rammig, B. Steinmüller: "Synthese digitaler Systeme"(Panel), SYDIS Workshop zum Abschluß des BMBF-Projektes, St. Augustin (Germany), November 1995

- J. Tacke: "Werkzeugintegration und integrierte Entwurfsführung" at SYDIS Workshop, St. Augustin, November 1995
- D. Frei, W. John: "Berücksichtigung von EMV-Aspekten im Verlauf der Systemplanung" (poster presentation), 1. EMV-Forum - Paderborn -, Paderborn (Germany), December 6, 1995.
- H. Holzheuer: "Beschleunigung der Signal-Integrity-Analyse komplexer Leiterplatten durch Verteilung der Simulation" (poster presentation), 1. EMV-Forum - Paderborn -, Paderborn (Germany), December 6, 1995.
- E. Gries, H. Holzheuer, F. Sabath, M. Ramme: "Simulation verlustbehafteter Leitungssysteme im Zeitbereich" (poster presentation), 1. EMV-Forum - Paderborn -, Paderborn (Germany), December 6, 1995.
- M. Gutzmann: "Untersuchung des Delta-I-Noise-Verhaltens von digitalen CMOS-Komponenten" (poster presentation), 1. EMV-Forum - Paderborn -, Paderborn (Germany), December 6, 1995.
- W. John, E. Gries, M. Vogt, R. Greve: "Validierung der Berechnung elektrischer Parameter für Verdrahtungsstrukturen auf Leiterplatten" (poster presentation), 1. EMV-Forum - Paderborn -, Paderborn (Germany), December 6, 1995.
- J. Müller, D. Ley: "Schnelle Analyse von Reflexionen in digitalen Schaltungen durch Netztransformationen", 1. EMV-Forum - Paderborn -, Paderborn (Germany), December 6, 1995.
- O. Rethmeier, D. Völlmecke, W. John: "Makromodelle für die Signal-Integrity-Analyse von verketteten Leitungsnetzen" (poster presentation), 1. EMV-Forum - Paderborn -, Paderborn (Germany), December 6, 1995.
- U. Keller, M. Bückner, S. Öing: "Influence of Finite Ground Planes on the Transmission Line Current Distribution" (poster presentation), 1. EMV-Forum - Paderborn -, Paderborn (Germany), December 6, 1995.
- J. Schrage: "Entwurfsunterstützung digitaler Komponenten durch einen Signal-Integrity-Testprozess" (poster presentation), 1. EMV-Forum - Paderborn -, Paderborn (Germany), December 6, 1995.
- H. Schmidt, B. Stube: "Automatische Bauelementeplatzierung auf Leiterplatten unter EMV- und thermischen Gesichtspunkten", 1. EMV-Forum - Paderborn -, Paderborn (Germany), December 6, 1995.
- W. Thronicke, R. Scholz, B. Planken, W. John, J. Lessner: "Lean Integration Platform" (poster presentation), 1. EMV-Forum - Paderborn -, Paderborn (Germany), December 6, 1995.
- M. Vogt: "Elektrische Charakterisierung von anisotropen Leitungssystemen mit einem hybriden FEM/BEM-Verfahren" (poster presentation), 1. EMV-Forum - Paderborn -, Paderborn (Germany), December 6, 1995.
- E. Radeke, D. Nolte: Software Demo OpenDM/Efendi, Datenbank-Stammtisch, University Dresden, December 13, 1995

- F.-J. Stewing: "Global Engineering Network", CDT, Lulea (Schweden), December 1995
- F.-J. Stewing: "Concurrent Engineering over the Global Engineering Network", ESoCE ICE '96 Workshop, Stockholm (Schweden), Dezember 1995

7.8 Exhibitions

- "European Product Data Technology Days '95", Munich (Germany), January 1995
- "G7 EXPO", Software Demo GEN Demonstration, Brussels (Belgium), February 1995
- "11th International Zurich Symposium & Technical Exhibition on EMC", Zurich (Switzerland), March 7-10, 1995.
- "1. Internationale Messe mit Workshops für elektromagnetische Verträglichkeit in Industrie und Handwerk", Dresden (Germany), April 25-27, 1995.
- Software Demo SDAI at Open Day, Cadlab, Paderborn, May 18, 1995
- Software Demo Efendi at Open Day, Cadlab, Paderborn, May 18, 1995
- "SIGMOD/PODS '95 Conference", Software Demo OpenDM/Efendi, San Jose (USA) May 22-25, 1995
- Intelligent Traffic Optimization at "Third Conference on Mechatronic and Robotics", Paderborn (Germany), October 4-6, 1995
- Heterogeneous System Modelling and Evaluation at "Third Conference on Mechatronic and Robotics", Paderborn, October 4-6, 1995
- "Object World '95", Software Demo OpenDM/Efendi, Frankfurt, October 1995
- Entwurfsführung mit SEA (System Engineering and Animation) at SYDIS-Workshop, GMD, St. Augustin, November 23-24, 1995

8 Funded Projects

8.1 Nationally Funded Projects

During the reporting period, Cadlab participated in a number of cooperation projects supported by the BMBF¹, AiF², GFaI³ or DFG⁴ as indicated in Table 1.

Title	Support program	Run time	Project partners
BIBLIO (MST-BIB)	BMBF	04.91 - 07.95	ABB CEAG LuS, Uni Paderborn, Uni Bremen, Bosch, DOSIS, FH Wiesbaden, FhG-IIS, Hahn Meitner Institut, Krone, Rhode & Schwarz, SRM-CAE, TU Braunschweig, Uni Dortmund, Texas Instruments, Mikron, FhG-EAS, SNI, SIMEC, TU Chemnitz, TU Dresden
MIMOSYS	BMBF	07.95 - 06.99	Uni Paderborn, Uni Bremen, Bosch, FH Wiesbaden, FhG-EAS, FhG-IIS, SNI, CiS, IL-Metronik, ITI, ANACAD, INCASES, IMO, Micro-Hybrid Electronic, TU Ilmenau
METEOR	BMBF	07.92 - 12.96	KfK/IDT, FhG-IIS, GMD, MBB, Uni-GH Wuppertal, Siemens, FhG-IIS-EAS, SNI, BOTECH, ebm, ETA, Harting, Jenoptik, Kuhnke, Mannesmann Tally, MicroParts, PROFI Engineering, AST, VDO, TU Berlin, Bosch, TU Chemnitz, Uni Erlangen, Uni Paderborn

Table 1: Nationally Funded Projects

-
1. Bundesministerium für Bildung, Wissenschaft, Forschung und Technologie
 2. Arbeitsgemeinschaft industrieller Forschungsvereinigungen e. V.
 3. Gesellschaft zur Förderung angewandter Informatik e. V. (Mitglied der AiF e. V.)
 4. Deutsche Forschungsgesellschaft

Title	Support program	Run time	Project partners
JESSI AC-5	BMBF	07.92 - 06.97	ABB, Bull, DASA, GFAI, ITALTEL, MATRA, Mercedes-Benz AG, Philips, SNI, Universität Paderborn, Alcatel SEL, WIDIS, INCASES, THE-SYS, TU Ilmenau, Vectorfields, Philips Research Labs (UK)
JESSI AC-12	BMBF	01.92 - 12.96	ANACAD, Bosch, CSEM, EZM, FhG/EAS, MATRA, Philips, Siemens, SGS-Thompson, S3, TEMIC
SYDIS	BMBF	01.93 - 12.95	GMD, Universität Paderborn, FhG-EAS, FZI Karlsruhe, SNI
OPAL	AiF	12.92 - 05.95	GFAI, Parsytec, SNI
QUELLE	GF _a I	09.93 - 03.96	GFAI, WIDIS, Universität Paderborn, TU Danzig
Schnittstellen-synthese	DFG	09.94 - 08.95	numerous partners from several german universities

Table 1: Nationally Funded Projects

8.2 European Funded Projects

In the reporting period Cadlab participated in the CEU funded projects (ESPRIT) as outlined by Table 2.

Title	Support program	Run time	Project partners
ESIP	ESRIT-II/III	10.93 - 09.95	Bull, ICL, SNI, TGI, Thompson-CSF, Racal-Redac, Philips (Uni Paderborn assoc. to SNI)
JESSI-Common-Frame	ESPRIT-II	05.93 - 04.95	SNI, ICL, SGS-Th., Siemens, Philips, Racal-Redac, TU-Delft (Uni Paderborn assoc. to SNI)

Table 2: European Funded Projects

Title	Support program	Run time	Project partners
ADVANCE	ESPRIT-II	01.94 - 07.96	GMD, Dassault Electronique, Philips, SMS (Shorts Missile Systems Limited), SNI, SSE (Software and Systems Engineering), Trinity College Dublin
TALENT	ESPRIT-III	11.95 - 01.97	MID, SNI

Table 2: European Funded Projects

8.3 Reports on Funded Projects

BIBLIO (MST-BIB) Reports:

- "Abschlußbericht (Period 04/91 - 07/95)", December 1995

JESSI AC-5 Reports:

- "Technical Report (Period 01/95 - 06/95)", July 1995
- "Technical Report (Period 07/95 - 12/95)", December 1995

JESSI AC-12 Reports:

- "Technical Report (Period 01/95 - 06/95)", July 1995
- "Technical Report (Period 07/95 - 12/95)", December 1995
- "Milestone Report", December 1995

OMSI Reports:

- "Abschlußbericht (Period 08/91 - 12/94)", June 1995

OPAL Report:

- "Abschlußbericht (Period 12/92 - 06/95)", June 1995

QUELLE Reports

- "4. Zwischenbericht (Period 12/94 - 02/95)", February 1995
- "5. Zwischenbericht (Period 03/95 - 05/95)", May 1995
- "6. Zwischenbericht (Period 06/95 - 08/95)", August 1995
- "7. Zwischenbericht (Period 09/95 - 11/95)", November 1995

SYDIS Reports:

- "2. Halbjahresbericht 1994", February 1995
- "1. Halbjahresbericht 1995", August 1995

9 Collaboration in Technical-Scientific Bodies

GI, GME, ITG:

- Member of ITG Technical Committee 5.2 (CAD) (F.J. Rammig)
- Member of GI Technical Committee 3.5 (CAD) (F. J. Rammig, B. Steinmüller)
- Member of Steering Committee for Working Group GI 3.5.1/ITG 5.2.3 "Methods for the Design and Verification of Digital Circuits and Systems" (F. J. Rammig)
- Member of Steering Committee for Working Group GI 3.5.4/ITG 5.2.6 "CAD Umgebungen für den Entwurf mikroelektronischer Systeme" (B. Steinmüller, F. J. Rammig)
- VDI/VDE-GMM Technical Committee 4.7 "Informationstechnik für Mikrosysteme" (W. John)
- Member of Steering Committee for Working Group GI 3.5.7/ITG 5.2.2 "Hardwarebeschreibungssprachen und Modellierungspadigmen" (W. Müller)
- Member of EURO-DAC / EURO-VHDL Steering Committee (F. J. Rammig)
- Member of GI FG 2.5.1 "Datenbanken" (G. Kachel, E. Radeke)
- Member of Working Group "Petrietze und Informationssysteme in der Praxis" (M. Brielmann, M. Niemeyer)

IFIP:

- National representative for Germany in IFIP TC10 (F. J. Rammig)
- Member of IFIP WG 10.5 (F. J. Rammig)
- Member of IFIP WG 10.5 SIG VHDL (F. J. Rammig)
- Member of IFIP WG 10.5 SIG CODES (F. J. Rammig)

Others:

- Member of DIN NAM 96.4.4 (F. Buijs)
- Contribution to the definition of EXPRESS Version 2 in the EXPRESS Working Group of DIN NAM 96.4.4 (W. Müller)
- Contribution to the definition of the SDAI in ISO TC184/SC4/WG7 "STEP Implementation Methods" (F. Buijs)
- Member of SNAK (Siemens Normen Arbeitskreis) STEP (F. Buijs)
- IEEE Taskforce on the Engineering of Computer-Based Systems, ECBS (M. Brielmann, F.-J. Stewing)

- Volunteer IEEE Technical Segment Committee on the Engineering of Complex Computer Systems, ECCS (F.-J. Stewing)
- Member of "Westfälisches Umweltzentrum" (WUZ), (B. Steinmüller)
- Founder Members of Glen Net e. V., (F. J. Rammig, B. Steinmüller, F.-J. Stewing)
- Taskforce "Numerical Methods" of the German Chapter of the IEEE EMC Society (E. Griese, F. Sabath)

Program Committees, Organization of Sessions at Conferences:

- PC Member EURO-DAC 95, Brighton, Great Britain 1995 (F. J. Rammig)
- PC Member EURO-VHD 95, Brighton, Great Britain 1995 (F. J. Rammig)
- PC Member ED&TC 95, Paris, France 1995 (F. J. Rammig)
- PC Member CHDL 95, Tokyo, Japan 1995 (F. J. Rammig)
- PC Member "Symposium on Reliable Distributed Systems", SRDS '95, (F.-J. Stewing)
- 1. EMC-Forum 'EMV-gerechter rechnergestützter Komponenten- und Systementwurf', Paderborn, 6th December 1995, Direction: W. John (Cadlab)

THE JOURNAL OF THE

ROYAL ANTHROPOLOGICAL INSTITUTE

1995

P. J. HENNING, B. HENNING & J. HENNING
The Henning Family