Annual Report 1995

Contents

1 Institut für Informatik und angewandte Mathematik (IAM)

1.1 Address

Neubrückstrasse 10, CH-3012 Bern, Switzerland
Telephone: +41 31 631 86 81, Telefax: +41 31 631 39 65
www:http://iamwww.unibe.ch

1.2 Personnel

Board of directors

Prof. Dr. Hanspeter Bieri; Prof. Dr. Horst Bunke; Prof. Dr. Dieter Hogrefe; Prof. Dr. Gerhard Jäger; Prof. Dr. Oscar Nierstrasz.

Professors

Prof. Dr. Hanspeter Bieri; Prof. Dr. Horst Bunke; Prof. Dr. Dieter Hogrefe; Prof. Dr. Gerhard Jäger; Prof. Dr. Hansjürg Mey; Prof. Dr. Oscar Nierstrasz.

Acting chairman

Prof. Dr. Horst Bunke

Secretaries

Daniela Heiniger; Ursula Hadorn; Isabelle Huber; Sylvia Schaad; Susanne Thüler.

Technical staff

Heike Horn

Scientific staff

Bernhard Achermann; Stephan Amann; Thomas Bebie; Bernhard Bühlmann; Andrey Collison; Juan Carlos Cruz; Luca Deri; Dr. Jens Grabowski; Dr. Andreas Greulich; Karl Guggisberg; Matthias Günter; Dr. Tien Ha Minh; Dr. Wolfgang Heinle; Alain Heuerding; Dr. Xiao-Yi Jiang; Dr. Catholijn Jonker; Reinhard Kahle; Guido Kaufmann; Josef Kleinle; Dr. Stefan Leue; Markus Lumpe; Willem Mallon; Dr. Markus Marzetta; Dr. Theo Dirk Meijler; Marco Menna; Bruno Messmer; Igor Metz; Daniel Möri; Simon Moser; Dr. Lorenz Müller; Tamar Richner; Rudi Scheurer; Jean-Guy Schneider; Stefan Schwendimann; Dr. Walter Senn; Michael

Seyfried; Dr. Jürg Stiefenhofer; Thomas Strahm; Christoph Streit; Dr. Daniel Tog-
gweiler; Patrick Varone; Dr. Werner Volken; Werner Wolff; Dr. Kuno Wyler; Karen
Yu; Heinrich Zimmermann.

2 Research Group on Computational Geometry and Graphics

2.1 Personnel

Head:	Prof. Dr. H. Bieri	Tel: +41 31 631 86 70
		email: bieri@iam.unibe.ch
Secretary:	D. Heiniger	Tel: +41 31 631 49 14
		email: heiniger@iam.unibe.ch
Scientific staff:	St. Amann	Tel: +41 31 631 46 79
		email: amann@iam.unibe.ch
	Th. Bebie	Tel: +41 31 631 48 64
		email: bebie@iam.unibe.ch
	B. Bühlmann	Tel: +41 31 631 33 21
		email: buhlmann@iam.unibe.ch
	A. Collison	Tel: +41 31 631 84 19
		email: collison@iam.unibe.ch
	Ch. Streit	Tel: +41 31 631 49 90
		email: streit@iam.unibe.ch

2.2 Research Projects

d-dimensional general polyhedra

These polyhedra, now normally called "Nef polyhedra", are those subsets of R^d which can be obtained by applying finitely many Boolean set operations to a finite number of linear half spaces. The project extends the theory of Nef polyhedra, develops and analyses appropriate data structures and prepares an object-oriented implementation of the kernel of a solid modeler for working with Nef polyhedra.

Research staff: H. Bieri, W. Nef

BOOGA

BOOGA (Berne's Object-oriented Graphics Architecture) is an object-oriented framework for integrating techniques from geometric modeling, computer graphics (2D and 3D), computer vision and image processing. Primarily, it is a system to investigate new approaches in computer graphics.
Main fields of interest are the combination of various illumination models, the generation of 3D scene descriptions based on various inputs (sketches, photographs,

etc.) and innovative user interaction techniques. Traditional approaches in computer graphics are generalized to achieve a common underlying model for a number of existing algorithms.

Research staff: St. Amann, Ch. Streit

BOOGA - Applications

- **Graphical Database**

  The goal of this project is to develop a database capable of storing and retrieving various graphical objects (e.g. 2D and 3D models, L-systems, fractals, surfaces, textures, geometric scenes, and rendered images).

  The system shall enable the user (typically a designer) to quickly compose new scenes by combining and modifying existing objects found in the database.

  The main challenge is to efficiently find the objects relevant to the user. Considering this problem, various content based retrieval methods are developed and tested using the BOOGA framework.

  Research staff: A. Collison

- **3D Reconstruction from Color Images**

  The goal of this project is to generate 3D structures from small sequences of color images. The range of input images is restricted to scenes containing persons standing on the same plane in 3D space. The task is subdivided into locating a person, finding its two dimensional shape and reconstructing its three dimensional body posture. Specialized algorithms for each step are being developed.

  Research staff: Th. Bebie

- **Virtual Reality**

  This project examines several problems in visualizing large datasets in urban engineering. The work will focus on acceleration techniques for interactive 3D graphics. In a further step, virtual tools will help the engineer to model a complex scene in realtime using an intuitive user interface. As an example, some parts of the city of Berne will be modelled and animated using acceleration techniques and elements from virtual reality.

  The project will be implemented using BOOGA as graphics framework and will help the developers of BOOGA to adapt the framework to the users needs.

  Research staff: B. Bühlmann

CIMEDIA

The goal of this (terminated) project consisted in developing a new kind of multi-media teaching tool. The underlying medium is a CD-i. The concrete application provides an innovative introduction to the basic notions of CIM. Experts in CIM, graphics design, music, psychology and system programming have been working together to examine and apply a number of possibilities of this new technology.

Research staff: B.Grossniklaus

Chief project manager: M.M. Schaub, CIM-Zentrum Muttenz der Ingenieurschulen beider Basel.

Financial support: Various Swiss industrial firms

2.3 Master's Thesis

- Bärtschi, Matthias: Modifikation und Implementierung des Algorithmus "Fleshing Out Wire Frames" von G. Markowsky und M.A. Wesley. (Modification and Implementation of the Algorithm "Fleshing Out Wire Frames" by G. Markowsky and M.A. Wesley.)

2.4 Ph.D. Theses

- Dubuis, Eric: Acceleration Techniques for the Radiosity Method.

- Metz, Igor: Bintree Lab: Ein Framework von Datastrukturen und Algorithmen für Bintrees. (Bintree Lab: A Framework of Data Structures and Algorithms for Bintrees.)

2.5 Further Activities

- Visiting professor at the Institute of Pure and Applied Mathematics (IMPA), Rio de Janeiro, Brazil, November 1994 - March 1995 (H. Bieri).

  Course "Spatial Data Structures".

- Program Committees:
  - Dagstuhl-Seminar 9622 on Geometric Modelling, 1996.
  - CSG '96: Set-theoretic Solid Modelling, Winchester, UK.

2.6 Publications

- Bieri H.: Nef Polyhedra - A Brief Introduction. In Hagen, H., Farin, G., Noltemeier, H. (Eds.): Geometric Modelling - Dagstuhl 1993, 43-60. Computing Supplement 10, Springer 1995.

- Bieri, H.: Two Basic Operations for Nef Polyhedra. To appear 1996.

- Bühlmann, H.: Die wichtigsten Begriffe in der objektorientierten Softwareentwicklung, nicht nur für Manager. To appear 1996.

- Dubuis, E., Bieri, H.: Dynamic Subdivision in Radiosity. WSCG 95. The Third International Conference in Central Europe on Computer Graphics and Visualization 95, 79-86, Plzen 1995.

- Nef, W.: Euler Characteristic and Euler's Theorem for Polyhedra: A Comparison of Two Approaches. Submitted.

3 Research Group on Computer Vision and Artificial Intelligence

3.1 Personnel

Head:	Prof. Dr. H. Bunke	Tel:	+41 31 631 44 51
		e-mail:	bunke@iam.unibe.ch
Secretary:	S. Thüler	Tel.:	+41 31 631 86 81
		e-mail:	thueler@iam.unibe.ch
Scientific staff:	B. Achermann	Tel:	+41 31 631 86 99
		e-mail:	ackerman@iam.unibe.ch
	Dr. T. Minh Ha *	Tel:	+41 31 631 86 99
		e-mail:	haminh@iam.unibe.ch
	Dr. X.-Y. Jiang	Tel:	+41 31 631 86 99
		e-mail:	jiang@iam.unibe.ch
	G. Kaufmann *	Tel:	+41 31 631 49 02
		e-mail:	kaufmann@iam.unibe.ch
	B. Messmer *	Tel:	+41 31 631 49 87
		e-mail:	messmer@iam.unibe.ch
	D. Möri *	until September 1995	
	K. Yu *	Tel:	+41 31 631 33 23
		e-mail:	yu@iam.unibe.ch

* with financial support from a third party

3.2 Research Projects

Range Image Analysis

The research in range image analysis is continued by the development of methodologies for experimentally evaluating both edge- and region-based range image segmentation techniques. Novel features of this project include the use of large real range image sets acquired by scanners of different types and a set of objective performance metrics. This research is done in cooperation with Univ. of South Florida, Tampa, Washington State University, Pullman, and University of Edinburgh.

Research staff: X.-Y. Jiang

Image Analysis of Printed Documents

A variety of problems occurring in the context of image analysis of printed documents are being investigated. These include recognition and understanding of GIRO check forms, recognition and execution of manual correction instructions on printed

documents, recognition of handwriting (isolated characters and cursive script), and contextual postprocessing.

Research staff: T. M. Ha, G. Kaufmann, D. Möri

Efficient Graph Matching Algorithms

In this project, we continue our effort in developing new and efficient algorithms for exact and error-tolerant attributed relational graph matching that can be applied in various domains. The basic idea in improving the efficiency of graph matching algorithms lies in suitable preprocessing procedures for prototype, or model, graphs. By means of these preprocessing procedures, the complexity of the actual matching step can be reduced. Applications of the new algorithms in the area of document image analysis are studied.

Research staff: B. Messmer

Analysis of Human Face Images

The first efforts in the area of analysis of human faces date back to the sixties. But face analysis is still one of the most challenging problems in computer vision and far from being solved. We are investigating new techniques and approaches in this area based on range images, full face images and profile images of human faces. Additionally, the integration and fusion of information from multiple sensing modalities is studied.

Research staff: B. Achermann, X.-Y. Jiang, K. Yu

Structural and Syntactic Pattern Recognition

The key idea in structural and syntactic pattern recognition is the representation of patterns by means of symbolic data structures such as strings, trees, and graphs. In order to recognize an unknown pattern, its symbolic representation is compared with a number of stored prototypes. In this project, we aim at developing new symbolic matching and parsing algorithms for a variety of applications.

Research staff: H. Bunke

3.3 Masters' Theses

- Nyffenegger, Ch.: Gesichtserkennung mit Hidden-Markov-Modellen (Face recognition using hidden Markov models)

- Zumbühl, M.: Lernen von 2D-Objekten anhand von Beispielszenen (Learning of 2-D objects from example scenes)

- Steiner, P.: Zwei ausgewählte Probleme zur Offline-Erkennung von Handschrift (Two selected problems in off-line handwriting recognition)

3.4 PhD Theses

- Möri, D.: Automatische Erkennung und Ausführung von Korrekturanweisungen in Textdokumenten (Automatic recognition and execution of correction instructions on text documents)

- Messmer, B.: Efficient Graph Matching Algorithmus for Preprocessed Model Graphs

3.5 Further Activities

Awards

- D. Niggeler received the first prize in the 1995 AT&T Foundation contest for his Master Thesis "A recognition system for handwritten numerals". This thesis was completed 1994.

- D. Möri received the *Preis der Fächergruppe Mathematik* 1995 for his PhD thesis.

Visits

- H. Bunke was special invited professor at Kagawa University, Takamatsu, Japan from July 15 to October 14.

Editorial Boards and Technical Committees

- editor-in-charge of the International Journal of Pattern Recognition and Artificial Intelligence by World Scientific Publ., Singapore (H. Bunke)

- member of the editorial board of Acta Cybernetica (H. Bunke)

- editor-in-chief of the book series Machine Perception and Artificial Intelligence by World Scientific Publ., Singapore (H. Bunke)

- member of the Technical Committee on Structural and Syntactic Pattern Recognition of the International Association for Pattern Recognition (IAPR) (H. Bunke)

Program Committees

- 3rd Int. Conference on Document Analysis and Recognition, Montreal, August 14–16, 1995

- IEEE Int. Symposium on Computer Vision, Coral Gables, FL, November 20–22, 1995

- 17. DAGM-Symposium Mustererkennung, Bielefeld, September 13–15, 1995 (H. Bunke)

3.6 Publications

Books and Special Issues of Journals

- Bunke, H., Kanade, T., Noltemeier, H. (eds.): Modelling and Planning for Sensor Based Intelligent Robot Systems, World Scientific Publ. Co., Singapore, 1995

- Boyer, K., Stark, L., Bunke, H. (eds.): Applications of AI, Machine Vision and Robotics, World Scientific Publ. Co., Singapore, 1995 (also available as special issue of Int. Journal of Pattern Recognition and Artificial Intelligence, Vol 8, No 6)

- Csirik, J., Bunke, H. (eds.): Formal Methods in 2-D Shape Analysis, Special Issue of Annals of Mathematics and Artificial Intelligence, Vol 13, No 3 & 4, 1995

Journal Papers

- Bunke, H., Csirik, J.: Parametric string distance and its application to pattern recognition, IEEE Trans. Systems, Man, and Cybernetics, Vol 26, No 1, 1995, 202 - 206

- Tu, H.-S., Matheny, A., Goldgof, D., Bunke, H.: Left ventricular boundary detection from spatio-temporal volumetric computed tomography images, Computerized Medical Imaging and Graphics, Vol 19, No 1, 1995, 27 - 46

- Jiang, X.-Y., Bunke, H.: Line segment based axial motion stereo, Pattern Recognition, Vol 28, No 4, 1995, 553 - 562

- Bunke, H., Csirik, J.: An improved algorithm for computing the edit distance of run-length coded strings, Inf. Proc. Letters 54, 1995, 93 - 96

10

- Jiang, X.-Y., Bunke, H.: Optimal implementation of morphological operations on neighborhood-connected parallel computers, Annals of Mathematics and Art. Intell. 13, 1995, 301 - 315

- Bunke, H.: Fast approximate matching of words against a dictionary, Computing, Vol 55, No 1, 1995, 75 - 89

- Ha, T. M., Niggeler, D., Bunke, H., Clarinval, J.: Giro form reading machine, Optical Engineering, Vol 34, No 8, 1995, 2277 - 2288

- Bunke, H., Roth, M., Schukat-Talamazzini, E.G.: Off-line handwriting recognition using hidden Markov models, Pattern Recognition, Vol 28, No 9, 1399 - 1413

- Dvorak, J., Bunke, H.: Concept and realization of a hybrid AI tool applied to computer vision, Int. Journal of Artificial Intelligence Tools, Vol 3, No 4, 451 - 466, 1995

Refereed Papers in Conference Proceedings and Edited Books

- Robmann, R., Bunke, H.: An edge labeling scheme for polyhedra in incomplete range images, Proc. 9th Scandinavian Conference on Image Analysis, Uppsala, Sweden, 1995, 723 - 730

- Yu, K., Jiang, X.-Y., Bunke, H.: Face recognition by profile analysis, Proc. Int. Workshop on Face, - and Gesture-Recognition, Zurich 1995, 208 - 213

- Ueltschi, A., Bunke, H.: Model-based recognition of three-dimensional objects from incomplete range data, in F. A. Sadjadi (ed.): Automatic Object Recognition V, SPIE Proceedings, Vol. 2485, 1995, 74 - 84

- Robmann, R., Bunke, H.: Towards robust edge extraction - A fusion based approach using greylevel and range images, in F. A. Sadjadi (ed.): Automatic Object Recognition V, SPIE Proceedings, Vol. 2485, 1995, 249 - 259

- Messmer, B.T., Bunke, H.: Automatic learning and recognition of graphical symbols in engineering drawings, Proc. Int. Workshop on Graphics Recognition, University Park, PA, 1995, 33 - 43

- Bunke, H., Liviero, R.: Classification and postprocessing of documents using an error-correcting parser, Proc. 3rd Int. Conference on Document Analysis and Recognition, Montreal, 1995, 222 - 226

- Ha, T. M., Niggeler, D., Bunke, H.: A system for segmenting and recognising totally unconstrained handwritten numeral strings, Proc. 3rd Int. Conference on Document Analysis and Recognition, Montreal, 1995, 1003 - 1009

- Bunke, H., Messmer, B. T.: Efficient attributed graph matching and its application to image analysis, in Braccini, C., DeFloriani, L., Vernazza, G. (eds.): Image Analysis and Processing, Springer Verlag, Lecture Notes in Computer Science 974, 1995, 45 - 55

- Yu, K., Achermann, B., Nyffenegger, C., Jiang, X.-Y., Bunke, H., Schukat-Talamazzini, E.G.: Kombination von Frontal- und Profilanalyse menschlicher Gesichter, in Sagerer, G., Posch, S., Kummert, F. (Hrsg.): Mustererkennung 1995, Informatik aktuell, Springer Verlag, 1995, 327 - 334

- Moeri, D., Bunke, H.: Off-line interpretation and execution of corrections on text documents, in Spitz, A. L., Dengel, A. (eds.): Document Analysis Systems, World Scientific Publ. Co., 1995, 397 - 412

- Jiang, X.Y., Bunke, H.: A framework for symmetry exploration in 3D object recognition, in Dori, D., Bruckstein, A. (eds.): Shape, Structure and Pattern Recognition, World Scientific Publ. Co., 1995, 138 - 147

- Ueltschi, A., Bunke, H.: 3D object recognition from range data using a relational matching technique with a hierarchy of constraints, in Dori, D., Bruckstein, A. (eds.): Shape, Structure and Pattern Recognition, World Scientific Publ. Co., 1995, 148 - 157

- Messmer, B. T., Bunke, H.: Efficient error-tolerant subgraph isomorphism detection, in Dori, D., Bruckstein, A. (eds.): Shape, Structure and Pattern Recognition, World Scientific Publ. Co., 1995, 231 - 240

- Kanai, J., Latifi, S., Rajarathinam, G., Nagy, G., Bunke, H.: Operations on compressed image data, Proc. Data Compression Conference, Snowbird, Utah, 1995, 432 (abstract)

- X.-Y. Jiang, Bunke, H.: Exploration of object symmetries in computer vision and robotics, in H. Bunke, T. Kanade, H. Noltemeier (eds.): Modelling and Planning for Sensor Based Intelligent Robot Systems, World Scientific Publ. Co., 1995, 257 - 272

- Bunke, H., Jiang, X.-Y., Ueltschi, A., Meier, U., Robmann, R.: Model-based multisensory robot vision, in H. Bunke, T. Kanade, H. Noltemeier (eds.): Modelling and Planning for Sensor based Intelligent Robot Systems, World Scientific Publ. Co., 1995, 289 - 308

- Hoover, A., Jean-Baptiste, G., Jiang, X.-Y., Flynn, P., Bunke, H., Goldgof, D., Bowyer, K.: Range image segmentation: The user's dilema, Proc. IEEE Int. Symposium on Computer Vision, Coral Gables, FL, 1995, 323-328

- Messmer, B., Bunke, H.: Subgraph isomorphism detection in quadratic time on preprocessed model graphs, Proc. 2nd Asian Conference on Computer Vision, Singapore, 1995, Vol II, 151-155

- Jiang, X.-Y., Hoover, A., Jean-Baptiste, G., Goldgof, D., Bowyer, K., Bunke, H.: A methodology for evaluating edge detection techniques for range images, Proc. 2nd Asian Conference on Computer Vision, Singapore, 1995, Vol II, 415-419

Technical Reports

- Hoover, A., Jean-Baptiste, G., Jiang, X.-Y., Flynn, P., Bunke, H., Goldgof, D., Bowyer, K.: A comparison of range image segmentation algorithms, Technical Report, Dept. of Comp. Sci. and Eng., University of South Florida, 1995

- Messmer, B., Bunke, H.: Subgraph isomorphism in polynomial time, Technical Report IAM-95-003, University of Bern, 1995

- Ha, T. M.: An optimum decision rule for pattern recognition, Technical Report IAM-95-009, University of Bern, 1995

4 Research Group of Computer Networks and Distributed Systems

4.1 Personnel

Head:	Prof. Dr. D. Hogrefe	Tel:	+41 31 631 49 94 / 89 57
		Fax:	+41 31 631 33 55
		e-mail:	hogrefe@iam.unibe.ch
Secretary:	S. Schaad	Tel:	+41 31 631 89 57
		e-mail:	schaad@iam.unibe.ch
Scientific staff:	Dr. J. Grabowski *	until September 1995	
	Dr. A. Greulich *	until July 1995	
	M. Günter *	Tel:	+41 31 631 33 37
		email:	guenter@iam.unibe.ch
	Dr. S. Leue *	until March 1995	
	M. Menna *	Tel:	+41 31 631 35 47
		email:	menna@iam.unibe.ch
	T. Richner *	Tel:	+41 31 631 33 15
		email:	richner@iam.unibe.ch
	R. Scheurer *	Tel:	+41 31 631 35 68
		email:	scheurer@iam.unibe.ch
	Dr. D. Toggweiler *	Tel:	+41 31 631 39 70
		email:	toggweil@iam.unibe.ch

* financial support from a third party.

4.2 Research Projects

4.2.1 Formal Description Techniques

The research on the topic of Formal Description Techniques (FDTs) focuses on specification, implementation and testing of distributed systems.
In particular, the goal of the development of a method with the following characteristics is aimed at:

- efficient and user friendly specification of function and performance, implementation-dependent as well as -independent

- implementation can be verified with respect to the specification

- different abstraction levels with smooth transitions between them

- automatic code generation

The central aspect is conformance testing. The evaluation of a product with respect to its specification is an important issue in systems engineering, in particular if parts of the specification are defined by standards (ISO, CCITT, ...).
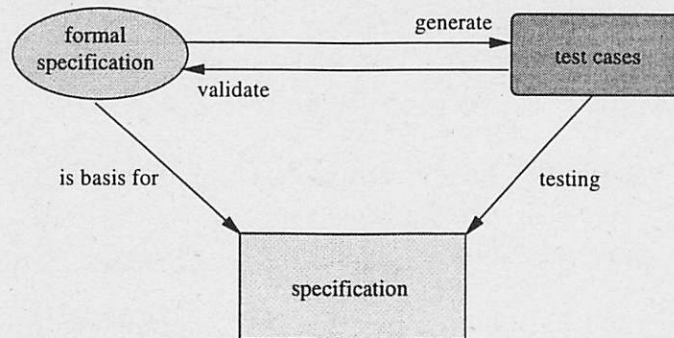

Figure 1: Specification, Implementation and Testing

Given a formal specification, how can one find out whether an implementation conforms to this specification? This is a general problem from software engineering and not specific to the application in the communication protocol area.

However, the communication protocol area has obviously a very urgent need to solve this problem. In this field specifications are produced, e.g. international standards, which serve as a basis for many different implementations at different places by different manufacturers. These implementations have to be able to cooperate with each other according to the specification they are based on.

In other areas of software engineering, e.g. production of text processing systems, things are different. Here a software manufacturer produces a specification more or less for his own use only. The manufacturer can decide later what it means that the final product conforms to his own specification on a pragmatic basis, just as it is opportune. This remark should not discredit manufacturers of text processing software, it should just indicate the difference in the importance of the conformance notion between protocol specifications and other types of specifications.

The motivation of this activity is the existence of formally described standards and therefore the need to define the meaning of conformance with respect to formal specifications.

Work that is performed under this subject:

- use of message sequence charts for specification and test case selection

- development of formal semantics for asynchronously communicating processes

- specification techniques and architecture for high speed networking

- conformance testing of real products

- participation in international research projects

15

- participation in standardization projects

- formal definition of the notion of conformance

- investigation of the role of time in specification and its influence on the concept of conformance

- development of algorithms, especially for test case selection

The following sections present the current research projects in this area.

PROJECT: Integration of Data Aspects into Message Sequence Charts

Research staff: Dr. Jens Grabowski, Dr. Daniel Toggweiler (until 31.12.95), Matthias Zimmermann, Prof. Dr. D. Hogrefe

Duration: 1.10.91 - 30.12.95

Financial support: Siemens-Albis

Within the Siemens-Albis AG the message flows of test cases for ISDN components are specified by MSCs. To describe complete test cases MSCs are currently not sufficient. Therefore the goal of this project is the enrichment of MSCs with additional information which is necessary in order to define complete test cases. The additional information concerns values of transported data, test verdict assignment and the expression of special behavior like default and optional behavior. It is intended to translate MSC test cases in TTCN and SDL descriptions. The scope of the project includes investigations on the relations between MSCs, TTCN and SDL.

PROJECT: Conformance Testing - A Tool for the Generation of Test Cases

Research staff: Dr. Jens Grabowski, Rudolf Scheurer, Dr. Daniel Toggweiler (until 31.12.95), Prof. Dr. D. Hogrefe

Duration: 1.10.91 - 31.12.97

Financial support: Swiss PTT

In the proceeding projects the SAMSTAG method and the SAMSTAG tool have been developed. They provide algorithms and tool support for the automatic generation of TTCN test cases based on an SDL specification and test purposes in form of MSCs.
The SAMSTAG tool is a prototype with several restrictions and limitations. A case study and various discussions have shown that especially an adequate treatment of data and timer is missing. Therefore the goal of the project *ended in June '95* was to adapt SAMSTAG to practical needs. The scope of the project included

16

investigations in partial order simulation methods for SDL specifications. Such methods may allow a more efficient generation of test cases.

In the *actual follow-up project* the SAMSTAG tool is used in another case study to show the possibilities and limitations of the SAMSTAG method in practice. The scope of this project is to generate test cases for the ITU-T recommendations *Q.2110 (SSCOP)* and *Q.2130 (SSCF at UNI)* from the Signalling AAL of B-ISDN.

PROJECT: Automatic Generation of Test Purposes

Research staff: Dr. Jens Grabowski, Dr. Daniel Toggweiler (until 31.12.95),
      Prof. Dr. D. Hogrefe, Rudolf Scheurer (from 1.1.96)

Duration: 1.10.94 - 31.12.96

Financial support: Siemens-Albis

The project *The Automatic Generation of Test Purposes* is part of the second series of the *Priority Programme Informatics* (SPP IF), Module 1: *Safe Distributed Systems*. It intends to improve the testing process of communication systems. The international standard ISOIIEC IS 9646 proposes the process of test suite generation to be divided into two steps: Development of test purposes, which select the important behavior of the specification, and Development of the test suite. The second step is treated within the SAMSTAG project. The SPP IF project automizes the first step of the OSI-Conformance Testing Methodology.

PROJECT: Δ^2: Formal Description Techniques, Architecture and Performance Evaluation for High Speed Protocols

Research staff: Stefan Leue (until 31.3.95), Marco Menna, Prof. Dr. D. Hogrefe,
      in cooperation with EPF Lausanne

Duration: 1.4.92 - 31.3.97

Financial support: Swiss National Science Foundation (joint project with EPF Lausanne)

In the course of this project different aspects of the protocol engineering process for High Speed Protocols are investigated. These distinguish themselves from conventional communication protocols in that they have to meet particular performance requirements as for example throughput, delay or reliability guarantees. These guarantees may be either deterministic or stochastic, and the respective requirements are sometimes referred to as Quality of Service (QoS) requirements. Starting point is the consideration of formal descriptions of these protocols, based on the CCITT specification language SDL. Firstly, the expressiveness of SDL is augmented by complementary specifications using probabilistic real-time temporal logics and equivalent automata models, which allows for a later verification and testing of the

QoS requirements. Secondly, the SDL description is used to derive a queuing network model in order to perform complementary performance evaluations. Thirdly, the formal description is the starting point for the derivation of efficient parallel implementations, in particular by exploiting inherent parallelism. These steps are currently investigated, future work in the project will address the implementation of these steps as an integrated toolset and its application to study cases.

PROJECT: MUTEST

Research staff: Prof. Dr. Dieter Hogrefe, in cooperation with other internationally distributed institutions, e.g. GMD Darmstadt and University of Montreal.

Duration: not fixed

Financial support: no funding

The central idea of MUTEST is to compare different FDs of a protocol by letting them generate a test suite each and running them against the test suites generated by the other FDs, as well as against standardized and other test suites.
Other approaches of validation FDs against other FDs and against test suites may be considered as well.

PROJECT: Graphical Methods in Testing Process

Research staff: Dr. Jens Grabowski, Robert Hegi, Prof. Dr. D. Hogrefe

Duration: 1.7.93 - 30.6.95

Financial support: KWF (Commission for the promotion of scientific research), Siemens-Albis, Alcatel STR

This project deals with the representation and interpretation of test results. A problem in practical testing is that there exist no standardized notation for test results. All the different manufactures of test equipment use their own notation. This has consequences for customers and test laboratories. E.g. the employees of the test laboratories have to learn a lot of different notations, for customers, it is difficult to make critical test reviews and to compare test results which are gained with different test equipment. One main goal of this project is to develop a standardized notation for test results and to contribute it to international standardization bodies. Furthermore, it is intended to visualize test results by means of Message Sequence Charts. The scope of the project includes investigations on the relations between MSC and the test case description language TTCN.

4.2.2 Network Design

Figure 2 shows a network of a hypothetical customer of a public service provider. The customer uses leased lines and packet switching in order to connect his various geographically distributed sites. The public service provider should be able to offer an optimal combination of services for such a customer. Beyond that, he must be able to change his service offers, e.g. tarifs, new services. He should also be able to optimize his capacity planning based on the requirements of the customers.

Leased Lines

Packet

LAN

■ Customer's System

□ System of Customer's Partner

— Permanent Connection
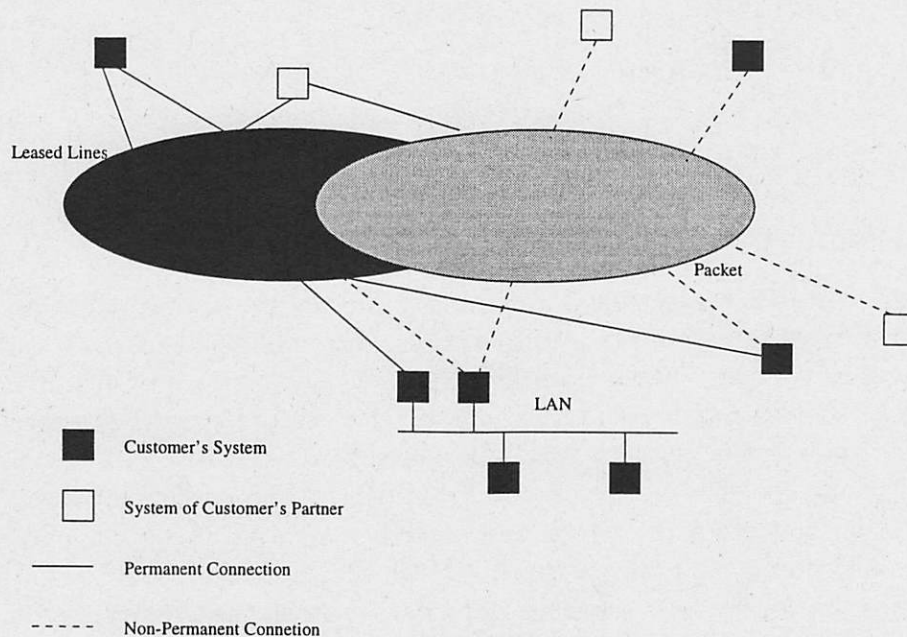
----- Non-Permanent Connetion

Figure 2: A private network

The customer has different applications which define requirements for the Networks which provide the communication between applications within and outside the enterprise. For example, there are the following application:

- interactive sessions at terminals (ASCII, X-Windows)

- speech and image transmission (telephone, telefax)

- CAD, ...

- transaction processing

- database queries

- file transfer

- monitoring and controlling

19

The applications define different requirements for a network with respect to transmission rate, quality, security and reliability.

The services like leased line, packet switching, ISDN, MAN, X.400, have different characteristics with respect to the above mentioned requirements and tarifs.

The non-trivial problem of the optimal choice to the services comes up. Beyond that, the customer requirements and the existing services give rise to new aspects on service offers, tarifs and capacity planning.

PROJECT: OPTINET

Research staff: Lorenz Brügger (until 1.7.95), Matthias Günter, Daniel Hanhart (until 1.8.95), Prof. Dr. D. Hogrefe, Lukas Spiess (until 1.12.95)

Duration: 1.1.91 - 31.12.96

Financial support: Swiss PTT

OptiNet is a research project on design tools for Corporate Networks (CN). A CN is an integration of privately run local networks over public networks. A hybrid CN bases on several services (leased-lines, ISDN, ATM). The work on OptiNet includes definitions, prototypes and case studies. OptiNet works on several abstraction layers. In the upper layers relevant traffic parameters are derived from organization- and application- specific key items and collected on the connection layer into a communication matrix. A prototype tool named COMMAT was built for this task. The communication matrix plays a central role in the developed model. The network design itself is performed in a separate step. For this task the prototypes OPTOLL, for pure leased-line networks, and NEDEMUS, for hybrid CNs, were constructed. The methods used in the project so far range from Operation Research, over expert system to genetic algorithms.

Also reliability factors and stop rules were studied. Software design aspects for easy maintenance and possible extension were taken into account.

Current research extends and refines the capabilities of the prototypes and includes:

- Boundaries on the optimization process (Meta-Optimization),

- Integration of ATM services (SwissWAN) into OptiNet.

OptiNet is a cooperation between the University of Bern and the R&D direction of the Swiss Telecom PTT.

4.2.3 Network Security

BFI and KOMBV

The project Network Security is a collaboration between the University of Berne and the BFI (Bundesamt für Informatik, Federal Bureau of Computer Science). In 1989, when the hackerintrusion into the BAG (Bundesamt für Gesundheit, Federal

Bureau of Health) happened, the section SI (Sicherheit, Security) of the BFI was founded on demand of the Federal Council.

In 1992, it was decided that the networks and information systems of the federal administration shall be embedded in a unique network coordinated by the BFI. This network, called KOMBV (Kommunikation in der Bundesverwaltung, Communication of the Federal Administration), is based on TCP /IP and will be realized in three steps, called KOMBV1, KOMBV2, and KOMBV3 (using ATM) until 1997. For using E-Mail, X.400 and X.500 using TCP /IP as transport layer (RFC 1006) was chosen.

PROJECT: NESI

Research staff: Dr. Andreas Greulich, Prof. Dr. Hogrefe

Duration: 1.1.94 - 30.6.95

Financial support: BFI

The BFI /SI is responsible to develop and evaluate security concepts for KOMBV. As the topology will be quite extended and include many heterogeneous systems, there are special security conditions. Additionally, it is planned to connect the KOMBV with external networks like cantonal (state) network, telecom networks, and mainly the internet. In order to develop security concepts, the project NESI (Netz-Sicherheit, network security) was founded. The University of Berne and the BFI /SI agreed to work together at this project in 1993. The contract was continued in 1994.

At the heart of NESI is an authentication service. Cryptographic algorithms are needed in order to allow strong authentication (equivalent to ITU-T X.509). Hybrid approaches are preferred to symmetric or asymmetric approaches. Those approaches require assigning and distributing certificates.

4.3 Master's Theses

- L. Brügger: Comparison of Heuristics Based on the Example of the Optimized Leased Line.

- A. Grossmann: Analysis of the OSF DCE security system.

- D. Hanhart: Reliability of the Optimized Leased Line.

- D. Keller: Security in Databases.

- L. Spiess: Use of ISDN as Backup for Private Lines.

- Ch. Zahler: Smartcard for Telecom Applications.

- P. Zumbrunn: Firewalls within the framework of an integral security policy.

4.4 Ph.D. Theses

- A. Greulich: Network Optimization Algorithms.

- J. Kroon: Specification and Testability of Telecommunication Systems.

- D. Toggweiler: Efficient Test Case Generation for Distributed Systems Specified by Automata.

4.5 Further Activities

Program Committees

- 15th IFIP conference on Protocol Specification, Testing and Verification, Warsaw, Poland, June 1995.

- 7th SDL Forum, Oslo, 25.-29. Sept., 1995.

- Third international Workshop on Feature Interactions in Telecommunications Software Systems, Kyoto, Japan, October 1995.

- IFIP workshop on Protocol Test Systems IWPTS 95, Evry, France, Nov. 1995.

- IFIP conference on Formal Description Techniques FORTE 95, Montreal, 17.-20. Oct.1995.

- Jahrestagung der GI und SI 1995, Zukünftige Kommunikationsarchitekturen, Zürich, September 1995.

- Founding member of the SDL Forum Society.

Reviewing activities

- Reviewer for Eurescom projects

- Reviewer for NSERC projects (Natural Sciences and Engineering Research Council of Canada)

- Reviewer for full professor positions in Europe, North-America and Asia

- Reviewer for all conferences being member of program committee

- Reviewer for Real Time Systems Journal

- Reviewer for IEEE Transactions on Software Engineering

- Reviewer for ACM Computing Reviews

- Reviewer for IBM Systems Journal

- Reviewer for INFORMATIK SPEKTRUM, Springer Verlag

- Reviewer for COMPUTER NETWORKS AND ISDN, North-Holland

- Reviewer for IEE Computers and Digital Techniques, IEE

4.5.1 Other

- Chair of the ITU/ISO project "Formal methods in conformance testing"

- Chair of the GI working group on "Formal description techniques" (FG 3.3.1)

- Member of the "Stiftungsrat SWITCH".

4.6 Publications

Papers and Books

- J. Grabowski, D. Hogrefe, I. Nussbaumer, A. Spichiger: Combining MSCs and Data Descriptions in order to Generate Executable Test Cases for ISDN Systems. In: Proceedings of the 'XV International Switching Symposium (ISS'95) - World Telecommunications Congress' Berlin, 1995.

- T. Walter, J. Grabowski: Towards the new Test Specification and Implementation Language 'TelCom TSL'. In: R. Gotzhein, J. Bredereke (editors): Proceedings of the 5th GI/ITG technical meeting on 'Formal Description Techniques for Distributed Systems', University of Kaiserslautern, Germany, June 22 - 23, 1995.

- J. Grabowski, D. Hogrefe, I. Nussbaumer, A. Spichiger: Test Case Specification Based on MSCs and ASN.1 . In: R. Braek, A. Sarma (eds.): SDL'95 with MSC in CASE, Proceedings of the 7th SDL Forum, Oslo 1995. Elsevier, Amsterdam 1995.

- E. Rudolph, P. Graubmann, J. Grabowski: Message Sequence Chart: Composition Techniques versus OO-Techniques - "Tema con Variazioni". In: R. Braek, A. Sarma (eds.): SDL'95 with MSC in CASE, Proceedings of the 7th SDL Forum, Oslo 1995. Elservier, Amsterdam 1995.

- E. Rudolph, P. Graubmann, J. Grabowski: Tutorial on Message Sequence Charts. In: Tutorials of the 7th SDL Forum,Sept. 25 - 29, 1995, Oslo, Norway. North-Holland, September 1995.

- J. Grabowski, T. Walter: Testing QoS Aspects in Multimedia Applications. In: "Mozart on Multimedia Highways" - Proceedings of the Second Workshop on Protocols for Multimedia Systems (PROMS), Salzburg, Austria, October 9 - 12, 1995.

- D. Hogrefe, S. Leue: Formal Description Techniques, VII. In: Proceedings of the 7th IFIP International Conference on Formal Description Techniques FORTE'94. Chapman & Hall, 1995.

- P. B. Ladkin, S. Leue: Comments on a Proposed Semantics for Basic Message Sequence Charts. In: The Computer Journal, 37(9), January 1995.

- P. B. Ladkin, S. Leue: Interpreting Message Flow Graphs. In: Formal Aspects of Computing, 7(5). To appear 1995.

- D. Toggweiler, J. Grabowski, D. Hogrefe: Partial order simulation of SDL specifications. In: R. Braek, A. Sarma (eds.): SDL'95 with MSC in CASE, Proceedings of the 7th SDL Forum, Oslo 1995. Elservier, Amsterdam 1995.

Technical Reports

- D. Hogrefe: Report on the Validation of the Inres System. Techical Report IAM-95-007, November 1995.

- M. Menna: A High Level SDL Representation of JVTOS (Joint Viewing and Tele-Operation System). Technical Report IAM-95-008, December 1995.

- J. Grabowski, R. Scheurer, D. Toggweiler, D. Hogrefe: Dealing with the Complexitiy of State Space Exploration Algorithms for SDL Systems. Technical Report IAM-95-010, December 1995.

5 Research Group on Theoretical Computer Science and Logic

5.1 Personnel

Head:	Prof. Dr. G. Jäger	Tel:	+41 31 631 8560
		email:	jaeger@iam.unibe.ch
Secretary:	U. Hadorn	Tel.:	+41 31 631 8426
		email:	hadorn@iam.unibe.ch
Scientific staff:	Dr. W. Heinle*	Tel.:	+41 31 631 3984
		email:	heinle@iam.unibe.ch
	A. Heuerding*	Tel.:	+41 31 631 8558
		email:	heuerd@iam.unibe.ch
	Dr. C. M. Jonker	until September	
	R. Kahle*	Tel.:	+41 31 631 4976
		email:	kahle@iam.unibe.ch
	Dr. U. M. Künzi*	Tel.:	+41 31 631 3984
		email:	kuenzi@iam.unibe.ch
	Dr. M. Marzetta	Tel.:	+41 31 631 8560
		email:	marzetta@iam.unibe.ch
	S. Schwendimann*	Tel.:	+41 31 631 4976
		email:	schwendi@iam.unibe.ch
	M. Seyfried	Tel.:	+41 31 631 3545
		email:	seyfried@iam.unibe.ch
	Th. Strahm*	Tel.:	+41 31 631 4998
		email:	strahm@iam.unibe.ch
	W. Th. Wolff*	Tel.:	+41 31 631 4989
		email:	wolff@iam.unibe.ch
	H. Zimmermann	Tel.:	+41 31 631 3316
		email:	hzimmer@iam.unibe.ch

* with financial support from a third party

Guests:	Prof. Dr. S. Artemov	(January to February)
	Prof. Dr. A. Cantini	(June)
	Dr. R. Goré	(May to June)
	Dr. W. Heinle	(May to June)
	Dr. S. Merz	(December)
	Dr. K.-H. Niggl	(February to April)
	Prof. Dr. J. Troer	(May)

5.2 Research Projects

Logic and computation

This very general project deals with the close connections between mathematical logic and certain parts of computer science, and emphasis is put on a proof-theoretic approach to some of the central questions in this area of research. These include the development of perspicuous and feasible logical frameworks for studying typical questions in computer science like termination and correctness of functional programs. We study applicative theories as well as strongly typed formalisms and are interested in the connections to constructive and explicit mathematics. Some of the relevant key-words are: Proofs as computations, formulas as types, polymorphism, flexible typing, explicit and constructive mathematics, universes of types, theories of types and names, functional programming.

Research staff: S. Artemov, G. Jäger, R. Kahle, M. Marzetta, K.-H. Niggl, Th. Strahm

Logic programming and deductive systems

Logic programming is understood in our research group in a very broad sense. We are interested in its mathematical and logical foundations, and proof-theoretic concepts and methods are more important to us than model-theoretic approaches. We consider extensions of logic programming and modern deductive systems in computer science, always emphasizing operational and procedural aspects.

Research staff: G. Jäger, C. M. Jonker

Algebraic and logical aspects of knowledge processing

In collaboration with Prof. Dr. E. Engeler, ETH Zürich.

Several research problems from the general area of knowledge representation are being investigated. They are directed toward the mathematical foundation of this area, and refer to algebraic and logical questions. The work of the group in Berne emphasizes the logical basis of knowledge representation. One of the first and most important steps in a logical approach to knowledge representation is the development and analysis of adequate formal frameworks, both from a declarative and procedural point of view. Depending on the context, various logical formalisms (e.g. Horn logic, modal logics, type theories, etc.) have turned out to be extremely useful. We focus on questions involving structural properties of suitable logical formalisms, and the interplay between logic and computation.

Research staff: S. Artemov, W. Heinle, G. Jäger, C. M. Jonker, R. Kahle, Th. Strahm

Executable models for analysis and implementation of complex systems

In collaboration with Dr. H. Lienhard, IvyTeam, Zug.

The goal of this project is to develop a tool for the modeling, simulation and verification of complex distributed systems. Our approach is based on a system of higher order Petri nets. This system should be improved in the following directions:

1. Inclusion of time in the model.

2. Extension of the analysis tools.

3. New concept that support efficient modeling of complex systems.

During 1995 we have developed in cooperation with Moscow State University a powerful *component concept* which will make modeling with Specs Petri nets much easier and quicker. Components are essentially subnets with two additional features, which give them a great flexibility and stimulate re-use:

1. they are organized in classes which inherit the properties and the updates from their superclasses, in the way which is familiar from object-oriented programming languages;

2. the procedural part of the net (the inscriptions) can be parametrised in a uniform way.

The complexity of our *deadlock detection* algorithms, which take into account also the inscriptions of the nets, has been further cut down. The definition of a logical query language for net properties with feasible decision algorithms is also an important aim of our research. The development of *analysis tools* has focussed on the newer application domains of Specs Petri nets i.e. the modeling of business processes, where questions of time and costs play an important rôle.

Research staff: G. Jäger, U.-M. Künzi, M. Marzetta

Financial Support: Swiss National Science Foundation (Schwerpunktprogramm Informatik)

Representation and automatic evaluation of empirical especially quantitative knowledge

In collaboration with Prof. Dr. B. Schmid, Universität St. Gallen (HSG).

This project is directed toward the investigation of methods for the representation, organization, and evaluation of quantitative information (such as deductive databases), and utilizes a practical application orientation as well as a theoretical perspective. This undertaking is of considerable economic and scientific relevance with respect to the automatic acquisition and evaluation of quantitative information

from heterogenous databases. The relevant theoretical problems shall be investigated in our group at the University of Berne, the application oriented problems by Professor Schmid and his group at the Hochschule St. Gallen.

Research staff: G. Jäger, W. Th. Wolff

A logics workbench

In collaboration with Prof. Dr. P. Läuchli, ETH Zürich.

The goal of this project is to provide an interactive system, covering a great variety of propositional logics, including classical, intuitionistic, modal and temporal logics, a well as non-monotonic formalisms and a module concerning the formulas-as-types interpretation.

Besides efficient implementations of decision procedures for the logics mentioned above, additional functions such as computation of normal forms, simplification of formulas and some standard operations are offered by the Logics Workbench (LWB). A programming language allows the user to extend and adapt the LWB according to his needs and preferences.

In order to make the Logics Workbench accessible to non-experts as well as a valuable tool for educational purposes, special emphasis has been put on a user-friendly graphical interface and the design of an online information system, which goes - both in depth and spectrum of the material presented - far beyond traditional help systems. Also the underlying theory is available via WWW, as well as tutorials for some logics.

Research staff: R. Goré, W. Heinle, A. Heuerding, G. Jäger, S. Schwendimann, M. Seyfried

5.3 Master's Theses

- F. Achermann: The LWB Programming Language.

- P. Balsiger: Simplification of Formulas in Classical Propositional Logic.

- H. Zimmermann: A Directed Tree Calculus for Minimal Tense Logic.

5.4 Further Activities

Awards

- Th. Strahm received the *Fakultätspreis 1995 der philosophisch-naturwissenschaftlichen Fakultät der Universität Bern.*

Editorial Board and Technical Committees

- Member of the editorial board of *Theoretical Computer Science* (G. Jäger).

- Member of the editorial board of *Journal of Symbolic Logic* (G. Jäger).

- Member of the *CICUS (Commission pour l'informatique, conférence universitaire suisse)* (G. Jäger).

Program Committees

- Member of the program committee of *Logic Colloquium '95* (G. Jäger).

- Co-chair of the *Special Session on Proof Theory at the Logic Colloquium '95* (G. Jäger).

- Member of the program committee of the *Swiss Computer Science Society* (G. Jäger, Th. Strahm).

Conferences, Workshops and Summer Academies

- *Theoretische Informatik in der Schweiz.* Workshop auf Schloß Münchenwiler (G. Jäger).

- *First Order Logic Programming.* Summer School on Logic of Computation, Marktoberdorf 1995 (G. Jäger).

5.5 Publications

- S. Artemov, G. Boolos, E. Engeler, G. Jäger, A. Visser, (eds.): Proof Theory, Provability Logic and Computation (special issue). *Annals of Pure and Applied Logic,* 75, 1995.

- F. M. T. Brazier, C. M. Jonker and J. Treur: Modelling coordination of cooperative design. Technical Report, Department of Mathematics and Computer Science, Vrije Universiteit Amsterdam, 1995.

- S. Feferman, G. Jäger: Systems of explicit mathematics with non-constructive μ-operator, Part II. *Annals of Pure and Applied Logic.* To appear.

- G. Geyer, K. Stanoevska-Slabeva, W. Th. Wolff: Representing quantitative knowledge with the Q-calculus. In *Lernen und Wissen: Strukturelle Aspekte, Quantitative Methoden und Aktuelle Anwendungen*. Gesellschaft für Klassifikation, Institiut für Statistik und Ökonometrie der Universität Basel. To appear.

- Th. Glass, Th. Strahm: Systems of explicit mathematics with non-constructive μ-operator and join. *Annals of Pure and Applied Logic*. To appear.

- R. Goré, W. Heinle, A. Heuerding: Relations between propositional normal modal logics: an overview. Submitted.

- W. Heinle: *Expressivity and Definability in Extended Modal Languages*. PhD.-Thesis, TU-München. Verlag Shaker, 1995.

- A. Heuerding, G. Jäger, S. Schwendimann, M. Seyfried: Propositional logics on the computer. In P. Baumgartner, R. Hähnle, and J. Posegga, (eds.), *Theorem Proving with Analytic Tableaux and Related Methods*. LNCS 918, 1995.

- A. Heuerding and S. Schwendimann: On the modal logic K plus theories. Submitted.

- A. Heuerding, M. Seyfried H. Zimmermann: Efficient loop-check for backward proof search in some non-classical propositional logics. Submitted.

- G. Jäger: A deductive approach to logic programming. In H. Schwichtenberg (ed.), *Logic and Computation*. Springer Verlag, 1995.

- G. Jäger: Power types in explicit mathematics? Research Report, Institut für Informatik und angewandte Mathematik der Universität Bern, 1995.

- G. Jäger: Proof theory of first order logic programming. In H. Schwichtenberg (ed.), *Logic of Computation*. Springer Verlag. To appear.

- G. Jäger, Th. Strahm: Totality in applicative theories. *Annals of Pure and Applied Logic*, 74(2), 1995.

- G. Jäger, Th. Strahm: Second order theories with ordinals and elementary comprehension. *Archive for Mathematical Logic*. To appear.

- G. Jäger, Th. Strahm: Some theories with positive induction of ordinal strength $\varphi\omega 0$. *Journal of Symbolic Logic*. To appear.

- C. M. Jonker: Negations in logic programming. In H. C. M. de Swart and L. J. M. Bergmans, editors, *Perspectives on Negation*, Tilburg University Press, 1995.

- C. M. Jonker: Rule-based calculi for logic programs with explicit negation. In *Proceedings Dutch/German Workshop on Nonmonotonic Reasoning*, Utrecht University, 1995.

- C. M. Jonker: Interpretation of negations in logic programming. Technical Report IAM 95–005, Institut für Informatik und angewandte Mathematik der Universität Bern, 1995.

- C. M. Jonker: Proof theory for extensions of logic programming. In *Proceedings of Extended Logic Programming*, to appear.

- R. Kahle: Natural numbers and forms of weak induction in applicative theories. Technical Report IAM-95-001, Institut für Informatik und angewandte Mathematik der Universität Bern, 1995.

- H. Schlingloff, W. Heinle: Relational semantics for modal logics. In *Proceedings of the 4th International Conference on Verification in New Orientations*, University of Maribor, 1995

- H. Schlingloff, W. Heinle: Modal logics and relation algebra. In C. Brink, G. Schmidt, (eds.): *Relational Methods in Computer Science*. Springer Verlag. To appear.

- Th. Strahm: Polynomial time operations in explicit mathematics. *Journal of Symbolic Logic*. To appear.

- W. Th. Wolff: ELIAS: Vocabulary. Research Report, Institut für Informatik und angewandte Mathematik der Universität Bern, 1995.

6 Research Group on Neurocomputing

6.1 Personnel

Head:	Prof. Dr. H. Mey	Tel: e-mail:	+41 31 631 86 46 mey@iam.unibe.ch
Secretary:	U. Hadorn	Tel: e-mail:	+41 31 631 84 26 hadorn@iam.unibe.ch
Scientific staff:	J. Kleinle *	Tel: email:	+41 31 631 34 03 kleinle@iam.unibe.ch
	Dr. L. Müller *	Tel: email:	+41 31 631 38 37 muller@iam.unibe.ch
	Dr. W. Senn *	Tel: email:	+41 31 631 34 04 wsenn@iam.unibe.ch
	Dr. J. Stiefenhofer *	Tel: email:	+41 31 631 38 37 jstie@iam.unibe.ch
	Dr. W. Volken *	Tel: email:	+41 31 631 33 32 volken@iam.unibe.ch
	Dr. K. Wyler *	Tel: email:	+41 31 631 86 48 wyler@iam.unibe.ch

* financial support from a third party.

6.2 Research Projects

BRAINTOOL - An integrated workbench for information process modeling in biological neural networks

BRAINTOOL is an interdisciplinary SPP-project within the priority programme Biotechnology (module: Neuroinformatics). The aim of the project is to study and simulate the information processing in biological neural networks and to develop neuromorphic artificial neural network algorithms and architectures of the 3rd generation. The research work is executed by a collaboration group between the IAM and the Institute of Physiology (PHY) of the University of Berne.

The research of the project is focused on three levels of modeling: (1) synaptical level (diffusion of neuro transmitter in the synaptical cleft), (2) cell level (information processing in the dendritic apparatus, reduction of modeling complexity by using a fuzzy rule approach), (3) network level (mathematical analysis of size principle in motor unit recruitment, oscillation in excitatory randomly connected neural networks).

Another aim of the project is to develop an integrated workbench which supports rapid prototyping in neuronal modeling and provides an extensive set of analysis instruments. 'Integrated' means that the workbench supports simulation and experimentation and facilitates the comparison of physiological experimental data with simulation results. The simulation environment of the workbench is based on Matlab/Simulink and the experimentation environment is based on Labview. The use of graphical programming environments like Simulink and LabView enables researchers without background in computer science to implement their own models. The workbench has an open system architecture, which includes a minimum of fixed models and structures. It rather acts as a platform for their easy implementation. Thus, BRAINTOOL differs from classical simulation systems and resembles more to a decision support system which allows a close interaction between theory and experiment. To avoid the development of isolated simulation code the workbench is based on toolboxes, which can be shared between users. Toolboxes are application specific collections of reusable components, which can be used to set up a single simulation or a whole experimentation environment (applications). Every user is free to customize his local workbench by modifying components of a toolbox or by creating new components or even new toolboxes. If these components are for other users of interest they will be included into the workbench provided that they meet all requirements posed in the 'BRAINTOOL Developer's Guide' (concept of distributed development). This way the available set of tools of the workbench is mainly defined by the applications and experiments of its users and it will grow with their needs.

Research staff: IAM: Prof. H. Mey, J. Kleinle, L. Müller, W. Senn, K. Wyler
PHY: Prof. H. Lüscher, M. Larkum, J. Streit, K. Vogt, T. Wannier

For further details, see: http://iamwww.unibe.ch/~brainwww

Neural Networks for Automatic Object-Recognition

Neural Network methods are tested for their ability to segment images. Input image classes are infrared and visual images in a natural environment. A two-stage neural network using SOFMs (selforganizing feature maps) is implemented to realize a multi-resolution approach. This approach improves robustness to pixel-noise. The

Image segmentation approach is studied using different multi-resolution feature-extractors (Statistical and orientation-specific). Each feature space is statistically evaluated. And finally the performance gains of hierarchical SOFMs is tested.

Research staff: L. Müller, J. Stiefenhofer, M. Heuer (GRD)

MMC - A fast Algorithm for Electron Beam Dose Calculations

The macro Monte Carlo (MMC) method is a fast algorithm suitable for electron beam dose calculations in clinical radiotherapy treatment planning. MMC has been developed to improve the speed of traditional Monte Carlo (MC) electron transport calculations without significant loss in accuracy at energies up to 20 MeV. The MMC algorithm uses results derived from conventional MC simulations of electron transport through macroscopic spheres of various radii and consisting of a variety of media. Based on these results, electrons are transported in macroscopic steps through the absorber. The absorber geometry is represented by a three dimensional (3D) density matrix typically derived from computer tomographic (CT) data. Energy lost by the electrons along their path through the absorber is scored in a 3D dose matrix. Transport of secondary electrons and bremsstrahlung photons are taken into account.

Research staff: W. Volken, P. Schwab (TNTech), H. Neuenschwander (AMS, Unispital Bern), C. Cris (AMS)

6.3   Master's Theses

- D. Stainhauser: Evaluation von Simulatoren für biologische Neuronale Netze.

- R. Walter: Ein Vergleich des Optionpreismodells von Black und Scholes mit einem neuronalen Netzwerk-Ansatz für das Pricing von SOFEX-Optionen.

- M. Kientsch: Eine Toolbox zur Programmierung von Regelstrecken der Biomechanik.

6.4   Ph.D. Theses

- Jürg Stiefenhofer: Image Segmentation using SOFMs (Bildsegmentierung mittels Selbstorganisierender Merkmalskarten)

6.5 Further Activities

Editorial Boards

- Swiss Union of Commerce and Industry, Research comittee (H. Mey, member)

Associations

- Assoc. Swiss Machinery Manufacturers, Research committee (H. Mey, president)

- Assoc. Techno Park Bern (H. Mey, president)

Committees

- Activities in NDIT/FPIT, an interregional society for postgraduate courses in Telecommunications and Informatics (H. Mey, president, L. Müller, director)

- Activities in FORMITT, a COMETT project on education in Telecommunications and Informatics on a European level (H. Mey, president)

- Member of the Swiss Science Council (H. Mey)

- Member of the Academic Committee University of Berne (H. Mey)

6.6 Courses presented at other institutions

- Postgraduate teaching activities (NDIT/FPIT courses): Neural Networks and Genetic Algorithms (L. Müller, K. Wyler), Operating-System Tools (J. Stiefenhofer), Information Security and Cryptology (L. Müller), Mathematical Workshop and Numerics (J.E. Boillat(ISBE), L. Müller (IAM), R. Müller (ISBE), Ch. Meier (ISBE))

- Teaching activities at ISBe: Cryptology (L. Müller), Neural Networks (L. Müller), UNIX Introduction (J. Stiefenhofer), Image Processing (J. Stiefenhofer)

- Teaching activities at SWS: Neural Networks (L. Müller)

6.7 Publications

Preprints

- Dynamics of a random neural network with synaptic depression; W. Senn, K. Wyler, J. Streit and BRAINTOOL. Submitted to *Neural Networks*, accepted July 12, 1995.

- Size principle and information theory; W. Senn, K. Wyler, H.-R. Lüscher and BRAINTOOL. To be submitted to *Biophys. J.*

- Phase-locking of two oscillating random neural networks; W. Senn, K. Wyler, T. Wannier and BRAINTOOL. To be submitted to *Biol. Cybernetics*

- Estimating Receptor Distribution at the Postsynaptic Side; J. Kleinle, K. Vogt, J. Streit and BRAINTOOL. To be submitted to *J. Theor. Biol.*

Technical Reports

- Recruitment by size and principle of least action; W. Senn, K. Wyler, H.-R. Lüscher and BRAINTOOL. No. IAM-95-004

- Various explanations of the size principle; W. Senn, K. Wyler, H.P. Clamann, H.-R. Lüscher and BRAINTOOL. No. IAM-95-12.

- An Evaluation Aid for Neuronal Modeling Software; D. Stainhauser, K. Wyler, L. Müller, W. Senn and BRAINTOOL. No. IAM-95-13.

7 Research Group on Software Composition

7.1 Personnel

Head:	Prof. Dr. O. Nierstrasz	Tel:	+41 31 631 46 18
		e-mail:	oscar@iam.unibe.ch
Secretary:	I. Huber	Tel:	+41 31 631 46 92
		e-mail:	huber@iam.unibe.ch
Scientific staff:	J. C. Cruz *	Tel:	+41 31 631 33 14
		email:	cruz@iam.unibe.ch
	L. Deri *	Tel:	+41 1 724 83 14
		email:	deri@iam.unibe.ch
	K. Guggisberg *	Tel:	+41 31 631 33 13
		email:	guggis@iam.unibe.ch
	M. Lumpe	Tel:	+41 31 631 49 03
		email:	lumpe@iam.unibe.ch
	W. Mallon *	Tel:	+41 31 631 33 13
		email:	willem@iam.unibe.ch
	Dr. T. D. Meijler *	Tel:	+41 31 631 33 14
		email:	meijler@iam.unibe.ch
	I. Metz *	until October 1995	
	S. Moser *	Tel:	+41 31 633 24 08
		email:	moser@iam.unibe.ch
	T. Richner *	Tel:	+41 31 631 33 14
		email:	richner@iam.unibe.ch
	J.-G. Schneider	Tel:	+41 31 631 49 03
		email:	schneidr@iam.unibe.ch
	P. Varone	until August 1995	

* financial support from a third party.

7.2 Research Projects

Composing Active Objects

Traditional software development techniques do not cope well with the needs of open systems, and in particular with rapidly changing requirements. This project aims to develop a new model for object-oriented software composition that cleanly integrates active objects and components, and demonstrate the practical value of the model by applying it to existing component sets. Specifically, this project will develop (1) an object model integrating active objects and components, (2) a composition language, and (3) an experimental component laboratory.

Research staff: J. C. Cruz, K. Guggisberg, M. Lumpe, W. Mallon, Dr. T. D. Meijler, T. Richner, J.-G. Schneider, P. Varone.

For further details, see: http://iamwww.unibe.ch/~scg/Research/cao.html

7.3 Ph.D. Theses

- Igor Metz, Bintree Lab: Ein Framework von Datenstrukturen und Algorithmen für Bintrees. (co-supervised with H. Bieri)

7.4 Further Activities

Editorial Boards

- Object Oriented Systems, Chapman & Hall (O. Nierstrasz)

- L'OBJET – Logiciel, réseaux, bases de données (O. Nierstrasz)

Associations

- CHOOSE – Swiss group for Object-Oriented Systems and Environments (Chairman, O. Nierstrasz)

- AITO – Association Internationale pour les Technologies Objets (Secretary, O. Nierstrasz)

Conference Chair

- Tenth European Conference on Object-Oriented Programming - Linz, Austria, July 8-12, 1996. (O. Nierstrasz, Conference Co-chair with Peter Wegner)

Program Commitees

- ACM SIGMOD 95 - San José, May 22-25, 1995 (O. Nierstrasz)

- Ninth European Conference on Object-Oriented Programming - Aarhus, Aug. 7-11 1995 (O. Nierstrasz)

- European Software Engineering Conference - Barcelona, Sept. 25-28, 1995 (O. Nierstrasz)

- The Fourteenth International Conference on Object-Oriented & Entity Relationship Modeling - Bond University, Gold Coast, Queensland, Australia, December 13-15, 1995 (O. Nierstrasz)

7.5 Publications

Books

- Oscar Nierstrasz and Dennis Tsichritzis (Ed.), *Object-Oriented Software Composition*, Prentice Hall, 1995.
  For details, see: http://iamwww.unibe.ch/~oscar/OOSC

Journal and Conference Publications

- Simon Moser, "Metamodels for Object-Oriented Systems", *Software - Concepts & Tools*, vol. 16, Springer Intl., 1995, pp. 63-80.

- Oscar Nierstrasz, "Research Topics in Software Composition", *Proceedings, Langages et Modèles à Objets*, Nancy, Oct. 1995, pp. 193-204.

- Oscar Nierstrasz and Theo Dirk Meijler, "Research Directions in Software Composition", *ACM Computing Surveys*, vol. 27, no. 2, June 1995, pp. 262-264.

Technical Reports

- Theo Dirk Meijler, "Viewing Software Composition as Composition of Metaobjects", draft manuscript, June 1995, submitted for publication.

- Simon Moser, "Estimating the Modern Software Process", draft manuscript, Dec. 1995, submitted for publication.

- Patrick Varone, "Implementation of 'Generic Synchronization Policies' in Pict", technical report, Nov. 1995.

- A. Wallin, Simon Moser and A. Graber, "Wiederverwendbarkeit mit Smalltalk", *INFORMATIK, SVI/FSI*, Zürich, Feb. 96, to appear.

A   Teaching Activities

Winter semester 1994/95:

S. Amann, A. Collison:	Einführung in die objektorientierte Programmierung mit C++
H.P. Blau:	Programmierung 1
H. Bunke:	Automaten und formale Sprachen
	Künstliche Intelligenz
	Seminar für Diplomanden und Doktoranden
E. Dubuis, Th. Bebie:	Praktikum in Computergrafik
D. Hogrefe:	Informatik 1B
	Computernetze
	Seminar für Diplomanden und Doktoranden
	Seminar: Teleteaching
G. Jäger:	Praktikum: Symbolisches Rechnen
	Logik und Informatik
	Seminar für Diplomanden und Doktoranden
	Blockseminar Bern und Zürich: Logik und Informatik
	Arbeitsgemeinschaft Beweistheorie
	Funktionales Programmieren
M. Marzetta:	Konstruktive Analysis
H. Mey:	Informatik 1A
L. Müller, K. Wyler:	Künstliche neuronale Netze
O. Nierstrasz:	Datenbanken
T. Strassen:	Unifikation
Ch. Streit:	Datenstrukturen und Algorithmen

Summer semester 1995:

H. Bieri:	Computergrafik
	3D-Grafik
	Projektive Geometrie für Computergrafik
	Seminar für Diplomanden und Doktoranden
	Blockseminar Bern und Zürich: Computergrafik und Multimedia
H.P. Blau:	Programmierung 2
H. Bunke:	Compilerbau
	Strukturelle Methoden der Mustererkennung
	Praktikum: Bildanalyse

	Seminar für Diplomanden und Doktoranden
K. Decker:	Parallele Computersysteme und Anwendungen
D. Hogrefe:	Praktikum: Rechnernetze
	Seminar: Offene verteilte Verarbeitung
	Seminar für Diplomanden und Doktoranden
	Betriebssysteme
G. Jäger:	Einführung in die theoretische Informatik
	Komplexitätstheorie
	Seminar: Theoretische Informatik und Logik
	Arbeitsgemeinschaft Beweistheorie
	Blockseminar Bern und Zürich: Logik und
	Informatik
G. Karjoth:	Verifikation verteilter Systeme - Methoden
	und Werkzeuge
H. Mey:	Informatik 2B
L. Müller, W. Senn,	
K. Wyler:	Künstliche neuronale Netze 2
O. Nierstrasz:	Informatik 2A
	Praktikum in Software Engineering
	Programmiersprachen
A. Scheuing:	Software Metrics

Winter semester 1995/96:

H. Bieri:	Datenstrukturen und Algorithmen
	Geometrisches Modellieren
	Seminar: Computergeometrie
	Seminar für Diplomanden und Doktoranden.
H.P. Blau:	Programmierung 1
	Informatik 1C
H. Bunke:	Automaten und formale Sprachen
	Künstliche Intelligenz
	Bildanalyse
	Seminar für Diplomanden und Doktoranden.
W. Heinle, T. Strahm,	
H. Zimmermann:	Seminar für Diplomanden und Doktoranden.
A. Heuerding,	
S. Schwendimann:	Logiksysteme in der Informatik
D. Hogrefe:	Informatik 1B
	Praktikum Rechnernetze
	Seminar für Diplomanden und Doktoranden.
	Computernetze

G. Jäger:	Blockseminar Bern und Zürich: Logik und Informatik.
H.-R. Lüscher, J. Streit, W. Senn, L. Müller, K. Wyler:	Neuronale Netze 1
O. Nierstrasz:	Datenbanken
	Semantics of Concurrency
	Seminar: Software Engineering
	Seminar für Diplomanden und Doktoranden.
M. Marzetta, T. Strahm:	Logik und Informatik
H. Mey:	Informatik 1A
R. Oppliger:	Informations- und Kommunikationssystem -Sicherheit
S. Schwendimann, H. Zimmermann:	Praktikum Symbolisches Rechnen