

APPRAISAL OF BOCHMANN'S RESEARCH CONTRIBUTIONS

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SUMMARY

Gregor v. Bochmann was one of the first to recognize the importance of precise and formal specifications for the analysis and systematic verification of communication protocols, and the semi-automatic development of their implementations and tests. Over the last 25 years, his work contributed to the establishment of several new research directions, such as formal description techniques for communication protocols and services, methods for test derivation from formal specifications, and the derivation of protocol and controller specifications from a given service specification. His work on formal description techniques strongly influenced the international standards in this area. The methods and tools developed in his group are not only useful for protocol engineering, but also in the more general context of software engineering for distributed systems and discrete event control systems. He is internationally recognized as a leader in this field. -- In addition, he has shown an exemplary leadership for promoting research collaboration between universities and industries. Besides leading many important research projects sponsored by industry and/or government, he participated in the creation of such research institutes as the Centre de Recherche Informatique de Montreal (CRIM) and the Canadian Institute for Telecommunications Research (CITR).

DETAILED APPRAISAL

Professor Gregor v. Bochmann is a Fellow of the Royal Society of Canada, a Fellow of the ACM ("The First Society in Computing"), and a Fellow of the IEEE with the citation "for contributions to the formal specification of protocols for data communications". In 1988, he received the Urgel Archambeault prize of the Association Canadienne Française pour l'Avancement des Sciences (ACFAS), and in 1989 he received the "Award for Academic Excellence in Research in the Area of Information Technology" from the Information Technology Association of Canada (ITAC) and the Natural Sciences and Engineering Research Council (NSERC), the first time this award was given. In 1997 he received a doctor honoris causa from the Joseph-Fourier-University in Grenoble, France. In 2001, he received the Thomas W. Eadie Medal of the Royal Society of Canada, and in 2002, he was the recipient of the Award for Excellence in Research at the University of Ottawa.

He completed his doctoral degree at McGill University of Montreal in 1971 in the area of elementary particle physics. With much practical experience in computer programming and financial support from a post-doctoral fellowship provided by the National Research Council (NRC) of Canada, he deepened his knowledge of computer science and joined the faculty of the Computer Science Department at the University of Montreal as an assistant professor in 1972. His first major research contribution was in the area of programming language semantics and compiler writing systems. His paper on the "Semantic evaluation from left to right" (Communications of the ACM, 1976) was a seminal paper which was extensively referenced in the literature until the late eighties.

However, instead of continuing in this promising direction, he reoriented his major research efforts to a very new area, namely communication protocols. At this time, first experience had been obtained with the ARPA network (which later evolved to the Internet) and commercial packet-switched data networks were introduced in several countries. Bochmann was

probably the first to concentrate his attention to methods for verifying that the communication protocols designed for a given system behave properly in all circumstances and provide the communication service they are designed for. He was also one of the first to recognize the importance of precise and formal descriptions of protocols in order to facilitate the analysis and systematic verification of the specification, and the semi-automatic development of implementations and testing scenarios. (Note: because of the concurrency within a distributed system, the verification of a protocol is much more difficult than the verification of a sequential computing application). His paper on "Finite state description of communication protocols" (Computer Networks, 1978) has been a standard reference in this area until today.

The "Unified method for the specification and verification of protocols", proposed in his paper at the IFIP Congress in 1977, combines the finite state model (FSM) with programming language elements as a tool for the description of communication protocols and distributed applications. This combined approach, sometimes called the "extended FSM model", has later been adopted by several standard description techniques for communication protocols and services, such as Estelle and SDL, as well as in a more general software engineering context in the form of state diagrams in object-oriented specifications, such as supported by the more recent Unified Modeling Language (UML).

During the period from 1976 through 1986, Bochmann made many contributions to the international standardization efforts on formal description techniques for communication protocols and services. This work was largely funded by research contracts from the Department of Communications (DOC), Canada. He participated in the international standardization meetings of ISO and ITU (formerly CCITT) as a delegate from Canada and contributed a large number of papers to these meetings. His contribution to the development of the Estelle language was publicly acknowledged in 1989 when Estelle became an International Standard of ISO. He also participated in the development of a related language, called SDL, which was developed within the ITU, and is now widely used in the telecommunications industry. The use of this language and related computer-assisted software engineering (CASE) tools are presently taught in certain courses at the University of Ottawa and elsewhere.

Since the eighties, Bochmann's research was largely oriented towards automated methods for the development of implementations and test scenarios from a given specification. His group was one of the first to build a prototype translator which generates programming language code from a given specification. Some of the introduced implementation strategies have later been adopted by the commercial SDL CASE tools.

Together with his PhD student Sarikaya, Bochmann was the first to propose the systematic testing of protocol implementations based on formal specifications given in the form of an extended FSM. His seminal papers from 1982 to 1987 led to many other research results in the area of protocol conformance testing. More recently, Bochmann and his colleagues were among the first to extend these results to partially defined and nondeterministic specifications and to stress the importance of a precise fault model for the estimation of the coverage of a given test suite.

In 1986, Bochmann participated in the study "OSI Support in Canada: Policies and Implementation Perspective" for the Department of Communications, Canada. This work gave the direction for the development of an OSI protocol conformance test center in Canada, an idea which was taken up around 1988 by the Canadian Interest Group for OSI (CIGOS), and finally led to the establishment of the Protocol Test Center of Hewlett-Packard in Montreal in 1992. In this context, Bochmann was also able to establish the NSERC - Hewlett-Packard - CITI industrial research chair on communication protocols at the University of Montreal. This chair provided funding for most of the research performed by Bochmann's research group from 1989 through 1997.

Collaboration with industry and technology transfer has been an important preoccupation in Bochmann's work. For instance, he was a member of the committee that established the "Implementation Committee" that defined the ground rules for the Centre de Recherche en Informatique de Montreal (CRIM) in 1985 and was a scientific director of CRIM from 1990 through 1997. In 1989, he also participated in the preliminary discussions that led to the establishment of two federal networks of centers of excellence (NCEs): CITR and IRIS.

He led many industry-funded research projects, such as the following. A project with IBM in 1989-90 involved the study of Prolog for the modeling and testing of the MAP application layer protocol MMS. Another project with BNR (now Nortel Networks) in 1988-91 was concerned with object-oriented system modeling and network management. During 1991-93, he participated in a research project with DMR (MACROSCOPE) concerning the modeling of distributed architectures for information processing and work organization. A project on SONET network management was done during 1994-95 with Positron, and a project on test development for communication software was done with EICON in 1996-97.

From December 1992 through July 1997, he led a large (3 M\$) university-industry collaboration project, called IGLOO, which was coordinated by CRIM and dealt with object-oriented modeling of distributed systems and network management. This project was funded by the Quebec Synergie fund, NSERC and the industrial partners BNR, Teleglobe, DEC, CAE, Servacom and Machina Sapiens. It involved researchers from the universities Montreal, Sherbrooke and UQAM, as well as from CRIM.

In the context of the Canadian Institute for Telecommunication Research (CITR), which was created in 1990 as one of the Canadian Networks of Centers of Excellence, Bochmann established and led a major project on software engineering. During a subsequent reorganization of the CITR research orientations in 1993, he initiated the establishment of a new major project entitled "Broadband Services" which dealt with access to multimedia databases over high-speed networks. He has since then participated in this project and a follow-up project entitled "Enabling Technologies for Electronic Commerce" as one of the principal investigators concentrating on quality of service management for distributed multimedia applications. Although this was a new research area for him and his group, he has already established himself as one of the recognized leaders in this field, as demonstrated by his invitation to program committees of several international conferences in this field.

End of 1997, he took early retirement from the University of Montreal, was honored as an emeritus professor, and started a new job as a full professor at the University of Ottawa in the newly created School of Information Technology and Engineering (SITE). With some new funding from Nortel Networks and Communications and Information Technology Ontario (CITO), he has established a new research group working mainly on quality of service management and communication protocols for telecommunication services over the Internet. He also collaborates with his colleagues within SITE for the establishment of new CFI-funded research lab on Advanced Internet Applications and Systems (AIAS). Currently he leads an NCIT-funded collaborative research project on "Optical Networks and IP Traffic", participates in a new NSERC NCE on "Agile All-Photonic Networks" (AAPN), and leads a research group in the area of software engineering on "Requirements-driven development of distributed applications".

He has organized many scientific conferences, such as the SDL Forum in 1999, the IFIP International Conference on Formal Description Techniques (FORTE) in 1995, the IFIP International Workshop on Protocol Test Systems in 2000 in Ottawa and 1992 in Montreal, the IFIP Workshop on Protocol Specification, Verification and Testing in 1986, and the ACM SIGCOMM Symposium in 1994. He organized a total of 13 conferences as general chair, co-chair or program committee chair during the last 15 years, and has been a member of the

program committee for more than 45 international conferences during the last 10 years. He has been a member of the editorial board for the journals "Distributed Computing", "Computer Networks" and the Electronic Journal on Networks and Distributed Processing. He has also been a guest editor for Computer Networks and the Journal on Formal Methods in Systems Design.

He has published two monographs, over 75 scientific journal articles and over 170 papers in refereed conference proceedings. He has supervised many researchers, including 18 PhD and 47 Master students, as well as many post-doctoral fellows. During the last 10 years, he has administered research grants and contracts totaling around \$ 9 million, and during the period from 1985 to 1989, his NSERC operating grant was the highest in Canada in the area of computer and information sciences.