A. G. Fraser

62 Carriage House Rd.
Bernardsville, New Jersey 07924
908-766-5247
agf@FraserResearch.org

EXPERIENCE

2002- **FRASER RESEARCH**

Founded Fraser Research Inc., a not-for-profit company organized for charitable and educational purposes. The company does research in science and technology to support a national communications infrastructure, and provides support for graduate education in telecommunications.

1996-2002 **AT&T LABORATORIES**

1998-2002 **Chief Scientist**
Research on the architecture of a large scale Internet with particular focus on the networked home. Developed 155 Mb/sec fiber to the home with electronic switching, provisioning and restoration in the distribution plant. Proposed an interpretation of IPv6 to accommodate large scale and mobility in the access network. With G. Mapp, showed how IP can be used as a signaling language, and proposed a technique for integrating virtual circuits within Ethernet so that recursively defined end-to-end flows could become first class citizens of the Internet. Supported E.Y.Chen who developed the Endpoint Architecture for networked consumer audio and video products.

1996-1998 **Vice President, Research**
Founded AT&T Labs Research when AT&T split off its equipment manufacturing business. This research laboratory employs about 450 research staff and annually employs about 80 visiting students. The research program has a strong emphasis on the information sciences and communication systems.

1969-1996 **AT&T BELL LABORATORIES**

1994-1996 Information Sciences Research **Associate Vice President**
Launched and managed research initiatives to expand AT&T's business interests. Led the design of a chip set that could make ATM a viable means of multimedia communication for consumer products and home networks. The Datapath Chip by H.Kanakia is the first ATM switch to be integrated into a DRAM, the Datapath Control chip by R.C.Restrick is the first to provide per-channel queuing for ATM, and Euphony by P.Z.Onufryk integrates signal processing capability, ATM interfaces and SAR functions into a microprocessor based upon the R3000. With N.S.Jayant, launched a project to create a set of high quality audio compression standards based upon perceptual audio coding. These included the base for MPEG 2 AAC, a high quality 320 Kb/sec 5-channel audio code, and a near CD quality stereo code that operates at 64 Kb/sec. This led to several business opportunities including music distribution on data networks, a music player for which the storage medium is an integrated circuit, and an FM radio station where digitally encoded music is broadcast with CD quality. Supported N.L.Schryer to promote the use of cable TV facilities to extend broadband wide-area networks into the homes of consumers, and supported A.G.Hume in the development of a streamlined method of billing for the AT&T network.

1987-1994 **Executive Director**, Information Sciences Research.
The Information Sciences Research Division covers basic research in computing science, computing systems, software systems, mathematics, acoustics, and video and speech processing. Promoted research on software engineering and on computer communications. Promoted data communications as a service business opportunity for AT&T. Personal research is on computer communications networks with emphasis on the technologies required for a national data network.

1982-1987 **Director**, Computing Science Research Center.
The center does basic research on many aspects of computing science and computer systems, including the theory of computation, programming languages, operating systems, data communications, computer graphics, and numerical mathematics. Promoted research on computer architecture and on the study of software architecture for switching systems. Created the Experimental Universities Network (XUNET) project to promote graduate research on computer networks.

Personal research on data communications. With W.T.Marshall and G.G.Riddle, invented the Universal Receiver Protocol, a light-weight modular data transport protocol and processing engine (1982). Assisted C.R.Kalmanek and R.C.Restrick in designing INCON, a communication system that can operate on existing residential telephone circuits and can support inexpensive socket outlets for packetized access to a wide area network.

1977-1982 **Department Head**, Computer Systems Research.
Responsible for studies of computer architecture, MSI and VLSI circuit design aids, data communications, and programming languages. Promoted development of a computer communications product, Datakit VCS, which (by 1990) serves all of Bell Laboratories, is used extensively by AT&T, the Bell Operating Companies, and AT&T customers internationally. Promoted a new research program on VLSI CAD.

Personal research on data communications and computer architecture. With S.C.Johnson created a (RISC) prototype computer optimized to execute compiled C language programs, and pioneered the iterative design procedure where proposed architectures are evaluated with the aid of a portable compiler and a large body of applications programs (1977). Invented the Group Contention Protocol which converts a bus with priority contention resolution into one that distributes service more equitably (1977). Proposed a technique for tracking people as they move within a building (1979). Developed C language procedures to support lightweight multi-thread computation able to support a large number (thousands) of threads (1979). Built a network simulator and studied the performance of different queuing strategies for virtual circuit networks.

1969-1977 **Member of Technical Staff**, Computing Science Research Center.
Research on data communications, circuit design aids and computer architecture. Invented virtual circuit switching and proposed an early form of space-division packet switching (1969). Invented window flow control (1970). These were demonstrated in Spider, a research network that provided computer communications at Murray Hill until 1977. Constructed a free-standing file store which became a service on the Spider network (1974). Proposed the use of small packets, now called cells, to carry mixed traffic types including voice and data. Designed Datakit, a modular network with hardware virtual circuit switching (1975). With G.G.Riddle, created the UNIX Circuit Design Aids system which mechanized the fabrication of prototype MSI circuits starting from schematic capture and ending at an on-line wire-wrap machine (1976). Proposed a system for inexpensive cell-based communications that might be ubiquitously deployed in residences and commercial buildings (1977).

1966-1969 **CAMBRIDGE UNIVERSITY**

Assistant Director of Research. Designed and implemented file system for the Atlas 2 (Titan) time sharing system (1967). Developed automatic file backup and archiving system (1968), and studied problems of providing a robust file system that operates with minimal supervision and can survive the usual forms of computer failure. Invented a general purpose technique for controlling the privacy of files and certain procedures in a time-sharing system (1968). Studied the relationship between names in a programming language and persistent names in an operating system (1972).

1959-1966 **FERRANTI LIMITED**

1963-1966 **Manager**. Responsible for compiler development.

1959-1963 **Member of Technical Staff**. Designed and implemented the operating system and a substantial part of the subroutine library for the SIRIUS computer.
Designed NEBULA, a programming language and compiler for commercial data processing (1961).
With J.D.Smart, developed COMPL, a high level language in which the compiler for NEBULA was written.

EDUCATION

1969 Cambridge University, PhD Computing Science

1966 Cambridge University, MA Computing science

1958-1959 Cambridge University, Diploma in Numerical Analysis and Automatic Computing

1955-1958 Bristol University, BSc (1st Hons.) Aeronautical Engineering

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PROFESSIONAL ACTIVITIES and AWARDS

2005 Elected member, National Academy of Engineering, for contributions to the development of packet-switched networks, including virtual circuit switching and flow control.

2001 IEEE Richard W. Hamming medal, for pioneering contributions to the architecture of communication networks through the development of virtual circuit switching technology.

2000 AT&T Fellow, for pioneering work and sustained leadership in the design and creation of large scale packet networks and their applications.

1994-1995 Engineering Council, School of Engineering and Applied Science,
Columbia University

1994 IEEE Communications Society, Best Tutorial Paper published in 1993

1992 ACM, SIGCOMM Award for virtual circuit switching, space division packet switching, and window flow control in the architecture and control of communication networks.

1989 IEEE, Koji Kobayashi Computers and Communications Award for contributions to computer communications and the invention of virtual-circuit switching.

1989-1994 Center for Computer Aids for Industrial Productivity (CAIP)
Advisory Board, Rutgers University

1986-1995 Center for Telecommunications Research (CTR)
Telecommunications Engineering Advisory Council, Columbia University

1985-1989	Chairman, Computer Science Visiting Committee, University of Texas
1971-present	Institute of Electrical and Electronics Engineers. Fellow (1989)
1960-present	Association for Computing Machinery National lecturer (1972-1973)
1958-1977	British Computer Society Fellow (1969) Council member (1967-1969)

UNITED STATES PATENTS

3,749,845	**Digital Data Communications System**, July 1973, reissued July 1983. This records the invention of virtual circuit switching.
3,979,733	**Digital Data Communications System Packet Switch,** September 1976.
4,218,756	**Control Circuit for Modifying Contents of Packet Switch Random Access Memory**, August 1980.
4,499,576	**Multiplexed First-In, First-Out Queues**, February 1985.
4,507,760	**First-In, First-Out (FIFO) Memory Configuration for Queue Storage**, March 1985.
4,513,411	**Transmission of Status Report of Equipment in a Digital Transmission Network**, April 1985
4,787,082	**Data Flow Control Arrangement for Local Area Network**, November 1988, with R.H.Delaney, C.R.Kalmanek and R.C.Restrick
4,852,127	**Universal Protocol Data Receiver**, July 1989, with W.T.Marshall, and G.G.Riddle
4,821,258	**Crosspoint Circuitry for Data Packet Space Division Switches**, November 1989
5,272,697	**Apparatus and Method for Time Multiplexing a Resource among a Plurality of Entities,** December 21, 1993, with S. Keshav and C. R. Kalmanek
5,329,589	**Mediation of Transactions by a Communications System**, July 12, 1994
5,434,914	**Name translation in communications networks**, July 18, 1995
5,835,580	**Method and Apparatus for Automated Provisioning and Billing of Communication Services**, November 10, 1998
5,835,595	**Method and Apparatus for Cryptographically Protecting Data**, November 10, 1998, with S.Keshav and A.M.Odlyzko.
5,894,476	**Minimum-Pin ATM Interface with Flow Control**, April 13, 1999

6,272,144 **In-band Device Configuration Protocol for ATM Transmission Convergence Devices**, August 7, 2001, with A.D.Bernbaum and H.R.McLellan.

SELECTED PUBLICATIONS

with T. Braunholtz, and P. M. Hunt, **NEBULA: A Programming Language for Data Processing**, *British Computer Society, Computer Journal* **4** (3),pp. 197-211, 1961

with J. D. Smart, **The COMPL Language and Operating System**, *British Computer Society, Computer Journal* **9** (2),pp. 144-156, August 1966.

with D. W. Baron, D. F. Hartley, B. Landy, and R. N. M. Needham, **File Handling at Cambridge University**, *Proc. AFIPS SJCC*, pp.163-167 1967.

Integrity of a Mass Storage Filing System, *British Computer Society, Computer Journal* **12** (1), 1968.

User Control in a Multi-Access System, *British Computer Society, Computer Journal* **11** (1), pp.12-16 1968.

On the Meaning of Names in Programming Systems, *Communications ACM* **14**, pp.409-416, June 1971. Also in *Operating System Techniques*, ed. C. A. R. Hoare and R. H. Perrot, pp. 37-60 Academic Press, 1972.

File Integrity in a Disc-Based Multi-Access System, in *Operating Systems Techniques*, ed. C. A. R. Hoare and R. H. Perrot, pp.227-254, Academic Press, 1972.
Also published in *Classic Operating Systems: From Batch Processing to Distributed Systems*, ed. P.B Hansen, pp. 167-194, Springer-Verlag New York, 2000.

On the Interface Between Computers and Data Communications Systems, *Communications ACM* **15** (7), p. 566, 1972. Also in *Advances in Computer Communications*, ed. W. W. Chu, pp 246-253, Artech House 1974.

Spider - An Experimental Data Communications System, *Proc. IEEE Conf. on Communications*, p.21F, June 1974.

Loop Transmission Systems for Data, *ACM Comp. Commun. Rev.* **4** (4) pp.2-8, October 1974.

The Present Status and Future Trends in Computer/Communication Technology, *IEEE Comm. Soc. Mag.* **14**, pp.10-19, September 1976.

Delay and Error Control in a Packet Switched Network, *Proc. Int. Conf. on Computer Communications* **2**, pp. 121-125, June 1977.

Unix Time-Sharing System: Circuit Design Aids, *Bell Sys. Tech. J.* **57**(6), pp.2233-2249, 1978.

Datakit - A Modular Network for Synchronous and Asynchronous Traffic, *Proc. Int. Conf. on Communications*, Boston, June 1979.

The Architecture of a Byte Stream Network, *Proc. Int. Conf. on Communications*, London, pp.634-639. September 1982.

Towards a Universal Data Transport System, IEEE J. Selected Areas *in Communications* **1**(5), pp.803-816, November 1983.

with S. P. Morgan, **Queuing and Framing Disciplines for a Mixture of Data Traffic Types**, *AT&T Bell Laboratories Tech. J.* **63** (6, part 2), pp.1061-1087, July 1984. Summarized in *Performance of Computer-Communication Systems*, eds. W. W. Bux and H. Rudin, pp.127-138 Elsevier science Publishers B.V,. North-Holland, 1984.

with W. T. Marshall, **Data Transport in a Byte Stream Network**, *IEEE J. on Selected Areas in Communications* **7**(7), pp.1020-1033, September 1989.

Opportunities and Obstacles for a National Research Network, *EDUCOM Bulletin* **23**(2), pp.22-31, Summer/Fall 1988.

Designing a Public Data Network, *IEEE Communications Magazine **29**(10)*, pp 31-35, October 1991.

with C. R. Kalmanek, A. E. Kaplan, W. T. Marshall and R. C. Restrick, **XUNET II: A Nationwide Testbed in High-Speed Networking**. published in *Proceedings of IEEE INFOCOM'92*. May 6-8, 1992, Florence, Italy pp. 582-589.

Early Experiments with Asynchronous Time Division Networks, *IEEE Network Magazine,* pp 12-26, January 1993.

The Origins of ATM, video tape, *University Video Communications ,* Stanford, California January, 1994

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