

Preface

The first chapter of this commemorative issue is devoted to the subject of computer systems architecture and development. It contains eight papers dealing with different facets of the evolution of modern computer systems at IBM over approximately the last three decades, beginning with the design of an experimental electronic stored-program machine in 1949 and covering the latest principal extensions to IBM's computer products and systems—large, intermediate, and small. Also included are accounts of the technological advances made, over the same time period, in the areas of data communications, real-time systems, and reliability/availability/serviceability (RAS).

In the first two papers, the evolution of modern intermediate- and large-scale computer architecture within IBM is described. These presentations are followed by a paper highlighting the evolutionary development of data communications products and systems at IBM, and then by a pair of papers describing the Corporation's involvement in the development and management of complex, on-line, real-time systems. Another two papers focus on the small systems area, and the chapter concludes with a paper reviewing the rather significant advances made in improving the RAS characteristics of IBM computer systems.

The intent of the issue is to document the especially noteworthy technical and scientific contributions made by IBM people to the state of the art of the computer industry. The authors were encouraged to emphasize significant accomplishments and innovations and to include the more important insights and assessments of their experiences in these developments. Thus, the papers generally do not try to establish detailed historical records nor do they attempt to include complete technical reviews of design considerations or of system or product characteristics. Information of this type is accessible through the references cited in each of the papers.

Because of space limitations, a number of interesting and important contributions or product developments are omitted. Selections of which items to include were made based on subjective judgments of which ones had, or would have, the most impact during the evolutionary period considered and beyond. For example, some of the more recent low-cost products are not covered in either of the two papers dealing with small systems. Other significant accomplishments not included are our earlier contributions to medical technology.

The first paper, by Bashe *et al.*, starts at the very beginning—the dawning of the age of the electronic

stored-program computer. It highlights the salient design aspects, architectures, and performance characteristics of IBM's principal computers during the fifteen-year period from late 1949 to the announcement of System/360 in early 1964. The computers discussed are differentiated from earlier machines in that they were designed with electronic-circuit technologies and were both organizationally and architecturally structured as stored-program machines. Included in this review are the "701 series" machines (701, 704, 709, 7090, etc.), the "702-series" machines (702, 705, 7080), the "650-series" (650, 7070, 7074, 7072), and the "1401-series" (1401, 1410, 1440, 7010, 1460), as well as several other unique systems including NORC, SAGE, the 305 RAMAC, and, finally, the Stretch system—which was the forerunner of System/360. By the end of the fifteen-year period covered in this paper, the data processing industry had emerged from obscurity to become one of the most important, and the time was at hand for replacing the older lines of computers with a new family characterized by a single architecture.

The architecture for the System/360 machines, and its subsequent extensions for the System/370 and related 3000- and 4000-series follow-on systems, is the subject of the paper by Padegs. It focuses on the key attributes of that architecture and its enhancements as well as on the rationale for providing them. Padegs also traces the evolution of the common I/O interface and describes the features of the I/O architecture for these machines. He discusses the main approaches for obtaining implementations of the architecture at widely differing cost/performance levels and offers some critical assessments of the experience gained in the implementation and use of the architecture.

A very significant factor in the remarkable growth of the computer industry has been the coupling of the technology of data processing to that of telecommunications. The need to provide convenient access to computing services at a distance as well as locally has been a primary motivation for the increasing growth of computer networks and distributed data processing. The rapid progress of data communications systems technology at IBM is described in the paper by Jarema and Sussenguth. Evolutionary developments in this area are traced from their origins in early off-line point-to-point transmission capabilities, through the development of batch and interactive terminals and systems, to the more recent distributed processing products. The main focus of the paper is on systems architecture, networking, and software development because of their particularly critical roles in the current and anticipated growth of computers in telecommunications applications.

The often specialized information processing requirements of the federal government are of particular interest to the Federal Systems Division of IBM, which has been heavily involved in the development of complex, on-line, real-time systems for diverse government applications for over twenty-five years. In the paper by Olsen and Orange, a representative sample of these programs is reviewed. These range from an early air defense system of the mid-1950s to a current modern naval light airborne multi-purpose system. The key issues characterizing real-time systems hardware and software development and their technological implications are discussed; significant aspects of real-time processing methodology, reliability and availability, and total systems responsibility are reviewed; and an evaluation of the lessons learned from this wealth of experience is presented.

A companion paper by James traces the evolution of real-time computer systems developed by IBM to support the U.S. manned spaceflight program since its inception. This paper provides an overview of approximately twenty years of development of command and control systems for NASA's Real-Time Computer Complexes (RTCCs). The emphasis here is on the development of RTCC systems, the tools and techniques used in the development process, the technological and architectural changes influencing this development, and the experience gained in the management of complex real-time programming systems.

The paper by Taylor is concerned with the IBM products referred to as small general-purpose systems: the System/3, System/32, System/34, and System/38 series of

machines. These systems were originally intended primarily for first-time users, and there have been extensive enhancements to these products in response to expanding customer requirements and to very challenging objectives regarding cost/performance, ease of use, and applications development support.

A companion paper on small systems, by Harrison *et al.*, traces the highlights of the evolution of small real-time IBM computers designed initially for sensor-based and industrial-control type applications. These are the 1720, 1710, 1800, System/7, and the Series/1 line of machines. Over time, their applications scope has broadened to include diverse operational environments such as discrete manufacturing control, laboratory automation, traffic control, and energy management systems.

In the concluding paper of this chapter, Hsiao *et al.* review the significant RAS improvements incorporated in IBM computer systems over the past quarter century. These RAS enhancements have been motivated by the considerable increases in function, number of components, and complexity, and by the ever-growing dependence on computers in the day-to-day operations of customer enterprises. The authors trace the evolution of computer RAS technology and methodology in IBM systems, and show how RAS capabilities have been enhanced through continual reduction in component failure rates and through improvements in system error detection, error recovery, and serviceability characteristics.

Editor