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System 75:

Introduction and Overview

By A. FEINER, E. J. RODRIGUEZ, and C. D. WEISS*

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In 1980, a group of system designers at AT&T Information Systems Laboratories (then a part of AT&T Bell Laboratories) was asked to produce a new communications system for the intermediate-size business office (40 to 400 users), to complement a larger system already under development—System 85. The new system was named the System 75 office communication system. Its purpose was to meet the competitive challenge for a high-function digital communication system whose integrated technology could address the evolving needs in office communications and automation. The proposal developed by our designers was based on an all-new hardware and software architecture.

In this intermediate-size range, the existing Feature Package 15 of the *Dimension*® PBX already had provided a challenging standard. Its more than 150 PBX features would have to be included in any new AT&T offering. Like the larger System 85, it would also provide integrated data switching capabilities, including 64-kb/s transparent switching; and simultaneous voice/data transmission using the Digital Communications Protocol (DCP)† that supports two 64-kb/s voice

* All authors are members of AT&T Information Systems Laboratories, an entity of AT&T Information Systems, Inc.

† Acronyms and abbreviations used in the text are defined at the back of the *Journal.*

and data channels and one 8-kb/s signaling channel at a single interface. With a significant fraction of customers requiring efficient multilocation service, it was recognized that the System 75 switch should also support multilocation networking services available in the current-generation *Dimension* systems and in System 85. These include Distributed Communication System (DCS) operation—permitting significant feature transparency between locations, a DS1 Interface to T1 facilities, Electronic Tandem Network support, and Centralized Attendant Service (CAS). AT&T Information Systems Architecture provided standards with regard to customer-system interactions, terminals, adjuncts and interfaces.

In mid-1983, an internal prototype with partial feature content underwent trials at AT&T Information Systems Laboratories. The first commercial customer received service early in 1984 and the product was publicly announced on April 26, 1984. The system's initial features are listed in the Appendix A to this introduction.

Customer systems have come of age insofar as complexity and sophistication are concerned. Based on the technologies of microprocessors, modern software engineering, and VLSI, products such as System 85 and System 75 have a range and extent similar to the much larger switching systems designed for central office use. Since we felt that there was much of interest to be reported on their design, development, and project methodologies, early in 1984 we decided to produce this special issue of the *AT&T Technical Journal* on System 75. This collection of papers was therefore assembled to serve as an example of modern design in customer communication systems.

There are four major groupings of papers in this issue. The first two papers deal with the switch and control architecture—realized in hardware and firmware—and the physical architecture of the overall product. The next group of four papers describes those functional components realized in software: switch services (a generalization of what is traditionally known as "call processing"); system management, including database aspects and user interface; maintenance for all hardware and software elements; and the real-time operating system. The third group of three papers treats project methodology and software tools upon which the methodology and firmware/software development rests. The first of these papers provides a project management overview and explains how designs from each development community are coordinated and integrated. The tools paper focuses on the software development methodology and tools environment. The test tool is described in a separate paper. Testing was a critical aspect of system development requiring a unique computer-based capability. The final topic deals with bringing the product to the people it serves—customers, and sales and service personnel—those who ultimately judge

the acceptability of the product. The paper describes how the product is introduced to these users, how their reaction is measured, and how corrective measures are taken where necessary.

An important theme throughout these papers is the degree of overall design and development unity and coordination that was required and achieved. Tools, for example, were specified jointly by tools builders and end-user developers. Although an early version of the operating system had been built to support some exploratory call processing development prior to the start of this project, its evolution and optimizations reflected the needs discovered by those developing services for System 75. All maintenance design required significant support in hardware and device design, firmware (on port boards and in the common control) and, of course, in the software. Specification, design, integration, and testing spanned all project areas. System test, performed by a separate test group, depended on an intimate knowledge of software and software-firmware interfaces, and on quick turnaround from developers for fixes to permit testing to progress beyond the curent trouble area. These are but a few examples of intra-project development coordination. The last paper of this issue illustrates the same broad coordination tasks involving all of AT&T Information Systems and its customers.

ACKNOWLEDGMENTS

Only a few of the many people contributing to the design and development of System 75 are authors in this issue. To the other creative and dedicated individuals who had a part in its successful development, we are most thankful and appreciative. Although this group of papers stresses the development aspects of System 75, centered in one organization, the project received outstanding support and product contributions from other AT&T Information Systems and AT&T Bell Laboratories organizations. Specific individuals and the areas in which they led are: D. A. Keller and R. S. Breen (Systems Engineering); D. B. James (architectural consultant); R. S. Berryman (selected software tools); and C. O. Riddleberger (AT&T Bell Laboratories Power Systems).

APPENDIX A

System 75 Features

Standard System Features

Advanced private line termination
Automatic route selection
Code calling access
Direct department calling
Direct inward dialing
Restrictions
  Code restriction
  Inward restriction
  Manual originating line
  Manual terminating line

Direct outward dialing
Emergency transfer
Flexible numbering of stations
Foreign exchange central office access
Intercept treatment
Intercept with lockout
Listed directory number service
Loudspeaker paging
Modem pool
Multiple call appearances of extensions
Multiple listed directory numbers
Music-on-hold access
Off-premises stations
Outgoing facility management
Outgoing trunk queueing
Personal central office line
Primary extension
Recorded telephone dictation access
Remote access
  Miscellaneous trunk restriction
  Origination restriction
  Termination restriction
  Toll restriction
Serial calls
Simultaneous voice/data communication
Station busy indication
System management
  Administration
  Maintenance
  System parameters
  Traffic measurements
Tandem tie trunk switching
Terminal dialing
Through dialing
Tie trunk access
Touch-Tone calling
Touch-Tone sending
Touch-Tone to dial pulse conversion
Uniform call distribution
WATS access

Standard Terminal Features

Abbreviated dialing
Personal, group and system lists
Automatic callback
Bridged call
Call answer from any station
Call coverage
  Caller response interval
  Consult/return
  Coverage information display
  Temporary bridged appearance
Call forwarding—follow me
Call park
Call pickup
Call status indication
Call waiting
Called party identification (with display)
Calling party identification (with display)
Common audible alerting
Conference
Conference/transfer
Data handlers from voice terminal
Dial access to attendant
Dialed number display (with display)
Distinctive alerting
Elapsed time display (with display)
Exclusion
Hold
Hot-line service
Hunting
Intercom
Integrated directory service
I-Use indication
Leave word calling
  Message retrieval (with display)
Manual signaling
Preference
Preselection
Priority calling
Recall signaling
Repertory dialing
Station-to-station calling
Station-to-station-only calling
Time of day and date display
Transfer

Standard Digital Modem Features

EIA RS-232C interface
Speeds up to 19,200 b/s
Synchronous or asynchronous operation (300 or 1200 b/s) for pooled modem operations
Full or half duplex operation
Keyboard dialing (ASCII)
Automatic answer
Automatic speed and mode detection
Automatic and manual self-test
Odd, even or no parity
Other data set like options (e.g., loss of carrier disconnect)

Standard Attendant Specific Features

Alternate console position(s)—up to 6
Attendant call waiting
Attendant direct extension selection with busy lamp field
Attendant display
Central attendant service
Direct trunk group selection
Night service
Release loop operation
Splitting—one way automatic

Class-of-service display
Incoming call identification display
Trunk identification display
Attendant lockout
Attendant transfer—all calls
Splitting—auto-manual
Straightforward outward completion
Trunk group busy/warning indicators to attendant
Trunk-to-trunk connections
Two-party hold on console

Message Center Agent Features

Display shows:
Called person's name and telephone number
Reason for call coverage (busy, no answer, send all calls, go to coverage)
Messages for callers from called person (such as status information)
Calling person's name and telephone number (if internal call)
Can record messages for intended called person or multiple people (causes their automatic message waiting lamp to light) as requested by caller
Has access to directory service to provide caller with additional information (like room number or supervision)

Peripheral Equipment

Terminals
Single line voice terminals
2500
7101 A with two fixed feature buttons
7103A with four fixed feature buttons and 10 programmable feature buttons
Multiappearance voice terminals
7300 Series
7303S with six fixed feature buttons and ten buttons each programmable to either activate features or as call appearances
7305S Same as 7303S plus 24 programmable feature buttons
7400 Series
These terminals provide simultaneous voice and data transmission. Addition of a Digital Telephone Data Module to the 7403D and 7405D models provides an RS-232C interface, allowing the connection of data equipment (data terminals, etc.) to the voice terminal.
7403D
7405D (also supports an optional 40-character numeric display and call coverage module)
Video Terminals
Data Terminal
513 Business Communications Terminal (data only)
Voice/Data Terminals
515 Business Communications Terminals Integrated with digital telephone

Data modules
These modules allow data equipment, such as terminals and computers, to be connected to System 75.
Digital telephone Data Module
Provides an RS-232C interface for data equipment when used in conjunction with a digital terminal (see above)
Processor Data Module
Provides an RS-232C interface to a host computer or standalone terminal
Trunk data module
Provides an RS-232C interface to a private data line or *Digital Data System*® data service unit to a remote computer or terminal

Attendant console
The attendant console includes a 40-character alphanumeric display, command keys, feature status indicators, alarm indicator, and a direct extension selector with busy indicators. The console plugs into any standard telephone wall jack.

Applications processor equipment
500 Business Communications Terminal
A data terminal, with a video display and keyboard connected to an Applications Processor via hard-wired 56-kilobit/second links

Printers
A family of printers is offered to work with applications processing services. The printers have varying speeds, print quality, and cost.
443: Low-speed, draft-quality matrix printer
445: Medium-speed, draft-quality line printer
460: Medium-speed, draft-quality matrix printer
450: Low-speed, reproduction-quality printer
Station Message Detail Reporting (SMDR)
Processing Options
COMMSTOR II & *Teleseer*® series
Stores details of all calls made and does SMDR processing using tariff tables
Local Storage Unit (LSU)
Stores details of all calls made for MDR processing
Applications Processor
The Call Detail Recording and Reporting feature provides SMDR processing on the associated System.
Printers
Local associated printer may be used to print formatted data

System Access Terminal
513 Business Communications Terminal
Optional 470 printer

APPENDIX B

System 75 Specifications

Switch Cabinet
70″h × 32″w × 24″d (large)
42½″h × 32″w × 24″d (small)

System Limits: (First Release)

Time Slots	512
Circuit Switch	64 Kb/s
Calling Rate	1800/hr
Traffic Limit	7200 CCS
Stations	400
Data Modules	200
Trunks	200
Trunk Groups	50
Pooled Modems	32
Attendant Consoles	7

Cabling Limits:

Analog	6000 ft.
Hybrid, MET	1000 ft.
Digital, Data Modules, 515 BCT	3400 ft.
513 BCT	5000 ft.

Thermal Output
Maximum—1250 watts (4250 BTU's/hr)
Typical Average—875 watts (3000 BTU's/hr)
[Cabinet is equipped with forced air cooling]

Power Requirements: 115V 60 Hz 50A
Dedicated unswitched outlet located within 10 feet. Approved grounding essential.

Environment:
Temperature—40°–110°F
Relative Humidity—10–95% up to 78°, decreasing to 35% at 110°
Well-ventilated area free of corrosive gasses and excessive dust or dirt.

AUTHORS

Alec Feiner is the Executive Director at AT&T Information Systems responsible for the development of office automation products. He started his engineering career with Bell Laboratories in 1953 and was a member of the team that developed the first stored program controlled electronic switching systems. Since 1969 he has been involved in customer premises telephony contributing toward the creation of numerous systems, among them, *Dimension*® PBX, *Horizon*® communication system, and System 75. A graduate of Columbia University, Feiner holds 40 patents and is the author of numerous articles on switching. He was awarded the Bell Laboratories Fellow Award in 1982 and in 1983 was elected to the National Academy of Engineering.

Ernesto J. Rodriguez, B.S. (Mathematics), 1967, Michigan Technological University; M.S.O.R., 1970, New York University; Bell Laboratories, 1967–1983; AT&T Information Systems Laboratories, 1983—. At Bell Laboratories, Mr. Rodriguez worked on computer access for *Picturephone*® service and was involved in developing software planning aids for the Digital Data System. He was also responsible for the software design and development of the Transaction Network and the Bell Packet Switching Network. Presently, Mr. Rodriguez is a Director at AT&T Information Systems Laboratories with responsibility for System 75 development.

C. Dennis Weiss, B.S. (Electrical Engineering), 1961, Stanford University; M.S. (Electrical Engineering), 1962, Columbia University; Ph.D. (Electrical Engineering), 1966, Columbia University; Bell Laboratories, 1972–1982; AT&T Information Systems Laboratory, 1983—. Mr. Weiss taught at Johns Hopkins University from 1966 to 1972. At AT&T, he has been involved with exploratory and development work on business communications systems. Currently, he is Director of the Integrated Systems Laboratory, responsible for System 75 development.