THE BELL SYSTEM TECHNICAL JOURNAL
Vol. 61, No. 5, May–June 1982
Printed in U.S.A.

1A Voice Storage System:

Prologue

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(Manuscript received July 31, 1979)

I. INTRODUCTION

1.1 Motivation

In modern times, distant voice communication in the United States has been predominantly by telephone. There are some applications for which voice is recorded, transmitted (perhaps by mail), and replayed, but this form of "taped letter" is the exception rather than the rule.

A constraining factor when communicating by telephone is that both the calling and called parties must simultaneously be available. The probability of a successful call completion is approximately 0.75. Unfortunately, the successful completion is often to the desired line but not to the desired terminating party and, thus, additional calls are required to complete the communication.

In many cases, the required communication need be only one way. When this is true, it would be convenient to leave a voice message on the first calling attempt. Such a capability is being introduced with the 1A Voice Storage System (VSS) and Custom Calling Services (CCS) II.

1.2 Elements of voice communication

Clearly, when people are together in the same place at the same time, they can simply talk. If they are available at the same time, but are in different places, they need some sort of transmission path between them. This path can be as exotic as a fiber optic cable carrying millions of conversations simultaneously in a digital bit stream or it can be as simple as a string between two tin cans.

If people are in the same place at different times, some storage media is required. For text, the medium could be paper on a bulletin board, a paper note, or a message scrawled on the washroom wall. For

storing voice communication, some sort of a sound recording mechanism is required.

The 1A VSS brings together a unified communication system incorporating the required transmission paths and storage media to permit voice communication between individuals who do not coexist in either space or time.

1.3 History

Early in the history of the telephone, telephone operators served as receivers and transmitters of messages for their customers. In many small towns, they simply jotted down notes, and periodically tried to deliver them whenever they had time available.

In all but the smallest exchanges, this quickly became an untenable situation. In self-defense, the operators quickly reverted back to simply making connections. The message storage function had to be provided in some other way.

Eventually, telephone answering bureaus sprang up, and these have been available for more than 50 years. Later, an attempt was made to mechanize the storage and playback of one-way voice messages through customer premises answer-and-record devices. These have been provided by the Bell System and several other companies since the early 1950s.

Initially, answer-and-record devices were quite expensive and their major use was limited to providing universal announcements which could be accessed by many people. They proved to be more economical when a single device was used to store the messages of many people than when they were used for individual customers.

The concept of a centralized vehicle to implement voice storage features had its origin as a Bell Laboratories research concept during the 1940s. On-going research into specific component technologies, control architectures, service definitions, and system implementations continued until the early 1970s when the required technologies had matured sufficiently to enable a cost-effective realization of a VSS. During 1975, the development of a VSS began, with the specific design for the 1A VSS reaching completion during 1976. The first 1A VSS was shipped to The Bell Telephone Company of Pennsylvania in August, 1978, with the expectation that it would be placed in service with CCS II features in 1980.

Many people have viewed the concept of storing and forwarding voice messages with almost as much enthusiasm as the concept of storing and forwarding text messages via so-called "electronic mail." Just as predictions were made in the 1930s that newspapers would soon be delivered by wire, many predictions have been made about the utility of delivering stored voice messages by wire. While the

technology for providing both of these services has existed for some time, the projected costs have always been prohibitive. With this thought in mind, the next section will describe some of the components which were required to build the 1A VSS with the attributes discussed above.

II. THE 1A VSS IMPLEMENTATION

2.1 Requirements

The 1A VSS must meet a host of access, cost, maintenance, reliability, and capacity requirements. Access to the beginning of any message must be provided within seconds. The costs must compare favorably with those of customer premises equipment.

The storage system should be as reliable as the transmission path connecting to it. It must provide sufficient capacity to ensure service when needed. Typically, the total storage capacity requirements for a shared facility are substantially less than for per-customer facilities.

The system must be engineered, taking into account estimates of expected holding time, average storage time, probability of message left, and the fact that 25 percent of normal "plain old telephone service" (POTS) calls terminate in "busy" or "do not answer."

The cost of storage is a function of both message length and storage time. While acceptable costs may be achievable through the use of analog recording equipment, we have found that access, maintenance, reliability, and versatility considerations all tend to favor a digital approach.

2.2 A new node in the stored program control network

As with many new telecommunication services, the cost of a 1A VSS must initially be spread over as wide a customer base as possible. This implies that a single 1A VSS system should provide storage capabilities for several switching systems rather than providing the required logic and storage in each electronic switching system (ESS) office.

The connection between stored program control (SPC) switching offices and the 1A VSS is represented schematically in Fig. 1. Note that the 1A VSS system looks much like an independent office. It receives inputs over special voice access trunks, it has its own control processor, and it directs traffic in and out of a storage subsystem directly instead of through the processor to the storage subsystem. From a control point of view, the ESS systems have ready access to the line state of customers, whereas the 1A VSS knows about the stored messages; therefore, control of the services requires close cooperation between the software in ESS and in 1A VSS.

To make CSS II features simultaneously available to hundreds of thousands of ESS customers on the basis of casual (i.e., daily) activation

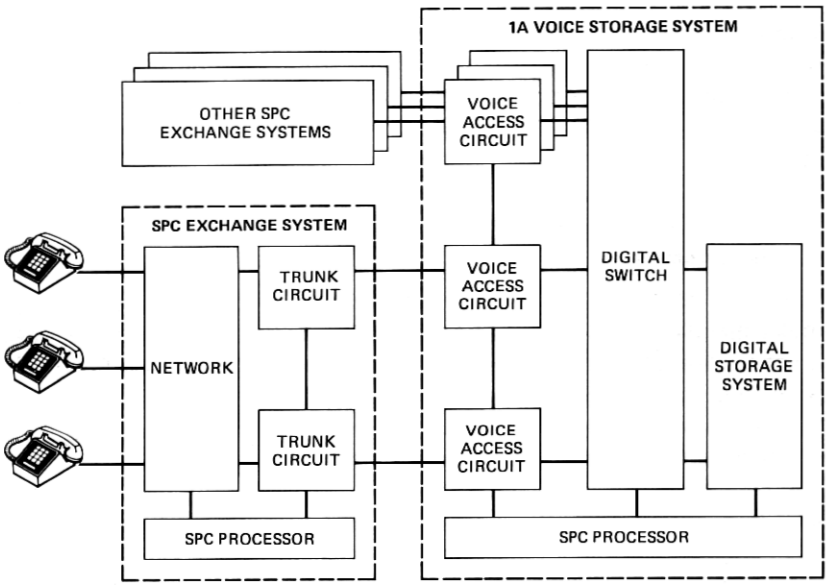

Fig. 1—The 1A vss in the SPC network.

and deactivation of service, the use of dedicated, per-line equipment was quickly ruled out in favor of trunk-interfaced equipment. The requirement to enable any customer's rapid access to messages stored on his behalf similarly ruled out the use of sequential storage media, such as analog or digital tape. Therefore, it is apparent that the storage subsystem is a major cost item and as such deserves considerable attention. Even though memory costs continue to go down between 20 and 30 percent per year, the amount of storage required is still large enough to keep the memory subsystem costs significant. This problem is made worse when reliability requirements force the duplicate storage of some messages.

If an encoding rate between 32 and 64 kb is required, bubble and charge-coupled devices (CCDs) become prohibitively expensive. Moving-head disks currently appear to provide the most viable solution from both economical and performance standpoints.

The advent of economical high-capacity disk storage has made the 1A vss economically feasible. The description of the implementation of the 1A vss is covered in the companion article "Architecture and Physical Design," by R. G. Cornell and J. V. Smith, in this issue of *The Bell System Technical Journal.*

2.3 Custom calling services II

With the availability of the 1A vss as a flexible node in the SPC

network, numerous imaginative and useful services can be provided. The initial CCS II services were chosen after extensive study of customer requests and market surveys to determine utility and convenience. The CCS II services are described in detail in the companion article "New Custom Calling Services," by D. P. Worrall, also appearing in this issue.

2.4 Call answering service

Answer-and-record services provided centrally can be considerably enhanced over those provided solely via customer premises equipment. For example, the customer's phone can be answered on "busy," as well as on "no answer." During an office busy hour, the number of busys and no answers are approximately the same.

With the use of the remote access options, the 1A VSS provides the answer-and-record service to customers who are away from their home telephone.

2.5 Advance calling services

The CCS II entry into the voice store and forward market is called Advance Calling. Advance Calling allows the calling party to record a message to be delivered at a future time. The customer may specify a future time or have the 1A VSS deliver the message immediately. Messages may be sent to most telephones which can be dialed directly, even to an individual's phone as a reminder or a wake-up call.

III. SUMMARY

Installation of the 1A VSS, as an extension of the transmission and switching facilities already provided by the telephone network, leads to a new dimension of utility and convenience for the telephone customer. For many people it will remove the frustration of trying to get through. For others, it will provide convenient access to information of special interest.

The technology is here today. The companion papers in this issue define the CCS II features, the implementation of the 1A VSS hardware, operational software, maintenance software, office engineering, and testing considerations.

The 1A VSS will provide a new dimension in voice communications which we have just begun to exploit.