HORIZON* Communication System – innovation in system design and development

Microprocessor and integrated-circuit technologies make a new business communication system economically feasible.

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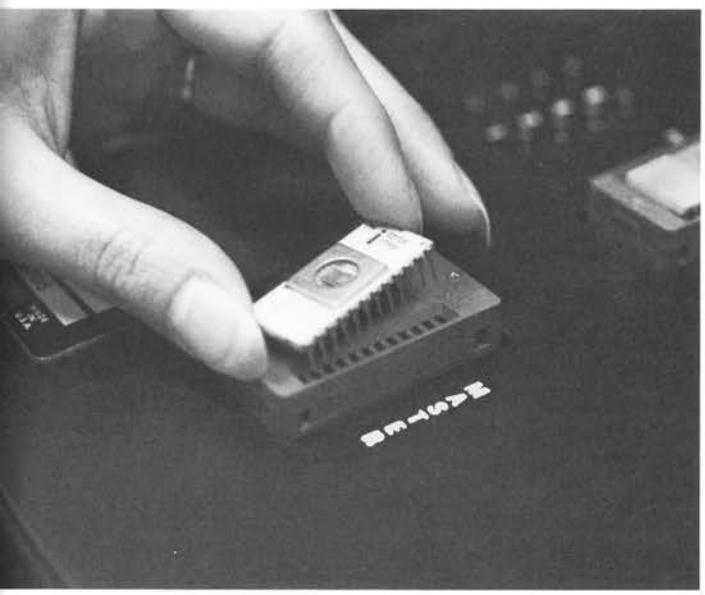
THE COMBINATION OF state-of-the-art microprocessor technology, stored program control, and the electronic telephone is providing a new communication system for business customers.

The *HORIZON* Communication System combines a broad range of features, which have previously been available only in large sophisticated PBXs. The new system introduces "skinny," four-pair station cabling and modern key-telephone service to the under 80-station market.

For economy and reliability, the *HORIZON* System uses microprocessor control, high-density solid-state memory and solid-state switching. The solid-state network and associated circuits also provide improved transmission performance.

Station, line, and auxiliary circuit packs contain a portion of the switching network. Thus, simply by adding additional packs, growth can be easily accommodated.



Programming PROMs. Above, Joy Van Note inserts a programmable read-only memory (PROM) into a programming console that writes information into these memory devices. At left, she establishes a link between the Development Support System and the console (foreground) with a CRT terminal. The Support System then converts programs stored in its minicomputer into a form that can be retained by the PROM and sends this data to the console, which performs the writing operation. PROMs are used in early systems to facilitate design changes.

The *HORIZON* System has built-in maintenance aids, which can automatically test the memories and control circuitry. In case of failure, light-emitting diodes glow at the central answering position and in the control unit on the individual circuit packs suspected of causing the problem.

The new system is easy to install. The Multibutton Electronic Telephone sets require only four wire-pairs—regardless of the number of buttons—instead of the 25 or more pairs needed for conventional key sets. In addition, the *HORIZON* System is easy to administer. A special terminal is used to enter and modify station, button, and feature information. Until recently, such changes were possible only with hard-wired cross-connections.

The *HORIZON* Communication System had its beginnings several years ago when AT&T and Bell Labs were exploring the need for a new key-telephone system that did not require the use of multi-wire cables and field-wiring arrangements. AT&T and Bell Labs also wanted to make the new system much easier to use than earlier complex systems. The Multibutton Electronic Telephone has been used effectively in *DIMENSION*® Custom Telephone Service, a system for PBX customers in the medium- to large-size range with a desire for additional key services and direct access to custom-calling services. The only complete communication systems available for smaller installations were the recently introduced *COM KEY** systems and the traditional PBXs.

The *HORIZON* System is designed for businesses with a growth potential of about 80 stations and 32 lines, which need more deluxe features than those offered by the *COM KEY* systems. People within the same company will find that the conferencing and transfer capabilities of the *HORIZON* System make it easy for them to consult with each other. Similarly, businesses requiring consultations or conferences with other firms will find line conferencing within the *HORIZON* System easy to use.

Multibutton Electronic Telephone

The Multibutton Electronic Telephone, first introduced with *DIMENSION* Custom Telephone Service (refer to *DIMENSION spectrum expands with Custom Telephone Service*, RECORD, November 1976), is the customer's

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interface with the system. Each set in the *HORIZON* System is equipped with 5 or 10 buttons that provide direct access to any of the system's custom-calling features without the need to flash the switchhook and dial a special code.

Also available with the *HORIZON* System is a 30- and a 40-button set for a centralized answering desk. (See photo on page 272.) To supplement these sets, a 40- and an 80-button station selector console is offered. A companion article on the *HORIZON* System beginning on page 271, *HORIZON Communication System: custom service for small businesses,* describes the electronic sets and the *HORIZON* System feature complement in more detail.

Control unit

The control unit is located on the customer's premises, typically in a closet, storeroom or office. The unit is modular in design to simplify testing and maintenance and to accommodate growth.

The control cabinet contains a power unit and one or two carriers holding the circuit packs that control the system. (See photo above, right.) With a single carrier, the *HORIZON* System can handle up to 52 stations and lines, depending on the features and options selected. A second carrier extends the system's capacity to 79 stations and 32 lines. Up to three-quarters of these stations can be the new electronic sets.

Because they are equipped with connectors, carriers are easy to install, test, and replace without the need for any hard-wiring connections.

Also included in the control cabinet are connecting units, the interface between the control circuitry in the carriers and the wiring to the stations and to the central office. (See photo opposite.) At the connecting unit, bridging clips are provided in the wiring to each station and line. By removing these clips, a craftsperson easily gains access to a particular station or line for maintenance and testing. Also at the connecting unit such hardware options as music-on-hold and external alerts can be wired into the system. In the event of a local commercial power failure, relays in the connecting unit transfer a maximum of five stations to the central-office lines to ensure basic telephone service. A standard Bell System emergency transfer panel can be

mounted adjacent to the control unit to provide additional power-failure service.

Connecting units are usually mounted in the control cabinet, but they may also be installed near the termination fields where lines from existing stations come together. The control and connecting units are then interconnected with standard cables.

The cabinet that houses the power unit, carriers, and connecting units was introduced with the *COM KEY* 2152 System. But because the *HORIZON* System uses high-density semiconductor parts, it provides approximately twice the station and line capacity as the *COM KEY* system in the same space.

Two interfaces—central-office circuits and tie-trunk circuits—are available to connect the *HORIZON* System to central offices and PBXs at other locations. The central-office lines can be used in a pool for trunk-type services or as personal lines when providing key-telephone service.

The microprocessor, which uses two types of solid-state memory, is housed in the control unit. The read-only memory (ROM) contains the system program—the routines that dictate system features and operation. Information is entered into this memory during the manufacturing process and cannot be changed.

The other memory, a random-access memory (RAM), contains information about the status of the system. The random-access memory also holds translation information such as line and station numbers, button assignments and station restrictions—information that can be changed through the Service Access Unit. Until recently, it was necessary to make hard-wired changes to enter translation data into a system.

Service Access Unit

The Service Access Unit (SAU) provides a simple and convenient way to change feature assignments and intercom numbers and to add or remove stations. The unit, which can be carried from one location to another in a portable carrying case, is a maintenance as well as an installation aid. Using the Service Access Unit, a craftsperson can gain access to error indicators such as error pegs, or counters, and test the operation of an entire circuit.

The Service Access Unit contains a 12-button touch pad for entering the translation data that control the system features, a four-character numeric display for data and test information, six control buttons, and LEDs that guide the user in entering data. (See illustration on page 274.) The Service Access Unit also contains a small tape unit, which makes it easy to enter into the *HORIZON* System a large amount of translation data. This data is pre-recorded on a mini-cassette for use during installation and is rewritten on the mini-cassette after each series of changes to make a permanent record of the new system translation.

The Service Access Unit can be connected to the system at the cross-connect field in the control unit, or it can be operated from up to 1000 feet away over standard station cabling.

Development Support System

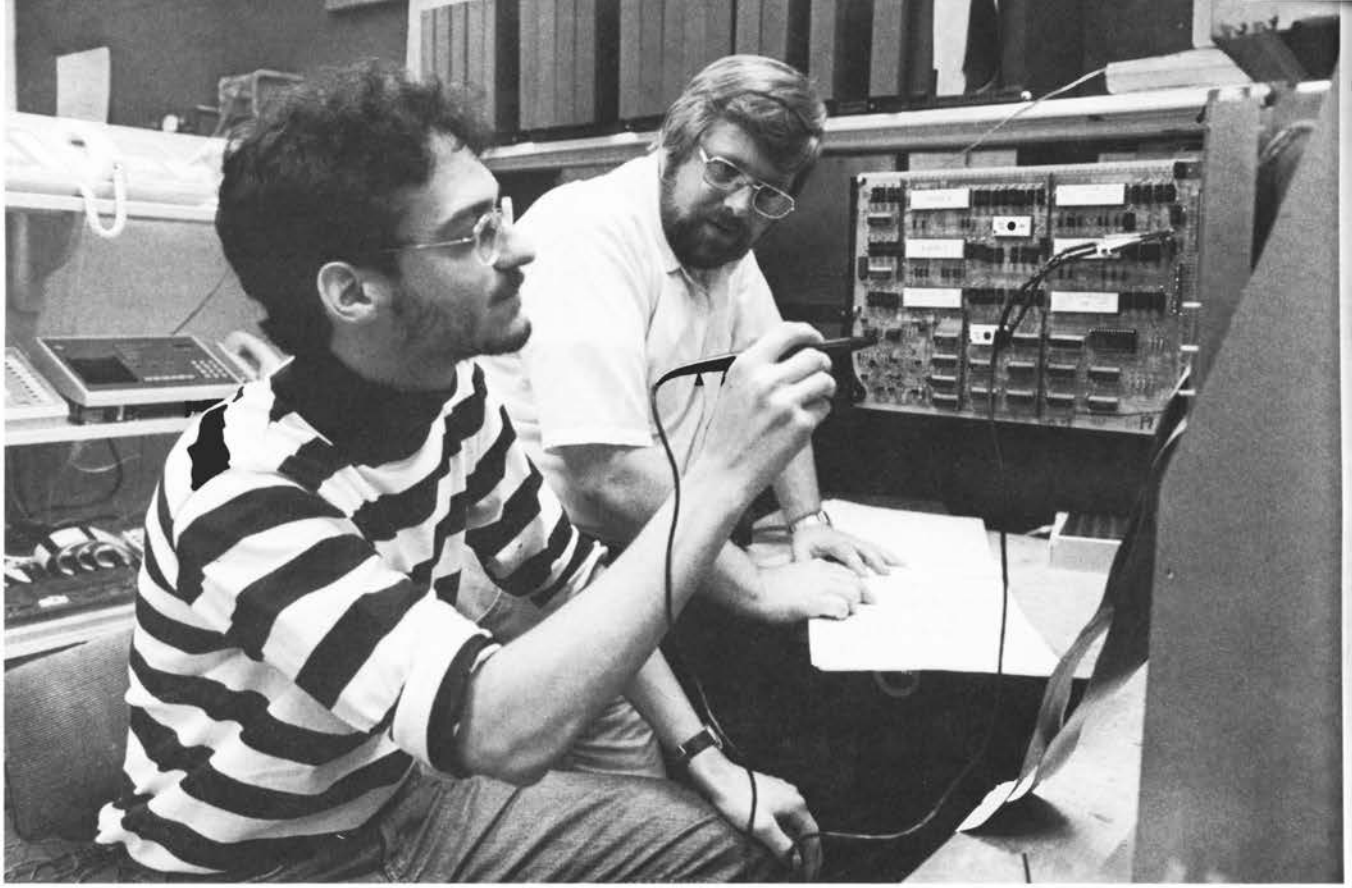
A new system helps software engineers design, integrate, test, and maintain software for the *HORIZON* System. The design of the Development Support System grew out of Bell Labs work with small microprocessor systems and also from the experiences with earlier developments, including electronic switching systems (ESS) and *DIMENSION* PBX systems.

The Development Support System includes a PDP-11 minicomputer that operates under the control of the UNIX Operating System—a general purpose time-sharing system. The Development Support System also includes a simulator for testing software on the minicomputer, terminals for entering and editing programs, and a complete *HORIZON* System that's controlled by the minicomputer.

The Bell Labs software engineer can use any computer terminal in the Development Support System to design routines, create files, compile, assemble, and integrate program modules, and debug and test the software. At the same terminal, the engineer can control the *HORIZON* System's microprocessor-based controller and memory.

For example, a software designer may be required to write a special program that causes the lamps in the electronic sets to flash under a defined set of circumstances. The designer writes the set of instructions in a new language, which resembles a high-level language and was designed for the *HORIZON* System and the Development Support System. After the instructions are entered into the Development Support System's minicomputer, the designer watches the *HORIZON* System connected to the minicomputer to determine whether the lamps are operating in

Control unit. Using a logic probe, engineer Jim Lawlor checks control signals sent between the processor and network boards. Below, Scott Kennedy, a physical design engineer, compares the labeling on the connecting units to information in the system's TOP document.



the desired manner. If not, the designer, sitting at the terminal, can halt the system, use an interactive program to determine the cause of the problem, make the necessary changes and try again. In this way, the designer can test the routine on an actual *HORIZON* System instead of relying strictly on a simulated system.

For software problems uncovered in the field, an engineer can connect a special test unit to the customer's *HORIZON* System. This unit provides sophisticated diagnostic tools that mimic the test and control capabilities available on the Development Support System.

With the test unit and a data link to the Development Support System, an engineer can examine the translation memory and determine whether there are any inconsistencies that might cause a problem. The test unit also permits the engineer looking for a memory error to examine the contents of the entire memory and compare it to what it should be. (See photo on opposite page, left.)

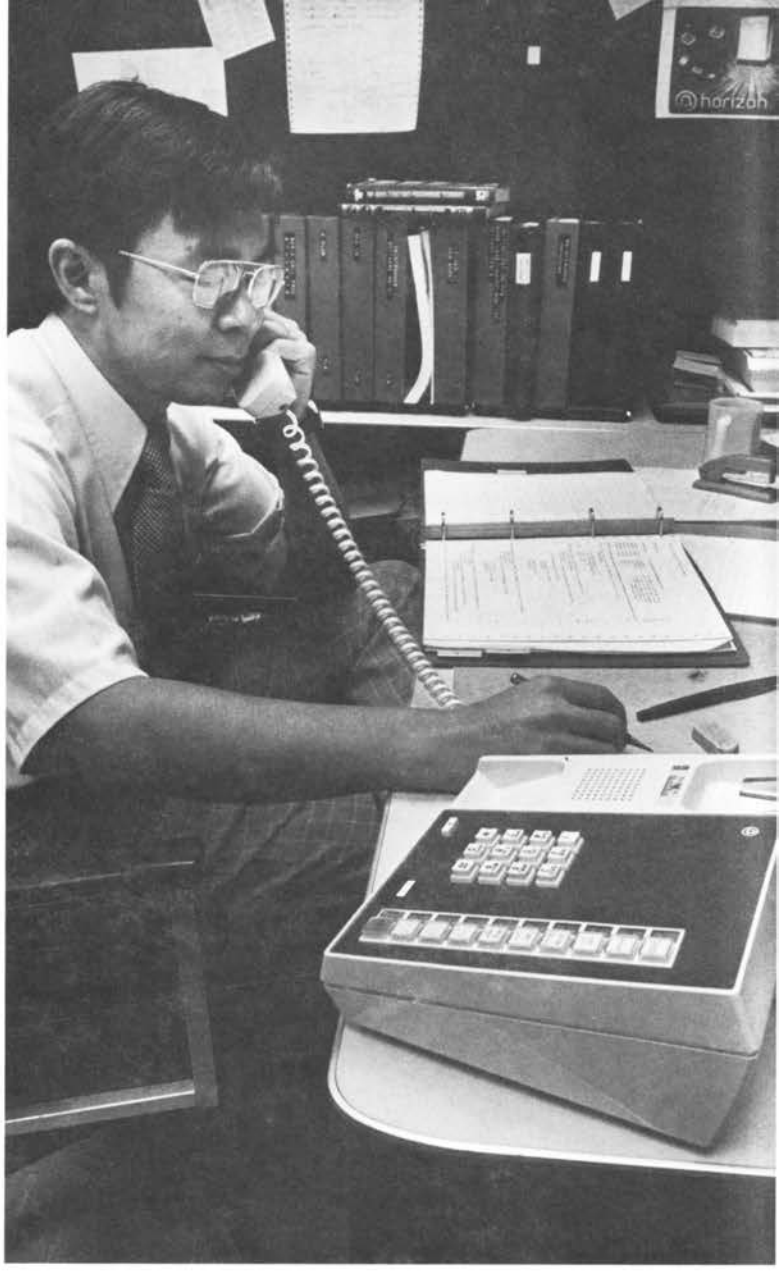
The Development Support System has other capabilities, such as helping prepare software documentation. It also loads and controls a facility for writing instructions in programmable read-only memory (see photos on pages 276 and 277), which is later encoded in the read-only memory, and provides a means for engineers using terminals to communicate with each other.

A team effort

The development of the *HORIZON* System was a coordinated effort that involved not only many Bell Labs departments but also many Bell System organizations. AT&T defined the product needs and with input from Bell Labs and Western Electric planned the system's introduction into the field.

At an early stage in the development process, Operating Company representatives attended a workshop, sponsored by AT&T, to discuss the characteristics of the proposed system. Many of their suggestions have been incorporated into the *HORIZON* System.

Bell Labs engineers worked closely with their Western Electric counterparts to ensure a smooth transition from development to manufacture. Bell Labs engineers developed and wrote special tests used by Western Electric to check out individual circuit packs



Development testing. At left, circuit designers Paul Berkowitz (left) and Jim Van Derveer check a new version of a printed wiring board they developed for the new system.

Troubleshooting. Above, without interrupting service to the customer, Dennis Hunsberger (foreground) and Dana Runyon use the test unit they designed to examine a system's translation memory.

Checking out features. At right, software engineer Jack Wang uses a Multibutton Electronic Telephone to determine whether a program controlling one of the phone's features is operating properly.

and entire systems to be sure they meet Bell System performance objectives. A test set, controlled by a minicomputer, checks out the circuit packs; it automatically diagnoses problems and indicates which devices need replacement. To implement system tests, a specially designed program board takes control of the system and thoroughly tests both the system and peripheral hardware. The system test board diagnoses problems and indicates where errors exist.

Human factors specialists at Bell Labs also played a critical role. They conducted tests to determine the best way to implement and describe the new features and to train people in their use. In addition, a complete system documentation package has been developed to promote better understanding and use of the *HORIZON* System and to minimize training costs. The package includes the traditional Bell System documents, such as Bell System Practices, as well as special booklets, reference cards, charts, and an audio/visual program for the customer. (See photo on page 273.)

Experience to date

In May 1977, the first *HORIZON* System was cut into service in Louisville, Kentucky on an experimental tariff. The installation of 27 electronic sets and 16 single-line *TOUCH-TONE*® telephones went according to schedule.

Since May, several other systems have been installed in the Louisville area with equally good results. □