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Stored Program Controlled Network:

800 Service Using SPC Network Capability

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On April 25, 1982 the Federal Communications Commission approved the Bell System tariff for Expanded 800 Service. In the approval the FCC noted that the new features would "provide subscribers with operational and call routing flexibility previously unavailable." This service marks the first use, on a ubiquitous nationwide basis, of powerful call control capabilities provided by the stored program controlled network. This paper reviews the application of these capabilities to our 800 Service.

I. BACKGROUND

The 800 Service, which at one time was called Inward Wide Area Telecommunications Service (INWATS), allows a customer to establish an area of the country from which he or she can receive calls without charge to the calling parties. In the United States, the service is currently available for both intrastate and interstate calls. Tariff rates for the interstate 800 Service, for example, are currently based on the number of customer lines, the band of rate state or service area selected, the monthly hours of usage, and time of day. Over the last decade, the volume of 800 Service calls has increased to the extent that its traffic has become a substantial percentage of all toll calls served by existing telephone switching systems. The service has proven to be especially useful for business customers providing travel and hotel reservations, purchase orders, and credit verification, and in direct marketing applications. About one-third of the customers have unlisted 800 numbers, while many other numbers are heavily advertised on television and in newspapers and magazines.

Despite the commercial success of 800 Service, the ever-expanding

customer demands for the service and the manner in which that service is provided in the Public Switched Network have presented a number of problems for the telephone industry and its customers. Prevalent among the problems are the following:

(*i*) The requirement for a multiplicity of 800 numbers

(*ii*) Routing and numbering inefficiencies because of the service band screening operation

(*iii*) Ineffective attempts because of all-customer-lines-busy conditions

(*iv*) Network overloads because of mass calling to 800 numbers advertised on television

(*v*) The rigid geographical service band structure

(*vi*) The absence of traffic statistics for customers on the points of origin of their calls.

II. SERVICE TODAY

A customer purchases the service on an intrastate and/or interstate basis and is supplied with one or more 800 numbers. Such an arrangement is necessary because of current state and federal tariffs which require separate usage measurements and lines for intrastate and interstate calls. Interstate 800 Service is currently offered in six geographical bands relative to the state (more specifically the rate state) of the customer. Band 1 generally involves all states bordering the customer's home state; band 2 includes all of band 1 and additional states bordering band 1. This continues through band 5, which covers the continental United States and includes Puerto Rico and the Virgin Islands, and band 6 adds Hawaii and Alaska. In some cases, multiple bands of intrastate are also offered. Billing is done by clocking the call at the terminating local central office. A recent tariff change has been filed which provides for a usage-sensitive tapered schedule.

2.1 Previous method of routing calls

Figure 1 illustrates how 800 Service calls used to be routed through the network. The calls were routed by means of ten-digit numbers, the first 6 digits of which consist of two special three-digit codes. The first three digits were always 800. The second three digits consisted of an NXX code (N = 2 to 9; X = 0 to 9), corresponding to the terminating area code. One or more NXX codes were assigned to a particular area code. The first nine digits of the 800 number were associated with a particular band. This association was known only at the Terminating Screening Office (TSO) serving the particular NXX. NX2 codes were used for intrastate 800 Service.

When a customer dialed an 800 number, the call was routed to an Originating Screening Office (OSO), which was a toll switching office

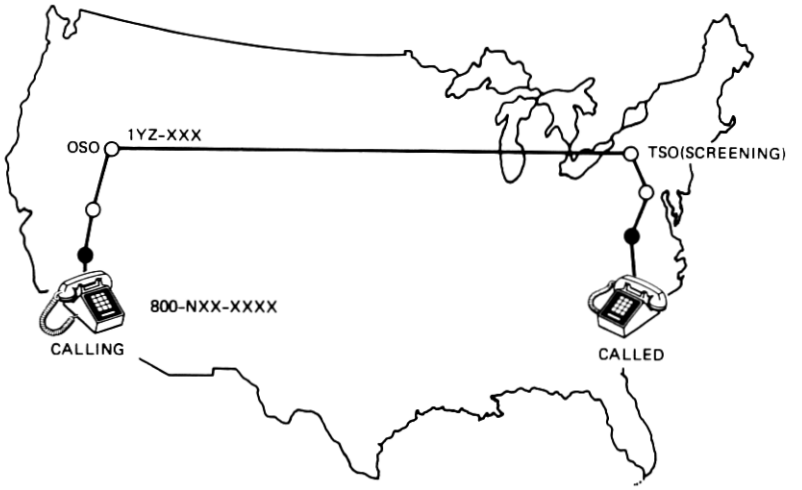

Fig. 1—Previous routing method.

capable of 6-digit translation. If an OSO served multiple rate states, adjacent rate states converted the 800 to 00X before sending the call to the OSO. In either case, by examining the first six digits of the call, the OSO determined the TSO to which the call was to be routed. The OSO then deleted the first six digits, substituted a 1YZ code (or code-converted the 800 to 08Z, if the call was to be routed through an intermediate office), the Y being an abbreviation for the NXX, with respect to the TSO which serviced up to five different NXX codes, and the Z indicating the rate band from which the call originated. The call was then routed to the TSO. By translating the first six digits it received, the TSO determined whether the call was permissible and, if so, the location of and routing to the local central office. The TSO then deleted the 1YZ code, prefixed an 0XX code or a directing digit for the local central office, and set up the call.

The problem with the above method of operation, developed over a decade ago in the era of electromechanical switching, was that it was inflexible. However, considering the technology available at the time and the desire to implement the service utilizing existing network capabilities, it was a most clever design and illustrates the robustness of the Public Switched Network. The system was based on communication using the ten-digit routing plan and six-digit translation capabilities. This resulted in routing restrictions, utilization of special codes, and constrained network management.

III. STORED PROGRAM CONTROLLED NETWORK

The Stored Program Controlled (SPC) Network, a network of proc-

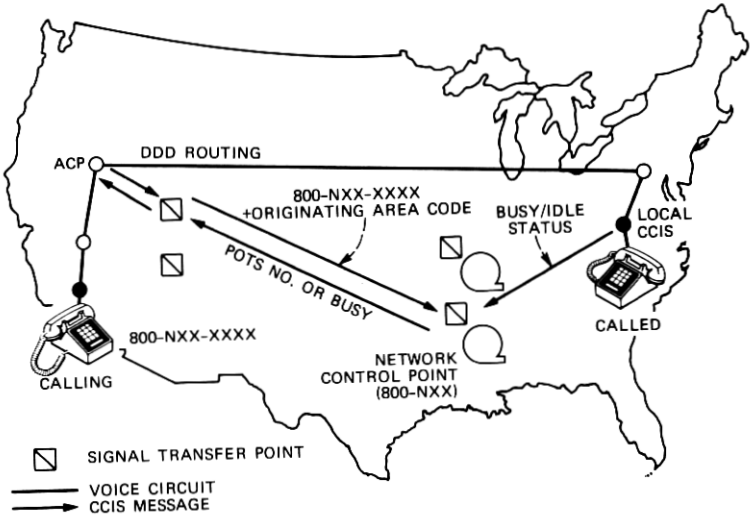

Fig. 2—Improved 800 Service.

essor-controlled offices interconnected with a packet signaling system (Common-Channel Interoffice Signaling—CCIS), removed many of the restrictions that existed. All nodes in the SPC network are able to communicate with one another. The SPC network is being augmented with CCIS-accessible processor-controlled data bases. These new network elements are called Network Control Points (NCPs). Such a configuration allows switching offices called Action Points (ACPs) to send inquiries to specific NCPs to find out how to proceed with the establishment of a call.

The 800 Service is one of the first call types to make use of this new technique. All 800 Service calls are routed to CCIS-equipped switching offices. Initially, this capability is in No. 4 ESS, No. 4A-ETS, and No. 1/1A ESS CCIS offices. Such offices send a CCIS message to the NCP to do the band screening operation. If the screening passes, a special unlisted telephone number is returned to the CCIS office which then sets up the call as any other DDD call. Billing is still being done at the terminating local office. Figure 2 illustrates how 800 Service calls are being routed through the network using the SPC network.

Under this approach, local offices equipped with CCIS would inform the data base of the busy/idle status of their 800 Service line groups. This would enable the network to stop ineffective attempts to busy 800 Service lines at the CCIS OSO office, where the busy signal would be returned to the caller. It is anticipated that in the future, calls may be routed to an alternate location when the data base recognizes a busy condition at the terminating location.

3.1 Data base configuration

The processor-controlled data bases, called network control points, which are to support this operation, are centrally administered by the AT&T Long Lines Department. They load information pertaining to each 800 Service customer into the data base. A more detailed discussion of the administration network is provided in the paper entitled "800 Service Using SPC Network Capability—Network Implementation and Administrative Functions," appearing in this issue of *The Bell System Technical Journal.* The NCPs are located at several of the CCIS Signal Transfer Point (STP) sites. The STPs are totally redundant and are engineered for mate-failure situations. The NCP on mate STPs are likewise redundant and engineered for mate NCP failure. NCPs in different switching regions contain different data. Each NCP pair is identified by a set of 800-NXX codes. It is the responsibility of the STPs to translate the 800-NXX code and route the message to the correct NCP. The STPs will be made aware of the NCP failures so that they could route the messages to the mate NCP.

IV. 800 SERVICE CALL PROCESSING

4.1 Action Point

The ACP is any CCIS-equipped switching office, toll or local, with the appropriate generic program. It is the job of the ACP to identify the incoming call as 800 Service, identify the area code from which the call originated (by incoming trunk classification or by examining an 00X code that a previous office substituted for the 800 code), format and send a CCIS inquiry message to either one of the STPs it homes on, and wait for a response. The CCIS message sent to the data base includes the dialed number (800-NXX-XXXX), the call's originating area code, the CCIS return address of the ACP, and a call identifier so that the response can be associated with the proper call.

The data base response contains either a special unlisted telephone number, a busy or closed indicator, an out-of-band indicator, or a vacant-line indicator. The call is then either set up as a normal DDD-routed call or given an appropriate announcement tone. A second message could be received with respect to an inquiry—a network management message. Such a message indicates that the data base has determined that a mass calling event is occurring to that particular 800 number and that a control action is requested at the ACP. The message would contain a gap interval of from a few seconds to 5 minutes. For the next 5 minutes the ACP will only allow calls to the affected number, spaced the specified interval apart, to be completed. This control would protect the voice network, the CCIS network, and the data bases from the overload effects of mass calling to particular

800 numbers. The process of detecting mass-calling events and determining appropriate gap intervals will be discussed later.

4.2 Network Control Point

The job of the NCP is to screen the call and translate the received 800 number into a nondialable yet routable "plain old telephone service" (POTS) number. This translation could depend upon the originating area code, the busy/idle status of a customer's line group, the time of day, or the day of the week. The NCP retrieves the file associated with the 800 number and checks the originating area code against a list of allowed area codes (band purchased). If this operation passes, an area code to POTS number translation is made. The 800 numbers may be associated with one or more such POTS numbers. Associated with each POTS number could be a schedule of the customer's opening and closing times for the week, an alternate POTS number, and a busy/idle bit. The process of updating this bit will be discussed later. An alternate POTS number may be assigned under the busy condition. If a call is allowed to transfer from one POTS number to the next, looping conditions are cared for.

V. NETWORK ADVANTAGES

5.1 Network management

The data base is in a unique position to detect, control, and monitor mass-calling situations. Mass calling to 800 numbers occurs frequently and is usually caused by these numbers shown on television. All calls to a particular 800 number go to the same data base for screening and translation. The data base monitors the number of attempts in each 5-minute interval against every 800 number. If a threshold, determined by the number of lines a customer has purchased, is exceeded, then a control action is taken. The thresholds have been picked so that even customers with relatively short holding times could maintain extremely high occupancies without setting off the control. The initial control tells the ACPs, when they send inquiries to the affected number, to space future calls at some initial gap interval for the next 5 minutes. The data base then monitors the effect of the control and either increases or decreases the gap interval in an effort to keep the attempt volumes equal to the threshold. These automatic control capabilities are backed up by manual control actions.

5.2 Busy/idle status indicator

The availability of CCIS at local offices will allow the removal of ineffective 800 Service attempts that are caused by an all-lines-busy condition. Local offices so equipped will send an all-lines-busy message to the NCP when the last line of an 800 Service line group goes busy.

An idle message will be sent when any line of the group goes idle. A 5-second interval between busy and idle messages is required to add stability and to ensure that the messages do not get transported because of CCIS retransmissions. As stated earlier, the data base under an all-lines-busy condition will tell the ACP to give the busy tone rather than set up the call. If the busy bit has been set for an 800 Service line group for approximately 5 minutes, the data base will send an audit message to the local office to verify the busy condition. This will ensure that a customer cannot mistakenly get locked into the busy state.

Simulations have shown that approximately the same amount of signaling resources are saved by eliminating the setting up of the ineffective attempts as are used to transmit the busy/idle messages. Thus, it appears that the Busy/Idle Status Indicator (BISI) feature would yield, with no signaling costs, significant switching and trunking savings.

5.3 Other network advantages

The new method of establishing 800 Service calls has many network advantages associated with it. The terminating screening office function was eliminated. This resulted in more efficient routing and network management control of 800 Service calls. Numbering inefficiencies were eliminated, mass calling can be detected and controlled, busy attempts will be eliminated from the network, special routing codes were freed, and the directory assistance and intercept processes were simplified.

VI. POTENTIAL SERVICES

One of the major advantages to the new method of routing 800 Service calls is that a great deal of flexibility is inherent in the architecture. As described above, the data base makes the translation from 800 number to POTS number be dependent on many parameters. This allows the network to act as a customized automatic call distributor. Hence, new customer services become possible from the new architecture. Of course, any new services would be subject to the filing and approval of appropriate tariffs. Some examples of potential new services follow:

- *Single Number*—Allows for a combination of inter- and intrastate services, under a single 800 number, so that customers will no longer be required to advertise multiple 800 numbers.
- *Permanent Number*—Allows a customer to move to a different part of the country without changing his or her 800 number.
- *Customized Number*—Enables a customer to have easily remem-

bered numeric combinations for their 800 number, where available.

- *Variable and Customized Call Handling*—Allows customers to distribute calls based upon the originator's area code, the time of day, and/or day of the week.
- *Call Detail Information*—Provides a customer with a listing of all or a sample of call attempts itemized by call-originating area code.

As a case study, consider a customer that operates five regional reservation centers. Under today's 800 Service they would advertise five interstate and five intrastate 800 numbers. Furthermore, they can either staff all five centers 24 hours a day, use private lines between centers for after-hour coverage, or simply lose after-hour calls. With the new system, subject to tariff considerations, they will have just one 800 number to advertise, with the call being routed to the closest open-reservation center.

VII. COORDINATION

An extreme amount of coordination and cooperation was needed to provide, on a universal basis, features like the ones described in this paper. Timing for introduction of the improved 800 Service was important. Since, for universal service, all 800 Service calls had to be routed to CCIS-equipped offices, large trunking penalties could have resulted from a rapid implementation before sufficient CCIS availability. However, a delay in the implementation could have resulted in losing the early network advantages and marketing potential of these features. Transition and implementation plans were developed which allowed us to convert the past method of operation into the SPC network method. This required the development and loading of new generic software at No. 4 ESS, 4XB/CCIS, and No. 1/1A ESS (additional generic software is required to support local CCIS and the BISI feature), and a new STP generic to handle signaling to NCPS, NCP hardware and software, and a new centralized administration system.

The capabilities described in this paper are good examples of the potential of the SPC network and what we believe will be its ability to yield cost savings, as well as features to meet future customer needs.