CALL CENTER SOLUTIONS

Dean E. Harvey, Shannon M. Hogan, and John Y. Payseur

Dean E. Harvey, Shannon M. Hogan, *and* ***John Y. Payseur*** *are with AT&T Business Communication Systems. Mr. Harvey is head of the Adjuncts Planning Department in Lincroft, New Jersey. Ms. Hogan is head of the Voice Messaging Department in Denver, Colorado. Mr. Payseur is head of the Adjunct Systems Development Department, also in Denver. Mr. Harvey is responsible for systems engineering of the call center, voice messaging, and other adjuncts associated with the Definity® communications system. He joined AT&T in 1968 with a B.S. in statistics from Iowa State University in Ames and an M.S. in statistics from Stanford University, Stanford, California. Ms. Hogan is responsible for software development of AT&T's voice messaging products. She joined AT&T in 1976 and has an M.S. in computer science* (continued on page 44)

A Call Center is a business location that distributes a large volume of inbound or outbound calls to a group of agents or voice response systems. The goal of the Call Center is to provide the best possible service to its customers at the lowest possible cost, i.e., to minimize customer waiting time and maximize agent productivity. The Call Center architecture must be flexible enough to deal efficiently with peaks in offered volume, to provide the necessary data to manage Call Center operations effectively, and to add new customer services without significant changes to the existing architecture. As the range of services becomes more complex, the architecture must also support new elements, such as voice response units (VRUs), host interfaces, Integrated Services Digital Network (ISDN) interfaces, and multi-site Call Center networking. We describe the basic elements of Call Center architecture, focusing primarily on premises-based solutions. We illustrate Call Center configurations using the integrated private branch exchange/ automatic call distribution (PBX/ACD) feature of AT&T's Definity® communications system. We highlight the current and future benefits of ISDN, which promises both to improve customer service and reduce costs.

Introduction

Call Centers evolved from traditional telemarketing centers (customer service, catalog order entry, reservations, direct sales, surveys, etc.) to offer services such as product hotlines, emergency numbers, and information help lines. The goal of the Call Center is to provide the best possible service to its customers at the lowest possible cost. To achieve this goal, the Call Center must maintain an optimal configuration of lines and agents within a specified budget. This configuration must serve callers within a time period acceptable to them. The Call Center architecture must be engineered to deal efficiently with peaks in volume, to manage Call Center data operations effectively, and to add new customer services without changing the existing architecture significantly. (For more detailed information on Call Center applications and standards, see References 1 through 6.) The architecture must be able to support new elements, such as VRUs, host interfaces, ISDN interfaces, and multi-site Call Center networking. We describe these elements of Call Center architecture, highlighting current and future benefits of ISDN. We focus primarily on premises-based solutions, using the Definity communications system to illustrate typical Call Center configurations.

Panel 1. Abbreviations, Acronyms, and Terms

ACD — automatic call distribution
ANI — automatic number identification
ASAI — adjunct/switch application interface
BRI — ISDN basic rate interface
Call Center — a business location that serves a large volume of inbound or outbound calls
Call vectoring — a Definity communications system capability that allows customized incoming call handling
CMS — call management system
CPNI — calling party number identification
DID — direct inward dialing
DNIS — dialed number identification service
FIFO — first-in, first out
intraflow — queuing of a call within a switch (to a backup split)
ISDN — Integrated Services Digital Network
look-ahead interflow — queueing of a call between switches (to an alternate site)
PBX — private branch exchange
PRI — ISDN primary rate interface
Q.931 — ISDN D-channel signaling specification
split — a group of agents with similar skills
VDN — vector directory number
VRU — voice response unit

Automatic Call Distribution

Automatic call distribution (ACD) is the fundamental architectural element of any Call Center. ACD is a feature of the switching system used to queue and route calls to groups of agents (see Figure 1). Typically, ACDs use the dialed number and/or the response to a call prompter sequence to determine which customer service is being requested (catalog orders, billing inquiries, nearest store location, etc). Groups of agents with similar skills are assigned to the same "split," e.g., billing inquiries to split 1 and catalog orders to split 2. By grouping agents together, and by distributing calls uniformly, the service time per call is minimized and each agent's time is used efficiently.

The switching system's ACD software manages both call queues and agent selection. (See Panel 1 for definitions of abbreviations, acronyms, and terms.) Commonly, there is one queue for each customer service (called number). Each queue is served on a first-in, first-out (FIFO) basis. Sometimes, priority queueing is used to handle calls more flexibly. As soon as an agent becomes available, he or she is automatically connected with the next caller from the appropriate queue. The agent/split selection algorithm assures that the "most available" agent from the appropriate split is assigned to the next call. If an agent is not available immediately, the ACD software plays an appropriate announcement to the caller.

As the call volume increases, the ACD system adjusts in several ways. Additional agents may log in to a split with heavy demand, or ACD supervisors may reassign agents among splits. The ACD software may invoke the "call intraflow" feature to queue the call to a backup

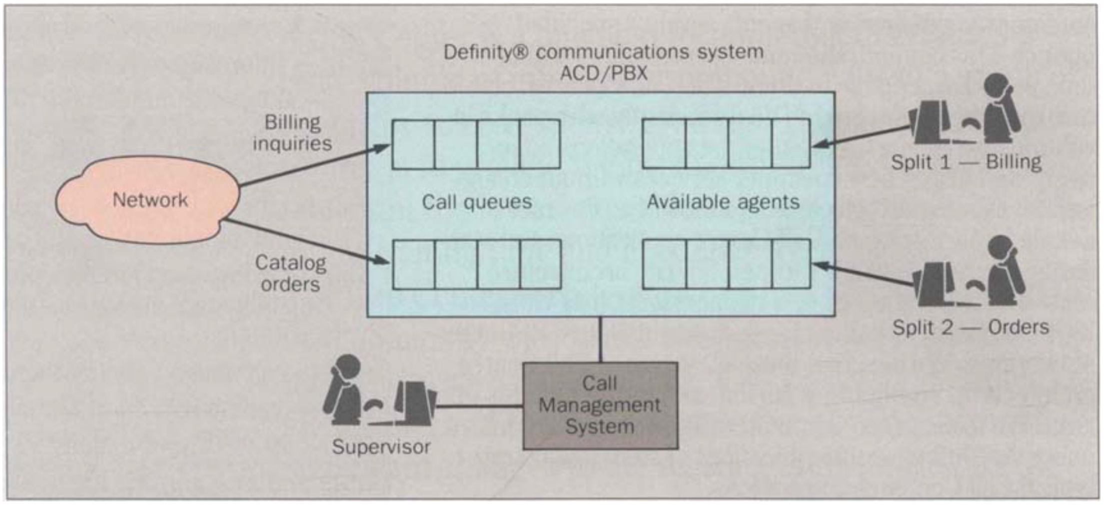


Figure 1. This simple ACD configuration shows how the Definity communications system's integrated ACD/PBX system is used to queue and route calls to groups of agents. The ACD uses the dialed number to determine which service a customer is requesting. The most available agent in the split receives the call, which is distributed by the ACD. The CMS allows Call Center supervision to monitor and control Call Center resources.

split after a set amount of time in the primary queue. An agent's phone automatically displays the called number (or service name) to let the agent know which service is being requested, even if the call has been diverted to a backup split used for other services.

Depending on the service being provided, an agent may have "after-call" work to complete before receiving another call. For instance, if data from the completed call must be entered into an order entry system, the agent manually signals the system when he or she is available for the next call. In cases where the agent may be available immediately following completion of the current call (e.g., directory information), the ACD may be configured to assume that an agent is available as soon as the current call has been completed.

Call Management System

The Call Management System (CMS) contains tools to help manage a Call Center. This system monitors all activities in the ACD, including trunk, queue, and agent status (e.g., when an agent logs in, makes a call, receives a call, or when a caller hangs up). In smaller ACD installations, CMS may actually reside within the Definity switch. In larger ACD installations, CMS typically resides in an adjunct processor. A control link is established between the switch and the adjunct processor to send changes in call and agent status.

The CMS provides reports on agent login IDs, splits, trunks, trunk groups, and call routing. These reports are designed to answer such questions as: Are enough agents assigned to billing? Are callers hearing busy signals from the network because of insufficient trunking? Are callers abandoning the system because of excessive delays? The CMS provides both real-time and historical reports.

Call Center management uses real-time and exception reports to determine when too many calls are queued for a given split. An administrative interface enables CMS to define ACD parameters (such as queue thresholds for intraflow) and helps Call Center supervision take corrective action in exceptional conditions. For example, Call Center management can reassign agents to balance call loads.

Panel 2. Sample Call Management Report

CMS SPLIT REPORT

Split: 1
Split Name: Billing

TIME	# ACD	AVG ANSW SPEED	# ABAND	AVG ABAND TIME	AVG TALK TIME	AVG AFTER CALL	# FLOW IN	# FLOW OUT	AUX TIME	AVG STAFF
8:00-9:00	32	:25	4	:32	5:15	:30	3	5	3:30	4.0
9:00-10:00	8	:07	1	:03	3:20	:00	0	0	9:30	2.2
SUMMARY	40	:21	5	:26	4:52	:28	3	5	13:00	3.1

# ACD	Number of incoming calls
AVG ANSW SPEED	Average time in queue before an agent answers
# ABAND	Number of calls abandoned before an agent is available
AVG ABAND TIME	Average time in queue before the call is abandoned
AVG TALK TIME	Average talk time once an agent answers
AVG AFTER CALL	Average time to complete a transaction once the caller disconnects
# FLOW IN/OUT	Number of calls intraflowed in/out of the split
AUX TIME	Work time not related to a specific call
AVG STAFF	Average number of agents staffed during the report period

Call Center management uses historical reports to forecast agent and trunk requirements, track agent productivity, and analyze call patterns (see Panel 2). The names associated with data such as login IDs and splits appear on the reports. Reports can be scheduled to run once or periodically. Custom reports can be created and tailored to the Call Center's specific applications.

Network Interfaces

In the past, the trunking between the Call Center ACD and the network has been provisioned on a predefined basis. Separate trunk groups were allocated to each Call Center service (billing, orders, outbound calls, etc.). For incoming calls, the ACD system used the trunk group ID to determine which service was being requested. Call Center management had to engineer the provisioning of each trunk group on a per-service basis for a peak volume forecast to ensure acceptable service times during heavy volume periods. As customer demands changed over time, Call Center management constantly monitored and changed these trunk groups to provide the proper level of service/cost. Engineering for peak loads by trunk group was often inefficient during nonpeak times, when the spare bandwidth on trunk groups with heavier loads could be reallocated to trunk groups with light loads.

Today, advances in network services (such as AT&T's Megacom® 800 telecommunications service) have consolidated several incoming trunk groups into one larger pooled trunk group. The customer may still dial different numbers, depending on the service being requested. The AT&T network then provides the ACD system with dialed number identification service (DNIS) routing numbers, which help determine the appropriate call treatment and routing. This allows much more flexible, efficient trunking to the network.

The network may also provide intelligent routing services. For example, calls may be routed to different Call Centers, depending on time of day and area code and exchange of origin (as inferred from the NPA or NPA-NXX of the calling party). A given service can have a single access number, but the network balances the load among several different Call Centers. The network can also translate a series of 800 numbers into a single DNIS routing number.

With the introduction of ISDN services, the interface can offer network bandwidth on demand. A primary rate interface (PRI) between the ACD system and the network has 23 voice (B) channels, plus an out-of-band signaling (D) channel. Channels can be allocated dynami-

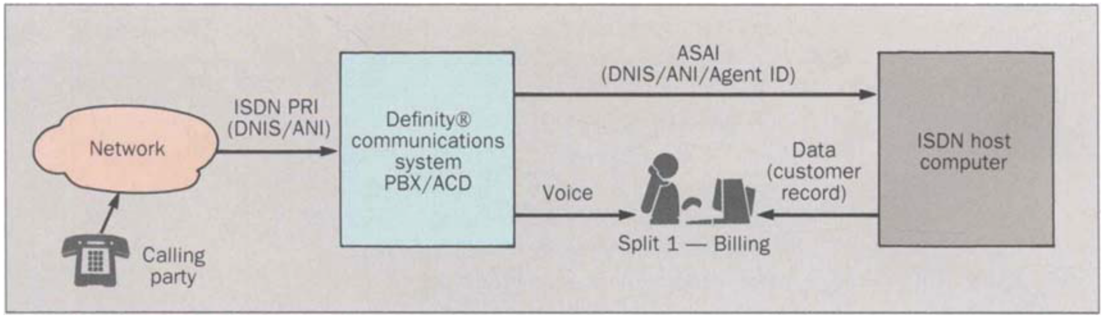


Figure 2. In this ISDN host computer configuration, the ISDN intelligent host interface (ASAI) automatically transfers customer information, the dialed number, and the agent's ID to the host computer before the agent answers the call. Because the customer record is available to the agent immediately, the customer receives quick, personal service.

cally among services on a call-by-call basis. PRI supplies DNIS information in the D-channel Q.931 messages. (Q.931 is an ISDN signaling message specification.)

ISDN also offers automatic number identification (ANI) to the ACD via Q.931 messages. ANI, sometimes referred to as calling party number identification (CPNI), identifies the telephone number of the calling party. The Call Center uses this information as an index for customer records, to classify customer contacts on a regional basis, or to return a call when the Call Center is overloaded.

The advanced services supported by ISDN help the Call Centers use network access resources most efficiently. They also offer the opportunity to serve customers better by increasing accessibility, decreasing customer waiting time, and by keeping each customer's records readily available.

Host Integration

Agents in most Call Centers use a host computer to complete a transaction with a customer. The host computer may provide information required to support the customer contact, such as order entry forms and addresses of the nearest dealer locations. Often, the host computer also has a record for each repeat customer. These records contain information such as address, phone number, previous sales, service calls, billing information, and the agent who last served the customer.

In many Call Centers, after the agent answers a call and gathers information from a customer, he or she enters the customer account number to access the customer's record in a host database. If the agent requires help from a supervisor or another agent to complete the transaction, the assisting agent also must enter the customer identification number into the host computer.

With an ISDN architecture and an intelligent interface between the ACD system and the host computer, the dialed number (DNIS), the customer identification (ANI), and the selected agent ID can be transferred automatically to the host before the agent answers the call (see Figure 2). The host then displays the appropriate customer record on the agent's terminal by the time the call is answered. This allows quicker customer response and more personal service, since the customer's name and account information are available immediately. If a call must be transferred later to a supervisor or another agent, the ACD system directs the host to transfer the data screen to the appropriate agent or supervisor.

Host access to DNIS and ANI also provides valuable information to Call Center analysis tools that profile customer calls. Based on the DNIS, the host can analyze which services are being requested and their peak periods of demand. Using ANI, the host computer can analyze calls based on point-of-origin and type of caller (e.g., preferred customer). The host computer can also retain ANI information for future callback needs if the information requested is not immediately available.

Voice Processing Integration

Voice processing technology offers new opportunities for automation of Call Center transactions and for more flexible call handling. It can give customers more services and input options to choose from and save agents from routine transactions that do not require extensive manual processing. The services described include:

- Auto attendant — The customer enters a Touch-Tone digit to access service information (e.g., "Enter 1 for billing, 2 to place an order, or ...")
- Automated transactions — The customer enters information (e.g., a catalog number, credit card number, etc) using Touch-Tone digits
- Voice capture — The customer leaves a message, as instructed by the VRU (e.g., "Please leave your name, phone number, and a brief message ...").

A frequent application of VRUs is the "auto attendant." Customers are given a single access number for a variety of services. The calling party is first connected to the VRU and is then asked to enter a Touch-Tone digit to request the service desired (e.g., 1 for billing, 2 for automated order entry, 3 for nearest dealer, 4 for a live agent, etc). When the user has entered a choice, the call is routed to the appropriate destination.

VRUs can also automate some of the more routine customer transactions. By using recorded voice or speech synthesis, the VRU can respond to Touch-Tone signals entered by a user. The user may select from choices given by the recorded or synthesized voice, or may enter actual data, such as a credit card number, catalog item number, or account number. The VRU may have a real-time or batch interface to a host computer, enabling the VRU to provide up-to-date information on account balances, nearest dealer location, or stock quotes. In more sophisticated applications, the VRU can capture a customer's voice message when agents are unavailable or the customer does not want to wait for the next available agent. The voice message may be something as simple as a call back number for future reference, a free-form message to be delivered to an agent for further follow-up, or a structured voice message that allows easy entry into an order entry system at a later time.

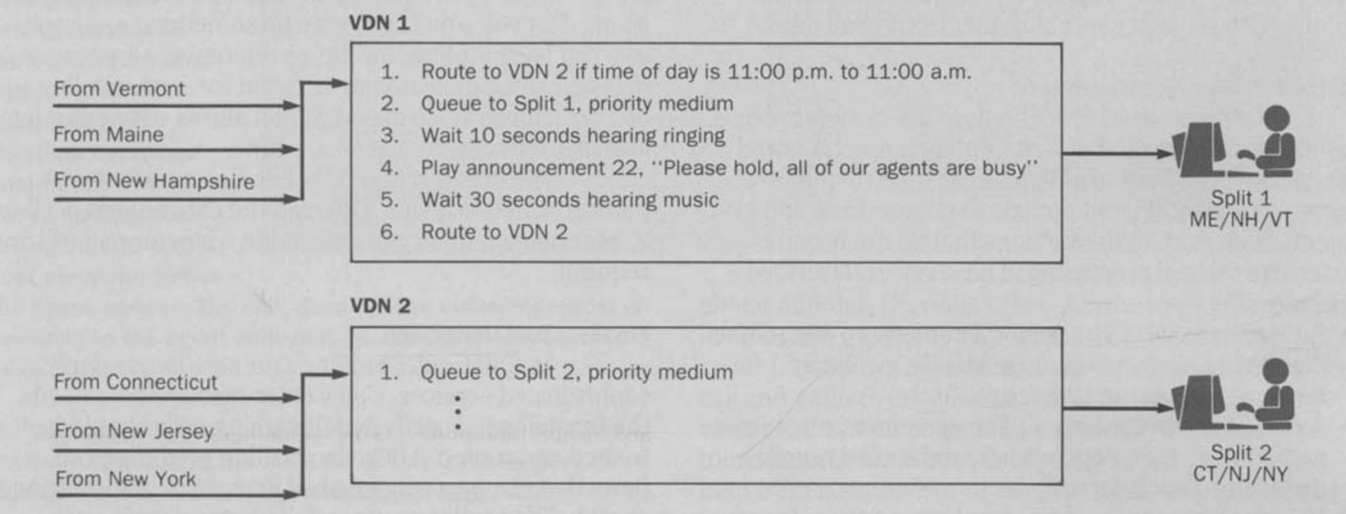
The CMS discussed earlier also monitors ACD ports attached to a VRU. Through the CMS reports, Call Center management can determine when more ports are required.

Flexible Call Handling

As Call Centers offer customers increasingly sophisticated services, Call Center management needs the flexibility to specify how incoming calls should be treated and routed. They also need to predefine call flows that can be easily invoked in unusual circumstances (e.g., holiday calling patterns). This preplanning can dramatically reduce the need for constant monitoring and adjustment of Call Center resources. Within AT&T's Definity communications system, this capability is referred to as "call vectoring." Call vectoring lets Call Center management:

- Provide special call treatment based on time of day (TOD) (e.g., night service) and day of week (DOW) (e.g., weekend service)
- Automatically change treatment based on how long the call has been waiting or on changing traffic or staffing conditions
- Respond to the waiting caller with appropriate feedback, such as music or announcements, during heavy calling periods
- Play multiple and/or recurring informational or delay announcements, selected according to TOD, DOW, traffic, and staffing conditions
- Appropriately control when billing (call answer) is started on the call
- Dynamically change the queueing priority of a call based on how long the caller has been waiting

Panel 3. Call Vectoring: Ticket Agency Application



A typical application of call vectoring. Calls reach a vector through the VDN. The digits sent from the network to the PBX/ACD select the appropriate VDN. Call vectoring gives Call Center management the flexibility to specify how incoming calls are to be treated and routed.

- *Problem.* A ticket agency serves the Northeastern region. The agency wants to have a single 800 number for all customers. The agency groups agents by states. During nonpeak hours, the agency sends all calls to the New York area split.
- *Solution.* The network DNIS provides a single 800 number access to the customer, but it selects a unique DNIS routing number to the ACD/PBX for each state of origin. The agent's voice terminal displays the DNIS information. Call vectoring routes calls based on time of day, allowing calls to go to the proper agent group. Call vectoring also queues to backup splits under heavy traffic conditions.

- Check multiple ACD splits for faster service
- Connect the caller to a voice mail or messaging system
- Route the call to local or distant destinations
- Remove selected calls (providing busy or disconnect).

Panel 3 shows a typical call vectoring application. Calls reach a vector via a vector directory number (VDN), which is an extension number assigned to the vector. The digits sent from the network to the PBX/ACD select the VDN to be used. The VDN maintains a one-to-one relationship with the service dialed or the service to be provided for that specific caller. It also serves as the application number and allows for specific call/agent handling and statistical reporting in the CMS.

VDNs are assigned to different vectors for different services or applications, depending on the specific treatment they need. Many VDNs can be assigned to the same vector, so that the same sequence of treatments can be given to calls that reach the PBX/ACD via different numbers or from different locations. VDNs can be preassigned to incoming trunk groups or sent in digit form to the PBX/ACD by the public or private network using direct inward dialing (DID) or DNIS.

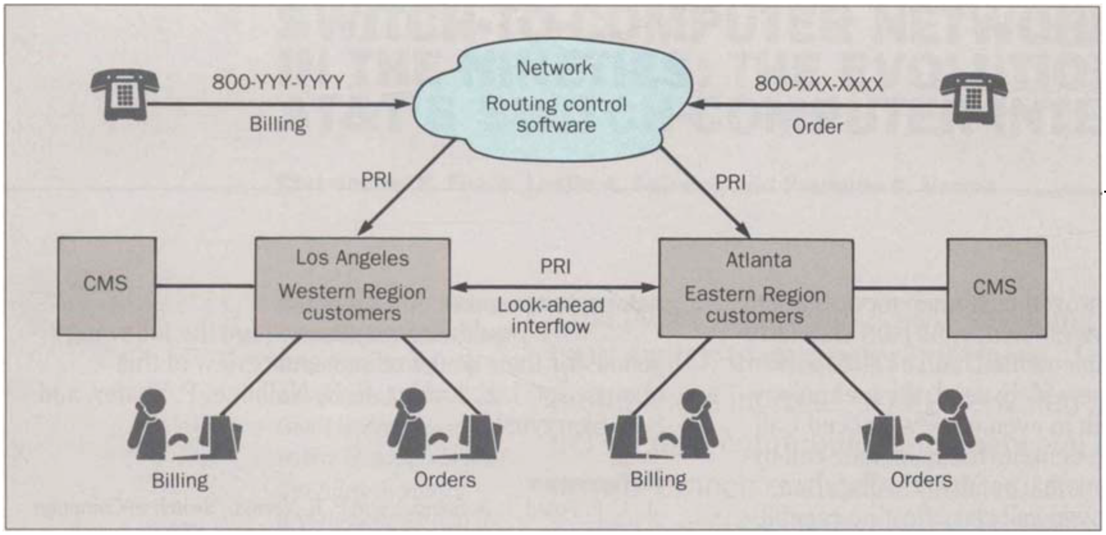


Figure 3. This networked Call Center configuration has a unique 800 number for each type of service. The intelligent network analyzes the DNIS and point of origin of each call. It then routes the call to the appropriate ACD site. In addition, the look-ahead interflow may forward calls from the original site to another site, depending on the amount of traffic and/or the time of day. ISDN D-channel Q.931 messages check the condition of the receiving site before the call is forwarded. Meanwhile, the call remains in the queue at the sending location and can be connected to a sending location agent if one becomes available before the call is rerouted.

A digital display telephone shows the answering agent the source of the call (the trunk group used for the incoming call or the actual calling party number with ISDN-PRI service) and the VDN to which the call was directed. Alphanumeric names can be assigned to VDNs so the agent can be given the name (and/or number) of the service being called.

Call Center Networking

So far, we have limited our discussion of Call Center architecture to a single site. Actually, many large customers have several ACD sites, often geographically dispersed. Call handling efficiency and agent productivity can be further maximized by treating these multiple ACD sites as a single ACD network. Each site may continue to be the primary point of contact for a given service or for a given geographical region. Networking the sites allows one site to serve as a backup site for another and provide:

- Night service
- Emergency backup
- Traffic overflow during busy hours.

Figure 3 shows a networked ACD configuration. The network offers a single 800 number for a given customer service, billing, orders, etc. However, the intelligent network actually routes the calls to the appropriate ACD sites, based on the DNIS and geographical point of origin of the caller. "Look-Ahead Interflow" forwards calls to another site based on traffic or time-of-day considerations at the original site. The "sending" location uses call vectoring to determine whether to hold or send the call. ISDN D-channel Q.931 messages check the condition of the "receiving" site before the call is actually forwarded. While the receiving location is being checked, the call remains in queue at the sending location and can still be connected to a sending location agent, if one becomes available before the receiving location accepts the call.

Call vectoring is used at the receiving location to decide whether to accept the call from the other location or to inform the sending location to keep the call. The sending location can then check other locations or treat the call some other way. Conditions for sending the call can be any combination of:

- Time of oldest call in queue
- Number of calls in queue
- Number of available agents
- Time of day and day of week.

The look-ahead interflow sends the number of the calling party (ANI) and the DNIS to the receiving location.

ISDN Call Center Directions

Throughout this paper, we have discussed the benefits that ISDN is already bringing to Call Center operations. ISDN has improved customer service, agent productivity, and network efficiency. As ISDN standards become more widely implemented, and as ISDN network capabilities become more widely used, the technology that ISDN offers will result in even more advanced Call Center applications. The benefits today include call-by-call service selection, dynamic bandwidth allocation, DNIS, ANI delivery, improved call classification capabilities, and initial implementation of host computer interfaces. In the future, it will offer a standardized adjunct-switch applications interface (ASAI), improved interworking between premises and network applications, and new customer service opportunities.

The ISDN ASAI controls ACD/PBX features from a host computer. ASAI allows true "third party" call control, in which the host may initiate and control calls for the switch. This interface will allow even more flexibility and control in the design of advanced Call Center applications.

Future ISDN standards and broader ISDN network deployment will also offer new architectural options and application opportunities for Call Centers. The increased signaling capabilities provided by ISDN Q.931 messages between the premises and the network will add more intelligent routing capabilities to the network (e.g., call routing according to load conditions within the Call Center).

Broader deployment of ISDN capabilities will increase application opportunities and flexibility in Call Center architectural options. Home Agent telecommunications software, a product of the Definity communications system, already allows agents to work at home. With ISDN, agents will be able to work from home even more efficiently. BRI support will carry two bearer (B) channels and one (D) signaling channel to the agent's residence. The B channels can support both voice and high-speed data sessions. The D channel can support low-speed data sessions, as well as provide a signaling and control channel between the home agent and the Call Center ACD/PBX. Call Center supervision will gain substantially increased flexibility in staffing the Call Center during peak load periods and in reducing Call Center operational costs.

Acknowledgments

We would like to acknowledge the following people for their contributions and review of this manuscript: J. E. Kohler, R. D. Nalbone, P. Shafer, and S. L. Skarzynski.

References

1. C. F. Foard, L. A. Spindel, and P. K. Verma, "Switch to Computer Networking in the Nineties: The Evolution of AT&T's Switch-Computer Interface," *AT&T Technical Journal*, Vol. 70, No. 5, September/October 1991, pp. 45–58.
2. D. R. Fischell, S. S. Kanwal, and D. S. Furman, "Interactive Voice Technology Applications," *AT&T Technical Journal*, Vol. 69, No. 5, September/October 1990, pp. 61-76.
3. C. J. Ryva et al., "Corporate Networking: Evolution and Architecture," *AT&T Technical Journal*, Vol. 70, No. 5, September/October 1991, pp. 2–13.
4. R. J. Basso et al., "OSPS System Architecture," *AT&T Technical Journal*, Vol. 68, No. 6, November/December 1989, pp. 9-24.
5. "Adjunct/Switch Application Interface (ASAI) Specification, Issue 1," *AT&T Technical Reference*, Select Code 555-025-203, AT&T Customer Information Center, Indianapolis, Indiana, November 1989.
6. "AT&T Integrated Services Digital Network (ISDN) Basic Rate Interface Specification," *AT&T Technical Reference*, Select Code 801-802-100, AT&T Customer Information Center, Indianapolis, Indiana, May 1989.

Biographies (continued)

from the University of Michigan, Ann Arbor, and an M.B.A from the University of Colorado, Boulder. Mr. Payseur is responsible for software development of AT&T's Call Management System and other Definity adjunct systems. He joined AT&T in 1972 with a B.S. in mathematics and an M.S. in computer science from Iowa State University.

(Manuscript received April 8, 1991)