THE AT&T SERVICE CIRCUIT NODE: A NEW ELEMENT FOR PROVIDING INTELLIGENT NETWORK SERVICES

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Increasing demand for advanced voice-and-facsimile network services has motivated the recent introduction of an important, new, programmable network element: AT&T's A-I-Net™ service-circuit node. This new network element complements existing network switching and database elements by providing internal network access to a programmable node that has highly specialized service circuits. These circuits support network services that involve the synthesis, interpretation, repetition, or translation of voiceband information. Although the central-office and operations-support interfaces we describe are designed for the United States market, the service-circuit node provides a flexible base for supporting interfaces that are appropriate for other markets, too. As service-circuit technology continues to advance to support complex, image-processing functions (e.g., facsimile or speaker recognition), service providers will require greater flexibility for developing services that use these functions. An applications-development environment, based on application-oriented-language technology, enables service providers to introduce new capabilities rapidly into existing networks.

Introduction

The increasing demand for advanced voice-and-facsimile network services has motivated AT&T's recent introduction of a programmable, network element into the target intelligent-network architecture depicted in Figure 1. This important new element—the A-I-Net service-circuit node (SCN)—provides internal network access to a programmable node that has highly specialized service circuits. Thus, the SCN complements existing network switching and database elements.

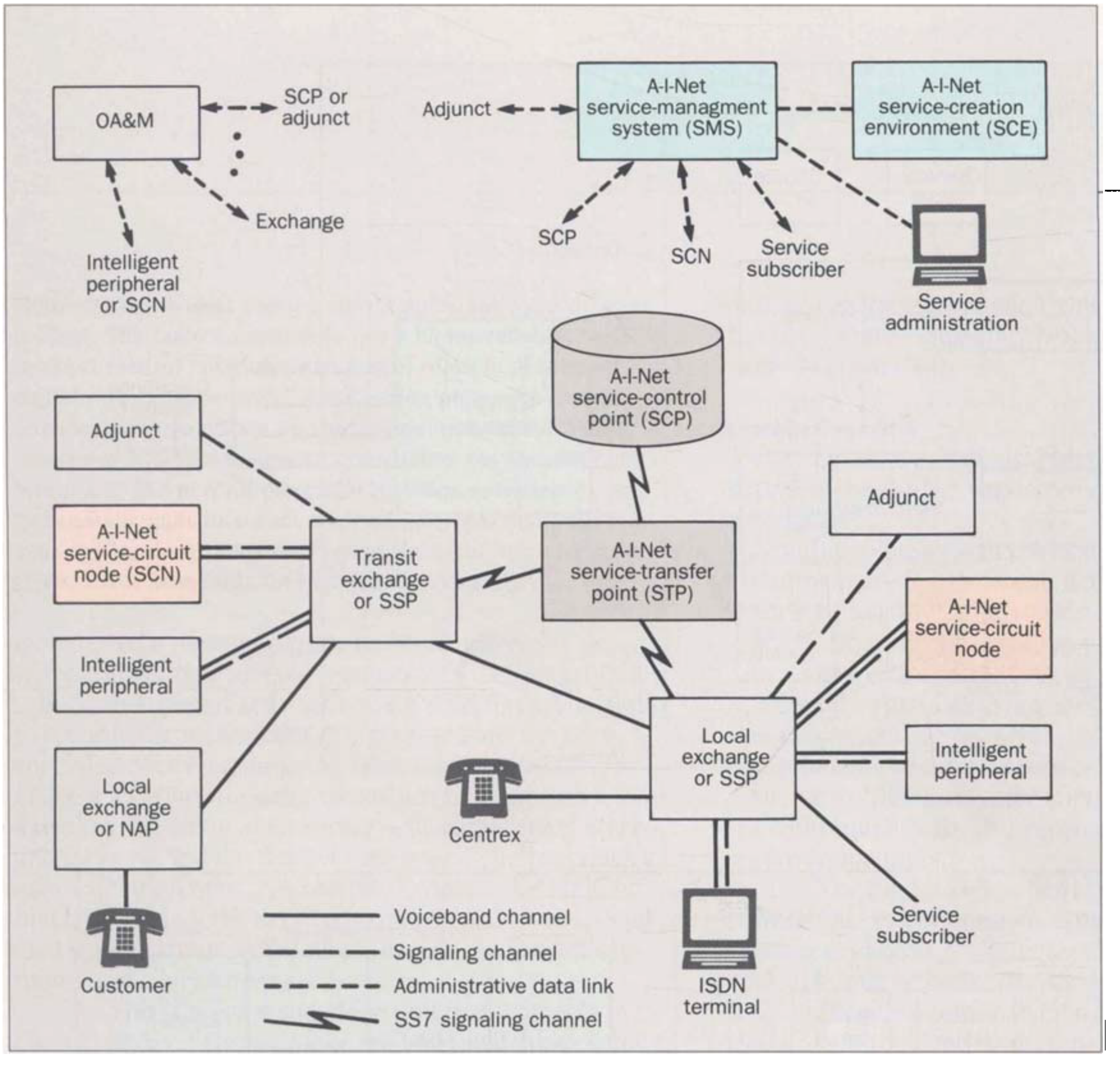


Figure 1. The A-I-Net service-circuit node (SCN) is a new, programmable, network element in AT&T's intelligent-network architecture. Now, existing network-switching and database elements have internal network access to a programmable node that has the highly specialized service circuits required for voiceband information services.

(Appendix A defines acronyms and terms.)

The A-I-Net service-circuit node, as described in this paper, is specifically designed to meet requirements of the United States market. However, the SCN also provides a flexible base for supporting applications for other markets. (The article by Workman et al. in this issue describes one such application.[1])

The SCN is a programmable system that gives a telecommunications-service provider the ability to create new services for its customers. As part of the A-I-Net family of products, AT&T Network Systems provides an applications-development environment that is based on application-oriented-language (AOL) technology. We refer to the applications-development environment for the SCN as the A-I-Net service-creation environment (SCE). The SCN executes application software developed using the SCE. (The paper by Morgan et al. in this issue describes the SCE.[2])

In addition, the SCN comes with a set of C-language subroutines (which are part of the SCE) for use when a low level of software control is needed. By using a combination of C language and the subroutines provided, the service provider can add special functions that AOL-based service packages can access.

This powerful service-creation system (i.e., the SCN and SCE), when combined with a broad array of service circuits, gives a service provider the ability to add many exciting services to the network. Service examples

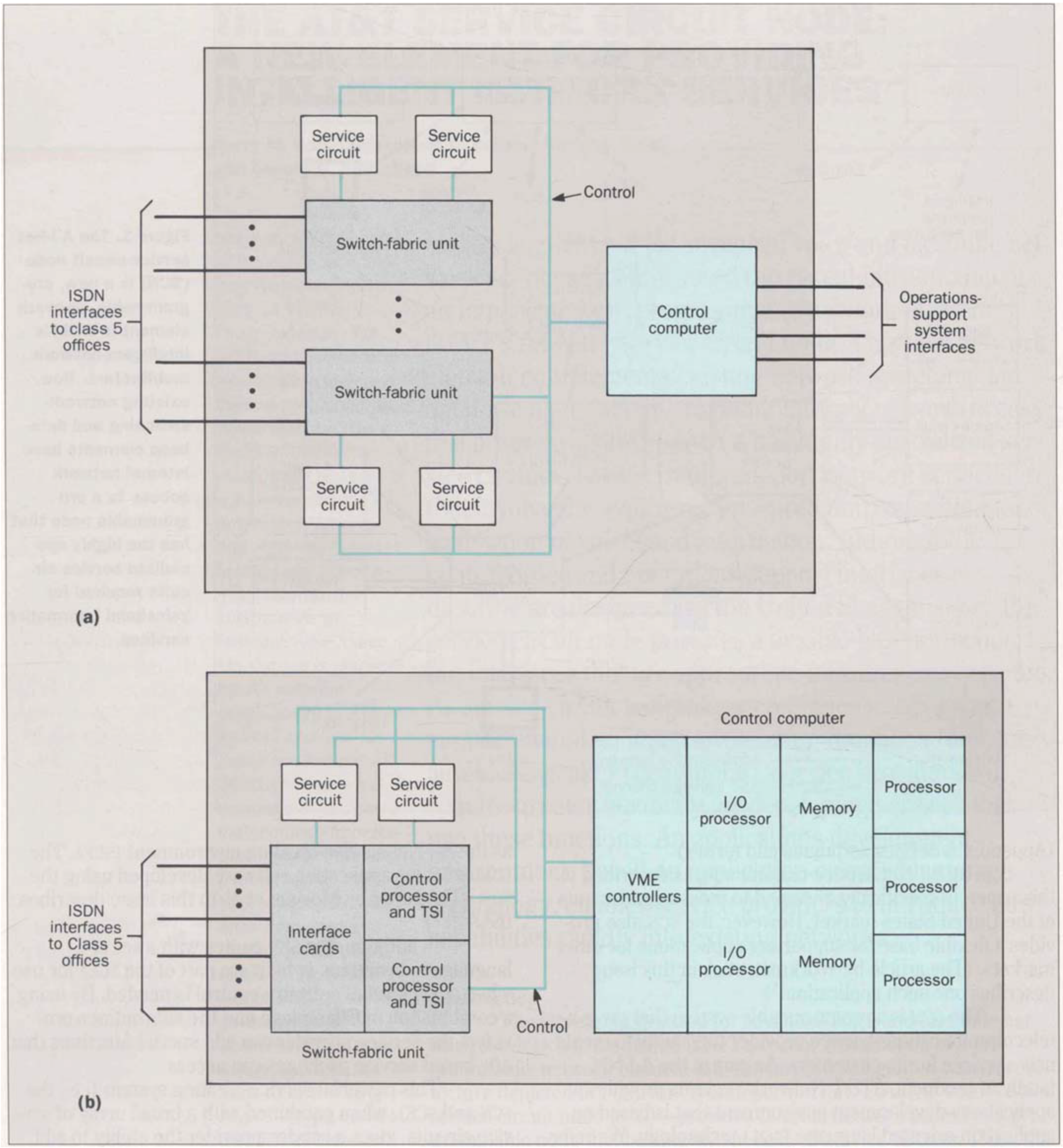

Service circuit
Service circuit
Control
Switch-fabric unit
ISDN interfaces to class 5 offices
Control computer
Operations-support system interfaces
Switch-fabric unit
Service circuit
Service circuit
(a)
Control computer
Service circuit
Service circuit
I/O processor
Memory
Processor
Control processor and TSI
VME controllers
Processor
ISDN interfaces to Class 5 offices
Interface cards
I/O processor
Memory
Processor
Control processor and TSI
Control
Switch-fabric unit
(b)

Figure 2. The A-I-Net service-circuit node. (a) System architecture. The main components are a highly reliable, fault-tolerant control computer and one or more fault-tolerant, digital switch-fabric units. A collection of service circuits provides such functions as voice announcements, DTMF receivers, and text-to-speech conversion. (b) System fault tolerance. The control computer provides software-transparent fault tolerance without intervention or aid from user applications. Fully duplicated time-slot interchangers (TSIs) meet standards for high-reliability systems.

include voice messaging, account-match types of services, call announcer (i.e., it announces the name of the caller), and specialized routing and screening. The ability to record custom announcements (e.g., one or more special-services announcements for each subscriber) enables a service provider to customize many services to users' needs. In the data services, facsimile (FAX) store and forward, and database-access areas, such services as user validation now are possible. By using the building blocks provided, the service provider can create specialized services to meet the needs of a single market segment or of a large user.

The SCN is a stand-alone unit that connects to class 5 offices. (These offices are local switching centers, i.e., a switching center to which user telephones are "directly" connected.) It is a reliable, central-office system that meets a service provider's needs for a highly reliable and easily maintained system. The SCN connects to standard operations-support systems to meet service-provider needs for remote-maintenance control, centralized collection of billing data and traffic measurements, and interfaces to service-management systems.

AT&T Network Systems offers a wide choice of service circuits that are fully integrated into the SCN. In addition, the interface to service circuits is documented, so that service providers can add their own service circuits, as desired.

The design of the SCN software architecture emphasizes the ease of adding new service circuits, so that the system's capability to support new services can be easily expanded.

System Overview

Figure 2a presents a high-level view of the architecture of the A-I-Net service-circuit node. The main components are:

- A highly reliable, fault-tolerant *control computer.*
- One or more fault-tolerant, digital *switch-fabric units.* (In a switch, the switch-fabric unit is the element that physically connects a calling party to a called party or to a service circuit, such as an announcement device. A digital switch-fabric unit switches signals that have been put into digital form.)
- A collection of *service circuits.* These circuits provide such capabilities as voice announcements, dual-tone multifrequency (DTMF) receivers, and text-to-speech conversion units.

The digital switch-fabric units connect to ISDN central offices over multiple, ISDN basic or primary rate interfaces. (ISDN is the Integrated Services Digital Network; the interfaces are BRI and PRI, respectively.) The SCN will provide a non-ISDN interface to the AT&T 1A ESS™ switch. During design, we were careful to make the central-office interfaces a separable part of the software, so that they are easy to extend or replace when new central-office interfaces are defined.

In this architecture, the general view is that a call is routed to the SCN from the class 5 office as the result of a *trigger* (for example, the particular directory number dialed; or *call-forwarded-on-busy,* i.e., the call is forwarded because the number dialed is busy). The call comes in on the class 5 interface, and the control information is sent to the control computer. This computer determines the service to be performed and instructs the switch-fabric unit to connect the call to one or more service circuits (sequentially) to collect digits, play announcements, receive and record a FAX transmission, play a message through a text-to-speech unit, etc.

From an SCN perspective, the call either is completed after the requested service has been performed, or is returned to the central office to be transferred to another line or trunk.

Hardware Overview. As stated earlier, the SCN's principal hardware components are the control computer, switch-fabric units, and service circuits. Figure 2b is an overview of the fault-tolerant architecture of the A-I-Net service-circuit node.

Control computer. We are using the newly introduced AT&T StarServer™ FT Model 3200 computer as the Phase 1 control computer for the AT&T SCN. (FT stands for *fault tolerant.*)

To offer the best price and performance and the widest range of options provided by the evolving RISC technology, we will introduce a new, bit-compatible, Phase 2 control computer on the SCN in 1993. (RISC means *reduced-instruction-set computer.*) Known as the AT&T StarServer FT Model 3300 computer, the Phase 2 control computer is being designed to meet central-office packaging requirements, as well as allow on-line growth of core hardware components.

Software that a service provider creates for the StarServer FT Model 3200 computer, using the SCE, will run without change on the StarServer FT Model 3300 computer. Both computers are hardware-fault-tolerant platforms that provide software-transparent fault tolerance without the need for application software to intervene or assist.

Switch-fabric unit. To meet the central-office standards of high-availability systems, the SCN switch-fabric unit is a digital switch fabric with fully duplicated time-slot interchangers (TSIs). The switch-fabric unit contains a 512-slot interchanger and provides nonblocking interconnect for up to 256 simultaneous calls; for example, for 256 connections between a class 5 office and service circuits. One or more switch-fabric units can be used in an SCN configuration.

The switch-fabric unit uses modular, enclosed cabinet construction. It provides interfaces between the central office and the SCN; that is, it provides control paths to the control computer, and voice and data paths to the service circuits. These service circuits include conference circuits and Touch-Tone generation or decoding circuits housed with the switch-fabric unit, plus additional service circuits housed in the AT&T common-service-circuit frame (CSCF).

Service circuits. The SCN offers a range of service circuits to support a wide array of services. These service circuits are of two classes:

- Standard, central-office, tone-related service circuits plus the conference bridge are incorporated into the switch-fabric system. This class includes tone generation, DTMF generation, DTMF receivers, power ringing, and conference bridging.
- The second class of service circuits are included in a CSCF, which connects to the switch-fabric unit via tip and ring (i.e., the standard, analog loop-subscriber interface) or T1 carrier or trunk. The CSCF includes service circuits for standard telephone-company announcements; custom announcements; interactive-voice response; recording voice messages; text-to-speech conversion; and FAX reception, storage, and transmission. A service circuit for automatic speech recognition is planned for the future.

The CSCF is a flexible, modular, and common-technology approach to providing general-purpose service circuits for service applications. This approach provides low-cost service circuits for initial development of a service, and also supports the addition of new service circuits with manageable impact on the development and engineering of existing service circuits and applications.

The system of service circuits is independent from the control computer or the switch-fabric system. When service-package applications (SPAs) are executed on the control computer, they access service-circuit capabilities through software modules called *service-circuit handlers* (SCHs). These modules control the various service-circuit systems over a common interface that consists of duplicated Ethernet links and an asynchronous, maintenance link. Service providers do not have to program the AT&T-provided service circuits.

To achieve reliability and availability of service circuits, we used configurable levels of duplication and $N + K$ sparing. (N spares are available for every K in-service units, where N and K are selected by the systems engineer.) This approach allows a service provider to engineer the system to achieve the provider's stated reliability and availability requirements in the most economical way possible.

Figure 3 shows the service-circuit architecture. The service circuits for the SCN are housed in the CSCF, a frame of equipment that contains up to eight shelves of service circuits. The shelves are called service-circuit units (SCUs). Each SCU consists of core circuitry (e.g., processor and communications functions) and service-circuit circuitry (e.g., voice-announcement cards, disks, facsimile transmission or reception cards).

Within a CSCF, the service circuits attach to the switch-fabric system via standard voice and data interfaces (e.g., analog tip and ring, T1). The CSCF's core circuitry attaches to the control computer via duplicated Ethernet links and single RS-232C links. A common backplane links the core and service circuits within an SCU.

Control Interfaces. The control computer has a fully duplicated control link to each switch-fabric unit and to the CSCF. Each control interface runs at 10 megabits per second. An emergency-reset, RS-232C link also runs from the control computer to the switch-fabric unit and to each CSCF.

Software Overview. The A-I-Net service-circuit node's software is designed to provide an open, modular platform on which customer services can be quickly developed and deployed.

The central element of this architecture is the control computer. All call processing and OA&M control of the SCN resides on the fault-tolerant, UNIX® system-based control computer. (OA&M means *operations, administration, and maintenance.* UNIX is a registered trademark of UNIX System Laboratories, Inc.)

Service circuits and peripheral devices are controlled from within the control computer. Programs that run in the control computer interact with the service circuits via SCHs that also run on the control computer. Service logic resides within service-package applications that control various service circuits via the SCHs.

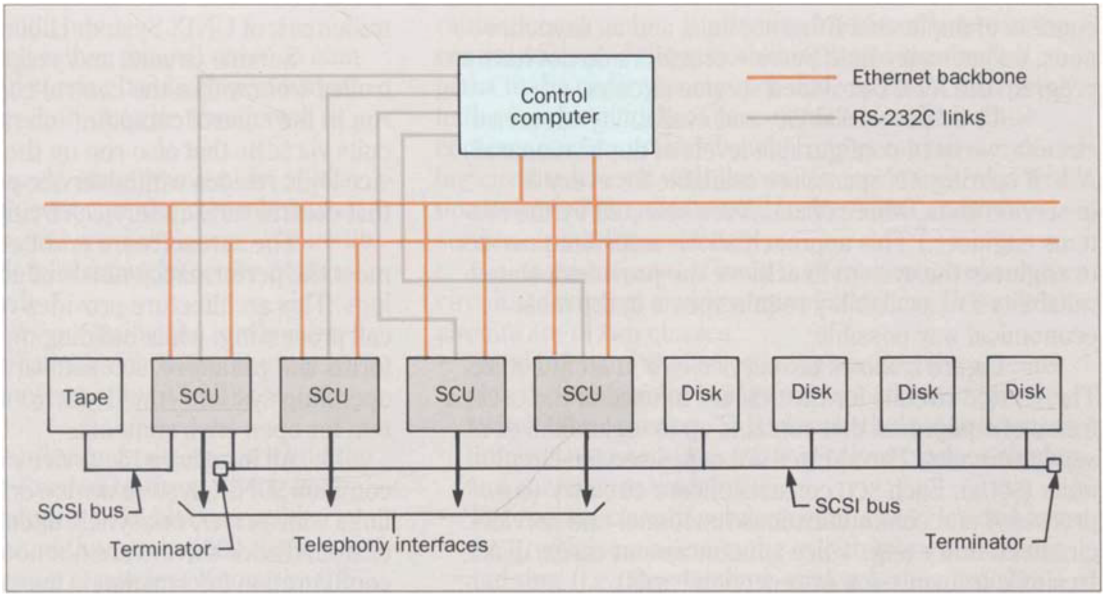
The SCN software architecture was designed to meet the performance needs of advanced-service offerings. This architecture provides responsive control of call processing, while building on industry-standard platforms and packages. SCN software runs under the UNIX operating system—the de facto standard operating system for open environments.

All interfaces to service circuits are through common, UNIX system device drivers—such as Ethernet links with TCP/IP, or asynchronous terminal links—so custom device drivers are not needed. Call-control and configuration information is managed by a commercial, SQL-compatible database package. System measurements are stored in the database for easy access, and measurements reports are generated using the standard, database report generator language. (TCP/IP stands for *transmission control protocol/internet protocol.* SQL, which is pronounced *sequel,* stands for Structured-Query Language, the ANSI-standard language for accessing and processing information in a database.)

Object-oriented design was used extensively in the SCN architecture. It provides a natural transition to the primary software-implementation language, C++, and is the best technology currently available for managing systems that undergo substantial software customization by multiple parties. (C++ is an object-oriented descendant of the C-programming language. Both languages were developed at AT&T Bell Laboratories.) Among the benefits that result from this design approach is the ability to add service-package applications and new service-circuit handlers to the system while it is running, without the need for a system reboot.

Call control is centralized on one processor in

Figure 3. The CSCF houses the service circuits for the SCN on shelves called service-circuit units (SCUs). Each SCU consists of core and service-circuit circuitry.



the SCN to simplify the software architecture. The control computer—initially, the AT&T StarServer FT Model 3200 computer (i.e., Phase 1) and, in 1993, the Model 3300 (i.e., Phase 2)—offers smooth, on-line growth of central-processing power. (Phase 2 will provide more physical interfaces for hardware and more processing power.) This hardware-fault-tolerant control computer also detects and operates through hardware faults without intervention from application or system software.

In the SCN architecture, high-volume bearer traffic is managed principally by switch-fabric units and service-circuit units. The control computer engages in high-level control functions. However, the strictly routine functions—such as playing announcements, or receiving and storing speech and FAX—do not rely on the control computer and do not use its resources.

Control-computer software. Figure 4 shows the control computer's software architecture. The control-computer software's major functions are partitioned into *call processing* (which includes the service-circuit interface and appears on the left in the figure) and *OA&M* (shown on the right).

Call-processing modules handle the real-time functions required to control the service circuits and provide the logic needed for real-time services. OA&M modules support the functions necessary to maintain the platform and process data generated by call-processing activities (e.g., billing and measurements). Interprocess communications, for both call processing and the OA&M functions, are provided by a message handler. The message handler supports an efficient, common-message transport capability for use by the platform's processes.

Service-circuit-handler modules provide low-level control and resource-allocation functions for the service circuits. An SCH is available for each external-device type, and all the SCHs are controlled by a single, logical interface—the service-circuit interface. An SCH is provided for each external-device type that is controlled by the service-circuit interface. To give the SCHs a common software structure, the service-circuit interface supplies standard software for each SCH. It also furnishes a standard message interface that other system modules use to

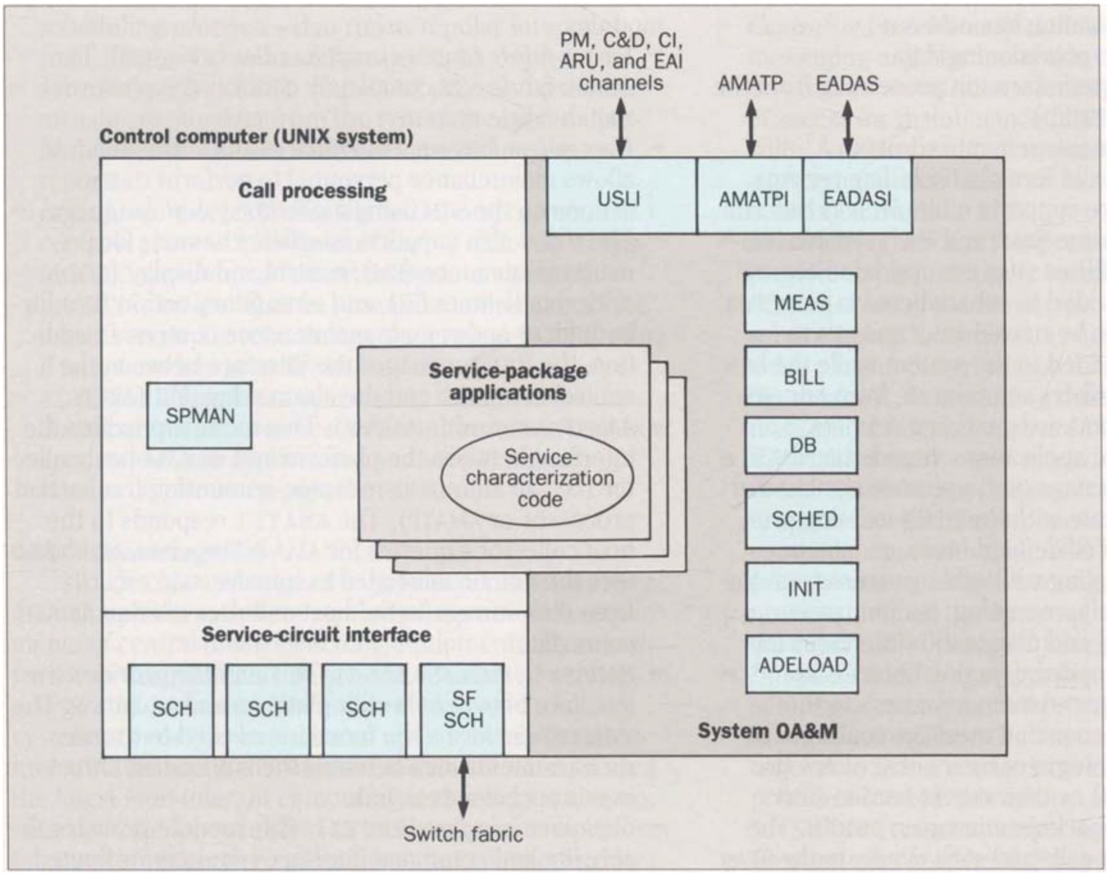


Figure 4. SCN control-computer software. Call-processing modules (in the left partition) handle real-time functions for controlling the service circuits, and provide the logic for real-time services. Modules in the right partition support system-OA&M functions that maintain the SCN platform and process data generated by call-processing activities. The service characterization code provides service-specific initialization and data-access information.

communicate with the SCHs.

The architecture provides SCHs for all AT&T-provided service circuits. This includes SCHs for the switch-fabric unit and for other service circuits that a service provider may order from AT&T (e.g., the voice-announcement SCH to control the voice-announcement subsystem).

By using the applications-development environment, the service provider's programmers can generate SPAs that have the service-specific control logic and OA&M functions needed to provide both subscriber and operations-support services. Major SPA functions include per-call resource management, measurements, billing, and audits. Included with each SPA are several scripts and forms definitions, which we call *service characterization code.* This code provides service-specific initialization and data-access information, including:

- SQL scripts for creating, initializing, and destroying the provisioning database tables for the service-package application
- SQL scripts for creating, initializing, and destroying the measurements database tables for the service-package application
- Scripts for converting subscriber data from an existing

service-package application to a new one
- Forms for editing the provisioning data
- Scripts for initiating periodic audit processing from the system scheduler (SCHED)
- Scripts for creating measurements reports
- Scripts for defining valid formats for billing records.

The architecture supports multiple SPAs that run on the platform at the same time, and each SPA can handle many subscribers. When SPAs are upgraded or new service options are provided to subscribers via new SPAs, subscribers may have to be moved from one SPA to another. A SPA can be added to the system while the SCN is in service, and subscribers can migrate from one SPA to another while both SPAs are providing service.

Service-package applications run on the SCN as a set of UNIX system processes and use message-handler messages to communicate with the SCN's existing processes and functions. Well-defined message interfaces are used for communicating with other processes on the platform that provide call-processing, maintenance, audits, database, billing, and diagnostics interfaces for SPAs. When a SPA is compiled, function libraries are included that provide shared-memory access to the tables used for SPA selection and message routing. The SPAs use these tables to register their subscribers (for call-processing services) or their OA&M-service start events with the service-package manager, SPMAN. The SPMAN then routes new calls and start events to the SPAs based on this registration information.

System-OA&M modules supply the support functions required to manage the entire system, and are not dedicated to specific service-package applications. Note that this includes modules, such as measurements and the database system, that interact with service-specific scripts. OA&M-interface modules supply connections between the platform and external support vehicles including SCCS, EADAS, and AMA host collectors. (SCCS is the switching-control-center system. EADAS is the engineering and administrative data acquisition system. AMA is automatic message accounting.)

Figure 4 also shows the following system-OA&M modules:
- *Switch-fabric service-circuit handler* (SF SCH). The switch-fabric SCH completely controls the platform's switch-fabric system.
- *User-system language interface* (USLI). This module allows maintenance personnel to perform OA&M actions on the SCN using a user-to-system language. The USLI also supports interface channels for primary maintenance (PM), control and display (C&D), critical indicators (CI), and emergency action (EA) for both local- and remote-maintenance centers. In addition, the USLI manages the interface between the control computer and the alarm-relay unit (ARU).
- *AMATP interface* (AMATPI). This module provides the interface between the platform and an AMA host collector (i.e., an automatic-message-accounting transaction processor or AMATP). The AMATPI responds to the host collector's queries for AMA billing data, and handles the functions needed to transfer AMA records from disk storage to the host collector over an AMATP connection.
- *EADAS interface* (EADASI). This module provides the interface between the SCN platform and an EADAS. The EADASI performs the functions needed to transfer measurements data between the SCN and an EADAS over a packet-access link.
- *Customer interface* (CUSTI). This module provides the security and command interface required for limited subscriber access to the appropriate service and subscriber-specific data.
- *Billing* (BILL). The billing process, BILL, collects billing records generated by service-package applications. It also generates the primary tracer records that are included in the billing data stored on the disk. BILL handles AMA billing records and, when they are fully defined, non-AMA billing records.
- *Provisioning database* (DB). The DB subsystem is the repository for provisioning data. It is also responsible for notifying the proper process when an update to the database may affect that process.
- *Scheduler* (SCHED). This module is responsible for

scheduling processes that run at regular intervals (e.g., diagnostic and audit processes).

- *Measurements* (MEAS). The MEAS process receives measurements data from the rest of the system, performs measurements thresholding, and produces reports.
- *Initialization* (INIT). The initialization process, INIT, controls process initialization during all levels of system initialization, and monitors system sanity while the SCN is active. That is, it monitors other processes' use of resources (CPU time and memory) to determine if a process has gone "wild."
- ADELOAD. The ADELOAD process is responsible for downloading the files needed from the SCE to load new service-package applications and service-circuit-handler applications onto the SCN.

OA&M Characteristics

The SCN is designed to provide a robust, easy to maintain platform that meets the stringent OA&M requirements of central-office switching equipment. (By *robust,* we mean this platform can provide a variety of services to a large customer set.) But unlike traditional switching systems, the SCN is based on an open systems architecture with well-defined, standard interfaces. Thus, it uses the latest fault-tolerant computing technology and open, standard interfaces to yield an easily maintained platform for supporting service applications that are supplied by many parties.

The SCN operates in a multiservice, multivendor environment, and its OA&M philosophy is to bring as much central control to the environment as possible. Therefore, the OA&M software and hardware architecture is designed to provide the following operational characteristics:

- *Local maintenance interface.* The SCN provides a single maintenance interface (that can be accessed locally, as well as centrally) for all its component parts. This gives maintenance personnel a single point of access to obtain system-status information and control all SCN operations, administration, and maintenance functions.
- *Centralized trouble notification.* The SCN centralizes the messaging and alarm functions of all its components.
- *Centralized maintenance access.* There is a single point of access for maintenance functions on the service circuits. A centralized maintenance-scheduling function allows maintenance functions on service circuits to be scheduled from the SCN.
- *Provisioning.* All SCN components and services can be provisioned from a single terminal. (It can be either central or local, the service provider's terminal or a service center's terminal, as desired.) The SCN provides a menu-driven screen interface to its provisioning database. Provisioning data may be reported in formats and at intervals defined by the service provider.
- *Centralized reporting of measurements.* The SCN's measurements-reporting system incorporates measurements for all its components, including system components provided by AT&T and those a service provider may add to the configuration. The service provider defines the format of measurements data in the report and the report interval.
- *Interfaces to existing operations-support systems.* The SCN provides interfaces to SCCS, EADAS, and a billing host collector. The SCN data can be integrated with other data that a service provider collects and, thus, provide a total picture of operations. The interface to SCCS allows remote monitoring and control of the SCN.
- *Conformance to operating standards.* The SCN components are central-office equipment, which allows the SCN to be integrated easily into existing central-office operations.

Operations-Support-System Interfaces

Standard, operations-support-system interfaces integrate the SCN's applications software and platform maintenance into the existing network of support systems for central-office switching equipment.

For example, system-OA&M modules provide interfaces to AMATP and EADAS (see Figure 4 and the earlier discussion).

An interface to an SCCS supports remote-maintenance-center capabilities. Multiple modem connections to the remote-maintenance center or to an SCCS provide access to the maintenance channels mentioned earlier: PM, CI, EAI, and C&D. The PM and CI channels originate from the control computer's asynchronous ports, while the EAI and C&D channels originate from a remote-interface board that supports capabilities for emergency action.

The SCN provides a software-distribution interface for updates of software from the A-I-Net service-creation environment. AT&T is willing to work with service providers to provide a complete service-management-system interface.

The C or C++ programming capabilities of the SCE allow interfaces to other operations-support systems to be added to the SCN. The SCN software architecture provides:

- A UNIX system platform
- A commercial database-management system (for storage and retrieval of operational data)
- An open, message-based control interface to all subsystems.

UNIX system processes to interface new operations-support systems can easily be built on this infrastructure.

Summary

The architecture and technology of AT&T's A-I-Net service-circuit node offer several unusual characteristics.

The SCN is a switching product that enables telecommunications-service providers to introduce new services and service capabilities quickly and easily into the central-office environment. It offers a complete hardware and software architecture and, from the outset, was designed to be programmable by the service provider. The SCN is a platform that includes a control computer, switch-fabric units, and a service-circuit complex. It provides the necessary hooks for new services, new service-circuit handlers, and service-dependent OA&M functions.

The SCN executes application software developed with AT&T's A-I-Net service-creation environment, an applications-development environment that is based on application-oriented-language technology. The SCE provides leading-edge tools and techniques for rapid development of new telecommunications services.

The SCN builds heavily on open, industry-standard capabilities. It uses a commercial, fault-tolerant computer—the AT&T StarServer FT Model 3200 computer—that runs the UNIX operating system; and SCN data is managed by a commercial, SQL-compatible database. The control interface between the control computer and AT&T-provided service circuits consists of a combination of standard, asynchronous links for emergency action and Ethernet links with TCP/IP for high-bandwidth control.

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Biographies (continued)

service-circuit node, and service-control point. He joined the company in 1966 and has an M.S. and Ph.D. in electrical engineering from Stanford University (California). Mr. West is responsible for AT&T's A-I-Net intelligent-network product requirements. He joined the company in 1982 and has a B.S. in mathematics from Harding University (Searcy, Arkansas), an M.B.A. from St. Edwards University (Austin, Texas), and an M.S. in electrical engineering from Georgia Institute of Technology (Atlanta). Mr. Whitehead is responsible for customer support of A-I-Net products. He joined the company in 1965 and has both a B.A. in psychology and an M.S. in experimental psychology from Emory University (Atlanta, Georgia), and an M.S. in computer science from Stevens Institute of Technology (Hoboken, New Jersey).

Appendix A. Abbreviations, Acronyms, and Terms

ADELOAD — a process that downloads all files needed from the service-creation environment to load a new service-package application or service-circuit-handler application onto the service-circuit node

adjunct — a local database that contains service logic and is connected to the switch over high-speed links

AMA — automatic message accounting

AMATP — automatic-message-accounting transaction processor

AMATPI — AMATP interface module; provides the interface between the platform and an automatic-message-accounting host collector.

ANSI — American National Standards Institute

AOL — application-oriented language

ARU — alarm-relay unit

BILL — billing process; collects billing records and generates primary tracer records included in the billing data that is stored on the disk.

BRI — ISDN basic-rate interface

C&D — control and display

CI — critical indicators

CPU — central-processing unit

CSCF — common-service-circuit frame

CUSTI — customer-interface module; provides the security and command interface required for limited subscriber access to the appropriate service and subscriber-specific data.

DB — provisioning database subsystem; repository for provisioning data. Also notifies the proper process when a database update may affect that process.

DTMF — dual-tone multifrequency

EA — emergency action

EADAS — engineering and administrative data acquisition system

EADASI — EADAS interface module; provides the interface between the service-circuit-node platform and an EADAS. Also performs functions needed to transfer measurements data between the service-circuit node and an EADAS.

FAX — facsimile

FT — fault tolerant

I/O — input/output

IN — intelligent network

INIT — initialization process; controls process initialization during all levels of system initialization, and monitors system sanity while the SCN is active.

ISDN — Integrated Services Digital Network

MEAS — measurements process; receives measurements data from the rest of the system, performs measurements thresholding, and produces reports.

$N + K$ sparing — $N < K$ spares per K operational units

OA&M — operations, administration, and maintenance

open architecture — the system's specifications are made public, so other companies can develop products for it.

PM — primary maintenance

PRI — ISDN primary-rate interface

RISC — reduced-instruction-set computer

SCCS — switching-control-center system

SCE — A-I-Net service-creation environment

SCH — service-circuit handler

SCHED — scheduler module; schedules processes that run at regular intervals.

SCN — A-I-Net service-circuit node

SCP — A-I-Net service-control point

SCSI — small-computer-system interface; an interface standard for peripheral devices, such as hard-disk drives and laser printers, that contain their own controller circuitry. (SCSI is pronounced *SKUH-zee.*)

SCU — service-circuit unit

SF SCH — switch-fabric service-circuit-handler module; controls the platform's switch-fabric system

SMS — A-I-Net service-management system

SPA — service-package application

SPMAN — service-package manager; routes new calls and start events to service-package applications

SQL — ANSI structured-query language, a standard database-access language

SS7 — Signaling System 7; a signaling protocol used by Bellcore and the LECs that follows Bellcore technical requirements and ANSI standards

SSP — service-switching point

STP — A-I-Net signal-transfer point

T1 — high-capacity carrier interface

TCP/IP — transmission control protocol/internet protocol

tip and ring — standard, analog, telephone-network loop interface

TSI — time-slot interchanger

USLI — user-system-language interface module; allows maintenance personnel to perform OA&M actions on the SCN using a user-to-system language. Also supports interface channels to local- and remote-maintenance centers.

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