Service Processing Systems for AT&T's Intelligent Network

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Many advanced network-based services are being provided on service processing systems that interoperate with, but are separate from, the network switches. The use of these systems has led to the implementation of powerful intelligent networks (IN). Service processing systems support the creation, modification, and scripting capabilities needed to provide these services. This paper:

- Defines service processing systems;
- Describes how market forces require their functionality;
- Discusses IN, voice recognition, and service creation technologies;
- Describes new services being provided through these technologies; and
- Lists some of the AT&T Network Systems intelligent network products and services.

Introduction

Advanced telecommunications features and services typically were developed first for large businesses, then migrated in orderly fashion to small businesses, then to residential and consumer markets. A simple example is caller ID, which displays the name of the calling party on a small screen attached to or a part of the telephone set. First developed for PBX users, this feature became available to the purchasers of high-volume 800 services. Then it was packaged by AT&T together with other features for CENTREX business customers, and now it's being offered by local exchange companies to all users.

Fundamental changes in customer lifestyles, work styles, and industry economics are starting, however, to alter this pattern of introduction:

- Innovations in technology, such as advances in computing power, miniaturization, speech recognition, and new software techniques that make telecommunications services quickly available for all types of users;
- The growth in small businesses that want

the sophisticated types of services that were traditionally in the price range of only large, shared-use customers;
- The increasing numbers of telecommuters who want to access, from their homes, the new voice, data, and video telecommunications services that traditionally would be targeted to business office locations;
- The increased mobility of users that is creating a market for a number of new personal communications services (PCS), such as single-number reach (700 services) and personal number portability;
- The globalization of corporations that is creating a demand in the international market for sophisticated services, even as they are being introduced into domestic markets; and
- End users who are requiring increased customization and control of services, regardless of the location from which they are calling.

An example embodying many of the above points is a business executive who, while waiting for a plane flight at the Hong Kong airport, opens a wireless laptop PC/tele-

Panel 1. Acronyms and Terms Used in This Paper

2NCP — Network Control Point
A-I-Net® — AT&T's advanced intelligent network
    product line
ACP — Advanced communications package
AOL — Application-oriented language
AP — Adjunct processors
AP — Applications processors
ASP — Advanced services platform
ASR — Automatic speech recognition
ATM — Asynchronous transfer mode
BCP — Basic communications package
BISDN — Broadband ISDN
C++ — Programming language tool
CENTREX — Customer services offered by local
    exchange carriers on the AT&T 1A ESS®and 5ESS®
    switches.
CLASS — Customized Local Area Signaling Services,
    the market name used by many local exchange
    carriers for a series of end-user features, such as
    caller ID, developed by AT&T Network Systems.
CCIS 6 — Common channel interoffice signaling
DGI — Decision graph interface
IN — Intelligent network
IP — Intelligent peripheral
ISDN — Integrated services digital network
ITU-T — International Telecommunication Union -
    Telecommunication Standardization Sector

IVR — Interactive voice response
NCP — Network control point
NSCX — Network services complex
OAM&P — Operations, administration, maintenance,
    and provisioning
ONA — Open network architecture
OSPS — Operator Services Position System
PBX — Private branch exchange
PCS — Personal communications services
SCE — Service creation environment
SCN — Service circuit node
SCP — Service control point
SDN — AT&T's Software Defined Network, supported
    by 4ESS® switches and SS7
SMS — Service management system
SMSI — Simplified message service interface
SN — Service node
SN/IP — Service node/intelligent peripheral
SNAP — Special network accessibility platform
SS7 — Signaling system 7
SSP — Service switching point
STP — Signal transfer point
TDD — Telecommunications devices for the deaf
TRS — Telephone relay service
TTS — Text-to-speech
VPN — Virtual private network
VRCP — 5ESS® voice recognition call processor

phone, dials a customer in Jakarta on one line—by speaking the customer's name—to update the customer's purchase order, and dials into a computer database in Los Angeles on another line—again by speaking a name—to download the customer's purchasing files. After completing the call to Jakarta, the executive updates the customer's information in the laptop, then faxes the customer's order to a manufacturing plant in Brazil—while forwarding electronic copies to the executive's L.A. office and to the company's home office in Brussels. Meanwhile, all calls made to either our executive's cellular car phone in L.A. or the executive's L.A. office are being routed to the laptop telephone, as well as calls from selected employee's in the L.A. office. All remaining calls are being forwarded to an answering system in a regional branch office in Saigon, our traveler's next destination.

    All this is possible today because the progress in computer processing, coupled with the merging of tele-

communications and computing, permits the implementation of powerful intelligent network (IN) service processing systems that support these types of services. To satisfy the current and short-term needs of end users, as well as to position themselves for future growth in long-term service trends, telecommunications service providers are quickly taking advantage of the intelligent network and the benefits that IN service processing systems offer.

Background of the Intelligent Network

    The concept of the intelligent network has evolved since it was first introduced by AT&T, in the mid-1970s, with the 4ESS™ Switch and the out-of-band common channel interoffice signaling system (CCIS 6), predecessor to signaling system 7 (SS7). While the 4ESS Switch and CCIS 6 initially supported long distance plain old telephone service (POTS), it wasn't long before databases for other services were being attached to the CCIS 6 network, and

later the SS7 network. These databases supported 800 services, virtual private networks, credit card validation, and now 700 and 900 services, to name but a few. The IN network has evolved to support multiple value-added services, as well as their creation, control, and management.

Table I. IN functions and physical elements

Function	Physical elements
Call control	Service control point (SCP)
Service switching	Service switching point (SSP)
Service control	Service control point (SCP)
	Service node (SN)
	Adjunct processors (AP)
Service data	Service control point
	Service node
Specialized resource	Intelligent peripheral (IP)
	Service node
Service management	Service management system (SMS)
Service creation environment	Service creation environment (SCE)

Some key characteristics noted by the International Telecommunication Union - Telecommunication Standardization Sector (ITU-T) in its definition of IN are:
- Extensive use of information processing,
- Modularization,
- Portability among physical entities, and
- Subscriber control.

Following the success of the 800, calling card, and virtual private network (VPN) services, many exciting new services are being introduced, such as personal communications services, voice dialing, and various store-and-forward and flexible messaging services. These new services have moved from the switch to service processing systems that interoperate with the switches. This modular, distributed nature of IN enables many benefits, including faster time-to-market for new services, an easier introduction of new technology in the network, and customization.

Architecture of the Intelligent Network
An intelligent network typically includes the following seven functional entities, and map into the physical elements shown in Table I.

The elements are described in Panel 2, while Figure 1 shows a typical IN architecture.

Service Processing Systems This section discusses the service processing system, its elements, architecture, and trends from single- to multi-function programmable platforms.

Figure 1. The architecture of the AT&T intelligent network. The SSP provides service switching between the customers, non-SSP end offices, the AP, and the IP. Call control signaling is between the SSP, AP, SN, STP, and SCP. Operations signaling is between the SMS and the SSP, SN, SCP, and SCE.

Defining Service Processing Systems. Service processing systems are those elements of the IN architecture that provide *service processing logic and control,* but do not provide *connection control and management* functions generally associated with switches. Examples of service processing systems range from:

- High-capacity, fault-tolerant service control points (SCP) or switching systems that colocate service processing and connection control, to
- Multi-application, programmable service nodes, to
- Low capacity, single-application adjunct processors.

Separating service processing logic from connection control provides such advantages as:

- Creating a service environment that is independent of the switching environment;
- Increased choice of hardware;
- Better opportunity for vendors to "ride the technology curve;"
- Faster introduction of new technology, like speech processing;
- Aiding in moving, or porting, existing services to new connection technologies, such as asynchronous transfer mode (ATM) and broadband ISDN (BISDN); and
- More economical prototyping and trialing of new services.

Along with these advantages can come some disadvantages, however. Many of these systems have separate operations, administration, maintenance, and provisioning (OAM&P) systems, and processes that are not integrated with the existing network infrastructure. Also, care must be taken to match the capacity and reliability characteristics of the chosen system with the services offered on them, as many are neither fault-tolerant nor scaleable to larger capacities.
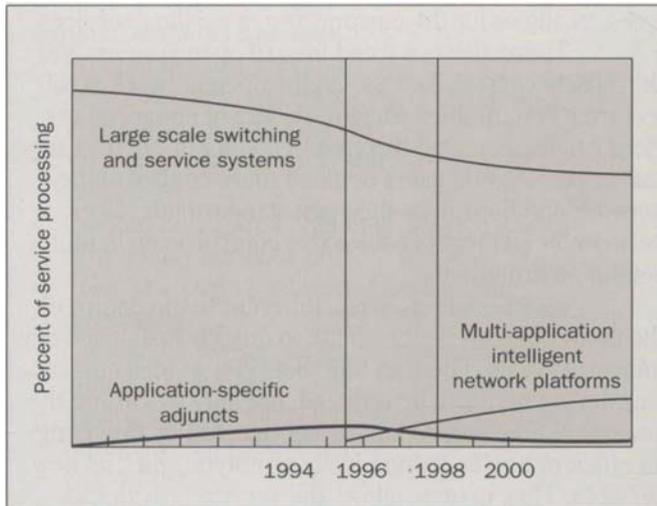
Service Processing Architecture Alternatives. The network elements that provide telecommunications services can be segmented into three broad categories:

- Large-scale switching and service systems,
- Multi-application intelligent network platforms, and
- Application-specific adjuncts.
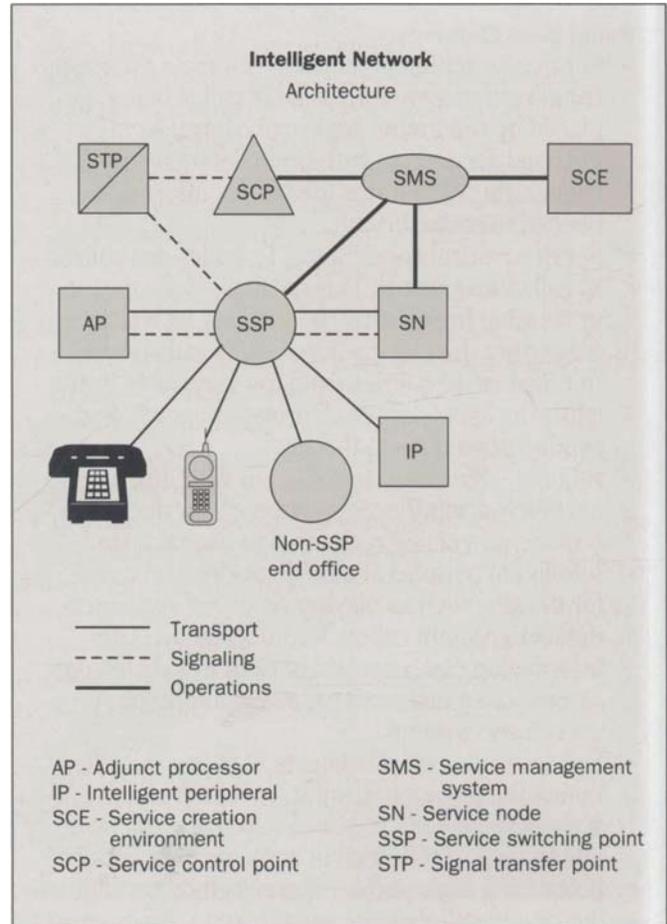
A large-scale switching and service system is a high-capacity, typically fault-tolerant node, such as a 4ESS switching system. Some SCPs fit this category. The second category, multi-application intelligent network platforms, are scaleable to larger capacities and often are programmable via SCEs. Service nodes are such an example. In the third category, application-specific adjuncts are usually non-fault-tolerant, often low-capacity, single-application adjuncts. Most adjunct processors and some IPs fall into this group.

With the advent of IN, service providers began migrating some service processing out of the switch and onto service processing systems. This began with large-scale switching and service systems, as in AT&T's 800 service architecture. More recently, a number of application-specific adjuncts also have been deployed that help

provide a faster time-to-market for a new service or technology. There are limitations, however. Adjuncts usually provide isolated islands of service, and they are not easily integrated into existing OAM&P structures, or with other services. Many application-specific adjunct systems also provide some service creation or customization, but, again, not in a way that can be extended, or ported, to other network elements.

In answer to the problem of service integration and scattered OAM&P, a trend in service processing has emerged that moves from one function per product to a multi-functional platform approach. This bodes well for the implementation of multi-application intelligent network platforms.

A qualitative study led by one of the authors in 1993 indicated a trend for service processing, as shown in Figure 2. This study shows that, in the past, nearly all service processing was done in the switches themselves, or in switches combined with other large-scale systems. Over time, while the lion's share of service processing continues to be provided by large-scale switching and service systems, application-specific adjuncts have begun to provide a small portion of service processing, and multi-application intelligent network platforms will provide even more. This, in turn, will *reduce* the share of services provided by application-specific adjuncts, as the benefits of easy-to-maintain, scaleable, multi-application systems mature.

Implementing Service Processing Systems

AT&T Network Systems offers a full range of IN service processing systems that have been introduced to meet the needs of their target markets. Some of the major products are:

A-I-Net.™ The A-I-Net product line is the flagship of the AT&T-Network Systems IN product offering in the United States. A-I-Net products include:

- Advanced services platform (ASP), which provides SSP functionality in the 5ESS® switch;
- Service control point (SCP), which provides centralized IN service processing;
- Service circuit node (SCN), which provides the SN functions;
- Signal transfer point (STP), nodes in the SS7 network that route signaling messages between switches and between SSPs and SCPs in the IN;
- Service management system (SMS), which manages the services, and
- Service creation environment (SCE), which creates and customizes services on the SCP and SCN.

Network Control Point (2NCP). A fault-tolerant, multi-processing element providing SCP service processing functionality in the AT&T network.

Network Services Complex (NSCX). An IP interfacing to the 4ESS Switch and the 5ESS international switch.

Voice Recognition Call Processor (VRCP). A service node/intelligent peripheral (SN/IP) providing automated operator services. VRCP is an adjunct attached to the 5ESS switch.

Operator Services Position System (OSPS). A processor-based system which, in addition to supporting operator services, automates certain services, including collect and third-number calls, by using speech recognition technology.

Applications Processors (AP). The AP product line includes the:

- Advanced communications package (ACP), which provides many valuable ISDN CENTREX features, such as

calling-name display, electronic directory, message-detail reporting, and facilities management;
- Basic communications package (BCP), which provides message-detail recording;
- The simplified message service interface (SMSI) translator, which provides a low-cost voice messaging interface; and
- Property management interface translator, which provides a CENTREX interface to hotel property management systems.

Key Technologies

In this section, we will discuss several of the key technologies supporting intelligent networks.

Intelligent Networks. IN services are increasing as a percentage of service providers' revenues world wide. Emerging markets include Europe, Asia, Latin America, as well as the United States. While many networks, especially outside the United States, have historically provided service processing entirely within the switching systems, many are now seeing the benefits of having the logical separation of service control from connection control, and are migrating from switch-based to IN-based services. This allows them to take advantage of computing trends and advances in commercial technology, independent of the switching technology.

New services will be supported by both technology improvements and innovations, such as increased computing speed and advances in speech recognition. Services also will be affected by lifestyle changes, such as the trend toward working at home, the growth of small businesses, the need to accommodate the physically disabled and aging population, and the younger generation's acceptance of computer technology. The result will be new user needs that will require the integration of IN with PCS, broadband, and multimedia services.

IN uses key technologies, such as distributed processing, data communications, database management, and application-oriented languages (AOL). IN's use of commercial hardware, its adherence to standards, and its use of open interfaces assist in the fast introduction of services and a greater degree of vendor independence.

IN service creation and service management systems enable the rapid prototyping of new services, segmented user trials, and a more effective introduction of services. In addition to providing a vehicle for new services, IN allows for the customizing of existing services.

There also is a trend toward open systems and third party control. Access, via the open network architecture (ONA), to third-party providers of enhanced services can be managed through IN elements, such as an SMS or SCP. As end users demand more control of the network and their data, the open standard interfaces between IN elements enables this control, even in multivendor environments.

Creating New Services. Inherent to the nature of the IN architecture is the ability to quickly install and customize services. The lead time between an idea and service deployment can be reduced, not only by cutting the amount of time to develop the service, but by providing an efficient way to economically prototype and trial new services. This, in turn, allows the service provider to quickly assess and fine-tune services, based on the promptly acquired feedback.

Standards for SCE are not thoroughly developed, and it is unclear whether the service-independent building blocks currently defined in the standards are sufficient to create completely new services. While standards work continues, proprietary service creation systems offer a means of differentiating products and services.

Service providers require varied levels of service creation capabilities. Some desire merely to modify services using a graphical user interface and icons. Others want to develop totally new services by setting up their own sophisticated software development processes and using C++ programming tools. The AT&T A-I-Net SCE has multiple levels of service creation control, including a decision graph interface (DGI) and application-oriented language that can be used by service providers, systems integrators, or third party software vendors. This capability is proving to be quite popular, with at least three software firms currently developing software applications for the AT&T A-I-Net product line.

Using Voice Processing. Voice processing is an umbrella term that includes several related technologies, such as automatic speech recognition (ASR) and text-to-speech (TTS) conversion. Many telecommunications companies are investigating ASR applications for their networks. One recent application is the use of ASR with custom calling services for the residential market, which is a shift from offering such services to businesses first. Other applications include voice digit and name

Panel 3. Major IN Services
- Freephone (800) services
- Personal communications services (PCS)
- Premium rate (900) services
- Virtual private network/software defined network (VPN/SDN)
- Custom Local Area Signaling Service (CLASS)
- Emergency services (911)
- Voice processing services (voice dialing, messaging)
- Complete-the-transaction services (ordering, billing, inventory)
- Calling card services (credit card validation)
- Automatic alternative billing
- FAX services
- Mass calling
- Televoting
- Calling name delivery (identifies the caller's name)

dialing for both cellular and land lines, and call/feature control for small and large businesses using CENTREX.

Some believe that ASR could replace the use of touchtone buttons on telephone sets as the common way to interact with the telephone network. Speaker independent, continuous speech ASR with *word spotting* and *talk through* are becoming more attractive to vendors of telephony products. Word spotting lets the system detect a word or phrase embedded in a longer sentence. Talk through permits a user to answer a prompt before the system completes listing all the options.

The trend in the marketplace is to have speaker independent, continuous speech ASR, with word spotting to allow for more natural speaking patterns. Talk through is critical to allow both experienced and novice users to interact with the system at their own speeds. AT&T holds several patents for "Talk Through" and "Word Spotting."

AT&T Bell Laboratories has a rich history of developing the basic technologies that have led to announcement services, 900 services, and speech recognition. Although today's interactive voice response (IVR) systems use touchtone signaling with digital speech announcements and prompts to complete a transaction, speech really is the most natural method of human communication. ASR promises the capability to transform the

current network interface of dialing with a finger into a true 21st century interface of dialing by voice.

One of the greatest obstacles voice processing technology has to overcome is the user's acceptance of addressing a machine instead of a person. The development of standard, easy-to-use interfaces has encouraged the acceptance of voice technology. As a result, user acceptance may no longer be a key issue in its implementation—at least in the United States. This is not universally true, however. In some cultures, such as in the United Kingdom and France, the acceptance of voice processing technology is low. In these countries, having a telephone call answered by a machine, rather than by a person, is sometimes considered an insult.

Notwithstanding cultural resistance, the integration of voice messaging, facsimile, and electronic mail, coupled with ASR and text-to-speech technologies, will allow people to speak to computers, and for computers to reply in kind.

New AT&T Network Services

This unit will look at some of the services supported by intelligent networks.

Personal Communications Services. PCS permits a network to switch a communication to a specific person, regardless of where that person is physically located, rather than to a predetermined device or location. While allowing terminal, services, and personal mobility, PCS is envisioned to offer sophisticated personal call management facilities as well. While some PCS services do not require IN, it can be a powerful system to create and manage services that are portable and customizable to individual needs. One example is:

Personal Number Calling. Subscribers can program a personal number so that incoming calls can be routed through the network to follow them to any other phone, thus making the person more accessible without limiting his or her mobility.

Local Services. Successful trials have been conducted of the following services:

ASR Applied to Custom Calling Services. Residential telephone subscribers are able to use ASR to access features, such as call forwarding and call rejection. This makes custom calling features more accessible to subscribers who have a hard time remembering the different activation codes, such as "*70."

Who's Calling. This service uses text-to-speech technology. When a subscriber answers the phone—but before the actual connection with the caller is established—a synthesized voice speaks the caller's name, obtained from a reverse directory, which maps telephone numbers to names. The subscriber can then choose to speak to the caller by pressing a touchtone button, or not to answer by hanging up—without the caller knowing that the call was screened.

Call Waiting Plus. This is an enhancement to call waiting. The called party, already engaged in a call, presses the switchhook after hearing the call waiting announcement tone. A synthesized voice announces the second caller's name—obtained from a reverse directory. The called party then can choose to accept the call or not. The calling party, however, does not know that the call was screened.

Wide Area Services.

Freephone/800 Service. In 1993, AT&T announced a new network platform that is producing the most powerful 800 services available. At the same time, several advanced 800 call routing features were introduced that take advantage of this new technology. The new platform simplifies the architecture for Advanced 800 Services and uses a new database technology to enhance feature provisioning and maintenance. The platform results in shorter call set-up times, faster call completion rates, and the ability to activate provisioned 800 numbers in real time. These capabilities are the result of the advanced software and hardware that have been installed in network-based processors, called network control points (NCPs).

800 Speech Recognition. Also in 1993, AT&T announced AT&T 800 speech recognition for call routing, and became the first long-distance carrier to provide voice-activated call routing in an 800 service network. Until this development was introduced, Advanced 800 Service subscribers had to provide operators to support the approximately 30 percent of 800 service callers who did not or could not use touchtone signaling when they were prompted for routing information. When such callers reached an Advanced 800 number, they typically had to wait for a representative to come on line and route their calls.

Now, AT&T's Advanced 800 Service customers have an automated prompt that asks their callers to speak into the telephone handset a number corresponding to a menu of options identifying the department or location they wish to reach. Of course, they also have the option to press touchtone buttons at any time. This new service also provides recognition of the Telecommunications Devices for the Deaf (TDD).

Automated Operator. Similar ASR technology was used in automating AT&T's long distance operator services in 1992, when AT&T enhanced its efficiency and service by using the VRCP system. This system listens to callers and responds to simple phrases, such as "collect," "person," and "calling card." The ASR in VRCP employs word spotting so that the caller can speak a phrase, such as "I'd like to make a collect call," and have the system detect "collect" and respond accordingly.

Special Needs Services. The special network accessibility platform (SNAP) is designed to automate services, such as the Telephone Relay Service (TRS) for hearing-impaired customers. TRS allows TDD users to converse with voice users over a telephone. The SNAP system is a multiprocessor adjunct that provides automatic call setup of TRS calls, a graphical operator interface, integrated billing and OAM&P, and customized measurements reports.

Conclusion

IN service processing systems permit AT&T to differentiate its service offerings from other vendors. The separation of service processing logic from connection control is a powerful tool to create and customize services, as well as to quickly prototype and deliver new services. The technological trends of intelligent networking, distributed processing, speech recognition, and service creation are being combined to allow more sophisticated control of services by both the service providers and end users.

Lifestyle changes have created the need for a wide range of new services. IN and service processing systems provide the tools to create and manage services that are both portable and customizable to individual needs. They also provide the means to quickly introduce new services and new technology into the network. Thus, the single function, "one-size-fits-all" adjuncts of yesterday are being replaced by scaleable service creation IN platforms that can support multiple services economically.

AT&T Network Systems offers a broad range of IN service processing systems, which have been used to introduce these new technologies. These systems quick-

ly and efficiently provide new services, and increased levels of customization and control. The IN, voice recognition, and service creation technologies available in these systems are helping to meet the service processing needs of telecommunication service providers and their customers.

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