INTERNATIONAL APPLICATIONS OF AT&T'S INTELLIGENT NETWORK PLATFORMS

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On November 7, 1988 the Digital Derived Services Network (DDSN) in the United Kingdom began providing switch-based Freephone service to British Telecom's (BT) customers. On January 29, 1990, advanced Freephone services were first offered to BT's customers. With the deployment of DDSN in the U. K., AT&T became the first equipment vendor to implement an intelligent network (IN) outside its base country. In addition to DDSN, in 1990 AT&T installed an IN in Spain, and is currently installing another in Italy. AT&T's experience with its international customers has encouraged developing a platform to address international IN needs. This paper discusses the critical components of this platform, and describes the IN architecture and operations systems of the British, Spanish, and Italian networks. It also presents a strategy for evolving these networks in a world of new and evolving services and standards.

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Introduction

Recent advances in technology make it possible for people to do business globally. In great measure, telecommunications advances have helped bridge the global community. The introduction of ISDN (Integrated Services Digital Network) and common-channel signaling have improved the productivity and effectiveness of global business. As many switch vendors introduce ISDN-based services, service subscribers and telephone administrations can realize facilities and network management savings. The savings have been amply proven with widely deployed Signalling System No. 7 (SS7) networks that offer telephone administrations and third party service providers opportunities to trial and offer new services. The IN is one of these opportunities.

The international market for IN-based services differs from the U. S. market. International success depends on recognizing these primarily cultural and socioeconomic differences, e.g., a country's size,

Panel 1. Acronyms in This Paper

ACP	action point	PIN	personal identification number
ASE	application service elements	PN	personal number
AFP	Advanced Freephone	PSTN	public switched telephone network
BFP	Basic Freephone	RFD	Rete Fonia Dati (Speech and Data Network)
BT	British Telecom	SCCP	Signalling Connection Control Part
CCITT	Consultative Committee for International Telephony and Telegrapy	SCE	service creation environments
		SCN	service circuit node
CLI	calling line identity	SCP	service control point
CSG	caller subscriber geography	SDFP	single destination Freephone
DDSN	Digital Derived Services Network	SDMC	single destination mass calling
DTMF	dual-tone multi-frequency	SDN	software defined network
IN	intelligent network	SDPC	single destination premium charging
IP	intelligent peripheral	SDSC	single destination split charging
ISDN	Integrated Services Digital Network	SDUN	single destination universal number
MF-E	multi-frequency signaling	SIB	service independent building block
MFOS	Multi-Function Operations System	SIP	Socièta Italiana per l'Esercizio delle Telecommunicazione, P.A.
NCP	network control point		
NSCX	network services complex	SMS	service management system
NETSTAR	NETwork Subscriber Transaction and Recording	SPC	stored program control
		SSP	service-switching point
NMS	network management system	STP	signal transfer point
OA&M	operation, administration, and maintenance	STEP	signaling transfer and endpoint
OS	operations system	TCAP	Transaction Capabilities Application Part
PBX	private branch exchange	VPN	virtual private network

population density, penetration and quality of telecommunication services, role of the media in advertising, and presence or absence of competition in certain business areas. In Europe, the gradual disappearance of economic and trade barriers within the Common Market will allow more competition and economies of scale to be introduced. IN can help stimulate competition among service providers in different countries by allowing a cross-border and global telecommunication strategy.

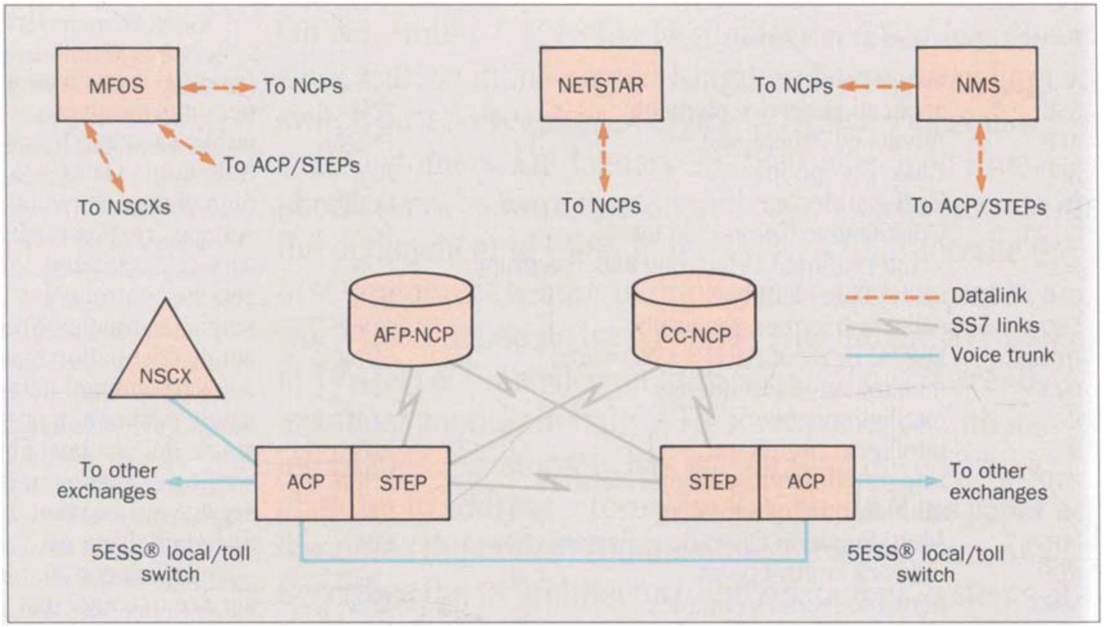
AT&T has implemented a national intelligent network, the Digital Derived Services Network, in the U.K., and is currently implementing national INs in Spain for Telefónica and in Italy with Italtel for SIP (Società Italiana per l'Esercizio delle Telecommunicazione, P.A.).

Though the basic functionality of these networks is the same, customer-specific requirements are different. A flexible, service-independent platform is critical in any IN strategy to allow cost-effective customer-specific IN capabilities to be rapidly introduced and evolved.

Intelligent Network Opportunities

Telecommunications networks can be classified as offering either basic or enhanced (or advanced) services. However, new *technologies* and new *services* should

Figure 1. AT&T's IN implementation for the international market.



not be confused. The importance of technology is in how effectively it serves the administration's needs. A digital technology base upgrades the performance of the existing network and potentially lowers cost; it also provides the infrastructure for future expansion to fiber, and potentially new technologies and services.

Telephone administrations see IN capabilities as a way to centralize their operations and administrative functions, and offer services to compete with other potential vendors or service providers. They see an opportunity to earn additional revenue from new services that will generate additional traffic, and that will generally improve and upgrade the public switched telephone network (PSTN).

Because existing telecommunications networks of most telephone administrations can operate in a multivendor environment, network-based intelligent services must be able to communicate with diverse equipment. Many opportunities exist to offer network-based intelligent services to help the telephone administration exploit and enhance the PSTN. These opportunities are further enhanced by offering the services on a network, nationwide, or even global basis.

AT&T has been offering intelligent services in the U.S. for over 20 years. However, global penetration of intelligent services is still limited. Advanced services such as Centrex and data networks are offered mostly on standalone products such as local exchanges and customer premises equipment. In addition, the telephone administration controls the regulatory environment and often the sale of most telecommunications products and services.

Many proposed IN-based services can be offered by telephone administrations on their existing networks. By exploiting the full capabilities of SS7, these services can be enhanced at a substantial savings to the service subscribers, the business community, and the telephone administration. In addition, SS7 gives telephone administrations the infrastructure to add additional intelligence to the PSTN.

Applications Of The Intelligent Network

This section discusses IN applications in terms of their architectures and capabilities, particularly as those factors are determined to a great extent by the country where the IN is deployed. Specifics of the AT&T international IN are discussed in detail, and the features available through the IN are outlined.

Architecture. Intelligent network capabilities can be implemented by using an overlay, integrated, centralized, or distributed IN architecture. The IN architecture and applications deployed in a specific country are based on the needs of the local market, market timing, and economic factors that are partially determined by the following considerations:

- The PSTN's capabilities and limitations—e.g., the availability of dual-tone multi-frequency (DTMF), SS7, and stored program control (SPC) switching—can lead to different implementations of the same service in different countries, and to different network architectures.
- The lack of standard international protocols—and different interpretations of standards that exist—lead to incompatible implementations of the protocols by different telephone administrations. To reduce the impact of implementing non-standard network interfaces, telephone administrations may confine deploying these protocols to a limited subset of the network. In addition, vendors sometimes must define proprietary extensions to the protocols to provide functionality that otherwise could not be achieved.
- Some intelligent services may already be offered. Telephone administrations prefer not to change how a service operates when the service migrates from one network to another. This can result in different adaptations of the same service in different countries.
- The telephone administration's need to consider factors such as reliability, fraud prevention, reporting, and billing, can affect the services and network architecture.
- Deregulation and competition from third party vendors may affect an administration's revenue-generating capacity and therefore provide additional incentive for the administration to deploy the intelligent services.

An IN architecture of any kind must allow graceful evolution of hardware and software. Figure 1 represents AT&T's implementation[1] of an IN, based on the philosophy of offering network-based intelligent services. This IN is a complete network product offering that can be implemented in several applications.

In the AT&T international IN, the service switching point (SSP) function is handled in the local and toll exchanges by the action points (ACPs). AT&T's NCP (network control point) performs the service control point (SCP) function. The other network elements are:

- The network services complex (NSCX) that handles the intelligent peripheral (IP) function
- The multi-function operations system (MFOS) that provides the operation, administration, and maintenance (OA&M) functions
- The NETwork Subscriber Transaction and Recording (NETSTAR) system that performs the service management system (SMS) function
- The network management system (NMS) that allows efficient use and management of the network.

The network's desired geographical coverage and traffic-handling capacity determine the number of service switching point nodes. The service switching point capabilities in the local and transit exchanges, when used with the other network entities, provide basic IN call-handling functions. The service switching points contain service-independent logic to query the network control point for routing instructions, playing announcements, and routing calls to their final destinations using the PSTN routing number returned by the network control point. The service switching points also contain logic to recognize IN triggers (based on dialed digits) for calls requiring advanced IN services.

The service control point (SCP) is a database of call-handling information, stored as modifiable records, for all advanced IN-based service subscribers. Thus, the service control point is the primary element of centralized call management. To ensure high reliability, service control points normally are redundantly deployed, each with identical customer records.

Some service switching points may be equipped with an adjunct intelligent peripheral that plays customized recorded announcements and prompts so the caller can give more information to help route the call. The caller can supply this additional information either by dialing dual-tone multi-frequency digits or by voice (i.e., by applying speech recognition techniques in the intelligent peripheral). This new information is interpreted at the service control point. The intelligent peripheral performs both functions in response to commands received from the service control point via the host service switching point (a service-switching point with access to the service control point).

Service subscribers may be connected directly to a service switching point or to other exchanges in the PSTN with service switching point access. The IN concept allows subscribers ready access to and control of databases with call processing information related to their services.

As Figure 1 shows, AT&T's NETSTAR service management system is the network element that offers this interactive capability. It is a central service management interface for the service subscriber, telecommunications administration, and network service provider. Subscriber records are created, validated, loaded into the service control points, and modified via the service management system's screen-oriented user-friendly interface. This system provides for loading, administering, and maintaining call-processing information at the service control point, and for obtaining service and user-related measurements. Administrative records for per-call charging, measurements, and network management are retained in the service switching point.

MFOS—a modular multi-functional operations system composed of several subsystems—is included in the AT&T IN. Each MFOS subsystem provides centralized OA&M functions for different network elements. MFOS provides alarm processing for all IN elements to quickly notify a network operator of the existence and source of any alarm condition. It also provides network element maintenance (including remote on-line access to the call processing-related IN elements), traffic data collection and analysis, and/or service switching point database administration functions. Not only will MFOS support day-to-day management activities, but it also will help with long-term strategies and engineering to ensure IN functioning. Although the OA&M function of the IN is best provided from a centralized location, MFOS also supports remote user terminals if an administration prefers distributed OA&M.

The network management system as well as MFOS allows a global view of IN traffic, but on a near real-time basis, allowing network traffic management. It regularly collects trunk group data and traffic congestion levels from the service switching points and traffic data (e.g., occupancy levels) from the service control points. In addition, certain critical event indicators (e.g., traffic overflow from a key group of trunk groups) are forwarded to this centralized operations system (OS). These data are analyzed and displayed on a color network status map for the entire IN network, and on an entity status display that shows the separate status (e.g., exceptions and controls in progress) for each service switching point and service control point. This allows the network traffic manager to see the effect of equipment outages, or unusual traffic patterns or volumes on the IN network. The manager can then use the network management system to set up controls, or change control thresholds in the switches and service control points to use network resources more efficiently.

NETSTAR, MFOS, and the network management system are connected to the corresponding service control points and service switching points via X.25 protocol links.

Because the IN can be large and has many functionalities, AT&T's experience suggests that the support organization using NETSTAR,MFOS, and the network management system reside in a centralized advanced service center to ensure close coordination to expedite problem-solving across the network.

Capabilities. The IN architecture can support diverse applications. Deployed IN-based services will help administrations derive many benefits. These include new revenue opportunities, network-wide offerings of telecommunications features that will not affect present local exchanges, and expanded and modernized public switched networks.

Consistent with a global IN architecture,[2] IN-based services are built from a platform of core capabilities that support the service independent building blocks (SIBs) used to create services and support different applications. AT&T's current IN-based services are supplied by several service-independent features. Some of the key features include:

- *Call barring* limits service to calls originating from certain geographical areas. For example, certain services — e.g., local weather reports—may be provided for certain regions of a country. This feature limits such announcements to specific geographical regions.
- *Calling subscriber geography* (CSG) routing directs a call to the appropriate office based on the caller's geographical area. This feature is typically used by service subscribers with offices in different parts of the country.
- *Calling line identity* (CLI) routing is similar to CSG routing, but allows routing on an office code basis.
- *Time and day* routing allows different treatments for calls based on the time or day. For example, if a caller tries to call the sales department of a company after hours or on weekends, an announcement requests that the call be made during business hours.
- *Call allocator* routes calls based on a percentage distribution to multiple destinations or announcements. This feature allows the service subscriber to distribute calls on a percentage basis to different offices in the country.
- *Call prompter* requests additional digits from callers for call routing or security purposes, without operator intervention. For example, an automobile dealer may indicate that pressing "1" routes the caller to the sales department, "2" routes to the service department, and "3" routes to the finance department. This feature also supports speech recognition capability, i.e., the caller can respond to an announcement using speech as well as dual-tone multi-frequency signals.
- *Courtesy response* allows a call to be completed to an announcement provided by the network services complex. The service subscribers can define their own customized announcements and use different ones based on the reason a call did not complete to a specific destination, e.g., the caller calls after business hours, or all lines a busy.
- *Alternate destination on busy* ensures that calls get completed by routing them to an alternate destination when the first destination is busy. This is useful to manufacturers that take telephone orders. If the phones in the sales department of one region are busy, the feature routes the calls to the sales department in another region, ensuring that sales are not lost because the caller cannot get through.
- *Call queuing* is similar to alternate destination on busy except, instead of routing the call to an alternate destination, it is queued until a destination is available. The call is queued close to the originating exchange, thereby saving network resources. To keep the caller's interest while in the queue, an announcement is usually played.
- *Command routing* helps the service subscriber plan for emergencies and unforeseen circumstances by building alternate call-handling plans that can be initiated in near real-time. This feature allows calls to be completed to another location if, for example, a storm shuts down the main office.

Any of these service features may be used separately. However, their full power comes when they are combined to meet a service subscriber's special needs.

AT&T currently offers these IN-based services in the international arena:

- *Freephone service* allows the call to be billed to the Freephone service subscriber rather than to the caller. Two types of Freephone service are available. The Basic Freephone (BFP) service is switch-based, and has limited features. The Advanced Freephone (AFP) service uses the network control point database and has a richer feature set.
- *Value-added billing service* is available to companies or individuals offering value-added services, e.g., tax or stock exchange consultancy. With value-added service, the caller is charged for the connection as well as for the service or information obtained. This cost may in turn be partly or wholly transferred to the service subscriber.
- *Shared payment service*: With shared payment service, the cost of calls is divided between the caller and subscriber.
- *Routing control service*: Enables subscribers to use terminals to examine and change their records containing service information and call processing instructions. Subscribers can transmit these changes at any convenient time via the NETSTAR service management system.
- *Calling card service*: This service allows the caller to charge calls to a billing number (i.e., an account provided by the telephone administration) with an associated personal identification number (PIN). Usually, customers receive instructions to enter the billing and PIN numbers via touch-tone buttons after the called number has been entered with an appropriate prefix. The IN then verifies the billing number and PIN entry in the network control point and, if the entries are valid, completes the call.
- *Call Me Card* service is similar to calling card service. The call is charged to the Call Me Card number, but calls may be made to only one destination. Companies can use this service to give key clients free access to their location, and have these calls charged to a specific account.
- *Personal Number service*: The Personal Number (PN) feature assigns a number to each service subscriber. Calls made with the subscriber's PN as the called number will be routed to a subscriber-determined location that the subscriber may update by dialing a network-defined update number. Thus, the PN subscriber can be reached anytime, and at any location, with only one number. This service offers a tracking mechanism for subscribers who move often among locations and need a reliable way to receive their calls.
- *Televoting service*: Allows a subscriber to use the public telephone network to conduct public opinion surveys. Each televoting call can be charged to the caller at a special rate based on the dialed number. The revenue from this service can be shared between the administration and the subscriber.
- *Virtual private network* (VPN) or *software defined network* (SDN): AT&T was the first to introduce this service in 1984, and has sold it to large and medium-sized business customers in the United States. Many VPNs are now in operation. They are designed to provide business or government customers with private network capabilities—including customer control—over PSTN facilities. This is an attractive service for customers with geographically distant offices. Virtual private network users realize at least two cost-saving benefits: lower tariffs based on shared PSTN facilities, and no network operation and maintenance activities.

Besides these IN-based services and features, the network architecture has the potential to support other advanced services, including:

- *Teleconferencing* for a multipoint bridging capability accessible from the PSTN. The feature allows subscribers to establish conference calls—each with up to 59 locations—either directly or with the help of an operator. Conference calls can be used for either voice or analog graphics (i.e., voice-band data) applications, such as an electronic blackboard.
- *Credit card calling* service is similar to calling card service: it allows callers to use a commercial credit card

to charge their calls.
- *National emergency number* service allows police and fire departments to use the network to route emergency calls to a single national number to the nearest police or fire station for appropriate action.
- *Voice mail* offers storing and forwarding of voice messages. Subscribers can have a personal answering service that gives callers a prerecorded message when the subscriber is either busy or away from his or her location. Based on the subscriber's request, voice mail will accept messages or forward calls. It can be used with other IN services, such as personal number, to ensure that calls will get to the subscriber.

Many of these services can be combined to offer other enhanced services; for example, voice mail can be combined with the virtual private network or televoting with a calling card; or a teleconference charged to a credit card. These combinations expand the capabilities of IN, thereby increasing revenue opportunities to the administration.

Many IN-based services, such as access to third-party databases (e.g., stock market, airline, hotel, and restaurant reservations), can be enhanced, and new services can be provided by implementing other access methods like ISDN.

The service creation capability helps subscribers enhance existing services to meet their needs. Details of IN's service creation capabilities are detailed by Morgan et al. in this issue.[3]

Managing The Intelligent Network

Because the IN is a major investment in the network, management plays a critical role in successfully deploying IN capabilities and services. Based on the U. S. experience, the following items are key when considering IN management.

Service Adaptation Capability. Modular features and service offerings will allow inexpensive adaptation of services to accommodate the needs of different administrations. The administration and service subscribers should also be able to create new services. Modularity and a user-friendly interface allow two different kinds of service adaptations:
- The subscriber can make changes to their service record to provide better service to their customers. For example, if a Freephone service subscriber has two routing destinations for incoming calls based on caller location, and if one destination gets more calls that result in incomplete or ineffective call attempts compared to the other destination, the subscriber can alter the routing algorithm to distribute calls more evenly.
- The administration can modify IN-based services by asking vendors to provide customized applications. These could range from signaling adaptations to satisfying complex OA&M requirements; and from translating reports and commands into national languages to new services geared to the administration's needs. The idea is to allow for more direct service creation capabilities by the administration. AT&T is actively investigating vendor customization.[3]

OA&M. OA&M capabilities are essential to keep IN elements running smoothly so service quality can be maintained and controlled. OA&M also coordinates the functioning of the IN elements among themselves and with the public network. Managing an IN telecommunications network introduces a greater level of OA&M complexity.

Besides the standard OA&M procedures applied to the PSTN, the IN OA&M capability must provide additional capabilities for network-wide management, traffic measurements, maintenance, network recovery, performance, and diagnostic functions. These functions are unique to IN because they must be closely coordinated among several IN elements to permit management and control. Different controls are applied to the PSTN because they could involve only one or two network elements.

IN's OA&M functions should also provide tools to identify high-demand services, services that cause overload from inadequate facilities, and services not in great demand. The administration can use these tools to relieve potential bottlenecks that could degrade call-completion rates. The capability can also be used to market and tariff new services.

AT&T's IN operations system products (i.e., MFOS, NETSTAR, and network management system) offer these functions. From its first IN implementation, AT&T has understood the importance of providing the tools for O&M personnel to ease network data analysis, identify potential network problems, and respond quickly to customer complaints. The systems are able to prevent, detect, and diminish service-affecting situations, and allow the service subscribers to retrieve statistical data so they can assess the performance and commercial impact of their services.

Customer Support. AT&T is both an IN operator and supplier. Thus, in its years of U. S. operation, AT&T has understood that customer support is essential to successfully deploying and expanding IN-based services. Customer support suffers if the IN is not administratively and operationally supported. This last point is extremely important because IN subscribers are typically the administration's key business subscribers. In provisioning IN-based services, the importance of customer support is sometimes underestimated. The system must be designed to address issues of network management, service provisioning, IN-based services marketing, training, and service creation and deployment.

These issues should be considered when implementing an IN:

- Training and documentation help the administration deploy and manage IN-based services and equipment.
- Marketing schemes developed for basic telephone services may need revision or redesign.
- New tariffs may be needed.
- Administrative departments may have to reorganize to streamline the order process.
- New operation and support procedures may need to be developed.

AT&T consults with telephone administrations to assist them in marketing and pricing IN services. Help is provided to define procedures for service provisioning, service maintenance, and network traffic management to manage AT&T international IN network and services efficiently.

AT&T's International IN Implementations

The following sections describe AT&T's IN implementations in the United Kingdom, Spain, and Italy. These sections address adapting and evolving the IN architecture for different markets. In each market, IN capabilities and network functionalities give subscribers new revenue-generating services, and service and feature control capabilities.

DDSN in the U. K.. The DDSN network is AT&T's first internationally implemented IN. BT initially implemented an analog-derived services network in 1985 to provide switch-based Freephone and split-charging services. Value-added billing (or premium charging) was introduced in 1986 for a growing market. Network capacity and BT's modernization plans caused the DDSN to be implemented to replace the analog-derived services network.

The DDSN was deployed as an overlay network. The overlay architecture allowed smooth, quick introduction of new IN services into BT's network, where a variety of signaling protocols and non-SPC switches are supported. Thus, IN capabilities could be nationwide,[4] and service subscribers could either be directly connected to the action points (with terminating-only IN traffic), or could be connected to any PSTN switch.

The initial DDSN deployment of IN capabilities included switch-based Freephone services, including switch-based supplementary service features such as call diversion and PBX (private branch exchange) night interception. Translation to the real network routing number was done through the distributed databases contained in the action points. Initially, eight 5ESS® switches with integrated action point and STEP (signaling transfer and endpoint) functionality were deployed to handle the traffic. The network has now grown to 13 5ESS switches.

Three network control point pairs and six network services complexes will be in service by 1992.

The action points are fully interconnected using BT's version of SS7, which sets up voice paths among the action points and to the PSTN. As the services increased in popularity, additional 5ESS switch action point/signaling transfer and endpoints were added to handle traffic growth.

In 1989, the switch-based IN was evolved to support centralized IN services. A network control point pair was added at London and Manchester, and a separate SS7 network—using the North American protocol—was provided to carry non-circuit-related information between action points and network control points. MFOS and NETSTAR were placed in Oswestry for OA&M support of the IN. The MFOS configuration included network element maintenance, alarm processing, traffic facility, and network management subsystems. Later, a trouble ticketing subsystem was added to centralize information and network problem tracking. The Advanced Services Center was deployed in London for centralized service provisioning and service maintenance.

The services first deployed on the centralized database were Advanced Freephone, premium charging, and split charging services that enhanced the existing switch-based Freephone service. The dialed IN number prefix was used to distinguish and bill for these different services.

The DDSN was recently augmented with additional OA&M capabilities and new service features, enhanced switch-based supplementary services, and the support of originating service subscribers on the action points. Additional services planned for BT include personal number, televoting, and mass calling.

The Intelligent Network in Spain. Telefónica began to offer basic switch-based Freephone service in 1988, and plans to commercialize the AT&T IN offering in 1991. It will include provisioning both switch-based and centralized database IN services.[5] This IN will support new revenue generating capabilities and services.

Similar to the DDSN in the U. K., this is a fully meshed overlay network. However, the 5ESS switch action point/signaling transfer and endpoints in the Telefónica IN may carry toll traffic and IN traffic. Directly-connected terminating IN-based service subscribers are also supported on the action point/signaling transfer and endpoint. The North American version of SS7 carries non-circuit-related information between network control points and action points; for voice paths among the action points, the Spanish version of SS7 is used. Between the action points and the PSTN, both SS7 and the Spanish version of multi-frequency signaling (MF-E) are used.

The Telefónica IN configuration has the following network elements:

- Six action points located in Madrid, Barcelona, Sevilla, Valencia, Bilbao, and León.
- Three network control points, located in Madrid and Barcelona. One network control point will provide calling card service, one pair will be used for the other services.
- Seven network services complexes because of increased announcement traffic requirements as a result of implementing interactive services such as personal number, calling card, and televoting.
- One NETSTAR, MFOS, and network management system located in the centralized Advanced Services Center in Madrid. The MFOS configuration includes network element maintenance, alarm processing, and the traffic facility subsystems.

Telefónica's IN-based services will include: switch-based Freephone and centralized database services including Advanced Freephone, premium charging, split charging, televoting, mass calling, personal number, calling card, and Call Me Card. As in the U. K., the services and charging are distinguished by the prefix of the dialed IN number.

Several new services and service features were introduced to support Telefónica. Of particular note in the IN offering is Spanish speech recognition. Because of low dual-tone multi-frequency penetration in Spain, another mechanism had to make features such as call prompter available to all callers. Therefore, AT&T's speech recognition technology was incorporated into the network services complex. As in all IN applications, additional services for Telefónica are planned.

SIP's Intelligent Network. SIP in Italy has offered Freephone service since 1987. It is currently implemented on the Rete Fonia Dati [Speech and Data Network (RFD)], an overlay network based on digital switches and the Italian version of SS7. SIP's basic motivation to evolve the switch-based IN architecture was to find a flexible and cost-effective solution to the rapid growth of existing services, and its need for new revenue-generating capabilities and services.[6] The SIP IN is scheduled for network deployment in 1991.

Because SIP's network supports different vendors' switches, the primary objective of the new IN architecture was to integrate the IN with the existing network by providing service switching point capabilities on existing exchanges. The service control point would offer full redundancy and load sharing, and would support one or more services on each database.

SIP's IN is part of the toll network and consists of operations systems, service control point, service switching point, service management system, intelligent peripheral, and signal transfer point (STP) network elements. A pair of service control points and one mated STP pair will be in Milan. A second mated STP pair—and another pair of service control points and the operations systems (network management system, MFOS, and NETSTAR)—will be in Rome. The service switching points in the SIP network will be distributed across the network.

AT&T will provide the network control points, STPs, NETSTAR, MFOS, and the network management system to support the IN. The existing local switching vendors interested in being part of the Italian IN will supply the service switching point functionality. The STPs will be introduced for the first time in the SIP network to support IN signaling traffic. The IN in Italy will be integrated into the local and toll network, and will use an open interface based on the Consultative Committee for International Telegraphy and Telephony (CCITT) Transaction Capabilities Application Part (TCAP) between the service switching points and the service control points. This open interface makes possible a multi-vendor environment for SIP's IN.

SIP's service switching point is based on service-independent concepts currently being defined by CCITT. The interface between service switching points and service control points is based on the Signalling Connection Control Part (SCCP) and TCAP defined in the CCITT Blue Book Series of Recommendations, with application service elements (ASE) defined by SIP to support the service-independent concepts. Vendors must conform to SIP's service switching point-service control point interface specification. The initial draft of the service switching point-service control point interface specification was released early in 1990.

SIP's IN architecture will support the following services:

- *Single Destination Services*: single destination Freephone (SDFP), single destination mass calling (SDMC), single destination premium charging (SDPC), single destination split charging (SDSC), and single destination universal number (SDUN).
- *Advanced Services*: Advanced Freephone, virtual private network services, advanced mass calling, personal number, advanced premium charging, advanced split charging, televoting, and advanced universal number.

Calling card service also is planned as a future offering. The mechanism to distinguish and bill for these different services is based on tariff tables in the service switching point and instructions sent to the service switching point from the service control point.

In addition to the service switching point capabilities, SIP's IN will also include enhancements to existing capabilities and services, and advanced customer control capabilities.

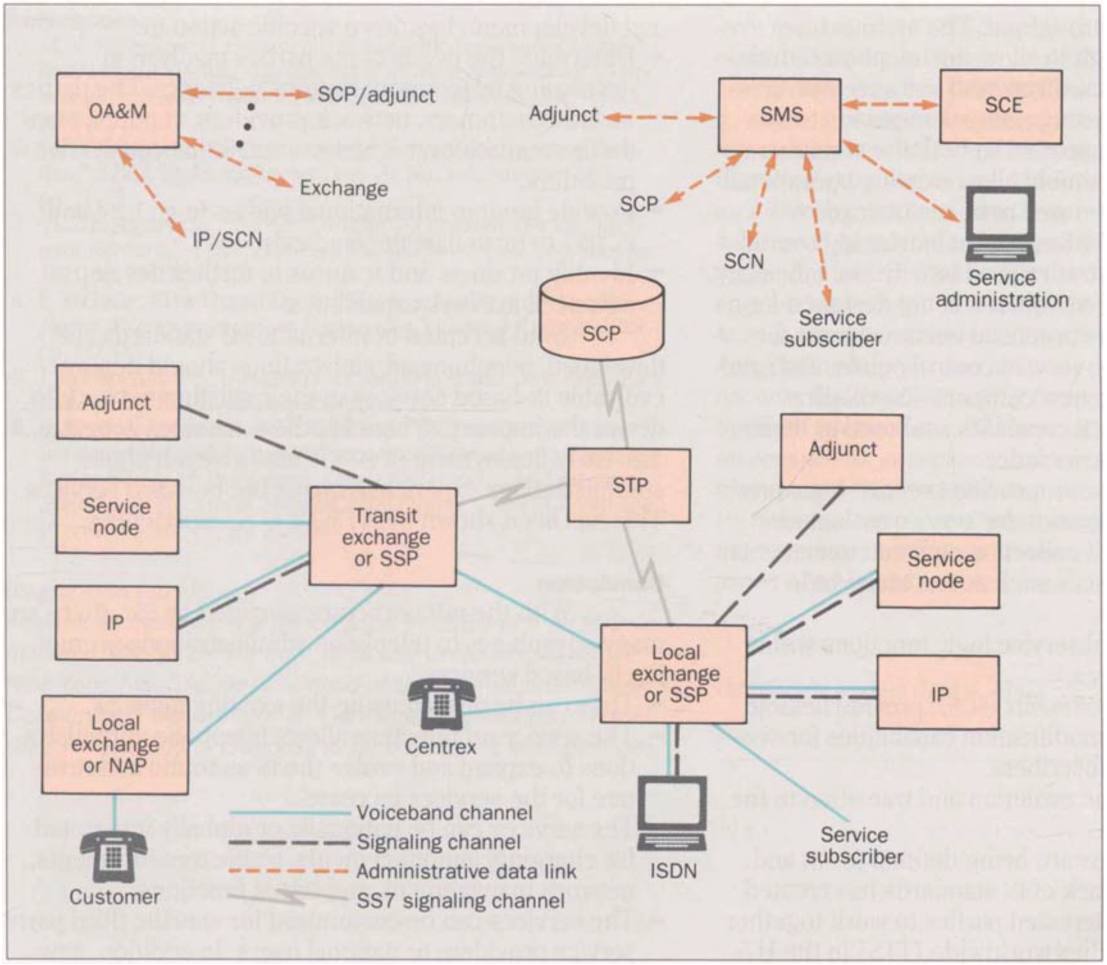


Figure 2. AT&T's global IN architecture.

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Evolution For International Applications

AT&T is committed to evolving its IN architecture based on customer needs and direction from international standards organizations. Figure 2 shows AT&T's vision of the global IN architecture. The company will continue to evolve and enhance the IN architecture to support new network capabilities and services to meet the needs of BT, Telefónica, and SIP.

IN is a major investment for telephone administrations. Therefore, flexibility in the evolution of IN capabilities is a principal concern. The IN architecture should allow new hardware and software technologies to be gradually introduced. But the new technologies must add value to IN elements via lower cost, improved performance, and increased throughput. The architecture should be flexible enough to allow the telephone administration to expand the hardware and software with relative ease. Upgrading existing network elements to new hardware should be transparent to both the administration and customer, and should allow existing operational and administrative procedures to be maintained. Enhancements should be targeted at increasing overall operational and administrative productivity and efficiency.

New network elements are being designed for a global platform. With the proposed enhancements for service switching points, service control points, and intelligent peripherals, these new components will give administrations additional capabilities tailored to their customers' needs. These include:

- *Service circuit node* (SCN): provides service logic processing and call termination for service assistance functions such as digit collection and announcements, and for complex services such as FAX store-and-forward.
- *Adjuncts*: provide local service logic functions within the local exchange area.
- *Service creation environments* (SCE): provide flexible service creation and modification capabilities for service providers and subscribers.

Wyatt et al.[2] describe the evolution and transition to the global platform.

Future directions are being defined for IN and IN-based services. The lack of IN standards has created an opportunity for all interested parties to work together in various standards bodies worldwide (T1S1 in the U.S., ETSI in Europe, and CCITT internationally) to define a common IN standard. These activities are expected to produce additional refinements to current INs that will be deployed later in the 1990s.

Concepts common to most plans for future IN systems are: quicker deployment of new revenue-generating services, and standard interfaces between principal system elements. AT&T supports these concepts and, as part of an ongoing process of evaluation and development, has taken specific action to:

- Determine the needs of the parties involved in developing telecommunications networks. The parties include customers, network providers, vendors, standards committees, regulators, and enhanced service providers.
- Provide input to international bodies (e.g., ETSI and CCITT) to formulate IN standards.
- Identify products and features to further develop advanced network capabilities.

Until accepted IN international standards are developed, telephone administrations should deploy evolvable IN-based services in their existing network to derive the impressive benefits these services generate. The early deployment of IN will also give telephone administrations experience managing IN-based services. This has been shown by AT&T's U.S. experiences.

Conclusion

With the infrastructure provided by SS7, there are many advantages to telephone administrations promoting IN-based services.

- They can be offered using the existing network.
- The service architecture allows telephone administrations to expand and evolve the IN as traffic and revenue for the services increase.
- The services can be nationally or globally integrated for charging, announcements, traffic measurements, network management, and OA&M functions.
- The services can be customized for specific third party service providers or national users. In addition, new services can be quickly introduced.

The IN is rapidly evolving and changing the telecommunications industry. Together with SS7, IN promises to offer an opportunity to both the telephone administration and service subscribers to find new sources of revenue and to reduce operating costs. The IN also offers the potential to bridge the communications barriers between nations and make the global community a reality.

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Biographies (continued)

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