INTELLIGENT NETWORK OAM&P CAPABILITIES AND EVOLUTIONS FOR NETWORK ELEMENTS

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The intelligent network (IN) gives telephone companies a timely way to create new services for their customers. For IN to succeed, the network operations, administration, maintenance, and provisioning (OAM&P) strategies for IN must be in place, evolvable,and workable. An operations platform with IN-specific OAM&P capabilities must be developed before new IN-based services are deployed. This operations platform must be flexible enough to provide the necessary OAM&P support for any IN services without additional development work from network element (NE) and operations system (OS) vendors. Once a new service is created, the IN network must be able to deliver and maintain the service by using the OAM&P capabilities available in the IN operations platform. This paper discusses the capabilities and evolutions of major network element's OAM&P for the United States IN in the areas of billing, service provisioning and verification, network engineering, network traffic management, and maintenance.

Introduction

As telecommunications technology advances, users expect their service providers [i.e., Local Exchange Carriers (LECs)] to respond quickly to requests for new services. Amid growing competition from private branch exchange (PBX) vendors, interexchange carriers, and other LECs, a carrier's responsiveness to such requests will affect its ability to win and retain market share. Though post-divestiture competition among many network element and operations system vendors may have resulted in some lower costs to LECs, the growth of the multi-vendor network environment has driven overall LEC operations costs higher, and has made it harder to deploy a new service throughout a LEC's network in a given time frame. Because the

Panel 1. Terms and Acronyms in This Paper

ACG	automatic call gapping
AIN	Advanced Intelligent Network
AMA	automatic message accounting
ANI	automatic number identification
ARS	automatic route selection
ASP	advanced services platform
BAF	Bellcore AMA format
CMISE	common management information element
DAS	digit analysis selector
DDD	direct distance dialed
DSU2-RAF	Digital Service Unit—Recorded Announcement Frame
EADAS	Engineering and Administration Data Acquisition System
GT	global title
GTT	global title translation
IEC	interexchange carrier
IDP	individualized dialing plan
IN	intelligent network
LEC	local exchange carrier
MDR	message detail recording
MTP	message transfer part
NAP	network access point
NE	network element
NM	network manager
NTM	network traffic management
OAM&P	operations, administration, maintenance and provisioning
ODP	office dialing plan
OMAP	operations, maintenance and administration part
MRVT	message transfer part routing verification test
OS	operations system
OSI	open systems interconnection
PBX	private branch exchange
RAO	revenue accounting office
RHC	Regional Holding Company
RMAS	Remote Memory Administration System
ROP	receive-only printer
ROSE	remote operation service element
SCCP	signaling connection control part
SCCS	switching control center system
SCN	service circuit node
SCP	service control point
SLEE	service logic execution environment
SLP	service logic program
SMS	service-management system
SOCC	selective origination code control
SRVT	SCCP routing verification test
SSP	service switching point
STP	signal transfer point
TCAP	transaction capabilities application part
TDMS	traffic data management system
TRFC-30	30 Minute Traffic Report
UDCI	user defined customer interface

objectives of IN, discussed in the introduction to this issue,[1] include providing an architecture platform to define and control services, a basis for faster service development and deployment, and cross-vendor-compatible operations procedures and interfaces, LECs are motivated toward IN by economic and strategic necessity.

Telecommunications service users will not tolerate degraded service quality as the price for new IN services. Indeed, they will expect the same—if not better—reliability, performance, and integrity from all services. Service quality will depend critically on network OAM&P capabilities. Thus, provisioning an IN service for a customer must involve proper service assignment and verification. Customer information must be consistent across network elements and operations systems for the service to work. Automatic and manual surveillance and maintenance procedures must be in place to lessen the

chance of problems occurring; and, when a problem occurs, tools and testing capabilities must be available to sectionalize and identify the source of the problem. Billing capabilities must be flexible enough to allow LECs to develop different pricing and marketing strategies. Network traffic management capabilities must be available to prevent or correct IN-related network congestion. IN traffic information must be available to network administrators to manage network capacity. These requirements constitute the major challenges to designers of IN operations networks.

This paper presents AT&T's vision of IN capabilities and evolutions for the United States in the billing, service verification and provisioning, network engineering, network traffic management, and maintenance areas. operations capabilities provided in or planned for the A-I-Net™ advanced network platform, AT&T's version of AIN Release 0 (advanced services platform, or ASP), originally conceptualized by Bell Communications Research. The Signaling System No. 7 (SS7), service management system (SMS), and operations system products are discussed in the context of supporting this platform, as are plans for meeting long-term IN needs in each functional area. (The OAM&P capabilities for AT&T's SCN [service circuit node] are covered elsewhere in this issue.[2])

IN Architecture And Characteristics

From the operations point of view, the major components of an American IN include the SSP (service switching point), network access point (NAP), SS7 network, service logic execution environment (SLEE), service management system, and operations systems. (For the architecture of A-I-Net Releases 0 and 1, see Russo et al. in this issue.[3]) Here we will discuss briefly the SS7 network, service management system, and the IN characteristics that affect the operations platform.

The SS7 Network. The SS7 network (see Figure 1) is critical to the service control point/service switching point IN architecture. It transports signaling information as message packets between network elements. These packets are switched through signal transfer points (STP) that form the backbone of the SS7 network. The most salient SS7 network function for IN is the transport of queries and responses between service control points and service switching points. The call control-specific data in the query and response are encoded in the transaction capabilities application part (TCAP) of either message.

The data that the SS7 network needs to route each message are encoded in the signaling connection control part (SCCP) and message transfer part (MTP) areas of the messages. A service switching point, to pick the correct routing, relies on the customer-specific "global title" in the query's signaling connection control part. Thus, the service switching point sends the query to a signal transfer point that translates the global title to the SS7 network address ("point code") of the right service control point, and to a "subsystem number" that corresponds to the right service application process within the service control point. The signal transfer point then forwards the query to the service control point. When it receives the query, the service control point routes it to the process shown by the encoded subsystem number, creates a response, addresses it to the service switching point's point code (obtained from the query), and sends the response to the service switching point via one or more signal transfer points. These signal transfer points route the response directly (i.e., without global title translation), based entirely on the service switching point code encoded in the message transfer part of the message.

The service management system performs service management functions in A-I-Net Release 0, including service creation, network management, support for call processing in the service control point, and support of OAM&P functions. (The service creation function is discussed in Morgan et al. in this issue.[4]) Here, we will focus on the OAM&P functions supported by an IN's service management system.

Four major IN characteristics that can be inferred from IN objectives and architecture are:

- Distributed intelligence in multiple network elements

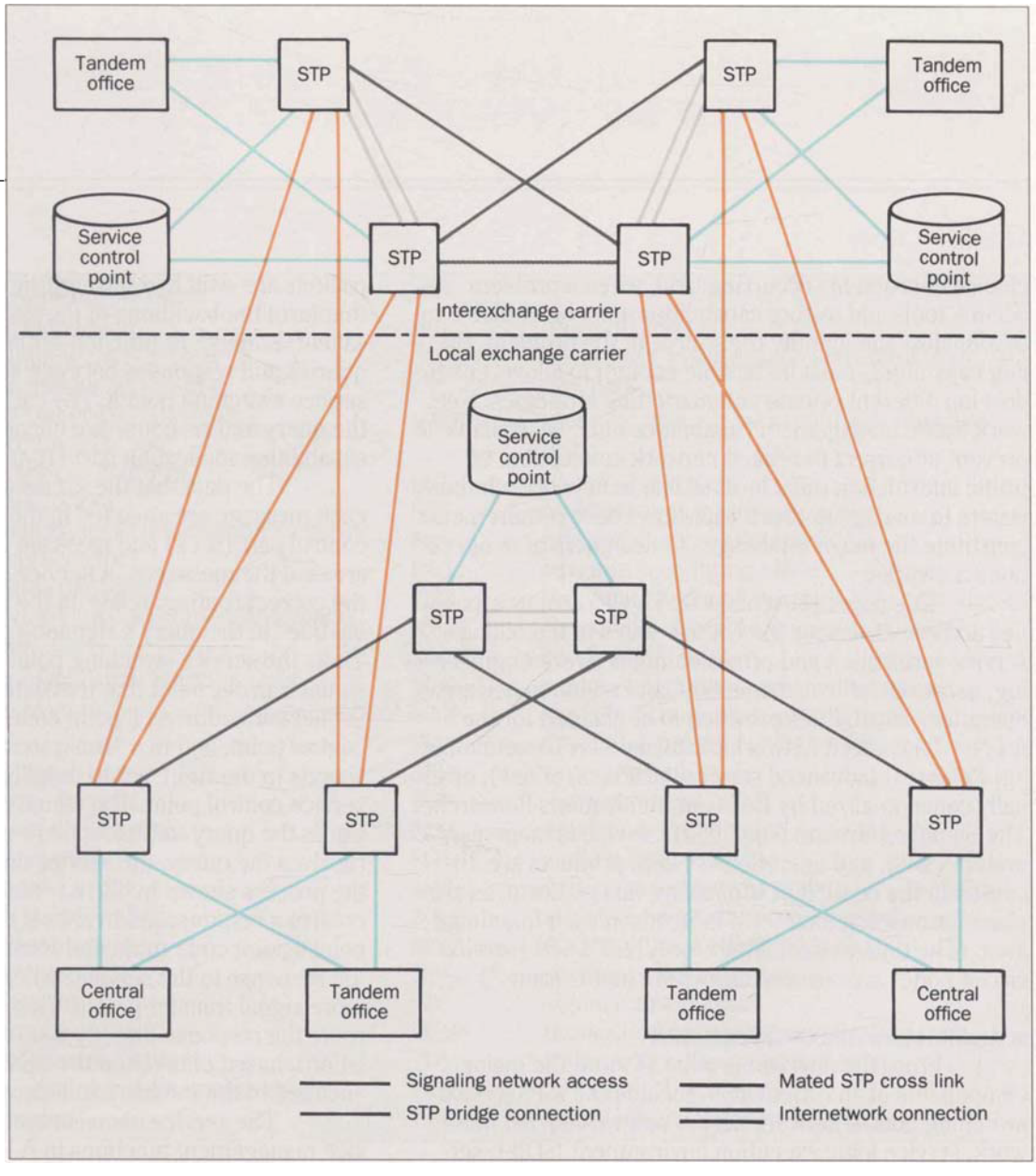

Figure 1. The SS7 signaling network architecture is a duplicated network with multiple signal transfer points and service switching points.

- Tight coupling between network elements
- The ability to introduce new NEs or new software on existing network elements
- Standard interfaces.

Thus, for LECs to control new service creation, the service creation process must be detached from the underlying platform.

LECs should not have to request new development from vendors to support new IN services. Because the service switching point or network access point provide customers with basic access, it must be possible to partition IN service logic across the service switching point or network access point and service logic execution environment. The service logic execution environment's service logic must control the rest of the network. As a result, many IN services will depend on

interfaces among multiple network elements. These interfaces will become more complex as IN services become more sophisticated. Also, new network elements can be expected as additional functions are required. Because network elements will generally be provided by different vendors, standard interfaces will be needed between network elements, and between network elements and operations systems. These considerations imply significant effects on all functional areas in the operations area. In the next section, we will turn to AT&T's strategy for the capabilities and evolution for each functional area and corresponding subareas.

Intelligent Network OAM&P

AT&T's operations platform for an IN network is driven by two basic approaches:

- OAM&P capabilities must give LECs maximum flexibility, including the ability to build and support diverse IN services, and the ability to provide an integrated IN operations network from different vendors' products.
- The IN operations platform must capitalize on existing OAM&P capabilities and procedures to minimize IN operations costs.[5]

The new capabilities should be interworked with existing OAM&P functionality to provide backward compatibility, i.e., be compatible with systems already in use.

This section discusses the following functional areas in the IN network:

- Billing
- Service provisioning and verification
- Network engineering
- Network traffic management
- Maintenance.

We will describe the network element capabilities of AT&T's A-I-Net Release 0, then discuss evolutions and future work for AT&T's A-I-Net Release 1 and beyond.

A-I-Net Release 0. The advanced services platform on the 5ESS® switch is the AT&T switching system platform that provides services for A-I-Net Release 0. The 5ESS switch can be used in the network as a service switching point or network access point. Also, the AT&T 1A ESS™ switch can be used as a network access point to interface with the 5ESS switch to provide IN services. Development of OAM&P capabilities for the advanced services platform was based on Bellcore's TR 402,[6] and incorporated critical enhancements in the billing, maintenance, and operations system areas. The following sections describe the operations capabilities in the operations platform.

Billing. The IN's major objective is to create new services to attract customers to the LECs. Because of an IN network's complexity, the following are the basic principles for designing the billing capabilities:

- The network must be able to record the use of facilities and services defined by the telephone company. Such recording gives LECs the flexibility to create new customized services and the ability to charge appropriately.
- Usage recording must cover customer as well as interexchange carrier (IEC) information.
- Automatic message accounting (AMA) records generated for IN services must comply with the Bellcore AMA Format (BAF).
- IN billing must allow the service provider to control the automatic message accounting recording. The service switching point must be flexible enough to receive and record usage data from the service control point. Real-time or near-real-time billing is necessary to meet the customer's needs.

ASP. In today's network, all charging information—i.e., service type, billing number, service feature code, and routing information—is generated by the switch. Control of automatic message accounting recording is limited. To increase this control and provide a platform the telephone companies can use to support their own customized services, the service switching point containing the advanced services platform package (i.e., 5ESS switch A-I-Net Release 0 software) allows the service control point to control the call code field and service feature code field in the basic advanced services

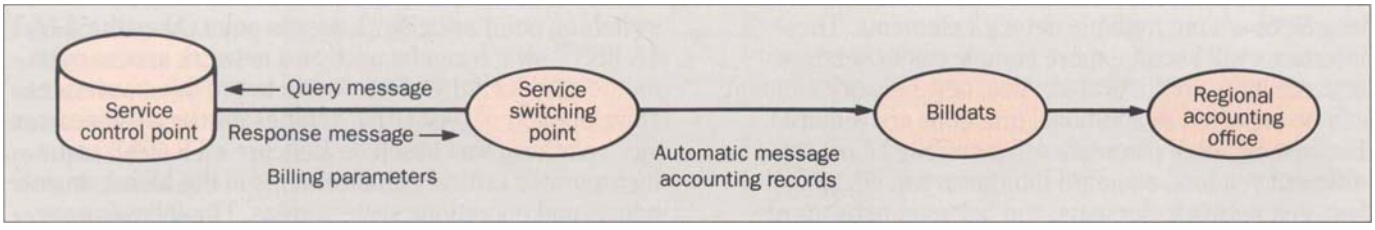

Figure 2. AT&T's A-I-Net™ Release 0 billing architecture, showing the interactions between the service control point, service switching point, the Billdats data collector, and the revenue accounting office (RAO).

platform automatic message accounting structure code. Also, the advanced services platform service switching point will append data modules needed for the additional charging information (i.e., business customer ID, billing number, WATS type, third party billing, and alternate billing number) received from the service control point. The service control point sends this information via the billing parameters in the transaction capabilities application part response message. Figure 2 illustrates the billing interactions and billing architecture for IN.

ASP SSP Recording. The service switching point can record advanced services platform calls originating from a line, remote access, or trunk. Automatic message accounting records will be generated with one mandatory data module and several optional data modules to present billing information to the revenue accounting office (RAO). The optional data modules are generated and appended based on the billing information returned from the service switching point. If the IEC carrier can identify an advanced services platform call, the service switching point can then record IEC carrier advanced services platform terminating access usage by generating special call and structure codes. Any combination of the optional modules can be used, and more than one of each kind can be appended to a single automatic message accounting record.

ASP NAP Recording. The network access point can detect an advanced services platform call and route it to a service switching point. An originating advanced services platform call type identifies the call as an advanced services platform call. No data module is appended to this automatic message accounting record. Because there will be two records generated for one advanced services platform call (one at the network access point, and one at the service switching point), the telephone company has the option to turn this recording capability on or off.

MDR SSP Capabilities. The message detail recording (MDR) capability is available to advanced services platform customers via the 5ESS switch. The advanced services platform information will be included in the originating private and public message detail recording records. The advanced services platform information includes a new value in the feature interaction field to indicate an advanced services platform call, and the routing information received from the service control point in the called number field. The access code field records the direct distance dialed (DDD) prefix instead of the advanced services platform access code. An originating private message detail recording record is created for an advanced services platform call routed from a network access point to the service switching point. The called number field records the customer-dialed digits after the advanced services platform access code. The outgoing facility identification field records the trunk facility between the network access point and service switching point.

SMS. As discussed above, per-call automatic message accounting billing record generation at the service switching point can be controlled by the service control

point. The service management system stores billing instructions in the call processing plan distributed to the service control point. The service control point will pass the billing information to the service switching point in response to a query during call processing. This information is then used by the originating service switching point to generate automatic message accounting records for processing by the LEC revenue accounting office.

Billdats. Billdats is a centralized automatic message accounting collector that interfaces with several switching systems to collect automatic message accounting records. The advanced services platform automatic message accounting records are treated as any other existing automatic message accounting records, and are collected and forwarded to the revenue accounting office. Billdats provides additional near-real-time billing capability by periodically receiving data from all switches and generating message detail recording records for customers.

Service Provisioning and Service Verification. Once an IN service is loaded into a service control point, the LEC must be able to assign the service to its customers. In the service switching point or network access point, user-specific triggers and events must be assigned. (A *trigger* is an indication to the switch that special action must be taken to continue processing a call.) In the service control point, customer events have to be associated with service logic programs (SLP) that determine the IN services being offered. The service switching point and network access point must also contain data for customer-specific variables such as office configuration, office parameters, office dialing plans, and digit analysis tables. signal transfer points to which the service switching point sends queries for global title translation (GTT) must also have the correct global title translation data for each customer. These steps comprise the *service provisioning process.*

Thus, service provisioning for one customer will require network administrators to populate customer-specific data in all network elements—i.e., service switching point, network access point, signal transfer point, and service control point. The populating must be possible at each network element—either on site, through a local interface, or remotely—through a service-provisioning operations system.

All provisioning data must be verified before a service can be made available to customers. Routing information in the service switching point, signal transfer point, and service control point has to be checked to ensure that calls can be routed through the desired facility. Billing information in the automatic message accounting record must be similarly verified to ensure that customers can be billed appropriately. Communication between service switching point software and the service logic programs also need to be ensured. Because multiple network elements are involved, network administrators need access to all network elements from one location. AT&T is planning several tools and capabilities—many of them new to the LECs—for these verification functions.

ASP SSP/NAP Service Provisioning. In A-I-Net Release 0, the 5ESS switch with advanced services platform software can be provisioned to act as a service switching point or network access point. The service switching point requires significant interaction with the service control point. The service switching point's provisionable office data include the advanced services platform digit analysis selector (DAS), service control point trunk DAS, service control point line DAS, and the point codes or capability codes of the signal transfer points that will perform global title translation in the IN routing queries. The service control point trunk digit analysis selector and service control point line digit analysis selector analyze digits contained in the service control point's response message. Advanced services platform dialed numbers are defined on an office basis, so any call to these dialed numbers will cause a query to the service control point.

On both the service switching point and network access point, the default interexchange carrier must be identified, and the points' values must agree for equal access signaling to be used to send information that

identifies advanced services platform calls. Also, automatic number identification (ANI) digits will be used to identify incoming advanced services platform calls from the network access point, and the network access point and service switching point values must agree.

Provisioning for the network access point office and the service switching point is similar, but there are several major differences. An office parameter is used to identify a 5ESS switch as either a billing or non-billing network access point, depending on whether the service provider wants to generate billing records for advanced services platform calls at the network access point. Though the network access point and service switching point triggers are similar, they are handled differently. Unlike the variety of service types on the service switching point, there is only a single network access point service type: "No Query." This means the network access point should route the call to a service switching point instead of trying to send a query. Because the network access point does not receive responses from the service control point, there is no need to identify a service control point line digit analysis selector or service control point trunk digit analysis selector. As with a service switching point, an advanced services platform-specific digit analysis selector is defined on an office basis. The digit analysis selector contains the advanced services platform dialing plans, and trigger provisioning generally is similar to that of the service switching point.

As noted, triggers tell the switch that special action must be taken to continue call processing. Specifically, the switch must first *suspend* call processing, send a query to the service control point, and wait for a response before resuming. For advanced services platform call processing, triggers are found at three different points: off-hook, digit collection and analysis, and routing. At each trigger point, several triggers can be provisioned. (See Russo et al.[3] for a detailed discussion of triggers.)

SSP/NAP Service Verification. AT&T has planned an "ASP Test Query" capability to verify IN service implementation. The network administrator will be able to enter an input/output (I/O) message that the switch interprets as an advanced services platform trigger, but without an associated call in progress. From the service control point point of view, there is no difference between a test query and a query associated with a call. The response message from the service control point will be interpreted and presented on the terminal where the network administrator accessed the service switching point. Because the response message will contain customer data, routing information, and billing information, the craft workers can use it to verify service provisioning. The test query can be initiated from the service switching point, or from a remote maintenance operations system. Figure 3 illustrates the procedure for the test query capability.

Signal Transfer Point (STP). When service logic execution environment functionality resides at an service control point, the service switching point will send queries to the service control point via the SS7 network. First, the service switching point addresses and sends the query to one of the signal transfer points that can do the global title translation needed for the rest of the routing. Thus, these signal transfer points must be populated with the correct global title translation data. The global title (GT) to be translated will be automatic number identification for originating triggers and dialed number for terminating triggers. It will be translated to the point code of the service control point and the number of the subsystem in the service control point that will process the query (subsystem number). The subsystem corresponds to the service control point call processing application. The signal transfer points that need the global title translation capability will be populated with the GT, service control point point code, and subsystem number by telephone company craft workers. If a 6-digit global title translation is used for the service in question, not every customer will need a separate recent change operation by the craft worker for service to be started or ended. If a 10-digit global title translation is used,

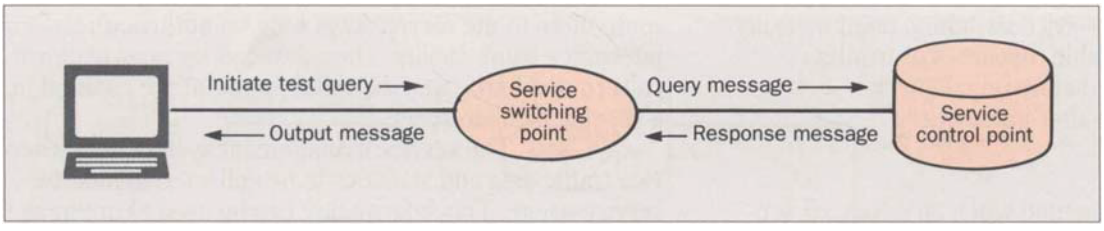

Figure 3. The flow of an IN test query, showing the interactivity between the initiator, the service control point, and the service switching point.

however, every customer will need a separate recent change operation.

Though a received response to the test query implicitly verifies at least one possible signaling connection control part route from service switching point to service control point, it does not verify them all. For example, with a mated pair of global title translation-performing signal transfer points and a mated pair of service control points, there would be four possible signaling connection control part routes. The signaling connection control part routing verification test (SRVT) verifies all signaling connection control part routes. The SRVT is part of the operations, maintenance, and administration part (OMAP) of the SS7 protocol, and is planned for AT&T's 5ESS, 1A ESS, 4ESS and 2ASTP™ products. Interpretation of SRVT results assumes that the administered message transfer part routing is correct. End-to-end message transfer part routes are verified with the message transfer part routing verification test (MRVT)—also part of OMAP—that is already available on these AT&T switching products.

SMS. The service management system provides service creation, plan building, and administrative functions that support call processing plan creation, modification, and deletion. The service management system also manages the placement and removal of call processing plans. In addition, the service management system controls the activation and deactivation of call processing plans. The service control point interacts with service switching points and uses these call processing plans to control an IN call's destination. The service management system verifies all plans and tables before they can be activated in the IN. This ensures that the call processing plan will work when it is installed in the network.

There are two general types of verification. The first—*data entry verification*—is performed immediately after the user enters the relevant data. The second—*on-command validation*—is performed when the user gives a command to validate the plan. On-command verification checks the internal logic of the call processing plan to make sure it is logically complete. It also compares data entered in various other places with the data in the plan, to ensure that consistent names and values have been used. The objective is to check the plan's total logic and that all necessary data is present.

Remote Memory Administration System (RMAS). RMAS is a service-provisioning operations system for switching systems that interfaces with other switching systems. It allows service orders to be scheduled for completion, then tracked as work progresses. Failed orders can be edited and released; a history file records successful orders.

Network Engineering. As an IN becomes more complex, more information is needed on traffic patterns and network usage to properly engineer the network. To assess the quality and reliability of an IN network, information on error conditions and resource availability also must be reported.

ASP. New measurement counts have been developed so network administrators can evaluate IN-specific network usage and network problems. Eighteen advanced services platform-related measurement counts are collected by service switching point offices and one measurement count is collected by network access point offices.

There are four service switching point measurement counts for unavailable resources or trunks:

- Resource unavailable before initial query
- Resource unavailable after initial query
- All IEC trunks busy
- All telco trunks busy.

These counts are incremented when an advanced services platform call fails because of a resource problem.

There are five counts related to the message flow between the service switching point and service control point:

- Invalid command message
- Invalid command sequence
- Return error or reject message
- Advanced services platform queries sent to the service control point
- Normal route response messages received.

With these counts, a network administrator can determine what happened to the service switching point-service control point link.

There are four counts associated with call processing failures and abandoned calls:

- Call processing failure before initial query
- Call processing failure after initial query
- Abandon before outpulsing
- Abandon after outpulsing.

These counts are used to track internal service switching point call processing failures. In addition, the following counts are provided for the advanced services platform feature:

- Network management (NM) control blocks call
- Signaling failure/time-out at service switching point
- Advanced services platform calls originating in service switching point-dialing complete
- Advanced services platform calls received from a network access point.

There are also several counts for tracking the usage and reliability of Digital Service Unit—Recorded Announcement Frame (DSU2-RAF) announcement devices.

NAP Measurement Counts. Network access point offices can detect advanced services platform calls and route them to the service switching point through an interoffice trunk facility. The advanced services platform calls routed to the service switching point are counted in a specific measurement.

SMS. The service management system allows service traffic data and statistics to be collected to monitor service usage. This information can be used to optimize service logic or reallocate service resources, e.g., by redirecting calls or reassigning service agents to certain locations according to time of day. Data can be collected by placing sample nodes in the call processing plan. After data are received from the service control point, they are made available for downstream processing.

EADAS. EADAS (Engineering and Administration Data Acquisition System) is a centralized system that collects administrative and engineering information from central offices. It has a flexible front end interface and allows the telephone company to define reports. Advanced services platform measurement counts are reported on the 30 Minute Traffic Report (TRFC-30) and can be collected by EADAS through the existing interface. Normal EADAS operation procedures are in place to support the advanced services platform network. In the future, a traffic data management system (TDMS) will be introduced into the network to collect data from the entire network (e.g., switches, service control points, and signal transfer points). This allows the LECs to have a global view of the network in a centralized location.

Network Traffic Management (NTM). NTM is a collection of network capabilities designed to control network traffic. Its purpose is to provide real-time network surveillance to maximize call completion during abnormal network conditions. There are three types of network control capability for the IN:

- The first controls traffic between network elements, and is already available in existing networks. Usually, it is used at the network control center.
- The second capability is currently available on the switch. If the switch detects an overload condition, the number of queries will be reduced to prevent congestion.
- The third capability is specific to the IN. It protects the

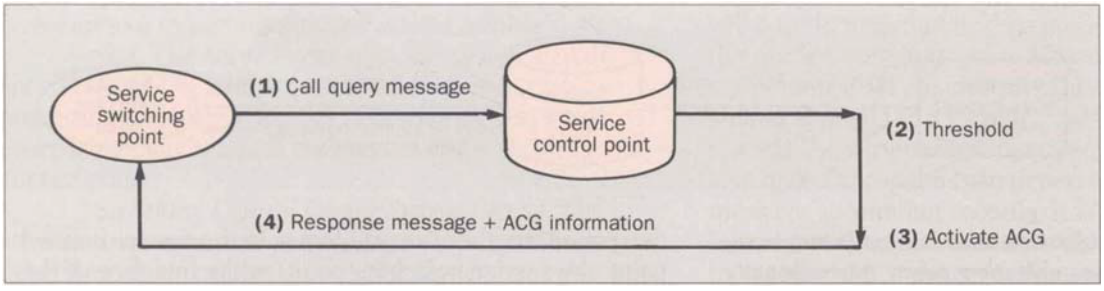

Figure 4. The service control point/service switching point automatic call gapping (ACG) control. In case of a potential service control point overload, ACG automatically throttles queries until the traffic is reduced.

service control point from overload, and should focus on initial requests by service switching points.

ASP. Several automatic and manual network traffic management controls have been developed for the existing network. These controls also can help ease congestion problems for IN. Also, two network traffic management capabilities were provided for A-I-Net Release 0 to control the message flow between the service switching point and service control point. They were service control point automatic call gapping (ACG) and selective origination code control (SOCC).

The major purpose of the service control point automatic call gapping capability is to protect the service control point from overload. A threshold is determined in the service control point database by the network controller. When the number of queries from a specific service switching point exceeds the threshold, the automatic call gapping capability automatically begins. When the response message is returned to the service switching point, all network control information is attached. The call associated with this trigger query message will be treated normally. Starting with the next advanced services platform call, however, the service switching point will limit the number of queries sent to the service control point according to the instructions received from the service control point (i.e., service key, control code). The network control will be stopped automatically, based on the control duration shown in the response message. Figure 4 illustrates the automatic call gapping capability.

Thirty-two controls can be activated at the service switching point via the service control point overload control. The service control point can install or delete network control duration and gapping levels.

The selective origination code control adds flexibility to the telephone company's control of its network. This capability will not only protect the service control point, but also can protect other network elements. Network control demands for the service control point are manually input by craft workers. When the next query message is received from the service switching point, the network control demands will be attached automatically to the response messages. The service switching point will then start to throttle the query messages based on the control demands. Figure 5 illustrates the selective origination code control capability.

The selective origination code control allows network controllers to control service switching point traffic. It can activate up to 64 network control levels, and can install infinite gap and infinite duration controls. Going beyond the 6-digit control that can be performed by the service control point overload control, the selective origination code control can exercise 3-, 6-, 7-, 8-, 9-, and 10-digit control.

SMS. The service management system manages several IN-provided network management functions. It provisions, maintains, and updates network management data at the service control points.

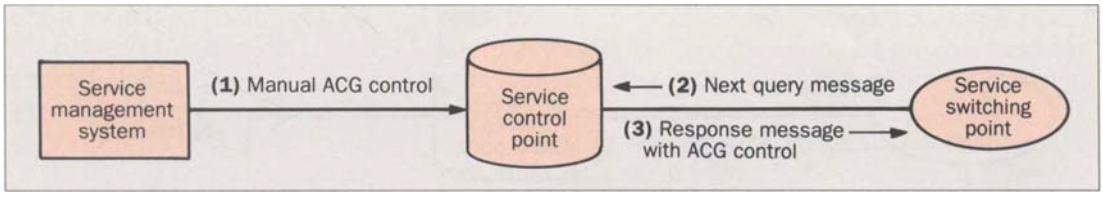

Figure 5. The selective origination code control (socc) in the service control point-service switching point. This capability gives the telephone company greater flexibility in network controls.

EADAS/NM and NetMinder. The EADAS/NM (Network Manager) and NetMinder are the AT&T network control systems used in the network control center. They interface and receive data from EADAS, and can monitor the network traffic and activate network controls remotely. The NetMinder is designed to interface with network elements other than the switching offices to provide more efficient and flexible traffic controls to the network. The advanced services platform capability can be smoothly integrated into these network control systems. The advanced services platform measurements are given to EADAS, which interfaces with both systems. The information from these two systems is used to guide imposition of automatic call gapping controls via the selective origination code control capability.

Maintenance. Creating an IN service requires coordination between the service switching point and service control point. The databases in these two network elements must be consistent to provide the required service. Besides the existing maintenance and testing capabilities in the switch, signal transfer point, and service control point, specific maintenance capabilities are needed to maintain the service switching point-service control point interface. These new maintenance capabilities must allow the network administrator to verify a service after it has been created, and to sectionalize a problem when a complaint is received.

The first phase of troubleshooting is to determine whether the problem is in the service control point, the service switching point, or the interface. If the problem is in the service switching point, a second phase isolates it further.

ASP. Two maintenance capabilities are introduced in A-I-Net Release 0 to help network administrators maintain IN service: advanced services platform test query and service switching point event trapping. The advanced services platform test query was described in the service verification section and is cited here because it relates to the service switching point event-trapping capability.

The service switching point event trapping capability allows craft workers to activate manually up to nine predefined event traps in the service switching point. The events are:

- Network management blocked
- Play announcement
- Automatic call gap component received
- Failed query
- Reject message received
- Return error message received
- Timeout waiting for service control point response
- Send notification
- Termination notification.

These events can be made applicable to all advanced services platform calls that trigger them. With each event, an output message is sent to the receive-only printer (ROP) and the craft worker's I/O channel. The traps can be deactivated manually.

Though the advanced services platform test query and service switching point event trapping are independent capabilities, when coupled they provide a

powerful tool to sectionalize and isolate trouble.

SMS. The service management system can do special studies to isolate service control point call processing problems. It can also, as noted, test a call processing plan before it is activated in the service control point.

Switching Control Center System (SCCS). The advanced services platform maintenance capabilities described above can be invoked locally, and are also supported remotely in the switching control center system (SCCS). The SCCS has a user-defined custom interface (UDCI) that helps the network administrator maintain new network elements with minimal changes to support system or center operations. The SCCS can interface not only with the service switching point but also with signal transfer point and service control point. All alarms will be centralized in the SCCS, helping the network administrator relate one alarm to another to determine the problem.

In addition to SCCS, a new system—"Total Network Surveillance"—is being introduced to the network to provide a network view that allows LECs to isolate and sectionalize a problem more efficiently.

A-I-Net Release 1 and Beyond. Despite the reasons for introducing IN, starting with a full set of IN capabilities that support all IN attributes may not be practical or cost-effective.[1] OAM&P capabilities are also evolving, and the capabilities required to support an IN network are still being explored. Looking beyond A-I-Net Release 0, there are requirements and expectations set forth by Bellcore,[7] U S West, BellSouth, and other providers. This section provides an overview of IN OAM&P evolution.

Billing. In A-I-Net Release 0, though the service control point controls automatic message accounting record generation by sending billing parameters to the service switching point, vendor-specific service switching point development work is still necessary if LECs want to add AIN information to the automatic message accounting record or automatic message accounting data modules. Full flexibility must be evolved to allow greater control by the service logic execution environment. It will have to generate its data modules and send them to the service switching point. However, the service switching point should not interpret this information; instead, it should append the data to the A-I-Net records it generated. The service logic execution environment should also have the capability to generate standalone automatic message accounting records. It is possible the service logic execution environment will have an interface to the host collector, or the service logic execution environment will be able to send the records to the service switching point for storing and forwarding.

Service Provisioning and Service Verification. In A-I-Net Release 0, service provisioning must be done for individual network elements. One service order requires multiple inputs to multiple network elements. The multiplication of inputs not only slows the service provisioning process, but also increases the possibility of entering inconsistent data. To avoid this problem, interactions between network elements should be expanded from call processing and billing to include service provisioning. The network administrator should have to interface with only one network element to input the necessary customer data. This network element should be able to determine if other network elements in the network need updating. If necessary, service provisioning messages would then be sent between the network elements to update customer data. Customers should also be able to access and update their subscription data.

Real time service activation and deactivation should be allowed. Because customers, other network elements, or a provisioning operations system could make service provisioning requests, a standard interfaces-and-procedures for service provisioning among network elements would be needed. The common management information element (CMISE) and remote operation service element (ROSE) with the open systems interconnection (OSI) 7-layer protocol have been proposed and are being evaluated for the interface.

Network Engineering. As previously noted, the interaction between the service switching point and

service logic execution environment becomes more complex as A-I-Net services become more sophisticated. Thus, additional granularity will be needed in the measurement area. Specific counts will be required on a per trigger and per event basis. Possibly the measurement taken will also be based on trigger criteria (i.e., digit pattern and line subscription) to provide additional information for network and market studies.

Network Traffic Management. In A-I-Net Release 0, the network traffic control capability is developed on an individual office basis. For example, when call gapping is in effect in a service switching point office, the IN-related events with matching service key and controlled code will be throttled. This may not be enough for the IN of the future. The LECs may want to control IN traffic based on customer characteristics (e.g., trigger type and priority) or customer group. All additional controls would give LECs the flexibility to provide services to selected customers under overload conditions.

Maintenance. An important idea in IN maintenance is to offer an integrated network view that allows a service view or customer view. For example, to sectionalize problems, the network administrator must be able to do an end-to-end test call involving all IN network elements, and receive the test results in real time. Because this call would be flagged as a test call, all involved network elements would report associated failures to the site where the test call originated.

Conclusion

The IN concept implies additional flexibility and complexity in existing networks, and thus creates opportunities and challenges for LECs and vendors. This paper has focused on IN OAM&P functionality in AT&T products. We have presented the strategies and existing capabilities for IN, and have discussed future opportunities in each OAM&P functional area. With the deployment of A-I-Net Release 0 and repeated IN trials, both LECs and vendors will learn more about IN, and more IN OAM&P capabilities will be identified, developed, and integrated into existing networks.

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Biographies (continued)

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(Manuscript received April 9, 1991)