International Intelligent Network (IN)

Definition

In an intelligent network (IN), the logic for controlling telecommunications services migrates from traditional switching points to computer-based, service-independent platforms. This provides network operators an open platform provisioned with generic service components that can interoperate with elements from different vendors, based on published, open-interface standards. This platform can be used to develop new and different services.

Overview

This tutorial addresses the evolution and direction of the IN based on International Telecommunications Union–Telecommunications Standardization Sector (ITU–T) and European Telecommunications Standards Institute (ETSI) standards development.

Topics

1. Driving Forces behind the Intelligent Network
2. Overview of the Intelligent Network Architecture
3. Capability Sets: Standards for Intelligent Networks
4. Future Trends for Intelligent Networks
   - Self-Test
   - Correct Answers
   - Glossary
1. Driving Forces behind the Intelligent Network

Within the traditional telecommunications environment, telecommunications companies acted both as network operators and service providers. The network operator is the entity that owns and operates the network infrastructure. A service provider is an entity that offers services to the subscribers. The service provider uses the network infrastructure of a network operator to deliver the service to the subscriber but is responsible for the management and development of the service.

Service offerings were more likely driven by technological availability rather than customer need, as much of the network infrastructure has been based on proprietary interfaces with bounded capabilities. This type of environment resulted in long development times and large investments to deploy services. New technological capabilities, privatization and deregulation, and changes in market and customer demand have driven the emergence of INs. The result is an increase in competition that has forced operators and services providers to add new features rapidly to attract and retain customers.

The IN can play an important role in providing such new features and services. In an intelligent network, control of call processing is moved out of the switch and into the network. The idea is to give service providers the ability to develop new services quickly, independently, and inexpensively; a capability they do not have when new services are implemented on network switches. With the IN, service providers or their IN vendors develop the intelligence or service logic to provide new services using service creation environments. Then they deploy this intelligence on service control points within the IN. So, service providers can use the facilities of the IN to deploy new services to their subscribers without any change to the programming in the network switches. By separating services from switching equipment, the IN opens markets for telecommunications-service creation and switching-equipment providers.

2. Overview of the Intelligent Network Architecture

Within traditional public switched telephone networks, the hierarchy of switching equipment and software must be upgraded each time a new service is added to the network. This is a complex and costly process. Further, network switches could not provide new number translation, routing, and charging capabilities. As telecommunications services have evolved, the need to reduce the overhead for service use has increased along with the need to simplify maintenance and service upgrades or additions.
The IN essentially separates these services from switching equipment and organizes a centralized system so that providers need not perform major modifications on multiple switches when they introduce new services. The first step in IN development was to create separate service data in a centralized database outside the switching nodes. The second step was to separate the service programs, or service logic, and to define a protocol that would permit interaction between switching systems and intelligent nodes containing the service logic and data.

For service switching points and service control points (intelligent nodes) to work, common channel signaling, or out-of-band signaling, was required as opposed to the traditional inband signaling. Relying on out-of-band signaling, or signaling system 7 (SS7) protocols, provides the mechanism to place service logic and service data into dedicated network elements that can remotely handle call control and connection. SS7 also enables intelligent applications to communicate with other applications and to access databases located in various parts of the network.

Certain network elements can be distinguished in every IN, as shown in Figure 1.
Service switching points (SSPs) are stored program control switches that interface to the SS7 signaling network. The SSP embodies the call control function (CCF) and service switching function (SSF) entities. The SSF recognizes IN service calls and routes the appropriate queries to the service control function (SCF) that resides in a service control point (SCP) via the SS7 network through signaling transfer points (STPs). STPs are high-capacity, high-reliability packet switches that transport signaling messages, using large routing databases, between the IN nodes.

SCP commands are used by the SSP to process calls. The SCP is a fault-tolerant, high-capacity, transaction-processing entity that provides call-handling information in response to SSP queries. The service management point (SMP) provides operation, administration, and maintenance functions for the IN. The intelligent peripheral (IP) provides enhanced services or functions under the control of an SCP, possibly relayed by an SSP, such as play announcements and speech recognition.

As seen in Figure 2, the IN architecture is fundamentally based on SS7 and its protocol architecture. A common signaling transport capability known as the message transfer part (MTP) handles the corresponding open systems interconnection (OSI) physical, data-link, and network layers. The next level, signaling connection control part (SCCP), augments the MTP by providing both connectionless and connection-oriented message transport, as well as enabling addressing capabilities for message routing. The transaction capabilities application part (TCAP) provides procedures for real-time transaction control. The final layer, IN application protocol (INAP) defines the operations required between IN network elements, such as SSPs and SCPs.

**Figure 2. IN Protocol Stack**

<table>
<thead>
<tr>
<th>Intelligent Network Application Protocol (INAP)</th>
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<tr>
<td>Transaction Capabilities Application Part (TCAP)</td>
</tr>
<tr>
<td>Signaling Connection Control Part (SCCP)</td>
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<tr>
<td>Message Transfer Part (MTP)</td>
</tr>
</tbody>
</table>
All of these basic elements form the infrastructure in IN, which supports the notion of separating service-control functions from service switching-functions, to realize more rapid-services development and deployment. Another equally important concept in IN has been the notion of service independence. Here, the primary goal has been to identify and create generic sets of reusable service components that could be used to build new services and loaded into SCPs to generate new services rapidly. These service components are also known as service independent building blocks (SIBs).

To provide a framework that would lead toward IN engineering standardization, the IN conceptual model (INCM) was developed (Figure 3). The INCM, which is solely a tool for describing IN capabilities and characteristics, is composed of four "planes" that represent different aspects of implementing IN services. This model depicts the relationship among services and service features, global service logic (SIBs), distributed service logic, and the physical network entities such as SCP and SSP. These planes include the service plane, the global functional plane, the distributed functional plane, and the physical plane as shown in Figure 3.

![Figure 3. IN Conceptual Model—INCM (from Q.1201)](image)

The service plane describes services from a user's perspective, where a service consists of generic blocks or service features that make up part or all of a service (e.g., Freephone). The global functional plane deals with service creation and is
comprised of the SIBs that will be used to create service features. Global service logic defines how SIBs are linked together to form features and how these SIBs interact with another basic SIB known as the basic call process (BCP). The BCP is the process that optimally supports services that do not require special features and is basic to the processing of all services. The distributed functional plane defines a set of functional entities that perform specific actions. SIBs are implemented through a specific sequence of functional-entity actions performed by those functional entities. *Table 1* describes functional-entity components as well as their relationship to IN physical entities.
<table>
<thead>
<tr>
<th>Physical Component</th>
<th>Distributed Functional Component</th>
<th>Description</th>
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<tbody>
<tr>
<td><strong>Service Switching Point (SSP)</strong></td>
<td>Call Control Function (CCF)</td>
<td>Controls call processing and provides network connection services</td>
</tr>
<tr>
<td></td>
<td>Service Switching Function (SSF)</td>
<td>Supports IN triggering during call processing and access to IN functionality</td>
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<tr>
<td></td>
<td>Specialized Resource Function (SRF)</td>
<td>Supports the interaction between the call processing software on the switch and the service control function</td>
</tr>
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<td></td>
<td>Call Control Agent Function (CCAF)</td>
<td>Supports specialized network resources generally associated with caller interaction; provides user access to the network</td>
</tr>
<tr>
<td><strong>Service Control Point (SCP)</strong></td>
<td>Service Control Function (SCF)</td>
<td>Executes IN service logic and influences call processing on the switch via its interface to the SSF</td>
</tr>
<tr>
<td></td>
<td>Service Data Function (SDF)</td>
<td>Manages customer and network data for real-time access by the SCF in the execution of an IN service</td>
</tr>
<tr>
<td><strong>Intelligent Peripheral (IP)</strong></td>
<td>Specialized Resource Function (SRF)</td>
<td>Supports specialized network resources generally associated with caller interaction</td>
</tr>
<tr>
<td><strong>Service Management Point (SMP)</strong></td>
<td>Service Management Function (SMF)</td>
<td>Allows deployment and provision of IN services and allows the support of ongoing operation</td>
</tr>
<tr>
<td></td>
<td>Service Management Access Function (SMAF)</td>
<td>Provides an interface between service managers and the SMF (could be implemented in a separate physical element, the SMAP)</td>
</tr>
<tr>
<td><strong>Service Creation Environment Point (SCEP)</strong></td>
<td>Service Creation Environment Function (SCEF)</td>
<td>Allows services provided in the IN to be defined, developed, tested, and input to the SMF</td>
</tr>
<tr>
<td><strong>Service Data Point (SDP)</strong></td>
<td>Service Data Function (SDF)</td>
<td>Manages customer and network data for real-time access by the SCF in the execution of an IN service</td>
</tr>
</tbody>
</table>
As Table 1 also shows, each functional entity is mapped to a particular physical entity within the network. This is depicted in Figure 4. The information flows defined in the distributed functional plane are implemented in the physical plane through the appropriate INAP.

![Figure 4. Mapping of Functional and Physical Elements](image)

### 3. Capability Sets: Standards for Intelligent Networks

International standards work for IN began in 1989 within the ITU and the ETSI. These standards bodies have been developing IN capability sets that will be upwardly compatible in parallel. The ITU builds its "Q.1200 Recommendation Series for IN Architecture," and ETSI takes these recommendations and modifies them for use by European operators.

Capability sets refers to a set of services and service features that can be built using SIBs. All capability sets use the IN conceptual model. Each capability set is associated with a planned phase in the standards process. The first capability set, CS–1, was defined by the ITU in 1992 but was found to be too extensive and incomplete by ETSI. ETSI defined the Core INAP standard in 1994 as a subset of the original CS–1. The ITU adopted this work and reissued the standard in 1995. This 1995 release of the CS–1 recommendations is generally referred to as "CS–1R," for "refined."
For CS–1 IN services to be implemented, Core INAP supports the interactions among the functional entities defined earlier: SSF, SCF, SRF, and SDF. Application service elements (ASEs) are available in the Core INAP specification to provide a definition of specific application interactions between functional entities. In general information flows/operations within ASEs are defined within Core INAP using the abstract syntax notation 1 (ASN.1) nomenclature. Examples of basic CS–1 information flows include the following:

- connect
- prompt and collect user information
- analyze information
- play announcement
- release call

Using a common IN service, the premium rate service, the interrelationship of services, service features, and the SIBs is provided below. The premium-rate service provides a business owner with a special premium-rate number. Customers that call this special number are charged at a special rate for both the call as well as for information and/or services obtained through the call. The network operator collects the revenue associated with the call and distributes a share to the business owner of the premium-rate number. Examples of premium rate include weather, stock, sports, and other information services.

A premium rate service has two core service features:

1. The **one number** service feature permits the business owner (subscriber) to have two or more terminating lines in a number of locations, using a single premium-rate number.

2. The **premium charging** service feature permits the subscriber to receive some of the revenue associated with each premium-rate call.

There are other optional service features associated with the premium-rate service, such as call distribution, time and origin-dependent routing, recorded announcements, and many others.

Within the premium-charging service feature there are three associated SIBs: the charge SIB, the call log information SIB, and the service data management SIB.

Within the charge SIB, there are a number of information flows/operations at work. For example, the SCF can issue a `FurnishChargingInformation` information flow that carries charging characteristics for a particular call to the SSF. Once the SSF receives these characteristics, the SSF generates a billing
Within the same SIB, the SCF may also issue the SendChargingInformation information flow that sends charging characteristics to an SSF that controls the way that the SSF charges for a call. Other information flows are associated with this SIB, such as EventNotificationCharging and ApplyCharging that perform related charging functions.

In summary, the INCM is used to first describe a service without reference to the distribution of functionality within the network. The service is then decomposed into service features, and all service features must be mapped onto corresponding SIBs. Each capability set defines the catalog of services, service features, and SIBs. Service designers can create new services within the boundaries of the capability sets, usually building SIB chains or service scripts.

4. Future Trends for IN

Work on CS–2 in the ITU–T study group was started in 1994 and was completed in 1997. Because of the large size of the CS–2 recommendations, they are being scheduled for publication in late 1998. CS–2 includes many new capabilities over CS–1. There are more interfaces between the functional entities, along with some additional functional entities. Figure 5 shows the functional relationships for CS–2.

As can be seen in Figure 5, additional functional entities are defined for CS–2. Additional relationships are also defined between the existing functional entities.
CS–2 allows for more advanced and complex services than those offered with CS–1. CS–2 allows for greater integration and access to information in the operator's network and across operators' networks. This is particularly evident in the relationships between SCFs and SDFs. The multiple SCFs and SDFs can reside within an operator's network, or can be in different operators' networks.

Three types of service categories have been identified in CS–2: telecommunications services, which were also available in CS–1 service management; services, and service creation services, which are both new to CS–2. Telecommunication services are the standard IN services that are offered to subscribers by the operators. Service management services are defined for the following groups: service customization, service control, service monitoring, and other management services. Service creation services are grouped as follows: service specification, service development, service verification, service deployment, and service creation management.

ETSI is currently developing the corresponding CS–2 specifications for the European operators and vendors. It is expected that the specifications will be finalized by the end of 1998. The ETSI specifications are closely aligned with the ITU–T recommendations, except for the CUSF/SCF interface.

Telecommunication management network (TMN) provides the framework for standard modeling of telecommunications management services, management information, and management interfaces. Initiated by the ITU, the TMN framework defines network management architecture, composed of functional, physical, and informational elements, for a minimum platform to provide interoperability between network components and management systems. In CS–2, the service management functions are defined down to the distributed functional plane. The generic TMN protocols are expected to be used, with no modification to the INAP protocol foreseen.

Other initiatives supporting long-term evolution of IN are also in progress. The international Telecommunications Information Networking Architecture (TINA) consortium is seeking to develop an architecture that addresses open communications and applications that operate in a distributed computing and processing environment. However, this architecture is not backward-compatible, with the function-oriented IN service described in the INCM. In the TINA model, network functions are separated into a service segment that deals with service provisioning, and a delivery segment that provide functions for switching and transmission of information that is technology dependent. This model is more consistent with a manager-agent separation currently in use within computing network management standards.

IN is also impacting the mobility segment, as fixed-mobile convergence operations emerge. Current mobility systems have incorporated IN capabilities to support call routing, charging, handover, and other related mobility functions.
There is current interest in merging mobility systems with the IN in a uniform approach (i.e. fixed mobile convergence), since IN already provides the required network intelligence for fixed networks. Future generation-mobility-systems standards, such as the universal mobile telecommunications system (UMTS) are being based on the IN architecture within ETSI.

Additional effort in supporting operator-specific services to mobility customers while roaming in visited, GSM–based networks is also underway through the Customized Applications for Mobile Network Enhanced Logic (CAMEL) initiative in ETSI. CAMEL defines the specifications necessary to offer IN services in a mobile environment. The CAMEL specifications are based on the ETSI Core INAP specifications. CAMEL Phase 1 was finalized in 1997, and provides basic call control. CAMEL Phase 2 has been completed in 1998, and offers more sophisticated capabilities, such as user interactions and charging.

**Self-Test**

1. In an IN protocol stack, the INAP layer __________.
   a. handles the corresponding OSI physical, data-link, and network layers
   b. provides procedures for real-time transaction control
   c. defines the operations required between IN network elements
   d. enables addressing capabilities for message routing
   e. none of the above

2. Capability sets are a set of services and features built by using SIBs and are based on the IN conceptual model.
   a. true
   b. false

3. Which of the following information flows/operations can be found within the Charge SIB?
   a. ApplyCharging
   b. CallLogInformation
   c. ChargeCardingInformation
   d. all of the above
4. IN can play an important role in providing new features and services because ________.
   a. it gives service providers the ability to develop new services quickly
   b. control of call processing is moved out of the switch and into the network
   c. it opens markets for switching-equipment providers
   d. all of the above
   e. none of the above

5. Network switching can provide new number translation, routing, and charging capabilities.
   a. true
   b. false

6. Relying on out-of-band signaling provides the mechanism to ____________.
   a. utilize traditional inband signaling
   b. perform modifications on multiple switches when new services are introduced.
   c. store programmed control switches that interface to the SS7 signaling network
   d. all of the above
   e. none of the above

7. The INCM, which is solely a tool for describing IN capabilities and characteristics, is composed of four planes that represent different aspects of implementing IN services.
   a. true
   b. false
8. The premium charging service feature permits the business owner (subscriber) to have two or more terminating lines in a number of locations, using a single premium-rate number.
   a. true
   b. false

9. The ____________ deals with service creation and is comprised of the SIBs that will be used to create service features.
   a. service plane
   b. basic call process
   c. global functional plane
   d. all of the above
   e. none of the above

10. ETSI is currently developing the corresponding CS–2 specifications for the European operators and vendors, which are closely aligned with the ITU–T recommendations, except for the CUSF/SCF interface.
    a. true
    b. false

**Correct Answers**

1. In an IN protocol stack, the INAP layer ____________.
   a. handles the corresponding OSI physical, data-link, and network layers
   b. provides procedures for real-time transaction control
   c. **defines the operations required between IN network elements**
   d. enables addressing capabilities for message routing
   e. none of the above

   See Topic 2.
2. Capability sets are a set of services and features built by using SIBs and are based on the IN conceptual model.
   
   **a. true**
   
   b. false
   
   See Topic 3.

3. Which of the following information flows/operations can be found within the Charge SIB?
   
   **a. ApplyCharging**
   
   b. CallLogInformation
   
   c. ChargeCardingInformation
   
   d. all of the above
   
   e. none of the above
   
   See Topic 3.

4. IN can play an important role in providing new features and services because ________.
   
   a. it gives service providers the ability to develop new services quickly
   
   b. control of call processing is moved out of the switch and into the network
   
   c. it opens markets for switching-equipment providers
   
   **d. all of the above**
   
   e. none of the above
   
   See Topic 1.

5. Network switching can provide new number translation, routing, and charging capabilities.

   **a. true**
   
   **b. false**
   
   See Topic 2.
6. Relying on out-of-band signaling provides the mechanism to ______________.

   a. utilize traditional inband signaling
   b. perform modifications on multiple switches when new services are introduced.
   c. store programmed control switches that interface to the SS7 signaling network
   d. all of the above
   **e. none of the above**

   See Topic 2.

7. The INCM, which is solely a tool for describing IN capabilities and characteristics, is composed of four planes that represent different aspects of implementing IN services.

   a. **true**
   b. false

   See Topic 2.

8. The premium charging service feature permits the business owner (subscriber) to have two or more terminating lines in a number of locations, using a single premium-rate number.

   a. true
   **b. false**

   See Topic 3.

9. The ______________ deals with service creation and is comprised of the SIBs that will be used to create service features.

   a. service plane
   b. basic call process
   **c. global functional plane**
   d. all of the above
e. none of the above

See Topic 2.

10. ETSI is currently developing the corresponding CS–2 specifications for the European operators and vendors, which are closely aligned with the ITU–T recommendations, except for the CUSF/SCF interface.

a. true

b. false

See Topic 4.

Glossary

ASE
application service element

ASN.1
abstract syntax notation 1

BCP
basic call process

CAMEL
customized applications for mobile network enhanced logic

CCAF
call control agent function

CCF
call control function

CS
capability set

CUSF
call unrelated service function

ETSI
European Telecommunications Standards Institute

GSM
global system for mobile communications
IN
intelligent network

INAP
intelligent network application protocol

INCM
IN conceptual model

IP
intelligent peripheral

ITU–T
International Telecommunications Union–Telecommunications Standardization Sector

MTP
message transfer part

OSI
open systems interconnection

SCCP
signaling connection control part

SCE
service creation environment

SCEF
service creation environment function

SCEP
service creation environment point

SCF
service control function

SCP
service control point

SCUAF
service control user agent function

SDF
service data function

SDP
service data point
SIB
service independent building block

SMAF
service management access function

SMF
service management function

SMP
service management point

SRF
specialized resource function

SS7
signaling system 7

SSF
service switching function

SSP
service switching point

STP
signaling transfer point

TCAP
transaction capabilities application part

TINA
telecommunications information networking architecture

TMN
telecommunications management network

UMTS
universal mobile telecommunications system