



Signaling System 7 (SS7) Gateway Solution for Internet Access

Definition

A signaling system 7 (SS7) gateway is an intelligent network (IN)–based system that can be used in conjunction with network-access servers (NASs) to offload the circuit-switched network congestion caused by dial-up Internet users. This system is also capable of creating new services for Internet service providers (ISPs).

Overview

This tutorial outlines the architecture necessary to employ SS7 technologies for Internet access and proposes the SS7 gateway as a potential solution for public switched telephone network (PSTN) overcrowding.

Topics

1. Introduction
 2. Existing Scheme for Internet Connection
 3. SS7 Gateway Solution
 4. Internal Architecture and Functional Overview
 5. Processes of the SS7 Gateway
 6. Summary of Benefits
 7. Conclusion
- Self-Test
 - Correct Answers
 - Glossary

1. Introduction

The Internet is growing at an explosive rate, and every day more people are getting on-line. Some estimates project that by the year 2001, 94 million Internet

users will be on-line in the United States alone. Another estimate expects that Internet users will reach 500 million by the year 2000 throughout the world. Meanwhile, the number of ISPs is growing rapidly.

According to Federal Communications Commission (FCC) statistics, currently there are more than 4,000 ISPs offering services in the United States with more than 31 network backbones. Most Internet users today are using modems and standard telephone lines to connect their computers to the ISP of their choice. The lengthy connection time for Internet users has created a heavy burden on the PSTN. To deal with increasing numbers of Internet users and sustain the same level of services for plain old telephone service (POTS), incumbent local-exchange carriers (ILECs) must upgrade their networks by adding intermachine trunks (IMTs) and ports on their existing switches.

Adding expensive voice-based circuit-switching infrastructure for carrying packet-oriented data is not a desirable solution, especially when the customer cannot be billed for these enhancements. For this reason, there has been a constant effort to find alternative solutions to divert Internet traffic from the PSTN. Some of these solutions are based on new and emerging technologies. Most of these solutions are either expensive or do not offer the level of reliability and service that is expected from a system within a telephony network.

In addition, ISPs are not content with the current scheme of Internet connection. Although most ISPs are enjoying the flat telephone rate for their customers, a congested PSTN does not help ISPs either. In fact, ISPs hope to concentrate on their core business and leave connectivity and maintenance of the data network to the networking providers, provided the ISPs do not lose control over network management and the authentication of their customers. Adding a combination of the SS7 gateway and any of several alternative remote access servers (RASs) to the telephony network provides an excellent solution for both telephone companies and ISPs. Although this tutorial focuses on the United States telecommunications environment, the problem at hand exists throughout the world.

2. Existing Scheme for Internet Connection

Figure 1 depicts the current scheme for connecting dial-up Internet users to ISPs using the PSTN. The figure shows a typical network topology. The central-office (CO) switches are connected to tandem switches via IMTs. In some cases, the CO switches are directly connected via interoffice trunks.

Figure 1. Dial-Up Internet Users' Connections to ISPs Using PSTN

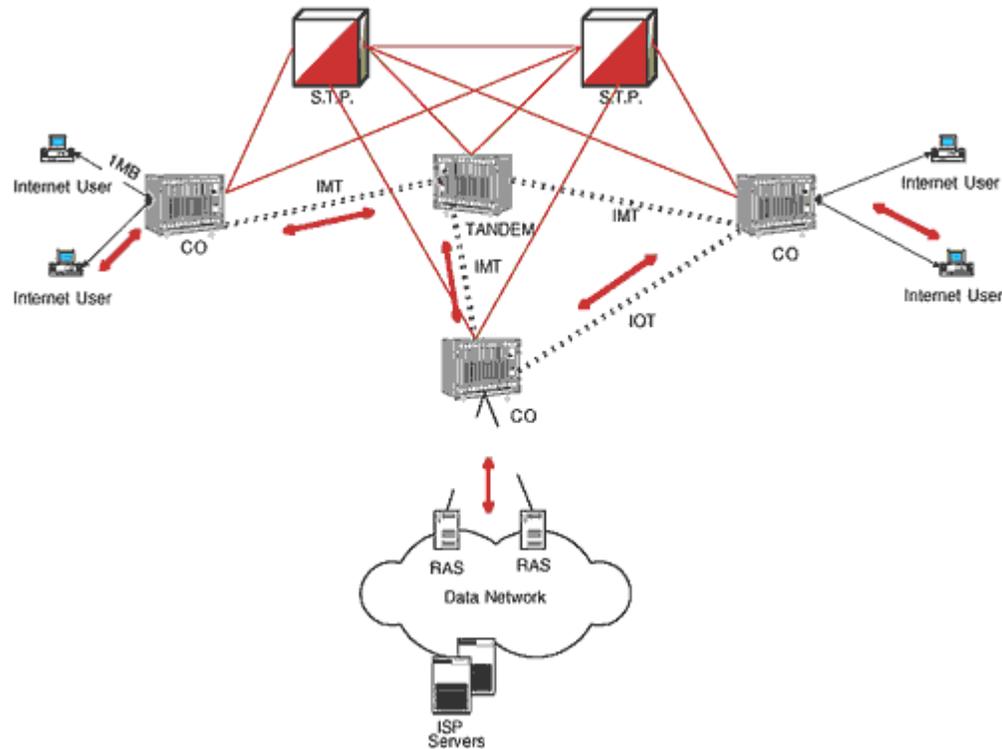


Figure 1 shows two typical paths in a representative PSTN for a dial-up connection. In the first scheme, calls from Internet users go through an originating local CO switch (ingress Class 5), a regional tandem switch (Class 4) and a terminating local CO switch (egress Class 5) and are terminated via either multiline hunt group (1 Mb) phone lines or integrated services digital network (ISDN) primary-rate interface (PRI) at the ISP site or a data-networking provider site. This means that for the duration of an Internet session between a user and an ISP, which is data-oriented and does not require circuit switching, two circuits on each involved switch are busy and tied exclusively to this call. In the second scheme, dial-up calls go through directly from an originating CO switch (ingress) to a terminating CO switch (egress) via interoffice trunk.

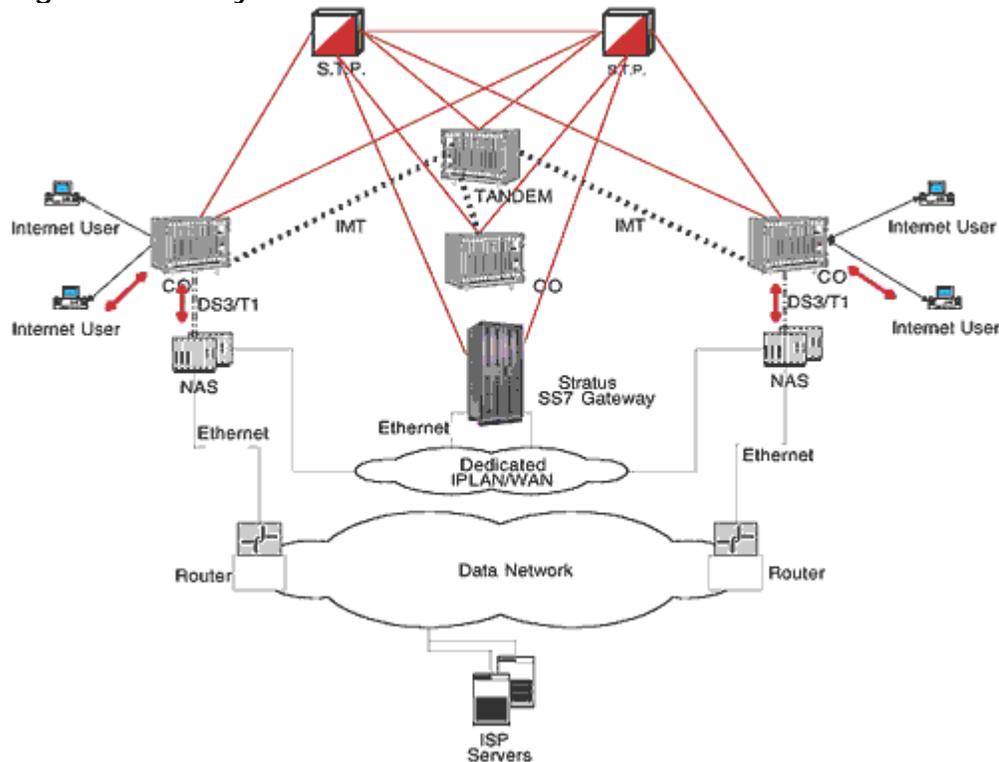
The telephony network was designed for voice calls with an average mean connect time of two or three minutes. Statistics show that the average call made by Internet users is between 20 and 40 minutes. As more people use their telephone lines for Internet access, telephone companies are forced to purchase more switch trunk ports and add more IMTs to avoid congestion in their networks. Failure to make these upgrades limits access not only for ISP calls but also for all of the voice calls originating and terminating on the involved switches. Based on one estimate, a large local-exchange carrier (LEC) spends about \$30 million per year in additional costs just for Internet-related load balancing.

3. SS7 Gateway Solution

The solution is to bypass all switches and IMTs except the ingress switch. In this solution to the congestion problem, the originating switch routes calls that are intended for ISPs to ports that are connected directly to the RAS of the ISP. In this solution, the SS7 gateway enables the RAS to accept the signaling required for call setup and call teardown.

Figure 2 shows the system overview of this solution. The major feature of this solution is bypassing the egress and tandem switches, as well as all the IMTs, and terminating all signaling associated with Internet access within a region to a regional SS7 gateway.

Figure 2. SS7 System Overview



In this scheme, network-enabled RASs—or NASs—can be co-located with the local switches or centralized in one location. Based on today's technology, each NAS can have at least 672 ports (one DS3). Some networking vendors are currently working to increase this number. Every call to an ISP is identified by the called number and is routed to one circuit within the range of circuit trunks that are connected to these modem banks (the NASs). The routing is based on one of the following techniques: IN office-based triggers, local-number portability (LNP) routing of ISP numbers, IN single number service, or *XX service code. The integrated services digital network user part (ISUP) messages

associated with these calls are routed by shielded twisted pairs (STPs) to the SS7 gateway. A combination of the SS7 gateway and the NAS devices in a region suggest the image of a switch to the network and the originating switch. Each SS7 gateway can manage many NAS devices in one location or many.

Because the call model for an Internet access call is rather simple, it is possible for one SS7 gateway to manage tens of thousands of NAS ports. Each gateway has a unique point code and is connected to at least one pair of STPs via multiple A links. It is important to note that each gateway can handle many remote point codes (ingress switches). The original switch sends ISUP messages that are received by the gateway and are translated into a set of equivalent messages. These messages are transmitted via a dedicated Internet protocol (IP) wide-area network (WAN) to the proper NAS device. The NAS devices are connected to two IP WANs. The first WAN is a dedicated WAN for communication between the gateway and the NAS modules. The second WAN is the data network that carries data between the end Internet users and the ISPs.

4. Internal Architecture and Functional Overview

Creating virtual-switch architecture is the main goal for deploying an SS7 gateway. SS7 gateways are designed in a way to meet objectives for reusability, expandability, and interoperability. The optimal solution would employ Enterprise Computer Telephony Forum (ECTF) architecture framework recommendations as the base for the internal architecture of an SS7 gateway.

SS7 gateway development integrates ECTF standards wherever these standards are applicable and are ratified—i.e., S.100. In the areas that ECTF has not recommended a standard—i.e., the interface between the gateway and NASs—a generic approach based on the most relevant and accepted standards, such as Q.931, is followed.

Because the SS7 gateway is part of the telephony network, the platform must adhere to all requirements and standards that govern the operation of a system at telco switch sites. One such platform, the Stratus Continuum 400-CO, is well suited for this application. The 400-CO is a custom rack-mounted system based on the Continuum Series 400 systems and has been available for over a year. The enclosure meets applicable new equipment building system (NEBS) and European Telecommunications Standards Institute (ETSI) criteria for CO computing elements. The fault-tolerant pair and spare processing architecture provides the continuous availability that is a requirement in such environments.

5. Processes of the SS7 Gateway

The main processes of an SS7 gateway include the following:

- **SS7 stack**—The stack must be based on existing standards.
- **SS7 call routers**—The call routers are based on the system call-router process in the ECTF architectural framework. There will be one or many instances of this process in a single gateway.
- **call manager**—This process is one of the main elements of the gateway application. This process is implemented as a finite state machine maintaining the call state for each instance of a call between an end user and a port on a NAS. The main purpose of this process is to convert the messages into a set of generic NAS interface messages. This process is developed as an S.100-style application. There will be a few instances of this process in any gateway system. Each call-manager process will support a configurable number of ports.
- **NAS line controller**—To handle the transactions between the NAS units and the gateway, a set of separate processes, called NAS line controllers, was designed. Each of these processes can be configured to support connectivity with a specified number of NAS units. This process is the only NAS-dependent process in this architecture. However, this generic design can be easily modified to support devices from any or all of the major networking companies.
- **operation user interface**—The operations character user interface (OCUI) provides a messaging and user utility. OCUI provides an interface between the user or craft worker and the NAS to perform craft functions.
- **alarm manager**—The alarm-manager server is a background process that provides a centralized receptacle for alarm events. The alarm-manager process consists of several processes.

6. Summary of Benefits

The convergence of voice and data networks has long been a topic of discussion for industry analysts. An SS7 gateway for Internet access realizes this vision by providing the following benefits that are the stepping stones for a new network infrastructure. Many experts believe that the SS7 gateway system will lead to a cost-effective alternative for voice over IP (VoIP). These benefits include the following:

- cost savings and competitive advantage (Available cost reduction will enable telcos to offer competitive rates to the ISPs, which in return could mean more saving to the end users of the Internet.)
- the bypassing of most switch ports and IMTs in the network during an Internet-access connection
- using existing telephone lines to the end users
- the use of all IN capabilities available today for routing and management (because originating switches are still involved in data-oriented calls)
- the support of many NAS modules with one gateway (Every gateway can support up to tens of thousands data ports on many NAS modules that can be located in multiple telephony networks in many different areas.)
- availability of services (Using a fault-tolerant platform combined with a proven solid SS7 provides availability that is expected from the telephony network.)
- manageability (providing a centralized monitoring, management, and reporting point, because each gateway can potentially support many circuits connected to many remote point codes)
- international gateway (Multiple variants of SS7 can be implemented on each gateway system. This provides the ability to connect international calls where, for example, an originating switch may support International Telecommunications Union [ITU]–SS7 and the terminating NAS may support American National Standards Institute [ANSI]–SS7.)
- an expandable, reusable, and flexible architecture (An SS7 gateway design influenced by the ECTF framework architecture allows the customization and enhancement of this application based on specific customer needs.)
- dynamic allocation of the NAS ports between ISP customers (Because the NASs are part of the telephony network and do not belong to the ISPs, the ports on the NAS modules may be dynamically allocated to a specific ISP.)
- running the gateway application on a general-purpose computer

7. Conclusion

The convergence of data and voice networks is a reality. The traditional voice-telephony network used for data traffic is growing beyond its limits. Some experts believe the voice network used for data traffic will be replaced by a new digital data network for data, image, and voice traffic. The new network switches will be a combination of data switches integrated with a specialized fault-tolerant computer that provides the SS7 signaling and other control and management functions.

Self-Test

1. Despite their many other benefits, SS7 gateways cannot alleviate PSTN overcrowding.
 - a. true
 - b. false
2. The lengthy connection time for Internet users has created a heavy burden on the PSTN.
 - a. true
 - b. false
3. Adding voice-based circuit switching infrastructure for carrying packet-oriented data can lessen the congestion of the PSTN rather inexpensively.
 - a. true
 - b. false
4. The processes of an SS7 gateway include an NAS line controller.
 - a. true
 - b. false
5. The average call made by Internet users is _____, which greatly exceeds typical _____ telephone calls for which the telephony network was designed.
 - a. 18 minutes; two-minute
 - b. 20 to 40 minutes; two- to three-minute

- c. two hours; 45-minute
 - d. seven minutes; one-minute
6. Based on one estimate, a large LEC spends about _____ per year in additional costs just for Internet-related load balancing.
- a. \$50,000
 - b. \$800,000
 - c. \$2 million
 - d. \$30 million
7. In the SS7 gateway solution, what is bypassed?
- a. all switches
 - b. all IMTs
 - c. only the ingress switch
 - d. all switches and IMTs except the ingress switch
8. In the SS7 scheme, to what are the NAS devices connected?
- a. two identical WANs
 - b. two identical IP WANs
 - c. one IP WAN that is dedicated for communication between the gateway and the NAS modules
 - d. one IP WAN that is the data network that carries data between the end Internet users and the ISPs
 - e. c and d
9. What is the main goal for deploying an SS7 gateway?
- a. to create virtual-switch architecture
 - b. to create IMT-driven switch architecture
 - c. to use existing architecture more efficiently
 - d. to bypass switching entirely

10. Benefits of an SS7 gateway include which of the following?
- a. cost savings and competitive advantage
 - b. the bypassing of most switch ports and IMTs in an Internet connection
 - c. using existing telephone lines to the end users
 - d. availability of services
 - e. manageability
 - f. all of the above

Correct Answers

1. Despite their many other benefits, SS7 gateways cannot alleviate PSTN overcrowding.
- a. true
 - b. false**
- See Overview.
2. The lengthy connection time for Internet users has created a heavy burden on the PSTN.
- a. true**
 - b. false
- See Topic 1.
3. Adding voice-based circuit switching infrastructure for carrying packet-oriented data can lessen the congestion of the PSTN rather inexpensively.
- a. true
 - b. false**
- See Topic 1.
4. The processes of an SS7 gateway include an NAS line controller.
- a. true**

b. false

See Topic 5.

5. The average call made by Internet users is _____, which greatly exceeds typical _____ telephone calls for which the telephony network was designed.
- a. 18 minutes; two-minute
 - b. twenty to forty minutes; two- to three-minute**
 - c. two hours; 45-minute
 - d. seven minutes; one-minute

See Topic 2.

6. Based on one estimate, a large LEC spends about _____ per year in additional costs just for Internet-related load balancing.
- a. \$50,000
 - b. \$800,000
 - c. \$2 million
 - d. \$30 million**

See Topic 2.

7. In the SS7 gateway solution, what is bypassed?
- a. all switches
 - b. all IMTs
 - c. only the ingress switch
 - d. all switches and IMTs except the ingress switch**

See Topic 3.

8. In the SS7 scheme, to what are the NAS devices connected?
- a. two identical WANs
 - b. two identical IP WANs

- c. one IP WAN that is dedicated for communication between the gateway and the NAS modules
- d. one IP WAN that is the data network that carries data between the end Internet users and the ISPs

e. c and d

See Topic 3.

9. What is the main goal for deploying an SS7 gateway?

- a. to create virtual-switch architecture**
- b. to create IMT–driven switch architecture
- c. to use existing architecture more efficiently
- d. to bypass switching entirely

See Topic 4.

10. Benefits of an SS7 gateway include which of the following?

- a. cost savings and competitive advantage
- b. the bypassing of most switch ports and IMTs in an Internet connection
- c. using existing telephone lines to the end users
- d. availability of services
- e. manageability
- f. all of the above**

See Topic 6.

Glossary

ANSI

American National Standards Institute

CO

central office

ECTF

Enterprise Computer Telephony Forum

ETSI

European Telecommunications Standards Institute

FCC

Federal Communications Commission

ILEC

incumbent local-exchange carriers

IMT

intermachine trunk

IN

intelligent network

IP

Internet protocol

ISDN

integrated services digital network

ISP

Internet service provider

ISUP

integrated services digital network user part

ITU

International Telecommunications Union

LEC

local-exchange carrier

LNP

local-number portability

NAS

network-access server

NEBS

new equipment building system

OCUI

operations character user interface

POTS

plain old telephone service

PRI

primary-rate interface

PSTN

public switched telephone network

RAS

remote access server

SS7

signaling system 7

STP

shielded twisted pair

VoIP

voice over Internet protocol

WAN

wide-area network