



# Competitive Public Switched Telephone Network (PSTN) Wide-Area Network (WAN) Access Using Signaling System 7 (SS7)

## Definition

Using conventional Internet access equipment, service providers may access signaling system seven (SS7) in the public switched telephone network (PSTN) for a cost-effective means of providing Internet services.

## Overview

This tutorial discusses competitive PSTN access for WANs using SS7 signaling. WANs are continuing to evolve with the ever-increasing integration of voice and data services. With this evolution comes the demand for more features and bandwidth from the carriers of this traffic. A major portion of this demand is for Internet access from remote client locations for business and residential users. With the advance of digital modems supporting up to 56-kbps data rates and improved computer platforms, users can dial local Internet service providers (ISPs) and connect directly to the Internet for flat rates and no time limits. Flat-rate Internet service has driven the average connection time higher than fifteen minutes per call. Dial-up ISP subscribers may get the busy signal during high-demand periods, and the incumbent local exchange carriers (ILECs) may experience service outages or delays for their other customers. Their busy-signal problem can be alternatively addressed without a costly bypass or large switch installation by using SS7 instead of local switch services. SS7 is now already deployed in 90 percent of the North American telephone service market.

The Telecommunications Act of 1996 deregulated the local loop, enabling new service providers such as competitive local exchange carriers (CLECs) to install, lease, or resell unbundled loop or switch access services to customers. CLECs now have the opportunity to compete with ILECs and alternative service providers in giving customers access to the PSTN, thereby obtaining access and call termination revenues from the ISP's subscribers. ISPs may also become

CLECs in order to meet competitive pressure in service offering and lower Internet access rates.

## Topics

1. Benefits of SS7
2. Current Network Issues
3. Switched WAN
4. WAN Access Issues for Service Providers
5. Getting CLECs and ISPs onto SS7–Based WANS

Self-Test

Correct Answers

Glossary

## 1. Benefits of SS7

SS7 is a cost-effective option for service providers that reduces access costs and possibly allows CLECs to receive reciprocal termination revenue from the ILECs. This is made possible when CLECs use ILEC trunk facilities instead of the end switch office's local switching services. CLECs can then also provide advanced database features such as advanced intelligent network (AIN), 800/888, line information database (LIDB), and other ILEC database services.

SS7 enables CLECs to avoid subscriber-based measured-per-minute call charges and primary rate ISDN (PRI) access charges. One SS7 connection can service multiple trunks, resulting in additional cost savings as the CLEC adds capacity. CLECs can offer PRI service in new markets and where ILECs do not currently offer PRI services. Virtual services within the CLEC/ILEC locations can be enhanced by per-port offerings to ISPs, enabling these ISPs to avoid buying the network equipment.

Using complementary conversion equipment to interface to the SS7 network on one side and PRI ports on the access side, ISPs who become CLECs can now retain their equipment investment in remote access servers. ISPs/CLECs in non–PRI markets can access SS7 for advanced services and improved network performance such as reduced call setup delays. They can also offer PRI services to their customers as a competitive advantage.

## 2. Current Network Issues

WANs are changing on a daily basis to serve the growing demand for advanced voice and data services. DS-1 (T1) physical link connections are running at 1.544 Mbps, and end-loop services such as asymmetrical digital subscriber line (ADSL) and other high-bandwidth service offerings are continually expanding. Indeed, more and more technologies for using these physical DS-1 transport facilities are being developed to improve the efficiency of the bandwidth and to support the integration of voice and data services. However, this rapid Internet access expansion overloads the PSTN. The Telecommunications Act of 1996 greatly increased the number of options for local access services and other service providers. Efficient dial-up access is of paramount importance for customers who are paying both line access and Internet access charges, as well as losing time and money on nonconnected calls. This convergence of service demand with emerging providers is pushing the resources of network facilities beyond the capabilities for which they were originally designed.

### Remote Access Server Technologies

The rapid increase in the number of ISPs is made possible by low-cost Internet access products called remote access servers. This type of network equipment is undergoing rapid evolution through the use of 56-kbps digital modems and increased modem-per-system capacity. Product offerings of up to 672 modems per system are common in today's market. ISPs are typical subscribers of telephone service for terminating calls from their dial-up customers; consequently, LECs can sell these ISPs either basic subscriber loops or PRIs, running 23 traffic (B) channels and the one common signaling data (D) channel. PRIs offer the ISP access to advanced services such as 64 and 128-kbps data rates to customers (in available markets) and special routing and switch service functions offered by the LEC. Analog loops provide low-cost access for start-up and rural ISPs and in markets where PRIs are not available. Another alternative offers channelized T1 subscriber access from the LEC in markets where T1s but not PRIs are available. These services allow for in-band signaling like a subscriber loop circuit. The subscriber loop and dial-up channelized T1 interfaces suffer from extended call setup delays, as the dialed number must be presented as in-band tone signals.

The above service offerings from the LEC are derived from features and equipment configurations on the end central-office switching platform. As an ISP operates according to incoming dial-up calls, all calls must come into the one central office serving the ISP (unless larger ISPs have multiple locations for access). An ISP may provide service beyond a local access and transport area (LATA), and, as LECs support inter-LATA calls, utilization of the trunk-side switch ports becomes quite high for ISP calls.

# Switching

A 1996 ILEC traffic study concluded that traffic volume for non-Internet (i.e., voice and fax) was typically between 4–5 minutes per line during peak time, while traffic volume for an ISP call usually averaged 17–18 minutes per line. With a 4:1 ratio in the difference between voice and Internet traffic utilization of incoming trunks to the end office, the end office quickly becomes overburdened for other local subscribers and other services carried by that end office. ISPs, with their high subscriber to port ratios, use the trunk ports constantly throughout the day and night, thereby denying them use for other services. LECs have been addressing this problem by adding costly switch-capacity and trunk facilities to their network. While this helps with the existing problem, it does not solve the problems caused by the expansion of ISP providers and customers in the marketplace. It also changes the cost infrastructure model for the LEC in offering local service.

Trunks between central offices are switched via SS7 in over 90 percent of the North American market. This highly efficient, common-channel, message-based signaling system is the foundation for getting call information from the origination exchange to the end terminating office. The SS7 switched network is provided through STPs. Because SS7 is also a data-packet, message-based service, it is ideal for routing voice, data, packet, and video services; the customer is able to select the circuit bandwidth required based on the call, which is an effective means of transporting ISDN service offerings. SS7's messages also contain all information for the call setup, which reduces the post-dialing delay, improving revenue opportunities for service providers.

Because Internet traffic is routed to end offices via trunks between local exchange offices in a LATA, the calls from the ISP subscribers are indeed already routed to the end offices via SS7. This results in a concentration effect at the ISP's end office, and all of this trunk traffic is routed into the end-office switch for the ISP.

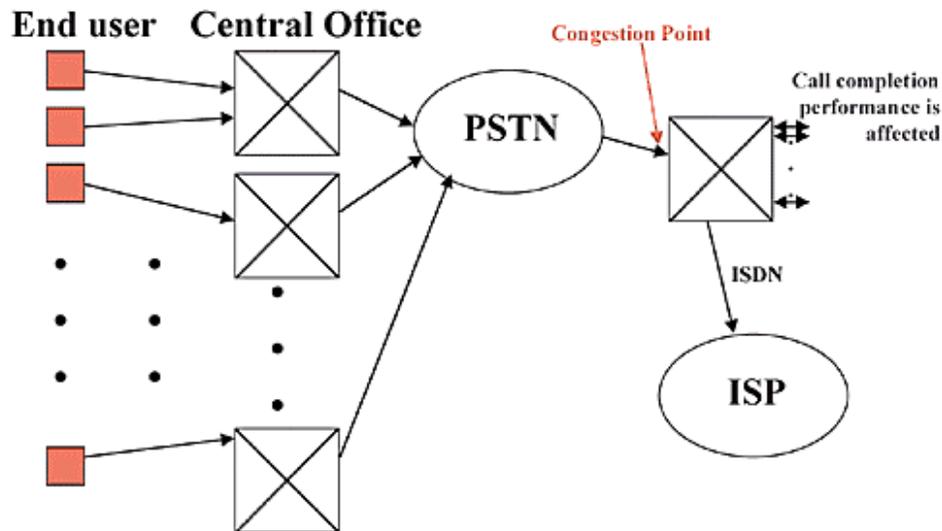
## 3. Switched WAN

LECs have developed an SS7–based switched network between local telephone end offices, tandem offices that serve interexchange carriers (IXCs) with switched access services, and dedicated trunks for business customers requiring larger bandwidth extensions between their locations. Technologies including PSTN–switched voice traffic, frame relay, other data services, ATM, and higher bandwidth data services are available to the business and IXC environments.

Residential and business consumers using powerful computing platforms drive the great demand for Internet access. These platforms are now equipped with 400-MHz CPUs or greater, 3-D graphics, multimedia capabilities, and e-mail facilities and are able to use all 56 kbps of technology available over local loops.

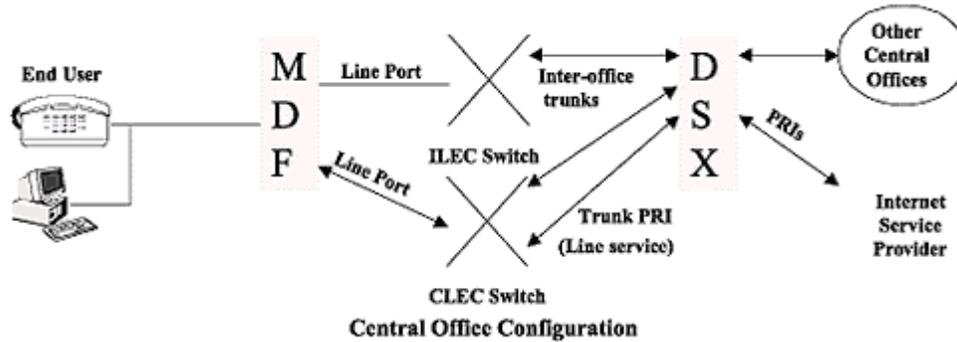
While people continue to analyze, debate, test, and install ISDN and ADSL technologies in limited urban environments, dial-up services are available in both the analog and digital domains of ILEC deployments. See *Figure 1* for an illustration of a typical ILEC connection for providing residential user access to the ISP by using PRI ports.

Figure 1. A Typical ILEC Connection for Providing the Residential User Access to the ISP by Using PRI Ports



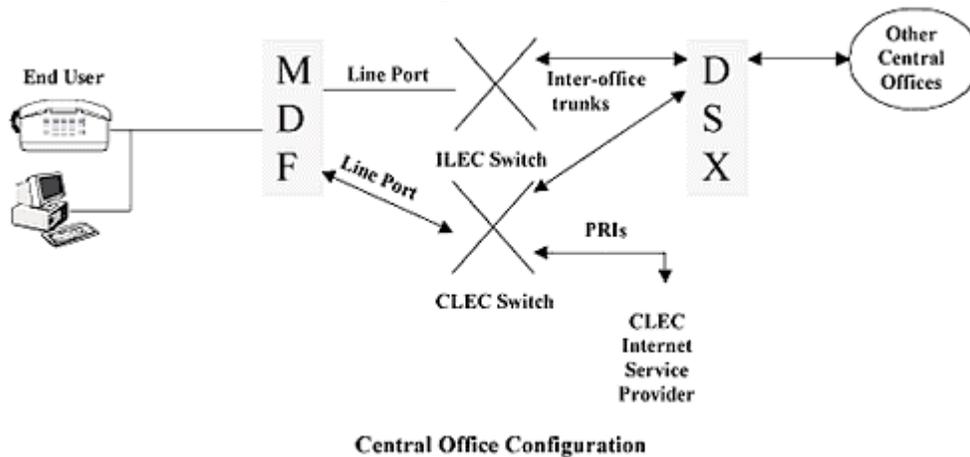
The connection for the ISP customer served by the same central office is a simple route inside the switch from the PRI subscriber port to the end-user line port. The case is more complicated for the ISP's customers not served by the same central switch. The calls are routed through the ILEC's LATA via interoffice facility (IOF) trunks from the switch that originates the call and sends it to the switch PRI port for the ISP. These same IOF trunks also serve end users wanting connections to their long-distance carriers as well as voice calling or dedicated direct-dial data services in the LATA. See *Figure 2* for an illustration of a CLEC with collocated switching services serving unbundled loops and ISP customers. The CLEC has the option of installing its own switch or purchasing switched local-loop services from the ILEC for the CLEC's customers. In *Figure 2*, the CLEC installs its own switch for competitive service offerings and can connect directly to the ISPs via the ILEC's digital crossconnect facility (DSX) as well as purchase the unbundled local loops from the ILEC.

Figure 2. A CLEC with Collocated Switching Services Serving Unbundled Loops and ISP Customers



IOF trunks are required between the CLEC's switch and the ILEC's switch at the same central office as well as to other ILEC/CLEC locations in the LATA. ISPs have a competitive choice in that they may purchase PRIs from either the CLEC or the ILEC and other service providers under the configuration seen in *Figure 2*. Because CLECs can purchase many different types of unbundled services, a switch is not necessarily needed by the CLEC for local services. Alternatively a CLEC might purchase a digital PBX for specialized local services, use unbundled trunks with line-side features from the ILEC, and offer PRIs directly from the ILEC to ISPs. Any of the above cases still require that IOF trunks be used through the other LATA end offices to gain access to the ISPs, thereby becoming a congestion point in the network at the end office servicing the ISP. Furthermore, CLECs must purchase line-side PRIs for its ISPs at a cost premium, versus switching services using the IOF ILEC trunk. *Figure 3* demonstrates a case in which the CLEC and ISP are the same or the CLEC offers resold ISP facility access to ISPs.

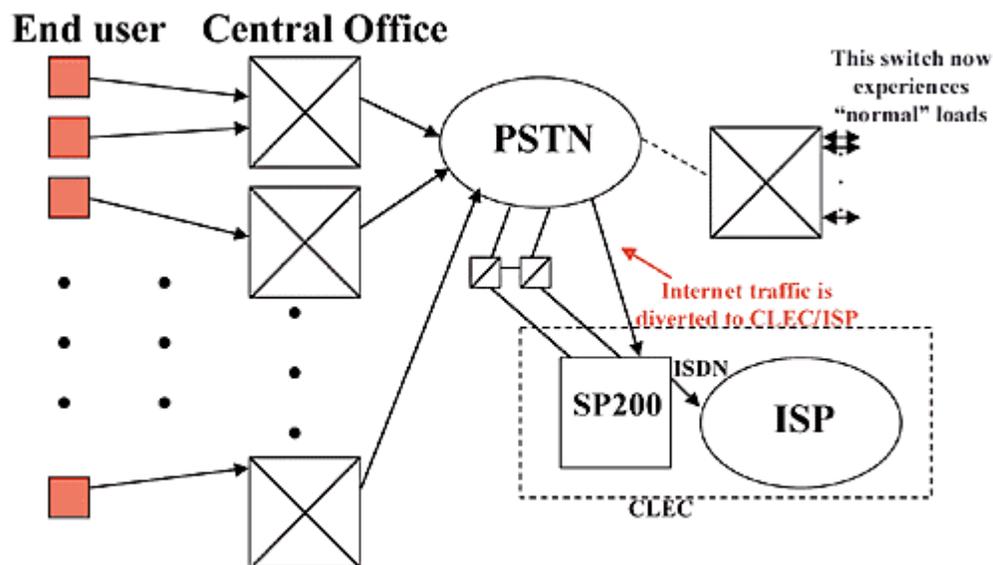
Figure 3. A Case in Which the CLEC and ISP Are the Same or the CLEC Offers Resold ISP Facility Access to ISPs



Collocated ISP and CLEC combinations allow for direct PRI connections to the CLEC's switch, or if virtual switch services are offered by the ILEC, the CLEC and ISP remote-access equipment can connect directly to the central office DSX facility, eliminating the need to purchase DS-1 or higher transport links, as shown in *Figures 1* and *2*. Again, with line-side treatment of the PRI facility, routing through the CLEC's exchange or the ILEC's end office is still necessary, and the IOF trunks are dedicated for service for ISP functions.

Realizing that the PSTN cannot handle the ISP points of presence (POPs) traffic, some ILECs have begun to implement Internet bypass facilities for large POPs and congestion regions. See *Figure 4* for an example of this capability.

Figure 4. An Internet Bypass Facility for Large POPs and Congestion Regions



Based on the previously mentioned traffic study, an ILEC could install remote-access servers in hub locations to terminate local dial-up traffic into remote-access servers and pass this data via an overlay frame-relay network to the ISP. The ISP would subscribe to the ILEC's switched frame-relay-network services to terminate this data traffic, requiring dedicated trunk facilities to the ILEC for the amount of bandwidth desired. This offers the ILEC an advantage: the ILEC may either offer ISP services or selectively route high-density ISP traffic away from IOF trunks and into the frame-relay network. This facility addresses large POP locations but does require a significant up-front investment in high-capacity remote-access-server equipment. Recurring dedicated trunk and frame-relay-service charges also must be considered for the ISP.

Smaller-market CLECs face a significant expense to overlay frame-relay-network access for a limited or initial customer base, which might not pay the added

facility access charges. CLECs with multiple locations would be confronted with purchasing leased dedicated trunks and either overlaying their own frame-relay network or purchasing switched frame-relay–network services from the ILEC. This might be desirable for the large corporate environments with high-data transport demands, but for small-to-medium sized competitive ISP startups and limited-access rural markets, the cost may be prohibitive.

Recent product offerings of remote access server platforms using SS7 signaling gateways have the same bypass issues as the frame-relay servers. Dedicated IOF trunks are required to move switched traffic to the gateway location, thus increasing recurring access costs. In addition, distributed placement of SS7 gateways is expensive as a result of the initial computing platform requirement costs at each location.

## 4. WAN Access Issues for Service Providers

CLECs, interexchange carriers (IXCs), and ISPs entering the WAN environment must face decisions in capital infrastructure investment, initial service capacity, service offerings, growth handling, and acquisition of market-share. ILECs have an established and deployed market, whereas the whole process of unbundled competitive service offerings is new or still being developed in many locations. ISDN service offerings are not available in all locations, and customers who desire PRI services must routinely wait for access.

For CLECs, some key issues include the following:

- comparing the capital investment of switch vs. unbundled switch services from the ILEC
- minimizing switch costs while accessing ISP markets
- supporting growth with enhanced service offerings
- gaining termination reciprocal revenue share from the ILECs and IXCs
- entering the ISP market

When designing CLEC networks, the ISP factor must be considered for proper service capacity and growth potential. Lack of PRI service or exceeding switch capacity will cause customer outages and troubleshooting network expenses for CLECs and ILECs together. By using SS7 IOF facilities, CLECs can properly allocate trunks and switch capacities for their customer base without large-scale server, gateway, or switch investments.

IXCs and ISPs entering the CLEC market face the same issues. While IXCs may already have distributed SS7 facilities, service offerings on the local side can be competitive with the ILECs by properly distributing ISP traffic and avoiding ILEC PRI access charges. ISPs are facing competitive pressure from many angles. Competition from other ISPs, CLECs entering the market, advanced offerings from ILECs and IXCs, pricing pressures, and service offerings are some important issues in the ISP business. ISPs that rely on PRI service from service providers pay a premium for access and, in some markets, measured service per minute. Their customers, however, demand flat-rate services. ISPs who become CLECs can connect to end offices and the PSTN using SS7 and save recurring PRI access charges. ISPs and CLECs can also offer PRI services in areas where PRIs are not offered by ILECs and only channelized services are available.

## 5. Getting CLECs and ISPs onto SS7–Based WANs

CLECs/ISPs are motivated to provide connectivity for existing access server infrastructure to the WAN with SS7 because of the following:

- CLECs and ISPs can remove ISP traffic from the end-office switch and eliminate the busy-signal problem.
- CLECs can receive termination reciprocal end office revenue from the ILEC by using SS7 vs. local line switching services provided by the ILEC.
- Performance will improve with a reduction in call setup time by several seconds per call vs. channelized in-band signaling.
- CLECs can offer PRI services in markets currently not supporting PRI.
- ISPs can support multichannel, multipoint-to-point protocol (PPP) calls from their customers vs. channelized dial-up access only.
- CLEC and ISP access charges are reduced with SS7 and IOF facilities vs. PRI facilities.
- They can maintain payout from the existing infrastructure investment costs.

# Self-Test

1. All but which of the following are characteristic of SS7?
  - a. reduces access costs for service providers
  - b. can service multiple trunks with one connection
  - c. requires CLECs to use the end switch office's local switching services
  - d. allows CLECs to receive reciprocal termination from the ILECs
  
2. All but which of the following statements are true of ISPs?
  - a. Their rapid wealth is made possible by low-cost Internet access products.
  - b. They operate according to outgoing dial-up calls.
  - c. They may provide service beyond a LATA.
  - d. Start-up and rural ISPs are provided low-cost access by analog loops.
  - e. They are rapidly increasing.
  
3. All but which of the following are true of adding costly switch capacity and trunk facilities to the network?
  - a. The end office is not so overburdened by voice traffic.
  - b. The ISP trunk ports may be freed for other services.
  - c. The ISP trunk ports may be freed for other local subscribers.
  - d. The cost infrastructure model is changed for the LEC in offering local service.
  - e. The problems caused by the expansion of ISP providers and customers are solved.
  
4. All but which of the following statements are true of the SS7–based WAN environment?
  - a. CLEC and ISP access charges are increased with SS7 and IOF facilities vs. PRI facilities.

- b. CLECs can receive termination reciprocal end-office revenue from the ILEC.
  - c. CLECs have access to increased services such as AIN, LIDB, and other database services.
5. A CLEC must have a switch to provide local service.
- a. true
  - b. false
6. CLECs/ISPs are motivated to connect to the WAN via SS7 despite increased call setup times.
- a. true
  - b. false
7. Unless larger ISPs have multiple locations for access, all calls must come into the one central office serving the ISP.
- a. true
  - b. false
8. ILECs do not have an established and deployed market, whereas the whole process of unbundled competitive service offerings has already been developed in many locations.
- a. true
  - b. false
9. IOF trunks are required between the CLEC's switch and the ILEC's switch at the same central office.
- a. true
  - b. false
10. ISPs entering the CLEC market face all but which of the following issues?
- a. competition from other ISPs
  - b. competition from ILEC advanced offerings
  - c. access premiums for PRI service from service providers

- d. the inability to offer PRI services in areas where only channelized services are available
- e. the cost of measured service per minute

## Correct Answers

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- c. access premiums for PRI service from service providers
- d. the inability to offer PRI services in areas where only channelized services are available**
- e. the cost of measured service per minute

## Glossary

### **ADSL**

asymmetrical digital subscriber line

### **AIN**

advanced intelligent network

### **CLEC**

competitive local exchange carrier

### **DSX**

digital cross connect

### **ILEC**

incumbent local exchange carrier

### **IOF**

interoffice facility

### **ISDN**

integrated services digital network

### **ISP**

Internet service provider

### **IXC**

interexchange carrier

### **LATA**

local access and transport area

### **LEC**

local exchange carrier

**LIDB**

line information data base

**PRI**

primary rate interface

**PSTN**

public switched telephone network

**SS7**

signaling system seven

**WAN**

wide-area network