Technical Paper

Leveraging the Intelligence of SS7 to Improve IP-Based Remote Access and Other IP Services

A Look at Alternative Implementations

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Contents

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A Look at Alternative Implementations

The proliferation of Internet usage has placed unprecedented demands on carrier networks. The public switched telephone network (PSTN), which was built and optimized to handle voice calls lasting an average of three to five minutes, is now flooded with data calls that last an average of more than 20 minutes.

In order to use network resources more efficiently, service providers hope to leverage the existing Signaling System 7 (SS7) overlay network. Today, much of the IP-based remote access uses Primary Rate Interface (PRI) connections to establish call connections to central office switches. PRI has two significant limitations: it provides fixed connections to carrier switches, and it is relatively expensive to scale, requiring a dedicated control channel for a small number of spans. Using SS7 would give service providers more intelligent and flexible call routing, as well as a more scalable network solution.

Several approaches have been suggested for implementing this integration of SS7 and IP networks. This paper looks at these alternative approaches and their respective advantages and disadvantages.

Acronyms and Abbreviations

CDR
Call Detail Record

CLASS
Custom Local Area Signaling Services

CO
central office

CPU
central processing unit

ECTF
Enterprise Computer Telephony Forum

IETF
Internet Engineering Task Force

IMP
inter-machine trunk

INF
Intelligent Network Forum

IP
Internet Protocol

ISP
Internet service provider

ITESF
Internet Traffic Engineering Solutions Forum

MGCP
Media Gateway Control Protocol

NEBS
Network Equipment Building Standard

POP
point of presence

PRI
Primary Rate Interface

The Limitations of Today's PRI-Based Connections

The boom in Internet traffic has been a mixed blessing for carriers, creating new business opportunities and sources of revenue and, at the same time, putting more stress on existing network infrastructures. The PSTN, which was designed to handle voice calls with an average holding time of three to five minutes, is being bombarded with data calls with 20-minute average holding times.

The result is that carriers and Internet service providers (ISPs) are looking for ways to build out or bolster their infrastructures to handle the enormous—and still growing—volume of IP-based remote access traffic.

One area in which service providers and carriers can move quickly to reduce the strain on their networks and improve service to subscribers is to use the SS7 overlay network instead of PRI to route data calls to remote access systems.

Figure 1 shows the current model for handling data calls using PRI. As the figure shows, PRI requires a dedicated one-to-one connection between an access concentrator

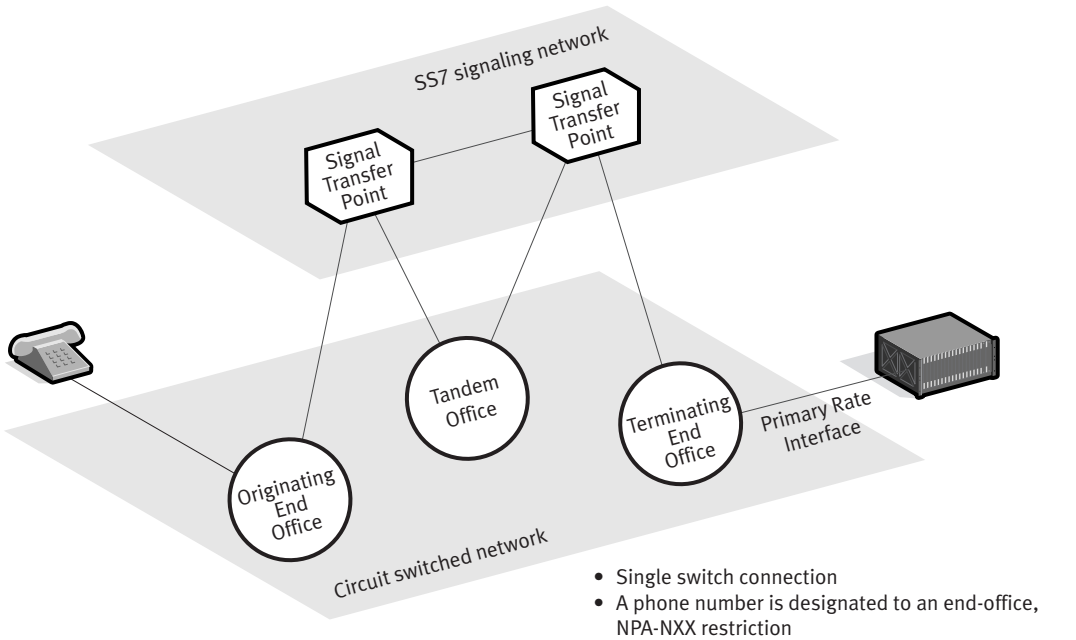

Figure 1. *Access Concentration in a Switched Network*

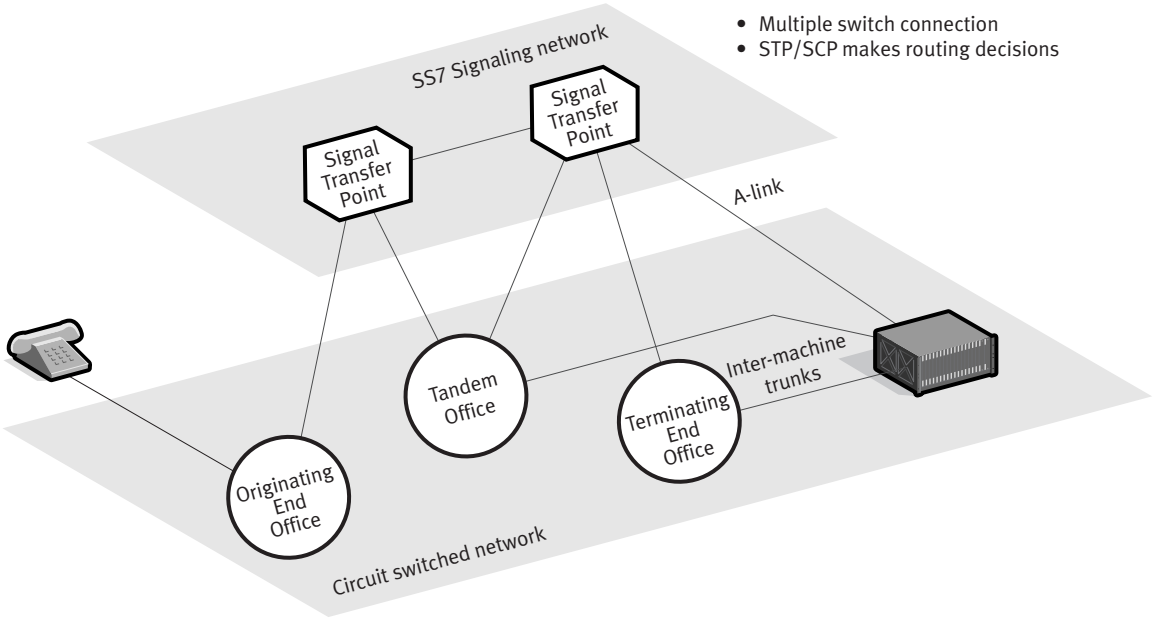

Figure 2. *Access Concentration in an SS7 Network*

and a central office (CO) switch. During peak calling periods PRI has no ability to reroute data calls to a different CO switch. Therefore, if the CO switch to which an access concentrator is connected is saturated with calls, new callers coming into the access concentrator will get a busy signal. Typically, service providers work around this problem by overprovisioning their networks, which is an expensive solution to the problem.

This fixed connection poses another problem for service providers: scalability. While PRI lines are not exorbitant on a per-line basis, the fact that service providers must buy one PRI line for every CO switch connection makes this an expensive technology to scale.

Figure 2 shows a better model, one in which the service provider uses the SS7 network to provide advanced, intelligent routing for IP calls. With SS7, calls coming into an access concentrator can be routed to any one of a number of CO switches, resulting in a much higher call completion rate and better utilization of network resources.

SS7 is also a more scalable solution for high-volume networks. PRI, for example, might cost a service provider $500 per line, per month. If a service provider has 100 lines, the cost would be $50,000 per month.

With SS7, a single set of signaling links (e.g., A-link) will be higher, but each link can support multiple inter-machine trunks (IMTs) to CO switches, and each IMT costs about $300 per month. With the same 100-line configuration described above, the monthly cost for 100 IMTs is $30,000 per month, plus $1,000 for the SS7 link.

In this example, by using SS7 the service provider can save close to $20,000 per month on connection costs. If these savings are extrapolated out to thousands or tens of thousands of lines, the savings of SS7 over PRI is significant.

How close is the industry to achieving this marriage of IP and SS7, and what are the different ways to approach the integration?

Alternative Approaches for Integrating IP and SS7

There are three ways to begin integrating an IP-based network with SS7. The following section looks at the advantages and disadvantages of each.

Acronyms and Abbreviations

PSTN
public switched telephone network

SCP
Service Control Point

SLAP
Signaling LAN Application Protocol

SS7
Signaling System 7

STP
Signal Transfer Point

VoIP
Voice over Internet Protocol

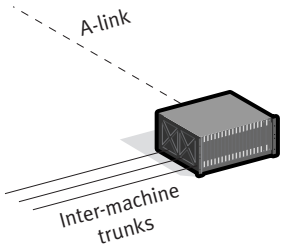

Figure 3. *Direct SS7 Integration*

Direct Integration

The first approach is to give the access concentrator the ability to interface directly to SS7 as shown in Figure 3. The advantage of this approach is that it keeps all the functionality of the SS7/IP integration contained within a single device, making it the most manageable (and, theoretically, the most cost-effective) solution.

The limitation, however, is scalability, because each access concentrator would require its own connection to the SS7 network. A more desirable solution is one that enables the service provider to share one SS7 connection among several access concentrators.

External SS7/PRI Converter

A simpler way to gain an SS7 connection for several access concentrators is to use an external converter to handle the translation of SS7 to PRI signaling, as shown in Figure 4. The converter is also limited in scalability. Most converters support only a small number of PRIs. Therefore, in a larger point of presence (POP) configuration, more converters would be required, making this method less cost-effective for larger service providers.

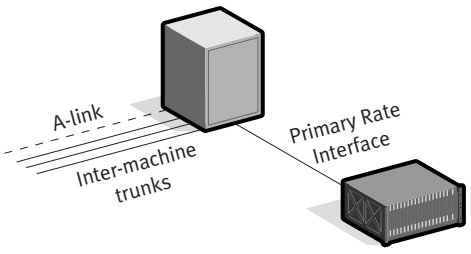

Figure 4. *External SS7/PRI Converter*

SS7 Gateway

Like a converter, the main function of a gateway is to act as a bridge between the existing PSTN and IP networks, translating the signaling information between the two incompatible network types. Unlike simple converters, however, gateways provide added intelligence for security and control. They are also special-purpose devices that can be equipped for greater redundancy and resiliency (e.g., NEBS compliance), which is desirable or even required by carriers for connection to SS7 networks.

The other advantage of gateways over other solutions is the tremendous scalability and cost-efficiencies that gateways can provide in larger networks. As shown in Figure 5, a gateway can interface to multiple access concentrators on the IP side and share a single connection on the SS7 side.

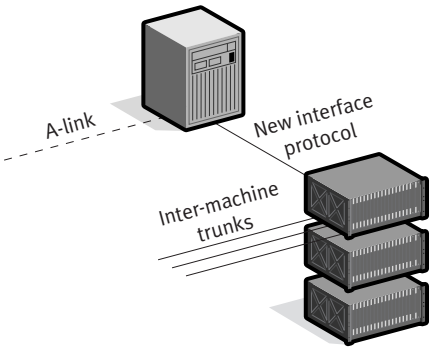

Figure 5. *SS7 Gateway*

The disadvantage of an SS7 gateway is that it uses a special (and currently nonstandard) interface protocol to talk to the access concentrator. Over time, however, there will be a standards-based interface protocol for IP-to-SS7 communications (see the sidebar, "Standardization Activities for SS7/IP Integration"). 3Com is actively involved in promoting the adoption of an SS7–IP standard. The SS7 gateway architecture is the generally accepted model for SS7–IP integration.

The next section takes a more detailed look at the gateway architecture, as implemented by 3Com in our Total Control® multiservice access platform.

Standardization Activities for SS7/IP Integration

There are a number of standards efforts under way that will help accelerate the integration of IP-based and SS7-based networks. These are the primary ones to watch:

- Bellcore's Internet Traffic Engineering Solutions Forum (ITESF) is starting a working group to standardize solutions for Internet-related congestion.
- The Intelligent Network Forum (INF) has been approached to start a working group to standardize the interface between SS7 gateways and remote access concentrators
- The Internet Engineering Task Force (IETF) has developed draft standards for internetworking between IP networks and the PSTN. The Media Gateway Control Protocol (MGCP) is currently gaining strong momentum.
- The Enterprise Computer Telephony Forum (ECTF) has architectural recommendations that will promote modularization of trunk devices.

A Closer Look at the Gateway Architecture

An SS7 gateway solution is actually comprised of three components: (1) the SS7 gateway, also known as a media controller; (2) a private signaling network; and (3) the access concentrator, also known as a media gateway.

We have already discussed the function of the SS7 gateway and the access concentrator. The private signaling network, as shown in the middle of Figure 6, is also an important part of the design.

The private signaling network ensures the separation of the signaling data from the user data. This separation is an important value to the carriers that own the SS7 networks because they want to ensure the high integrity and low latency of today's voice communications. Separating the signaling data from the user data is also important for security reasons—it keeps subscribers from intentionally or unintentionally corrupting the SS7 signaling information. This is why 3Com advocates the use of a private signaling network in a gateway implementation.

This private signaling network would be based on a vendor-proprietary signaling protocol until such time as an industry standard emerges. 3Com has already developed a robust Signaling LAN Application Protocol (SLAP) for this layer of the architecture. Figure 7 on page 6 shows how an SS7 gateway might be implemented today.

Exploiting SS7

The primary role of PRI is to provide call control, but it is a static form of call control because calls are always routed to the same switch. SS7 adds a far more sophisticated level of call control that includes, among other things, scheduling and load balancing.

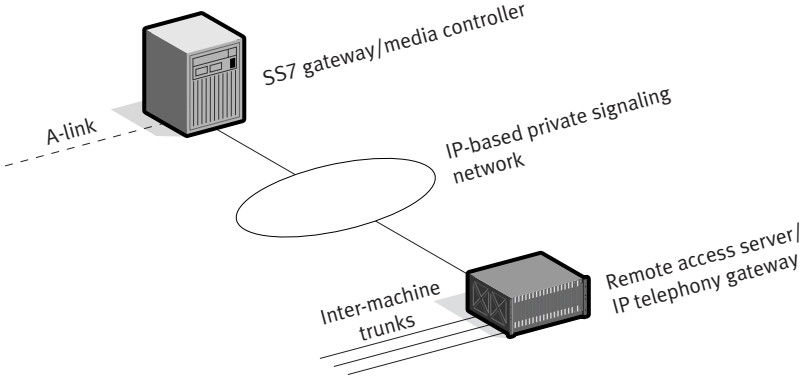

Figure 6. *SS7 Gateway Architecture*

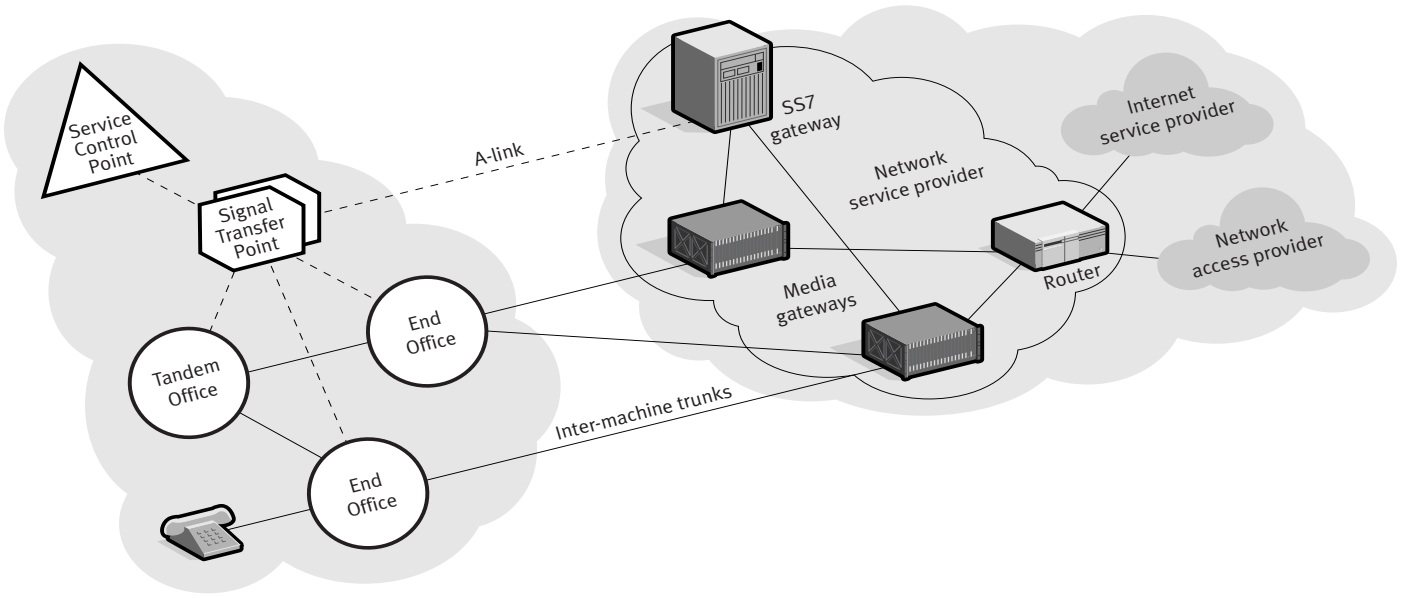

Figure 7. *First Integration of SS7*

The benefits of SS7 are not limited to enhancing IP data services. Service providers are already in the process of testing and deploying Voice over IP (VoIP) services. Using SS7, service providers will be able to support their VoIP offerings with capabilities like Free Phone (1-800), Local Number Portability, and Custom Local Area Signaling Services (CLASS).

The next section provides more details about how service providers might integrate SS7 and VoIP.

Implementing VoIP Using the Gateway Approach

Service providers are moving quickly toward converged networks that are capable of handling voice and data over the same infrastructure for several reasons. First, packet networks are more efficient to build and maintain than traditional voice networks. Service providers can potentially reduce their access charges with VoIP.

Long-term, of course, the benefits of a converged network infrastructure will be

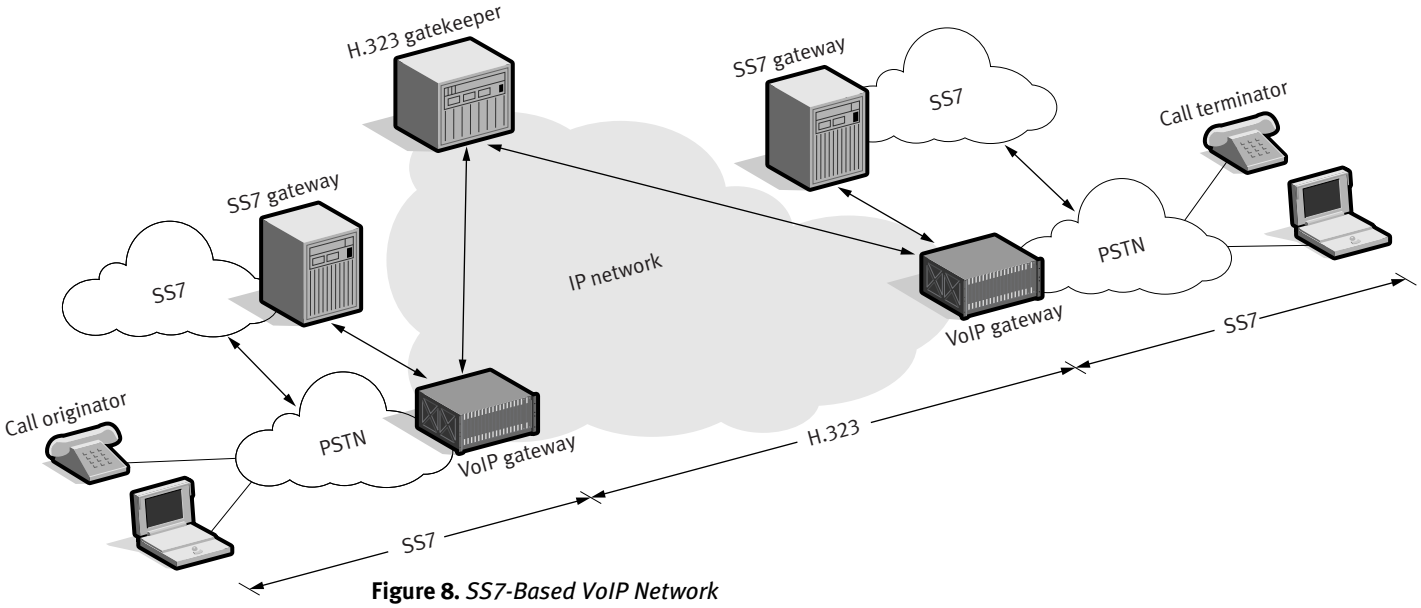

Figure 8. *SS7-Based VoIP Network*

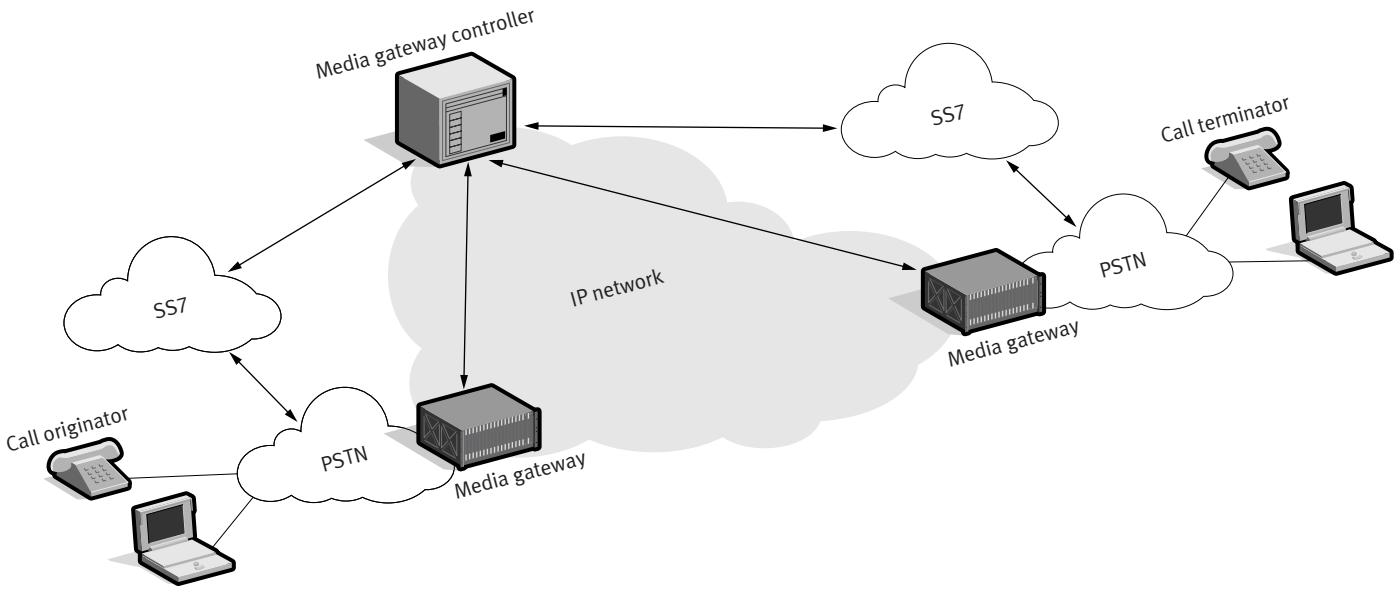

Figure 9. *VoIP Implementation with Media Gateway Controller*

much broader than simply saving money. A converged network will be the basis of many new services that simply are not possible or are cost-prohibitive today, such as Web-enabled call centers, voice-enabled e-commerce, desktop conferencing, virtual second line, enhanced RAS, and collaborative computing.

Figure 8 shows how a service provider might architect a VoIP network using an SS7-to-IP gateway.

SS7 provides the call control on either side of the traditional PSTN, while H.323 provides call control in the IP network. The access platform (referred to in this environment as the media gateway) provides the circuit-to-voice conversion.

The access concentrator nearest the call originator is referred to as the "hop-on" gateway, because this is where the subscriber hops on the IP network. The access concentrator nearest the call termination point is referred to as the "hop-off" gateway, because the call hops off the IP network and returns to the PSTN. For telephone-to-telephone calls, a caller always traverses at least two gateways to complete a call.

Figure 9 shows how this architecture might evolve to eliminate the signaling paths between the SS7 gateway and media gateway, directly connecting the SS7 gateway to the media gateway controller, which can also implement the H.323 gatekeeper function. This would enable the media gateway controller to get all the relevant call control information directly from the SS7 gateway, eliminating one of the signaling paths and improving network reliability, performance, and internetworking.

Why a Three-Tier Architecture for VoIP Works Best

3Com believes that a three-tier architecture is the optimum one for an IP telephony solution for the following reasons:

- It separates the gatekeeper and back-end server functions, enabling greater flexibility in provisioning CPU, I/O, and storage for each.
- It enables maximum network security. Typically, gatekeepers reside regionally in POPs where the media gateways are located. In many cases, this POP may be co-located with a competitor. Therefore, it is very important to have the ability to separate the back-end servers—which contain sensitive Call Detail Records (CDRs), network routing information, and customer account information—in a physically secure and independent location.

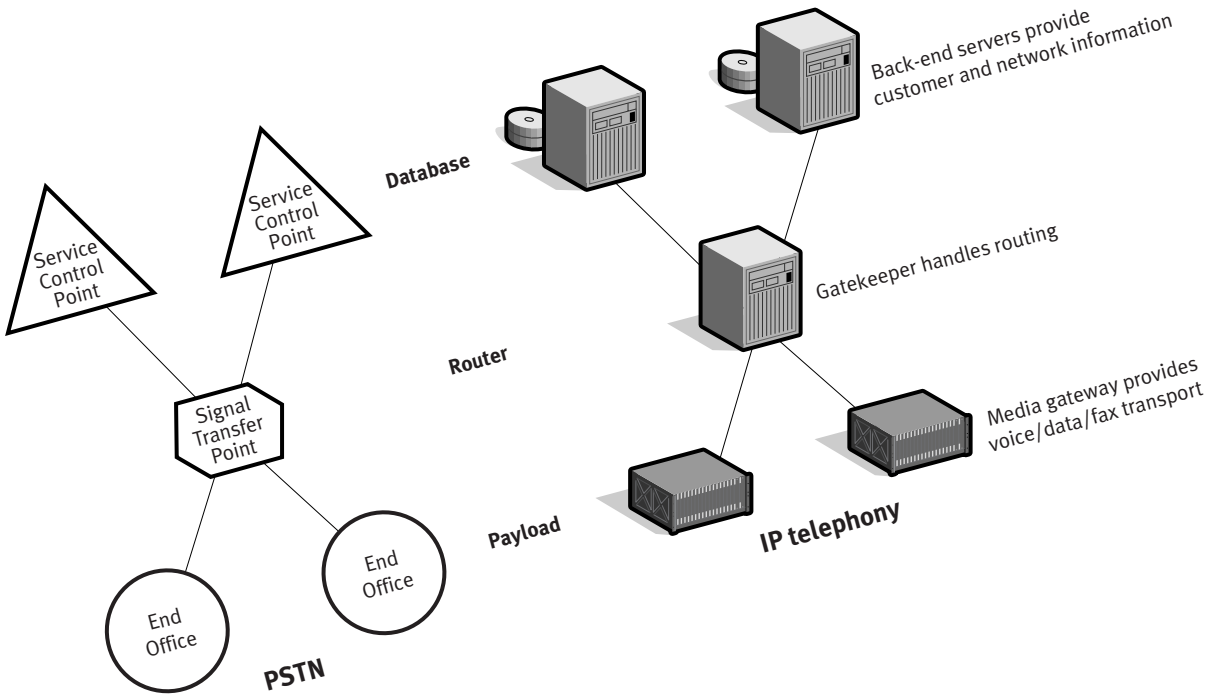

Figure 10. *Three-Tier IP Telephony Architecture*

- It mirrors the C7/SS7 architecture (see Figure 10) and enables seamless integration between the two.

Figure 11 shows more clearly what this three-tier IP telephony architecture would look like deployed.

Conclusion

The industry is moving toward converged network infrastructures to provide a more efficient and effective way of handling increased call volumes as well as delivering new, enhanced services. The integration of SS7 and IP is an

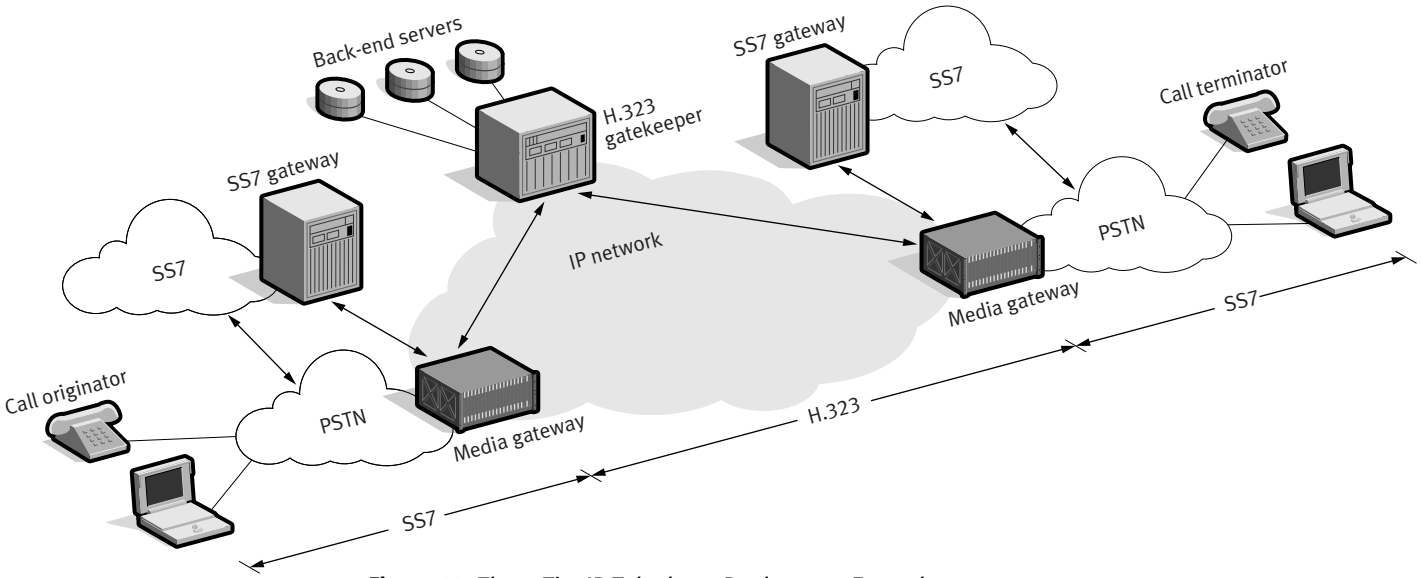

Figure 11. *Three-Tier IP Telephony Deployment Example*

important evolutionary step that will also provide significant short-term benefits. 3Com's goal is to evolve our access concentrator to communicate with the SS7 network and to provide an SS7 gateway to bridge the PSTN and IP networks with the appropriate security and control. Our vision is to architect these solutions for maximum scalability and minimum disruption to the service provider's existing operations. 3Com believes that service providers' own business and technology strategies will specify this type of evolutionary approach. ◘

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