♦ Portal Services: An Evolution of Voice Features

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Broadband access will not only change the character of data transmission and user platforms, it will have a profound effect on voice features. In the converged network, the feature developer has new tools to control configuration, activation, and content delivery to the end user. These new resources, available from converged telephony endpoints, include Web pages, electronic forms, interactive graphics, bookmarks, and Java applets. The Internet and Broadband Enhanced Telephony project, sponsored by Lucent Technologies' Switching Solutions Group, has established a demonstration environment that shows how to develop these new interactive features. The goals are to establish frameworks that will speed feature development, demonstrate the feasibility of Internet-enabled telephony services in an open-source environment, and integrate these services with video and high-speed Internet access in a broadband endpoint. This paper discusses the demonstration environment, the new user platform hardware and software, and the roles of converged data and programmable switches. The paper also presents an overview of one of the initial features developed—a conference portal.*

Introduction

One of the goals of the Internet and Broadband Enhanced Telephony (IBET) project is to demonstrate the feasibility of Internet-enabled telephony services in an open-source environment with very limited development time and resources. The ultimate goal is to integrate these voice services with broadband video and high-speed Internet access in a broadband endpoint. In a converged Internet and telephony network, a number of trends that allow the delivery of innovative services are emerging. One of these trends is the development of open application programming interfaces (APIs) derived from the computer telephony industry. Another is the Web server, which supports data sharing, forms, and hyperlinks. A third is the personal computer/network appliance trend, which enables Internet protocols and browsers on a variety of endpoints. In its first phase, the IBET project draws on all these capabilities to demonstrate features in what we call an *Internet-telephony-enabled portal service*, which makes any user a high-powered expert. The portals are accessed via a browser using Internet protocols. Services are presented as hyperlinks that require one click to launch complex software routines transparent to the user.

Architecture

This section describes the architecture of the demonstration environment established by the IBET project.

Demonstration Network

Although the initial demonstration network is implemented on an addressable local area network (LAN), the same network nodes and services will function on any corporate wide area network (WAN), wireless LAN (for example, Lucent Technologies'

WaveLAN®), intranet, internet, or broadband fiber access (BFA) network. **Figure 1** shows the network configuration for the initial demonstration services.

The router provides access to the Internet and the ability to address messages between servers and endpoints. The hub provides additional port capacity to connect a number of endpoints. Figure 1 shows the three types of endpoints used in the demonstration:

- *Internet protocol (IP) Web phones*, which are equipped with a 10Base-T network interface, a Mantra protocol handler (described in the "Call Coordinator" section), and a software browser;
- *Personal computers*, which are equipped with a 10Base-T network interface and Microsoft NetMeeting;* and
- *IP phones*, which are equipped with a 10Base-T network interface and an International Telecommunication Union (ITU) H.323 protocol handler.

The Ethernet network provides standard transmission control protocol (TCP)/IP services with no special functions or extensions.

Portals

Portals are creating the main experience users have on the Web. Until recently, portals were simply giant gateways of information gathered from multiple resources of different content types and presented in a uniform way to end users (for example, www.excite.com, my.netscape.com, and my.yahoo.com). These large-scale portals attract millions of people to the Internet by providing a simplified and familiar browsing experience—a uniform view combining multiple, otherwise hidden and unorganized information repositories.

More recently, a new trend in portals related to the enterprise and its intranets appeared. Similar to Internet portals, intranet portals help employees access and manage huge amounts of data and increase productivity. In order to provide enterprises with intranet portals, companies started to develop software and tools to support this new model. Jetspeed,[1] StarPortal,*[2] and iPortal[3] are some of the main contenders. As a result, a new computing model emerged; this model allowed applications (such as e-mail, calendar, group sharing, and task management) and data (such as bookmarks, files, address, and photo album) to be stored on servers in the intranet. Some companies already provide such services (for example, www.magicaldesk.com, visto.com, and opendesk.com), which only require a Web browser and an Internet connection to log on anytime, anywhere, by any device.

Why are portals so important? They are convenient. Most of the services provided by major portals are already available on the Web (for free), but a user would have to juggle his/her bookmarks and spend much time finding and collecting the sites that provide each of these services. Portals do this for the user and allow him/her to take advantage of advanced personalization techniques so that information is organized and rendered as desired. A modern portal can be

Panel 1. Abbreviations, Acronyms, and Terms

AAL-1—ATM adaptation layer type 1
AAL-2—ATM adaptation layer type 2
API—application programming interface
ATM—asynchronous transfer mode
CC—call coordinator
DSL—digital subscriber line
DSP—digital signal processor
H.248—component of H.323 protocol suite used for media gateway control
H.323—suite of protocols for multimedia conferencing standardized by the ITU-T
HTML—HyperText Markup Language
IBET—Internet and Broadband Enhanced Telephony
IETF—Internet Engineering Task Force
IP—Internet protocol
ITU-T—International Telecommunication Union, Telecommunication Standardization Sector
LAN—local area network
LDAP—lightweight directory access protocol
MGCP—media gateway control protocol
MMRS—multimedia resource server
PC—personal computer
PMS—programmable media server
RTP—real-time transport protocol
SIP—session initiation protocol
SPS—service provider servlet
SQL—Structured Query Language
VoIP—voice over IP

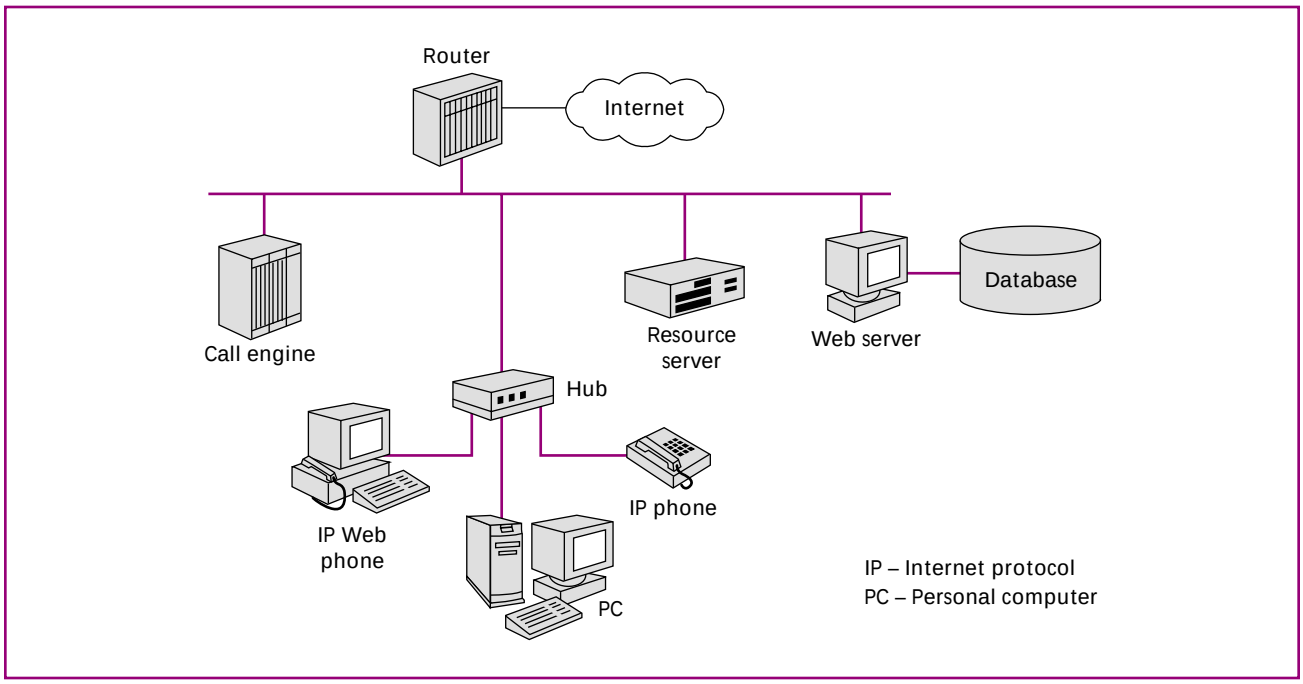

Figure 1.
Demonstration network.

implemented using a collection of Web servers and engines performing a variety of functions, including:

- *Managing personal database information* (for example, user profiles consisting of preferences, interests, skills, hobbies, call lists, and buddy lists);
- *Managing transactions* (for example, e-commerce, shopping carts, and e-auction);
- *Managing access to personalized information* (for example, the presentation of relevant information first, based on the user profile);
- *Ensuring mobile access* (for example, personalized views available from anywhere on the Web); and
- *Providing agent and assistant services* (for example, information locator, people locator, and skills/jobs matching).

In summary, a portal is a familiar place with memories of previous preferences or experiences. It is up to the user to register and customize the portal environment with relevant information and take advantage of portal engine capabilities. For example, a telephony portal enables a user to have a single point of access to place calls, receive calls (for example, from simple call buttons in the user Web page), and customize multimedia telephony services such as call forwarding, time-of-day routing, call agents, answering systems, and reach lists.

The portal service designed for the IBET project provides a familiar interface to voice-over-IP (VoIP) call functions. The portal supports user registration, personalization, and access to enhanced telephony services.

Call Engine

The call engine for the IBET project is the Lucent Softswitch Version 2.0,[4] which provides a number of capabilities including the call coordinator (CC) and the device servers. These elements are described below.

Call coordinator. The CC provides the connection control for signaling information and arranges the media paths between device servers and endpoints. The underpinning of the CC is implemented by a distributed call model called *Mantra*. The CC has the following responsibilities:

- Maintenance of the state of all calls;
- Coordination of communications between device servers and resource servers;
- Implementation of a call-back API for communicating with the service provider servlet; and
- Maintenance of a hierarchical namespace for each call using the Styx® protocol[5] for remote communications, providing for routing of calls based on a

directory service dial-plan strategy. The dial plan is implemented using simple flat files that associate a phone number with an endpoint IP address.

Device servers. The Lucent Softswitch 2.0 implementation includes support for device servers that perform the traditional functions of a gateway and, optionally, a gatekeeper. The gateway functionality is the translation between the endpoint protocol and the Mantra protocol. In the current implementation, we are using an ITU H.323 protocol device server. The gatekeeper functionality allows an ITU H.323 protocol endpoint to register with the device server and subsequently inform the CC that a new endpoint is available. The commands used to communicate with the CC are `addBox` and `dropBox`. We are currently using NetMeeting and Sagitta[6] IP phones as our ITU H.323 protocol endpoints.

An additional IP Web phone endpoint that implements the Mantra protocol and therefore does not require an external device server resource is also used. It contains the necessary code to interface with the CC and perform the registration functions of a gatekeeper.

Resource Servers

The demonstration uses both a hardware-based resource server and a software resource server. These elements offer media resources to the endpoints, such as tone detection, playing announcements, recording announcements, and general speech services. The software resource server implementation we used is a version of the elemedia® programmable media server (PMS). This engine can run on the same physical hardware as the call controller or, for performance reasons, on a remote machine. The elemedia PMS is a media-processing engine capable of terminating real-time transport protocol (RTP)/universal data protocol (UDP)/IP or ATM adaptation layer type 1/type 2 (AAL-1)/(AAL-2) audio streams and performing some processing on those streams. Additional capabilities exist to provide conferencing through audio stream mixing.

As an alternative to the elemedia PMS software resource server, we have integrated the multimedia resource server (MMRS) from the 7R/E™ project. This is a separate piece of hardware and software configured to support dual-tone multi-frequency (DTMF) detection, stored announcement playback, automatic speech recognition, text to speech, voice dialing, multimedia bridging, Internet call waiting hosting, and voice-mail hosting. The target for using this platform is high-performance bridging of voice streams in conferencing and broadband applications.

The communications protocol used to communicate between the resource servers and the CC is media gateway control protocol (MGCP).[7]

Endpoints

Multimedia endpoints are the ultimate delivery agents of the service portal experience (described in the "Portals" section) to the end users. Endpoints enable services to reach customers. With the sophisticated protocol and user interfaces enabled by the Internet, a popular endpoint can reach millions of customers, driving the need for new services and ultimately driving the required changes to the network infrastructure to support the new service and access demand.

If it were not for the availability of free and sophisticated Web browsers in the early 1990s, the ultimate Internet experience might have been confined to research labs for another decade. Similarly, Internet telephony endpoints could be leveraged to drive a new service infrastructure and the demand for ubiquitous broadband connections.

A growing range of devices that provide a combined voice and Internet experience to users everywhere is becoming available. These devices include:

- Cellular phones with Internet access;
- Wired IP phones (business phones providing VoIP using a direct Ethernet link connection for LAN, digital subscriber line [DSL], cable, or WaveLAN access);
- IP Web phones (IP phones with a touch screen enabling simultaneous e-mail, browsing, and VoIP calls);
- Play stations (possible future IP endpoints);
- Televisions and set-top boxes;
- Audio-capable pocket organizers and palm devices (wireless or wired); and
- NetMeeting-enabled notebooks, personal computers, and workstations.

These devices are widely known (except for the more recent IP-based phones and IP Web phones). The IBET team has been using "standard" IP phones as

Figure 2.
Business IP phone.

well as custom IP Web phones to experience the portal services as end users and demonstrate the types of services best rendered on each of the devices. As a result, the service portal experience is almost identical between a personal computer endpoint and a custom IP Web phone, while service experience is limited to voice and voice announcements and menus using a standard IP phone. The Lucent IP phone, shown in **Figure 2**, uses the Lucent Phone-On-A-Chip™ solution (T-8301/02 chips).

Standard IP phones provide a typical 24- to 32-key business phone, a handset, and a two-line display. The phones are ready to connect to an Ethernet wall connection. Available IP phones provide VoIP based on the ITU H.323 protocol or the session initiation protocol (SIP), for example. These IP phones are limited by a two-line display preventing access to the Web for browsing and data communication.

A Web phone is a cross between a single-board computer and a traditional telephone (an embedded computer motherboard with digital audio support and a touch-sensitive screen). Some of the first Web phones became available in the fall of 1998 and in 1999, including the Lucent/Philips IS2630 (shown in **Figure 3**) and the Alcatel WebTouch*[8] phones. Such devices combine a complete analog phone device, a diskless computer providing e-mail, a browser, and a variety of organizer applications (such as call list and directory manager, notepad, and calendar). Web phones are limited by the speed of dial-up modems, prohibiting VoIP.

Figure 3.
IS2630 phone.

Custom IP Web phones. A 1998 experiment, part of a Bell Labs research project, provided the first demonstration of a Lucent prototype IP Web phone based on a modified IS2630 Web phone.[9] These IP Web phones enabled VoIP calls using the Lucent Softswitch Version 1.0. We reused the results of this experiment and included our enhanced version of IS2630 Web phones as part of our IP endpoint infrastructure.

Unlike today's personal computers, IP Web phones are connected all the time—always available to receive and send data. To be able to handle emergency calls, IP Web phones need to restart (or power up) and become operational in about 10 seconds. In short, these computing and communication devices need to be as robust and ubiquitous as a "plain old telephone service" (POTS) telephone. Yet the IS2630 IP Web phones use an Intel StrongARM* 1100 processor, 16 Mb of memory, 4 Mb of flash memory, and a lightweight custom network operating system (the Inferno® operating system[10]). The flash memory stores two kernels and an application suite file system, providing VoIP, browsing, e-mail, software video rendering, and orga-

nizer applications. The application suite seamlessly extends to a network server, using the Styx protocol, where new applications and application extensions are made available.

IP Web phone customization. To enable IP data and voice services, the original IS2630 phones underwent the following changes:

- Hardware modification to reuse the existing digital signal processor (DSP)/voice codec (to apply it to capture and render packet audio) and redirect the resulting audio input/output (I/O) to the existing analog voice system. This enables handset audio and speaker phone (as well as existing volume-control features) to work identically with packet audio or analog audio.
- Interface modification using the PC memory control interface adapter (PCMCIA) to support 5-V (as well as the original 3.3-V) operation, enabling the use of a broader range of Ethernet access card.
- Software modification to include audio driver (RTP/real-time control protocol [RTCP]), media manager, telephony server, configuration manager (remote Lucent Softswitch 2.0 provisioning), changed DSP driver, upgraded IP stack, and selected Ethernet card driver.

The IP Web phone experience is greatly enhanced over that of the original Web phone by the speed of direct Internet access, making this a very attractive device for service delivery to the business office via LAN or wireless LAN, or to the home via DSL, cable modem, or high-speed wireless.

For example, using a 10Base-T network interface card, an IP Web phone enables a quality audio call over IP to proceed unchallenged while very fast online information access is available (for example, from a browser while accessing e-mail). In addition, the phone functionality and software are seamlessly extensible to the network, where servers can provide complimentary applications on demand.

The next generation of IP Web phones could be enabled by a new IP phone platform provided by Avaya, formerly Lucent's Enterprise Networks Group. The new hardware, based on Lucent's Phone-On-A-Chip technology, uses a universal serial bus (USB), enabling platform evolution toward video extensions, video conferencing devices, and the realization of broadband IP Web phones. Other proposed designs include Intel's new Linux*-based Web Appliance[11] platform.

Web Server Applications

The demonstration applications for the IBET project have been implemented as a portal service (shown in **Figure 4**). Just as corporations use portals as a new way to bring together employees, customers, and suppliers (whether or not they share the same infrastructures), the service portal benefits telephony users by seamlessly providing the capabilities of the Lucent Softswitch 2.0 to different clients such as computers and Web phones. From any type of Web-enabled client, users will be able to read their mail, participate in multisite company conferences, and access/share documents from anywhere (on the road, at home, from abroad, or from customer sites).

In order to deploy portals (corporate or service), regardless of the final applications intended, one needs to put in place the following common services:[12]

- Membership services for establishing a portal community,
- Presentation services for creating/maintaining page layout,
- Personalization services for allowing users to create their own virtual office spaces,
- Security services for remote account access or extranet access via user authentication, and
- Integration services for bringing together applications using HyperText Markup Language (HTML) and Extensible Markup Language (XML).

We have developed our own portal services that support a minimal set of the common services described above. Although all services are provided via an open-source Linux machine, these services could have been implemented on other proprietary operating systems. The personalization service is provided via a Structured Query Language (SQL) server that allows users to register themselves and change their account information, for example. The membership service is provided via lightweight directory access protocol (LDAP) servers—one for a directory compatible with NetMeeting users and the other for dynamically deploying services. The directory allows users to

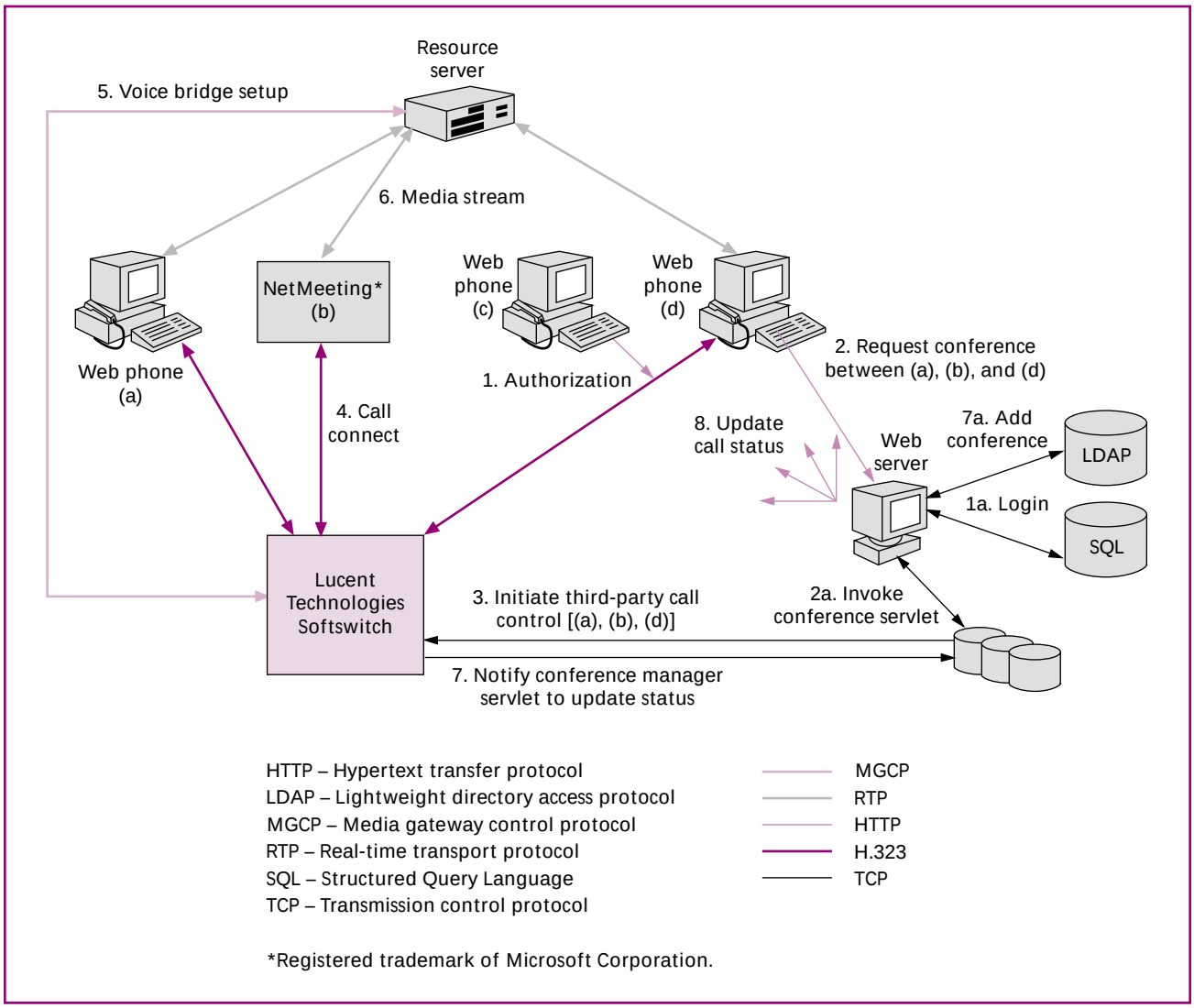

Figure 4.
Portal service scenario.

browse a list of on-line users and set up conferences between multiple users in a very friendly manner. All call controls are Web based, allowing one to add, drop, and set up conferences with the click of a mouse. The open nature of the Lucent Softswitch 2.0 API is fully used in that context, as it allowed us to control and operate call control remotely via Java* servlets running from our portal server, distinct from the Lucent Softswitch 2.0 server.

Finally, a telephony service creation tool is provided to the user to manage his/her own services. It is based on the following simple query, which is general enough to permit the deployment of complex services from a user perspective.

```
query: "FROM <a user> WHEN <a date>
   WHERE <a location> WITH <a pwd>
   USING <an application>"
result: <phone number> | <announcement number>
```

For example,

```
FROM my_boss WHEN office_hours WHERE office
   -> my_office_phone_number
FROM my_mom
   -> busy_tone
```

The user's services are stored in an SQL database via the personalization and membership services. The user has access to his/her services all the time and can

Figure 5.
Conference service portal home page.

create, delete, modify, activate, or deactivate services in a very simple manner. Activation/deactivation can be based on manual operation or an automatic procedure using an expiration/alarm trigger.

Service Example

This section presents an overview of one of the initial features developed in the IBET demonstration environment—a conference portal.

Web Portal Design

We have integrated, on a Linux machine, an Apache[13] Web server running the Java servlet module extension Tomcat,[14] an OpenLDAP*[15] server, and a MySQL[16] server for our architecture. The Web server allows users to have simple access to their information (such as account, address book, call records, and buddy list) and to carry out complex telephony operations seamlessly. Next-generation telephony services, such as CLICK2CONF, will integrate different technologies to provide a new level of simplicity combined with enhanced features to the user. In the context of our lab, from the portal service page, a user can set up a conference and decide later to conference-in an expert—all in the click of a mouse (or one touch on the screen). At any time during the conference call, a user can chat privately with any set of participants to increase the effectiveness of the conference call. As of today, all of these services would be quite difficult to set up based on standard telephony features and endpoints. The Web is the perfect support to provide these kinds of services to any type of browser-enabled multimedia endpoint such as a desktop computer, an IP Web phone, or an Internet appliance.

Web pages. Figure 5 shows the home page for the conference portal developed for the demonstration. The Web call manager, described in more detail below, is the controlling user interface for the demonstration. The page can be loaded on a personal computer, an IP Web phone, or any network device with a Web browser.

Figure 6.
Services page.

Figure 6 shows the services page, which allows the user to access customized services stored in the SQL database and provides easy management of the service options.

Figure 7 shows the conference screen, which allows the user to select among registered users to establish a conference call. Any user can establish a call and drop or add him/herself or another user from the call at any time. The Web call manager translates the selections into the required commands to the Lucent Softswitch 2.0 to establish the media streams between each endpoint and the conference bridge. This process is described in more detail below.

Web call manager. The Web call manager is a family of Java servlets dynamically generating HTML contents that support all the features we have mentioned earlier. Special attention has been paid to the HTML pages so they can be quickly accessed by any type of client (no plug-in or Java applet necessary). This model tends to load the server more but provides the ubiquity service providers are looking for—it is easy to install and easy to manage, and it presents no special requirements for the clients.

Databases. The LDAP[17] server acts as our user directory and conference repository database. All users have access, via the Web call manager, to other online users who previously logged into the system. The mobility aspect of our demonstration is thus embedded into the LDAP server. Wherever a user is logged in, the client (audio-enabled) device becomes the user's default phone to which all incoming calls will be routed. When the user is logged off, voice mail will take the call. All the user has to do is log in wherever he/she wants to be reached.

The LDAP server is also used to keep track of a current conference with its participants. At any time,

Figure 7.
Conference screen.

the Web call manager gives the logged-in user the ability to check who can participate in the conference, add any logged-in user, or drop any user if necessary. In coordination with the CC, the conference object is kept up to date as users join or leave the conference. The conference repository is always able to reflect the current situation.

NetMeeting users also have the ability to use this LDAP server as their directory service so that the Web call manager community can reach them directly at their desks. In addition, the LDAP server functions as the buddy list repository for users so that they can keep an eye on who is on line, where, and whether or not they can be reached in real time. An SQL server stores user account information (name, password, e-mail address, and preferences) and routing services.

A Web portal service delivery provides cross-platform development advantages, enabling different types of endpoints to access common services from a generic Web browser without requiring custom software.

The Lucent Softswitch Service Programming Interface

The programming language used in the Lucent Softswitch 2.0 implementation is Java and its virtual machine. Java is object oriented, providing the capability to encapsulate standard call-processing functionality and allow these features to be overridden at the application level. This provides for the ability of users other than internal system developers to implement new services. The concept underlying third-party programmability is the service provider servlet (SPS).

New service offerings on the Lucent Softswitch 2.0 are programmed in the SPS via the documented callback API to intercept the triggers in the call model. The SPS initially reads in a configuration database to set up the device groups, protocol handlers, and call capacity data. It is then ready to begin processing calls.

A sample call flow would use the following callbacks:

1. `onInitCaller`
2. `onInitCallee`
3. `onCalleeRouteSelect`
4. `onCallProceeding`
5. `onCallAlert`
6. `onCallConnect`
7. `onCallBusy`
8. `onCallDisconnect`

At each point in the call flow, the SPS can choose to allow normal processing or intervene to add call features. New call features are provisioned via the portal Web pages that update the SQL feature set definition shared with our SPS implementation.

Our sample service encapsulates all call logic in the SPS. There are two control strategies provided in the implemented SPS for processing calls. The normal first-party call control is handled when the endpoint initiates a call. The CC receives a `CallRequest` from a device server and begins the call-processing flow. The other method is through the third-party call control initiated from the Web call manager. A simple protocol has been implemented to accept call requests from the portal service Web pages and through the SPS to initiate processing of users in a call. Upon acceptance, a `CallID` is returned so that additional users can be added or current users can be dropped. The SPS implements internal state information on the status of the calls, which allows the service to distinguish the difference between third-party and first-party call control. During the processing of the call, user announcements are presented to the user at connection time in the form of stored announcements from a resource server. The following are examples of the command protocol used to control adding and dropping endpoints from a call:

```
COMMAND=CALL&PHONE=16307138070&PHONE=16307138071
COMMAND=ADD&CALLID=0&PHONE=16307138059
COMMAND=DROP&CALLID=0&PHONE=16307138070
```

The ITU-T protocol suites (for example, H.323 and H.248) and the Internet Engineering Task Force (IETF) protocol suites (for example, SIP and MGCP) provide sufficient proxy signaling to establish the required connections, and access to the public network can be provided via IP public switched telephone network (PSTN) gateways.

Conclusion

Portal services for voice can be implemented today with available Internet capabilities. Today's browser implementations offer all the capabilities needed by the client device. Server technology can support a number of advanced applications, and currently available Web servers can adequately host and support portal services. Since users can register and provision themselves, the number of staff required to operate a portal service is minimal. Billing can be handled as flat rate or per use with simple usage routines in the Web server linked to commercial back-office billing software.

Communications portals will accelerate the move to IP-based voice. This will especially be true if early service providers catch a wave similar to the business-to-business Internet boom. Work is under way to integrate the IBET project portal services with broadband fiber access[18] technology.

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