♦ The Future of Network-Provided Communications Services

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Next-generation services represent a real opportunity to network service providers for growth and retention of the customer base, as well as for new revenue generation from an existing customer base. This issue of the Bell Labs Technical Journal will treat many aspects relating to this opportunity. Three key ingredients for offering next-generation services are intelligent endpoints, network servers capable of providing such services, and flexible transport amenable to multiple traffic types. Easy programmability of the network servers can be critical: "killer apps" are elusive and trial and error with rapid turnover of services and service variants is expected. Supporting an application programming interface (API) may not be sufficiently useful for customers; Lucent Technologies' Full Circle℠ program, discussed in this issue, includes various additional forms of support. Equipping the network servers with a set of base capabilities is also needed to give multimedia support, a unified look and feel for multiple service add-ons, and acceptable operations and maintenance. A variety of technologies are being used to support next-generation service capabilities. These include portal technology for adapting to a range of endpoint capabilities, policy management, object-oriented technologies (for example, frameworks and components), protocols and meta-protocols such as Extensible Markup Language (XML), and Internet-related technologies (for example, browser and language technologies).

Introduction

What presents the greatest opportunities for growth in network-provided services? Endpoint intelligence and the Internet. What threatens the viability of network-provided services? Endpoint intelligence and the Internet. The threat presented by endpoint intelligence is that it could reduce the telecommunication service provider to a pipe provider; the opportunity presented by endpoint intelligence is that it can communicate with network intelligence to invoke complex new services that generate serious revenue. The threat presented by the Internet stems from its ubiquity and its free services; the opportunity presented by the Internet is the ability to combine network knowledge and functionality with Internet access and Internet-provided services.

Telecommunication service must still deal with traditional telephony services—some of which are visible (for example, call waiting, call forwarding, incoming caller ID, centrex) and some of which are invisible (for example, local-number portability and Communications Assistance for Law Enforcement Act [CALEA] capabilities). Meanwhile, a profusion of endpoint-based services and Internet-provided services of every form are experiencing enormous growth and a healthy diversity. E-commerce is an extremely high-growth area, but trying to tap into e-commerce revenue with the traditional telephony portfolio of services is a challenge. Will the future of network-provided services be dominated by opportunity or by threat? A set of emerging technologies and capabilities may well determine the outcome.

What constitutes a service? Anything a service provider can sell that is not equipment is a service. Services currently include basic transport—from dark fiber to T1 to OC3, some enhancements to basic transport including frame-relay service and Internet protocol (IP) virtual private networks (VPNs), familiar business and residence voice telephony service, and then a vast plethora of existing and potential services that can be referred to as "enhanced services." This last category includes "e" (electronic) and "i" (Internet/IP) services. The growth in these areas portends significant revenue opportunities and unprecedented growth (see **Panel 2**). This issue of the *Bell Labs Technical Journal* largely focuses on this last category of services, presenting network and technology enablers and experience with them in the lab and in the field.

A major technology enabler, at the center of enhanced service activity, is the emerging set of application programming interfaces (APIs). APIs provide the means to rapidly equip components with new capabilities by component vendors, the service providers themselves, or even third parties. Perhaps even more significantly, they open the door to real-time programmability of the telecommunications network by application service providers (ASPs). **Figure 1** contrasts these two aspects of programmability.

Associated with this work is how services architectures and services platforms can maximize the utility of both aspects of programmability. Follow-on concerns are security (how the control structure and resources of the telecommunication network are protected from misuse—whether purposeful or accidental) and manageability (how these services are provisioned, billed, maintained).

Browser technology and intelligent endpoint devices (especially wireless devices) have catapulted not only service capabilities, but also new ways for users to activate and control their services. Slavish reliance on the limited numeric control pad is gone. Click-to-x and scroll-and-select are here to stay. Complex services now have become realistic, and combination or "blended" services—mixing new and traditional service building blocks—are a reality.

Since the telecommunications network and the Internet are logically separate (although they share some physical facilities), methods are needed to combine telecommunication network information and services with Internet services. "Internet-ifying" services opens the door to tapping e-commerce growth, and new protocols—established for network-to-network communication involving the Internet—and new service architectures open the door to this capability. What does the telecommunications network have that can enhance Internet-based services? Location information is one asset. Combining location information with Internet browsing, especially for mobile phone users, would enable location-specific information (for

Abbreviations, Acronyms, and Terms

API—application programming interface
ASP—application service provider
ATM—asynchronous transfer mode
CALEA—Communications Assistance for Law Enforcement Act
CD-ROM—compact disk read only memory
CLEC—competitive local exchange carrier
DSL—digital subscriber line
H.323—ITU standard for multimedia (real-time voice, data, video communication) across IP-based networks
IETF—Internet Engineering Task Force
ID—identification
IN—intelligent network
IP—Internet protocol
ISV—independent software vendor
IVR—interactive voice response
JAIN*—Java* APIs for Integrated Networks
JTAPI—Java* Telephony Application Programming Interface
JSP*—JavaServer Pages
OAM&P – operations, administration, maintenance, and provisioning
OC3—optical carrier digital signal rate of 155 Mb/s in a SONET system
OLO—other licensed operator
PC—personal computer
PINT—PSTN/Internet INTernetworking
PSTN—public switched telephone network
SIP—session initiation protocol
T1—terrestrial (North American) facility to transport signal at primary rate of 1.544 Mb/s (24 64-kb/s channels)
VHE—virtual home environment
VLSI—very large scale integration
VPN—virtual private network
WAP—wireless application protocol
XML—Extensible Markup Language

Panel 2. Revenue Potential from Communications Services

Revenue potential

- Enhanced services
  - Converged data and telephony (“Internet-ized” services, voice-enabled Internet services, e-mail notification, ICW, click-to-dial/fax, IP centrex, voice/data VPN)
  - Multimedia (audio/video/text groupware, real-time streaming audio/video)
  - Messaging (unified messaging, persona information manager, short messaging)
  - Mobility, location services, presence
  - Hosting
- Voice services
  - End-user visible (call waiting, call forwarding, incoming call ID, centrex service)
  - Other services (local number portability law enforcement assists)
- Data transport and connectivity services
  - IP VPN
  - Connection management
  - Content delivery
  - LAN-to-LAN interconnect
  - Connection to Internet backbone
- Basic transport services
  - Private line
  - Frame relay
  - IP VPN

example, nearby restaurants, concerts, sporting events) and navigation services.

As broadband access—the two most prevalent examples being digital subscriber line (DSL) and cable modem access—becomes more widely deployed, new avenues open up for enhanced services. How best to control and manage these converged services and how best to apply bearer treatment remain major issues.

New Business Models

What are the successful enterprises going to be like in this arena? What will they sell? How will they be and remain competitive? All these questions relate to the emergence of new business models—business models that enable enterprises like Yahoo to rival enterprises like Sears in spite of enormous disparities in capital holdings.

The new business models may lead traditional telecommunication service providers to work with application service providers, either as a transport service (both the ASPs and end users are charged) or as resellers (end users are charged for a rich suite of services with a single bill, single help number, and so forth). The technology enablers for employing such approaches on a large scale are network APIs. The pressure that would cause telecom service providers to employ such approaches is competition from non-traditional carriers who offer such arrangements and threaten to erode their customer base.

Similarly, the new business models may lead network product vendors to work with independent software vendors (ISVs), either in partnership arrangements or as resellers. The technology enablers here are component APIs. The pressure is again competition. Programmability is becoming an important capability to telecom and other service providers.

APIs and Programmability

In the area of commerce, there is contention between offering unique value and customer-demanded conformity, which drives a product toward commodity status. Customers demand conformity to keep from being stranded and at the mercy of individual vendors. Service providers have long been demand-

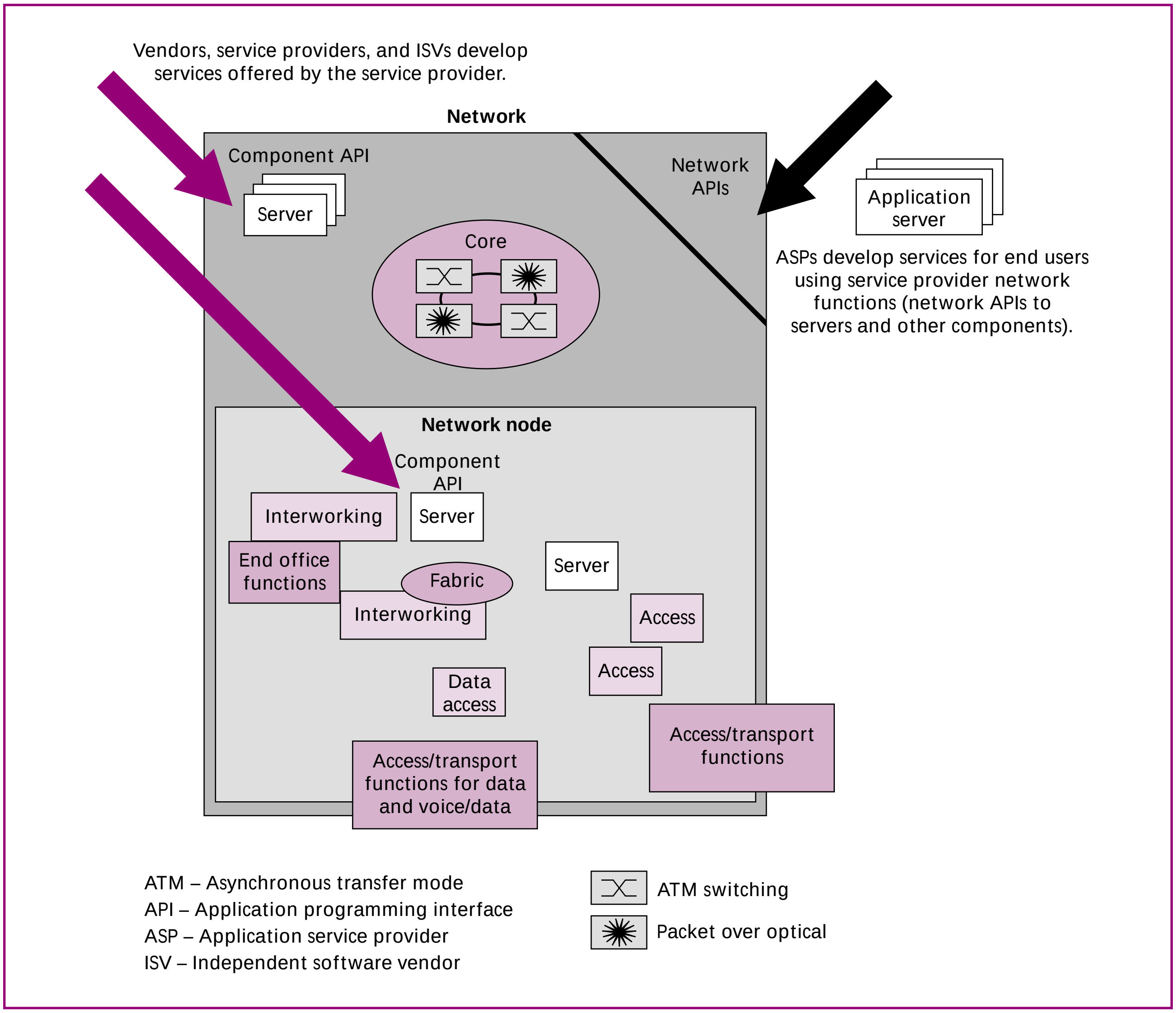

Figure 1.
Component programmability and network programmability.

ing open protocol interfaces of their vendors so that products from various vendors can be mixed at will in network configurations. The new frontier for such conformity is in APIs for providing services on feature servers and application servers located in the service providers' networks. Certain customers of the service providers are also demanding open interfaces; these are the ASPs. In this era of network services competition—with competitive local exchange carriers (CLECs) in the United States and other licensed operators (OLOs) in other countries—the network service providers themselves are subject to open interface demands. As discussed, new business models come into play or the viability of the service provider enterprise is threatened. Service providers find they must move to new business models in order to retain and grow their customer base while increasing network usage.

As Bakker et al. mention in "Rapid Development and Delivery of Converged Services Using APIs,"[1] industry consortia have been tackling the task of determining suitable API suites, and individual vendors are proposing their own APIs for interim use. For example, Lucent has provided its Full Circle™ API—described by Bear et al. in "Open, Programmable

Networks"[2]— which includes the emerging Java* Telephony Application Programming Interface (JTAPI) standard. Bakker et al.[1] describe and compare JTAPI, Parlay, and other APIs, showing that full coverage of needed capabilities is not yet achieved by this set of APIs, but also showing some promising convergence, particularly in the Java APIs for Integrated Networks (JAIN*)/Parlay alliance. It should be noted that Parlay and other newer APIs, such as 3G-OSA, emphasize that the APIs must accommodate more than just voice/call services.

Supporting an API, however, is not sufficient for vendors with a real commitment to open networks and component programmability. For this reason, the Lucent Full Circle program[2] includes vendor support and a multi-purpose programmable platform, the Lucent Softswitch. Other Lucent products such as the 7R/E™ converged services server, described in "Programmable Service Platforms for Converged Voice/Data Services" by Dianda et al.,[3] are built on the Lucent Softswitch and offer the Lucent Full Circle API with appropriate extensions.

Enabling the Components

Several of the APIs build on objected-oriented technologies. These APIs provide object models, object frameworks (for inheritance purposes), and components (for example, "beans" of various types, as discussed in an earlier paper[4]). This implies that the API language bindings and software environments of platforms must support these capabilities. This need gives rise to the explosive growth of softswitches and server platforms built on softswitches such as the Lucent Softswitch.[2] As Dianda et al.[3] discuss, new capabilities, in addition to programmability, include handling enhanced services (for example, converged voice/data/video), blending services, and deploying usable/scalable services. To support these new capabilities, APIs need to go beyond support for traditional telephony call models and transactions. Newer protocols such as XML and SIP become important, as does the ability of the server platform to handle access sessions, service sessions, and high-capacity/high-capability bearer channels. Also introduced in the Dianda paper[3] are service and OAM&P framework architectures supporting usability and scalability.

Meuwissen et al.[5]describe a platform for providing enhanced services in "The FRIENDS Platform—A Software Platform for Advanced Services and Applications." This platform provides a session context and component/component containers to support run-time context and concurrency policies. The authors discuss experiences with the lab prototype of this platform, which is able to bundle and integrate disparate services.

In "The SPEED Platform for Programmable Bearer Channel Processing," Andrews et al.[6] discuss a platform supporting both control and bearer processing that is constructed with high-performance VLSI and advanced physical design concepts. The platform is designed for superior scalability when offering high-bandwidth and other enhanced services. This programmable platform, which provides an API suite, has been prototyped. Current plans are to use it as the platform for an advanced wireless system component.

Enabling the Network

A guiding principle in the new arena of services is borrowed from the Internet and data networks models. To the extent practical, services are decoupled from access and transport. This is a radical departure from some common telecommunication product architectures. The decoupling enables the service to be developed once and deployed to multiple access types (traditional telephony, native ATM access, IP with H.323, IP with SIP, and other access types). The importance of this separation is emphasized in many of the papers in this issue—particularly in "Speech-Enabled Services Using TelePortal™ Software and VoiceXML*" by Ball et al.[7] In this paper, the separation is needed to support traditional telephony endpoints with TelePortal software, which is designed to bring a variety of Web-based services to telephony endpoints.

In "A Shift in the Mobile Network Service Provisioning Paradigm," Torabi[8] considers a new dimension of the separation of service from transport. He discusses methods of decoupling services from the particular serving network so that a service can be passed through to a remote end user in a wireless roaming scenario, enabling "any service, anywhere, at any time." The author introduces a new paradigm of wireless network service provisioning to support this concept. A principle facet of this paradigm and, in general, of globalizing a subscriber's wireless services involves decoupling of the service provider from the particular network operator in the form of a virtual home environment (VHE), described in greater detail in an earlier paper.[9]

Developing and applying the concept of decoupling provisioning from the subject services, Lui, Karunasekera, and Leangsuksun, in "The Enhanced Service Manager: A Service Management System for Next-Generation Networks,"[10] describe the incorporation of several technologies, including service creation and schema generation tools, XML, and JavaServer Pages* (JSP*), to enable a service-independent provisioning platform. This platform picks up service-specific information from service definition specifications, yielding an instant, automatic customization of the provisioning operations.

Tapping the Internet

The Internet makes accessible vast amounts of information. The telephony network also has significant information (for example, subscriber location information) and a delivery with even higher penetration than the Internet per se. Uniting these two networks brings the Internet to wireless users. The combination of network knowledge and the Internet makes a host of location-based services possible for wireless users.

In "Enhanced Services in WAP-Enabled Networks," Batni, Lee, and Varney[11] discuss the wireless access protocol (WAP). This protocol is used to combine the Internet with wireless access; it enables personalization and other service differentiators that are useful and enjoyable to the end user. WAP-enabled Web pages employ a form of XML that a WAP gateway uses to send reduced-bandwidth Web-page information to micro-browsers on mobile phones. The WAP infrastructure allows telephony network information and Web information to be combined, making available a richer array of services to wireless users.

Kozik, Faynberg, and Lu discuss the Internet Engineering Task Force (IETF) PSTN/Inernet INTernetworking (PINT) work in "On Opening PSTN to Enhanced Voice/Data Services—The PINT Protocol Solution."[12] PINT is an architecture and protocol for controlling the PSTN from the Internet. The architecture these authors describe utilizes the intelligent network (IN) infrastructure. Example capabilities are click-to-dial-back, click-to-fax, click-to-fax-back, and voice-access-to-content. These capabilities are discussed in the informational PINT RFC 2458;[13] the relevant protocol is standardized in the standards-track RFC 2848.[14]

Making the Transition from Old to New

It may be desirable to preserve the ubiquity, quality, and reliability of the telecommunications network while migrating to other networks and/or including new services. This is one aspect of old-new interplay. In "Building the Bridge: Devising an Architecture to Migrate Voice-Band Calls to Packet Transport and Multimedia Services," Sijben et al.[15] present a transport-independent functional architecture that aids the transition from telephony to packet with these concerns in mind.

In "Delivering Seamless Services in Open Networks Using Intelligent Service Mediation" by Grech et al,[16] the realization that the telephony network will be employed in the delivery of new services originating in ASPs gives rise to the need to protect the network from compromise. Policy management—using a "policy envelope"—is the mechanism described in this paper for providing the protection telecom service providers need for wide deployment of third-party-provided services.

Enabling the Endpoints

Endpoints are another aspect of old-new interplay. Traditional endpoints (landline telephones, conventional mobile telephones, for example) abound, while the diversity of intelligent endpoints continues to grow. "Soft endpoints" ranging from PCs, the most widely used endpoints for Internet access, to programmable mobile phones and other hand-held devices are widely available. The "portal" concept becomes important for accommodating traditional endpoints and for enabling enhanced services to work with a diversity of endpoints. The concern is no longer with a cut-and-dry service, but with the experience provided for the end user, given the combination of the service or services and the range of endpoints the end user will employ. A case in point is the "road warrior" scenario, where an end user who is traveling may have available reduced-capability endpoints, but will desire the same services and, to the extent possible, comparable look-and-feel to what he or she can experience in a richer way with the home-location endpoints.

The voice telephone is accommodated with TelePortal software in "Speech-Enabled Services Using TelePortal™ Software and VoiceXML.*"[7] Among other capabilties, TelePortal can provide a more universal access to the World Wide Web by supporting traditional telephony endpoints. Key technologies needed for this are the TelePortal middleware—a voice-oriented markup language to convey Web-page content to the TelePortal server—and interactive voice response (IVR).

Clarisse et al. describe a demonstration network that employs the portal concept with a variety of endpoints in "Portal Services: An Evolution of Voice Features."[17] A basic set of "portal services" is provided to support conferencing and messaging. The demonstration network is extensible to voice/data/video broadband services for which the portal design would adjust the end user experience based on the endpoints involved.

The "soft endpoint" concept removes the static nature associated with conventional telephony endpoints: just as a new CD-ROM from America Online* can instantly upgrade the service customers receive, so, too, a new CD-ROM or a new download package can instantly change the endpoint capabilities radically. Telecom service providers are in a prime position to utilize intelligent endpoints since most often endpoint connectivity is through the telecommunications network. However, telecom service providers would need to deploy, within their network, control mechanisms that would have the capability of communicating with intelligent endpoints. Dianda et al.[3] discuss the architecture of such a control mechanism. More importantly, however, the telecom service providers would need to provide service possibilities that would give end users the incentive to enter into such an arrangement with them.

Today, both new chip technologies and the Internet provide unprecedented support (and delivery mechanisms) for new classes of wired and wireless endpoints with rich feature-set potential. Tiny, inexpensive and compelling, these new devices are more than a telephone and PC combined. It will be increasingly common for user interfaces to these new "telephones" to be mini-browsers rather than keypads. New "high-end telephones" will stream video as well. New devices both in the endpoint devices and in the network require intelligence and sophisticated software. Software for endpoint devices will go beyond simple firmware and include an operating system and application suites supporting dynamic updates and data synchronization.

The ability to provide new software to the endpoint, coupled with portal technology, presents new opportunities to provide network-enabled services bridging across multiple devices (wireless phone, wired phone, hand-held devices, and laptop/PC integration) that are only achieved by developing new software on the devices (and portals) that is enabled by networks. This is not to say that penetration of "hard" IP telephones is not expected. Both SIP and H.323 phones are and will continue to be available.

Summary

Development within several technology areas may well determine the future of network-provided communication services and the strength of telecom service provider enterprises. The key technology areas are:

- *APIs*, both component and network, with the latter including protective mechanisms for untrusted third parties;
- *Portals*, as a method for accommodating variety in endpoints and end users, enabling the creation of a desired "communication experience";
- *Policy management*, as a method of protecting the telecom network and network resources from compromise by third parties;
- *Frameworks and components supporting the deployment of services*, including service management frameworks, service bundling frameworks, OAM&P frameworks, service creation frameworks and components;

- *Platforms*, with programmability and scalability and enhancing bearer capabilities as important aspects;
- *Protocols*, addressing network-to-network (such as Internet to telephony network), network to gateway (such as with portal-related gateways), end-user to network (such as those used by intelligent endpoints); and
- *Internet-related technologies*, browser and language technologies that telecom service providers can use to their advantage in offering enhanced services.

To get a sense of how these technologies will manifest themselves early in the twenty-first century, read on.

*Trademarks

America Online is a registered trademark of Quantum Computer Services, Inc.

JAIN, Java, JavaServer Pages and JSP are trademarks of Sun Microsystems, Inc.

VoiceXML is a trademark of the VoiceXML Forum.

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