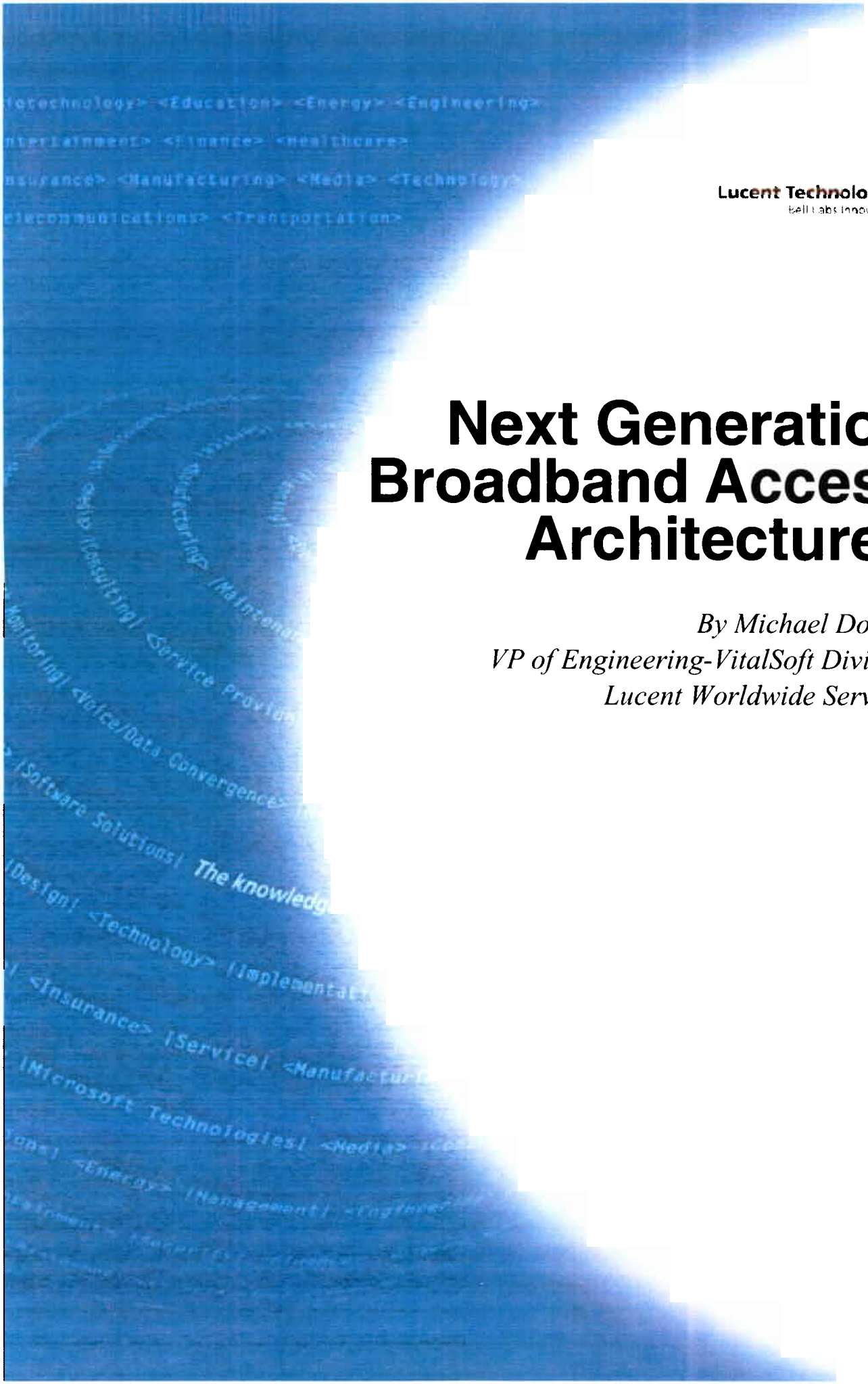

Lucent Technologies
Bell Labs Innovations

Next Generation Broadband Access Architectures

By Michael Dooley
VP of Engineering-VitalSoft Division
Lucent Worldwide Services



Next Generation Broadband Access Architectures

By Michael Dooley, VP of Engineering-VitalSoft Division, Lucent Worldwide Services

Introduction

Increasing residential and business demand for faster Internet connections has resulted in huge incremental revenue opportunities for Broadband Access providers. This high-speed service enables a variety of value-added high data rate (HDR) services such as "Always On" high-speed Internet Access, Enhanced On-line Gaming, Personal Videoconferencing, On-line Shopping and Banking, Virtual Private Network (VPN) telecommuting, and Entertainment on Demand. The early success of these high-speed Internet access rollouts, coupled with increased consumer interest, promises to result in many new subscribers and increased revenues for access providers estimated to reach five billion dollars by 2005.

Access providers are equally excited about the potential opportunity to deliver IP-based telephony service over the same infrastructure. Early service rollouts by several major Multiple System Operators (MSOs) have shown penetration rates of 20% based on today's circuit-switched technology. Conservative estimates specify an incremental revenue opportunity for telephony to reach over seven billion dollars in the U.S. alone by 2005.

Business customers present another large revenue opportunity for access providers as they will soon require a higher level of network performance and reliability than what is currently available from today's access solutions. The integration of voice and data service delivery will soon become the norm, and end users will demand these advanced services at costs far below today's offerings from incumbent service providers. Operators will eventually be required to offer businesses Service Level Agreements (SLAs) to become a viable alternative to incumbent service providers and will need to construct networks that are reliable, highly scaleable, and optimized to deliver high-speed data, telephony service, and Quality of Service (QoS) guarantees to many subscribers simultaneously. Unfortunately, most of today's access equipment is not equipped to handle the requirements and challenges of tomorrow's networks.

Access providers must plan now and be prepared to support the stringent demands of next generation services. To ensure a competitive position in the marketplace, access providers must be able to provide the framework for next generation applications and new HDR capabilities.

As Broadband infrastructures such as Cable, DSL, Fixed Wireless, and Fiber to the Home (FTTH) continue to penetrate home and small business markets, access providers need to identify and deploy a network architecture that can profitably support these next generation services. In doing so, decision-makers need to be educated and knowledgeable of the architecture investment that they make. This will avoid costly reconfiguration and hardware/software capital expenses.

In selecting the best architecture for the job, access providers must be sure that their choice will best position them to enable the current and next generation of Broadband offerings, as well as support cost-effective service activation, provisioning, and on-going maintenance. This paper will explore the access options available, identify key points, and suggest the type of architecture your organization will need for new and evolving Broadband business models.

Architecture Options

Today's access provider has several alternative architectures available to choose from including Static IP Addresses, Dynamic Host Control Protocol (DHCP), and Point-to-Point Protocol over ATM (PPPoA), and Point-to-Point Protocol over Ethernet (PPPoE). In order for them to provide access, both the access device (Cable Modem, xDSL Modem, etc.) and the end-user PC devices need to be provisioned with IP Address and TCP/IP parameters. While each of these architectures may address some of the specific needs of growing access providers, only one can meet the broadest range of requirements for next generation access options – DHCP.

Solution 1: Static IP Addressing

Static IP (Internet Protocol) Addressing is the most straightforward Broadband IP configuration option. It utilizes static IP Address assignments and the available Broadband services which are provisioned to provide "always on" access.

Customers typically pay a flat monthly fee for access, and Broadband operators can also charge for differentiated services. These differentiated services are based on pre-provisioning or by configuring network equipment with Quality of Service (QoS) parameters associated specifically with the IP Address that has been configured.

The Static IP Addressing architecture can be difficult and time consuming to provision and maintain. This architecture is difficult to implement on the client side, is expensive to install, and difficult to set up and maintain. It requires a complex configuration process involving manually configuring network parameters on the access device, and on each and every PC that is being provided Broadband access. Nevertheless, commercial customers who need, and can pay for a fixed, fast pipe to the Internet, may find this architecture acceptable. However, Service Providers should be aware that growth options with this architecture are limited.

Solution 2: PPP (Point-to-Point Protocol)

PPP (Point-to-Point Protocol) is a mechanism for creating and running Internet Protocol (IP) to connect dial-up customers to their Internet Service Providers (ISPs), who then provide Internet access to the customer. The Point-to-Point Protocol over Ethernet (PPPoE) and the Point-to-Point Protocol over ATM (PPPoA) combine the PPP protocol with Ethernet and ATM technologies to provide high-speed Internet access using high-speed Broadband access technologies.

PPP over Ethernet (PPPoE) is a proposal specifying how a host personal computer (PC) interacts with a Broadband modem (i.e. xDSL, cable, wireless, etc.) to achieve access to the growing number of high-speed data networks using Ethernet technology. Relying on two widely accepted standards, Ethernet and the PPP protocol, the PPPoE protocol implementation requires virtually the same end user knowledge required for standard dial-up Internet access. However, the majority of current client operating systems (Windows®) do not include a PPPoE client. This

architecture requires the Broadband operator to supply, install, maintain, and support the required client software installed on each end user PC.

PPP over ATM (PPPoA) achieves access to high-speed data networks using an ATM network connection to the subscriber PC providing an added benefit of end-to-end Quality of Service (QoS), including latency and bandwidth availability guarantees. This architecture approach requires an ATM network interface card in the subscriber PC as well as configuration of special drivers. These requirements add additional costs and increase deployment and implementation complexity. Support and availability for these hardware and software requirements are often issues with the PPPoA architecture. To take full advantage of the ATM technology, the network has to support switched virtual circuits (SVCs), which are not widely available. The ATM network interface cards are expensive and not always available. And finally, PPPoA software is not available for all platforms and does not support home Local Area Networks (LANs), cable, or wireless access.

The most widely used Operating systems (i.e. Windows 98, Windows ME, Windows 2000, or Windows NT®) support dial-up PPP connections as a standard component. Although, one major difference between dial-up based PPP, and an Ethernet or ATM connection is speed. A standard Ethernet connection operates at 10 Mbs (Mega - million bits per second) or 100 Mbs maximum theoretical throughput, whereas an analog modem operates at speeds up to 56 kbps (kilo - thousand bits per second).

Another advantage of PPPoE or PPPoA is that it requires no major changes in the operational model for Internet Service Providers (ISPs) and carriers that are currently providing dial-up Internet service. Legacy billing and accounting systems can take advantage of this technology, with little disruption as PPP enables service selection and authentication by interfacing with a RADIUS server, which can be configured to capture session-based information for billing purposes. The RADIUS accounting records generate when a session starts and ends (login and disconnect) enabling access providers to capture this information to produce a bill using a flat rate charge per hour, or tiered approach such as: up to 10 hours free and then $2 an hour after that. Access providers can also provide unlimited access at a specific charge such as $19.95 a month.

Despite having the familiar dial-up access look and feel that consumers are used to, PPP has drawbacks that will cause issues in the next generation Broadband deployments. The access providers must install, maintain, and configure proprietary PPPoE or PPPoA clients. The architecture requires a user ID and password to be entered each time a connection is made, thereby diluting the concept of "always on" since it actually requires users to login each time they want to connect to the network. Finally, next generation Internet appliances will potentially have problems connecting to the network if they have not implemented a PPP client.

Solution 3: DHCP (Dynamic Host Configuration Protocol)

The Dynamic Host Configuration Protocol (DHCP) is an Internet protocol for automating the configuration of computers that use TCP/IP. DHCP can be used to automatically assign IP addresses to deliver TCP/IP stack configuration parameters such as the subnet mask and default router, and to provide other configuration information such as DNS servers

DHCP has been used extensively within the Enterprise for several years, and is now finding its way to the Broadband application space. Architecture based on DHCP offers increased flexibility and speed as it relies on DHCP servers to automate network access. It also does not require any proprietary or third party software to be installed on client PCs. The DHCP server, transparent to

the end user, automatically assigns IP addresses and configures PCs that are accessing the network. This automation eases Broadband service implementation.

When utilizing the DHCP architecture, the Broadband user is unknown to the network when first granted access through the DHCP server. They are assigned limited access to a specific area while the authentication process is being completed. Once the authentication or registration process is complete, the user reboots their system and is granted a real IP Address that corresponds to the level of service that has been selected.

Another advantage of DHCP is that it enables network changes to be made centrally. It allows for centralized administration of the IP Address space and the associated TCP/IP parameters that are configured on the access devices and the end user PCs. When network changes are needed, they can be made at the DHCP server level; there the changes will be propagated to the network devices. This central approach supports effective management of these parameters and supports the active monitoring of IP Address space utilization.

Customers typically pay a usage-based or flat fee for DHCP services. An argument exists that DHCP does not provide the capability to authenticate end users and therefore support a "fee-for-service" business paradigm. As high-speed access becomes more commonplace, most providers are not charging on a "per usage" basis, but rather a "flat-fee" model, or a model that is based on the applications and/or level of service that the subscriber has selected.

How the Protocols Compare

Comparing Options	Static IP	DHCP	PPPoE/P PPoA
Automates IP configuration	No	Yes	Yes
Authenticates User each Session	No	No	Yes
Authenticates User by Device	Yes	Yes	No
Enables Differentiated services	Yes	Yes	Yes
Supports Multiple User sessions	Yes	Yes	Yes
Works easily with multiple PCs	Yes	Yes	No
Requires 3rd party client software	No	No	Yes
Works with DSL modems	Yes	Yes	Yes
Works with Cable modems	Yes	Yes	No
Works with Wireless modems	Yes	Yes	No
Easily supports new VoIP Services	No	Yes	No
Easily supports Interactive Entertainment Services	No	Yes	No
Easily supports streaming Video Services	No	Yes	No

Preparation for Next Generation Access

Next generation Broadband access will provide huge business and growth opportunities for those who are properly prepared. Access providers need to plan and prepare now to support the new infrastructure that will be required to offer these high-speed services.

"Always On" High-speed Internet Access, Enhanced On-line Gaming, Personal Videoconferencing, On-line Shopping and Banking, Virtual Private Network (VPN) telecommuting, and Entertainment on Demand services all require configuration of the access device and the end user PCs in a way that is standards-based, vendor independent, and reliable.

In preparing for tomorrow's networks, providers need to consider several criteria when selecting a next generation architecture including implementing a standards-based solution, vendor interoperability, Carrier-Class reliability, true scalability, and manageability.

Conclusion

In this paper we have attempted to review the key issues facing organizations striving to evolve their network infrastructure to support new and evolving next generation access options. We've seen that DHCP meets the broadest range of requirements for next generation access and delivers a well-proven protocol that scales well for any size access provider. It provides a way for users to easily connect to a network in an "always on" scenario, using the utilities provided by the operating system vendors without having to rely on third-party client software. This eliminates any maintenance or support issues related to third-party software. DHCP also allows for centralized administration and supports various access technologies including Cable, DSL, Fixed Wireless, and Fiber to the Home access options.

Preparing your network for next generation access involves making sound infrastructure investment decisions now. Many organizations contemplating their infrastructure choices may not be aware that the decisions they make now could potentially cost them additional capital and reconfiguration expenses in the future.

Lucent Technologies has the expertise and experience to help you make the proper decision on investing in a PPP, Simple IP Addressing or DHCP architecture. We can help you plan now to protect your investment in the future.

Lucent Technologies Worldwide Services

Lucent Technologies Worldwide Services is a global provider of network consulting and software solutions for complex enterprise networks. Lucent provides professional services and software tools designed to optimize network and application resources.

Lucent provides professional services for the full lifecycle of a network, including planning, and design, implementation, operations and optimization and maintains expertise in the most complex network technologies and multi-vendor environments.

Lucent offers value-added IP services and provides management tools to integrate, monitor and control services across a distributed network. Lucent is the only provider that supports IP services from multiple vendors, including Microsoft® and IBM®. We have the experts and experience to deliver complete solutions for access providers, offering seamless planning, implementation, operations, maintenance and management of your network.

For additional information please contact a Lucent Technologies Sales Representative, or visit our website at: www.lucentservices.com or call 1-888-767-2988 in the U.S. or 1-650-318-1020 outside the U.S.

Copyright © 2000, Lucent Technologies Worldwide Services

This is an unpublished work protected under the copyright laws. All rights reserved.
WP.IP.BRODBD.1200