EXHIBIT R

Breathing new life into Layer 4

A new advance adds intelligence to content routing decisions

By Rob Friedman, Executive Vice President, Business Development, Digital Envoy

Over the years, the Internet has grown and changed in many ways, adding more functionality, applications, and most importantly, users. In order to respond to these changes, broadband and enterprise networks are evolving to handle ever-increasing traffic and high bandwidth applications. This has spawned the need to find new ways to optimize the experience for users and deliver on the promise of broadband.

As the gap between the broadband "haves" and "have-nots" continues to grow, certain Internet content delivery fundamentals are failing to change with the times, thus stalling the promised delivery of broadband-optimized content. This fact has helped slow the rate of broadband adoption, which forces many to deliver content tailored to the lowest common denominator of dial-up users. So how does the broadband world simplify and automate the delivery of media rich content?

It makes sense to revert back to the basics and take a look at the layers of the Open System Interconnection (OSI) model, which serves as the architectural framework for content delivery, and understand how a new technological advance has the power to add intelligence to content routing decisions at the network layer, providing new levels of content quality to both broadband and dial-up Internet users.

The 7-Layer OSI model

The OSI model is the standard description for how messages—and content—should be transmitted between any two points in a network. This framework is broken into seven layers of functions that take place at each end of a communication.

Application (Layer 7). This layer supports application and end-user processes. Quality-of-service is generally identified, user authentication and privacy are considered and any constraints on data syntax are identified. Everything at this layer is application-specific. This layer provides application services for file transfers, e-mail and other network software services.

Presentation (Layer 6). This layer provides independence from differences in data representation (e.g., encryption) by translating from application to network format. The presentation layer works to transform data into a form that the application layer can accept. This layer formats and encrypts data to be sent across a network, providing freedom from compatibility problems. It is sometimes called the syntax layer.

Session (Layer 5). This layer establishes, manages and terminates connections between applications. The session layer sets up, coordinates and terminates conversations, exchanges and dialogues between the applications at each end. It deals with session and connection coordination.

Transport (Layer 4). This layer provides transparent transfer of data between end systems, or hosts and is responsible for end-to-end error recovery and flow control. It ensures complete data transfer.

Network (Layer 3). This layer provides switching and routing technologies, creating logical paths, known as virtual circuits, for transmitting data from node to node. Routing and forwarding are functions of this layer, as are addressing, internetworking, error handling, congestion control and packet sequencing.

Data link (Layer 2). At this layer, data packets are encoded and decoded into bits. It furnishes transmission protocol knowledge and management and handles errors in the physical layer, flow control and frame synchronization. The data link layer is divided into two sublayers: The Media Access Control (MAC) layer and the Logical Link Control (LLC) layer. The MAC sub

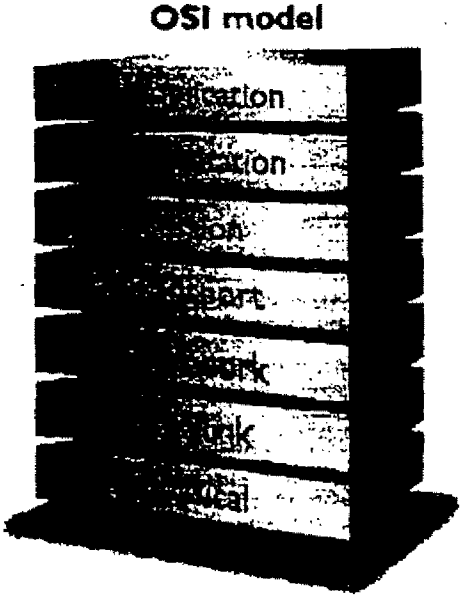


Figure 1: The seven layers of the Open System Interconnection model.

layer controls how a computer on the network gains access to the data and provides permission to transmit it. The LLC layer controls frame synchronization, flow control and error checking.

Physical (Layer 1). This layer conveys the bit stream–electrical impulse, light or radio signal–through the network at the electrical and mechanical level. It provides the hardware means of sending and receiving data on a carrier, including defining cables, cards and physical aspects.

Traditionally content networking equipment–which works to move low- and high-bandwidth content to end users–functions at layers 3 and 4, routing Internet users based on their IP addresses and bandwidth available at the destination server. While Layer 7 provides more information about a specific user, routing based on Layer 7 information is a time-consuming, resource-constraining endeavor that is costly to implement for the results achieved.

Enter Layer 4+

New technological advances have been developed to create richer profiles around IP addresses, allowing for instantaneous decision-making based solely on information available at layers 3 and 4 of the OSI Model. This new intelligence–dubbed "Layer 4+"–has the potential to revolutionize content delivery and make the promise of broadband content a cost-effective reality.

Layer 4+ brings two new factors into the Layer 4 decision-making process: Geographical and topological information about IP addresses allows companies to understand where users, servers and content are located. More intelligent data-handling decisions can be made at this layer that allow for the optimized delivery of broadband content.

With this intelligent routing, visitors can instantly be differentiated and rerouted based on factors such as: city-level geography; connection type (broadband vs. dial-up); network topology; and user type and priority.

This new intelligence, dubbed 'Layer 4+,' has the potential to revolutionize content delivery and make the promise of broadband content a cost-effective reality

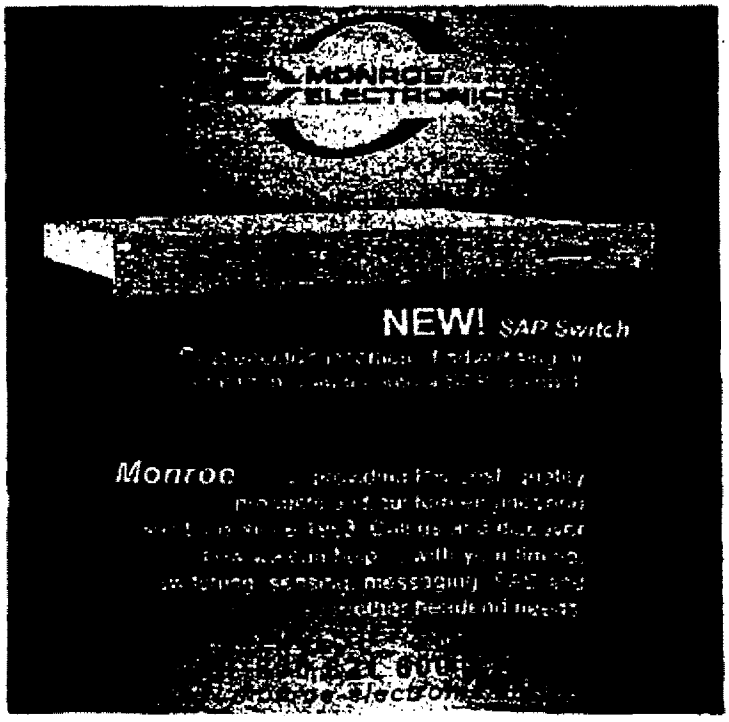
As enhanced visibility into a visitor's profile becomes possible at the lower networking levels, enterprises and service providers will be able to:

- Instantly differentiate between high bandwidth and low bandwidth visitors, serving rich content to cable modem users and stripped down content to dial-up users.
- Route visitors to servers based on connection type and location. For example, a broadband user may be routed to a less congested, geographically and topologically closer server to enable better QoS and optimize the delivery of high-bandwidth content.

Getting the information–A Herculean task

One of the major limiting factors regarding the ability to obtain Layer 4+ information is the enormity of the task. Layer 4+ routing is dependent on the pre-analysis of the entire IP address space. There are more than 4 billion possible IP addresses, and detailed analysis of each of them is a Herculean task, especially in light of the fact that IP addresses are constantly being assigned, allocated, reallocated, moved and changed due to routers being moved, enterprises being assigned IP addresses or moving, and networks being built or changed.

In order to keep up with these changes, complex algorithms, bandwidth measurement and mapping technology, and finely tuned delivery mechanisms



are necessary. Once all of the IP space is analyzed, each address must be periodically updated to reflect changes in the IP address information. This process is analogous to Internet search engine spidering in its enormity, yet requires far deeper layers of intelligence to keep the information about the constantly changing 4 billion-plus IP addresses current.

While this task is daunting, this is exactly what allows more intelligent Layer 4 decisions to be made.

How it works

Using information that relies on both the network topology and the geographic proximity of a user to content, more intelligent decisions can be made as to where that user should be sent for content.

With current approaches, if a user and the content being accessed are on the same network, the user is likely to be sent to that server. This would be the case regardless of the physical distance between the user and the server, whether the distance is 100 miles or 1,000 miles.

Using more intelligent routing technology, content can be more effectively distributed at the Layer 4 level. So now, instead of content being "dumbly" routed, the "nearness" of content-to-user is calculated based on the geography and network topology between the user and the server farms that hold the content being accessed. Furthermore, from the topological and geographical information that is extracted from an IP address, it is possible to detect the speed of an Internet device, allowing broadband content providers to stop wasting bandwidth and start serving media appropriate content to high-speed surfers.

Content customization and control

While the ability to more effectively route traffic alone is a compelling argument for this technology, there is a "bonus" feature that makes it even more appealing: The ability to customize and control the delivery of content based on the geographic information collected about an IP address.

So not only can broadband content be optimized for delivery from a networking perspective, but it can also be optimized for delivery from a relevancy perspective, and can be controlled based on the type of content.

For example, a retailer can now show merchandise that is appropriate for the area in which a Web surfer resides; an enterprise can show its content to foreign visitors in their respective languages; and a content provider can ensure that only end users within a certain geographic area have access to certain content in order to meet contractual obligations.

With content customization and control, enterprises, service providers and retailers can provide the look, feel and usability on their Web site from the time a Web surfer first visits—something that was nearly impossible to accomplish without users actually sharing information about themselves. This clearly increases the potential audience of any site that is attempting to address and attract an otherwise unknown set of site visitors, and has further implications from the standpoint of being a "good corporate citizen."

With this new, intelligent routing approach, streaming networks and Web sites will be able to instantly recognize details about users based only on their IP addresses, permitting a higher QoS for broadband users....

Fuel for the broadband fire?

With this new, intelligent routing approach, streaming networks and Web sites will be able to instantly recognize details about users based only on their IP addresses, permitting a higher quality of service for broadband users while maintaining a more basic service for dial-up users. The ability to control and customize content will enable more targeted, media-rich content to be delivered to broadband users—further accentuating the differences in experience between broadband and traditional dial-up users. That could continue to fuel the broadband fire and help simplify the process of delivering on the promise of broadband. ■