



STREAMING MEDIA WORKFLOW: AN OVERVIEW

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INTRODUCTION

Streaming media has brought rich content to life over the Internet. With the emergence of web “radio,” consumers are tuning in to a new world of digital content through modem, wireless, and broadband connections alike. The huge success of streaming in the consumer marketplace today provides a glimpse of the vast commercial potential for monetizing digital content, regardless of available bandwidth.

Streaming media is the most flexible way to distribute digital content. It supports multi-channel distribution, allowing content providers and distributors to reach customers, employees, and business partners seamlessly, through any kind of Internet access device, from PCs to home set-top boxes and all emerging wireless devices. Content can be distributed live or on demand.

Streaming also contains security mechanisms that can be used to manage content access. These features allow content providers and distributors to precisely control who has the ability to tune into the stream, and whether they have the rights to play it once or record it.

With the concept having already been proven by web radio and video, technology providers are introducing all the major solution pieces for providers and distributors to build new digital content businesses, and for organizations to add streaming as the most efficient means for providing training, corporate communications, and B2B complex data transfers through the global reach of the Internet.

Digital content involves a value chain that extends from the point of creation and authorship, through distribution, consumption, revenue realization, and relationship management. The solution “ecosystem” covers the entire life cycle of digital content, as it is created, programmed, distributed, and archived. That involves processes such as managing content creation, asset management, maximizing global distribution to target audiences, and providing closed-loop tracking of how content is consumed. To build revenue opportunities, solutions are available to carefully guard digital content access and reproduction rights, while providing full integration with solutions and services aimed at the order management and financial clearing cycle.

Open systems architectures are the linchpins for building effective streaming media infrastructures. They enable content providers and distributors to take advantage of the widest selection of solutions available, and they provide the ability to upgrade to the most reliable and scalable Internet commerce platforms. Because audiences span national boundaries and world regions, scalability and reliability are critical to ensuring that content is always available to customers when and where they need it.

Sun has become a leading Internet commerce platform because of its openness, network-friendliness, and proven reliability, availability, and scalability. Sun has put together one of the industry's largest ecosystem of third-party streaming media solution providers, covering the entire digital content life cycle. This paper presents a technology roadmap to help digital content providers and distributors build complete streaming media solutions.

What is Streaming?

Streaming is the ability to distribute “continuous” digital content over networks in real time in much the way that content is transmitted in real time over conventional broadcast networks. It includes a broad utility that supports advanced capabilities to search, store, and repurpose digital content.

The viewer experiences the content—regardless of whether it is in audio, video, graphics, or text form—within seconds after he or she selects it. Streamed content is flexible enough to be packaged to the form factor of any target device, regardless of display size or bandwidth limit.

There are several modes for providing streaming, with the choice dependent on the nature of the content, and the demand for that content over time. Live content is typically multicast (using familiar “publish and subscribe” methods) because it is the most efficient method for reaching large audiences simultaneously. Alternatively, content can be sent on demand via unicasts (individual streams) to each user.

Content can be streamed to any Internet-ready device, a capability that supports multi-channel distribution that can adapt the same content to different audiences with different needs. Content can be distributed to PCs and home multimedia set-top boxes, plus an expanding array of wireless appliances (such as WAP phones and PDAs), along with the next generation of in-vehicle infotainment systems.

Table 1. Streaming Media Capabilities by Bandwidth

| Connection | Bandwidth | Media Type | | | |
|--------------------|-------------------|------------|--------------------|-----------|--------------------|
| | | Text | Audio ¹ | Animation | Video ² |
| Modem | 28.8 - 56 kbit | Yes | Yes | Yes | Partial screen |
| ISDN/Frame Relay | 64 - 128 kbit | Yes | Yes | Yes | Partial screen |
| Cable Modem/DSL | 100 kbit - 1 mbit | Yes | Yes | Yes | Full screen |
| Corporate Networks | 1 mbit+ | Yes | Yes | Yes | Full screen |

Notes:

1. CD/DVD-quality audio at 300 kbits+
2. VHS-quality video at 300 kbits; DVD-quality video at 1 mbit+

Most importantly, streaming was designed to accommodate the protection of ownership and reproduction rights for digital content owners. Content owners, licensees, or distributors can directly control which viewers or subscribers have the right to watch or record the content, greatly limiting the chance for piracy.

The Emergence of Streaming Business

Historically, Internet file transfer required the downloading of all the data before the user could view the contents. However, because rich media files—including audio and video—contain more data than conventional text or simple graphics files, downloads proved time consuming, especially for users with low-bandwidth modem connections. On the corporate side, although bandwidth was often superior to consumer connections, such files could easily cause bottlenecks with other data traffic.

Streaming emerged as a more economical way of sending continuous, rich media using existing bandwidth. Instead of requiring that the entire file be downloaded at once, it allowed the contents of files to be reproduced on the end user's desktop machine in time-sliced bits. Like all web solutions, streaming began life with home-grown, often costly solutions that simply focused on transmission and reproduction. There were few, if any, features that protected security or provided revenue generation mechanisms.

Today, streaming has evolved to become the latest tool for web commerce. It provides the means by which digital content providers—from broadcasters to record labels and film studios—can build stronger relationships with their customers through providing:

- The ability for viewers to personalize the content (which they can “tune in”);
- A flexible technology for content providers (which allows them to transform content into multiple products and services that generate multiple revenue streams);
- Enhanced data communications for corporate uses, including video training and internal corporate communications; and
- Superior control over content consumption and distribution.

New, integrated solution sets provide functionality spanning all facets of content development, management, and distribution, providing the most secure form of content delivery available over the Internet.

Market Potential

The opportunity is huge. According to Cahners InStat, worldwide broadband services and content revenues to residences and small business alone will grow by 10x to over \$300 billion by 2004.

The Consumer Market. The obvious target is media and entertainment. Thanks to the popularity of web radio, streaming has typically been perceived as a consumer-oriented technology. As the business model for streaming is emerging, content providers are unlocking treasure troves of old content, from classic films and TV programs to old records.

Streaming has provided a valuable new channel for media and entertainment providers who supplement the customary theatrical distribution with the convenience and global reach of the Internet. New solutions that integrate with established on-line-commerce shopping, financial reconciliation, and closed-loop audience tracking, are enabling media and entertainment companies to use streaming as the route to building 21st century business models that monetize the full value of their digital assets.

On the horizon, content owners will “publish,” taking advantage of all the features of digital media, including new opportunities to personalize products and interact with their audiences. Furthermore, they will not simply “repurpose” existing content, but actively produce or adapt shows specifically for the web, incorporating web computing features, such as interactivity and live chat.

Consequently, streaming will supplement, not replace, conventional broadcasting or theatrical distribution. For instance, the rapid spread of broadband will stimulate the introduction of dramatically visually enhanced forms of entertainment, such as the addition of alternate takes or additional camera angles.

However, the opportunities for streaming veer well beyond broadband. With the emergence of new Internet access points, such as wireless PDA devices or in-vehicle systems, timely material as news, sports, financial market results, traffic, air travel conditions, or weather could be simulcast or narrowcast to targets with far different form factors, bandwidths, and listening or viewing conditions.

For instance, using voice recognition software, conventional television newscasts could be simulcast in streaming text format to wireless PDAs. Alternatively, business professionals or consumers could get tailored narrowcasts transmitted to PDAs, Internet phones, or in-vehicle systems, presenting personalized weather forecasts for their city, traffic conditions for the routes that they are traveling, and financial market data only for their stocks.

The bottom line? With broadband, narrowband, broadcast, or narrowcast, streaming can provide a “continuously connected” experience to the user, regardless of whether he or she is at home, in the office, or traveling anywhere in between.

The Corporate Market. Although streaming works under all types of bandwidth conditions, huge amounts of bandwidth are available today within corporate Local Area Networks and backbones for streaming use. In the corporate world, streaming is a way to effectively spread messages in real time or on demand, and as a means for enhancing services. Just a few examples of corporate streaming applications include:

- Enhanced remote training opportunities that can make on-line courses far more interactive;
- Expanded use of telemedicine, where expert practitioners can provide diagnostic assistance and real-time instructions for remote surgical procedures; and
- Corporate communications, for providing real-time or on-demand access to messages from top management.

Business Implications

By breaking down the barriers to content distribution, the publishing and streaming of digital content creates unique business challenges which revolve around several basic issues, including:

- **Security and Rights Management.** This ensures that all players in the value chain, including content owners, content providers, and content distributors, are fairly compensated for their intellectual property and services.
- **Audience Tracking.** A key cornerstone of any successful commerce strategy is to track how well the product or service meets market demand. For digital content, the challenge is especially pressing, given the ease with which content can be accessed. Content providers and distributors need to know who is watching or listening to their content—and to which portions of it. They also need to track viewership or listenership by channel. The requirement to protect the rights of content owners makes audience tracking even more critical; to be compensated fairly for the use of their content, content distributors must know which customers to bill and how to allocate subscriber fees to specific content owners.
- **Personalization.** E-commerce customers have grown accustomed to having the ability to tailor their own web experiences. For digital content, listeners and viewers are already gaining the ability to build their own personalized music and video channels. This is a key value-add when compared to conventional methods of content distribution, where the same material is broadcast, presented in theatres, or sold via CD, videocassette, or DVD formats.
- **Targeted Advertisements.** Sponsored content requires a feedback mechanism in order to prove that advertising works.
- **The Right Service at the Right Price.** The Internet's huge popularity has created bottlenecks to the point where it has often been derided as the "World Wide Wait." The emergence of rich media as a popular form of using the web could exacerbate the problem. The spread of broadband, which promises to ease congestion along the "last mile," has raised the bar on customer expectations for service. Consequently, quality of service is becoming a competitive necessity for digital content providers.

While it is beyond the scope of this paper to provide a comprehensive discussion of the business issues related to building a streaming media strategy, technology plays a critical supporting role in the solution. For instance, making the right technology choices will determine how well the issues of service quality and security are addressed.

DEVELOPING A STREAMING MEDIA STRATEGY

Viable strategies for distributing digital content via streaming start with business models that determine how revenue will be generated, and how audiences are to be served. Strategies must be designed around all aspects of the value chain, addressing:

- Monetizing approaches;
- Relationship management;
- Content packaging and consumption;
- Rights protection; and
- Content delivery.

As the leading platform provider for Internet commerce providers, Sun can help digital content providers and distributors develop effective technology strategies to fulfill their business goals.

Monetizing Digital Content Assets

Where will the revenue come from? There are numerous possibilities, including:

- Selling or renting access to content directly to the listener or viewer;
- Adopting a sponsorship model, where banner ads or similar promotions are used to pay for content that is distributed free to customers; and
- Providing barter arrangements with other content providers, distributors, distribution networks, or various service providers.

These are just a few of the possibilities for converting digital assets to revenue. The list of options will undoubtedly grow as the digital content industry matures.

Relationship Management

There are two principle forms of relationships, including those with business partners and the audience. Each type of relationship must be handled differently. The common thread, however, involves how revenue is generated and passed along, and what role the content plays with each participant in the value chain.

On the business side, attention must be paid to the relationships between content authors, owners, and distributors to ensure that contracts are honored and royalties flow smoothly. If the content is ad-sponsored, the provider or distributor must determine which party controls the actual selection and presentation of content. And, like any e-business, electronic payment processing workflows and relationships with financial clearing institutions must be established.

On the customer side, content providers should track their customer relationships to ensure return business and stronger buyer loyalties. It starts with the basic e-commerce building blocks that ensure that the customer has a good experience. The merchant (in this case, the provider or distributor of digital content) must ensure that the web site is enjoyable, and easy to navigate. The content that the customer selects should be easy to access and—if payments are involved—that orders for content are managed quickly and efficiently.

Beyond the basics, the content provider should track customer preferences to ensure that they are always presented with relevant choices, and, where appropriate, promotions that encourage cross-selling or up-selling. If ads play a prominent role in the distribution of content, the content provider should track ad exposures and, based on customer viewing or ordering patterns, present the most relevant ads. In the long run, content providers should analyze historical data to understand what content, promotions, and ads are most effective—both at the demographic group level, and at the 1:1 marketing level.

Packaging and Consumption

What type of content is best suited for streaming distribution over the Internet, and how should it be presented?

Media and entertainment companies have treasure troves of content, mostly in analog form, sitting in their archives. Once digitized, archival material gains new revenue generating opportunities. New material, such as new movies or CD recordings, gain additional sales value through the addition of digital collateral assets.

On the corporate side, enterprises have training assets that can be distributed more cost-effectively to remote locations, and have requirements for sending corporate messages or information updates internally to their employees and, increasingly, to strategic trading partners in their supply chains. Streaming can also provide a less expensive videoconference transmission alternative because it uses data communications, rather than conventional telecommunications lines.

Additionally, streaming could be used with advanced voice recognition and language translation to automatically communicate messages and presentations to local languages, using a combination of speech-to-text and language translation technologies that are emerging in today's digital asset management systems and Internet search engines.

Designing for Multi-Channel Distribution. The key to success is designing a seamless **multi-channel** experience. Although streaming first emerged with desktop computing clients, the flexibility of streaming allows content to be deployed to many other targets, each of which has its own data link, playback, and display capabilities. As mentioned above, these targets may range from Internet phones to PDAs and in-vehicle systems.

Additionally, each type of device may be used differently or in different contexts. For instance, while a PC or web-enhanced television is mostly likely to be viewed within a home or office, portable devices have smaller footprints and, more importantly, are viewed while the user is in transit—where the user’s attention span is likely to be shorter. Therefore, while deployments to stationary targets, such as PCs or home multimedia platforms, might emphasize vivid or data-rich experiences, the presentation for people on the go will not only have to fit a smaller screen, but be summarized to allow them to view the content more rapidly.

Customization and Personalization. Furthermore, unlike conventional broadcasting, web deployment supports the ability to serve customers with more individualized packages and the ability to interact—or talk back. The obvious solution for personalization is to use basic web browser features, such as cookies, to personalize the web experience based on the user’s past surfing patterns and content choices. More sophisticated capabilities are available from analytic applications that help target content choices, promotions or specially bundled offerings, and cross-selling opportunities from demographic information, such as gender, region, personal taste, and viewing device.

Additionally, the web provides a venue where customers can be more proactive in shaping their choices. With the use of powerful e-commerce on-line marketplace packages and digital asset management tools that make rich media content searchable, customers can be given the ability to piece together their own programming packages. For instance, customers could bundle a collection of episodes from a classic TV series that revolve around a specific theme or extended plot line, order alternate “directors cuts,” screen test bloopers of cast members, biographies, and access to chat rooms with cast or crewmembers and fellow fans. Or, in the case of a current television series, recent episodes could be bundled with updates that are narrowcast to PDAs.

For the content provider, there are several huge marketing advantages to providing customers the ability to individually tailor their own content. First, it improves customer satisfaction because personalization increases the likelihood that customers will receive exactly what they want. Additionally, personalization provides an extremely valuable market research tool by providing a more precise idea of what customers want. The opportunities afforded by personalization make it critical that content providers implement closed-loop customer tracking with the goal of fine-tuning content choices, promotions, and, where appropriate, ad insertions.

Rights Protection

The popularity of content distribution technologies, such as Napster, has brought the issue of digital rights protection to the forefront. The global reach of the Internet, the spread of broadband, and the ability of new technologies to freely replicate content could rob content owners of the royalties to which they are legally entitled—and ultimately undermine the music and entertainment industry.

The granting of downstream access rights to customers must be managed by upstream systems that track who owns the rights to the content and which parties must be compensated. In the case of classic records, films, and television programs drawn from the archives, the issue may be extremely complicated.

The need for these systems has become even more critical in the wake of proposed settlements between Napster and BMG, and MP3.com and Universal Music. Just as recording artists are compensated based on record sales, similar mechanisms are needed to compensate for reproduction of digital content, regardless of how it is distributed. For instance, under the Napster-BMG agreement, Napster customers will pay monthly subscription fees that will go to the recording company. To enable record labels to distribute royalties fairly, tracking systems are necessary to determine whose music is being downloaded or streamed, in order to reliably parcel out compensation to content owners.

Streaming provides unique protections as the result of its ability to carefully control recording rights. Unless set by the provider, streamed content cannot be easily recorded. Here, subscriber management systems are essential for granting customers access based on their subscription agreements. Specifically, these systems would determine which customers have access—and at what levels—to which titles or classes of content. For instance, depending on how much the customer pays, access privileges might be limited by schedule, the number of times the customer may view the content, or the channels by which the customer may access the content.

Content Delivery

With the growing popularity of digital content, content owners and distributors must pay close attention to how the content is physically going to get to the intended user. This has become a critical issue because bottlenecks can easily emerge at the origin server, or at any other point along the way to the customer. Furthermore, the growing popularity of digital, rich media content could exacerbate the situation. The strategies will vary based on the target audience size, regional distribution, size of the content files, and time dependence of the content.

There are many options for delivering content that balance the costs of server, data replication, and transmission. The distributed nature of the Internet itself means that messages are sent through a series of backbone links to routers that choose the fastest—or least congested—route to the destination. As the web has grown more crowded, popular sites have chosen to bypass these bottlenecks by:

- **Content Delivery Networks (CDNs).** CDNs transmit content from origin servers to ISPs across the country or globe which are physically closer to end customers. (These strategies are also known as sending content to the “edge of the network.”) In most cases, CDNs use dedicated or Virtual Private Network (VPN) backbones to bypass the delays of the public Internet.
- **Web Caching Services.** These services store content, or portions of it, at local or regional ISPs. This is especially critical for highly requested, bandwidth-intensive rich media files which otherwise might be slow to retrieve.
- **Content Peering.** The distributed nature of the Internet also allows CDNs to team up, as necessary, to pool their capacity for content that is highly in demand. Content peering relieves each CDN of having to build the entire infrastructure itself. Instead, it can take advantage of extra capacity that may be available on adjoining networks to offer the added level of service assurance. CDNs that peer must have agreements to ensure that each network is compensated for service. To simplify the process of establishing content peering agreements, initiatives including Content Bridge, Content Alliance, and the Adaptive Content Exchange (ACE) have been proposed to standardize the interfaces between CDNs.

For content providers and distributors, the choice of whether to use CDNs and caching services is driven by customer expectations for quality of service. The computing and networking infrastructure requirements of rich media makes content delivery and caching one of the most strategic issues facing the provider or distributor. Deciding factors on whether to use CDNs or caching include:

- Audience size and expectations for quality of service;
- Geographic spread of target audience;
- Data file size; and
- Mode of deployment (live multicast vs. on demand).

The decision is rarely black and white. In most cases, there are cost/benefit tradeoffs from using delivery networks and caching services. It starts with the cost of using CDNs; in most cases, the more regional servers that are used, the higher the cost. The same principle is true for caching; the more servers that are used and the more data that is staged on them, the higher the cost. All these factors must be weighed against the price that can be charged for content—or in the case of sponsored content, the ad revenue that may be realized.

Therefore, content distributors often use hybrid strategies to ensure that the audience receives high service levels without overpaying for CDN or caching capacity. For instance, if demand is expected to be higher in certain regions, a hybrid strategy of using a CDN for audience members in that area may be used, while other requestors are directed to the origin servers. Additionally, if demand is high for an extremely data-intensive stream—such as the newest hit single from Madonna or Ricky Martin—the first portion of the digital content file might be cached at the edge of the network (to avoid initial data retrieval delays), with the remainder piped through the CDN.

Sun has worked with the major players in content distribution to build scalable platform and application architectures that improve the experience of viewers and listeners all across the Internet.

INFRASTRUCTURE OVERVIEW

Best of Class Solutions

The digital content life cycle involves the entire organization, from creative or artist relations staffs to business development, sales and marketing, copyright, legal, IT, and network operations groups. This requires an ecosystem approach to assembling solutions, handling everything from business transactions to network operations and compute-intensive content creation and ingestion.

Because there is no single, silver bullet solution that encompasses all of the business processes, content providers and distributors require best of class approaches that integrate multiple solutions. Furthermore, because the web is becoming the prime medium for digital content distribution, customers expect to complete transactions during the same session; they will not tolerate picking a selection and then logging onto to another web site to buy or rent it.

The bottom line? Seamless integration becomes mission critical. Once content is ready for release, asset management systems must automatically catalog it and make it searchable. When customers select the content, one of two things must happen. If the content is ad-sponsored, ad insertion solutions must be activated. If the content is sold or rented to the customer, integrated e-commerce systems must quickly process payments or subscriptions. Furthermore, because the content may be sent through third-party CDNs—which may or may not be peered—the provider's business systems must, in turn, integrate with network providers to ensure that content is physically delivered.

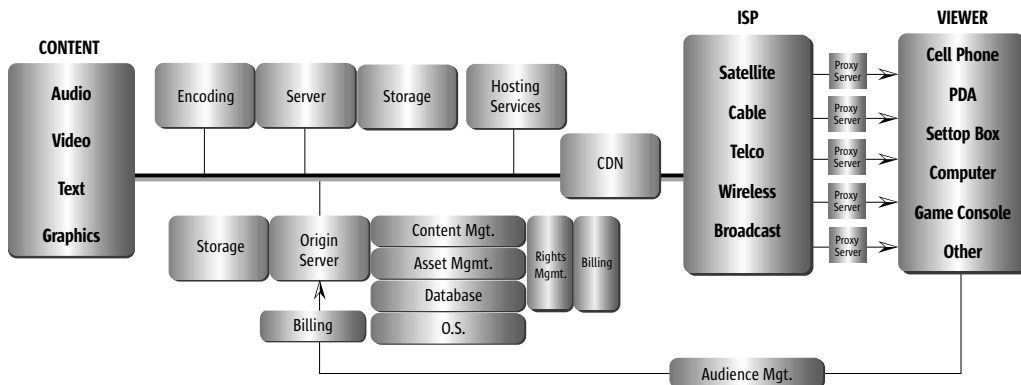
Platform Strategy

Open systems architectures are essential to building the digital content infrastructure that supports a streaming media strategy for two important reasons: solution choice and platform robustness. Open platforms provide the widest selection of digital media solutions and the most seamless integration paths. Additionally, open platforms have become the environments of choice for Internet commerce because they are the most dependable and scalable.

DIGITAL CONTENT ARCHITECTURE

Sun has become a leader in Internet computing, owing to its long-time commitment to networking and open systems and its highly scalable, reliable platform solutions. Based on the experience of building e-commerce and digital media management solutions, Sun has developed a technology roadmap for building digital media streaming solutions. This section describes that roadmap.

STREAMING MEDIA WORKFLOW



Media Storage

Media storage is used for enterprise repositories, portals, and streaming delivery projects, providing a combination of short- and long-term storage. The varied nature of digital content requires a robust architecture that accounts for the differing characteristics of rich media types, including:

- Text, which is relatively compact;
- Graphics, which can be data-intensive and, when animated, highly dynamic;
- Audio, which is highly dynamic; and
- Video, which is highly dynamic and the most data-intensive of any data type.

Additionally, media storage strategies must reflect demand patterns for the content. Just as frequently used, conventional transaction data is striped onto the most accessible portions of disk, similar strategies must be employed when determining where and how to store rich digitized media content. Typical strategies could include:

- **Time-dated, Highly Current Content.** Material, such as news, sports contests, or the latest music releases, may have relatively short life cycles of high demand. This content should be placed on the most accessible storage media—and in some cases, replicated and cached at the edge of the network—for short periods, before it is archived.
- **Current, Non-dated Content.** Data-intensive content that is frequently in demand, but not as volatile as today's headlines, might be stored using “near” on-line storage.
- **Historical Content.** This content, which is relatively static, enjoys relatively constant demand, and has a long life cycle, is likely suited for off-line storage and slower delivery.

Distribution also becomes a factor in media storage strategy. For highly popular content, response is critical, yet so is the cost and administrative overhead of replicating and synchronizing content to multiple staging sites at the edge of the network. Therefore, many content providers are adopting hybrid strategies that stage the first portions of heavily requested content (e.g., first few seconds or minutes) either on their own caching servers, or via third-party caching providers, at the edge of the network. This provides the best of both worlds: quick response for the “first minute” with adequate time to stage the remainder of the show from the origin server.

Storage capacity must be rapidly scalable to provide the right amount of capacity at the right price. Rapid growth of the digital content market requires a flexible storage strategy, where storage capacity can be added in economical increments, rapidly, without having to replace or redesign the architecture of the entire subsystem. Content providers must be able to focus on developing and delivering content, rather than continually changing their storage strategies in response to changing market requirements.

Server Platform

The resource-intensive and mission-critical nature of rich media, and the highly competitive quest for viewer “eyes,” require content providers to adopt carrier-class platforms to ensure that viewers reliably enjoy a good experience while patronizing their sites. The dominance of broadcasting in the delivery of news and entertainment has caused consumers to expect high service levels. Thanks to well-ingrained broadcast viewing habits, viewers expect their TV or radio stations to always be on the air, available whenever they turn the TV set or radio on.

Businesses have similar high expectations. The speed of Internet commerce, and the mission-critical nature of B2B transactions, makes carrier-grade service mandatory for time-critical business processes, such as the status of inventories, orders, and shipments.

Not surprisingly, rich media must meet these same rigorous standards for consumer and corporate applications alike. That translates to several key criteria for platform selection, including:

- **Scalability.** The vastly fluctuating patterns of Internet traffic demonstrate the need for platforms and operating environments that can scale rapidly. These conditions are also likely to characterize the rich media over IP environment. That dictates hardware platforms that are easily upgraded on the fly, and operating environments that support this capability.
- **Open Architectures.** As mentioned previously, the digital content ecosystem requires solutions based on best-of-class tools. Developing on an open architecture ensures a wide choice of applications and development tools.
- **Networked Architecture.** The large bandwidth appetite of rich media, combined with the volatile nature of customer demand, dictates a networked computing architecture that supports highly distributed deployment. To eliminate bottlenecks and achieve carrier-grade service levels, applications and data must be deployed multiple server and client targets over IP networks. They must be designed to operate efficiently, and adjust to the varying bandwidth conditions that characterize public and internal IP networks.

Content Management

This phase encompasses the entire pre- and post-production process associated with content generation. For instance, to support multi-channel distribution, the capability to edit and adapt content to the requirements and consumption patterns of different targets is becoming essential. Personalization features that allow viewers to tailor their own content become yet another critical component for maximizing revenue potential.

Additionally, emerging technologies, such as SMIL (Synchronized Media Interface Language) and XML (extensible Markup Language), are becoming important for building shows and presentations that combine audio and video with text and graphics.

The major functions of content management include:

- **Workflow Management,** for ensuring that consistent processes are followed while authoring and developing content.
- **Publishing Processes,** for converting content to usable formats, including digital capture devices and, for on-demand content, editing systems.
- **Personalization and Profiling solutions,** for helping users customize the content for their own needs and enabling content providers to understand how their customers consume their content.
- **Ad Tracking,** for checking the effectiveness of banner ads and promotions on the site or related sites.

- **Relationship Marketing**, for helping content providers build ongoing interactions with customer groups and business partners, such as syndicators (third parties which redistribute content) and service providers.
- **Bill Payment and Presentation**, for providing the mechanisms for revenue generation. This requires real-time integration with caching, distribution, and network management systems that deliver the content to the customer, along with back-end transaction systems that manage customer subscriptions or other forms of on-line purchases.
- **Audience Management**, for tracking the relationship with customers and the patterns by which content is consumed. This is critical to allowing content providers to best serve audience needs, build stronger customer loyalties, and unlock new revenue opportunities. The answers can provide business intelligence on what type of content is most popular, to which audiences, and in which regions—and in turn, can help the content distributor ensure that the right capacity is in place to satisfy current and future demand for similar kinds of content. This requires a mix of analytic solutions that focus on what content is being requested, what portions of the content are being rerun, and who is requesting what content at what time of the day or week and in what region.

Digital Asset Management

This is the process of “ingesting” digital content, involving the acquisition, encoding, and logging of content. With digital asset management solutions, rich media content can be automatically categorized for the purposes of searching and maintaining access rights and payment relationships. Additionally, the technologies can be applied to translating content into different languages, broadening the potential audience base.

This includes tools and solutions that perform some or all the following tasks:

- Collecting raw content from its original digital or analog source;
- Transforming the content into digital format that can be manipulated and stored on-line;
- Generating meta data through advanced capabilities that can parse structured and unstructured data formats, along with advanced technologies, such as speech or image recognition;
- Indexing the content and providing search engines to allow it to be searched by customers and content developers alike;
- Maintaining security by encrypting content to prevent piracy;
- Scheduling processes, for sequentially programmed content;
- Version control, for ensuring that customers and content developers alike are working with the most current content.

Distribution Management

This stage handles all customer care, access control (and rights management), related financial transactions, and actual delivery of the content to the end customer or user. And, as part of the delivery function, content distributors must deal with network management issues.

The physical Internet is becoming increasingly diverse. Today, the mix includes high-speed fiber backbones—including public, private, and VPN—along with local loop delivery via low-speed conventional phone lines, DSL, cable networks, and on the corporate side, frame relay and higher-capacity T1 and T3 lines. Additionally, depending on world region, wireless networks have already emerged or are emerging, encompassing a mix of low- and high-bandwidth wireless distribution systems, along with local packet cellular and regional/global satellite networks.

Recognizing this diversity, network management has become a cornerstone of any e-commerce solution. For digital content, the need is even more critical, because rich media files can be quite large. These solutions optimize the use of a mix of resources that vary by region, target device class, and in the future, by Quality of Service (QoS) level.

The components of distribution management comprise:

- **Caching**, where content is replicated and stored on servers at the edge of the network. Caching is often used for accelerating the retrieval of popular content. There are several different types of caching strategies (see box).
- **Content hosting**, where third-party data centers are used to house video and multimedia servers and content distribution solutions. This is closely related to caching.
- **Network management**, for the delivery of high QoS levels by routing content along the optimum path to the customer or end user.
- **Bandwidth management**, for determining the necessary amount of bandwidth for delivering the content. This is especially critical, given the size of rich media files and the volatility of demand. These services provide the ability to dynamically allocate content according to demand and content type/size.
- **Streaming server**, which “transmits” the content in real time to the end user. There are several streaming formats that are available today. Sun supports any streaming format that is platform-independent, such as RealPlayer, and is supporting current and emerging open streaming format standards, such as MPEG 1, 2 and 4.
- **Financial clearing**, for providing systems by which customers can pay for content.
- **Mediation**, for ensuring that royalties and other fees go to the intended authors copyright holders.

- **Syndication**, which allows content providers to manage business relationships with third-party content aggregators, or which allows content providers to gain access to, and retransmit, third-party content.
- **Transcoding**, which converts digital content to a form that can be sent to the streaming server for distribution.
- **Usage clearing**, which manages end user permissions and access rights to the content.
- **Media commerce management**, where transactions for content consumption are billed in real time.

- **Caching**. There are many approaches for accelerating the delivery of content by staging it at points along the edge of the network.

Traditional “pull” approaches stage content only at the origin server, and are sent to the user after the user submits a request. Because this process funnels all requests and content distribution onto the origin server (and the network links that serve it), “pulling” content is extremely susceptible to bottlenecks and single-point-of-failure conditions.

By contrast, caching stages content closer to the requestor. Caching strategies are often used in conjunction with Content Delivery Networks that transmit content from origin servers via backbones (that are less susceptible to Internet congestion) to strategically located ISPs. Those ISPs retransmit the content to the requestor. Caching is an additional service that stores some or all of the content on a server hosted at an ISP.

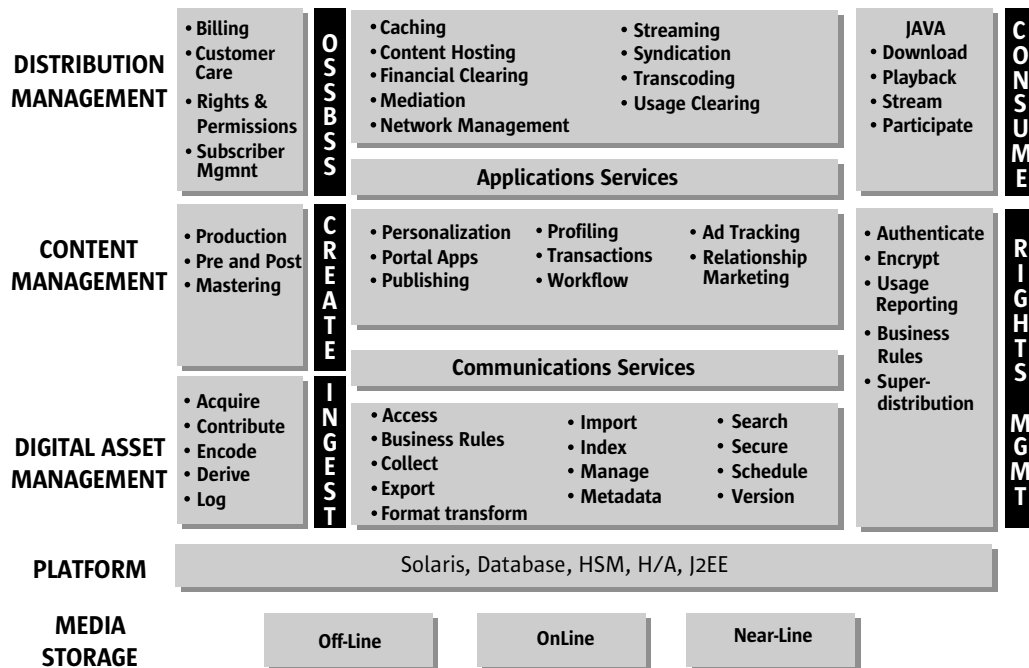
There are many different types of caching strategies. A few examples include:

1. **Push**: When user requests content, it is downloaded and then stored at a delivery point closer to the user. “Push” caching strategies benefit all succeeding users, located close to the caching server, who ask for the same content.
2. **Intelligent Push**: The content distributor or delivery network dynamically analyzes where content should be deployed. It determines which content (or portions thereof) should be pushed to the edge of the network. This strategy can also be differentiated by region, if users of specific content are concentrated in any particular geographic areas.
3. **Hybrid Push/Pull**: Because digital content occupies so much storage, it is often not economical to cache an entire rich media program on remote servers. Hybrid strategies may be used which cache certain portions of content, while other portions are sent from origin servers. For instance, the first minute of a video presentation might be cached, while the last part of the program is stored and deployed from the origin server.

Content Consumption

With multi-channel distribution assuming a driving role in the packaging and distribution of streamed content, content developers must work with a variety of platform standards for emerging targets outside the desktop PC. Because of the high variability of mobile targets, the Java™ 2 Platform, Micro Edition (J2ME™) is becoming an extremely popular platform for developing applications that can be written once and run on any compliant smart phone, pager, PDA, or in-vehicle system.

SUN™ DIGITAL CONTENT INTEGRATION SOLUTIONS



Servers and Storage

As a leader in Internet commerce, Sun provides a complete line of server and storage solutions that deliver high levels of reliability and availability. They are backed by a comprehensive digital content solution partner program.

It begins with the Solaris™ Operating Environment. The advantages of the Solaris Operating Environment for digital content providers and distributors include:

- **Scalability.** The Solaris Operating Environment offers numerous features to bolster scalability, including near-linear performance increases as processors are added to server platforms; complete support of high-availability clustering; and multi-processor support of up to 64-CPU configurations.

- **Availability.** The Solaris Operating Environment is designed to support the always-open 24 x 7 environments required for e-commerce. Features, such as the ability to add processor capacity without taking the system off-line, allow digital content providers and distributors to upgrade their systems without interrupting the streaming of digital content.
- **Performance.** Features such as kernel-based multi-threading help resource-hungry digital content applications deliver the high levels of performance demanded by customers.

In turn, Sun's platforms build on the robustness of Solaris System with configurations optimized for the needs of Internet commerce. Sun's Netra™ family, an affordable platform line aimed at service providers. Console-managed Netra servers have been optimized for webserver deployment through features such as powerful I/O processing, hot-pluggable components such as SCSI disk drives, and compact size for rack-mount environments.

Additionally, workgroup servers, such as the Sun Enterprise™ 450 server, provide affordable, scalable, and highly reliable platforms that have been proven for e-commerce. Sun's workgroup servers have been designed to deliver high performance for the mix of compute-, data-, and I/O-intensive applications that are used for digital content-based e-commerce. Additionally, serviceability features, such as standard ECC datapath and memory protection, automatic system recovery, and hot-swap power supplies and disk drives, provide the level of availability demanded by today's digital content service providers.

Sun also offers enterprise-class platforms, such as the Sun Enterprise 10000, that deliver enormous capacity and logical partitioning capabilities typically associated with mainframes. Additionally, Sun and its partners jointly offer pre-tested server and database configurations that allow e-businesses to quickly go live with pre-tested, standard system database and file management configurations.

Sun backs its scalable server platforms with one of the industry's most economical storage environments. The Sun StorEdge™ array delivers economical, modular capacity that can be added incrementally, often on-the-fly, to meet your content storage needs.

JAVA™ TECHNOLOGY

As a popular application environment for e-commerce, Java technology provides a unified, open technology platform that scales from embedded device to desktop, set top, and enterprise server. This scalability and productivity is critical for streaming media applications, which, like most e-commerce systems, must be built quickly and be deployable over a wide range of target platforms.

Java technology has grown popular among web developers because of its highly productive features. For instance, its object-oriented application development environment supports the latest component-based technologies and code reuse, while its “secure sandbox” prevents common application failures due to memory leaks. Today, there are several Java technology frameworks that specify services and provide the APIs, against which applications can be deployed without regard to platform differences. The key frameworks for digital content providers include:

- Java 2 Platform, Enterprise Edition (J2EE™)
- Java 2 Platform, Micro Edition (J2ME™)
- Java TV™ API

Together, these standards provide a common application platform that allows application developers to write once and deploy consistently anywhere.

Additionally, Sun is working actively with developers and partners to enhance products that are based on Java technology. Sun has established the Java Development Lab to provide members of Sun’s Developer Connection™ program with direct access to lab space, software, equipment, and Java technology engineering expertise. Furthermore, Sun has teamed with several partners to develop the iTV Performance Lab, a testing facility designed to demonstrate to cable network operators how they can shorten the deployment cycle, reduce the deployment risk, and ensure the robustness of ITV services.

Java 2 Platform, Enterprise Edition (J2EE™). A new standard for e-commerce applications, the Java 2 Platform, Enterprise Edition (J2EE) provides the foundation for applications that help monetize digital content. J2EE technology specifies a comprehensive range of services required for distributed, enterprise-scale, web commerce applications, including:

- Component definitions;
- Web page generation;
- Object/relational data mapping;
- Standard interfaces for directory services; and
- Transaction management, messaging, and database access.

Applications that comply with J2EE technology specifications will be portable and interoperable. Building J2EE technology-compliant applications ensures that digital content providers can build truly extensible applications that can evolve and grow with their marketplace.

Java 2 Platform, Micro Edition (J2ME). This specification is providing a standard for the development of a new generation of open, mobile phone, PDA, and set-top box applications for deploying digital content on a wide range of appliances that fully comply with Java technology standards.

Java TV API. The Java TV API will greatly facilitate the transition to Interactive Television (iTV)—a technology that will allow cable operators and content providers to develop new programming forms that increase viewer involvement and revenue flows.

With iTV now in its formative stages, many different set-top box and designs and platforms are now emerging. The emergence of the Java TV API will free cable operators from being dependent on single sources of technology. As long as the set-top box or other converter technology complies with the Java TV API, their applications will deploy successfully without the need for porting or re-authoring.

iPlanet™ e-Commerce Solutions. Sun, Netscape, and AOL have teamed up to form the iPlanet™ alliance. Inheriting the products from Netscape™ and Forte™, iPlanet, a Sun-Netscape alliance, offers a growing family of e-commerce solutions and Java technology application development tools. The iPlanet family of products provides all the essential building blocks and solutions for building J2EE technology-compliant web commerce applications.

It begins with infrastructure products, including the iPlanet™ Web Server, which provides the industrial-strength, highly secure and reliable gateway for delivering dynamic, personalized content in an easy-to-manage environment. The iPlanet Application Server in turn provides one of the industry's most robust, J2EE technology-compliant platform for deploying e-commerce applications. iPlanet Application Server is also joined by a growing family of e-commerce applications covering processes ranging from B2B trading to buying, selling, and billing.

To develop J2EE technology-compliant applications, iPlanet offers the Forte™ for Java™ open source development framework. Completely open, modular, and extensible, Forte for Java framework provides a powerful IDE that is fully scalable. Available as a community source edition for independent programmers, the Forte for Java framework is also available in enterprise editions that fully support team development.

iForce™ Solution Sets

Sun has always been focused on helping its customers get the most out of the Net. The latest example: iForce™ solution sets. An aggregation of best-of-class applications that is scalable, easy to customize, and follows open standards, iForce solution sets give customers a jump on the process by providing a scalable blend of software, hardware, networking, financing, and consulting services. The iForce solution sets can help companies create a sustainable business advantage, while reducing risk, shortening time to market, and minimizing investment. Solution sets are targeted to a range of industries and a variety of e-commerce functions, allowing enterprises to immediately fulfill their e-business strategies and compete in the Internet economy.

Media Commerce Solution Set. Real-time billing solutions are the key to monetizing the delivery of streamed digital content. Sun has partnered with several key players to deliver one of the industry's first integrated broadband service delivery framework, enabling the distribution, personalization, and billing of broadband value-added services. Detailed usage information is captured from the traffic server and fed into billing platform to monetize the content distribution.

Sun's Partner Strategy

Sun is backing its commitment to open platforms by working with leading solution providers covering the digital content ecosystem. An Internet computing leader, Sun offers the widest array of scalable, reliable best-of-class solutions to integrate the entire digital content life cycle.

CONCLUSION

Streaming media requires robust, scalable end-to-end solutions. To build a digital content business that utilizes streaming, content providers and distributors alike need a carefully architected solution that covers the entire value chain, from content creation and rights management to asset management, personalization, content delivery, customer care, and financial settlement.

The solution must be scalable for many reasons. First, rich media content consumes significant storage, computing, and network resources. Additionally, user demand can be huge—and unpredictable. A standards-based approach using open system platforms is necessary to ensure access to the widest selection of best of class solutions and provide a straightforward path for integration.

Streaming media is here today. The popularity of Internet broadcasting has demonstrated the reliability and robustness of streaming as the one of the safest, most efficient ways of distributing rich media content over the web. Streaming is becoming a logical route for allowing content providers and distributors to monetize their offerings.

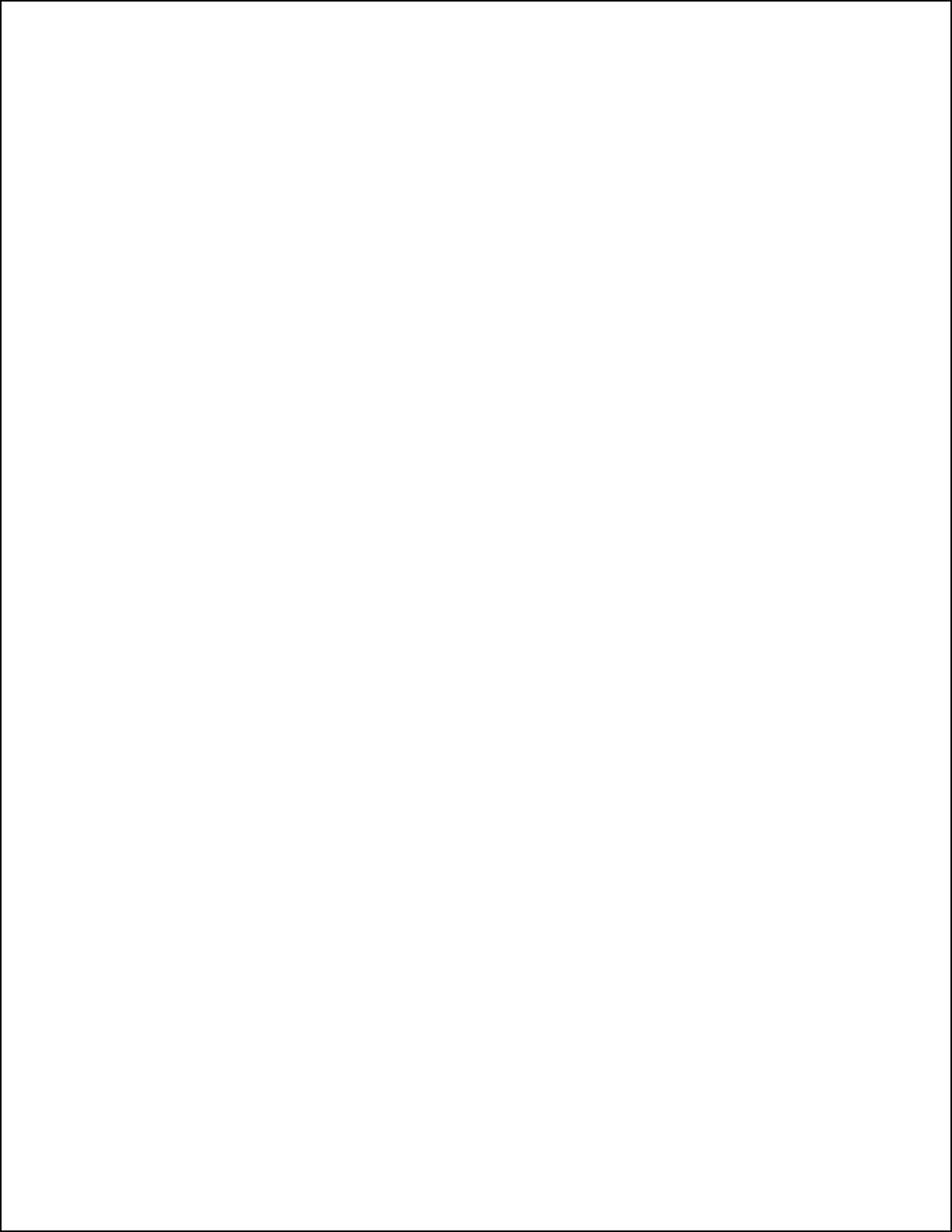
The competitive possibilities are just beginning to emerge. For instance, while streamed video over IP could provide a convenient alternative to renting movies at the video store, this is just the tip of the iceberg. For instance, streamed video over the Internet creates the ability for audiences to personalize their own entertainment products. On the corporate side, it also provides new channels for internal communications, interactive training, and B2B commerce.

Furthermore, streamed distribution can integrate with the e-commerce and analytic application building blocks by which content providers and distributors could build true closed-loop relationships with their customers. This could provide the ability to precisely track audience tastes in near real time—without the time delays and uncertainties of conventional audience sampling techniques. Additionally, by enabling customers to build their own content packages, content providers can build stronger, more lasting relationships. And, the combination of closed-loop tracking of advanced analytic tools will allow content providers to conduct better predictive market analyses.

Sun, a leader in Internet commerce and infrastructure, is your logical partner for putting together the roadmap for building the infrastructure for streaming media e-commerce. Starting with the scalable, robust Sun Enterprise Servers, the Solaris Operating Environment, and Sun StorEdge™ systems, Sun is the logical infrastructure choice.

As the pioneer in networked computing, Sun can help your organization develop a technology infrastructure that fully supports the Internet and all major open platform streaming media standards. Thanks to Sun's long experience with networked computing, your organization will gain access to tools that help you manage the deployment of assets distributed across data centers, delivery networks, and service providers.

This foundation is backed by one of the industry's most comprehensive digital content integration solution partnerships. Your organization gains access to the solutions that you need to develop content, manage it, protect access and intellectual property rights, and complete the transformation into products that contribute to the bottom line. And, thanks to Sun's commitment to industry standards, your technology investment will be protected. With Sun, the choice of best-of-class solutions will continue to be one of the widest in the industry.



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