Utility Model for On-Demand Digital Content

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We expect the proposed model to

- enhance the consumption of digital media content;
- provide easier access to archived content;
- promote innovation in the development of newer hardware, software, and devices related to various aspects of content delivery and consumption; and
- generate demand for newer and novel content-related services and applications.

Before developers can implement the proposed model, however, they must address several important issues.

Rapid and converging technological advances in computing, communications, and consumer electronics have caused an explosion in the generation, processing, storage, transmission, and consumption of enormous amounts of digital content. Analysts expect these trends to accelerate in the near future and to have profound effects on content delivery and consumption.

The term *content* generally refers to movies, songs, news, or educational material that spans various application domains, including personal entertainment, business, and education and training.

The technology model currently used to supply this content seems inefficient and ineffective today. Newer models must be developed to support the ubiquitous, transparent, and cost-effective on-demand delivery of digital content, as driven by user preferences.

We propose a *content-utility system model* for digital content delivery and consumption that resembles traditional utilities such as electrical power and water supply systems.

Several recent trends demonstrate the emergence of the utility model in the entertainment sector. For example, Apple Computer's hugely popular on-demand audio service, iTunes, provides consumers with free 30-second previews and selective downloading of music tracks for a reasonable fee. This service has created a demand for new hardware such as the iPod, iPod mini, and iPod shuffle content-consumption devices.

Only a robust and scalable model can handle the vast amounts of content today's consumers demand.

Five film studios—MGM, Paramount, Universal, Warner Bros., and Columbia—have backed initiatives to put 100 of their recent releases on Web sites as downloads that cost from three to five dollars and self-erase after one viewing. Time Warner recently introduced a digital cable service that features *movies-on-demand* through its interactive iCONTROL service, which provides instant access to hundreds of movies anytime.

These trends indicate the necessity and success of a well-designed content-utility model. Such a model defines the roles and interactions of the content-utility system's components and subsystems and also identifies the need for policies related to the system's overall functioning.

CURRENT TECHNOLOGY

To date, the most common means of content delivery to consumers have been print media, broadcast TV, cable, radio, and, more recently, the Internet.

Our focus is on digital video content, which can be broadly classified as either online or offline delivery. The most common forms of online delivery systems are broadcast, cable, and satellite-dish systems. Packaged content, such as CD-ROMs and DVDs, provide the most common forms of offline delivery. Both online and offline delivery schemes have several drawbacks.

The major limitations of online delivery include the following:

- push delivery with no interactivity,
- rigid schedules fixed by the sender,
- fixed viewing locations,
- fixed viewing devices,

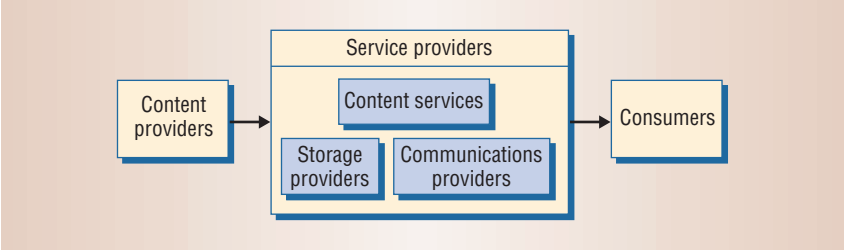

Figure 1. Content-utility system. The main entities include content providers, service providers, and consumers.

- fixed tariffs independent of actual usage, and
- fixed content not tailored to individual users.

Even pay-per-view and video-on-demand systems have several limitations.

The major disadvantages of offline, packaged content are

- the entire prepackaged content must be purchased, with no selective purchase of tracks or scenes allowed;
- the difficulty of transporting an entire collection makes it essentially nonportable; and
- the actual media use may be sporadic because the user seldom accesses the entire content, and a major portion of the content might be used only once.

These drawbacks stem from inherent rigidities in the delivery and consumption model, which its developers based on older technologies and infrastructures. Developers can now leverage emerging technologies and techniques to create a new model that provides content on demand to subscribers anytime, anywhere, for consumption on a selection of devices in a variety of modes supporting user-specified preferences.

CONTENT-UTILITY SYSTEM MODEL

Conventional electrical power or water supply utility systems have complex and capital-intensive mechanisms for generating, processing, storing, distributing, and sharing system resources. However, they hide their inherent complexities from the consumer. A traditional utility system can be characterized as offering availability, transparency, tamper-proof mechanisms, and fair billing.

The content-utility system we propose would have similar characteristics. Currently, no digital content-utility system incorporates this model.

System overview

Figure 1 shows the three main entities in our proposed content-utility system: *content providers*, *service providers*, and *consumers*.

The content providers are responsible for creating content, processing it to conform to certain formats, and developing the content metadata. The service providers conglomerate several distinct entities and facilitate effective and easy content consumption. These entities include *storage providers*, who, broadly, provide and manage content storage; *communications providers*, who transfer content over communications and data networks swiftly and seamlessly; and *content services*, which provide facilities for easy and effective content consumption. The *consumers* use a variety of devices for rendering the delivered content, including devices ranging from HDTV to cell phones.

Figure 2 shows the major operational outline of the process for providing content to consumers. The system first captures/generates the content. It then processes and packages the generated content (which involves editing, formatting, encoding, and so on), then stores it (after generating indices) for online access. It also incorporates appropriate content-protection mechanisms such as digital watermarking and encryption to prevent misuse at storage, during transmission, or during consumption. The system then delivers the content to consumers swiftly and economically, while taking into consideration consumer preferences.

Major subsystems

Our content-utility system model's major subsystems and their key functionalities include the following:

- *content management*—handles format conversions, performs content analysis for deriving metadata and providing protection;
- *storage management*—deals with issues such as placement and distribution of content on disks, request scheduling, cache management, and compression;
- *communications management*—determines the most efficient means of transmitting content over heterogeneous networks, channel coding, and managing quality-of-service parameters;
- *content services management*—provides a variety of basic and enhanced services;
- *digital rights management*—monitors the appropriate consumption of content per the usage rights specified in the license associated with the user and content;
- *user profile management*—maintains user profiles and preferences and facilitates customization of content and focused advertisements; and
- *billing and payment management*—addresses billing issues, tracks payments, and determines royalties for content creators and providers.

SYSTEM FEATURES

Our content-utility system model provides several significant benefits.

Content-consumption flexibility

Consumers can choose to view contents of interest at times and places they find suitable using a variety of viewing devices such as a TV, desktop computer monitor, laptop, PDA, or cell phone. Users can pause the programs at anytime, then resume viewing later from the same device and location or from a different one.

High interactivity

Consumers can have frequent and meaningful interactions with the content-utility system for a variety of purposes:

- requesting programs at certain times, at specific locations, and on certain devices;
- sending control signals to browse, play, stop, fast-forward, pause, and rewind;
- providing perceptual and content feedback on program quality;
- setting user preferences; and
- following up on advertisements of interest.

Relative reduction in data replication

Several factors will reduce data replication, including the availability of powerful, cost-effective services that offer customized content anytime and anywhere. On the other hand, the overhead of storing and managing huge amounts of content and the lack of services for local content will discourage local storage and greatly reduce local-content replication.

Content services

An important advantage of our proposed model is the availability of several services that enhance content usage and enrich the user's experience. These services, which generally are not available in content stored on personal media, include content directories and browsing, content-based query and search, and usage billing. Enhanced services include customized content delivery and viewing preferences, cross-referencing, and user-specified special effects.

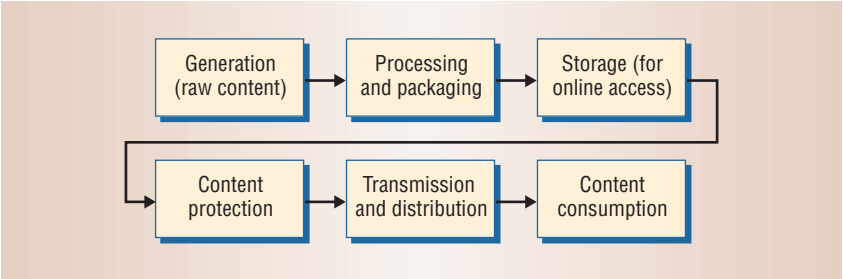

Figure 2. Major steps in the delivery of content from provider to consumer.

Minimal burden on consumers

In the model we propose, there may be little or no need for purchasing enormous amounts of packaged content because most of this data will be available on demand. This minimizes the need for storing and managing physical media and tracking specific items of interest such as audio tracks and video clips. As an added convenience, a user could program a virtual set-top box *universal interface* to manage the subscribed services, then periodically reprogram it to reflect upgrades or changes in service plans.

Cost amortization

Appropriate amortization results in significantly reducing the cost of content delivery and services. The perception of reasonable cost and fair billing for content use will be a significant factor in reducing piracy.

MAJOR ISSUES

A few of the major generic issues that must be addressed when providing content on demand and transparently are

- *storage management*—dealing with issues such as placing and distributing content on servers, I/O scheduling, content caching techniques, and supporting a variety of storage formats;
- *content indexing, query, and search*—deriving metadata and providing support for browsing and content-based queries and search; and
- *content transmission*—sending data over heterogeneous networks using different protocols and standards while adhering to various quality-of-service requirements.

Several of the major issues specific to the content-utility model that must be addressed follow.

Tariff structure

Like conventional utility systems, the tariff structure should be profitable to the various providers in the chain from production through consumption. At the same time, it should be fair and affordable for consumers.

The tariff structure must also be flexible and scalable to support newer devices, services, and content modes, since these will likely change rapidly. With enormous amounts of content available, it may be cheaper and more attractive for consumers to rent it than to own it. Therefore, content leasing and renting models must be developed.

Billing and payment

This system should support innovative pricing and payments such as micropayments. The payment mode could be prepaid, depending on the content and quality options; value-based, with a fixed price for the content; volume-based, with the price linked to the amount of content consumed; or subscription-based, with the price fixed regardless of the types and amount of content consumed.

Billing could be based partly on the amount of bits consumed so that, for example, a movie viewed on a cell phone would cost much less than one viewed on an HDTV system.

Content customization

Several content-customization schemes must be supported, such as delivery of content with user-created annotations, notes, remarks, ratings, and special effects, and maintenance and updates of user-created albums. Suitable tools for specifying and managing user profiles, and the means for actually customizing the content, also must be developed.

Digital rights management

A fair and robust digital rights management system must be developed. The system should support various modes of usage and granularities of content, provide specifications for suitable content usage rights, monitor content usage while respecting privacy issues, offer methods for establishing the authenticity of rendering devices, and provide methods for determining appropriate remuneration for content creators and providers.

Content protection and privacy

As content becomes more pervasive, several points of vulnerability will leave it open to misuse. Adequate protection mechanisms must be built in, without adding excessive costs. This requires developing appropriate policies and technologies. While deterring unauthorized users, these measures should also provide anonymity and privacy to legitimate consumers.

High availability

Because consumers now depend heavily on the online content available on demand, the content-utility system should have an availability level comparable to water and electrical utilities systems. This requires designing appropriate mechanisms for fault tolerance, graceful degradation, and quick recovery. In addition, the system should also ensure the content's integrity.

Technological advances and the convergence of computing, communications, and consumer electronics have begun to profoundly affect the delivery and consumption of content. This trend has fostered the need for a robust and scalable content-utility model that considers several dimensions, including technology, economics, and usability. ■

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