A Regional Broadcast-Centric Education System

Dr. Hisham El-Shishiny, Senior Project Scientist
Technology Group, Arabic Competence Center
IBM Egypt and Middle East

Dr. Miriam J. Masullo, RSM
Thomas J. Watson Research Center
IBM Research Division, US

Dr. Antonio Ruiz, Director
Telecommunications and Media ISU
IBM Corporation, US

IEEE Symposium on Computers and Communications
Alexandria, Egypt
July 1-3, 1997
ISCC'97

Abstract

In this paper we argue that a *broadcast-centric* solution can be enabled to provide educational services, in particular distance learning, to an entire region. This solution can provide equity access to resources for all schools in a large region, or access for undergraduates and postgraduates students to an open regional university. The approach described includes a combination of broadcast delivery and local redistribution of content and/or direct and interactive access to the content over the broadcast infrastructure. It requires that special consideration be given to the organization of content for distribution in this manner; therefore those issues are discussed. Enabling technologies are described.

Introduction

Education, as a public institution, is being redefined by technology access. There is growing consensus about the value of digital libraries of educational multimedia content [1], especially to reach populations in regions that have limited access to quantity and quality content. For these resources to be of value, teachers and students must be able to reach it. A regional Digital Library would provide needed content, a common language, and a central location for coordination of services. A regional education infrastructure for equity access is also needed and must be coordinated with the development of the Digital Library.

Digital broadcast networks, as implemented in direct broadcast satellite (DBS) [2], hybrid fiber coax (HFC) networks, and wireless terrestrial broadcast networks, are being used for delivery of digital compressed video. The emergence of the digital video broadcast (DVB) standard has added capabilities for near video on-demand (NVOD), time delay broadcast, real-time and non-real-time transactions. But applications enabled by these technologies are limited to a download model, or require a return channel for direct interactivity.

More recently, the *data carousel model* where data is cyclically repeated in the broadcast for immediate use has been proposed to support direct interactivity in the DBS medium for educational applications [3]. New regional solutions can be enabled with this approach to provide, in particular, equity access to digital libraries from schools and homes where there is limited infrastructure or no infrastructure at all. They can also be deployed to provide more cost

effective access for these users. Such a solution holds great promise to improve technology-based education infrastructure rapidly and uniformly. Content development for this environment does require special consideration, but much developed content in the form of educational videos, and Web pages can be re-deployed for this purpose. Since the satellite headend is the focal point for transmission of content in the DBS approach, centers can be designated regionally to coordinate services and applications and to aggregate and organize content.

These large-scale regional solutions (infrastructures) could answer such important research questions as:

- ✓ How can we truly bridge the gap between poor and remote schools with those in economically and geographically well-established areas?
- ✓ What architectures will best support communications and collaboration, as well as provide equitable access to sources of content (digital libraries) for all students?
- ✓ How can we expand the role of libraries and museums in order to organize and disseminate their content across the infrastructure and integrate it with curriculum?
- ✓ How can the different distance learning solutions available integrate coherently with content development?
- ✓ Given the huge acceptance of television, how can we integrate its use with formal education?

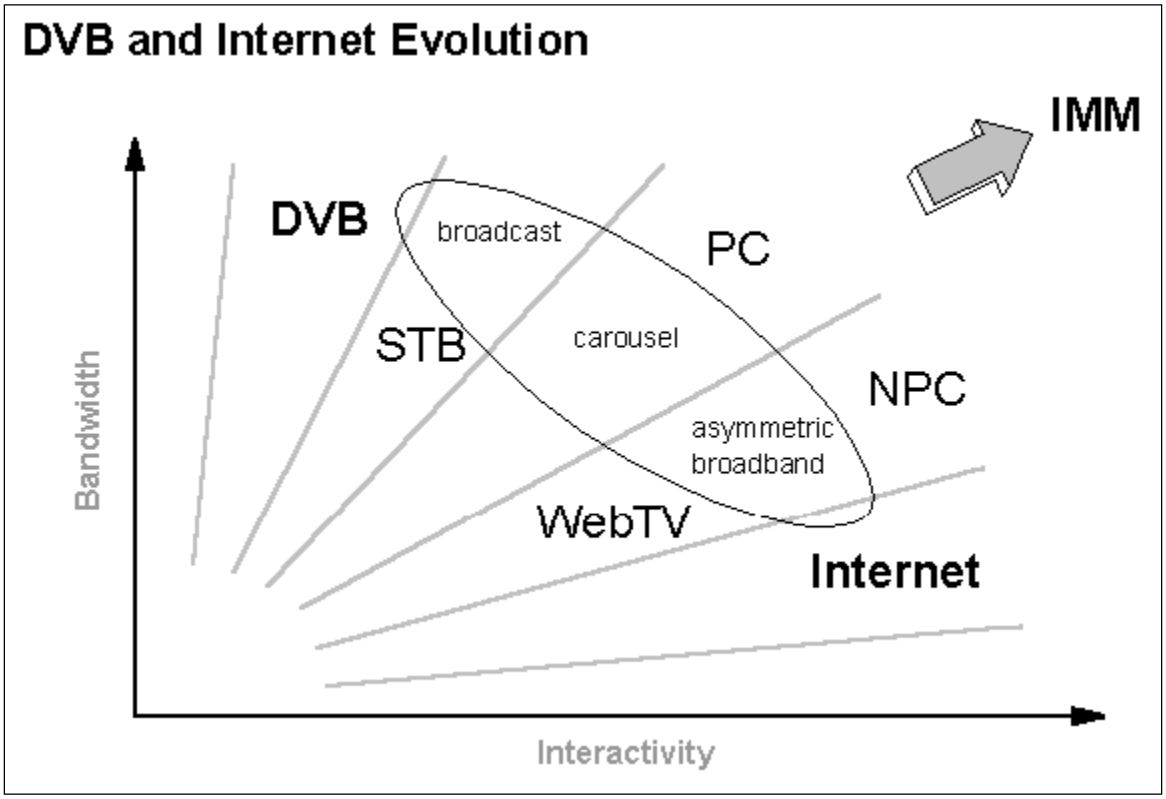

Figure 1. Internet and DVS evolution towards interactive multimedia

Motivation

Internet deployment, based on the point-to-point connectivity model with high interactivity and low-bandwidth delivery of content is limiting. In particular, remote areas and underprivileged areas will have less access time and receive poorer content (mostly text). In the meantime, DBS access in the DirecTV (TM by Hughes Corporation), meant to reach areas not covered by cable television, is a digital broadcast medium, mostly used for the delivery of multiple digitally compressed video streams. Further deployments of DirectPC (TM by Hughes Corporation) also make the digital broadcast medium suitable for software and data downloading.

Elements of the Solution

The Internet can be defined in terms of these fundamental elements:

- ✓ A networked infrastructure
- ✓ A set of transport protocols (TCP/IP and HTTP)
- ✓ A content development approach (HTML plus GIF, MPEG, etc.)
- ✓ A content organization approach in the form of World Wide Web pages

Interactivity, on the other hand, can be defined in terms of:

- ✓ Choice of content
- ✓ Transaction capabilities
- ✓ Hyperlinking to other choices and transactions

Interactive applications in education have evolved from:

- ✓ Standalone
- ✓ To networked multimedia
- ✓ To digital libraries

We can trace this evolution in the way developed content is adapted. In each case content and content development changes form and in each case the benefits to education are defined by the success of the approach in *reaching* and then *engaging* the student. These are the hallmarks of educational technology, and our principal goals.

All these "elements" can be combined to create a solution for education that deployed on national or regional scales becomes a dedicated *education infrastructure*. The key elements of that solution are then related to:

1. The network
2. The content
3. The client (access) devices

Education Infrastructure Solution: The Network

The broadcast-centric model deploys the DVB standard as the most progressive solution, consistent with common technical specifications for the following:

- ✓ Uses of the MPEG transport stream multiplex
- ✓ Content deployment and information services
- ✓ Common forward error correction
- ✓ Common scrambling
- ✓ Conditional access

DVB satellite services are currently deployed and being used in all continents. DVB cable services have been operational in Europe and Australia since 1995. A single DVB standard has the potential of resolving the division among NTSC, PAL, SECAM and MAX. These advantages make a DVB-based broadcast-centric solution a good candidate for consistent global deployment. DBS cable and wireless are all networks that can enable the broadcast-centric solution.

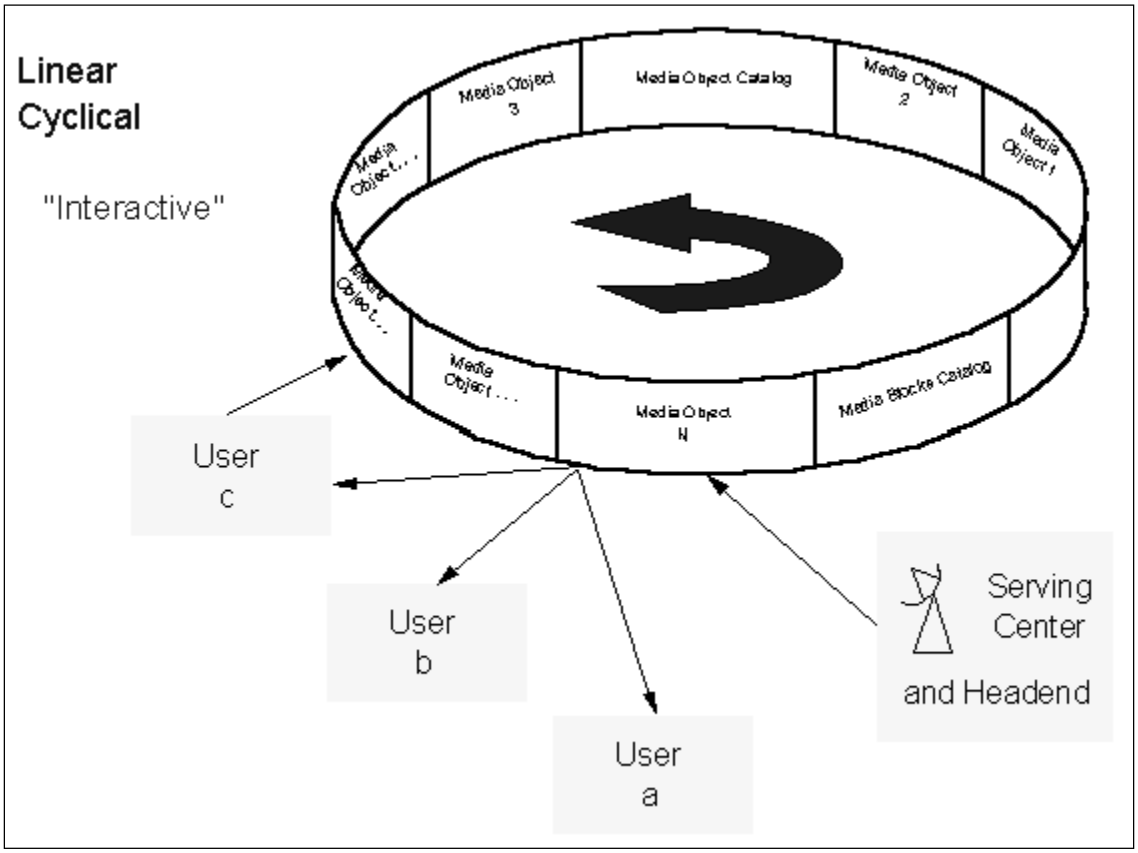

Figure 2. Transactions in the interactive data carousel approach are handled at the user end and serviced at the point in time when the broadcast reaches the desired object

More recently, this same standard has been enhanced for the distribution of information such as multimedia and other data content. Digital Data Broadcast (DDB) is an IBM solution for the delivery of information using a broadcast system and DVB headend and clients. The key feature of DDB is the use of *carousels of information* that rotate updated or scheduled information, very much like a "disk in the sky", which is received by the end user playing or receiving device for immediate or delayed playback. Because of the high-speed data broadcast capability (30 megabits/second), the user will experience "apparent interactivity" without the need for a

dedicated return channel. Local user interactions (with the PC or TV) are responsible for extracting the desired data segment from the carousel, not transmission sequence. The transmission is linear and cyclical in nature, supporting this form of interactivity.

Access to DVB from a TV requires a Digital Set Top Box (Digital STB). The scope of the application programs can range from mainly text with simple graphics to rich multimedia depending upon the capabilities of the DSTB. A PC is in that sense, less limiting, of course. Web or any other source of content that are either TV or PC oriented can be prepared and reused for access in this way. This provides a "Web-TV" like solution through the DVB system, by-passing the bottleneck of the Internet. In addition, the investment required by a school can be as low as a single PC or TV with a digital set-top box. This makes the infrastructure feasible and physically accessible to students anywhere, even from their homes.

The following describes the delivery options available to the broadcast-centric model:

	DBS	Internet	
Stand-Alone PC or TV Client	✓		A single stand-alone PC or TV client with access only to DBS
Stand-Alone PC or TV Client	✓	✓	A single PC or TV client with access to both DBS and the Internet
Gateway Server to Intranet	✓		A PC or other Gateway/Server connected to DBS enabling an intranet
Gateway Server to Intranet	✓	✓	A PC or other Gateway/Server connected to both DBS and the Internet and intranet

Figure. 3 Solution options available

Two types of content access services are identified for these options:

- ✓ Interactive applications that do not require a return channel
- ✓ Transaction oriented applications that require off-line or on-line return channel capabilities

Interactive applications that do not require a return channel include educational video enhanced with interactive home page (like) content of a curricular nature. Particular functionality can be built into these applications, for deployment over the digital broadcast medium, in specific ways. Choice over the content selected, by a given user, at a given time, from what is being broadcasted, as well as transaction (interactivity) functions over the content is possible.

Broadcasted content is scheduled or requested a-priori by the school for a given time span during which the materials are made available over the carousel. These time spans can correspond to curriculum plans, courses, or geographic locations.

Education Infrastructure Solution: The Content

The use of interactive multimedia in education is in evolution [4]. Development of new digital libraries presents an opportunity to reorganize and redeploy large amounts of developed content for dissemination via an education infrastructure. But, because the way in which content is represented and disseminated affects the way in which it would be best organized [5]; this education infrastructure would require special preparation of the content. Digital libraries change the representation method from physical documents and analog tapes, for example, to digital files stored in a computer (atoms to bits) [6]. Communications infrastructures determine the method of dissemination. In a technology-driven education infrastructure both the representation and the dissemination approaches affect our current base of prepared content. It is labor intensive to move content from physical to digital form. It must be digitized or encoded. Once in digital form it can be accessed directly via a network, or combined with other classes of content to create multimedia folders or Web pages. Authoring of interactive multimedia is also labor intensive, and requires additional specialized tools, such as IconAuthor, or ToolBook. Web page development using HTML is not effortless either. A fair amount of design and development is needed to create interactive, hyperlinked home pages. A lot of development effort is being directed to creating these classes of content.

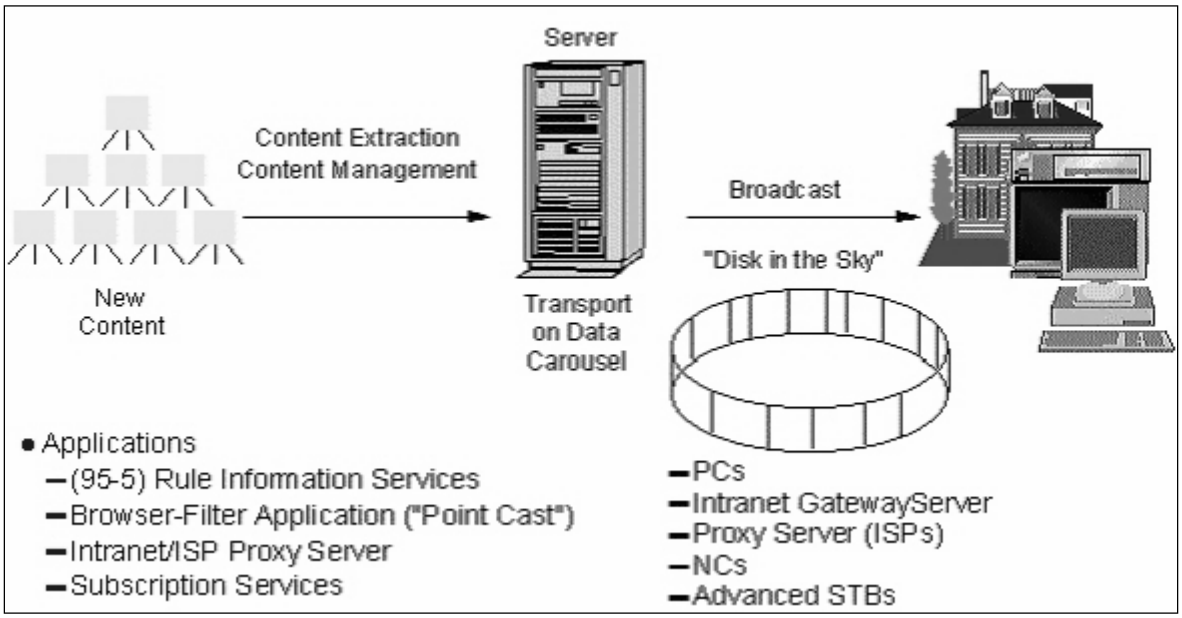

Figure 4. Content extraction and interactive data carousel applications

While there exists a vast amount of developed content, both in physical form (books, tapes, etc.) and digital form (Web pages, CD-ROMs), moving to a distributed network approach (infrastructure) would require adaptation of content forms. Development of content in both these forms proceeds at a fast pace, in addition to the already accumulated content. These are materials organized to be disseminated in the form of publications, or via the standard broadcast medium. Recognizing that quality is an issue in any case, there is no reason why these materials cannot be leveraged for dissemination via an education infrastructure. Technologies that have come to be called digital libraries, such as imaging and encoding, can be applied to prepared books and videos for the infrastructure [7]. However, it is likely that neither class can be applied

directly. The preparation will be different, driven by different requirements for content organization. This is a serious consideration because of the time and resources spent in creating materials in those currently popular and useful forms.

Using the DVB for digital broadcasting it is possible to deploy not only digital compressed video but also, in the same manner, other forms of information extracted from home pages currently on the Internet. These data objects can be prepared in HTML or other forms, but are limited to the kind of interactivity provided by the broadcasted carousel and cannot be used to openly "surf" the Web. For the broadcast-centric solution both digital and non-digital developed content can be reused and applied depending on the client device used to exploit it. The two models considered are the TV and the PC. The nature of the medium makes full use of the characteristics associated with the client devices (TV or PC).

Education Infrastructure Solution: Client Devices

TV users "request" materials (i.e., select channels) with a remote control, and do not wait minutes for content to be downloaded. A linear, but cyclical, content broadcast approach combine with the appropriate content organization model for this purpose, makes the content continuously accessible on-demand, during the timeframe of the broadcast. This approach results in the delivery quality and response that users expect of broadcast TV, and with the "apparent interactivity" mode of the carousel. For most parts of the world it will also result in faster turn around of content than from the Internet.

The same data carousel model with multimedia media (i.e., images, clips, etc.) and data objects (for example, metadata that indexes the media objects) may be delivered to PCs in the same manner. The processing power of a PC makes deployment simpler at the local level, but the same limitations would exist if there were no return channel. That is, the PC user experiences apparent interactivity with designated content, but cannot openly surf the existing Web, only that subset which is being broadcasted.

Users in sites, such as a home, where there is no download capacity in terms of local storage, can access content for immediate use. Remotely located schools with no connectivity can use the carousel model in this fashion or for caching and then processing content at any time. The model can, more generally, be deployed for broadcast, multicast and PointCast delivery, and also for delivery to gateway servers (such as ISP Internet service provider), cache servers and Internet proxy servers. Using the data carousel, we are able to take the digital broadcast solution beyond the limitations of the download model.

Summary and Conclusions

A broadcast-centric infrastructure solution is proposed to address some of the current infrastructure limitations imposed by the Internet and standard broadcast solutions. The advantage of this solution is that it can work together with the Internet or other network, or can be deployed stand-alone in a variety of configurations for all access environments and cost models. The solution is based on currently available technology and can leverage already developed content. Special consideration must be given to the way in which the content is organized and presented to the end-user.

Another consideration, with the region in mind, is the huge interest that exists in broadcast television. A 1994 survey indicated that the number of households that have TVs in the Middle East is estimated to be 50 million. The survey furthers indicates that 93% of the populations of Egypt follows TV programs; and about 2/3 of that population follow the programs daily.

This form of distance learning can be well adapted to the interests of the populations at large and provide access for undergraduates and postgraduates to a virtual open university on a regional level. In the Middle East for example, ArabSat and NileSat satellites (soon to be launched) can be used to distribute the multimedia educational materials throughout the Middle East. Open learning distribution may thus become a feasible possibility based on these new satellites services, especially in the absence of a wired networked infrastructure in the region. The common language, in this case Arabic, and the existence of a regional organization such as the Arab League, lend well to central coordination of educational services on regional basis.

This example illustrates how the region, as the organizing unit of educational services, is both a culturally and educationally sound approach, as well as a technically feasible solution based on broadcast-centric information services. The principal advantage of this solution is in its potential for equalizing access to, in this case, educational resources, for potentially all regions of the world. And while doing so make use of the worldwide acceptance and familiarity with the broadcast medium. A broadcast-centric solution for regionally based education infrastructure with respect to *equity access, quality content* and *cost effectiveness* is the most realistic point of departure for these kinds of initiatives.

References

1. Masullo, M.J., "Infrastructure, Education and Digital Libraries", *Conference on Advanced Technology in Education*, Cairo, Egypt, March 1996.
2. Alpert, M.S., De Sonne, M.L., *DBS: The Time is Now*, National Association of Broadcasters, Washington, D.C., USA, 1994
3. Ruiz, A., Masullo, M.J., "A Universal and Global Education Infrastructure", *UNESCO World Congress* Moscow, Russia, July 1996.
4. Mack, R., Masullo, M.J., Meyer, J., "Educational Multimedia: Perspectives in Evolution", IBM Research Report, New York, USA, 1997 (in press).
5. Masullo, M.J., Calo, S., Nguyen, T., Willner, B., "Multimedia On-Demand and the Organization of Education Systems", *Proceedings of IFIP WG 3.2 Conference on University Uses of Visualization*, University of California at Irvine, Irvine, California, USA, Elsevier Science Publishers B.V., July 1993.
6. Negroponte, N., Knopf, New York, USA, 1995.
7. Masullo, M.J., Mack, R., "The Role of Digital Libraries in K-12 Education", *D-Lib Magazine*, Reston, USA, September 1996.