IN-HOME INTELLIGENCE FOR INTERACTIVITY

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ABSTRACT

Set-tops have played a critical role in providing entertainment to the home in the cable industry. As the advent of advanced technology has created an opportunity to provide additional services to consumers, the need for a fully integrated two-way network to support these services has arisen. The issue of intelligence in the system is a key element of interactivity, and one which has been at the center of a great deal of debate.

This paper will look at the various components of the two-way network and will focus on the advantages of placing intelligence in the home to provide interactivity. The data communication network will be presented, along with the technology required to enable all levels of interactivity in the home. The potential interactive services will also be covered, with focus on introducing interactivity in the analog environment and migrating to the digital environment.

INTRODUCTION

The race to evolve the information highway from a one-way broadcast oriented network to a two-way interactive infobahn has begun. Fueled by the ongoing improvements in fiber optic technology, the advent of cost effective, high quality digital compression technology, and the reduction in the costs of computing power and graphics, the movement to the information superhighway has gained significant momentum. As a result, the broadband "cable" network has moved to center stage and decisions made today about what technology to deploy will have significant ramifications for years to come. While few people believe this evolution will occur overnight, the failure to recognize and respond to this paradigm change now will be tantamount to standing at the dock after the boat has left.

Because there are many divergent forces pulling the interactivity movement in different directions, the evolution path is not crystal clear. Tests are being conducted in various markets throughout the world in an attempt to find the "holy grail", the ideal compilation of on-line, off-line, and home control applications. Many of the tests are approaching the situation from the marketing standpoint of searching for the "killer application", but no one has yet to find it (if one exists at all).

This paper will also focus on issues surrounding the evolution to interactivity and the requirements of the network and in-home technology. A brief summary of the network topology will be given, followed by a discussion of digital compression technology. The focus will then turn to the use of computing power in a distributed intelligence architecture as a means to provide the level of support for interactivity with the TV. While the essence of the paper will be on interactivity with the TV, many of the concepts also apply in multimedia to the PC.

NETWORK ARCHITECTURE

Traditional networks constructed over the past several years have been designed and built to serve current levels of programming, that is a one-way broadcast delivery of entertainment services to the home. This typically entailed the use of some fiber optic technology in a backbone configuration coupled with a standard coaxial based distribution network. While the economic benefits of this approach were quickly evident to network operators, long-term architectural growth capability was not provided. Expanding beyond this level of fiber optic utilization typically required a major rebuild due to the need to splice fiber and relocate distribution amplifiers.

As operators began to look at the potential for adding new revenue generating services such as two-way impulse pay per view, a new architecture took hold. This type of distribution network , commonly known as Fiber -to-the-Feeder (FTF), provided the reduced node sizes necessary to effectively carry data upstream in a sub-split system. While the cost of such an approach could exceed the traditional network costs by 10 - 20 %, the long-term benefits in flexibility justified the additional investment. It also required the network could be rebuilt only one time, with an easy migration path to a more advanced network.

A number of FTF architectures have been proposed, each with its trade-offs between cost and flexibility. One such approach, known as the Broadband Telecommunications Architecture (BTA), enables the system to be designed for further segmentation by strategically placing the node locations initially and laying enough dark fibers to handle the potential traffic in the future (see figures 1 & 2). As the traffic volume from the two-way interactive services grows, the BTA system can be segmented further by reducing the node size both downstream and upstream. Node sizes down to 500 homes downstream and 125 homes upstream can easily be facilitated to ensure no contention on the network, regardless of the type or level of services available.

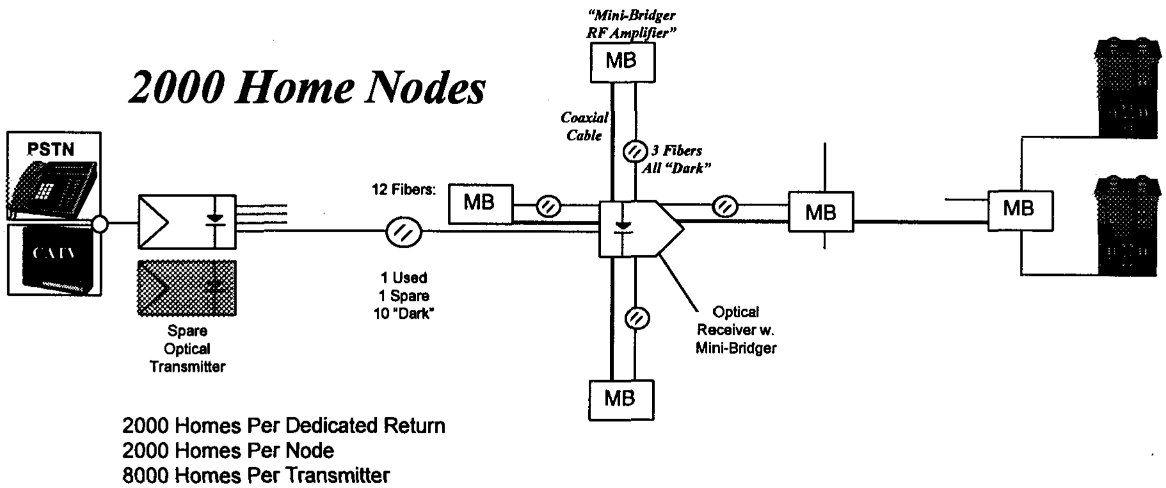

Figure 1 - BTA Stage I

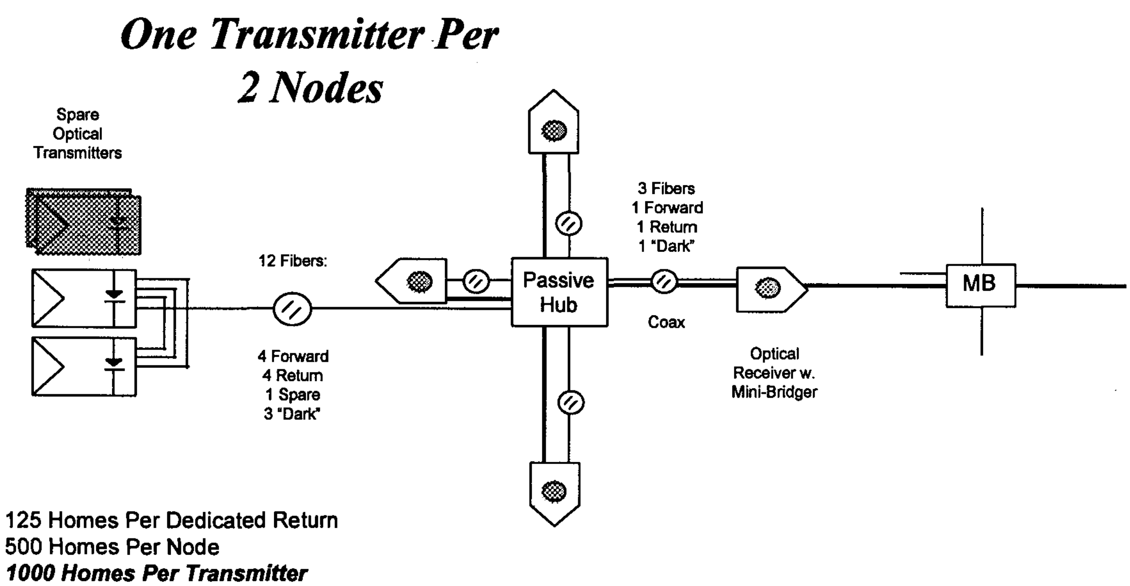

Figure 2 - BTA Stage V

By reconfiguring the network, the evolution to a full range of interactive services can be facilitated. When analyzing the requirements of interactivity, it is useful to develop a system for categorizing them. For simplicity, four types of interactivity have been defined. Type one interactivity is broadcast in nature and requires no upstream signaling. Basic applications such as electronic program guides fall into this category. Type two interactivity adds a non real-time upstream path (14/64 Kbps) for the collection of purchase data on impulse pay per view and impulse home shopping.

Type three interactivity introduces the concept of a client / server network, but still in an asymmetric environment. This requires real-time signaling downstream (1.5 Mbps) and upstream (64 Kbps) and intelligence at both ends of the network. Movies and information on-demand are examples of this level. The final level of interactivity adds the dimension of symmetry to the network as is found in telephony and video telephony. The complications of supporting this level of service will not be fully addressed in this paper in order to maintain the focus on more near-term applications, but in general they represent a more complex overlay of level three interactivity.

DIGITAL COMPRESSION

While the development of the network architecture will facilitate growth in interactive services, the advent of digital compression provides the high quality, bandwidth efficient transmission method necessary to carry all the video, audio, and data information to the consumer. Digital compression is not a necessary element for basic interactivity, but it provides a robust structure to facilitate the vast array of advanced level three services such as information on demand and downloaded video games.

Digital compression offers the benefits of bandwidth efficiency (2 - 10 programs per channel), along with CD quality digital audio and several high speed data pipes per channel. Real-time on-demand interactivity requires the ability to retrieve and playback information as required from a central server. With the use of digital compression technology for storage of the entertainment and information programming, true video on demand becomes feasible. These massive storage banks of information servers will enable the consumer to gain control of a virtual channel and simulate the point to point communication found on telephone networks, but at significantly higher speeds.

COMPUTING TECHNOLOGY

The third element in building the interactivity infrastructure, computing power and advanced graphics, has benefited from the rapid acceleration in the PC industry cost curve. Questions have been raised, however, regarding the need for advanced in-home intelligence. Several proponents have proposed a centralized intelligence network only, with only "dumb" data modems in the home for communication purposes. While this model appears more cost effective at first glance, a balanced approach between in-home and central intelligence offers the best long-term solution.

By examining the usage patterns across the network, the proper balance becomes evident. The first application evident to the user is the navigator, or user interface to the system. Because this service is likely to be accessed by many people simultaneously, at least a portion of the functionality must be maintained within the set-top to minimize the impact of the network. The need to wait for the set-top to "boot up" this application will not be tolerated by the consumer.

As the level of functionality expands beyond basic interactivity, this level of client/server balance continues to be critical. For example, it is not economical for a consumer to store a complete movie within their home (>1 GIGA byte). Therefore, in this application, only the navigator for the VOD service would be stored locally, while the movie itself is playing real-time on the network.

Games represent another area where a balance in intelligence between the client and server is critical Video graphics and processing technology is becoming more economical, but with the advent of 32 bit games, too much memory will be required in the home to store an entire game. Therefore, it is likely that a portion of the game will be downloaded to the set-top. As the user progresses through the various levels of the game, different portions will be downloaded transparent to the user, thereby eliminating any of the latency concerns on the network.

SET-TOP EVOLUTION

Traditionally, the set-top served as a device to enable access to a variety of broadcast services and limited two-way services such as PPV. High speed computing power and advanced graphics were elements of the PC environment and not the TV entertainment environment because the costs were too significant to justify the investment by the consumer and the typical applications did not require such capabilities. By coupling this technology with video from a digital compression network, however, consumers can now have access to a vast array of applications, from level one to level four.

Because virtually none of the services envisioned on this information superhighway have a proven track record, the capital required at both ends of the client / server network for mass deployment cannot be justified today. Therefore, the need for a proper architecture in the set-top from initial deployment is mandatory. To handle this requirement of multiple featured set-top products in the same system, a modular approach to the design of the set-top is mandatory. By developing a basic platform, both for the analog product as well as the digital product, and then enabling a PC technology upgrade module, the set-top can continue to grow and cost effectively change as various applications justify the incremental capital costs.

COMPUVERTER APPROACH

The CompuVerter combines the low cost analog and digital set-top platforms with a family of computer technology upgrade modules (see figure 3). The basic platform contains expanded bandwidth tuning (1 GHz), bit mapped on-screen display graphics, expanded two-way communication and navigation systems, network security, and digital compression The modular interactivity upgrade then adds the high capability processor, an optimized graphics subsystem for video games, synthesized speech, downloadable operating system(s) and applications, and an interface to in-home peripherals, both wired and wireless.

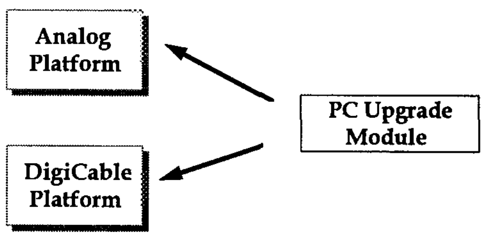

Figure 3 - CompuVerter Platforms

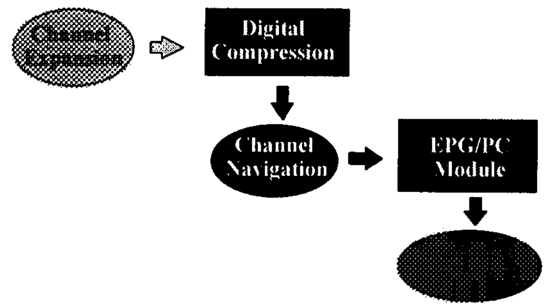

Figure 4 - Technology Evolution

The CompuVerter enables a vast array of interactive applications to be provided to the consumer, from the basic one-way broadcast type through the full client / server interaction type. Services likely to be provided on the network initially include a navigational gateway combining live video and sophisticated graphics, augmented video programming such as play-along games, enhanced home shopping (virtual shopping malls), information and video on demand, and downloaded video games.

The rollout of the CompuVerter in the network will clearly be driven by the need for advanced capability. Most people agree the initial application will be a navigator, probably starting in the form of an electronic program guide. With the proper planning, however, the intelligence in the home for the guide can also serve as the basis for other interactivity By coupling this with the basic type 3 applications such as VOD, an economic justification for in-home intelligence can be made (see figure 4)..

CLIENT / SERVER NETWORK

The CompuVerter will serve as the foundation of the client / server network for interactivity. Several other elements of the distributed intelligence architecture are the servers, switching devices, network controllers, and downstream data generators. The following diagram outlines the logical connection of these various devices in the network.

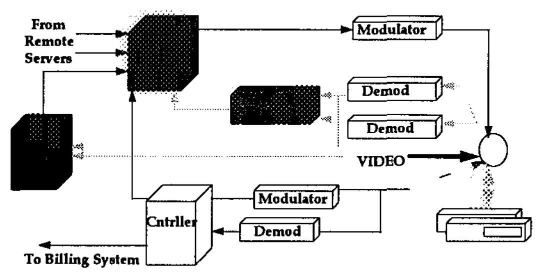

Figure 5 - Interactive Network

While this paper does not cover the functionality of each device in detail, it is important to realize the complexity of the headend interfaces in the client/ server environment. In order to facilitate seamless interactivity to the consumer, network control management is critical. More intelligence in the home will alleviate some of these issues, but the timing considerations between the set-top and headend will demand a fully integrated network.

CONCLUSIONS

The race toward the interactive world has begun. While some people have stated this will be a revolution, the technology required has already begun to be deployed in a more cost-effective evolutionary path. First, fiber rich architectures such as the BTA lay the foundation for the level of traffic which will be found on the highway. To efficiently carry the information to and from the home, a digital compression system will provide the ideal vehicle. When coupled with advanced graphics and processing technology from the PC industry in a client / server architecture, basic applications will be transformed to sophisticated multimedia environments.

The in-home component of the network will turn out to be the most critical element. With the modular design of the CompuVerter, a portion of the capital investment decision can be postponed until real market data on consumer demands can be assessed. The need for an intelligent in-home component of the network is more critical than ever in an interactive world due to the need to ensure flexibility, security, and growth. The CompuVerter provides such capability in a cost effective approach without limiting the potential for future applications. It also enables the entry into interactivity in an analog world and the growth in the digital world of the future.