NETWORK COMPATIBLE ARCHITECTURES

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Abstract

In recent years, fiber optic transportation equipment has caused the CATV industry to rethink traditional system architectures and service delivery methods. With digital compression in an explosive development phase and 1 GHz bandwidths rapidly becoming a reality, we are once again re-evaluating architectures and service delivery methods.

In this paper we will take a look at some of the techniques we can use today to make use of Network Compatible Architectures. These NCAs will allow for customer- and capital-friendly system upgrades in the future at the expense of a little pre-planning today.

INTRODUCTION

Having a Plan

The future for communication networks is bright. The emergence of fiber optics and the inevitability of HDTV, digital compression, PCN, Near-Video-On-Demand and more will help insure that bright future. As we look at our networks today, we have begun to ask ourselves if we are prepared for that future. Do we have a plan? In the following pages, this paper will try to provide some thoughts and guidelines for preparing this plan to attain network architectures compatible with the services and technologies of tomorrow.

DESIGN CONSIDERATIONS

System Demographics

As we begin to formulate our plan for the future, it's always a good idea to know where we are today. What are the system demographics? Total homes and homes per mile; Architectures will vary significantly depending on whether you have 40 homes per mile or 240 homes per mile. Ethnic diversity; If your market is segmented in such a manner that the primary language or language of preference is not English, then special segmented delivery may be of special concern. Occupational diversity; Not so much whether or not you are providing service to a blue collar or a white collar worker, but whether you service single family dwellings, private campuses (educational and industrial), or local institutions (business and governmental). Viewing diversity; Covers the types of programs and the number of channels necessary to carry them.

Existing System

Next, an inventory should be compiled on the equipment that is currently in the network and how it is configured. Most systems will consist of a variety of operational bandwidths and amplifier technologies. Understanding what is reusable in the network upgrade and what components can be brokered is important because these components can represent up to 10% of the network rebuild costs. The existing network architecture should also be reviewed (in most cases today it will be a tree and branch network) and as-built maps should be verified.

Future Network Requirements

Now that we know where we are, we can need to understand where we want to be. And, where we want to be may consist of several phases or stops. Start by reviewing the system demographics and determining whether or not you are providing the necessary services and communication conduits to the proper areas. Understand the application and impact technologies such as fiber optics, HDTV, interdiction and digital compression. Ask questions about how services such as near-video-on-demand, distance learning, inter- and intra-campus communication, alternate access and PCN can be integrated into a network.

Implementation Requirements

Define project implementation phases. The existing system may be 12 years old, use P3 cable, a combination of 330 and 450 MHz equipment, and provide 32 channels of basic programming and three premium services. Phase I of the project might expand the network to 550 MHz bandwidth and interdiction capabilities and at the same time provide for data communications between local bank branches and intra-campus data, voice, and video communication for a local business. Phase II of the project might call for the bandwidth expansion to 750 MHz and digital compression with HDTV, near-video-on-demand (NVOD) and PCN services. The portion of the band between 450 and 750 MHz will provide for the digital services while the band below 450 MHz will maintain its analog format. Further, existing cable and strand is to be used wherever possible to help contain costs and Phase II implementation should not require major construction efforts. A further requirement would call for existing bridger locations to be maintained.

Required Network Performance

Define the technical performance requirements of the network and how they will apply to each phase of the project. Phase I may require a 46 dB CNR, with distortions of greater than 53 dBc CTB, 53 dBc CSO, and 50 dBc Xmod with tap levels of 15 dBmV. Phase II of the project will call for a 48 dB CNR for analog programming, 43 dB for digital programming, distortions as in Phase I and tap levels of 15 dBmV. Service areas for Phase II may not exceed 2400 passings which should allow for the implementation NVOD and PCN. Note that tap levels do not have to change between Phase I and II even though the bandwidth expands since the digital signals will be more tolerant of a lower carrier-to-noise ratio.

Network Implementation

With the existing network defined and the requirements understood, we can now design a network that brings the two together. Experience has shown us that the design process will require us to begin with the 750 MHz design both coaxial and fiber and then "underlay" the 550 MHz design. This will hold true whether we are using fiber-to-the-feeder (FTF), fiber backbone, cable-area-networks (CAN), or traditional coaxial architectures. This is extremely important to do if costs incurred between Phases I and II are to be maintained. Many networks will be a hybrid of several of these design techniques.

Figure 1a shows an example of how the 550 MHz trunk design with future 750 MHz expansion capabilities might be implemented. This particular area has densities of 50 homes per mile. The 550 MHz fiber nodes will always be co-located at a 750 MHz node. This leads to a design which is less than optimal at 550 MHz from a spacing standpoint but it is more than compensated by the ease at which 750 MHz is implemented.

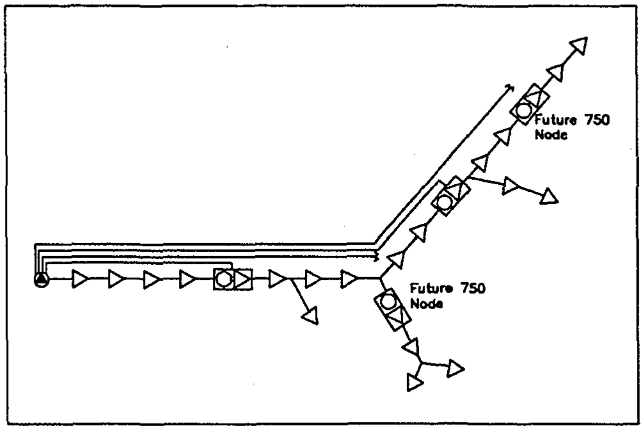

Figure 1a.
550 MHz CAN, 750 MHz FBB Ready

Figure 2a is an example of the distribution design architecture which makes use of a combination of trunk, network, and line extender amplifiers. Again, amplifier locations are optimized for their 750 MHz performance which detracts from the 550 efficiencies but is eventually recovered at the time of the 750 MHz upgrade.

Figures 1b and 2b show the final 750 MHz design implementations of the 550 MHz areas. In the backbone architectures the 750 and 550 MHz bridger locations are maintained at the original 330 MHz locations. The additional 750 MHz fiber nodes are added, trunk network amplifiers extend reach between original bridger locations, and where necessary trunk station signal flow is reversed through a module upgrade.

Actual network implementation methods now need to be considered. Consideration as to whether or not the fiber for 750 operation is placed in the system during Phase I or Phase II construction, whether or not 750 MHz or 550 MHz amplifiers are initially installed. The development of network amplifiers, also known as distribution amps, mini-trunks or mini-bridgers, has helped provided valuable design tools to extend nodal reach while at the same time reducing active counts and improving network

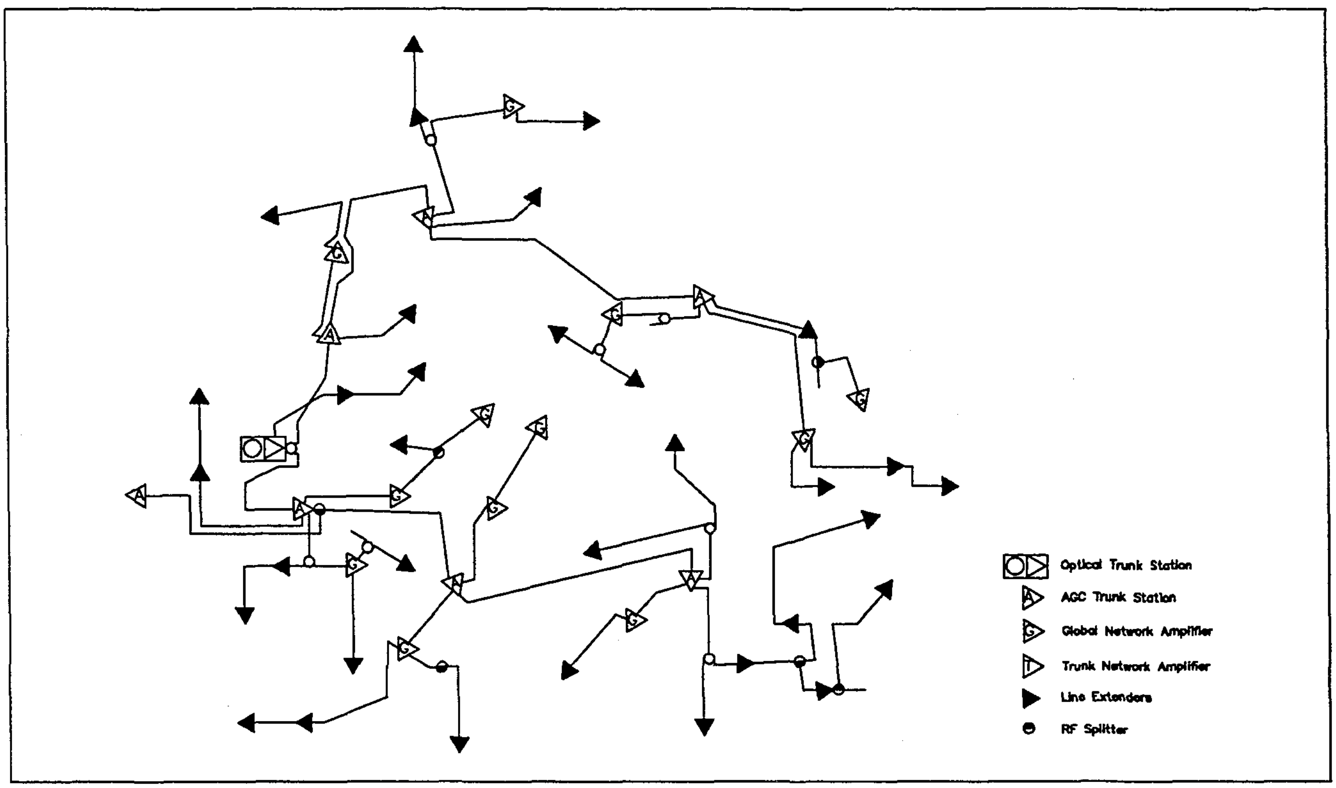

Figure 2a.

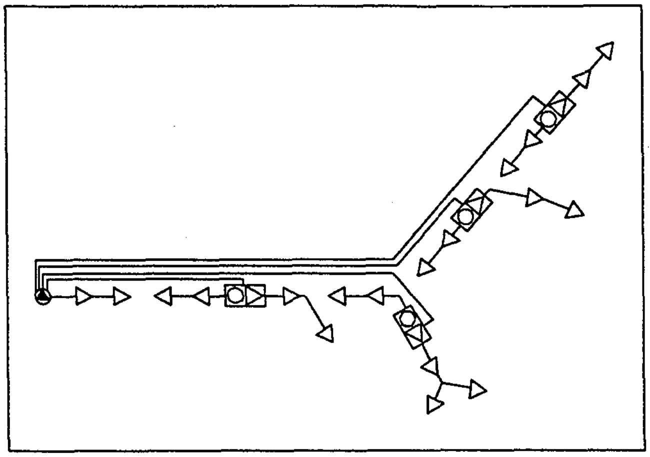

Figure 1b.
750 MHz Fiber Backbone Expanded From

reliability. Today, most operators would opt to place the extra glass and wait until the 750 MHz amplifier technology matures. A year from now, costs may dictate that the 750 MHz amplifiers also be installed as part of Phase I with operation to 550 MHz.

Tables 1 and 2 show some of the possible cost combinations that might be considered for the implementation of the two sample topologies. The first cost column represents a scenario where the system will be designed to 750 MHz but the fiber and RF electronics will only be installed for 550 MHz operation. All of the fiber will be installed but only the nodes required for 550 MHz operation will be installed. The second column represents the costs of upgrading that 550 MHz plant to full 750 MHz operation. The final column shows the costs of building the system with 750 MHz operational capabilities from the onset. Tables similar to this are useful in the process of deciding when and where to make network investments.

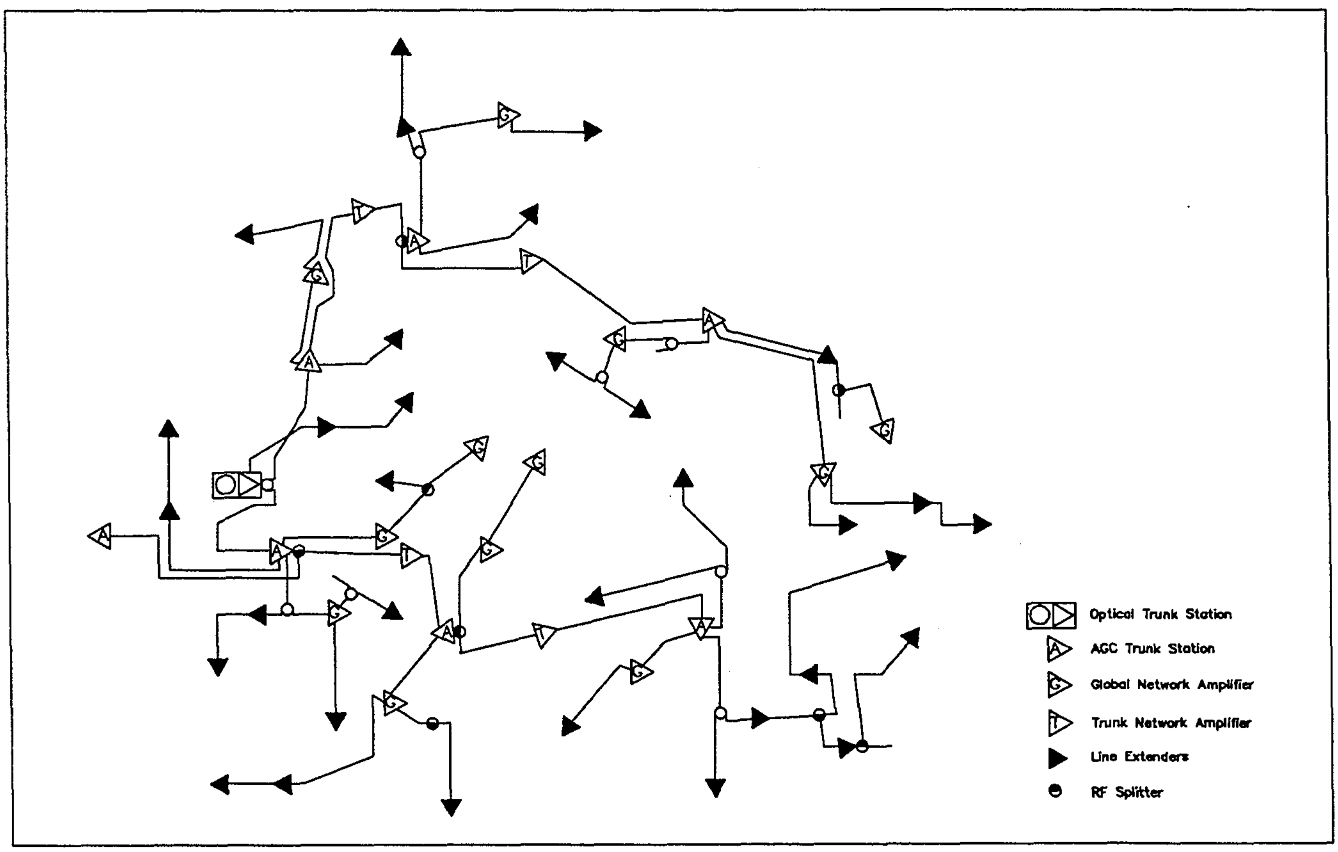

Figure 2b.

Table 1.
FTF Upgrade Cost Analysis

	550 FTF 750 DESIGN 550 ELECTRONICS	750 FTF UPGRADED FROM 550 FTF	750 FTF 750 DESIGN 750 ELECTRONICS
Fiber ($/Mile)			
Electronics	645	530	1175
Cable	1260	0	1260
Construction	550	0	550
	$2,455	$530	$2,985
Coaxial ($/Mile)			
Electronics	3105	2495	3510
Cable	4040	0	4040
Construction	3880	330	3880
	$11,025	$2,825	$11,430

Table 2.
Fiber Backbone Upgrade Cost Analysis

	550 FBB 750 DESIGN 550 ELECTRONICS	750 FBB UPGRADED FROM 550 FBB	750 FBB 750 DESIGN 750 ELECTRONICS
Fiber ($/Mile)			
Electronics	735	950	1685
Cable	1920	0	1920
Construction	620	0	620
	$3,275	$950	$4,225
Coaxial ($/Mile)			
Electronics	2710	2375	3025
Cable	475	0	475
Construction	1980	330	1980
	$5,165	$2,705	$5,480

SUMMARY

Much looms on the CATV horizon. Advances in both technology and services promise to continue through the decade. As an industry, we can not afford to wait for the advances to slow or stabilize for that will never occur and we will be passed by by others. We must take advantage of what we know, apply it today and prepare for the future. We must develop a plan with contingencies for the future and continue to move forward. This paper, in the space of a few pages, has attempted to shed some light on how we might do this. It makes no pretense of providing a solution for a utopian network but hopes to evoke some thought and effort to that end.