CABLELABS 1991 ADVANCED NETWORK DEVELOPMENT WORK

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Abstract

The cable network is often considered to be the portion from the headend to the subscriber's house. The network architect must widen his perspective to begin at the source of origination and extend to the customer premise equipment in the subscriber's home. This end-to-end assessment is necessitated by the advancements and migration of technology in production equipment and in consumer electronics. One of CableLabs' major tasks is to research Advanced Network Development (AND), to propose a model, and to test it. The intent of the AND process is to ensure that the fundamental principles of existing network topologies are not adversely impacted with the migration of new technology or functionality.

Advanced Network Development (AND)

The Network Architecture Model is a fundamental set of rules outlining a conceptual model of the cable network. In effect, the architecture defines the design of the network both in terms of functionality and physical deployment. The process of deriving the network architecture involves mathematical modeling, which includes network optimization. The tools used to constrain and optimize network solutions are the simplex method, Karmarkar and Multi-Frontal Method. Economic analysis and traffic engineering concepts are also employed to develop cost models, throughput capability, and points of contention. With these mathematical tools, we are able to develop and manage a complex set of parameters that allows us to constrain investment or technical attributes against an established set of objectives. These scenarios can then be evaluated in order to minimize the number of tests to be simulated or maximize investment opportunities.

Academic research plays a significant role in the development of a cohesive network architecture. While a great deal of the research is theoretical in nature, it serves to limit many of the network scenarios that are eventually evaluated. Network architecture is iterative in nature due to the ever-changing technology and functionality. Thus, it is obligatory to obtain a variety of perspectives and expert opinions to minimize any serious design flaw and to be in a position to optimize opportunities well in advance of the technology coming to fruition. The academic community provides CableLabs with this perspective. A list of a few of the universities or institutions CableLabs is working with is provided below:

University of Colorado, Boulder
University of Victoria, British Columbia
University of British Columbia
Simon Fraser University, British Columbia
Florida Atlantic University
Massachusetts Institute of Technology

Network simulation is an important component in developing a cohesive network architecture. The advent of the overlay of digital signals over analog to position cable to transport digital HDTV; switched video routing to provide selective programming; fiber to the hub or fiber to the bridger; the use of a hybrid fiber/coax network to provide bidirectional PCS services — all of these concepts must be simulated through a series of tests and configurations to validate the concepts derived from theory.

Finally, before the fundamental rules of a network architecture evolve into network design software, the concepts that have undergone rigorous testing and evaluation stages are rolled out into the Advanced Network Development Field Test. This is a controlled environment where the concepts are tested on a small area of a live cable system. The concepts evaluated here reflect tech-

nologies that have been simulated in the CableLabs' facility.

Network Design

Based upon the network architecture model, network design is a fixed series of parameters that specify the detailed engineering parameters for configuring a network. From this network design, installation crews can readily construct a new build or replacement/enhancement of an existing cable system. Typically, the use of network design software is constrained to specific parameters that preclude the network designer from conducting various "what if" scenarios. In general, the network solutions evaluated using these software systems include the coaxial-based cable system; fiber-to-feeder based system with or without a ring topology; and fiber to the bridger, with coax to the home. For each of these network designs, 300 MHz, 450 MHz and 550 MHz cable systems are developed.

The intent of the AND process is to ensure that the fundamental principles of existing network topologies are not adversely impacted with the migration of new technology or functionality. The tree/branch topology is an inherent strength of the cable industry's ability to provide cost-effective services and to compete with new entries into the cable business.

Standards Recommendations

With the convergence of technology being used by cable and the telco industries, the need to participate in standard-setting forums, particularly those that have long been the domain of telcos, is evident.

The State Department classification of CableLabs as a scientific institution allows CableLabs to participate and to make recommendations to the State Department. As a participant in the CCIR, CableLabs has access to CMTT, which also oversees the CCITT. The purpose of CableLabs' status as an observer is to ensure that the cable industry is in a position to interface with converging technologies now and in the future.

Traditionally, broadcasting standards have been managed by the CCIR. The CCITT has been governed predominantly by telcos and PTTs. However, in the last few years, the CCITT has become increasingly more involved in the development of digital broadband standards that include video services. To position cable, CableLabs has focused on key standards committees comprised primarily of telco participants to develop inter-operability of interfaces with various broadband networks. In October of 1990, CableLabs contracted a consultant to identify which committees would provide cable with the maximum exposure, with the least impact on dollars and resources. The results were recently discussed with the decision to begin with ANSI.

ANSI T1S1.5 is a subcommittee that focuses on digital broadband network architecture and video services. CableLabs has contracted a consultant, Dr. James S. Meditch, to represent the cable industry as an observer and eventually make recommendations to the State Department concerning interfaces to broadband networks. One of the objectives of this activity is to familiarize key individuals within the cable industry with the process of formating documents for submittal. This is an area that the industry can support by recommending key individuals to aid and facilitate this process.

The T1S1 subcommittee is responsible for development of SONET and ATM standards in the United States. As was mentioned in a report released by CableLabs in 1990, the SONET standard appears to be near completion. It is also a hardware-defined standard that is not necessarily well suited to the multiple bit-rate requirements of video. However, ATM is particularly well suited for variable bit-rate transport of video, since it is a software-defined standard that offers dynamic allocation of bandwidth. CableLabs involvement

will ensure that operational practices are developed for the cable industry in accordance with ATM standards.

CableLabs is also involved in observing the development of international standards on PCN, which is governed by the CCIR working group on wireless communications. This working group is responsible for recommending spectrum and technical attributes for PCN at the WARC92 international conference.

Personal Communications Network

CableLabs initiated the study of PCN in May of 1990, as part of a Telephony Study. This study assesses the operational issues of providing telephony, traffic engineering design parameters, and equipment evaluation of those systems that operate over a cable system. It also addresses the technical and non-technical attributes of providing telephony services over a cable system for both wired and wireless networks.

With the increased public awareness of and response by the cable industry to PCN experimental licenses, CableLabs sponsored a conference on PCN in early January of 1991. The conference brought together senior management from the cable industry, along with Dr. Jerry Lucas of TeleStrategies, key consultants, manufacturers, cable PCN participants and regulatory representatives from the FCC and legal entities to discuss the opportunities and technical and regulatory ramifications of cable's entry into PCS services. The conference was attended by over 100 individuals from the cable industry.

CableLabs has just formed a PCN Technical Advisory Subcommittee to look into the technical attributes and economic viability of providing PCS services over a cable network. Issues related to PCN, such as upstream spectrum 5-30 MHz, PCN cable interface, PSTN interface, and switching and interconnection to the PSTN, were identified as areas that required CableLabs' immediate attention. The scenarios associated with cable interconnection to the PSTN will be defined by CableLabs. They include the following types of interconnection:

PABX or Class 5 to MTSO
PABX to LEC
Class 5 to LEC Class 5 or tandem switch
Class 5 to IXC

A major issue surrounding the timing of PCS is the availability of spectrum. This issue will likely determine the technology that will be used in the United States in the forthcoming years. The technologies now under development include:

Frequency Division Multiple Access (FDMA)
Time Division Multiple Access (TDMA)
Code Division Multiple Access (CDMA)
Packet Division Multiple Access (PDMA)

FDMA and TDMA technologies are dependent on spectrum availability that is not readily available in large market areas, such as New York City, Chicago and Los Angeles. CDMA and PDMA are the most promising in terms of the spectrum availability and utilization, however, they reside in spectrum that is largely unprotected by the FCC in cases of interference. CableLabs is focusing on strategic alliances and research associated with these technologies to pursue the technology that proves to be the most economical and available for deployment in a timely manner.

CableLabs is examining a number of network architecture issues: the ramifications of PCS on cable's existing topology; propagation; delay; cell size; the need for fiber-to-the-radio base station versus a hybrid fiber/coax configuration; and switch deployment, including centralized and distributed switching functionality. This work will include joint tests with equipment manufacturers and cable field tests and demonstrations. CableLabs will be contracting a PCN Systems Integrator to facilitate the process of defining the network design. CableLabs is also evaluating spectrum

issues regarding the potential provision of PCS.

Conclusion

AND is an iterative process requiring continuous assessment of the end-to-end network infrastructure that delivers video source from the production end of the spectrum to the equipment that resides in the subscriber's home. Technology and customer demands will continue to change the complexion of the network. It is the task of CableLab's Advanced Network Development group to continually assess and optimize the network architecture to ensure the least impact and most functionality from the cable network design.