Lower Cost Alternatives to On-Demand Network Architecture

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ABSTRACT

1997 will be the year that broadcast digital services finally becomes affordable to consumers via cable. But to give the cable industry an edge over it competitors, the industry needs to be able to offer on-demand services, such as Video On Demand, to its customers. Unfortunately, the cost of the elements of an on-demand network are still too expensive to offer on-demand services. To make on-demand a reality different network designs and cost reduction efforts are still necessary. This paper will describe how the Asynchronous Serial Interface (ASI) standard can help to reduce on-demand network costs.

OVERVIEW OF ASYNCHRONOUS SERIAL INTERFACE

Asynchronous Serial Interface (ASI) is one of the physical layer specifications developed by the Digital Video Broadcasting (DVB) committee for the interconnection of headend equipment. The interface was developed to carry MPEG-2 data signals, although it can carry any type of data signal. An ASI port is specified to be an unidirectional link which operates at a data rate of 270 Mbits/second. There is approximately 216 Mbits/second of payload available on an ASI link after error detection and framing is removed.

An example of a Quadrature Amplitude Modulation (QAM) modulator implemented using ASI ports is shown in Figure 1. Each QAM modulator that is connected to an ASI link receives the entire 270 Mbits/second data stream. The QAM modulator processes the data stream to filter out the MPEG-2 programs that are addressed to it. The QAM modulator must also repeat or regenerate the data stream and pass in on to the next device in the chain.

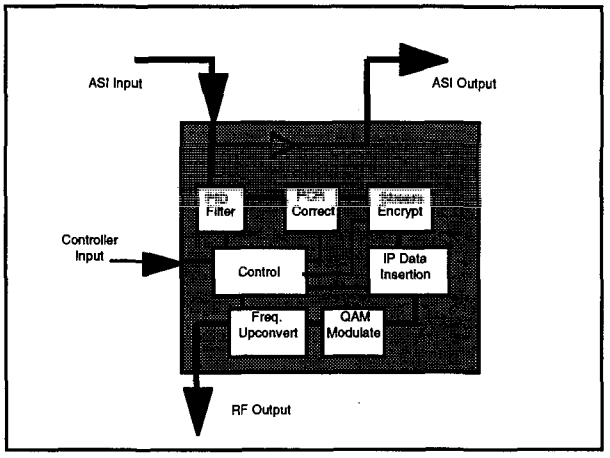

Figure 1 QAM Modulator with an ASI port.

ASI ports can be implemented with either a coaxial cable or a multi-mode fiber optic cable. Since the standard was developed for interconnection of headend equipment, these interfaces should operate over sufficient distances. If longer distances are required, for example to interconnect remote hubs, ASI ports could be implemented using single mode electronics since the specification is based on fiber channel electronics which also supports single mode electronics.

ON-DEMAND NETWORK ARCHITECTURE

The use of elements with ASI ports can help reduce on-demand network costs. To illustrate this, examine the typical on-demand network architecture which is shown in Figure 2. Two components of this network that can be replaced without loss of functionality are the ATM switch and the interactive cable gateway (ICG). The purpose of the ATM switch is to route signals from the servers making them available to any customer in any node. The main purpose of the ICG is to perform rate conversion. The ICG converts from the ATM switch's data rate of 155 Mbits/second into 38.8 Mbits/second which is the rate required by a 256 QAM modulator. The ICG also performs routing, stream encryption, security key insertion, and IP data insertion.

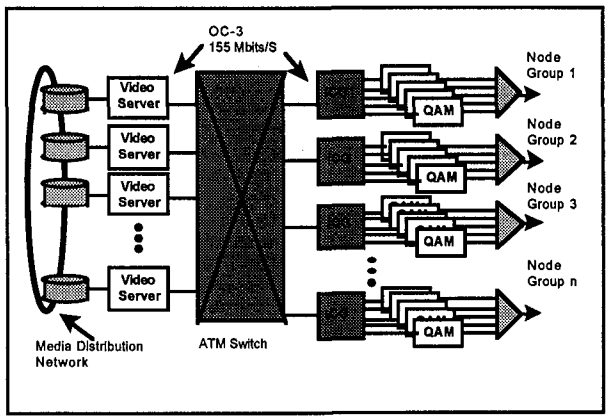

Figure 2 Typical on-demand network architecture.

By using ASI ports on the servers and the QAM modulators, both the ICG and the ATM switch can be eliminated from the on-demand network. Let's examine how a device with ASI ports can maintain the functionality of the network and help to reduce the overall cost.

ATM Switch Elimination

Media needs to be routed from any server to any customer. An ATM switch appears to be the ideal element to handle this task. ATM switches were designed to handle the task of routing many different types of data, such as video and IP data, from any input to any output. But the ATM switch may not be the ideal solution for routing information to customers in an on-demand network. The ATM switch has one big disadvantage, it was designed to be bi-directional. Most the information in an on-demand network flows from servers to customers, only a small amount of information flows in the reverse direction. Therefore, the ATM switch's reverse direction is used very little, which wastes money. The small amount of traffic that flows in the reverse direction is best handled by IP routers, which is usually the case even in networks that have ATM switches.

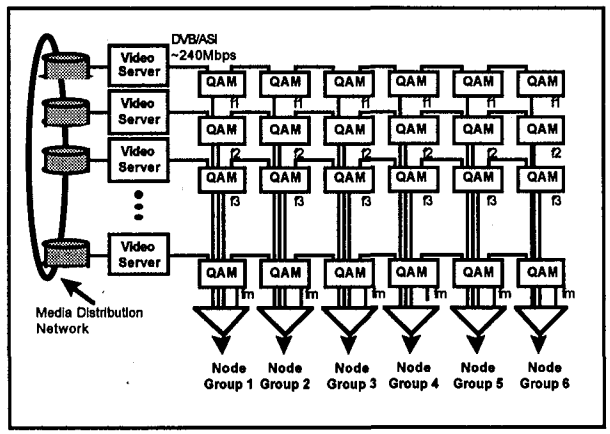

Figure 3 On-demand network architecture with ASI devices.

Clever QAM modulator output combining and the use of ASI ports on the servers and QAM modulators will eliminate the cost of the ATM switch. Figure 3 is a network based upon servers and QAM modulators implemented using ASI ports. In this network, media from any server can get to any customer in the same

way as in the network with the ATM switch, but this network was designed without an ATM switch. It may first appear that the ATM switch network has advantages over the network with device using ASI ports, but it does not. With a proper media distribution, which is required in both networks, the network featuring ASI devices can perform any routing combination that can be performed in the network with an ATM switch.

In addition to eliminating the cost of the ATM switch, using ASI ports on the servers should also be cheaper to implement than OC-3 ports on the servers. OC-3 ports are bi-directional. Since most of the information is flowing out from the servers, the return side of the OC-3 port is wasted. Elimination of this portion of the interface port will reduce the cost of implementation.

Interactive Cable Gateway Elimination

As stated earlier, the main purpose of the ICG is for rate conversion. The ICG converts from the ATM switch's rates into rates that are required by the QAM modulators. But this is a very expensive way to perform rate conversion. The input to an ICG is typically OC-3 or 155 Mbits/second. The output of the ICG is usually 26.97 or 38.8 Mbits/second, which are the rates required by 64 and 256 QAM modulators operating in 6 MHz wide channels. Given OC-3 inputs, an ICG can supply data to five 64 QAM modulator or four 256 QAM modulators. Assuming 3.5 Mbits/second for a MPEG-2 video and audio stream, an ICG is required for every 40 MPEG-2 video and audio streams. The average cost of an ICG is approximately $25,000. This adds $625 to the cost of every MPEG-2 video stream that is needed in an on-demand network.

Rate conversion is easily implemented in the network built using element with ASI ports. Each QAM modulator on an ASI link is commanded to accept only the MPEG-2 programs that are addressed to it. It doesn't matter whether it is a 64 or 256 QAM modulator, the modulator will accept only the proper amount of information to modulate. The network controller will insure that a QAM modulator never receives more data than it can modulate, which is the case in both networks.

The other functions that the ICG performed; encryption, security key insertion, and IP data insertion, now need to be performed by the QAM modulator. Adding these functions to the QAM will likely increase the cost of the QAM modulator. But it is unlikely that the addition of these functions to the QAM modulator will increase the cost per stream more than the $625 per stream of the ICG.

In addition to the cost savings, elimination of the ICG has other benefits. In a network built using ASI port devices, the data signals in the headend are in the clear until they are modulated. This aides in troubleshooting the network. QAM modulator redundancy can be implemented by commanding spare QAM modulators to process the MPEG-2 stream of a failed QAM modulator. In addition, ASI is a standard which will make it easier for many different manufacturers to build accessory devices such as; Ad insertion equipment, test equipment, and emergency alert equipment, which are required for successful implementation of on-demand networks.

SUMMARY

Asynchronous serial interfaces on headend equipment will help reduce the cost of on-demand networks. ASI also has several advantages over existing headend network designs. The use of ASI on the servers and QAM modulators will eliminate the need for 2 expensive components, the ATM switch and the interactive cable gateway, that were being considered for use in the headend. ASI is a standards based. This will make it easier for many manufacturers to develop devices such as, ad insertion equipment, test equipment, and add/drop multiplexers. The unidirectional nature of ASI also reduces cost and is better optimized for the data traffic carried on an on-demand networks.

This makes using ASI a better choice for headend interconnections. The cable industry must continue to rethink and optimize the way it will support on-demand services. On-demand network architectures still need further cost reductions to make them affordable for deployment, but using new approaches to signal distribution and continued cost reduction of elements will eventually make these networks a reality.

REFERENCES

Interfaces for CATV/SMATV Headends and Similar Professional Equipment, Digital Video Broadcasting Document A010, October 1995.