# INTERNET DELIVERY ON CATV - A BASIC OVERVIEW

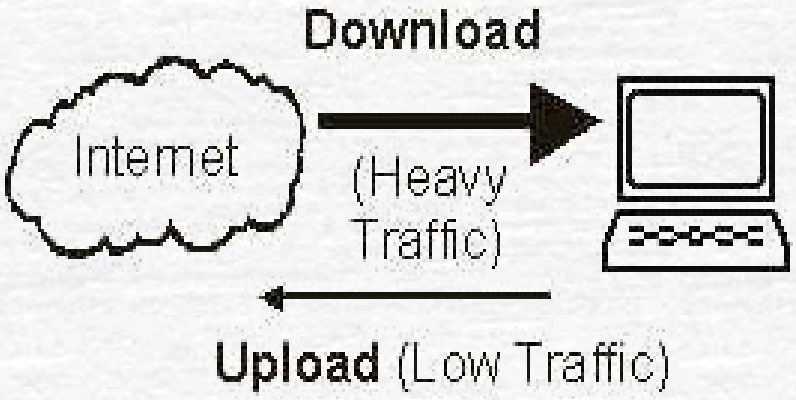
## THE BASICS

A basic question that is often not answered is " What really IS the Internet? " The Internet is simply a network of computers that are linked together. This is easily the world's largest network of any kind. In fact, internet traffic or content is the most rapidly growing phenomena in human history. It is estimated that the requirement for Internet content is doubling every 100 days !Any computer can be linked to this network of computers using a simple telephone line and a telephone modem.

Who owns the Internet? - No one! Since it is a network of multiple computers, it exists because all these computers want to connect to each other. If for any reason all these computer owners decide not to connect together, there will be no Internet. As users logging on to the Internet, we are all contributing to its existence, popularity & growth.

However, to ensure smooth connectivity, the Internet follows certain technical standards and protocols. If your computer follows these protocols, it too can be connected to the Internet and either receive or send out information to millions of other computers connected to the Internet. There are various methods / protocols by which information can be sent out or received from the Internet. These include Gofer, FTP and the World Wide Web (www). The World Wide Web presents the information in the most user friendly format with pictures and links. Hence the www has now become the most popular part of the Internet.

## THE INTERNET DATA




The information or data carried on the Internet is computer data which is carried in a Digital format. Detailing this data format is beyond the scope of this article but its suffices to say that the Internet data is not intrinsically modulated.

## MODULATION FOR CARRIAGE

Depending on the method of carriage or transfer of this data, different digital modulation schemes are used. The Internet data can be transmitted in bulk via satellite. For satellite transmission, the usual digital modulation used is QPSK. The Internet data can subsequently be sent out to individual users or customers using a telephone modem or a Cable TV network. The Cable TV network utilises QAM modulation (for details of different digital modulation techniques and their specific applications, readers are invited to read - "An Introduction to Digital Modulation" carried in Satellite & Cable TV magazine, December'98 issue).

## INTERNET INTERACTIVITY

When any computer (user) gets onto the Internet, the user requests to go to a particular site by typing in the site address. This information is sent into the Internet and information from that particular site is then transferred down into the computer. Clearly the signal travels in 2 directions. A signal is sent from the user computer to the Internet (up loaded). This is only a very small amount of information - the site address.

On receiving the site address, a much larger amount of information is then fed into the users computer (down loaded). This is shown in Fig. 1. This brings into focus a very important fact - on the Internet most of the time, users simply down load information, i.e. is pick up information from the Internet and load it into their computers. Only very small amount of information is usually up loaded or sent by the user into the Internet.

## DELIVERY THROUGH CATV

From the basic description of the Internet given above it is clear that any network that needs to deliver Internet content must be bi-directional i.e. the network must have a Reverse Path. The other fact that emerges is that the cable network needs to deliver only a relatively small amount of data in the Reverse Path. The bulk of the data transfer takes place in the Forward Path i.e. from the Cable Headend to the customer. A basic block diagram is shown in Fig. 2 which indicates how a telephone network or a Cable Headend located in between the Internet and the user helps deliver Internet content to the customer.

## THE MODEM

Before we move on to Internet delivery on a cable network lets examine how Internet content is delivered through telephone lines. This is the most common form of Internet delivery and probably accounts for more than 99% of users today. Clearly telephone lines are bi-directional. We speak and listen, during a telephone conversation. However the telephone lines carry a simple analog signal with a bandwidth not exceeding 3 KHz. If computer data is to be exchanged on telephone lines, it will need to be modulated. Therefore Internet data is first modulated by the ISP (Internet Service Provider) and then transmitted on the telephone line. This modulated data is demodulated by the user when received. Similarly the user has to modulate the data (such as his site request) and send it to the ISP. The ISP then needs to demodulate this received signal.

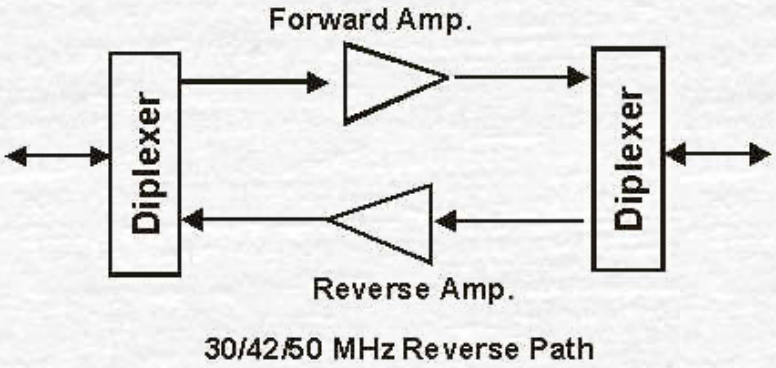
Clearly both the ISP and the user need to MOdulate and DEModulate the signals that they are sending out and receiving. This is done by a MO-DEM installed at each end. Similarly if a cable network is utilised for the transmission of these signals, it will need to employ a modem that works at Cable Tv frequencies. Such a device is popularly referred to as a Cable Modem.

## THE CABLE MODEM

Similar to a telephone modem, a Cable Modem consists of a frequency Agile Modulator + Demodulator. The digital data is automatically modulated at any available frequency between 5 MHz to 30 MHz. The Cable Modem scans the frequency band to find a suitable frequency which is unoccupied at that instant in time. It then sends out the modulated signal at the available frequency from the user to the Cable Headend. For receiving a signal from the Headend, the Cable Modem searches for a modulated data packet containing its address identification number. Each Cable Modem is uniquely identified by the cable Headend. This is done in a similar manner as an Addressable Set-top box is identified by the Headend. The Cable Modem will only demodulate signals which carry its identity. Typical specifications of a Cable Modem are indicated separately in the box.

## MODULATION

In the Forward Path i.e. for signals from the Headend to the customer, the Cable Tv system is required by law (BIS Specifications), to maintain a good C/N ratio of atleast 43 dB to the customer, for every channel. This good C/N ensures that the customer receives a clear, noise free picture on all channels. Clearly, the Forward Path provides an excellent, noise free environment for signal transmission. Hence the cable modem can use Quadrature Amplitude Modulation (QAM) in the forward path. QAM provides an extremely efficient method of transmitting large volumes of digital data over a small RF bandwidth. The limitation of QAM is that it needs a noise free transmission medium. Clearly this is available in the forward path of a normal CATV network.



30/42/50 MHz Reverse Path

The Reverse Path i.e. the transmission of signals from the E user to the Headend is done over the frequency band of 5 to 30 MHz. Unfortunately, the band of frequencies between 0.1 MHz to approximately 15 MHz is extremely prone to electrical noise such as that from sparking. Sparking is far more prevalent than normally accepted. The electric ignition of every petrol driven vehicle generates a constant stream of sparks for burning the fuel. Similarly the electric motor in several domestic appliances such as hair dryers, mixers and sewing machines generate spark noise. This spark noise as well as other impulse electric noise gets injected into a CATV system and provides a very high noise environment in the Reverse Path. Hence, any signal transmitted by the Cable Modem back to the Headend must be fairly immune to noise. The Quadrature Phase Shift Keying (QPSK) modulation provides an extremely robust method of transmitting signals over a noisy environment.

Consider transmission of satellite signals. Satellite signals received at the LNB have a signal power of just a few pico watts. (1 pico watt = A millionth of a micro watt !). Further, this very weak signal travels 36,000 kilometers through the atmosphere where it can be subjected to thermal noise, electrical impulse noise as well as other electro-magnetic transmissions. QPSK modulation ensures that the signal is received uncorrupted even under these adverse conditions. Hence, QPSK modulation is used for modulating the Reverse Path signal, sent by the cable modem to the Headend.

## NOISE

Noise has been a major concern for transmission of digital signals over cable networks. This argument has often been used to promote advance technologies such as Fiber Optic transmission for CATV networks. While fiber optics does provide a relatively noise free path, let us examine the facts on noise prevalent in a typical Indian CATV network. We have seen that as dictated by the BIS specifications, the forward path is supposed to have a C/N ratio of atleast 42 dB for each channel. Realistically, this is probably not achieved at most Indian customer's homes. While detailed tests can be done to determine actual C/N prevalent at customer homes, it would be adequate to preliminary determine at least the order of magnitude of the actual C/N for signals delivered to customers homes.

It is widely accepted that for a C/N of 39 dB, the television picture distinctly turns grainy. If the C/N ratio falls further to approximately 36 db the picture breaks up completely into snow. The image is still visible as an outline but viewing is definitely objectionable. For a C/N of 32 db the picture is almost not distinguishable from the background noise. From this it

is clear that most cable networks in the country certainly provide a C/N to their customers of better than 36 db and the C/N is definitely not as low as 32 db, even for UHF channels.

A quick look at the cable modem specifications indicates that the cable modem requires a C/N ratio of just 23.5 dB in the forward path for satisfactory operation with QAM modulation. Clearly this is easily achieved even by a fairly hopeless CATV network! The Reverse Path is ofcourse where there is maximum concern for signal degradation.
Once again let us consider the typical Indian CATV network. Most medium and large cable networks already incorporate a reverse path. This reverse path is typically utilised for sending a signal of a particular channel from the network back to the Headend. This signal is received at the Headend demodulated and retransmitted. Even after this very lengthy Processing, the signal remains of acceptable if not prime quality. Clearly the signal transmitted in the reverse and received at the Headend has a C/N ratio certainly not worse than 39 db.

Practical experience has indicated that the reverse path transmission is best for signals transmitted between 20 to 30 MHz. If transmission at lower frequencies is utilised, the signal rapidly picks up noise. From this it can be empirically deduced that the reverse path C/N over a typical stretch of an Indian CATV system is better than 39 dB over the frequency range 20 to 30 MHz. Once again referring to the minimum C/N specifications required by a Cable Modem using QPSK in the reverse path, is just 13 db !

## FREQUENCY BAND

When installing a Cable Modem system, the network needs to allocate a range of frequencies of operation of cable modems.The good news is that a frequency band of just 6 MHz in the forward path and 2 MHz in the reverse path is typically adequate for a fairly large cable modem network. Considering this fact and details presented earlier of the C/N ratios, a cable operator could easily allocate one forward channel - maybe even the highest frequency forward channel which typically does not provide good television reception ! )· For the reverse path the cable operator could keep aside a 2 MHz band say from 25 MHz to 27 MHz for Internet delivery.

## DATA & INTERNET DELIVERY

## SYMMETRIC DATA FLOW

While the uninitiated will probably think that there is no major difference between transfer of Internet content and computer data, this is not so. If 2 computers in different offices are to be inter connected for exchange of data, each computer is likely to send as much data as it receives. Hence the link needs to have equal capacity in both directions This is called Symmetrical data transfer.

## ASYMMETRICAL INTERNET

As we have seen earlier, Internet connectivity requires most of the data to be downloaded and only a relatively minuscule amount of data to be uploaded from the user to the Headend and the Internet. This is referred to as Asymmetrical (unequal in the 2 directions) data transfer. The latter (Internet connectivity) ideally suites CATV networks since they have a huge bandwidth for down loading content but only a small bandwidth in the reverse path for uploading. Hence while Internet delivery over a CATV network can be scaled to 1000 or even more users, the bandwidth would not allow data exchange between say 500 pairs of computers simultaneously, in a symmetrical data configuration.
For computers to exchange data, a Symmetrical system is to be designed and the design, including hardware requirements are quite different for symmetrical and un-symetrical data networks.

Hence the cable network needs to decide, at the design stage itself whether it plans to

offer Internet delivery (Asymmetrical data transfer) or computer data transfer (Symmetrical data transfer)

## GOVERNMENT RESTRICTIONS ON DATA DELIVERY AND TELEPHONY

The cable law in Its original form explicitly disallows use of a CATV network for transmission of Internet content, computer data or telephony. In recent months, the government has liberalised its Internet policy to permit privately owned organisations, to deliver Internet services to end users. It is believed that the government received atleast 250 serious ISP applications. Conventional Internet delivery has always been through telephone lines. Assuming that each of these 250 ISPs has a requirement of 1000 telephones each, it implies an additional requirement of 25 lakhs additional telephone lines. The DoT's primary objective is to make telephone access available throughout the country including the smallest town and village. In keeping with this, it is estimated that DoT may require upto 3 years to provide 25 lakh additional lines just for Internet!

Clearly the government needs an alternate mode of delivery and has therefore vide a DoT notification, stated "Providing access to INTERNET through authorised Cable TV shall be permitted to any service provider without additional licensing subject to applicable cable laws." From this it is clear that Internet can be delivered through CATV networks. However it is also apparent that telephony and other data communication is not yet permitted by the government, on Indian CATV networks.

Further, itis explicitly stated that no additional licensing is required as long as the Cable TV network is AUTHORISED. We have been repeatedly stressing in the magazine that Indian cable networks must register themselves at the head post office to ensure that they operate as authorised Cable Tv networks .

## CONCLUSION

The government has permitted delivery of Internet content on cable networks. We have also seen that such delivery is not only desirable for the end user but is also possible given the existing Indian Cable Networks. Contrary to popular belief, cable modems can easily operate on Indian cable networks. This is apparent from the typical specs of a cable modem, included in this article.

The cost of typical Internet Headend equipment is estimated at approximately Rs.20 lakhs while a cable operator may or may not decide to invest in this equipment, this figure is clearly less than what a typical ISP would have budgeted for a 1000 telephone lines plus modems alone ! Maybe, a cable network could enter into an alliance with an ISP and charge a carriage fee for the service. Even a carriage fee of approximately Rs.100 per subscriber would be deemed (very reasonable) by both the ISP and the end user specially considering the high down load speed possible as well as the fact that the customer is not billed for a phone call every 3 minu tes.

For the cable operator too, the fee should prove attractive and a very substantial increment for just one channel bandwidth in the forward path and a 2 MHz bandwidth in the reverse path. A further development that can be predicted is an intense interest amongst ISPs and other service providers for partnering with or even buying out CATV networks that service high income households or commercial areas.