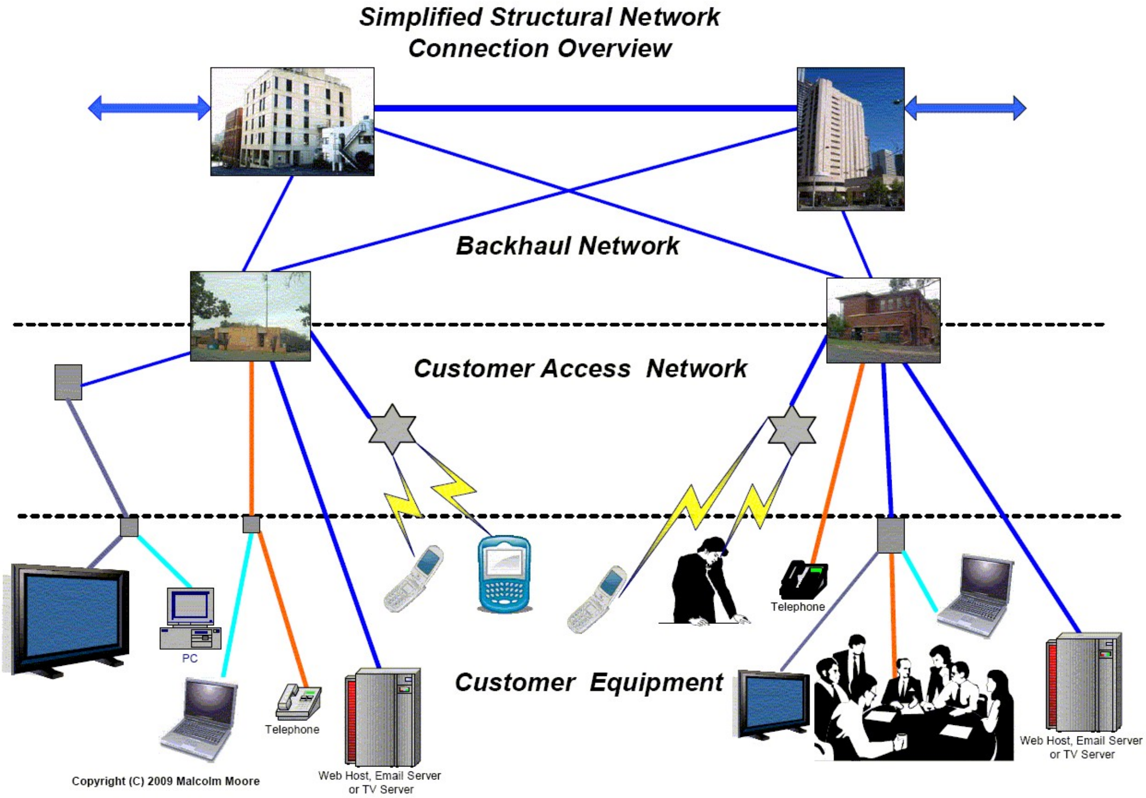
Cable Television and Internet

© Malcolm Moore
23-Mar-2003

(2003, 2005, 2007, August 2012)

Introduction

As shown in the descriptive picture below, Cable Television and Cable Internet is in reality a hybrid of two technologies. From an optical headend located in a local or regional exchange site the transmission is through single mode optical fibre (SMOF), shown as a blue line in the CAN layer below. The SMOF then connects to a remote node (grey box in the picture below) where the transmission mode is changed coax cable (grey line in the picture below) where it is locally distributed for a few km distance to the premises.



At the CAN / Premises interface point, the coax is terminated and passes into the Customer Premises Network (CPN). For Cable TV this is a Coaxial cable. For Cable Internet, the coax cable feeds to a Cable Modem where it becomes part of the CPN as a Local Area Network (LAN), which could be Cat5 cable, or a Wi-Fi premises radio network to connect with personal devices.

Cable Television - HFC

This technology grew out of the Community Access Television (CATV) era that started in about 1944 in the USA. Early Community Access Television (CATV) in the US America was a one-way transmission system from the headend to the customers. The basic concept was to transmit TV channels through Coax Cable, and the nominal frequency range was 100 to 500 MHz.

With improvements in engineering technologies in the 1970s, the capability of a 'back channel' was introduced, enabling the status of various amplifiers etc to be remotely interrogated from a central headend.

The Upstream channels were structured to run in the 25 to 75 MHz range so they did not interfere with the downstream channels. This technology advancement created a large improvement in service reliability and reduced the maintenance efforts.

From a District (or Regional in metropolitan terms) position, a Headend feeds TV content into several Coax cables that feeds directly past many Customer Premises. Splitters create several drops to feed to customers, the main (analogue) signal is then amplified and fed to more splitters (to more Customer Premises) and the process repeats itself.

This system is analogue and it incurs considerable signal degradation through this repeated amplification and attenuation process, making it a very difficult to go much further than a few kilometres without a fresh feed.

Pole Mounted HFC Nodes

The situation in the picture below clearly shows opposition telecommunications CATV cables performing a directly duplicate function and this practice has to be the most cost expensive option for service delivery. ***(A very little lateral thinking on duplicated networks brings in duplicated work forces, and duplicated management; and that is very powerful proof that competitive infrastructure is extremely inefficient!)***

This is a Pole Mounted Head End connected by Optical Fibre up to 60 km away and the Coax Cable with its amplifiers and splitters will have a range of one or two kilometres from this point.

Note the competitive Amplifier on the upper HFC CAN that is totally overlapping the competitive HFC spur from the pole mounted Head End.

Most of Telstra's remote Head Ends are pit mounted (under the footpath) and a considerable portion of Telstra's HFC Coax is also underground - avoiding this eyesore of pole-mounted cables.

The coaxial cables are usually highly visible and usually sits about a metre below power lines suspended on poles.

In many instances competitive suppliers have duplicated these access networks, and often the unseen cable is in the ground with telephony cables.

Here are two competitive HFC Networks with Coax Cable and amplifiers virtually mirroring each other

The prime reason that the coax cables are mounted on existing power poles is to minimise installation cost. It is far more expensive to bury coax cable and the associated amplifiers, splitters etc, so instead of following the standard in Australia of burying as much cabling as possible, competitive forces sought the cheap (and nasty) solution.

Coax cable connects to the premises, through a series of amplifiers and splitters. Power for the amplifiers is fed down line from several distributed power supplies that are usually pole or underground mounted, and include a small battery backup in each.

Introducing Optical fibre

With the introduction of practical Optical Fibre technologies in the late 1980s it became possible to transmit analogue signals up to 20 km without re-amplification, which was about 40 times further than Coax Cable and the engineering construction was extremely cheap in comparison to Coaxial Cable. By introducing Optical Fibres to replace Coax from the Headend to suburban sub-Headends - this gave a much greater geographic coverage; hence the term Hybrid Fibre Coax or HFC.

In 1992, the Australian Government fostered a fiercely competitive environment between Telstra and Optus to have HFC technology 'rush released' into Australian capital cities, and this debacle resulted in an extremely expensive implementation of an HFC CAN with a total industry price ticket about $7.2 Bn, where if is was installed in a non-competitive (Infrastructure Business) environment, it would have cost in total about $2.4 Bn to the Australian public, a saving of about $4.8 Bn (or an HFC network that would have passed another 200% more premises).

Lying Marketing Caught Out

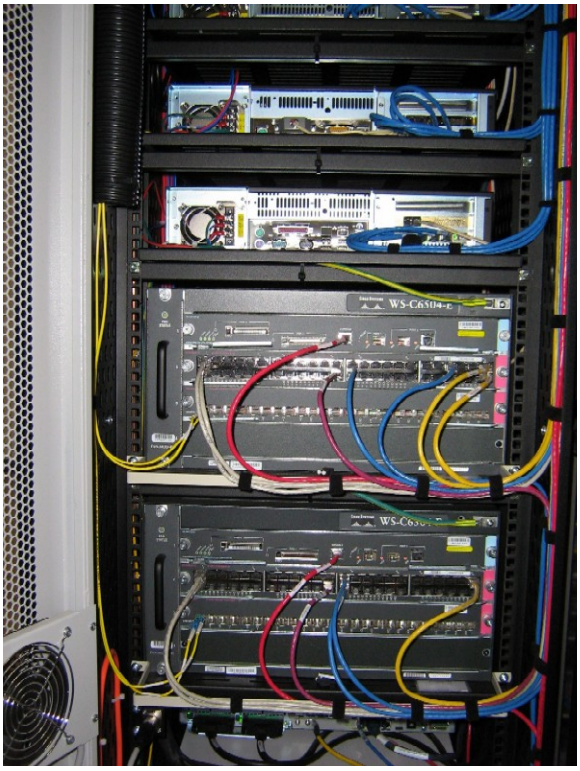
Be very aware that having a Coax cable “passing” a home does not automatically qualify that premises to have a service. There is a fundamental misunderstanding about CATV that marketing have seriously milked with the flawed belief the if CATV passes a premises it could naturally be connected. ***Nothing could be further from the truth!***

For every premises that the CATV Coax is connected, the available power is considerably reduced. This means that as more premises are connected, more amplifiers need to be included in series with the coax at very short and regular locations to keep the signal strength strong enough so that it is not in the noise.

Taking this argument a step further, almost no battleaxe block residences can be connected because the signal strength through the extended coax lead is so weak by the length of the driveway that these premise need an amplifier to make a reasonable connection – something that is expensive and makes the contract unattractive.

Introducing Cable Internet

With advances in Cable Internet technology in the early 1990s, Universal Broadband Routers appeared, and these effectively used CATV channels as downstream Internet channels in the nominal frequency range 500 MHz to 600 MHz, and used some of the much narrower back channels as the upstream channels.



This is a typical Broadband Router set-up seen at the back, and the front. At the back, the Universal Broadband Router has a large number of TV equivalent channels that it connects to an analogue combining unit – this is all the green coaxial cable. At the front (shown on the right) these Broadband routers connect with the pair of local IP edge Routers (not shown), and an optical; fibre mesh of geographically diverse paths to the regional IP switches.

The switching plane in the Local Edge Routers is the demarcation point between the CAN and the Backhaul Network, so all the equipment shown above is part of the CAN, to and including the Headend equipment, the fibre to the remote notes, the remote nodes and to Coax cable in the streets to the premises (and all the associated equipment).

This technology has proven to be highly successful to the point that there were so many Cable Internet users that the IEN infrastructure needed to be completely re-structured by 2005 so that hundreds of Universal Broadband Routers per capital city could be distributed to Local/Terminal exchange sites to relieve the extreme network congestion in the then single site capital city Headends.

Distributing the Headends

Again much of this will not be possible with the current IEN infrastructure in major capital cities and current 1 Gb/s links will need to be increased in bandwidth to (say) 10 Gb/s, and the associated Regional Switch/Routers will need to be considerably increased in throughput speed capability and/or require many Regional Switch/Routers in parallel to deliver the required data speed throughput.

This physical Optical Fibre IEN structure works well in metropolitan areas, but in non-capital cities, the distance from the dual regional router / switches is too far for physical Optical Fibre links, and SDH-based rings will be the necessary IEN technology to bring Broadband into non-capital cities.

At the Headend, the TV Channel allocations associated with Broadband Internet are passed through the Headend TV Multiplexer to a Headend Cable Modem and this multiplexer/modem then connects to a District Router in the IPN via the IDF. The demarcation point for Internet on HFC connecting to the IPN is on the Router (Equipment) side of this IDF. The demarcation point for TV, Radio and other broadcast/datacast content over HFC is at the Equipment side of the MDF that connects to the Headend Multiplexer - so the Headend Multiplexer (Universal Broadband Router) is part of the CAN.

At the Customer Premises, the demarcation point between the Customer Premises Equipment/Network and the (HFC) CAN is at the last cable connection point leading towards the Headend at the premises. (A premises located splitter is part of the HFC CAN.)

Introducing Digital Cable TV

Also by 2006 there were considerable advances in digital television techniques and these flowed into Cable Television where it was decided to put in a band of digital TV channels from 600 MHz to 800 MHz and then remove the analogue television channels.

Again this technology has decreased the maintenance requirements and reduced the overheads and improved the picture Quality.

These lower frequency channels will be available for Internet via more Universal Broadband Routers - but the upstream channel frequency specification may need to be increased to match the downstream Internet usage, and that may mean complete replacement of all existing HFC amplifiers.

Introducing DOCSYS3

DOCSYS 3 uses a much wider spectrum allowance for Upstream, so the filters in all the amplifiers (those shoe-sized boxes hanging in the coax near the power poles) will need to be replaced in their entirety before DOCSYS 3 can be considered. And then after that all the current Cable Modems in all the residences will need to also be replaced with DOCSYS 3 capability modems.

But wait, there is more, not only do the amplifier's filters need to be replaced, the Cable modems replaced in the residences, but the remote headends that have been established with DOCSYS 2 Universal Broadband Routers (uBRs) need to have their Broadband Interface cards replaced with DOCSYS 3 Broadband Cards, and the whole system need to be re-aligned for every card, every amplifier on every HFC spur. In this light, it may not be a sound business decision to go down this path and FTTP may start to sound like a solid business case.

With the analogue Pay TV removed from the headend and HFC CAN, this has moved the Pay TV into the over 600 MHz band, and opened up the lower than 600 MHz band for high speed bi-directional Internet communications in the HFC CAN.

For example, if the downstream was increased from 500 MHz to 600 MHz band to a 300 MHz to 600 MHz band now occupying 300% more bandwidth, and the Upstream was changed to cover from 30 MHz to 50 MHz band to a 30 to 230 MHz band, this would give a about a 1000% increase in Upstream bandwidth, so 30 Mb/s bi-directional data rate would be very probable, with a much larger utilisation per Universal Broadband Router (uBR).

Comments and Corrections are welcome