SCTE Installer's Course

Working for the Benefit of the Broadband Industry

Reference Manual

www.theSCTE.eu

Welcome to the SCTE™ Manual

This handbook is designed as a stand-alone reference manual for technicians working in the broadband telecommunications industry. It may be used either on its own or as an integral part of a classroom course including practical work to enable the student to progress to examination and certification.

We hope you and your career benefit greatly from this handbook and associated training course. Please consider joining the SCTE and taking advantage of the benefits that come from being part of the industry's foremost technical institution.

About the SCTE™

Founded in 1945, the SCTE is a non-profit making organisation, managed by an Executive Committee of elected volunteers, whose aim is to raise the standard of broadband engineering in the telecommunications industry. The Society particularly concerns itself with the training and career advancement of technical professionals in this field.

First introduced in 1994, the SCTE training courses have achieved wide acceptance as the standard for young technicians wishing to enter the field of cable telecommunications and for those wishing to advance their knowledge and career prospects. They are used in-house by a number of operating companies and SCTE engineers can be found working in a variety of international organisations.

As a Learned Society, SCTE is able to provide accreditation and certification for its members, giving them professional standing within the industry. Full Members and Fellows are allowed to use the designations MSCTE and FSCTE after their names whilst Technician Members may use TMSCTE. There are also categories for Student and Associate Members which carry the designations SMSCTE and AMSCTE respectively.

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Section One

Welcome to the SCTE training course for cable telecommunication installers that will provide you with the knowledge necessary to install customer connections efficiently and effectively.

1.1 The Installer's Course

After each section of the course, you will encounter a short assessment test that you are encouraged to attempt. This test will indicate whether you have understood the section content or need to have some part of it explained further. At the end of the course, you will sit an examination. The pass figure is 60% and will gain you the SCTE Certificate for Installation Technicians which will remain valid for 3 years. After the certificate expires you may apply to have your certificate re-validated for a further three years if you can show evidence of Continued Professional Development (CPD). The examination and certification process is more fully described in Appendix G including options for re-sitting examinations for those who fail at their first attempt.

1.2 What Is It All About?

Cable telecommunication networks were often called 'CATV' which stood for Community Antenna TeleVision, but that description is inadequate to describe modern networks which carry not just television and radio entertainment, but may also offer broadband communication via the internet, voice telephony and a variety of digital services such as interactive TV and video on demand. These various services depend on networks that permit interactive service and signal flows both to and from the connected customer.

The modern network has three major parts, a 'backbone' network that will use optical fibre technology and covers long distances; secondary distribution networks that derive their signals from the backbone network and distribute them to smaller groups of customers in relatively compact or geographically defined areas; and the third part, the local distribution network, that conveys the signals right into customers' homes and workplaces.

Optical fibre technology is used in the secondary distribution networks almost exclusively, and some advanced installations take fibre right to the home; more commonly, coaxial cables are employed in the local distribution network.

In this case, conversion from optical signals to electrical ones is carried out at points on the secondary network called 'hubs' or fibre nodes that contain the optical to electrical conversion equipment.

There are various and differing ways of building these networks which will be described more fully later in the course.

As an example, Figures 1.2a and 1.2b, are basic block diagrams of the kind of network just described. These will appear as a reference, a means of placing the parts of a network under discussion in relation to the whole network as we work through the course.

A cable telecommunications network, therefore, is a comprehensive communication network that offers an alternative to over-the-air broadcasting, plus broadband data communications and in some cases, an alternative telephone system. It has the advantage of being free from disturbances encountered in off-

air reception, it often offers higher speeds of internet access than can be obtained using the standard telephone network and provides competitive pricing on internet and telephone services. It can also offer more services such as video on demand, community TV, local news and weather, games and gambling, and personal TV – a showcase for your own video productions.

Cable telecommunications is developing all the time with added value features that are aimed at making life easier, communication more pleasurable and more easily accessible with higher and higher data rates for home and business users. For technicians and engineers in the industry, it is vital to keep up to date with new developments.

The SCTE, through its journal "Broadband", lecture meetings and a presence at major conventions, conferences and exhibitions, pursues its mission to educate, inform and advise its members of all the new developments as well as providing a forum for networking and the exchange of experiences and ideas.

1.3 Overview of a System

1.3.1 Cable Telecommunication Networks

Referring to the diagrams above, Figure 1.2a shows an overview of a typical metropolitan or city wide optical distribution network delivering services to intermediate nodes for further onwards optical distribution or to local service nodes serving the final distribution layer of the network.

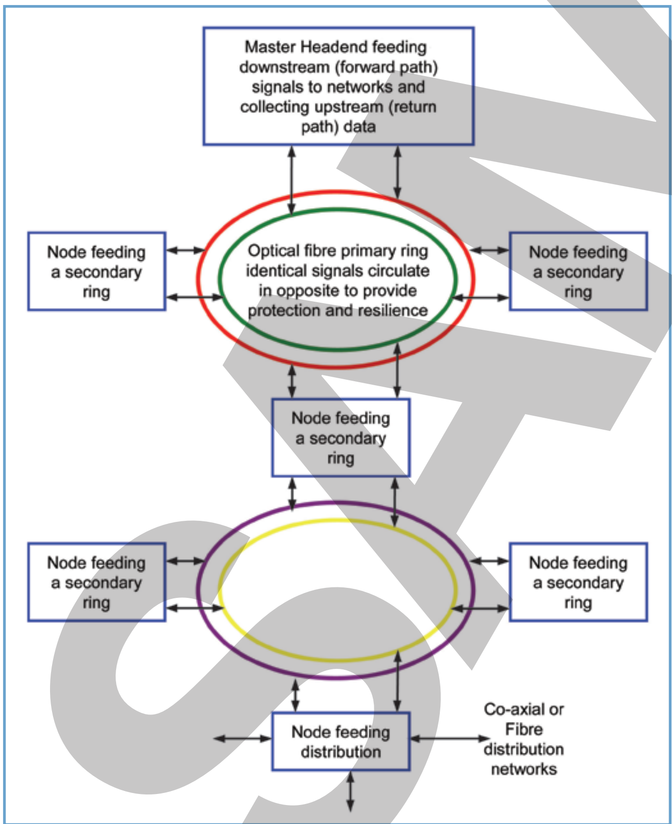

Figure. 1.2a: Generalised diagram of a cable communication network at city level.

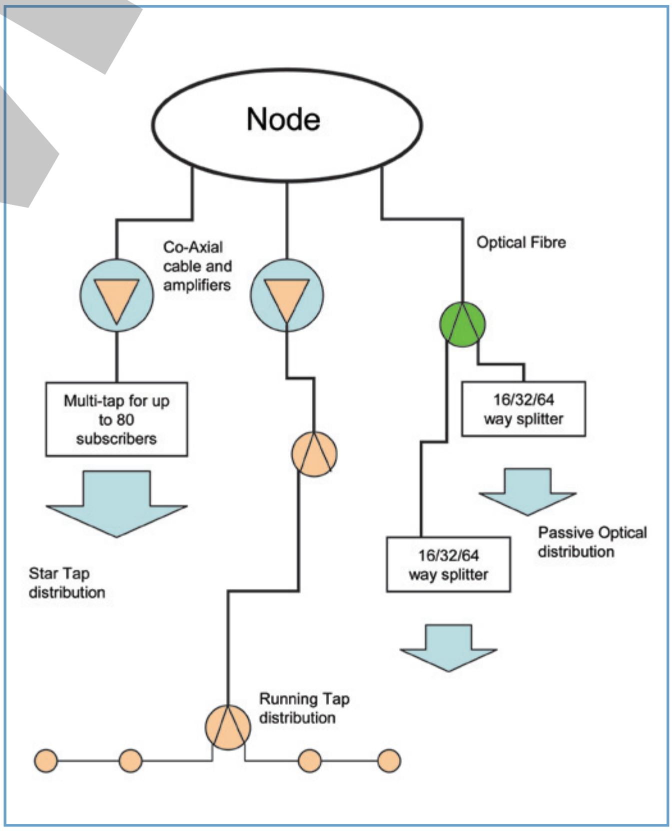

Figure. 1.2b: Types of final distribution network.

Figure 1.2b shows a simplified block diagram of the so-called final distribution or 'last mile' of a modern cable telecommunication network. The architecture of this type of network is called 'Hybrid Fibre/Coaxial' or HFC.

As technology develops, these models are changing as fibre pushes steadily deeper into the network driven by the continual pursuit of lower operating costs and higher performance. However all of the elements in this diagram are likely to be encountered in many networks for the foreseeable future.

HFC Network Detail

The starting point of the HFC network shown is the master headend. Here all the radio, television and data signals that will be transmitted over the network or passed to other networks are gathered together and made suitable for sending onward. The main headend may also be referred to as the 'central office'.

In a modern bi-directional network it is also the point at which upstream or 'return path' signals are collected and processed.

Large regional operating companies may only have a small number of master headends serving many cities. Under these circumstances a sub-headend is normally placed close to the centre of a town or city to act as both the administrative and engineering centre for the local operation.

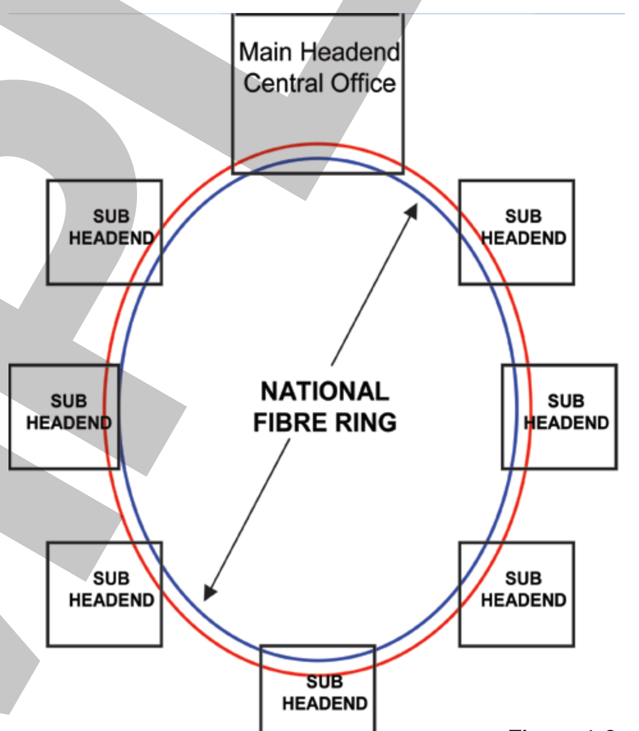

Figure 1.3a

The main headend and sub-headends are also the sites where interconnections can be made to receive from or exchange services with other third party providers.

In the case where many cities are served from a master headend,, the networks are normally linked together by an optical fibre rings design that provides protection against the failure of any individual route. These routes are sometimes described as supertrunks.

The arrangement is shown in Figure 1.3a above.

Secondary HFC Distribution Network

The headends or sub-headends supply signals to a further optical fibres that carry signals to the areas where signals are to be supplied to the distribution network. These may be in rings but sometimes the local construction issues may prevent this being possible particularly in the early deployments of a new network.

The signals are generally converted from optical into electrical at the local hub or node sites whose function is typically as in Figure 1.2b shown previously. Depending on how deep the fibre is being taken into the network these may range in size from a small building serving a few thousand homes down through large street cabinets serving some hundreds of homes right down to individual street side cabinets serving a few tens of homes.

Many factors will influence the actual architecture, the most critical of which is the use of overhead or underground cable methods of construction.

Final Distribution - The Subscriber Feeder or Drop Cable

There are generally two design layouts to be found. These being the tree and branch/running tap model or the tree and branch/star tap model. These are as shown in Fig. 1.3b and 1.3c below.

Generally the star tap model is the most economical for underground construction with the running tap model being best suited to overhead use. Local circumstances and or preferences can however use either.

From the technical perspective, the star tap model offers fewer cable connectors in the path from hub to home and is slightly better suited to two-way operation, however, in a well designed, built and maintained system their differences can be insignificant.

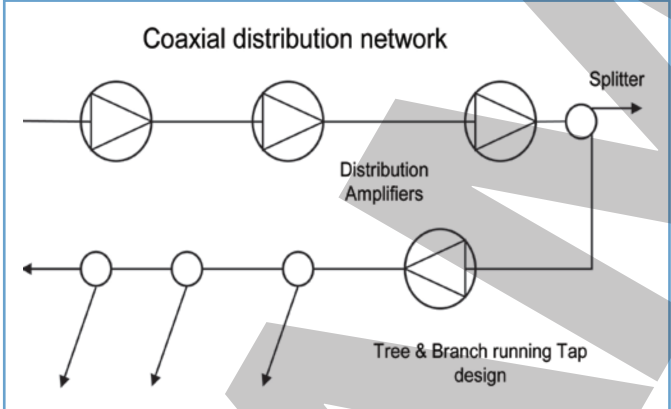

Figure 1.3b

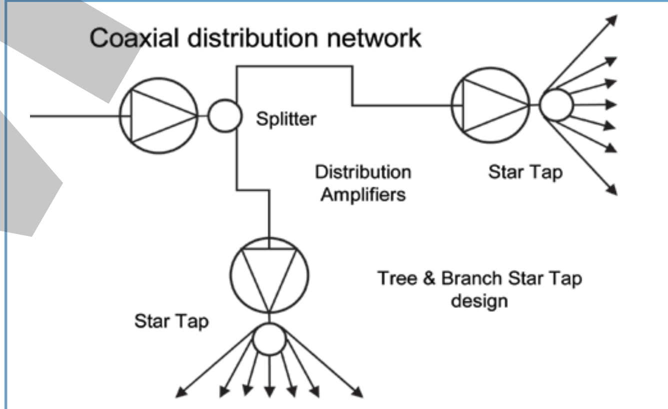

Figure 1.3c

The Return Path

However the network is configured, most operators today are required to provide a bi-directional network. Upstream communication is essential to provide subscribers with facilities such as internet access, ordering video on demand, telephony, network gaming and interactive TV services such as voting and competition entries. Communication with the headend and beyond is achieved via the cable set top box, or the home PC and modem. Return path signals occupy the frequency band from 5MHz upwards on the coaxial cable part of a network, the upper boundary often being around 50 to 65MHz depending on the system design, however, as broadband use grows that upper frequency may rise further.

All return paths are passed via the optical network to terminate at the headend where the signals are routed to local public telephone and data networks or passed to the data highway for onward transmission. In

some locations, the band from 5 to 25MHz may be unusable due to interference ingress, but better construction standards, underground instead of overhead installation and better attention to screening of network hardware can sometimes allow the whole band to be used for the return path.

The Cable Network Spectrum

Figure 1.3d below shows the entire cable spectrum from 5MHz to 1GHz. Not all present day networks cover the entire band, but eventually most networks will wish or need to use the full spectrum to 1GHz. The reason for this is the very large numbers of TV services that are available to, and required by, cable customers.

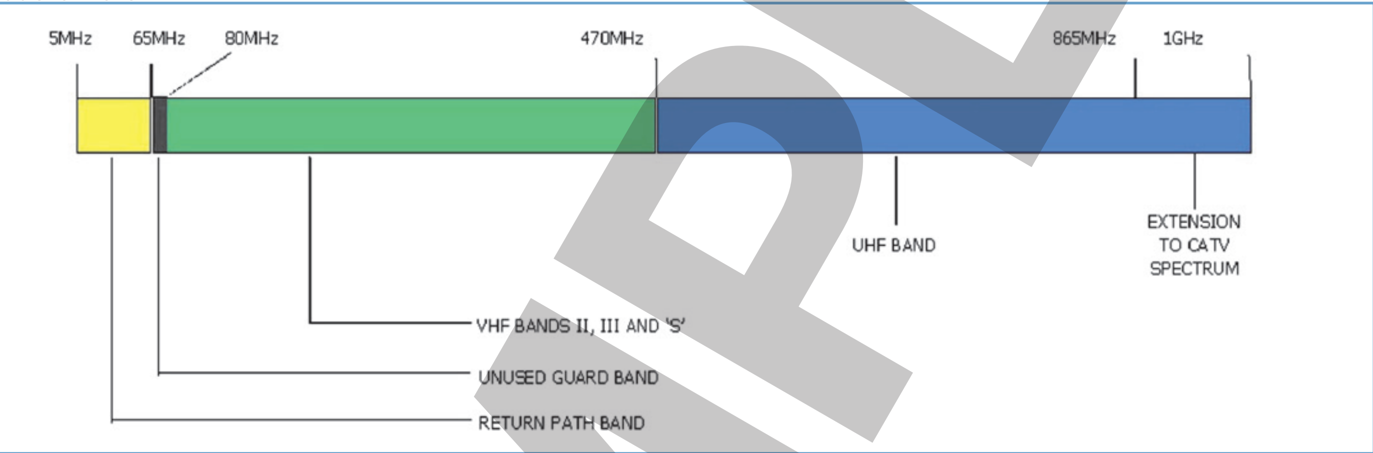

Figure 1.3d: Frequency spectrum currently used by CATV.

In this example, the small gap in the band between 65 and 80MHz is needed to separate the return path from the downstream path. This space is required because the filters that perform this function can only be realistically designed to provide this separation over a short range of frequencies between the return path or upstream band from the downstream band. It is sometimes called the 'cross-over region'.

Summary

a) Traditional CATV networks employing optical fibre and copper coaxial cables are called HFC systems. In many countries, the principal cable system operators link all their individual networks to a main head-end via an optical fibre backbone that is bi-directional.

b) Downstream signals are extracted from the backbone network at sub-headends, and upstream signals are also passed forward. The sub-headends supply smaller ring networks that transport upstream and downstream signals around the hubs. Hubs are points at which downstream optical signals are converted to electrical signals for feeding into the copper coaxial network, and upstream data is processed for onward transmission.

The coaxial network transports downstream and upstream (return path) signals between the hubs and the 'street cabinets'. At the street cabinet, the subscriber drop cable connections are made. Overhead networks will employ different subscriber feed arrangements that are dependent upon the type of dwelling to be connected.

c) The street cabinet contains an amplifier and subscriber tap panels that can feed up to 80 homes. The drop cables connecting the subscriber to the distribution network have no further amplifiers on them and are entirely passive. The older 'tree and branch' network architecture is rarely used in new networks but can provide a useful service under certain conditions.

   Overhead construction requires the distribution amplifier to be suspended at a convenient point and the subscriber taps located further away from it.

d) The return path conveys digital signals upstream from the subscriber to the headend and occupies the lowest part of the cable spectrum of signals, from 5 to 65MHz. Outgoing telephone conversations, internet traffic, VoD ordering, voting, gaming and tele-shopping are amongst the many applications using the return path.

e) A gap between 65 and 80MHz is maintained to allow adequate separation between upstream and downstream signals.

1.3.2 Telephony

Telephony has become an important part of the service offering for broadband operators. It enables them to compete with traditional telecom operators by 'bundling' TV, data and telephone services and offering them at a reduced rate.

There are three basic ways of providing telephony on a broadband network. The approach used by the broadband operator will depend very much on the age and technology employed in the network.

(a) Overlaid Networks

This particular architecture was commonly used in new build networks which were started in the early 1990s in the United Kingdom. The telephony system is a separate 'overlaid' network. This means that the cables carrying the telephony signals are separate from those carrying the CATV signals. They may, and most often do, share the same ducts and, in the case of the subscriber's drop, may even share the same cable sheath in the form of a twin or 'Siamese' cable. However, they are two completely distinct networks.

(b) RF Telephony

In older networks, where telephony services have to be added to a network which has been built using single coaxial cable drops and where duct space does not permit the addition of audio pairs or the replacement of the existing coaxial by a Siamese cable, a method of delivering telephony services to the subscribers was developed using RF carriers.

A special unit in the subscriber's home called a Voice Interface Unit (VIU) connects to a standard telephone instrument and converts the voice and signalling (dialing) signals into a digital signal. This digital signal is modulated onto an RF carrier in the system's return path band 15 to 21MHz. A second unit called the trunk interface unit is used, either at the headend or hubs, for the downstream channel or forward path in the band 297 to 330MHz which connects with a number of the VIUs in the homes using a special sharing or 'multiplexing' technique that means that several hundred users can share one channel with the negligible likelihood of getting a 'busy' tone on dialling.

RF Telephony has proved to be an ‘interim’ solution and is obsolescent.

(c) VoIP

Voice over Internet Protocol (VoIP) is a method of providing telephony using broadband data links. In general, it can be used across any IP-based network (such as the internet) but here it is specifically related to the use of DOCSIS broadband modems provided by operators to deliver high speed data. At the customer end, the modem equipment may allow connection to a standard telephone or alternatively to a special VoIP telephone.

At the operator headend or regional hub, the Voice IP traffic may be handed over to a normal switched telephony routing switch or passed on as IP traffic on a broadband link. In either case, local routing will be employed for calls beginning and ending within the operator’s network.

The use of VoIP imposes several requirements on the broadband data link in terms of guaranteed throughput of data and timing (jitter and delay) if the voice quality requirements are to be met.

Later versions of the DOCSIS specification take these into consideration.

Section One
Introduction and Overview

Revision

1. Which type of distribution network is most economical for overhead construction?
2. Name two uses for the reverse path.
3. What is the advantage of ring architectures?
4. Why must there be a gap between the frequencies used in the forward and return paths?
5. What is the advantage of cable delivery compared with 'off air?'
6. What does the acronym HFC stand for?
7. Why is the lower part of the reverse path band sometimes difficult to use?

(Answers can be found in Appendix L at the end of this course book).