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OUTSIDE PLANT

Access facilities using hybrid fibre/copper networks

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Access facilities using hybrid fibre/copper networks

Summary

This Recommendation gives information and guidelines about access facilities using HFC ("Hybrid Fibre/Copper") networks.

HFC networks are necessary for the future introduction of multimedia services with several broadband applications. HFC networks offer more chances of use as only pure networks for telecommunication or for CATV (Cable Television) distribution. Additional services as Pay-TV, Pay-per-View, Video-on Demand, home-banking, -working, -shopping and Internet access can be offered by means of these networks.

HFC networks represent also a step in the evolution process to GII (Global Information Infrastructure), that means a connection between CATV, telecommunications, data and mobile networks.

Appendix II provides examples of HFC networks.

Source

ITU-T Recommendation L.47 was prepared by ITU-T Study Group 6 (1997-2000) and approved by the World Telecommunication Standardization Assembly (Montreal, 27 September – 6 October 2000).

FOREWORD

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The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

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Access facilities using hybrid fibre/copper networks

1 Scope

This Recommendation:

- gives general information on the fundamental types of hybrid fibre/copper networks;
- describes the most important physical elements of HFC networks apart from transmission equipment;
- gives general information and guidelines for the installation of HFC networks.

2 Fundamental types of hybrid fibre/copper networks

Very different HFC network topologies can be considered, according to different Administrations' and private operators' requirements, different country or regional situations, different provided multimedia services. Moreover, HFC networks can be based on already existing telephone networks, both for the fibre and for the copper part of the network. However, the following general considerations can be applied to all the HFC network types.

An HFC network can be thought as composed of two main sections:

- First section: the "Transport Network" where the services are generated and delivered (at a national, regional or local level) up to main distribution points. The extension of the Transport Network can be huge. The physical transmission medium is the optical fibre.
- Second section: the "Access Network" where the final users are connected (at a local level) to the main distribution points. The extension of the Access Network is typically limited to a few kms in length. The bearer used in the first part of the Access Network is the optical fibre. The physical transmission medium of the last portion of the Access Network up to the users can be the symmetrical copper pair ("HFC-S" networks) or the coaxial copper/aluminium pair ("HFC-C" networks).

Typically, HFC-S networks are directly derived from traditional telephone copper access networks. The evolution towards new services can be achieved by means of particular data compression (JPEG, MPEG for instance) and transmission (HDSL, ADSL, VDSL for instance) techniques on the existing symmetrical pair cables. It is worth noticing that HFC-S type identifies a wide set of very different network solutions, according to the level of the optical fibre penetration into the Access Network and to the network topology. So, for instance, HFC-S type ranges from a simple point-to-point ADSL copper link up to FTTB ("Fibre To The Building") point-to-multipoint PON architectures.

The term HFC-C identifies a more restricted set of network solutions. HFC-C networks typically entail the installation of new active and passive coaxial components in the last portion of the Access Network, even if a simple update of an already existing HFC-C unidirectional network towards interactive services is considered. New HFC-C networks can offer up to 1 GHz bandwidth for CATV broadcast transmission and other broadband multimedia services.

It should be taken into account that:

- a study of economic factors, of already existing telecommunication networks, of present and future service requirements, of rules and regulations in each region should be carried out in order to decide between a HFC-S and a HFC-C type network;

- already existing infrastructures and ad hoc technical solutions should be used wherever possible in order to limit the environmental impact of the new HFC network, especially for the HFC-C network type.

3 Physical elements of hybrid fibre/copper networks

3.1 Optical elements

3.1.1 Optical cables

Both HFC-S and HFC-C networks make use of single-mode optical fibre cables in the Transport and in the Access Network.

It should be taken into account that:

- ITU-T G.652, G.653, G.654 or G.655 single-mode optical fibre should be used in the Transport Network. ITU-T G.652 or G.655 single-mode optical fibre are used in the Access Network;
- suitable studies have to be carried out in order to dimension the proper Access Network optical cable capacity: from 100 up to 1000 optical fibre cable capacities have been reported.

3.1.2 Optical connectors

Any standard (IEC) connector can be used in the Transport and in the Access Network.

In the case of analogue CATV transmission, the return loss of optical connectors needs to be carefully considered in order to meet the system requirements.

3.1.3 Optical amplifiers

Optical amplifiers are used both in the Transport and in the Access Network. The use of optical amplifiers as boosters can be associated with tree-type optical network topologies and with the use of optical splitters.

3.1.4 Optical splitters

In HFC networks, optical splitters are typically used in tree-type optical network topologies together with optical amplifiers in order to expand the distribution area of a single optical transmitter. In HFC-S PON (Passive Optical Networks) architectures optical splitters are used as branching devices both in central offices and in the field. From 1:2 up to 1:32 splitting ratios have been reported.

3.2 Electrical and copper elements

3.2.1 HFC-S networks

3.2.1.1 Symmetrical pairs cables

From 0.4 mm to 0.64 mm wire diameter symmetrical pairs copper cables are typically used in the Access Network for 100 up to 1500 metres typical distances. From 10 up to 3000 symmetrical pairs cable capacities are used, according to different Access Network requirements.

Studies and characterizations should be carried out on the already existing symmetrical pair copper cables in order to verify that they can support the chosen xDSL transmission technique. Refer also to the G.990-series Recommendations.

3.2.2 HFC-C networks

3.2.2.1 Coaxial cables

- *Coax-trunk cable*

1 GHz bandwidth, 12.7 mm (1/2 inch) or 19.05 mm (3/4 inch) outer conductor diameter, 75 ohm impedance coax-trunk cables are used in HFC-C Access Networks from 100 up to 500 metres typical link length between the launch and the last amplifier.

- *Coax-drop cable*

1 GHz bandwidth, RG-11 and RG-6 standard types, 75 ohm impedance coax-drop cables are used in HFC-C Access Networks from 50 up to 150 metres typical link length between the last amplifier and the coaxial network termination.

Wherever possible, cables should be chosen in order to limit the number of coaxial amplifiers. In spite of their low mechanical flexibility (which can constitute a problem during installation), 19.05 mm (3/4 inch) outer conductor diameter coax-trunk cables offer very good attenuation performance.

3.2.2.2 Coaxial connectors

The 15.825 mm (5/8 inch) and F type coaxial connectors are typically used for cable terminations. However, many different connector versions can be used according to the different coaxial cables versions, dimensions and applications.

Careful choice of connectors should be made in order to prevent in-field problems due to environmental causes (such as temperature, humidity, vibrations, etc.). In most of the cases, coaxial connectors should be protected by means of a shrinkable plastic sheath.

3.2.2.3 Coaxial splitters

Coaxial splitters are typically used on the output ports of coaxial amplifiers (especially in front of launch amplifier) in order to subdivide the electrical signal on the different coax-trunk cables of the HFC-C network. 1:2, 1:3 and 1:4 splitting ratios are common.

3.2.2.4 Coaxial taps

Coaxial taps are typically used on the output ports of the last amplifiers or for in-building coaxial distribution networks. Many types and versions are available on the market; 2, 4, 8 and 16 output ports coaxial taps are common.

3.2.2.5 Electro/optical converter and coaxial amplifiers

Electro/optical converters, launch amplifiers, line extenders and last amplifiers are used in HFC-C network respectively in order to transform the optical signal into an electrical one, to launch the electrical signal on the coaxial network, to amplify the electrical signal in the case of very long coaxial links (typically more than 500 metres), to amplify and to distribute the electrical signal to the final users area. The active tree-type coaxial network originated by a single electro/optical converter is usually designed in order to serve from 100 up to 500 users, by means of from 3 to 9 last amplifiers.

The use of line extenders should be limited to those cases of actual necessity.

3.2.2.6 Power supply

The coaxial portion of an HFC-C network is remotely powered from the electro/optical-launch amplifier cabinet by means of a properly dimensioned power supply (45-60 Vac, 10-15 A are typical values).

The power supply should be designed in order to limit the environmental impact (noise) in urban installation.

4 Installation

This clause gives general information and guidelines on some particular aspects of the installation of metallic cables forming a part of HFC-S and HFC-C networks. See L-series Recommendations for optical fibre cable installation practices.

4.1 HFC-S networks

HFC-S type identifies a wide set of very different network solutions, according to the level of the optical fibre penetration into the Access Network and to the network topology. So, installation procedures can involve a simple ADSL modem installation up to the in-field layering of new optical cables and ONU (Optical Network Unit) cabinets in the Access Network, with a huge variety of situations and potential problems.

It should be taken into account that:

- existing infrastructures should be used wherever possible (ducts, manholes, etc.);
- proper technical solutions should be studied in order to limit the environmental impact of new cabinets and new cable installation in terms of civil works, urban soil occupation, visual effect;
- proper technical solutions should be studied in order to ensure the reliability and the maintenance of the HFC-S network from the viewpoint of hardware and software;
- existing infrastructures should be studied as to how they could be reused in HFC-S networks.

4.2 HFC-C networks

With respect to the HFC-S type, the HFC-C type identifies a more restricted set of network solutions. Some information and guidelines are given in the following on different HFC-C network elements.

4.2.1 Coaxial cables

Coax-trunk cables are typically less flexible and more cumbersome than, for instance, optical cables. Due to these reasons, ad hoc manholes, ducts and installation procedures have to be used in order to avoid any cable damage.

It should be taken into account that:

- suitable pulling, handling and layering procedures should be observed in order to avoid cable kinks according to the cable recommended curvature radius;
- for in-duct installation, suitable ducts and manholes should be used for trunk cables. From 36 up to 63 mm diameter ducts have been reported for a single trunk cable installation;
- for aerial or wall installation suitable cable accessories (holders, steel wires, lashes, etc.) should be used to support and fix the cable.

4.2.2 Cabinets

The high number of outside plant cabinets for active equipment is a typical characteristic of HFC-C networks.

Suitable cabinet design should be carried out in order to ensure the operative range of active equipment according to their characteristics and to the environmental conditions (temperature, humidity, vibrations).