

Broadband: Network and topology

A broadband network consists of geographical parts. The topology of a network describes how the different parts of a network are connected. The most relevant topologies for the backbone and area networks are tree topologies, ring topologies and meshed topologies. For the first mile, two main basic topologies: point-to-multipoint (p2mp) and point-to-point (p2p).

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Network levels

A broadband network consists of geographical elements (horizontal dimension) which include 3 distinct parts:

- **Backbone network:** Consists of a ring of fibre optic cable connecting different areas of the municipality or region. The ring topology has the advantage to be robust (redundant network) against single fibre cuts or other faults (e.g. breakdown of one side). More advanced topologies (e.g. meshed) are sometimes used in the backbone section of the network.
- **Area networks** (i.e. backhaul): Connect several access nodes aggregating the local traffic further up in the network. Often implemented with a ring of optical fibre cable, although tree topologies can be used. If funds available for the moment are very limited the total end-users to be connected in the area are relatively few, microwave links may be used as a short- to medium-term solution.
- **First-mile (also called last-mile) connections to the end-users:** Links from the end users to the access nodes where the first traffic aggregation takes place. Each situation will present different logistic, economic and demographic conditions; hence different infrastructure solutions may be best suited.

Network topologies

The topology of a network describes how the different parts of a network are connected. For a backbone network, the most relevant topologies are tree, ring and meshed topologies. Other existing topologies listed below show a poor network failover and are therefore not as relevant for the backbone network.

- **Tree:** The traffic from each element is aggregated upwards in a hierarchical manner; a tree topology is generally cheaper, but less robust: In case of a fibre cut or other fault certain parts of the network will be disconnected for long periods of time. Moreover, for each step up the hierarchy, traffic originating from more nodes shares the same physical connection.
- **Ring:** Each network element is connected to two elements in such a way that all connections form a ring. The ring topology has the advantage that any node is connected to two neighbouring nodes (this is sometimes referred as “redundancy”). In case of a fibre cut or other fault, traffic can be rerouted the other way often automatically, while the fault is repaired.
- **Meshed:** Each network element is connected to several other elements; this is the most robust

and fastest but also most complex and expensive topology due to high wiring and hardware efforts.

- **Star:** All connections to the other nodes start from a central node. The main advantage of this topology is that all nodes can easily communicate with each other via a central node. The main disadvantage is that if the central node is interrupted, the whole network collapses. Depending on the network coupling element used in the centre of the star topology, collisions can be a problem. The data flow is performed by a single device. This can be advantageous for security reasons or restricted access, but if the central node is disrupted in the star topology, the entire network is vulnerable.
- **Bus:** All nodes are connected directly to a cable. Each host is connected to a common cable. The key devices allow the host to "link" to the shared medium. An advantage of this topology is that all hosts are connected to each other and can communicate directly with each other. It allows all network devices to read all signals from other devices. As regards the downside, in case the cable connection is interrupted, the connection of the hosts is interrupted.

Two main basic topologies for the first mile

- **Point-to-multipoint (p2mp):** The first aggregation node is transmitting information to a number of end-users over the same shared medium, using one transmitter. This take place both in wireless communications but also in wired communications, if the physical medium is simply split along the way between the aggregation node and the end users (e.g. fibre point-to-multipoint used in PON, or coax cable TV networks). In this case, the same physical signal is received by all end users, which are then sharing the bandwidth.
- **Point-to-point (p2p):** The first aggregation node is transmitting information to a number of end-users over dedicated physical channels, using a corresponding number of transmitters. In wireless communications this can be achieved if the communication beams do not overlap with each other (radio links), while in wired communications a dedicated line connects the aggregation node with each end user (e.g. fibre point-to-point and telephone lines).

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Broadband: Actors in the value chain

The basic roles of Physical Infrastructure Provider (PIP), Network Provider (NP) and Service Provider (SP) can be taken by different actors.

Broadband: Access to infrastructure & service-based competition

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Broadband: Plan definition

The key to successful regional broadband development lies in defining a plan that includes goals, collaborations, and specific needs and stakeholders.

Broadband: Action plan

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Broadband: Technology overview

An overview of different wired, wireless and upcoming broadband technologies and a description of their advantages, disadvantages and sustainability.

Broadband: Basic business models

Choosing the right business model depends on the roles of the market actors in the broadband value chain.

Broadband: Investment models

Investment models present interesting involvement opportunities for a public authority that engages in regional broadband development.

Broadband: Main financing tools

The European Commission has a range of financing tools for high-speed broadband development projects across the EU.

Broadband: State aid

State aid for broadband may be necessary in some places where the market does not provide the necessary infrastructure investment.

Broadband: value chain, actors & business models

Different business models are available to public authorities and other market actors in broadband development.

Broadband: Choice of infrastructure

Broadband networks require different infrastructure types based on different logistic, economic or demographic conditions. Use the questions to help choose.

Broadband: Technology comparison

A comparison of broadband technologies presents features of each solution and helps decisions on the best solution for different regions.

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