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Technical newsletter
The challenges and importance of fibre optic network architecture
PART 1

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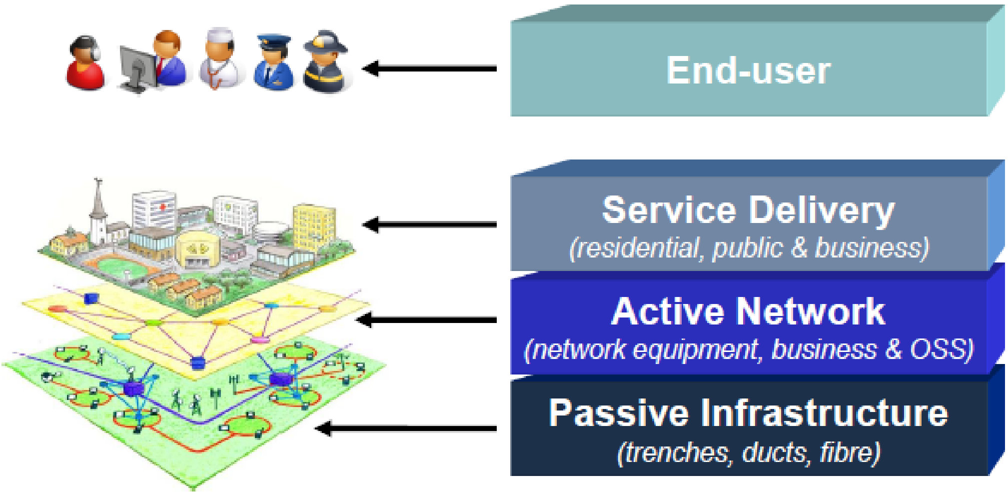
Full country-wide coverage by very high-speed long-distance fibre optic networks and access networks (FttX, in particular FttH/FttO and dedicated networks), working together with 4G/5G mobile networks, will provide cutting-edge technology for the applications and services of today and tomorrow (Smart cities).
Backbone and access networks are made up of several layers:



The various layers in a telecoms networks have very different expected lifespans. The passive infrastructure represents more than 80% of the overall cost and has to be operational for several decades. The other layers generally last a far shorter time, around 10 years for active equipment and 3 to 5 years for terminal equipment.

Network and service performance and quality are directly linked to the choices made by the various stakeholders involved in the various stages of the project, from design and construction to operation and maintenance.

See also the Europacable document "**Expected Lifetime of Passive optical infrastructures**".

The challenges confronting the quality of fibre optic networks

The quality, reliability and durability of fibre optic networks depend on many factors. The roll-out of fibre optic networks, particularly FttH/FttO, involves countless network managers (private operators, local authorities, etc.), players at all stages of the project, the use of a wide range of highly technical equipment and specific installation conditions.
Considered together, these requirements make it a complex task to ensure that the network design is coherent and consistent across the entire country, and to monitor and measure its quality at every single phase of the project.

Network sustainability

Passive fibre optic network infrastructures are designed to handle constantly increasing speeds (up to tens of Gigabits) for several decades, without having to be modified. These infrastructures may also carry all the data traffic of FttE/FttO and 4G/5G/6G mobile networks, as well as the data of dedicated networks for smart territories. The quality of the product and project design and their installation, as well as their reliability, are therefore essential to ensure the longevity, scalability and interoperability of these infrastructures, and consequently the profitability of the investment.
In addition, network pre-acceptance and final acceptance, in compliance with regulatory requirements, standards and best practice, are one of the major keys to the long-term future of the network infrastructure. Any malfunction will cause deficient performance of the constructed fibre-optic lines.

For more information, please see Europacable Technical newsletter "**Optical cable material selection and aging**".

Quality of service

Very high-speed fixed fibre-optic and mobile (4G/5G/6G) networks are the base of the digital society and the attractiveness of our regions.
Applications, services and uses, especially of intelligent territories, will grow in numbers and will be increasingly widely used. How the Covid epidemic was contained led to an explosion in teleworking, distance learning, teleconsultation and streaming...
Optimal security and very high availability in terms of connectivity, flow rates and transmission times are essential, and the only way of achieving them is by deploying high-quality infrastructures.

To achieve a sustainable network and ensure a high level of service, we need to ensure that a coherent network architecture is put in place and that high-quality infrastructure is deployed.

Quality of the architecture

Project consistency and network architecture design

First and foremost, the need for projects to be geographically and technologically coherent must guide the overall strategy for developing the architecture of end-to-end wireline fibre-optic communications networks.
The design of a communications networks infrastructure and architecture must take all these issues into consideration:

- **Its topology, size, location, environmental impact (energy efficiency), cost (CAPEX and OPEX), its operation and maintenance.**
- **Further, depending on the required quality of service, high availability demands high resilience and even redundancy of the networks.**

The reliability, durability, interoperability, homogeneity, and scalability of networks over several decades depend on two essential conditions:

- **The components of an architecture must meet functional, mechanical and environmental requirements for the external and internal parts of the network.**
- **Installation must be carried out in compliance with engineering and good practice rules (normative references, benchmarks, guides).**

The ultimate objective must be a high-quality network, taken into consideration from the initial design stage of the project, the preliminary studies (engineering) and the network architecture, as well as when calls for tenders are made, and the bids analysed.

For more information, please see Europacable Technical newsletter "Understanding an optical fibre cable datasheet" which shows how to select a cable among others during a bidding process for example.

Technical and economic optimisation must consider many criteria. For example, it is essential not to give priority to reducing investment costs (CAPEX) at the expense of operating and maintenance costs (OPEX). The higher the quality of the deployed infrastructure, the lower the operating and maintenance costs will be and the simpler its implementation. In the overall cost of a passive optical network, the cost of installation is much higher than the cost of the hardware (optical cables, accessories, etc.).
In another example, the location and number of optical nodes for FttH networks must be optimised as a trade-off between the service costs and collection costs.
If the passive equipment selected is not well designed and fails to offer the required level of reliability and scalability to achieve an expected lifespan of several decades, overall network performance will suffer, and the cost of Operation and Maintenance (OPEX) may increase considerably.

Network scalability

A sustainable network must be able to adjust to changing technologies. Accordingly, the infrastructure must be **adaptive** so that new connectivity points can be installed as well as new transmission systems that are ever-more efficient, every five to ten years.

Network interoperability

Interoperability is the capability of several existing or future systems and networks to work together without access restrictions.

Regulation must make sure that networks infrastructures are **consistent and interoperable** even when there are many players (local authorities, national operators, development operators) and equipments.

Technical interoperability requires that the equipment complies with current standards and can be interconnected (therefore having compatible interfaces).

Deployment interoperability requires that the equipment be consistent and installed according to the state of the art so as to be accessible and allows all the operators concerned to work on it.
Interoperability in operations calls for consistent network intervention procedures.

The concept of network security and high availability

Security and high availability are essential facets of a network and must be implemented as soon as the network architecture is designed.

Infrastructure security: The risks of faults must be identified in every area of the project and the appropriate standards of equipment and good installation practices chosen to guarantee the operating objectives.

The **availability** of a service is defined as the capacity of a system to ensure the operational continuity of that service over a given time. It is characterised by an availability rate calculated as the percentage of time units during which the service is available. This rate is often expressed in terms of downtime per year:

AVAILABILITY RATE	DEFINITION
99%	3.65 days/year of downtime
99,9%	8 hours 45 min/year of downtime
99,99%	4 hours 38 min/year of downtime
99,999%	~ 5 minutes/year of downtime
99,9999%	~ 30 seconds/year of downtime

The network designer must set an availability rate target based on the service levels he wants to attain. To do this, two tools at available: redundancy and resilience.

Redundancy means that the networks are "duplicated", and the routes are separate. It is essential for vital data flows. It depends more than anything on the quality and robustness of a network's passive and active equipment and its installation. It takes many redundancy levels to minimise the impact of a failure in any part of the network.

Resilience is the capability of a system to continue operating in the event of a breakdown, a technical failure, an intentional or unintentional incident and/or extreme stress. It depends more than anything on the quality and robustness of a network's passive and active equipment and its installation. Quality resilience is based on redundancy.

In today's digital economy, vital infrastructures like communications networks must be available non-stop, and the only way of generating maximum availability is only redundancy.

Failure to comply with one or more of these best practices when designing the architecture will directly impact the durability, lifespan, scalability, and availability of the network, as well as the operating and maintenance costs and, above all, the quality of service (QoS).

RECOMMENDED BY EUROPACABLE

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