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WSIS+20 FORUM
HIGH-LEVEL EVENT 2024

Joint ITU-D FNS and ITU-T SG15 workshop

Challenges and solutions for broadband infrastructure deployment in developing countries, rural and remote areas

Co-hosts

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ITU-T SG15

Challenges and solutions for broadband infrastructure deployment in developing countries, rural and remote areas

Part 2
Update on Fibre access technologies
Network topologies
Innovative solutions to reduce time and cost of deployment

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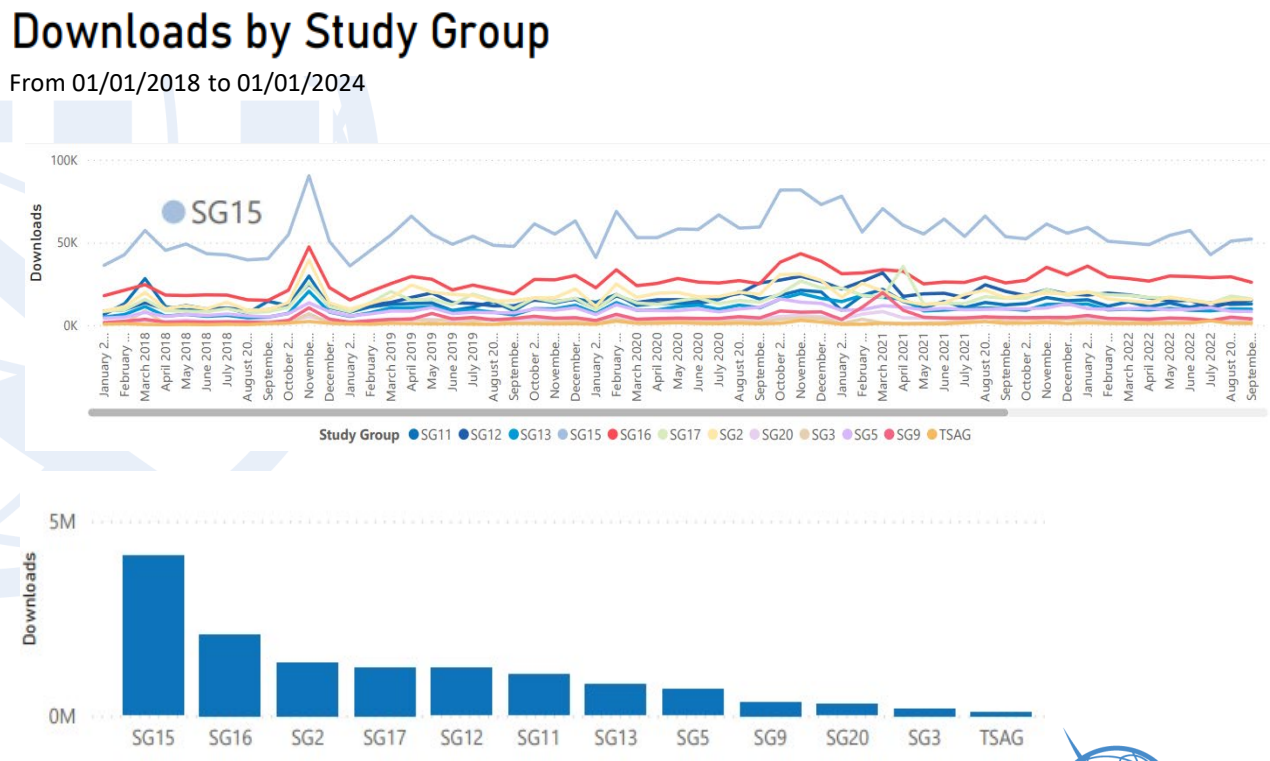
ITU-T SG15
Transport, Access and Home Networks

Who we are - What we do - Why we matter

- Standardization group in ITU-T for Transport, Access and Home Networks
- Activities relate to WSIS Action Line C2 “Information and communication infrastructure” and UN Sustainable Development Goal SDG 9 “Industry, Innovation and Infrastructure”



Fibre access technologies

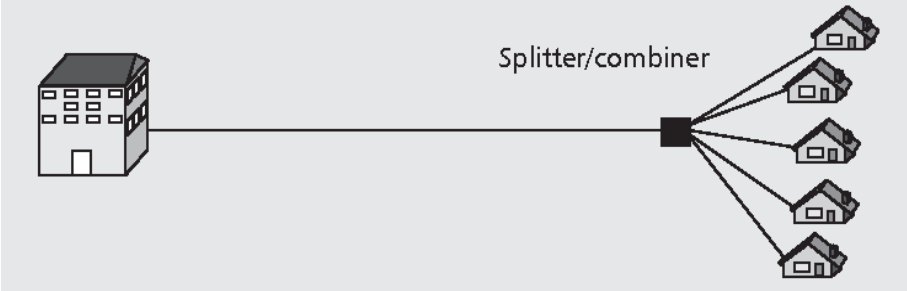
Advantages

- Fastest and most reliable broadband technology to connect homes, business premises and mobile cell sites
  - Highest speeds and longest distances at the lowest operating cost
  - Future-ready network easy to upgrade by simply upgrading electronics at the ends
  - Longer life-time and no worry about electromagnetic radiation
  - Less power consumption
- Tremendous development of innovative technologies in the last decade to provide
  - Higher download and upload speeds (PON and PtP)
  - Increase the fibre optic cable density and reduce the carbon footprint (G.657 with RCD, microcables)
  - Simplify and reduce deployment costs (microducts, cable installation by blowing, infrastructure sharing)
  - Mitigate labor challenges and eliminate splicing (pre-connectorized solutions)

Fibre access technologies

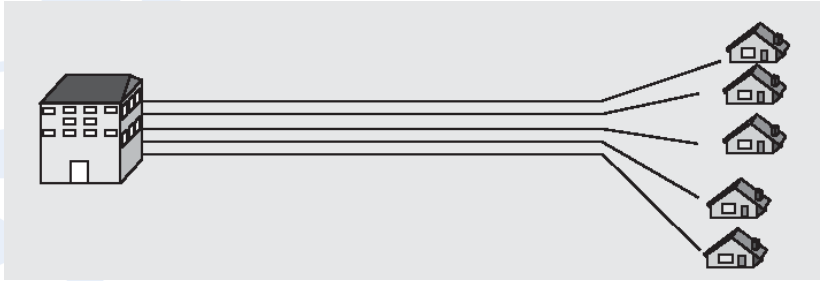
Two Types of Solutions for Fibre Access

Point-to-multipoint (PtMP) access using passive optical networks (PONs)



- Passive outside plant
- TDM/TDMA for medium sharing and access control
- High loss budget due to splitter loss
- Low port density at central office

Point-to-point (PtP) single fibre bidirectional (BiDi) access



- Passive outside plant
- Dedicated fibre for each user
- Low loss budget
- High port density at central office

Fibre access technologies

ITU-T PON Standards with Commercial Products

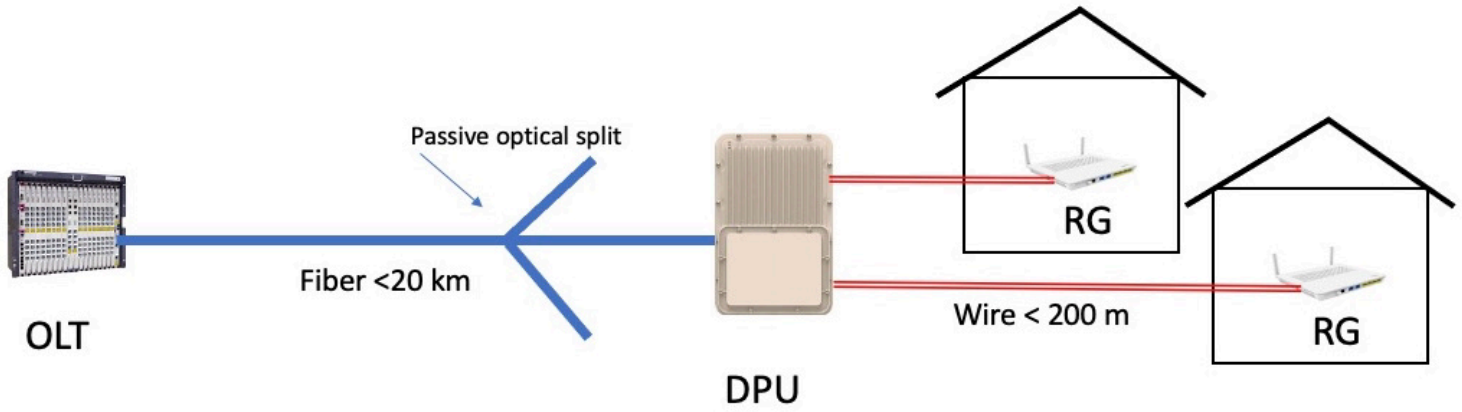
PON system	Downstream rate (bps)	Upstream rate (bps)	Standards	Standard approval year	Note
BPON	622M	155M	ITU-T G.983 series	1998	First commercial PON
GPON	2.5G	1.25G	ITU-T G.984 series	2003	Most widely deployed optical access system, market size >10B$
XG-PON	10G	2.5G	ITU-T G.987 series	2010	large scale deployment from 2018, >10M XG(S)-PON ports have been deployed, each port supports 32, 64, or 128 users
XGS-PON	10G	10G	ITU-T G.9807.1	2016	
NG-PON2	40G (4x10G)	10G (4x2.5G)	ITU-T G.989 series	2015	

BPON: Broadband passive optical network
GPON: Gigabit-capable passive optical network
XG-PON: 10-Gigabit-capable passive optical network
XGS-PON: 10-Gigabit-capable symmetric passive optical network
NG-PON2: 40-Gigabit-capable passive optical network

Latest standardization effort: 50G-PON (G.9804 series) is the next generation after 10G (XG-PON and XGS-PON), commercial products available in 2024

Fibre access technologies

Gigabit access using hybrid fiber – copper
Fibre To The extension point (FTTep)



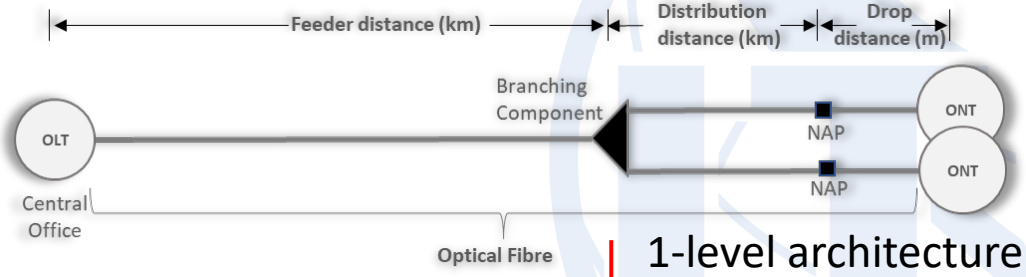
Existing copper wires used for the last 200m to reduce deployment cost

Fiber to the extension point architecture described in Broadband Forum TR419i2
Fiber PON standards: ITU-T G.984, G.987, G.989, G.9807.1, G.9804
Copper access standards: ITU-T G.9701, G.9711, G.9960

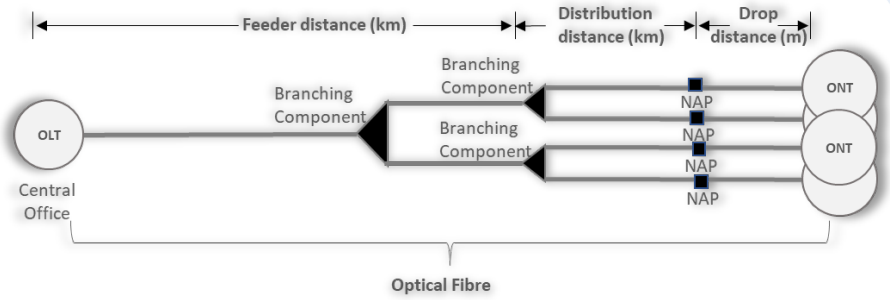
Fibre access technologies

ITU-T L.250 (01/2024) - Topologies for optical access network

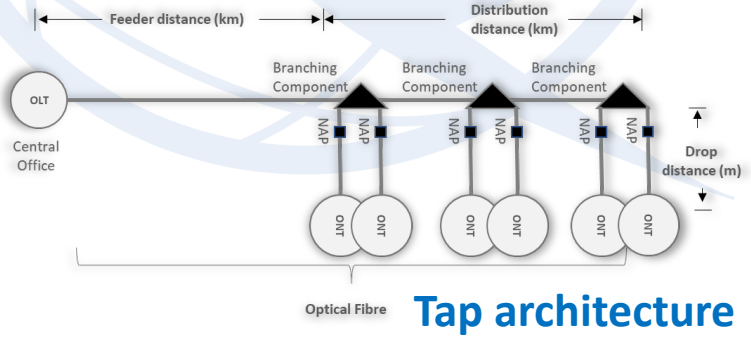
Optical fibre Point-to-multipoint



1-level architecture



2-level architecture



Tap architecture

Preferred architecture to connect low density areas

Features

✓ Reduce demands for number of fibres, leading to decrease of construction cost

× The branching unit (splitter) increases the insertion loss and reduces the transmission distance as the number of branches is increased

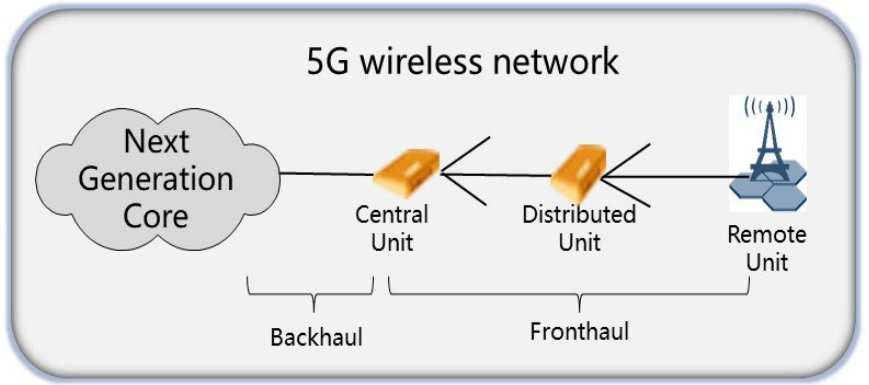
Tap architecture

✓ Tap architecture configuration enables to deploy extremely low fibre-count distribution cables

Fibre access technologies

ITU-T PtP Optical Access Standards

PtP Rate	Loss budget (distance)	Standards	Approval year
1 Gb/s	15dB (10km), 20dB (20km), 25dB (30km)	ITU-T G.986	2010
10 Gb/s	15dB (20km), 23dB (40km)	ITU-T G.9806	2020
25 Gb/s	15dB (20km), 23dB (40km)	ITU-T G.9806 Amd1	2020
50 Gb/s	15dB (20km), 23dB (40km)	ITU-T G.9806 Amd2	2021
100 Gb/s	10dB (10km), 15dB (20km)	ITU-T G.9806 Amd3	2023

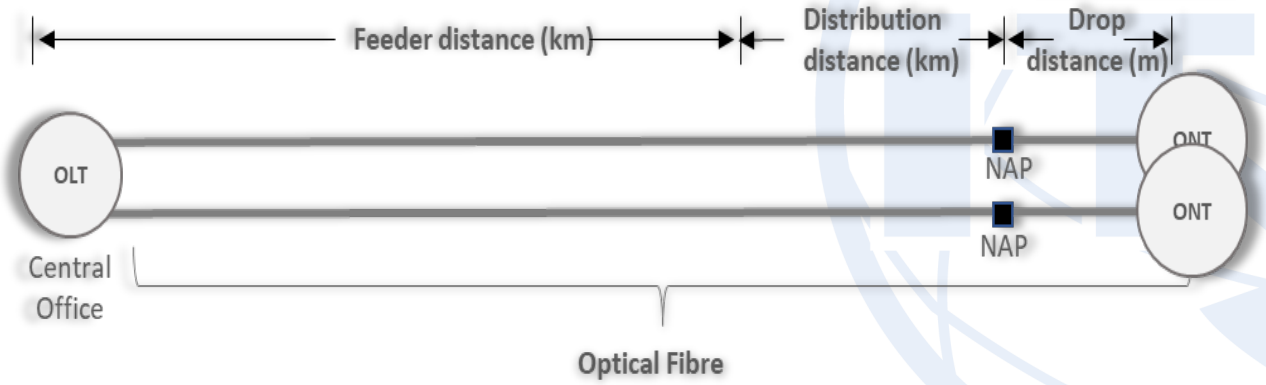


- ITU-T has specified 11 types of optical access links to support 1G, 10G, 25G, 50G, 100G PtP
- Main implementations of these links are wireless xHaul (fronthaul, backhaul)

Fibre access technologies

ITU-T L.250 - Access network architecture design choices

Optical Fibre Point to Point



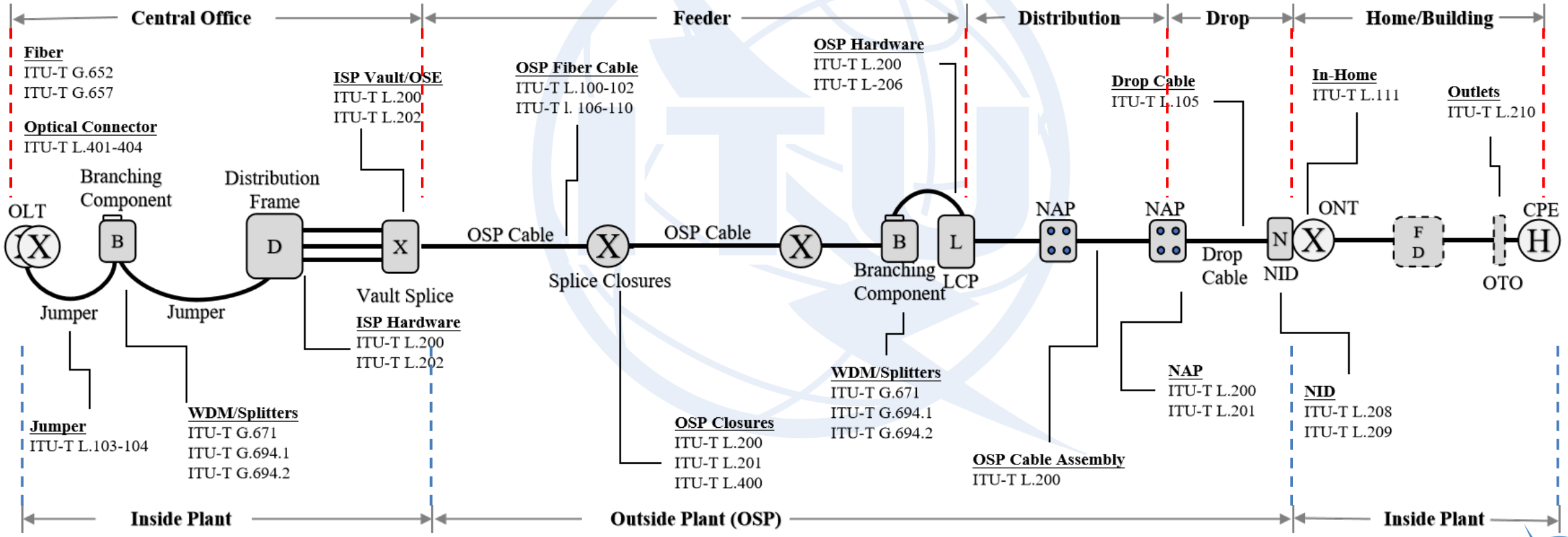
Features

- ✓ Low optical loss, providing maximum transmission distance between CO and end user;
- ✓ High bandwidth capability and provides an easy upgrade path.

- × A dedicated fibre for every user means high fibre count demands and high construction cost.

Fibre access technologies

ITU-T Access network components Recommendations



Fibre access technologies

Innovative solutions to reduce time and cost of deployment

Challenges Faced by Operators:

- Emphasis on **passing homes** and deployment **speed up**
- Shortage of **skilled labor**
- **Limited space** across all infrastructure
- **Demand for reliability** in varying environmental conditions

Bandwidth Demand & Future-Ready Networks:

- Emerging and advanced technologies mean FTTH networks need to support **higher data volumes**

Sustainability:

- Re-shaping how FTTH networks are deployed, **environmentally friendly practices** and **materials**

Network Infrastructure Selection: Strategic Criteria

Pre-connectorized & factory terminated solutions for **quality, future-ready** network deployments

More cables and **terminals** are being deployed in **less space**

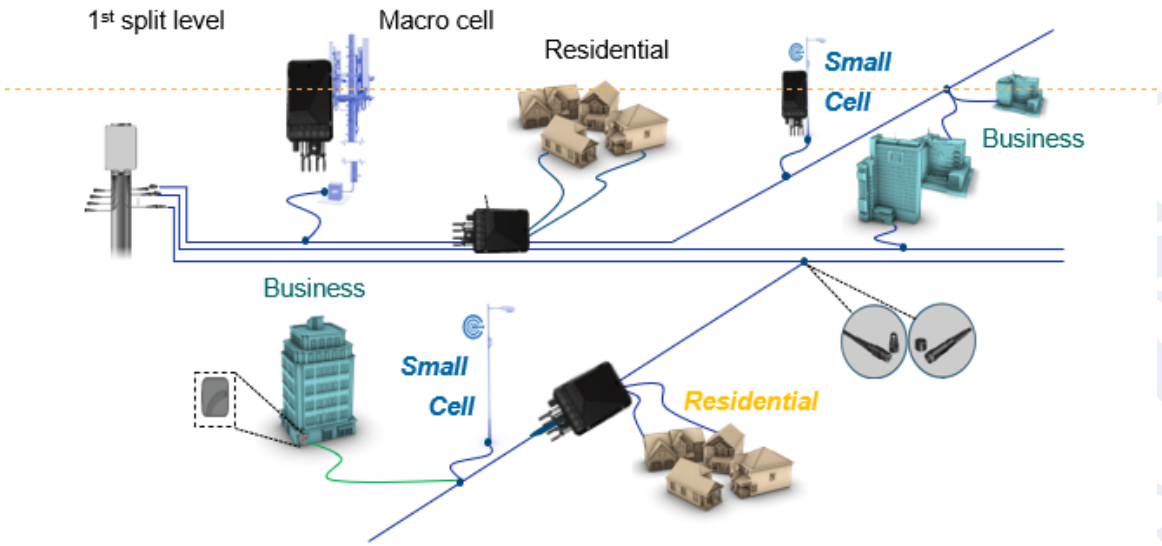
Smaller products with a **reduced carbon footprint**

Simpler products installed quickly and easily in the field

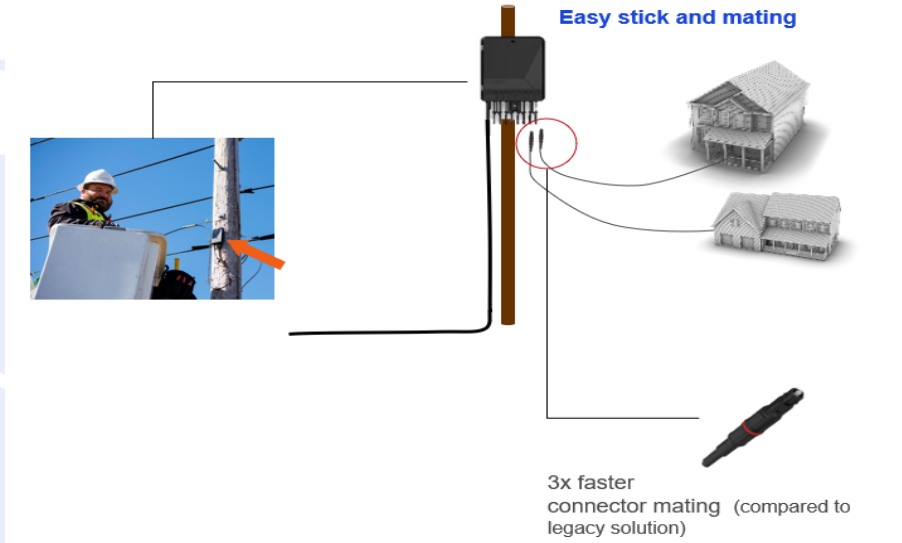
Fibre access technologies

Pre-connectorized & factory terminated solutions

Durable and Future Proof Solutions



Reduce complexity

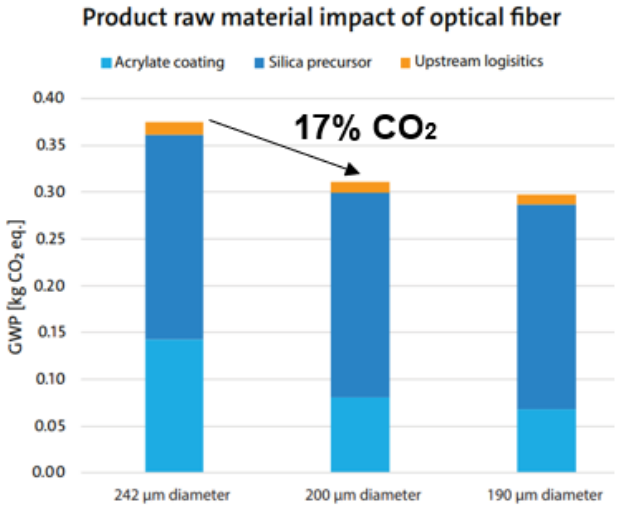


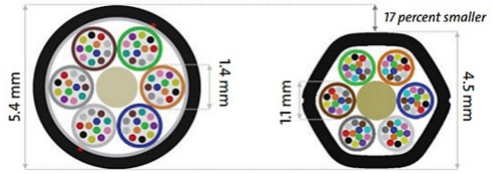
- Reduces civils, labor and time to deploy
- Eliminates splicing in the field
- Future-ready: versatile solution, easy to integrate future technologies (5G/6G)
- Quality & reliability: rigorous factory testing of all installed hardened connectors ensure longevity of the products
- Plug & play with innovative hardened connectivity : Easy stick and mating
- Smaller footprint
- Faster deployment allows higher number of Homes Passed and Homes Connected
- Cost effective with overall reduced TCO

Fibre access technologies

Fibre and cable innovations

Densification: Smaller fiber smaller cables



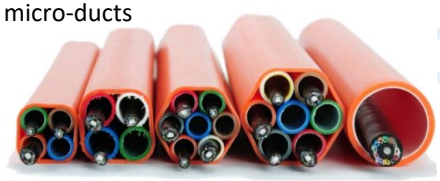


Micro cable
Standard 242 µm diameter fibre

Micro cable HD
200 µm diameter fibre

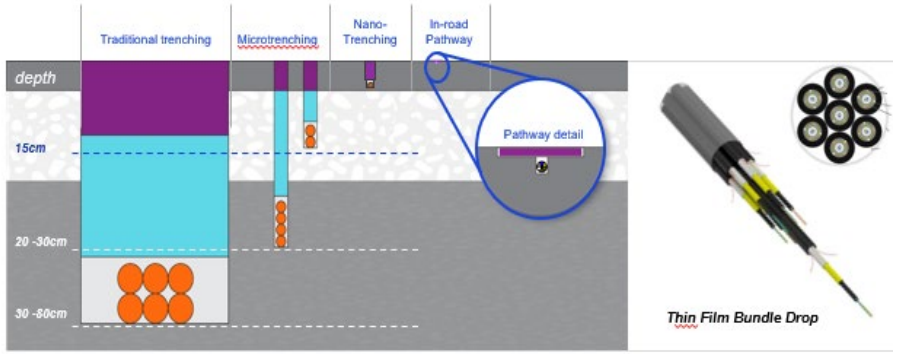
17% smaller Outer diameter

Micro-cables are less rugged than conventional loose tube cable and must always be installed inside micro-ducts



Sustainable

Greener deployment methods



Smaller fibers & cables allow smaller trenches

Duct Space Reutilisation

Consortium Builds/ Infrastructure Sharing

- Smaller fibers and denser cables
  - Proactively plan-ahead for fiber spares
  - Fiber innovation allows high performance fibers with reduced coating diameter
  - Increase cable and duct density while reducing size and raw material
  - Smaller fiber reduces raw material impact (~15-20% of total CF)
  - Renewable electricity brings additional cable footprint reduction (electricity ~80% of total CF)
  - Smaller cables (micro-cables) means minimal waste with innovative trenching methods (nano and micro trenches)
  - Installation by blowing in micro-ducts

Fibre access technologies

Other ITU-T SG15 optical fibre cable innovations for the access

- ITU-T L.100 (01/2024) Optical fibre cables for duct and tunnel application
- ITU-T L.109 (01/2024) Construction of optical/metallic hybrid cables
- ITU-T L.109.1 (11/2022) Type II optical/electrical hybrid cables for access points and other terminal equipment
- ITU-T L.108 (03/2018) Optical fibre cable elements for micro-duct blowing-installation application
- ITU-T L.110 (08/2017) Optical fibre cables for direct surface application
- ITU-T L.102/L.26 (08/2015) Optical fibre cables for aerial application
- In preparation
  - Terrestrial free space optics for mobile backhaul with short reach interfaces
  - Distributed fibre optic sensing system for terrestrial optical transmission system
  - Pre-connectorized cabling components for FTTx infrastructures

Fibre access technologies

Consideration of alternatives business models
Sharing the costs to build and/or to operate the network

- Common view amongst policy-makers and industry stakeholders that infrastructure sharing and co-investment models offer greater benefits at lower costs
  - Passive infrastructure sharing
    - Towers, poles, ducts and premises are shared
    - All the active network electronics remains proprietary to the individual network operators
    - Cross-sectoral infrastructure sharing: parts of the infrastructure are equally used by companies in other sectors of the economy
    - The simplest form of infrastructure sharing, but offers less scope for cost-savings than active infrastructure sharing
  - Active sharing
    - Electronic infrastructure such as switches and radio access nodes as well as some passive network elements
    - Offers greater scope for cost reduction, but complicates the operational procedures and makes service differentiation difficult.
    - Various sub-categories of active infrastructure sharing, particularly for mobile networks, depending on how deeply the active electronics are shared
  - Key role of regulation

Source: https://digitalregulation.org/the-infrastructure-sharing-imperative/

Fibre access technologies

Consideration of alternatives business models
Sharing the costs to build and/or to operate the network

- Open Access Network model
  - Separates the physical and operation layers of the network from the services layer of the network
  - In Open Access Network model, the owner and/or operator of the network does not supply services over its network, but allows internet services providers (ISP) to have wholesale access to its network to deliver services to the subscribers
  - Two types of models
    - Two-layer model: the network is owned and operated by one company, and ISPs deliver services over the network
    - Three-layer model: the physical layer (fibre and wireless infrastructure) of the network is owned by one company, operated and maintained by a second company, and ISPs deliver services over the networks
  - Avoids the uneconomical aspects of access network overbuild
  - Enable ISPs to offer their services in rural and low population density areas where the high deployment cost of their own network infrastructure would not be economically justified
  - Open Access Networks are successfully deployed worldwide in numbers of rural and low population density regions

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