# Broadband (IV): Cable access, Fiber, and other Media

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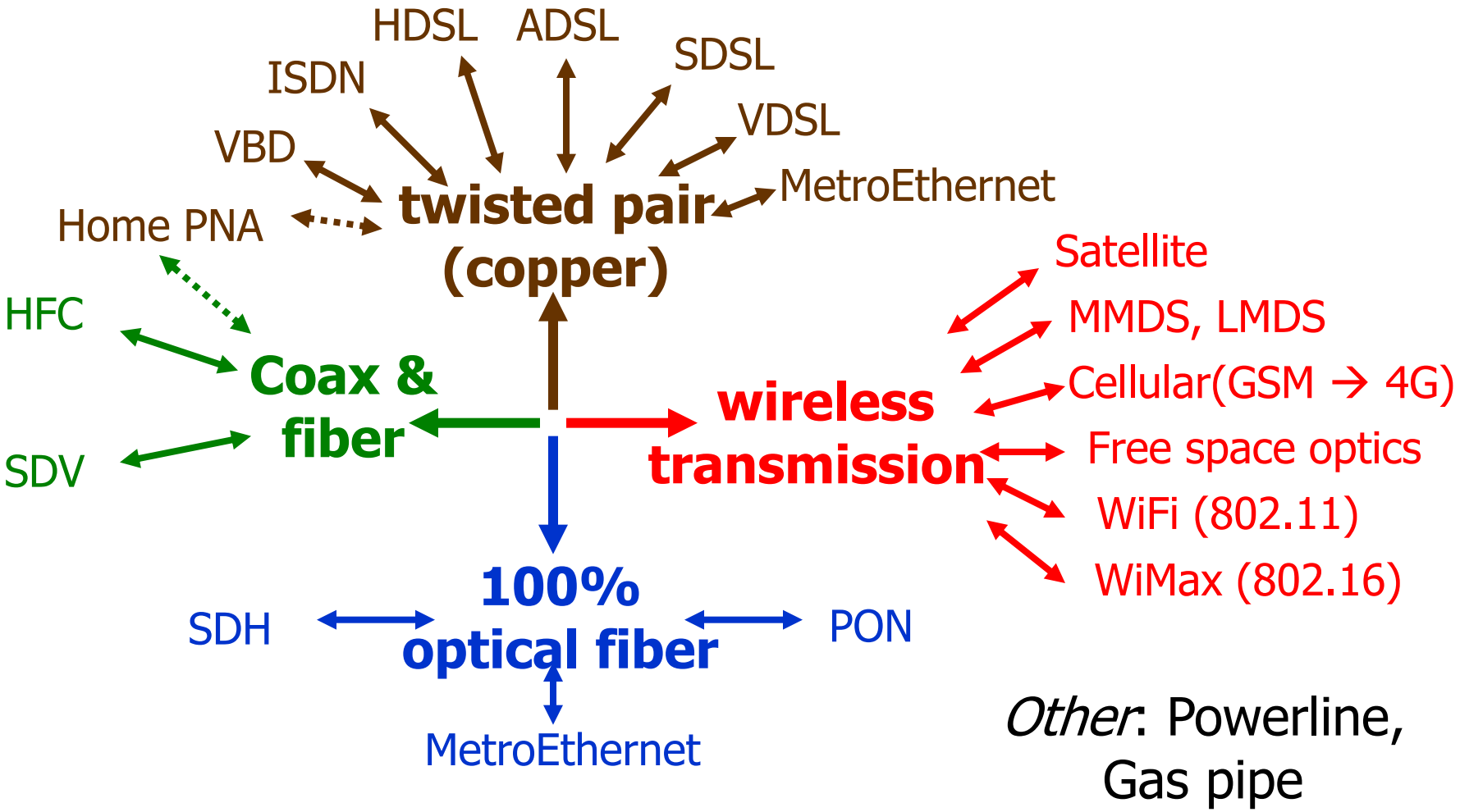
# Introduction

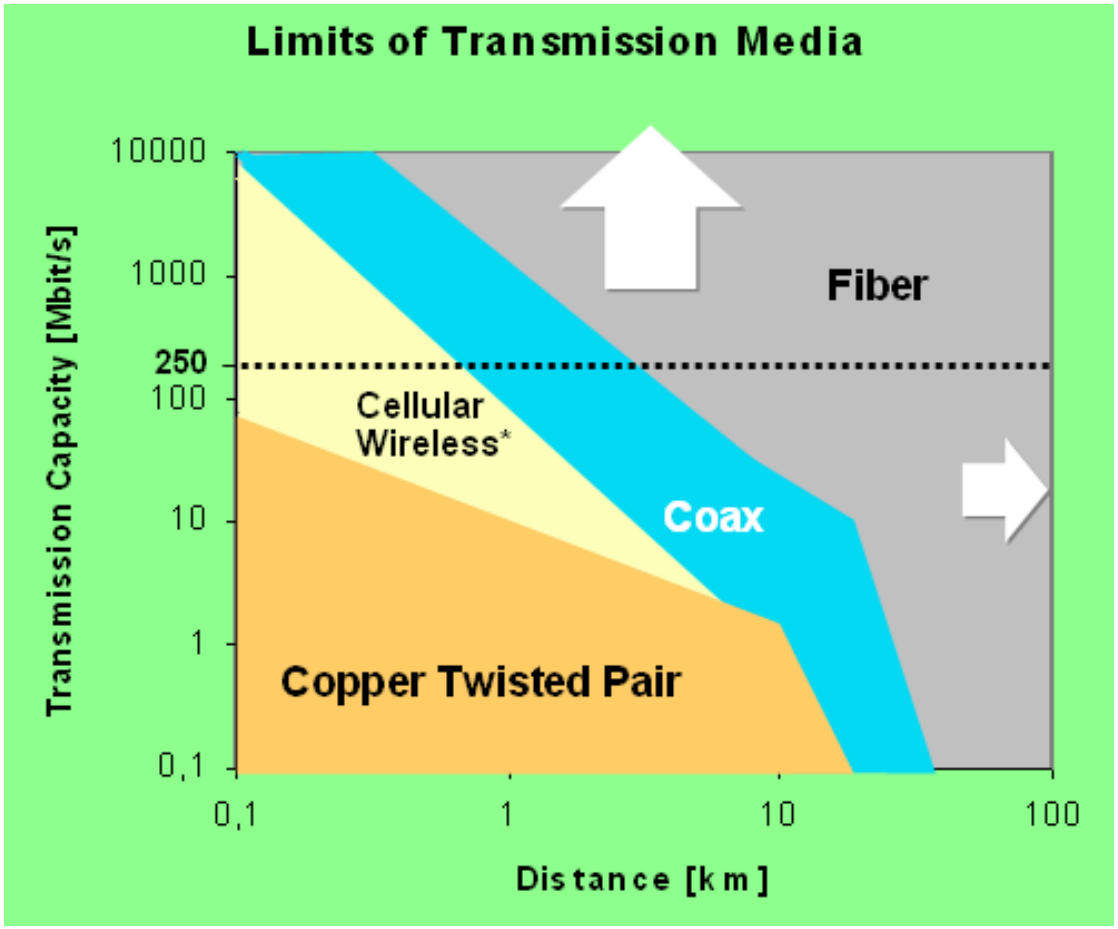
# Basic access technologies



# Outline

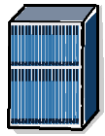
- CATV Coaxial cable
- Power cable
- Gas pipes
- Optical fiber

# Rates vs Access Loop Length



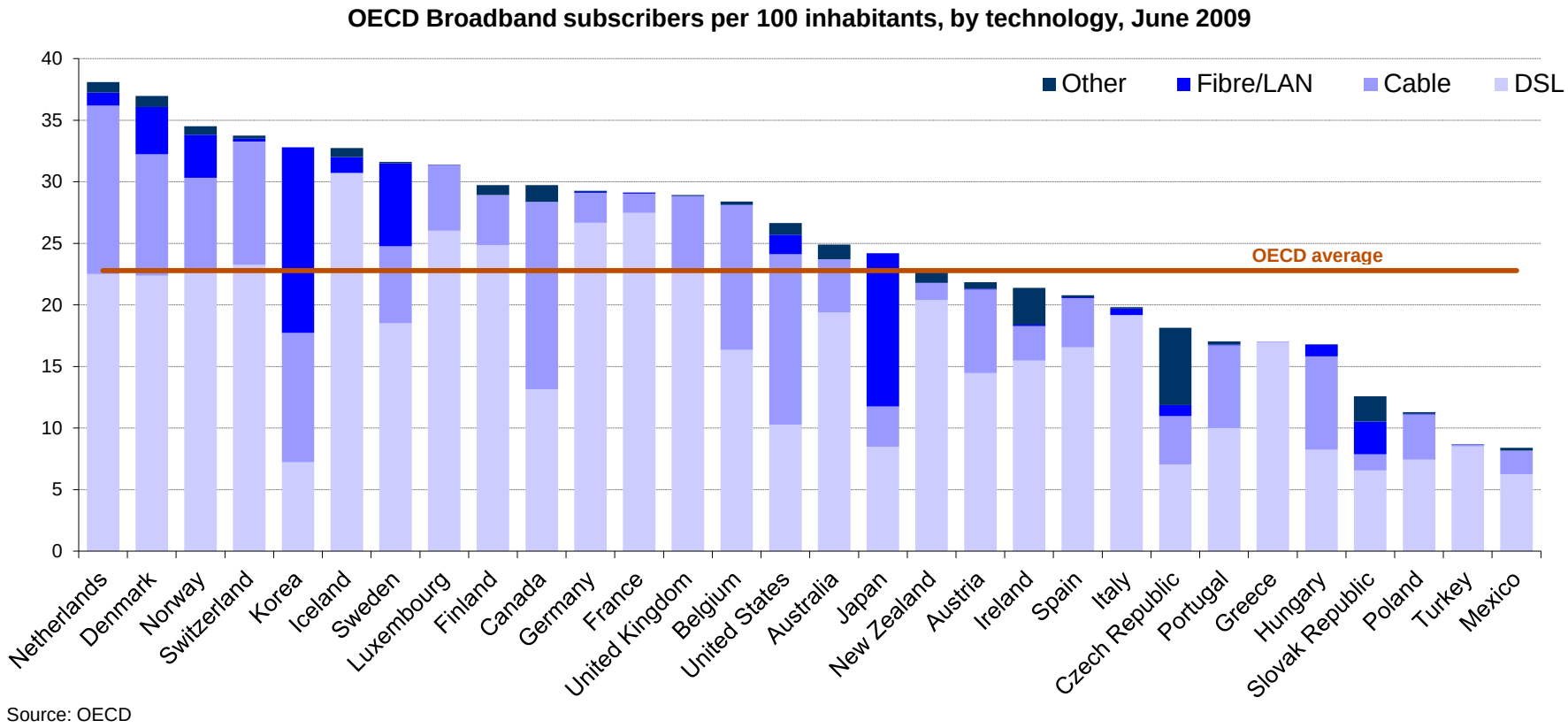

**Increasing loop length**

CPE



**Central Office DSLAM**

# The top countries worldwide: June 2009

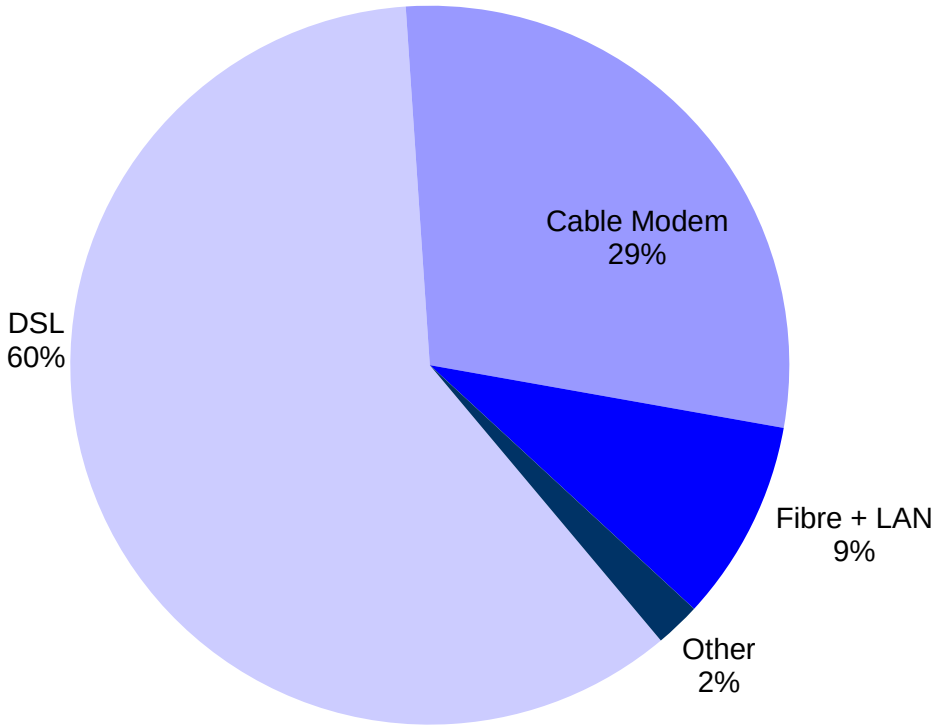



Source: OECD

Fiber and Cable are already significant

# Broadband subscriptions per technology: June 2009

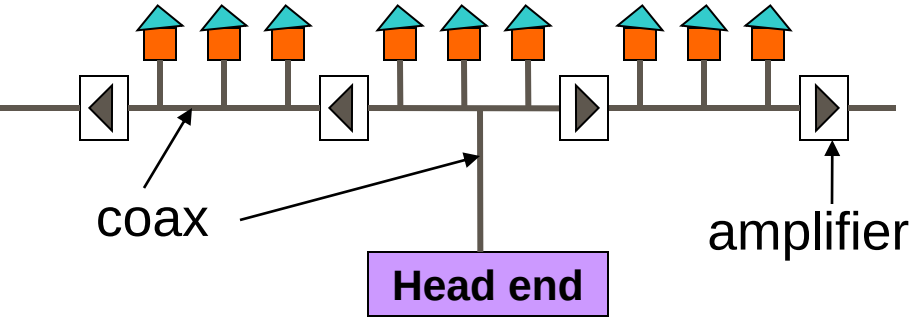
**OECD Broadband subscriptions, by technology, June 2009**



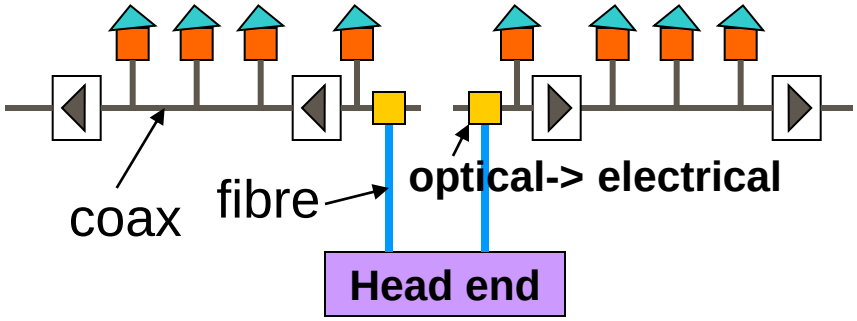

Total subscribers: 271 million
*Source :* OECD

# Broadband access over Cable, Powerlines, Gas Pipes

# Cable TV networks: The initial picture



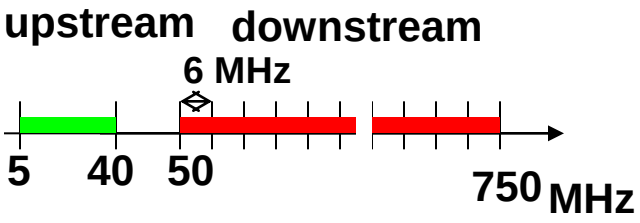

Cable network

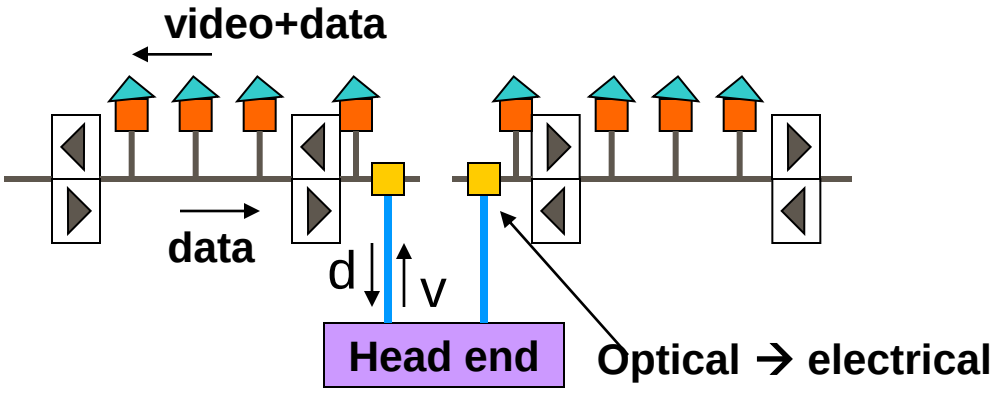



HFC network: Hybrid Fiber Co-axial

- Pure CATV and HFC networks
- Initially intended for uni-directional broadcasting only: tree-like architecture

# Bi-directional CATV networks

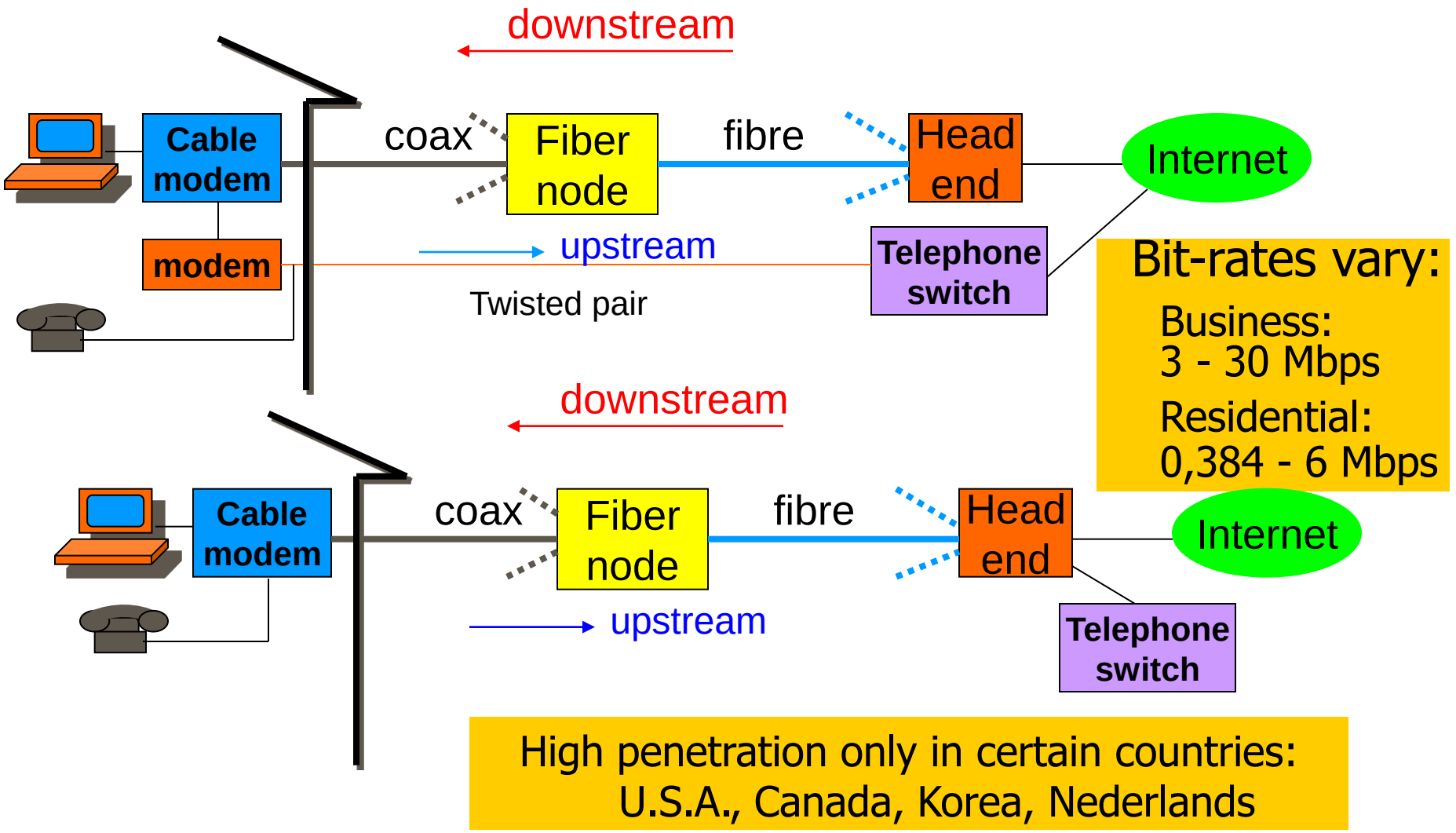


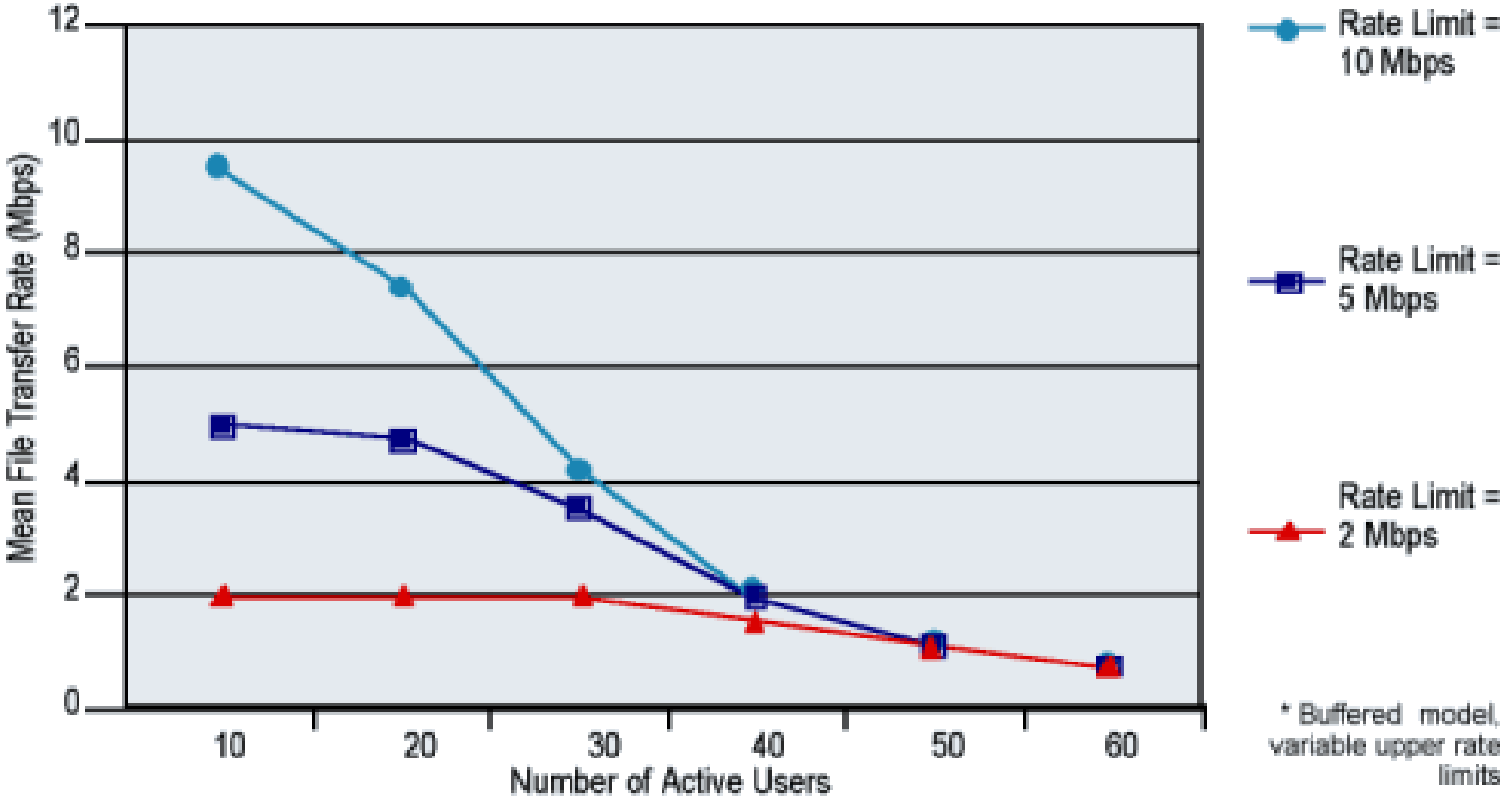

Bi-directional HFC network

- Both down- and up- streams are shared
  - Downstream: 6 MHz video channel (USA) → 30Mbps data
    - 8 MHz channels typically in other countries
    - New standards promise 100 Mbps per channel
  - Upstream: 1-10 Mbps
- Cable modems are used
- Triple-play can be offered
- "Last mile" can be as long as 100 miles (160Km)!

# Broadband access and telephony over Cable TV networks



# Data-rate vs. Users Trade-off in Cable




Source: © www.acma.gov.au

# Broadband over Powerline (BPL) (I)

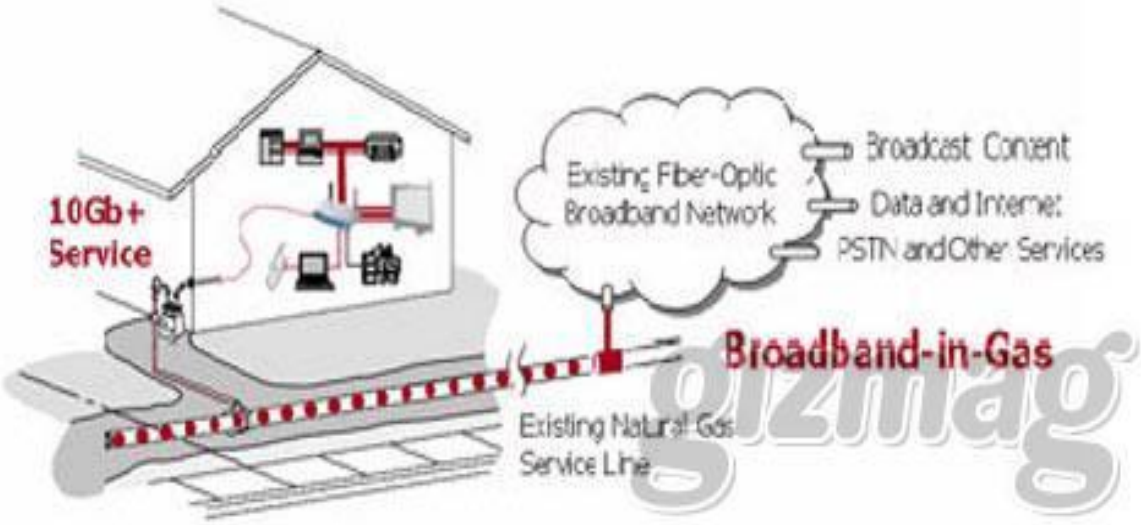
- Power distribution network used for delivering broadband services
  - Other names: Powerline Communications (PLC)
- Powerline and power grid are already here!
  - "No more wires"
  - Very large base of potential customers
- "Point-to-multi point"
  - Total rates up to 200Mbps (upstream & downstream) shared by all users
  - Actual rates depend on topology and other equipment connected
- Symmetric and asymmetric rates can be offered

# Broadband over Powerline (BPL) (II)

- Sharing of rates→ Typical rate 45 Mbps
  - USA: typically 50 houses per substation → ~1 Mbps per customer
  - Europe: can be 200 houses per substation → can drop to ~250 kbps per customer
- Access loop length may affect rates
  - Can be avoided with power adjustment
- Major issue: Interference, e.g. with commercial HF radios
  - Also raises security issues
- Still low commercial penetration
- Standards still evolving

# Broadband in Gas (BiG)

- Gas pipes can server as wave-guides
  - "Wireless" technology, but electromagnetic RF waves are not in the air
- BiG can offer up to 100 Mbps to distances ~10 km
  - Similar cost as DSL
  - Theoretically, distance can reach 100km




- Applicability limited only where gas network is present

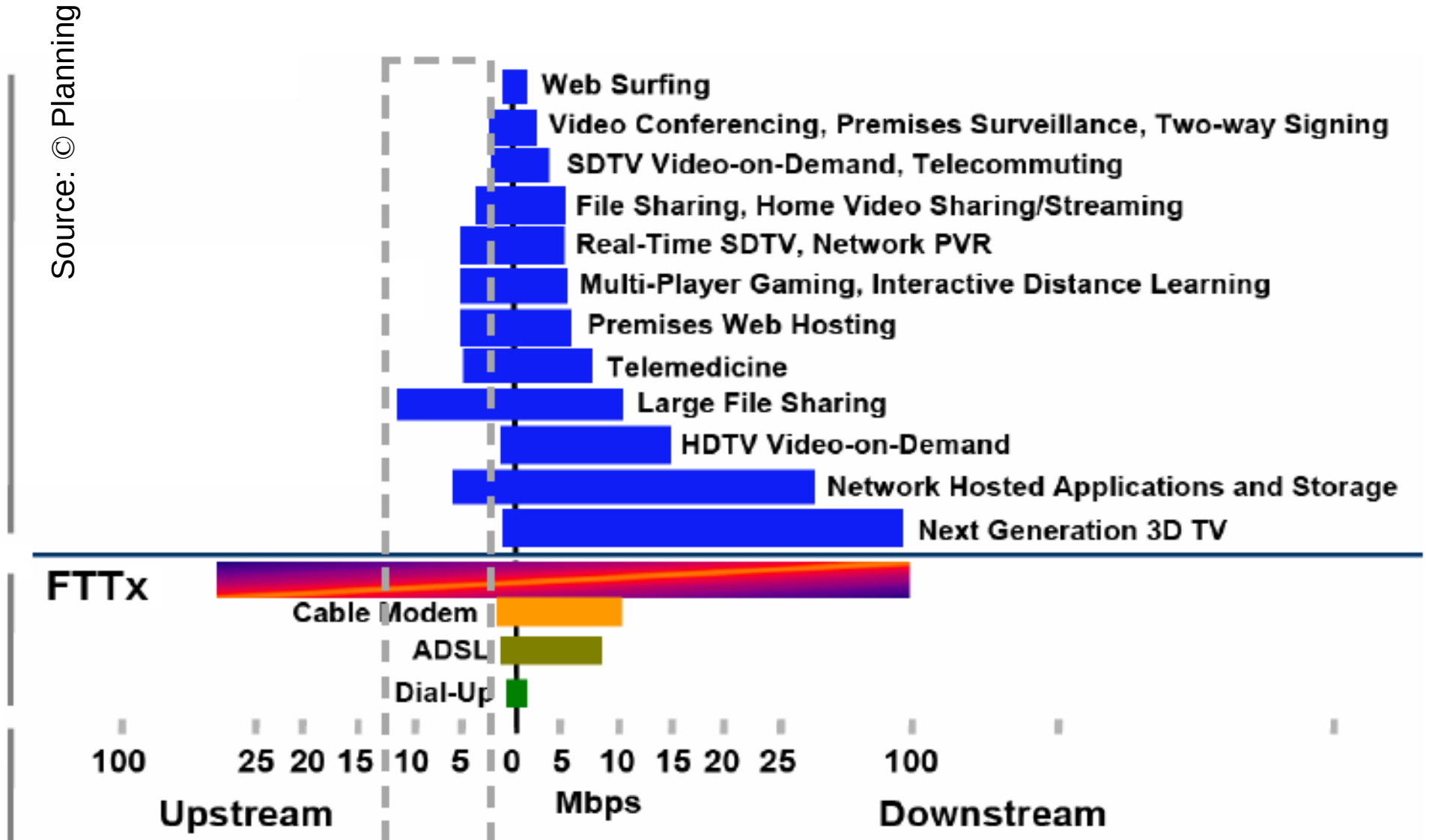
- Gas, water and sewage networks can also be used for laying fiber inside their pipes in a cost effective way
  - Rather than digging ducts in trenches in the streets

# Fiber Access and Metro Ethernet

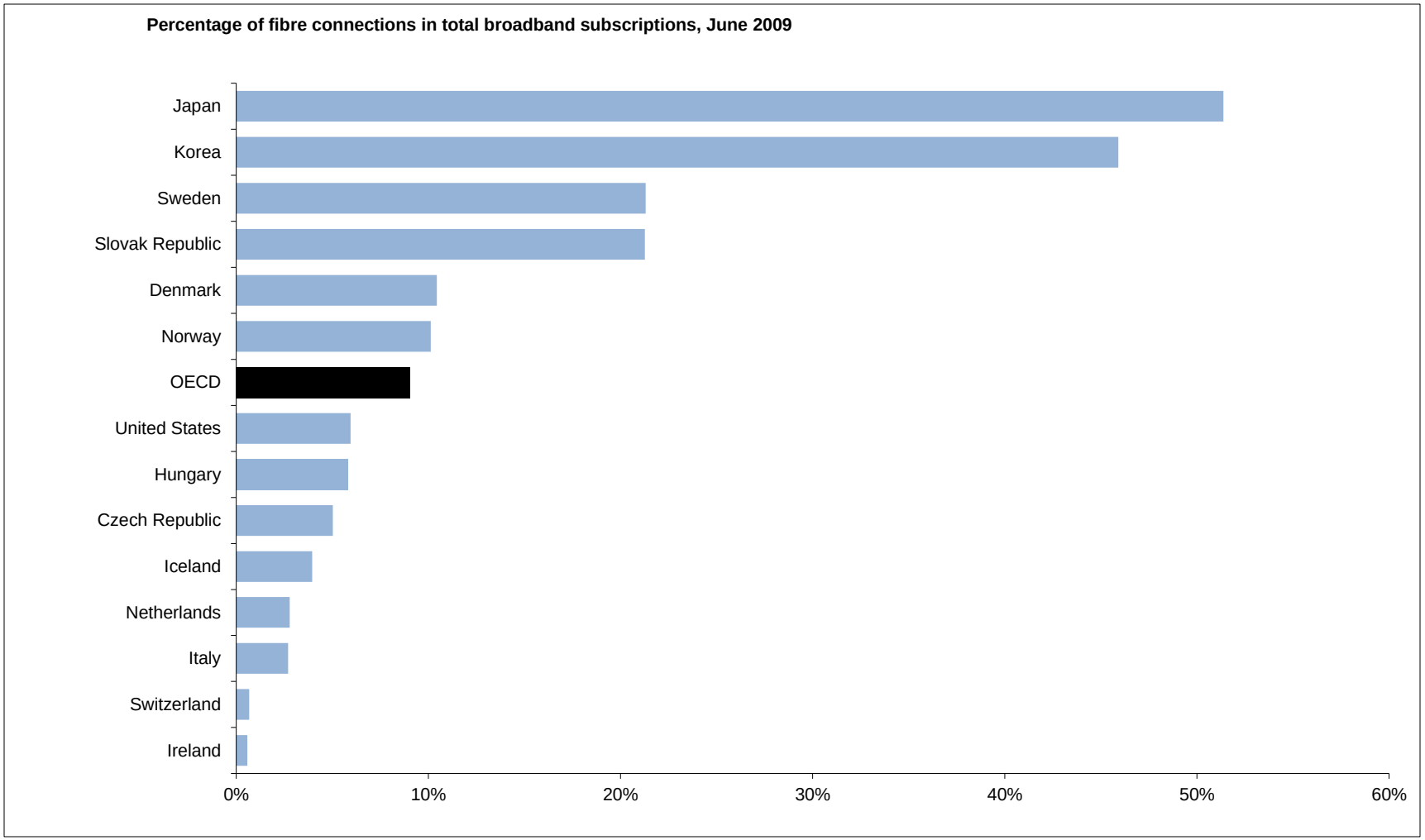
# Fiber networks

- Fiber is the most appropriate medium for backbone networks
- It can also be used in different parts of the access network
- Fiber supports large access rates symmetric or asymmetric
  - from ~1 Mbps to ~1 Gbps
- Certain applications are already very demanding:
  - HDTV,
  - peer-to-peer sharing of large files

# Applications & Rates vs. Broadband Access Technologies



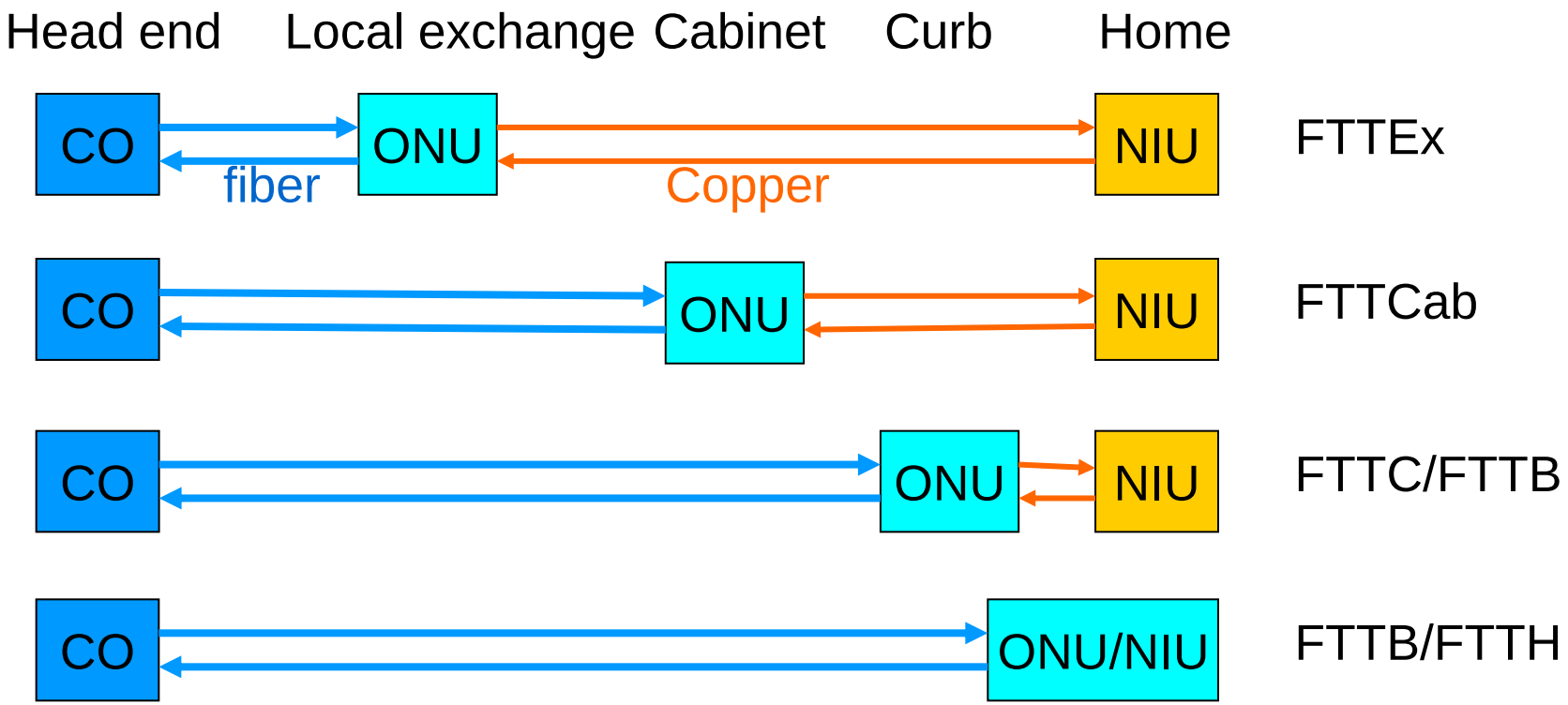
# Fiber Penetration



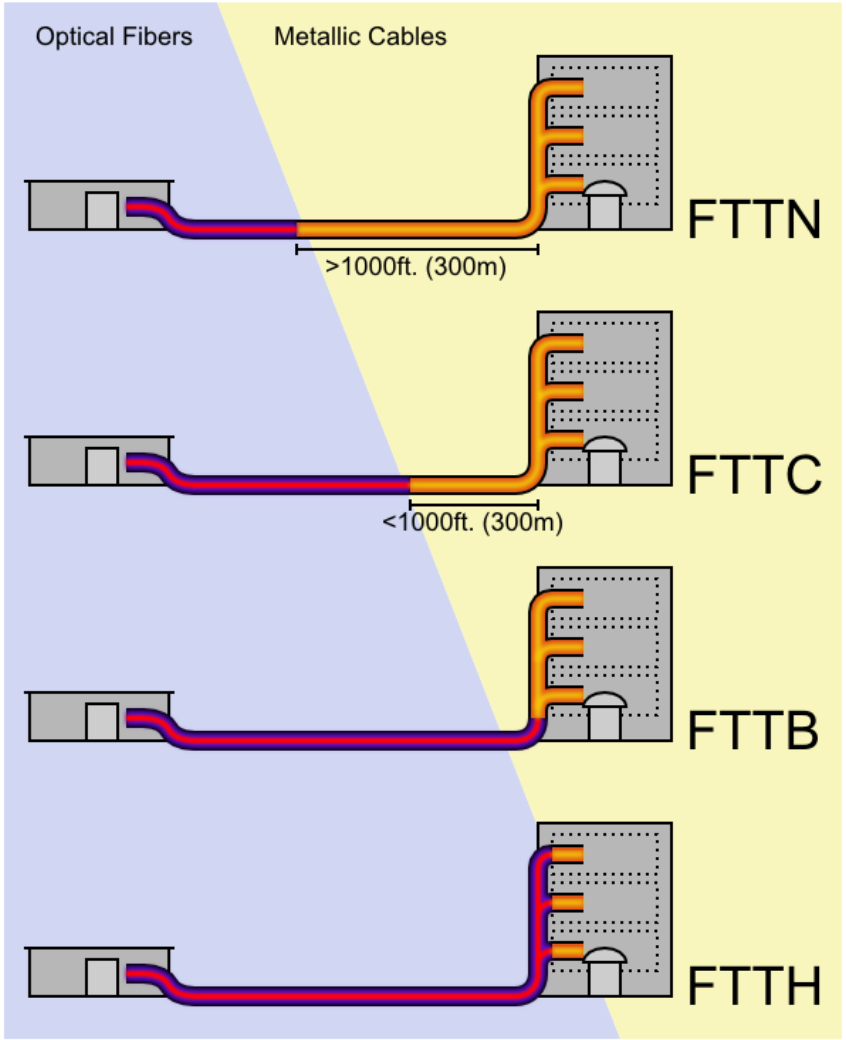

Source: © OECD

# FTTx (I)

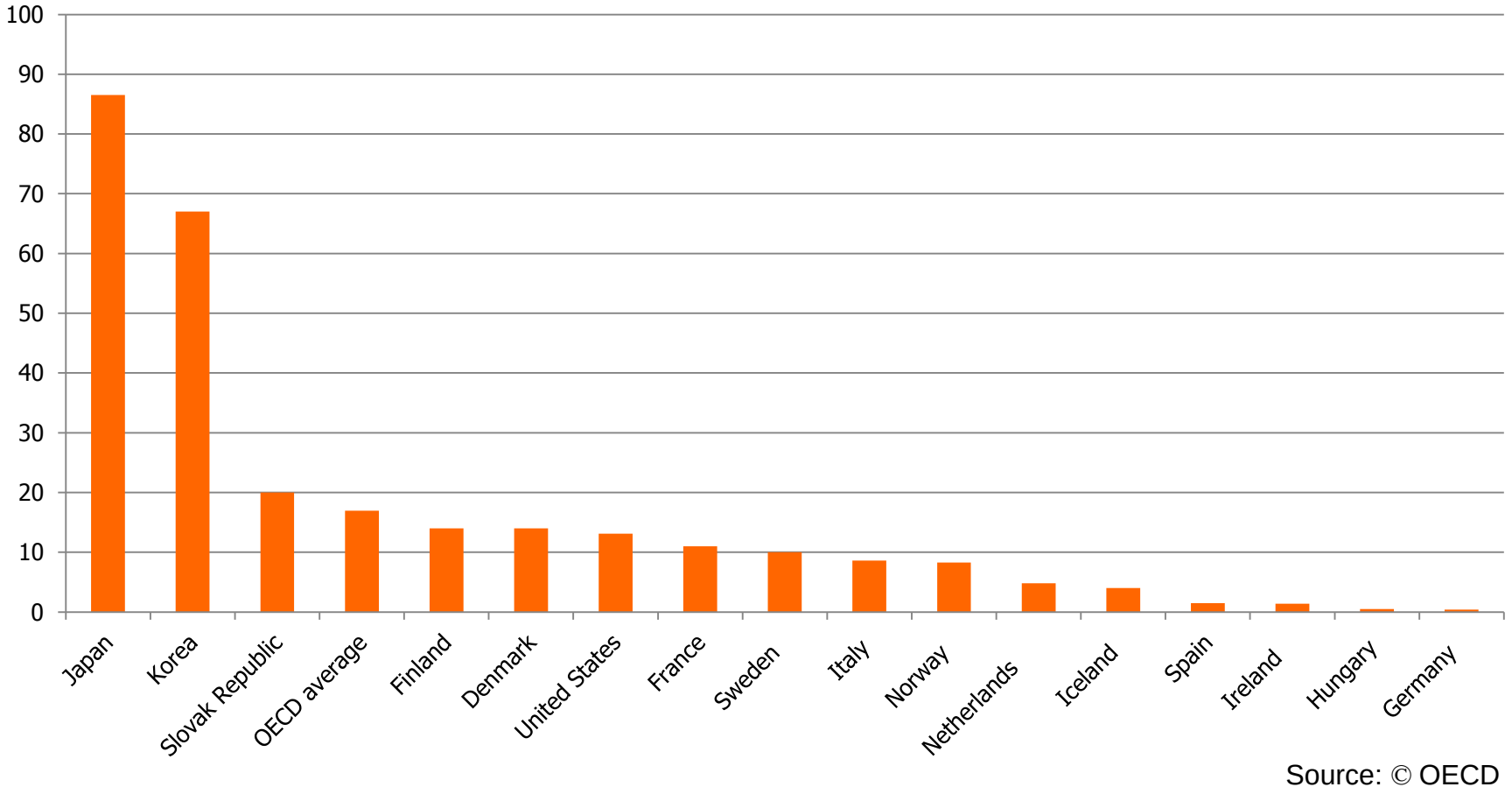
- Several variations of fiber access: FTTx, where x is the termination point



# FTTx (II)


Optical Fibers
Metallic Cables
FTTN
>1000ft. (300m)
FTTC
<1000ft. (300m)
FTTB
FTTH

# FTTH/B coverage: up to 2009

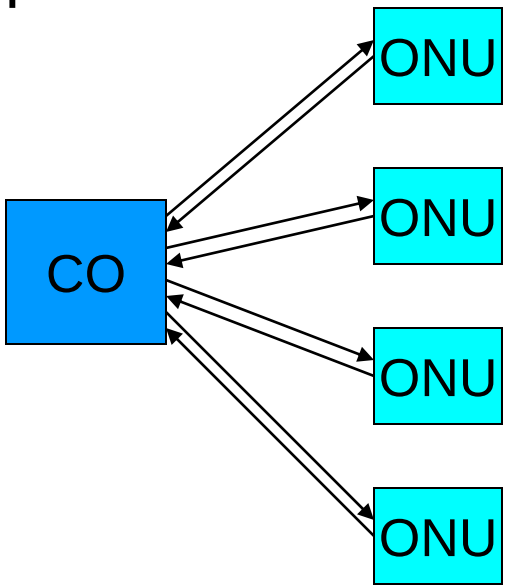



Source: © OECD

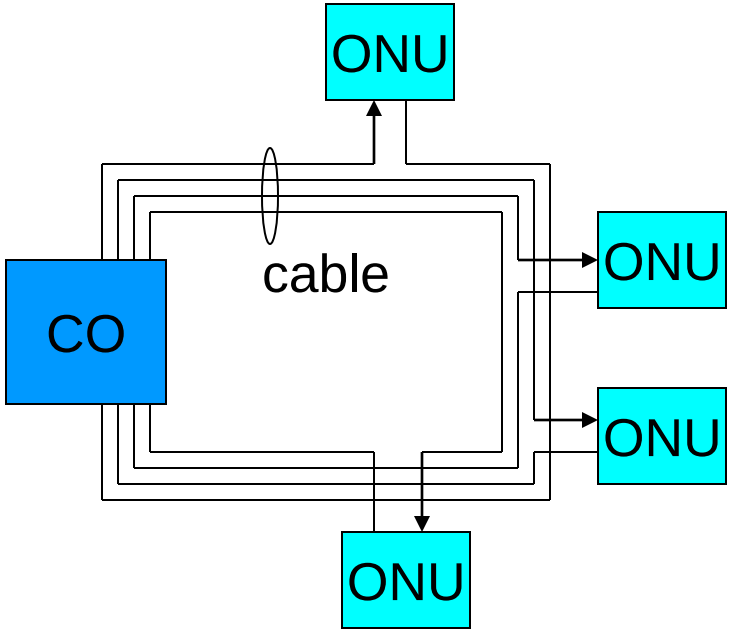
# From the CO to the ONU

## Point-to-point fiber

One pair of optical fiber from CO (Central Office) to each ONU (Optical Network Unit)



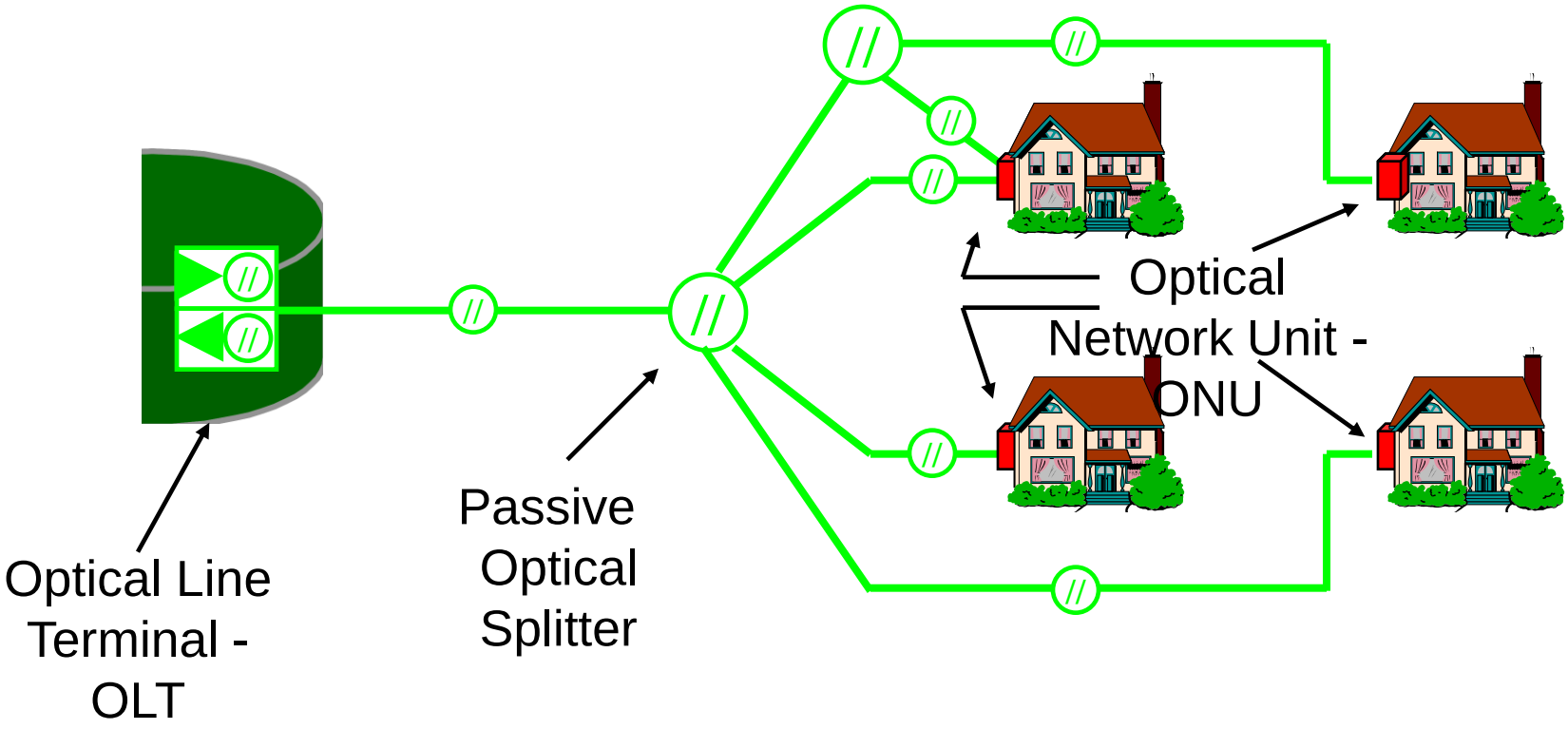

## SDH rings




No sharing of optical fiber, optical CO technologies
No power splitting, no synchronization of nodes

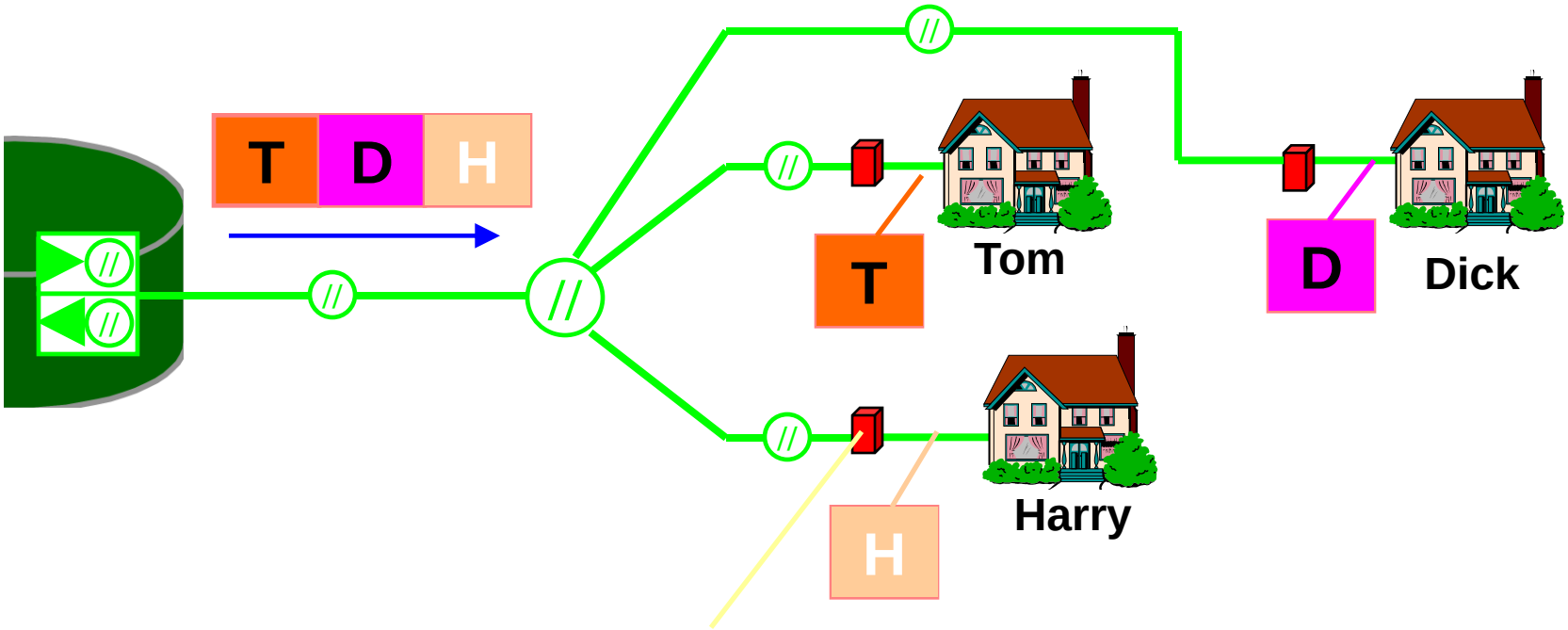
# Passive Optical Network (PON)

- Allows for better exploitation of fiber capacity
- Reduces the cost of FTTH



# Example of PON downstream paths

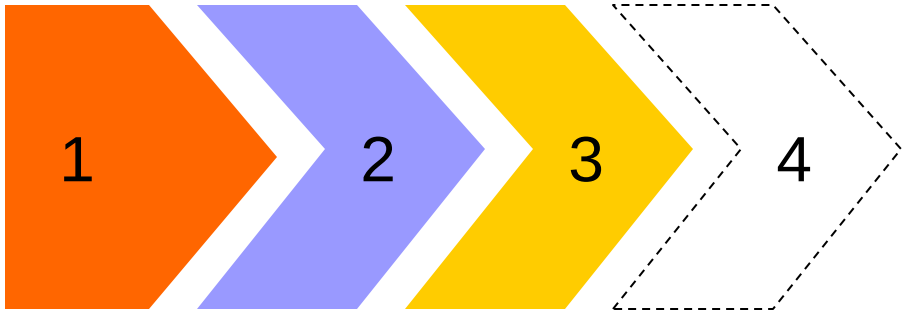
- Time Division Multiplexing



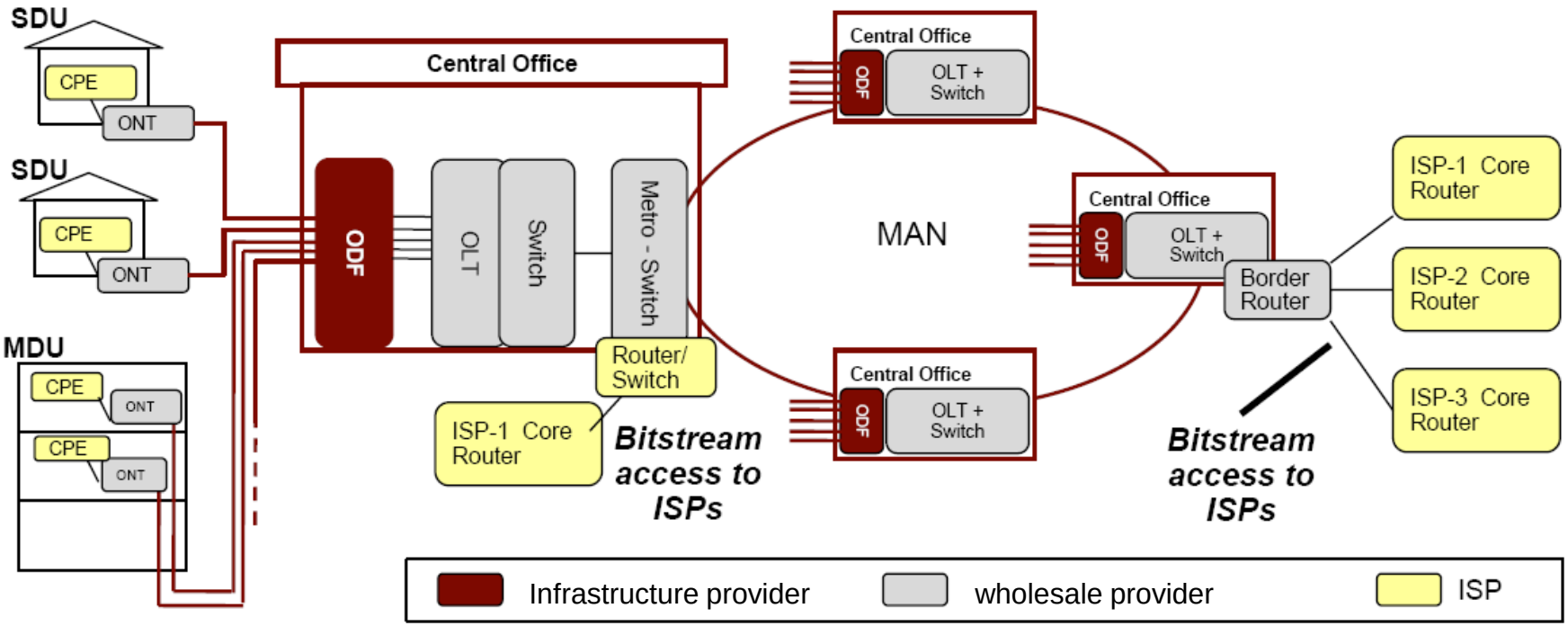

- Multiplexing can alternatively be performed at the level of wavelength λ

# Business Roles and Value Chain

1. Infrastructure Provider: owns and manages passive fiber infrastructure
2. Telecom provider: owns active devices (including Optical Line Terminal) and offers wholesale fiber access to ISPs
3. ISP: provides retail broadband Internet service to customers
4. Customer



# Architecture and Business Roles




Source: © A.T.Kearney/Planning

# Remarks on fiber networks

- FTTHome involves a dedicated fiber per customer, bringing ~1Gbps
  - Very expensive
- FTTBuilding, FTTCurb and PON FTTH
  - Are less expensive
  - Fit present needs of customers
- FTTB and FTTC are often combined with VDSL

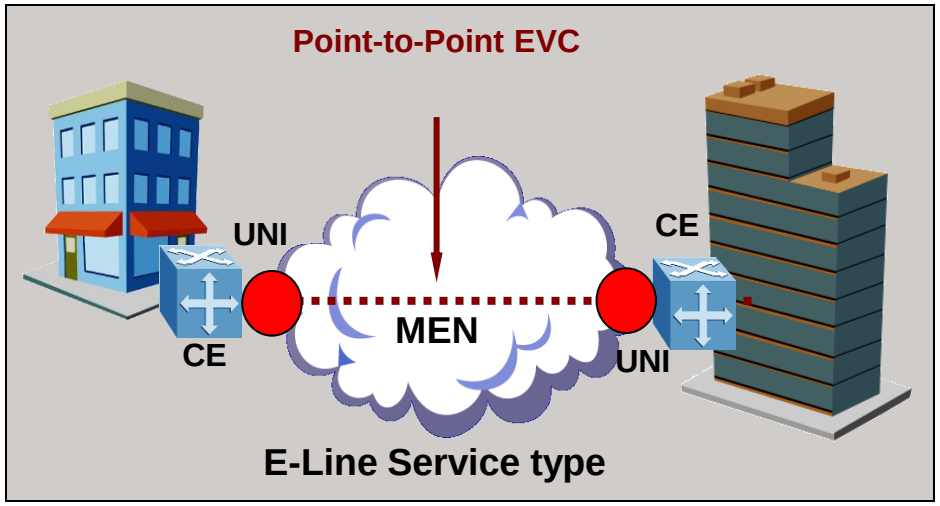
# Impact of fiber networks to OTE

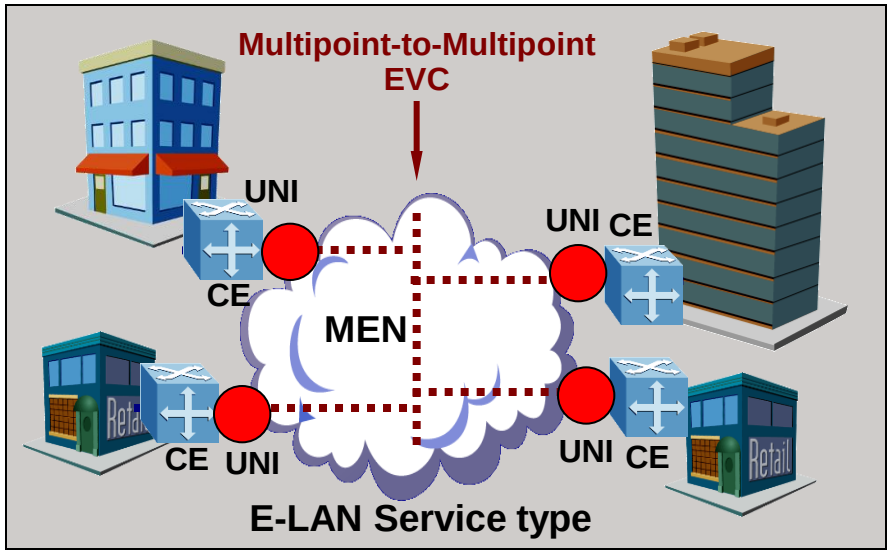
- Fiber networks compete with broadband leased lines
  - in both retail and wholesale markets
  - mainly in urban areas
- Combined with Internet access and VoIP, they compete with fixed telephony
- Can also compete with wholesale bitstream services of similar rate
- OTE can serve as infrastructure provider and/or wholesale provider

# Metro Ethernet (I)

- Carrier technology deployed by service providers in core metropolitan networks to supply various services.
- ME is Used for:
  - retail services, e.g. leased lines (for interconnecting LANs etc.)
  - wholesale services (interconnecting provider's POPs)
  - higher-level services (i.e. VoIP)
- ME is based on the transmission of Ethernet frames on a Metropolitan Area Network (MAN)
- Provides Ethernet Virtual Connections with capability for:
  - "point-to-point" E-line, which can also offer Internet access
  - "multipoint-to-multipoint" E-LAN, for LAN services and VPNs
  - Different service classes

# Metro Ethernet (II)



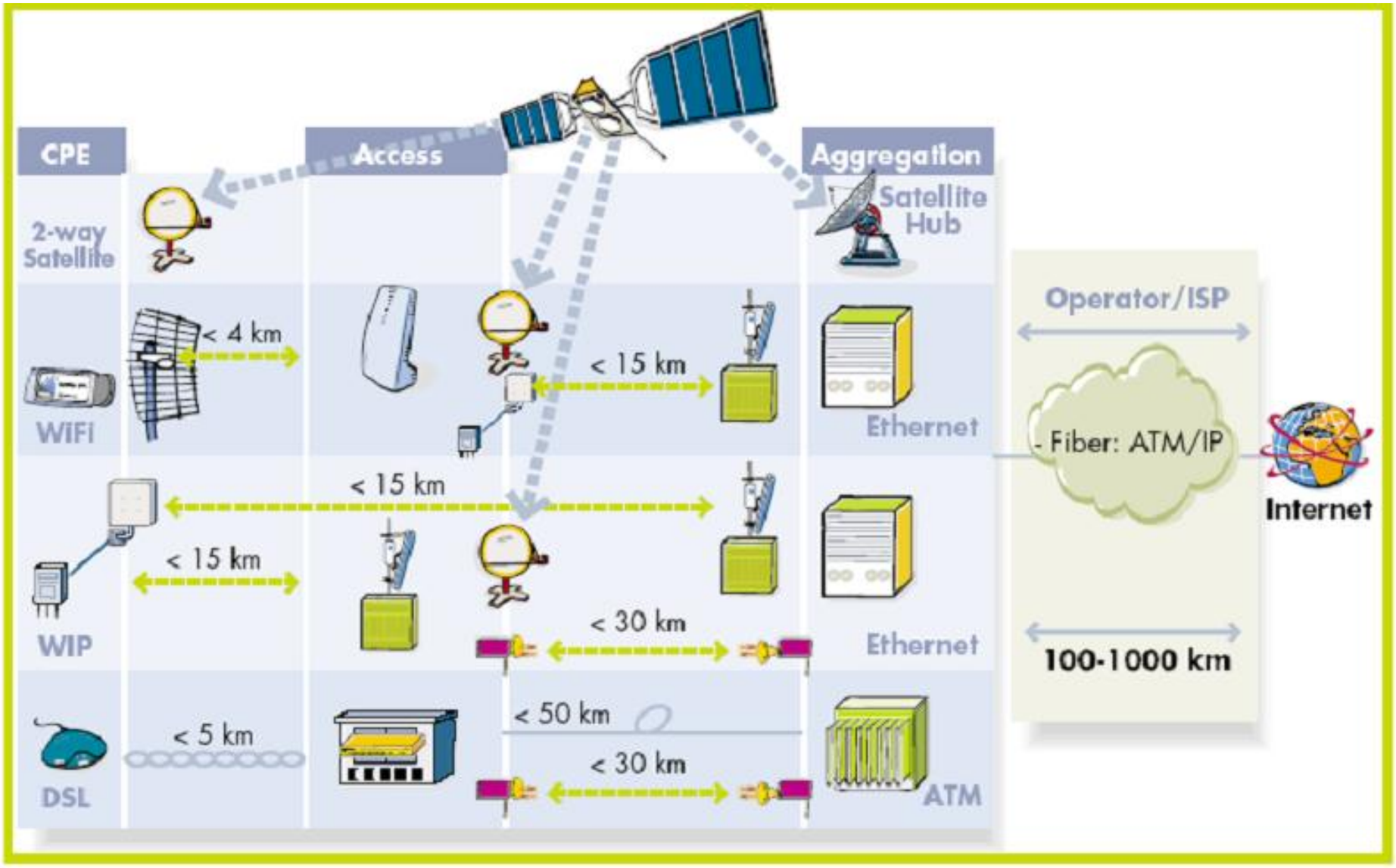



# Metro Ethernet (II)

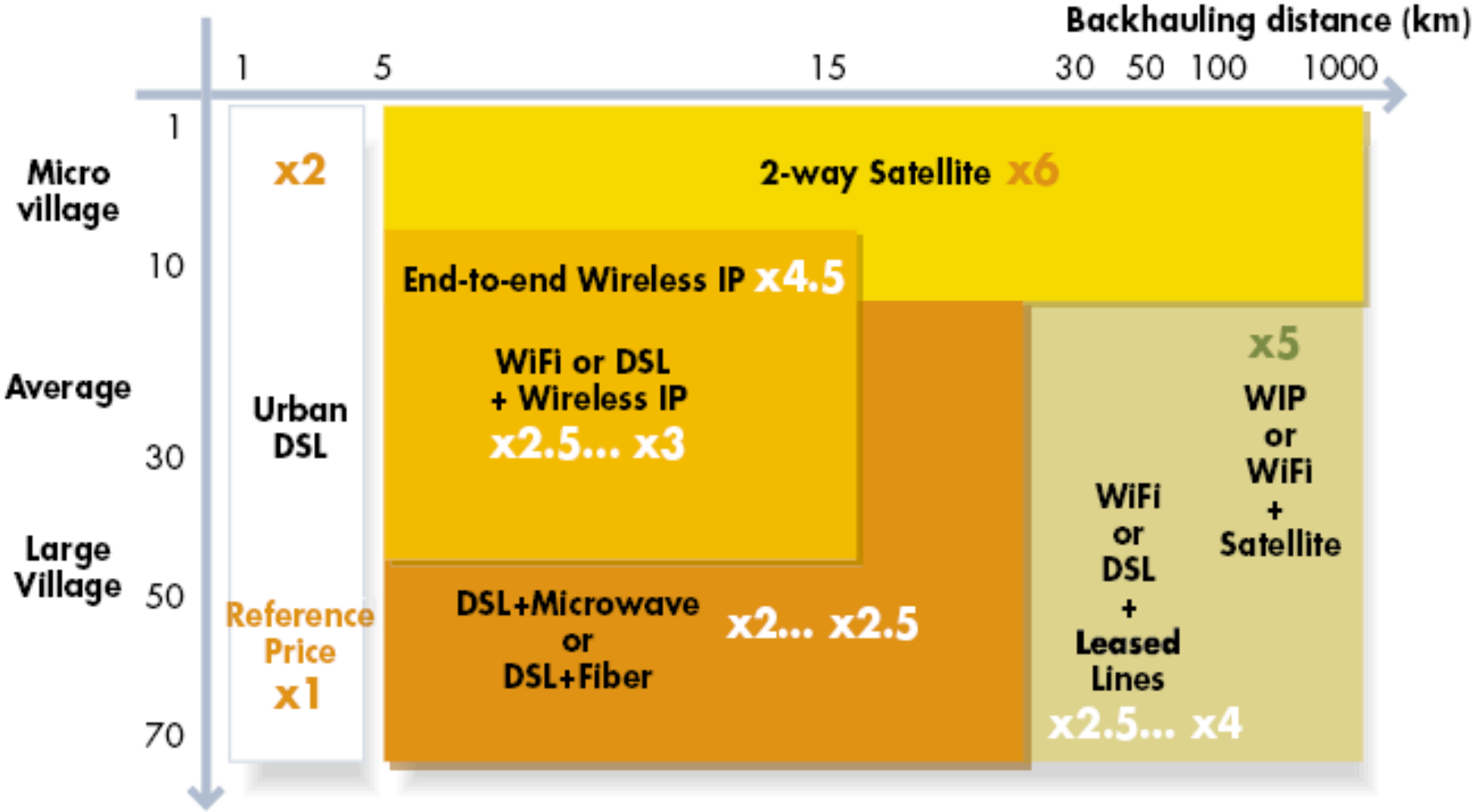
- Cost-effective solution with large customer base
- Allows flexible bandwidth profiles as a retail service
  - Ranging from 1 Mbps to 1Gbps, with small step
  - Supports: Committed + Excess rates
- E-Lines and E-LANs can be used to carry VoIP
- Impact to OTE:
  - Similar with fiber networks

# Concluding Remarks

# Certain Combinations of Access and Backhaul Solutions



# Cost Comparison of Certain Combinations




First technology listed is the access technology, while the second one is the backhauling technology

# And the winner is …

- DSL has significantly higher penetration so far, particularly for home customers in urban areas
  - Still the best combination of bit-rate, service quality, cost
  - Benefits from continuous upgrades
- Fiber To The Home delayed in most countries
  - Except the top ones: Japan, Korea etc.
  - Strategic efforts to boost its penetration in several countries, including Greece
- Business customers' demand for the various solutions is more balanced
  - Wireless is more successful in this segment

# The future picture

- Wireless technologies progress very fast
  - Cellular moves towards broadband
  - Fixed wireless moves towards mobility
  - 3G+ (LTE) and WiMax are expected to be the winning combination for mobile broadband
- Higher bitrates are coming up for all technologies, but this requires:
  - more fiber
  - upgrading of backhaul
  - more spectrum, for wireless technologies
- Penetration of new technologies will also depend on prices