



PSTN, NGA and cable access networks compared: a technical perspective

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Warning!

- This presentation is meant to be technical
- Hopefully not too boring
- Fun stuff (laws, regulations, etc) comes next

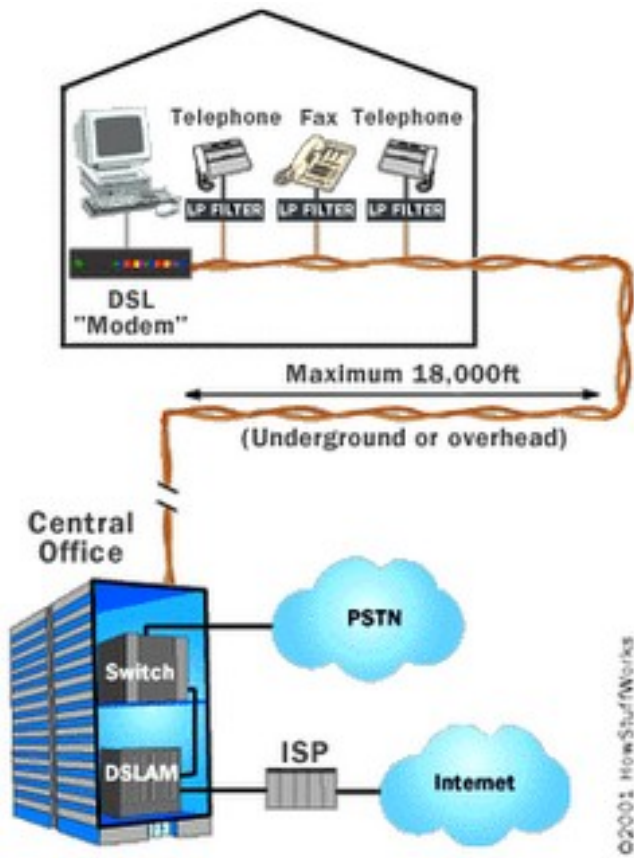


How to deliver broadband?

- Core networks currently over-provisioned
- Where is the bottleneck?
 - Access network a.k.a. “last mile”
- Upgrade legacy access or deploy new access?
- 10-100 Mbps on legacy access? No big deal
 - PSTN = ADSL2+, VDSL2
 - CATV = DOCSIS 3.0
- Beyond 100 Mbps? Not realistic
 - Inherent limits of electric wires
 - Fiber the most efficient way forward today
 - FTTx deployment scenarios



Legacy – PSTN

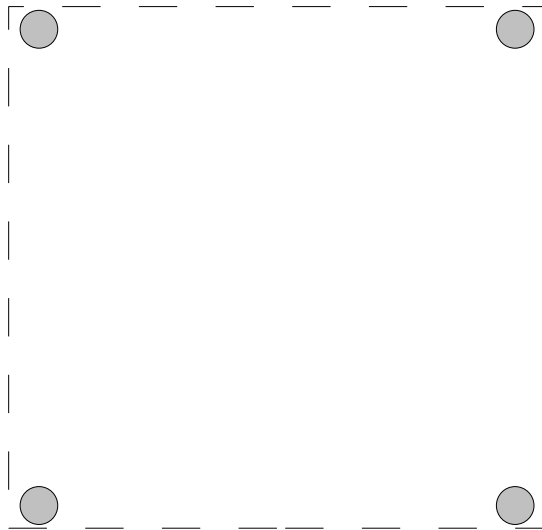


- Originally circuit-switched architecture
- One dedicated copper wire per subscriber
- Voice (circuit) and data (packet) split at LEX/CO

Legacy – Higher modulations

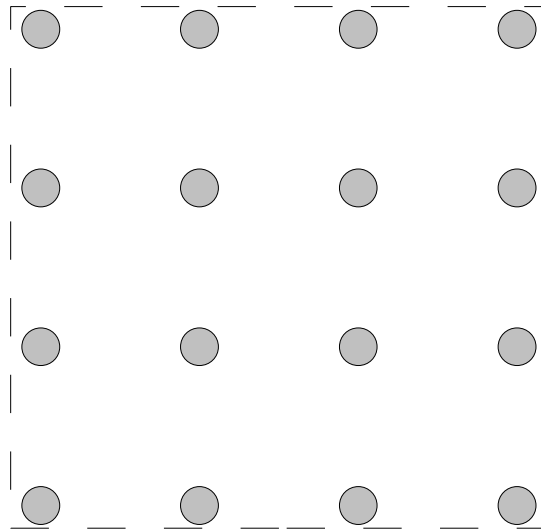
4 QAM
 $\log_2(4)$

= 2 bits/transmission



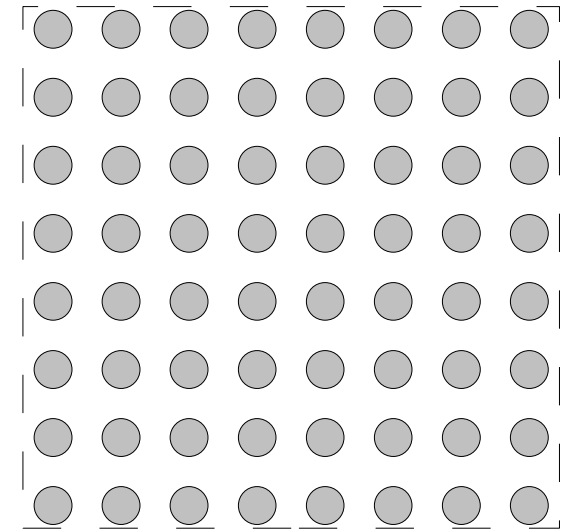
16 QAM
 $\log_2(16)$

= 4 bits/transmission



64 QAM
 $\log_2(64)$

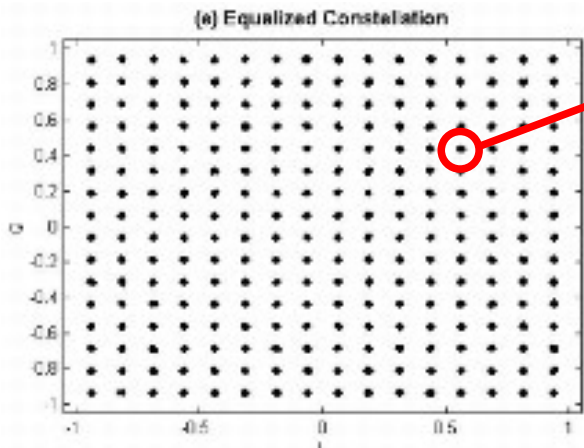
= 6 bits/transmission



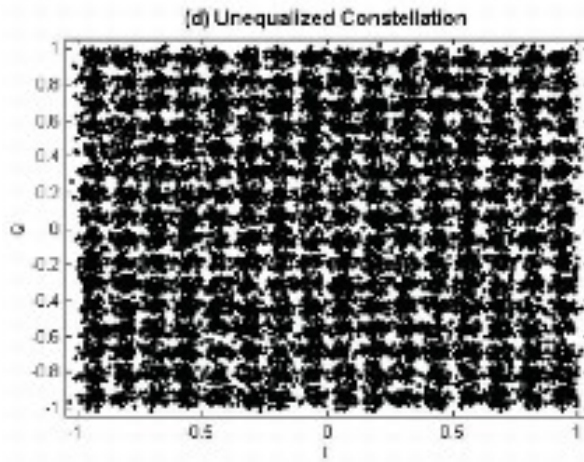
- The higher the modulation
 - The higher the bit rate
 - The more sensitive to attenuation and noise



Legacy – 100 Mbps over PSTN/ISDN



256 QAM
8 bits/symbol

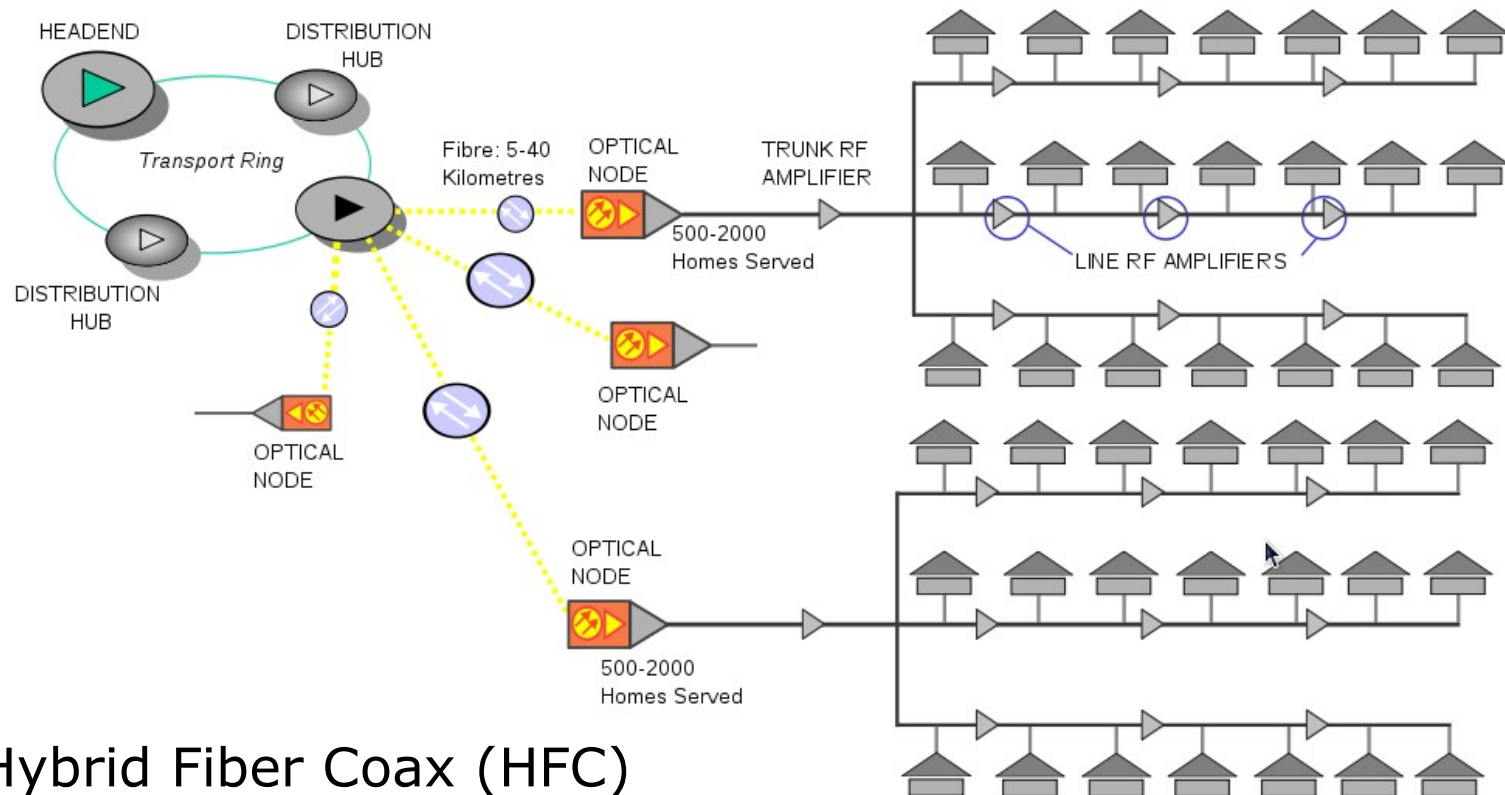


xDSL	MAX download [Mbps]	MAX upload [Mbps]	MAX range [km]
ADSL	8	1	5
ADSL2	10	1.2	3
ADSL2+	24	3	7
VDSL2	100		0.3

At least ADSL2+ required for IPTV HD (min 8 Mbps) within 1 km from LEX/CO

Source: Cisco

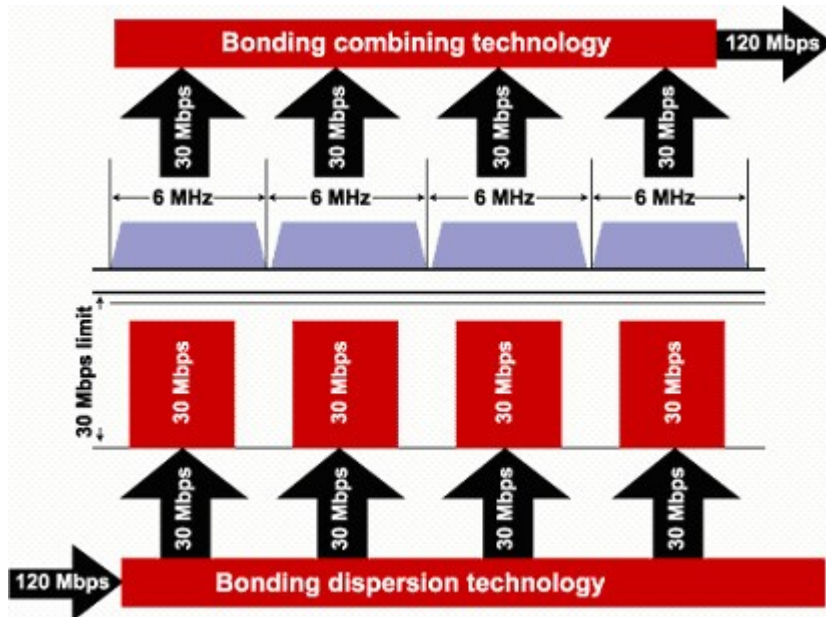
Legacy – CATV



Source: Wikipedia EN

- Hybrid Fiber Coax (HFC)
 - Fiber in the Core
 - Adapted access network (bidirectional amplis)
- Shared infrastructure (originally broadcast)

Legacy – 100 Mbps over CATV



Source: John Bartell, "DOCSIS 3.0 Tutorial",
<http://www.fttxtra.com/hfc/docsis/docsis-3-0-tutorial/>

- DOCSIS 3.0
 - Dynamic channel bonding enables $m \times 50$ Mbps downstream goodput
 - More bandwidth available thanks to decommissioning of analog TV channels
 - Still a shared infrastructure: bonding means sharing
 - New modems but same HFC network



Legacy – Pro's and Con's

- Pro's
 - Limited CapEx thanks to recycled infrastructure
- Con's
 - Not a full IP network
 - Optical fiber is better medium
 - Immune to electro-magnetic noise
 - Low attenuation: .3 dB/km (50% after 10 km) vs 20 dB/km in copper wire (50% after 150 m)
 - Enable fully passive networks



Full IP network

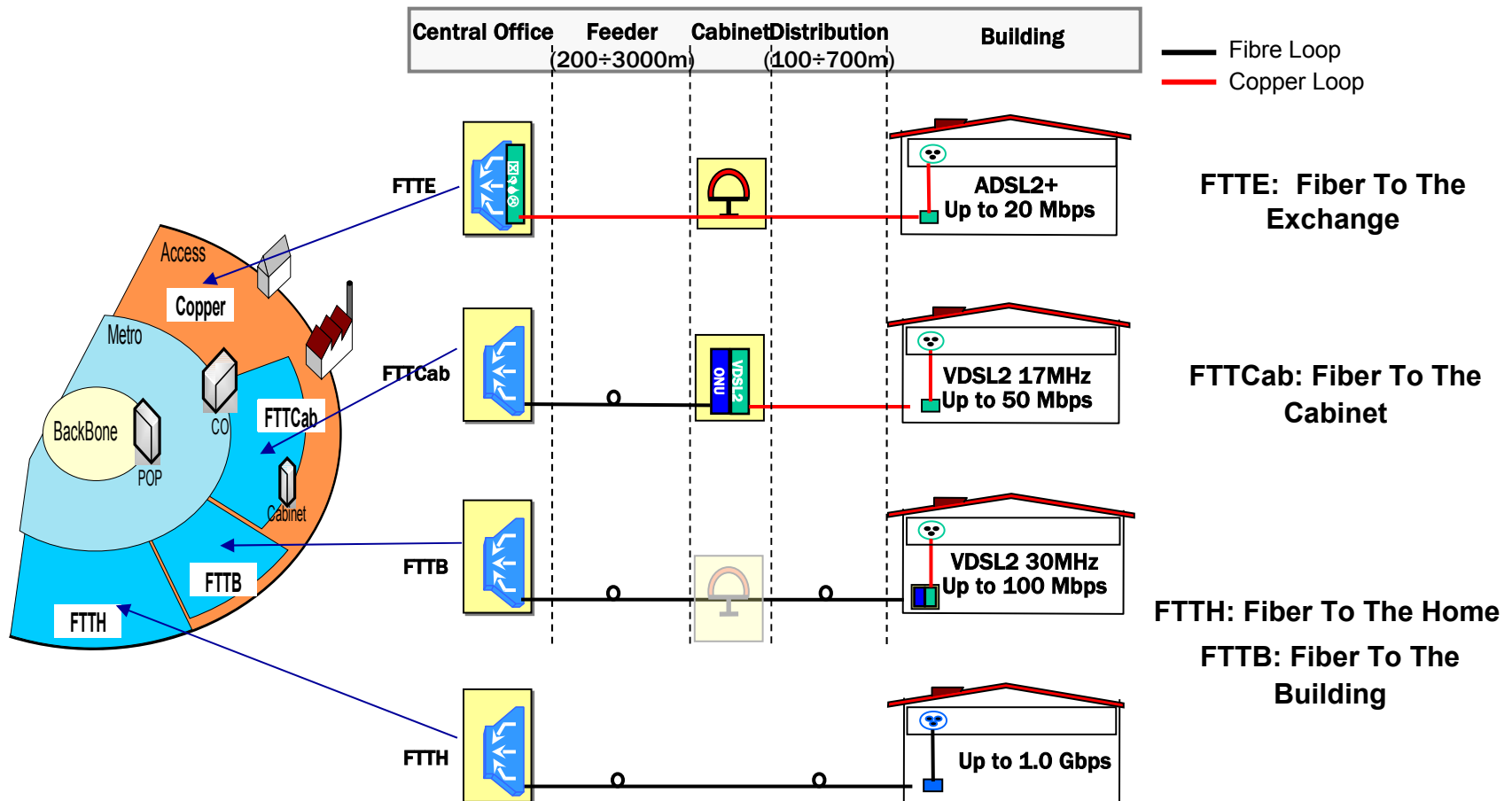


IP

ATM

Phy

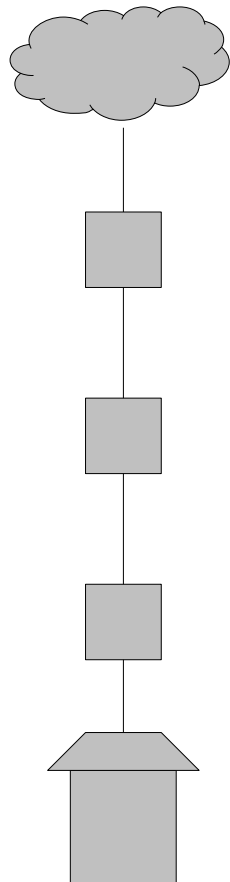
Coming through – FTTx for NGA



Source: Alfonso Mariconda, "Telecom Italia domestic NGN2: First deployment experience and current plan", <http://www.slideshare.net/ceobroadband/ftth-conference-2009-telecom-italia-domestic-ngn2>



A model for the infrastructure



Core / backhaul network

PSTN: Local Exchange (LEX) / Central Office (CO)
Optical Distribution frame (ODF)

HFC: Hub

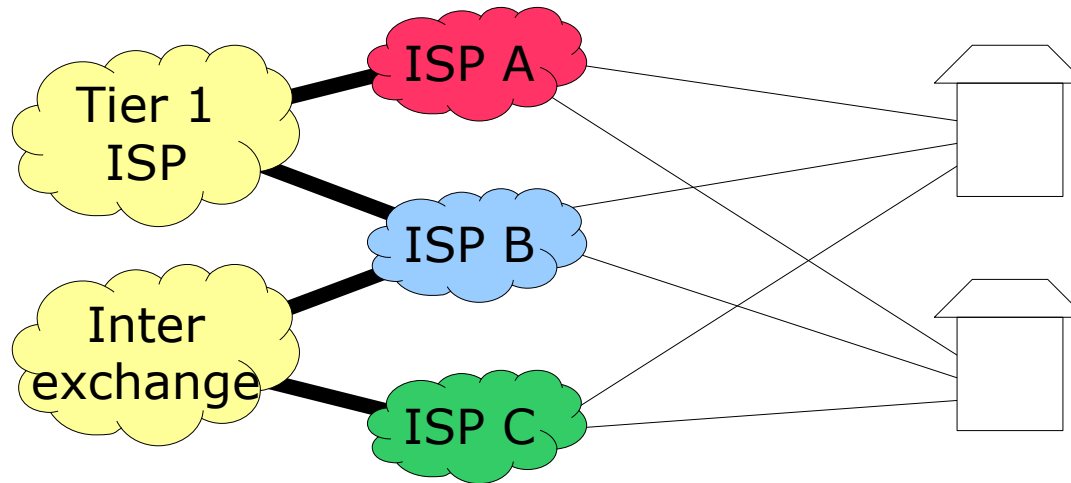
PSTN: Street Cabinet (SC)
HFC: optical node

Concentration point (optional)
Enables access to a subgroup of subscribers

Subscriber

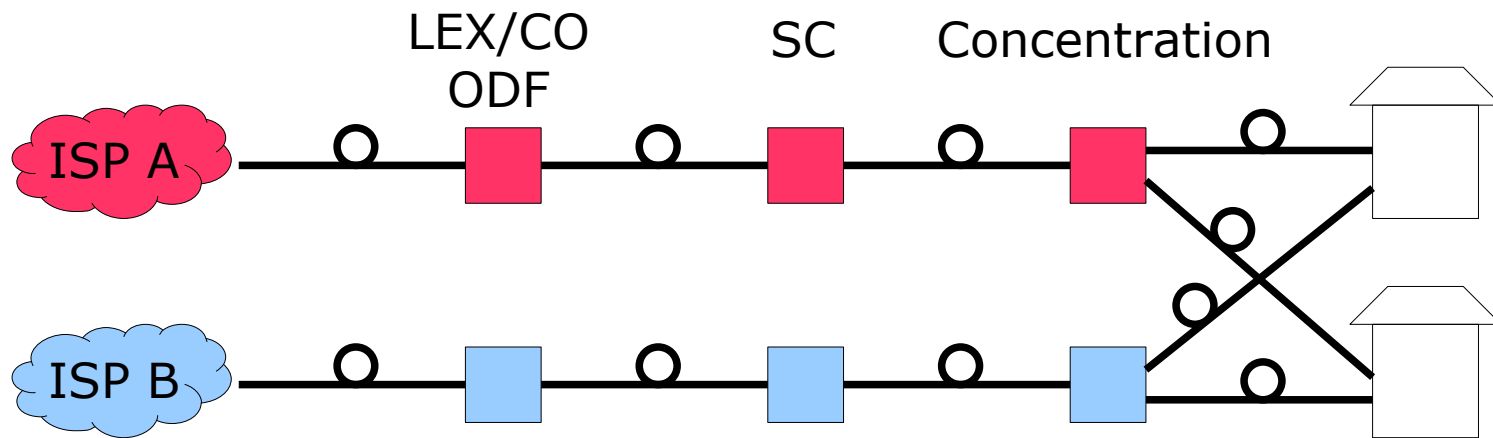


Full-mesh



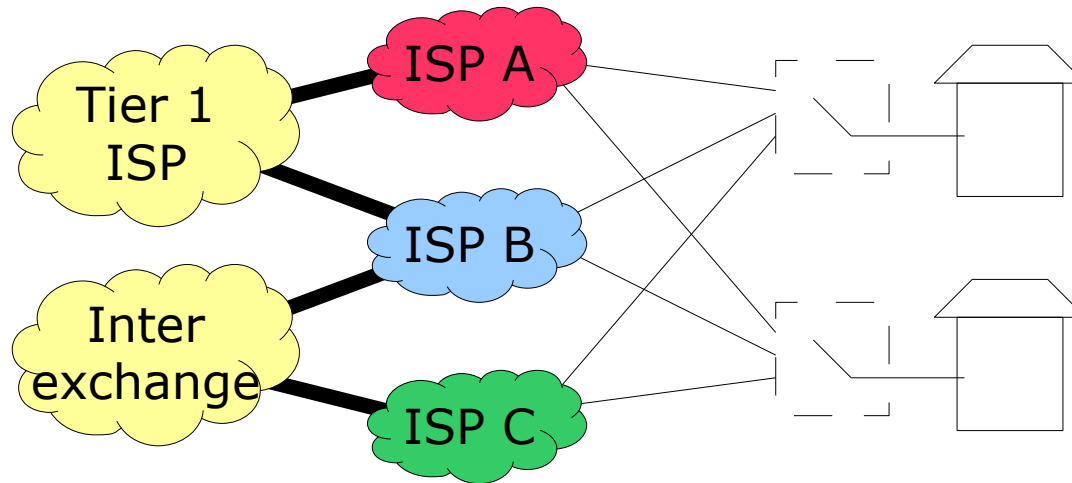
- Every end-user has a dedicated physical link to every operator
- Not scalable
- Most expensive scenario

FTTH Point-to-Point (PtP) / FTTB



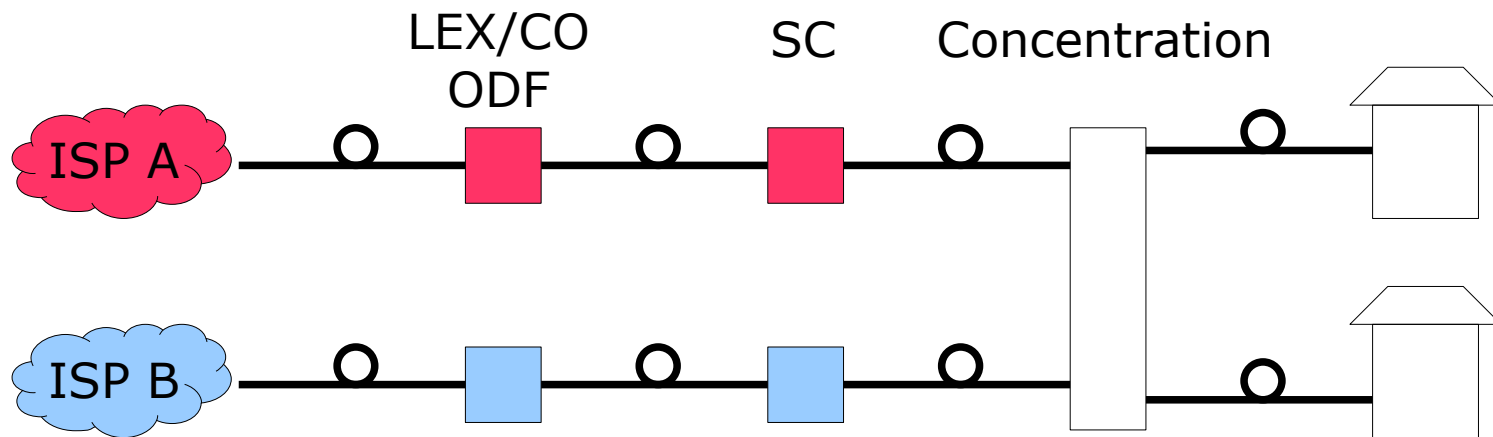
- PSTN-like architecture
- One plug/operator not user-friendly
- Not scalable, not affordable nowadays

Operator switch



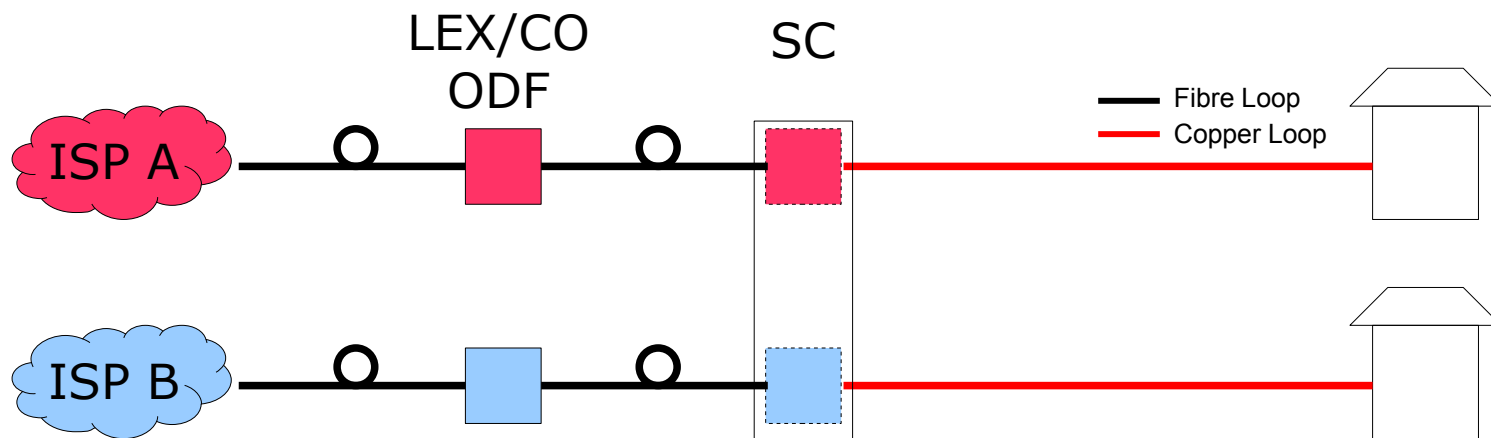
- Single physical link to the end-user
- At a given point upwards in the access network, enable any operator to reach the end-user

Unbundling at concentration



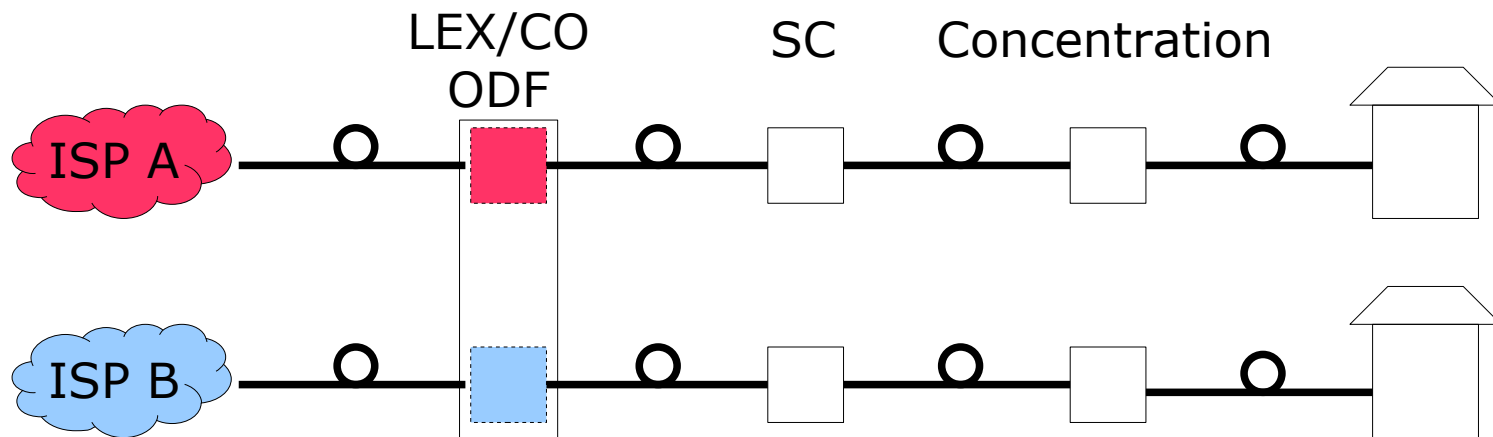
- FTTH scenarios
- Dedicated fiber running down to subscriber to be shared beyond last splitter
- Technically similar to ODF unbundling
- Requires deeper fiber roll-out

Street Cabinet unbundling



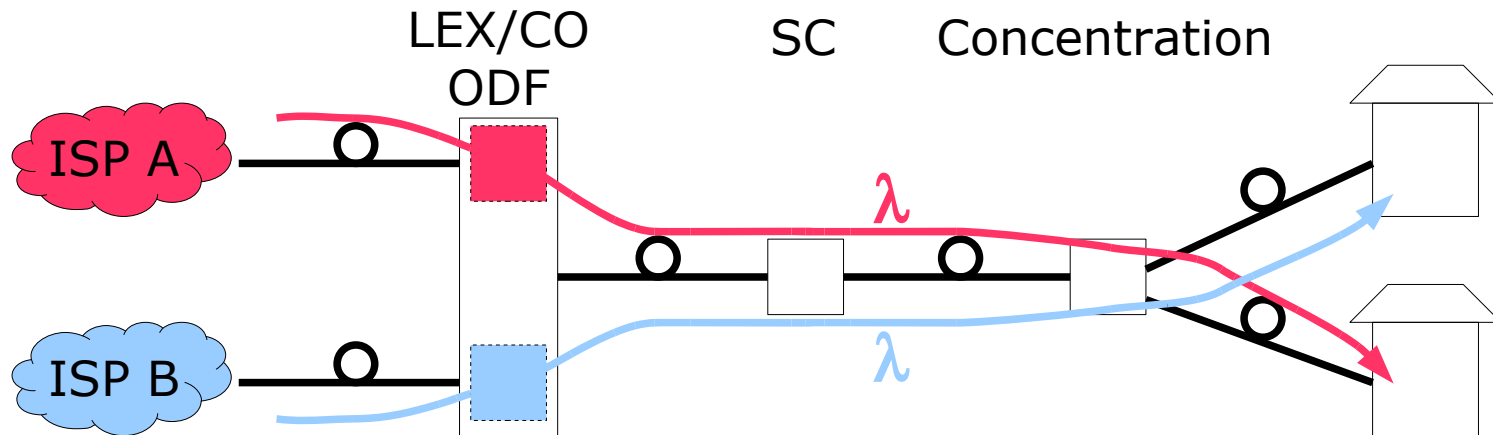
- Fiber to the Cabinet (FTTC)
- Hybrid solution: reuse of legacy access
- Optical-to-electrical converters at SC
- VDSL2 scenario
- Limited coverage

ODF unbundling



- PtP scenario
- Optical switching
- Sharing of the dedicated fiber running down to the subscriber

Wavelength unbundling

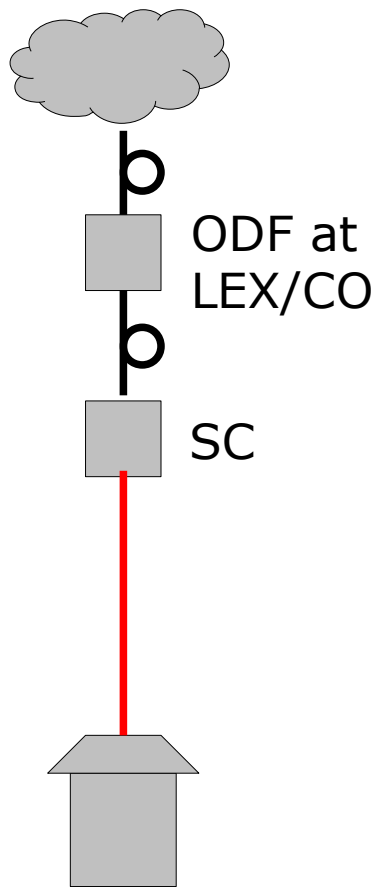


- Passive Optical Network (PON) scenario
- Sharing of the shared fiber running down to the subscriber
- Traffic multiplexed upwards beyond last splitter
- Wavelength Division Multiplexing (WDM)

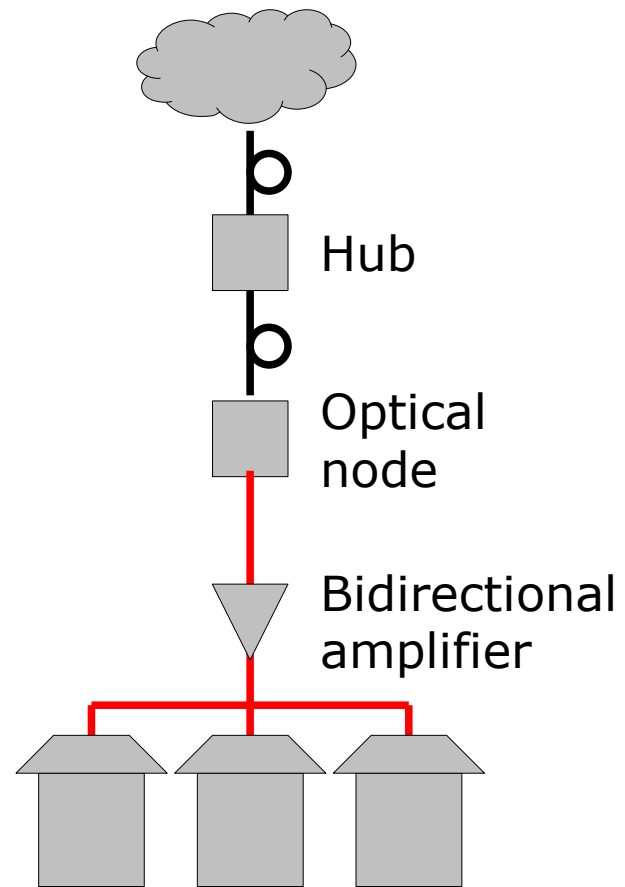


Summary

PSTN VDSL2



HFC DOCSIS 3.0



FTTH

