



Optical Access Seamless Evolution (OASE) - Research towards next generation access

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Life is for sharing.



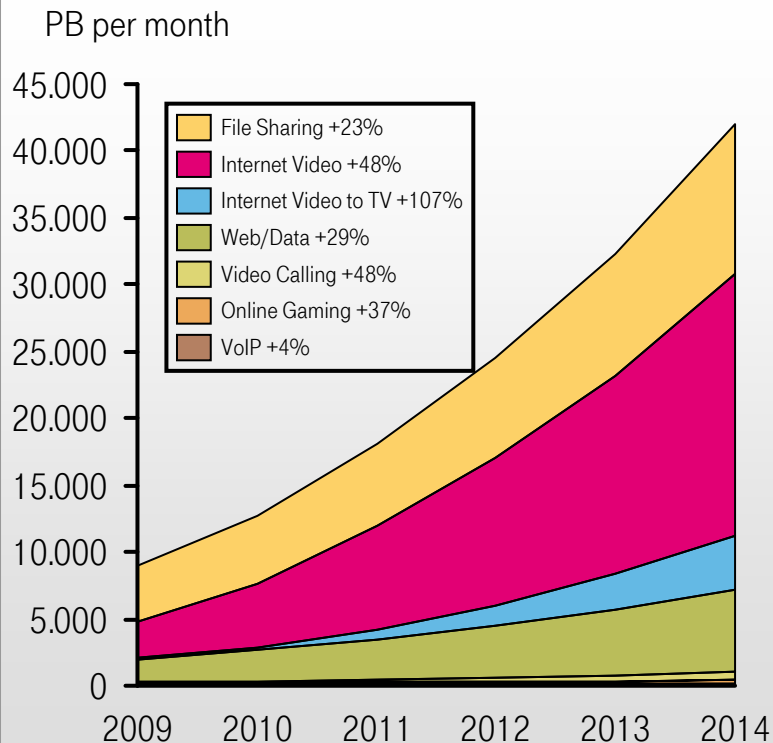
Outline.

- **Motivation**
- **Next Generation optical access:**
 - **node consolidation and resulting requirements**
 - **Protection**
- **Technology Options**
- **Potential business impact on architecture**
- **Summary**



Broadband market evolution.

Global Consumer Internet Traffic, 2009-2014



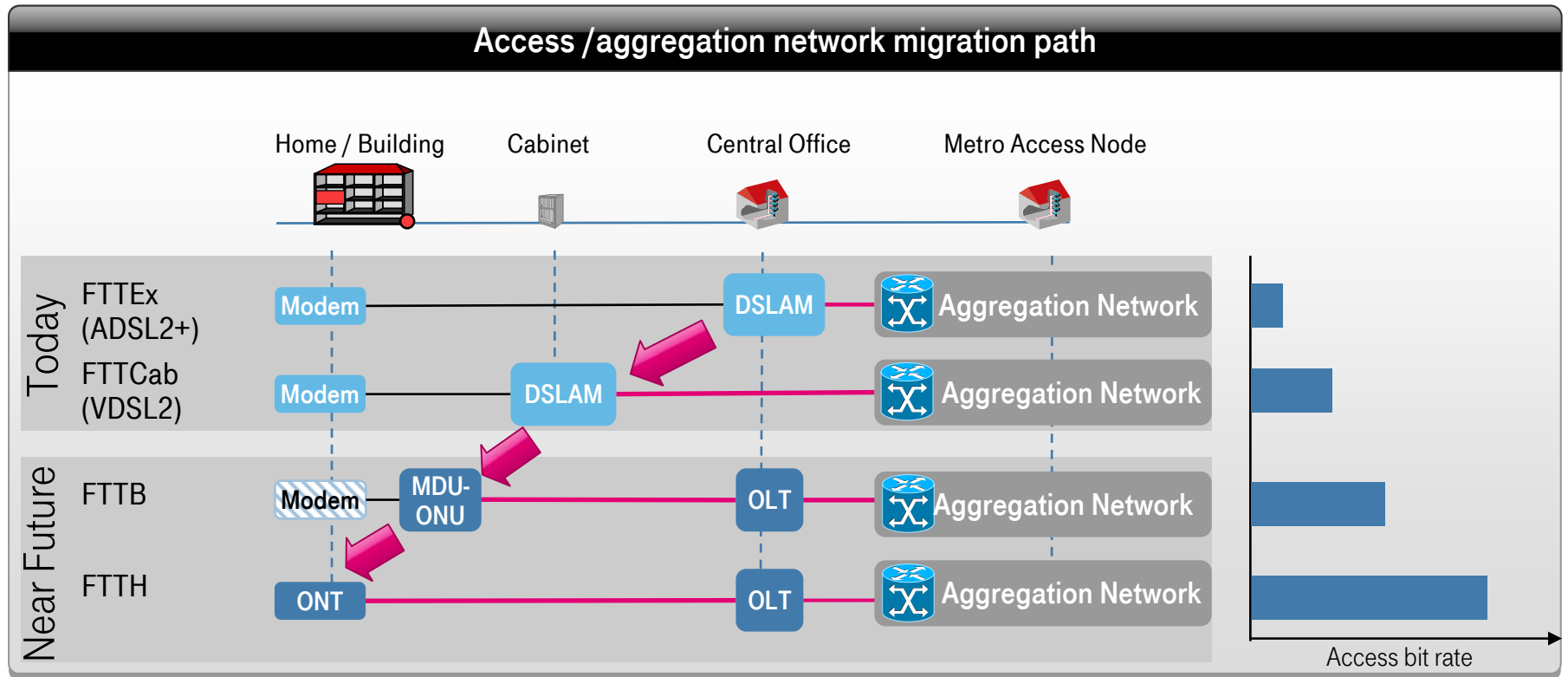
Source: Cisco Visual Networking Index: Forecast and Methodology, 2009-2014

- Video is one of the major drivers: “Internet video streaming and downloads are beginning to take a larger share of bandwidth, and will grow to nearly 60 percent of all consumer Internet traffic in 2014. “
- Internet Video to TV CAGR = 107%



Access network evolution.

Migration towards FTTH: Increased access bit rate per subscriber.



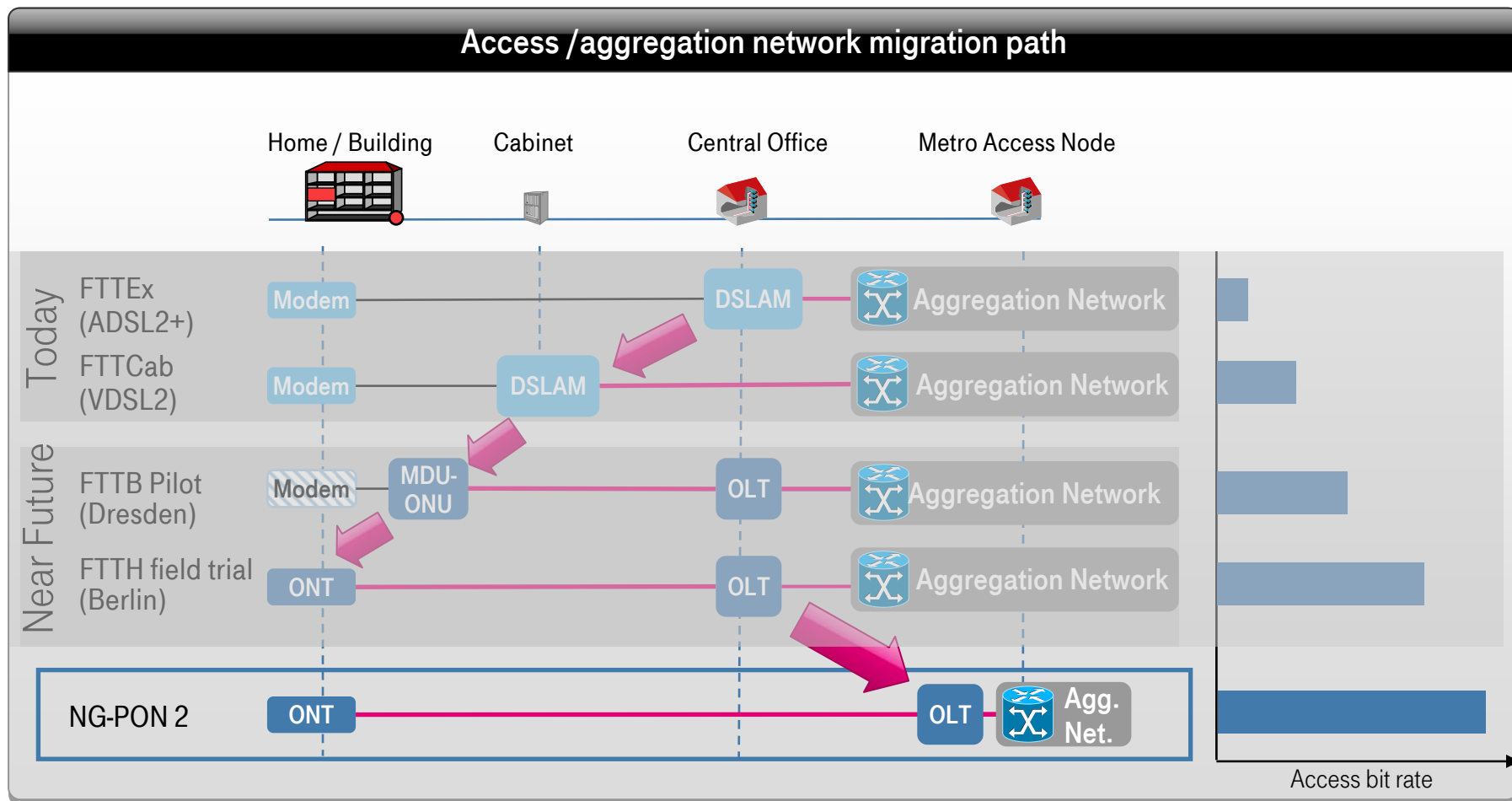
FTTH – Optical fiber access: No (practical) limitation in the access bandwidth.



Part 2: Next Generation Optical Access and resulting requirement

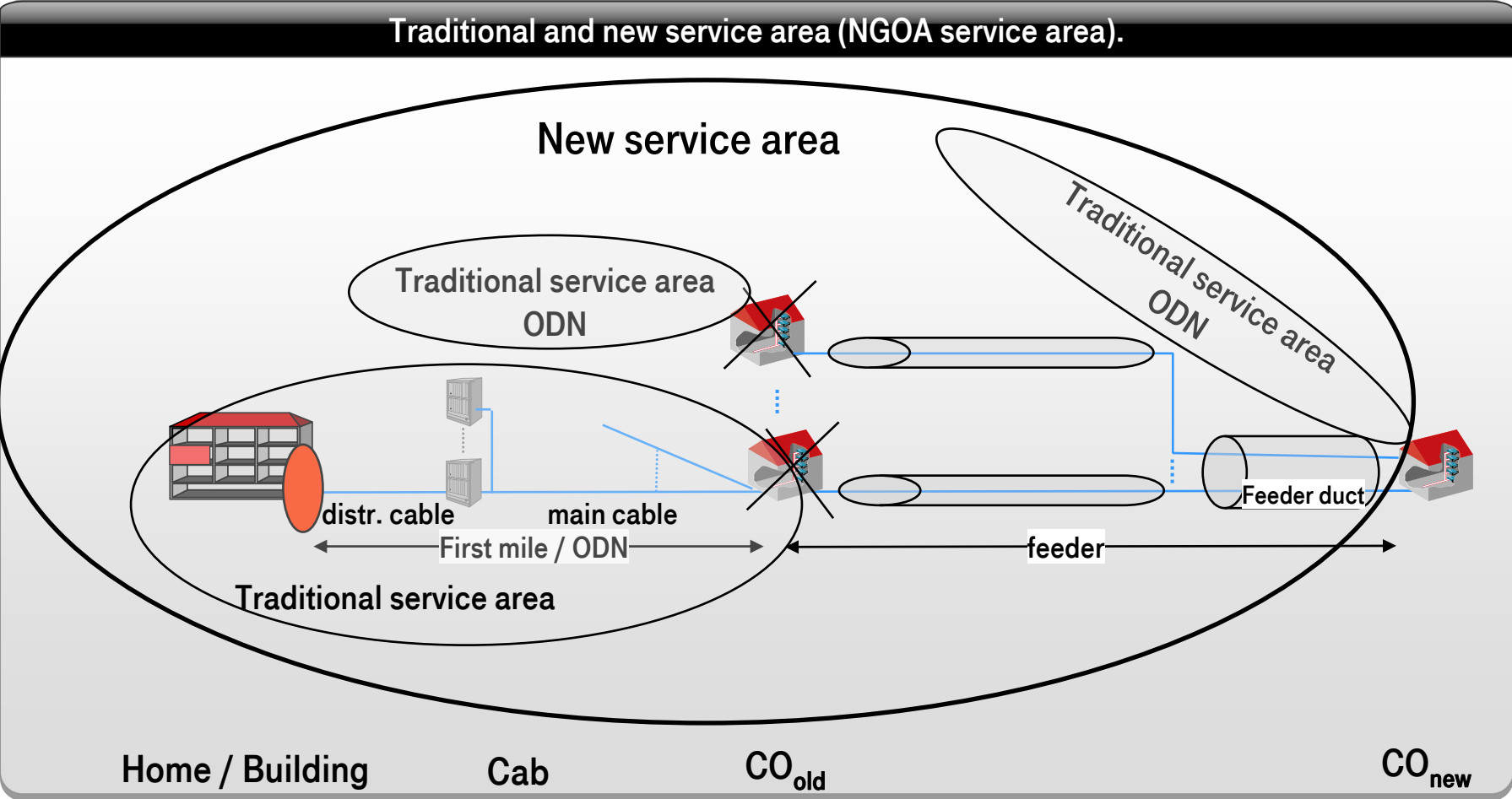
Transforming the optical access network into the structure of the Gigabit Society.

Minimal TCO at still growing bandwidth.



Next Generation optical access.

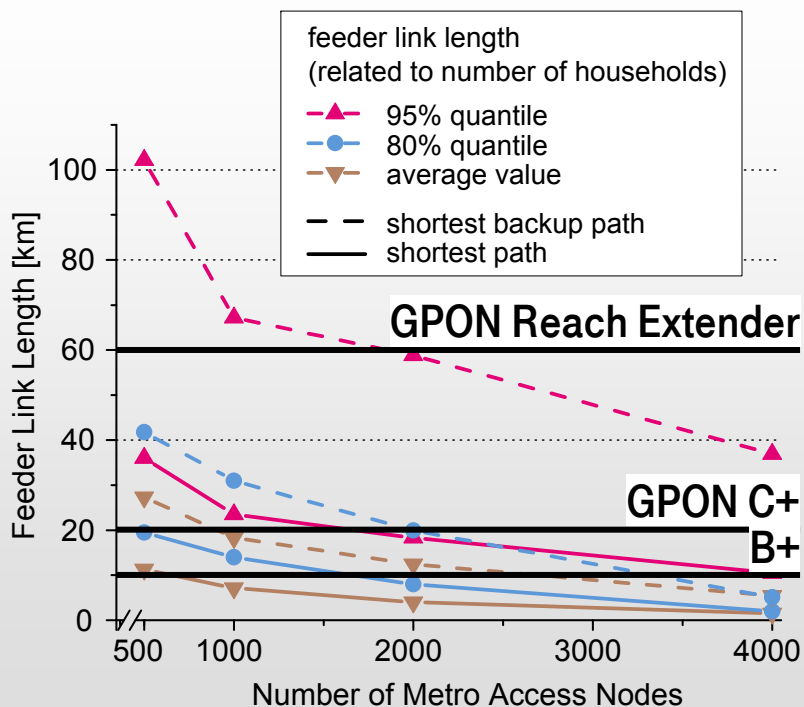
FTTH and node consolidation.



Feeder link length.

Which reach should be provided by NGOA systems?

Feeder link length = f(# metro access nodes)



Reach is not the challenge?

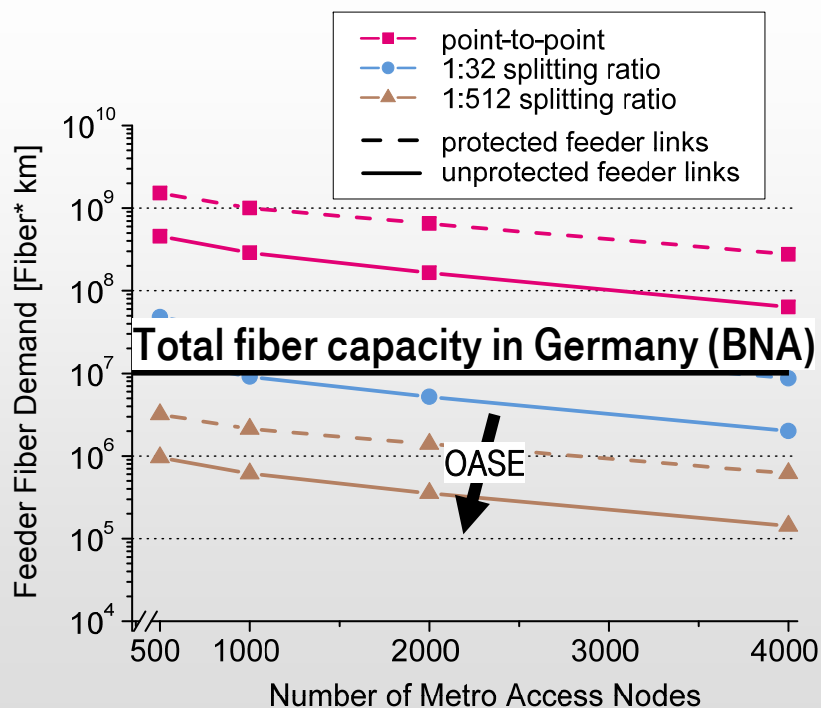
- Feeder links length ≤ 40 km for majority of households in all scenarios
- Very long feeder links for a minority of households only
- For total transmission distance subscriber line length in ODN has to be added (typically < 5 km)
- Typically about ($<$) 40 km reach are sufficient
- Protection will require longer reach (2x)



Feeder link fiber demand.

The dark side of site darkening - Additional cable required.

Feeder fiber demand = $f(\# \text{ metro access nodes})$



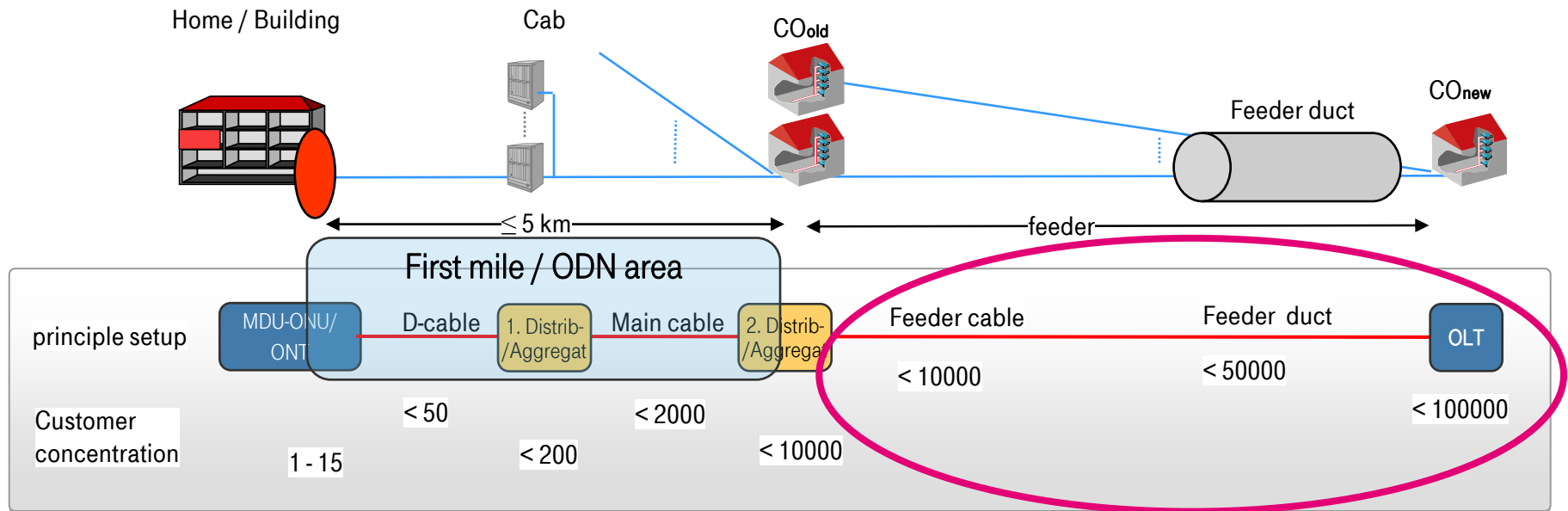
High splitting is required!

- Feeder cables are an important additional cost factor
- Feeder fiber demand depends on
 - Number of Metro Access Nodes / Feeder link length
 - Feeder fiber multiplexing (splitting)
 - Resilience requirements
- High splitting ratio is key to reduce additional feeder costs
- Resilience has to be optimized



Failure penetration range in FTTH applying node consolidation.

Protection is needed at high number of affected customers.



- On feeder cables and feeder ducts the maximum failure penetration range can be high
 - Example:*
 $(192 \text{ fibers/cable} - 33\% \text{ reserve}) * 32 \text{ subscribers/PON} * 75\% \text{ PON utilization} \approx 3,000 \text{ subscribers}$
- Redundant feeder fibers along disjoint paths might be needed



Failure penetration range is an important criterion for network quality.

Definition of maximum failure penetration range

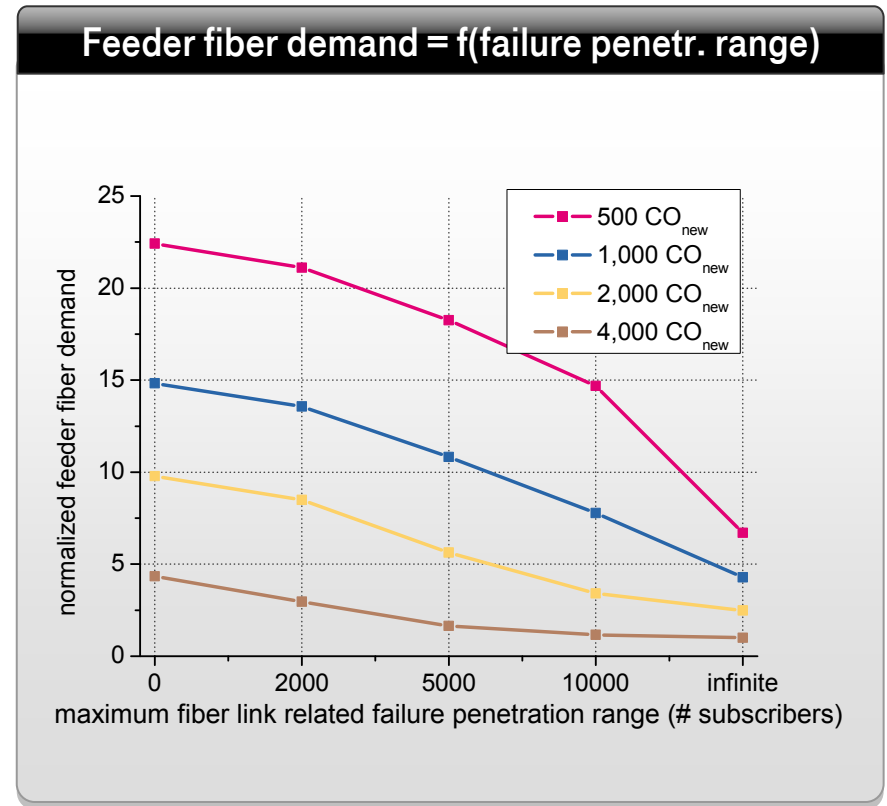
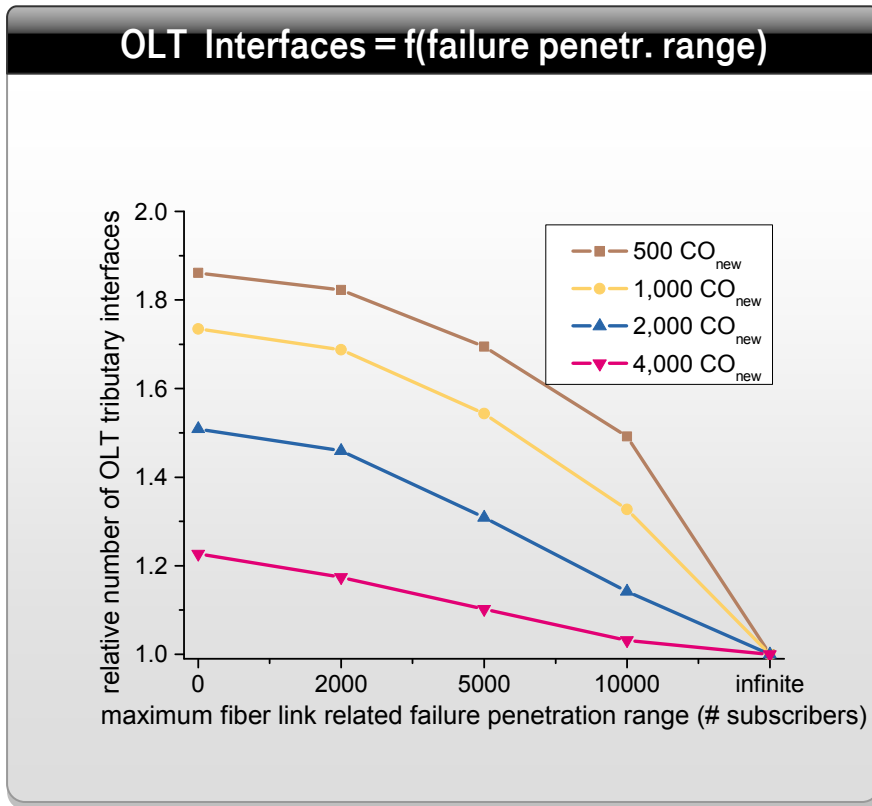
Maximum failure penetration range...

- equals the maximum number of customers or lines getting simultaneously affected by a single failure
- depends on the number of customers or lines connected to a certain device or sharing a link without any redundancy
- can be controlled by
 - limiting the number of customers or lines connected to a certain device or sharing a link
 - providing redundant network resources
- is independent from failure probability
- is therefore also independent from element/connection/link availability
- cannot be decreased by increasing the availability of network elements



Effort for protection of the feeder segment.

What are the costs associated with protection?



Variation of failure penetration range shows a strong dependence on costs of the feeder fiber.

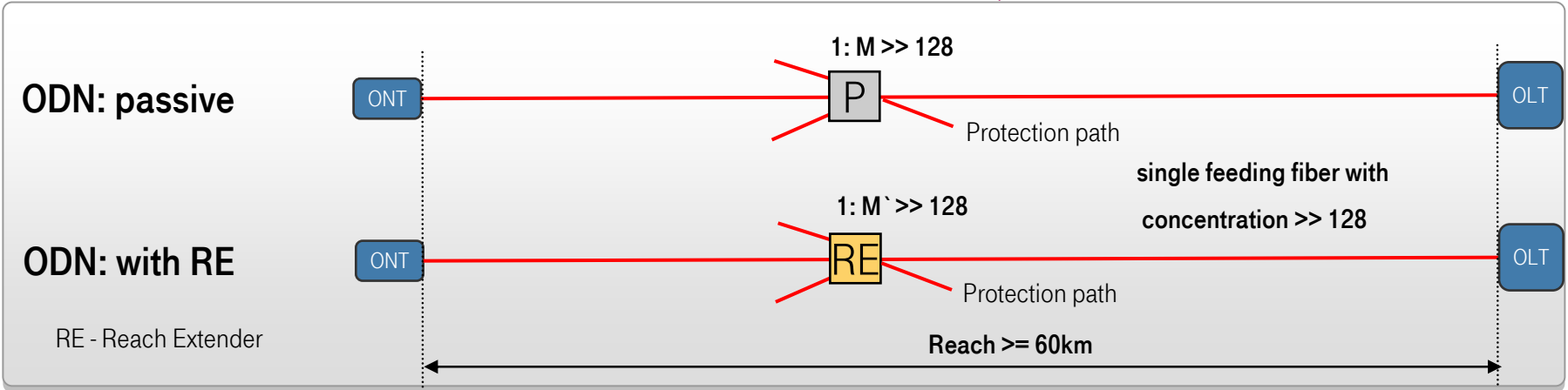
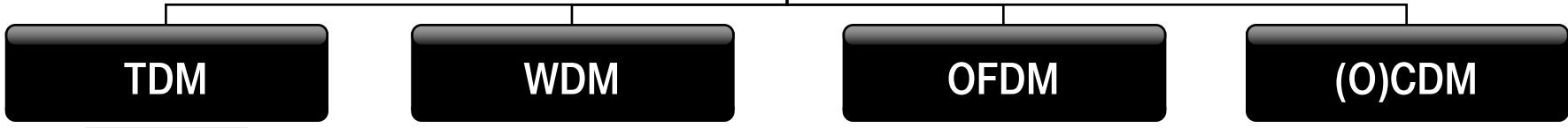


Part 3: Technology options.

NGOA technologies.

Technology options.

Technology options for NGOA

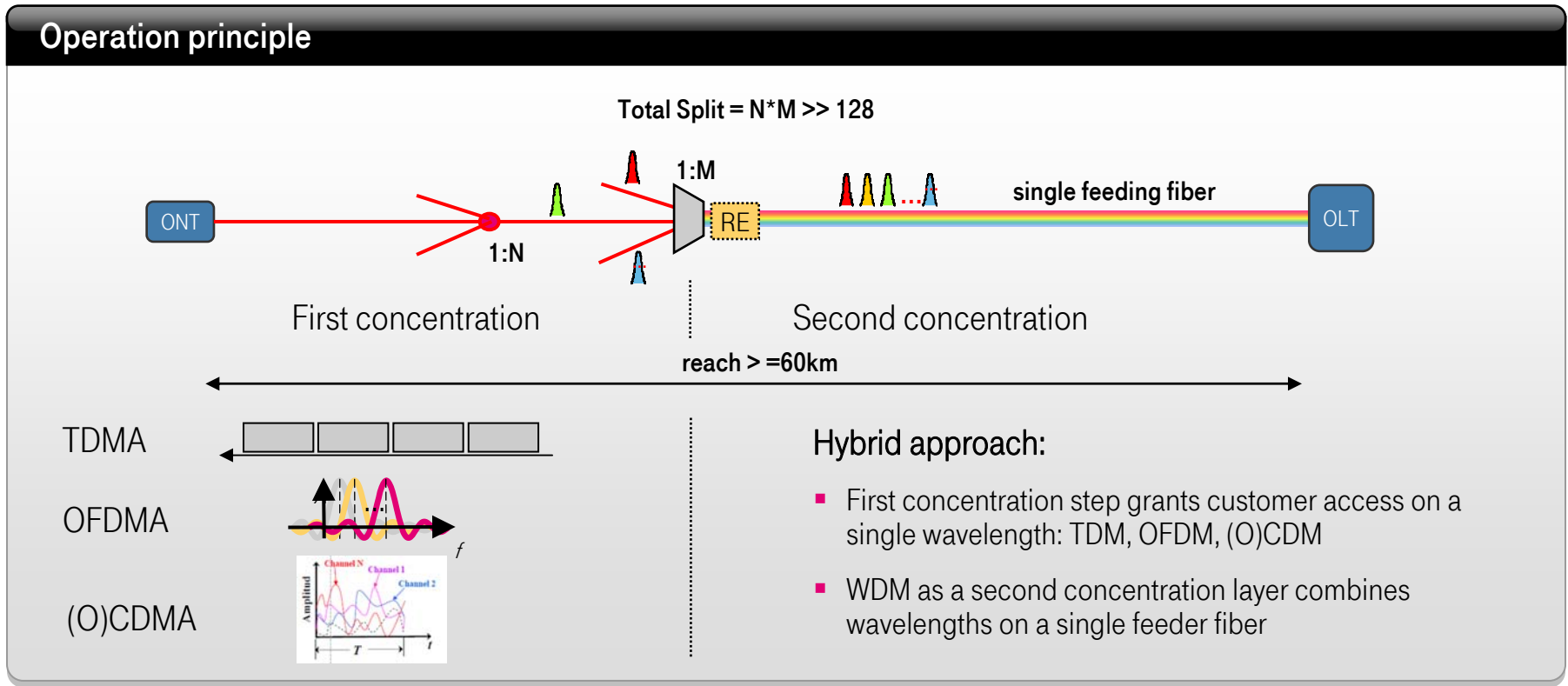


Major technology breakthroughs are needed to enable significant cost reductions!



NGOA technologies – potential of hybrid approaches.

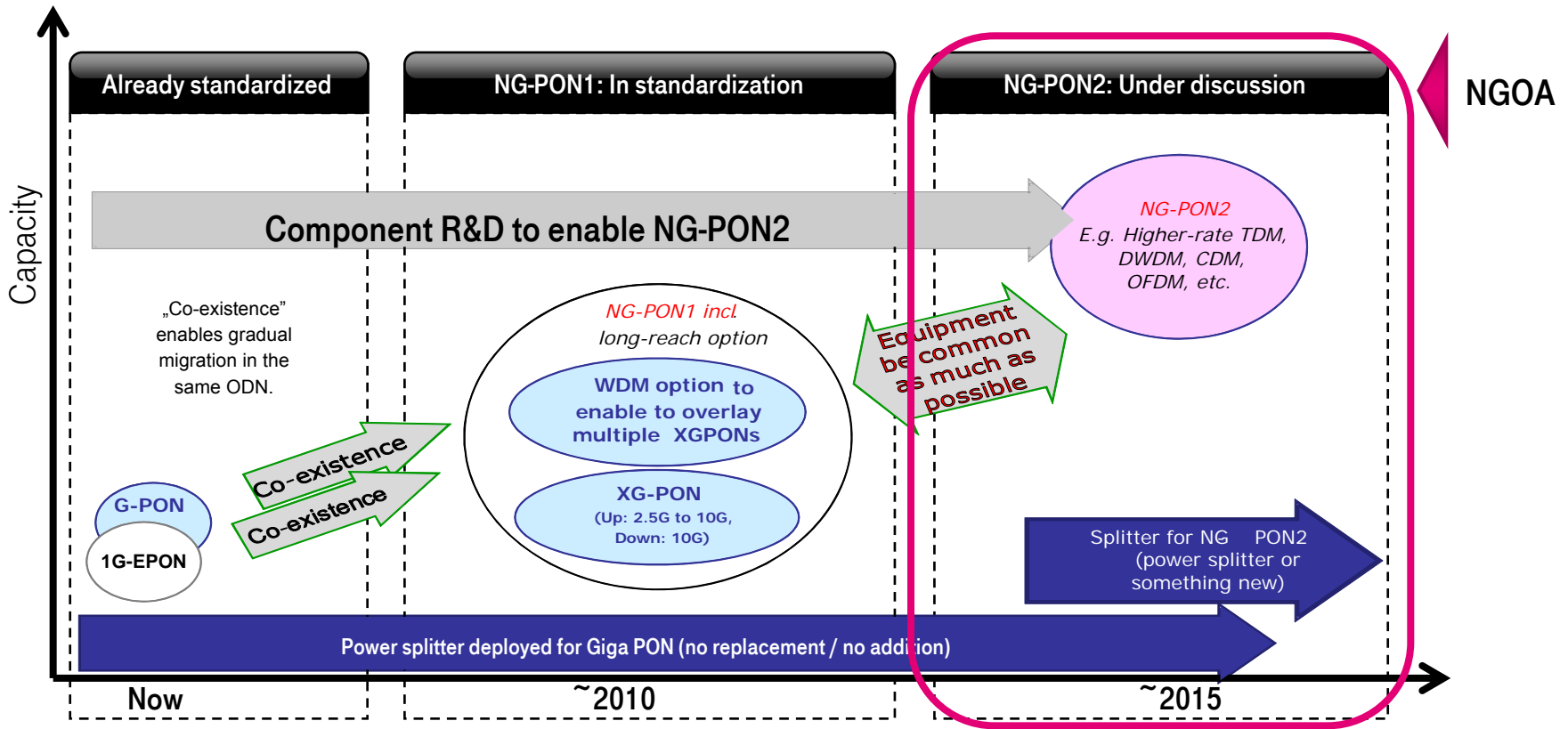
Hybrid approaches – combination of advantages of technologies.



**Optimal technology combination is under investigation.
Even in hybrid approach major technology breakthroughs are needed to enable significant cost reductions!**



NGOA – Reducing Total Cost of Ownership (TCO). FSAN Next Generation PON (NG-PON) Roadmap.

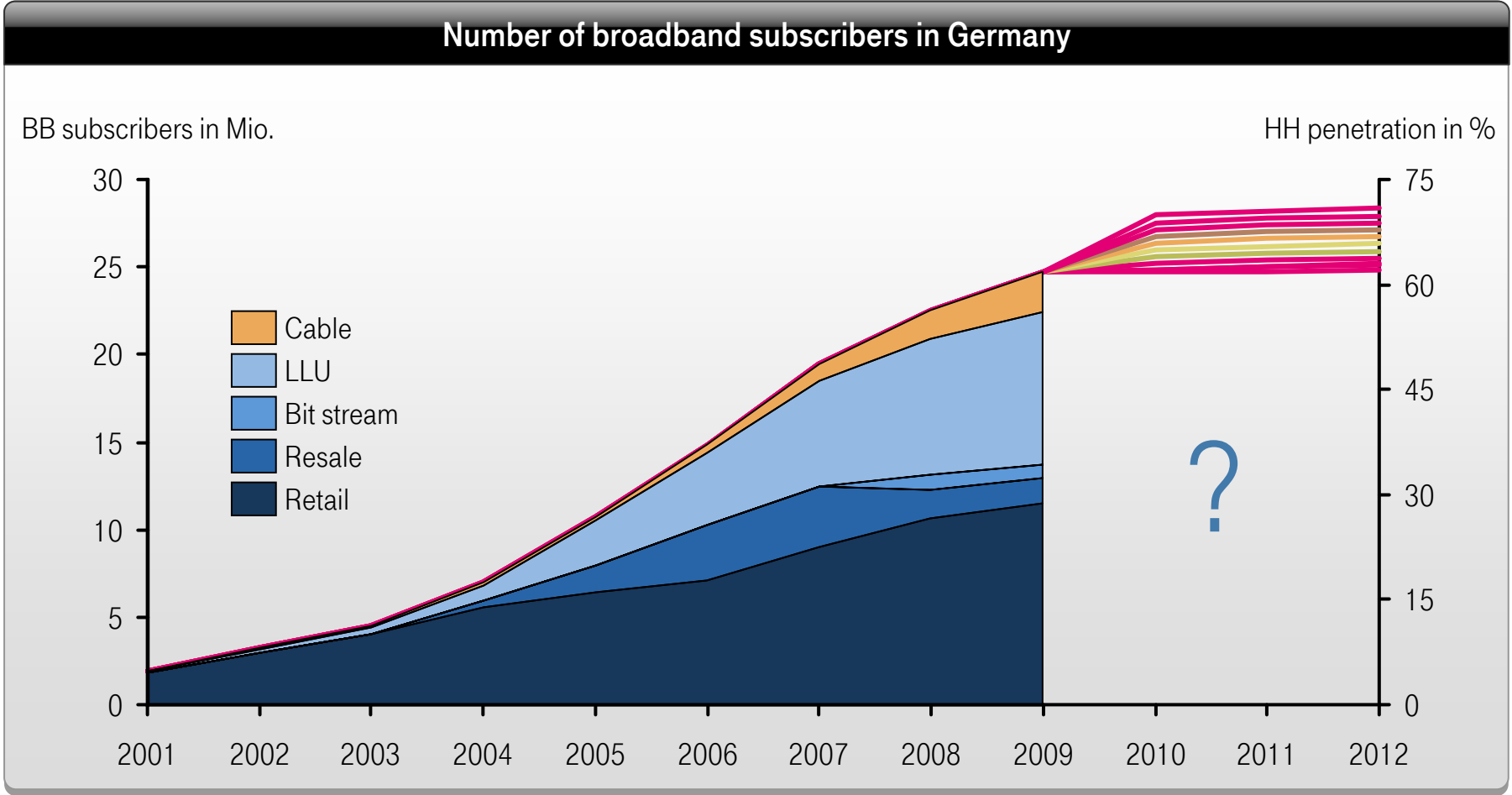


NGOA objectives: Higher data rates per user, long reach & higher split at lower TCO. There are various options and proposed solutions but no clear picture up to now!



Part 4: Business Impact on Architecture.

Number of broadband subscribers are going into saturation.

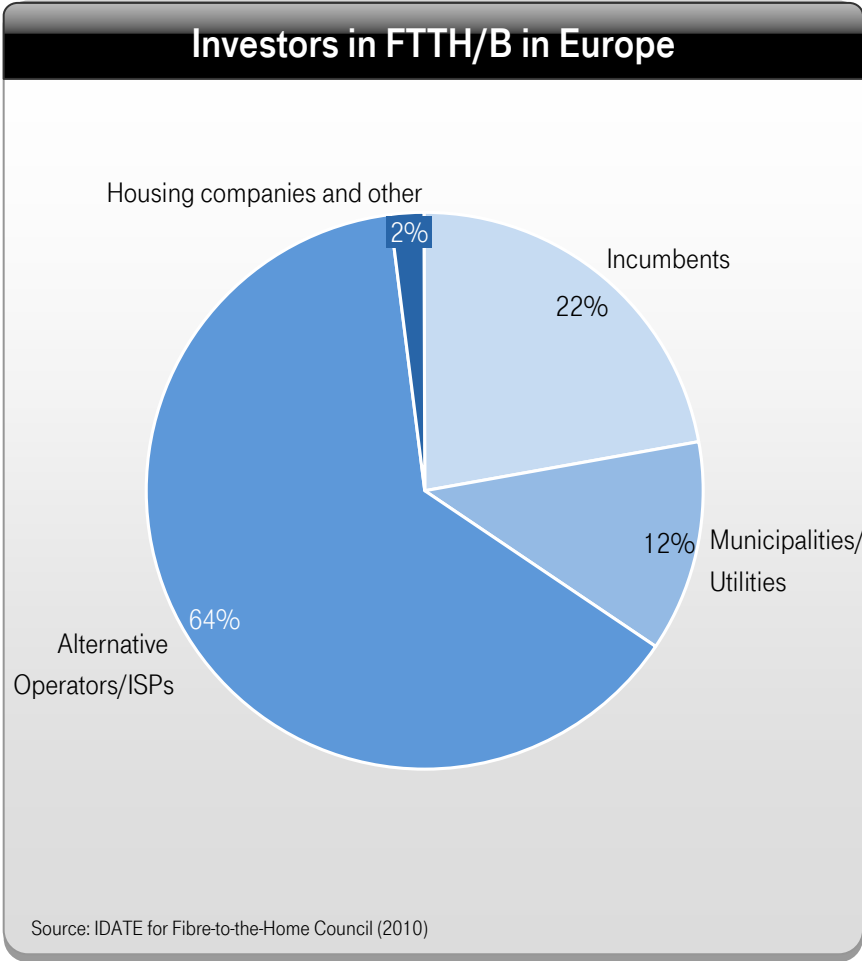
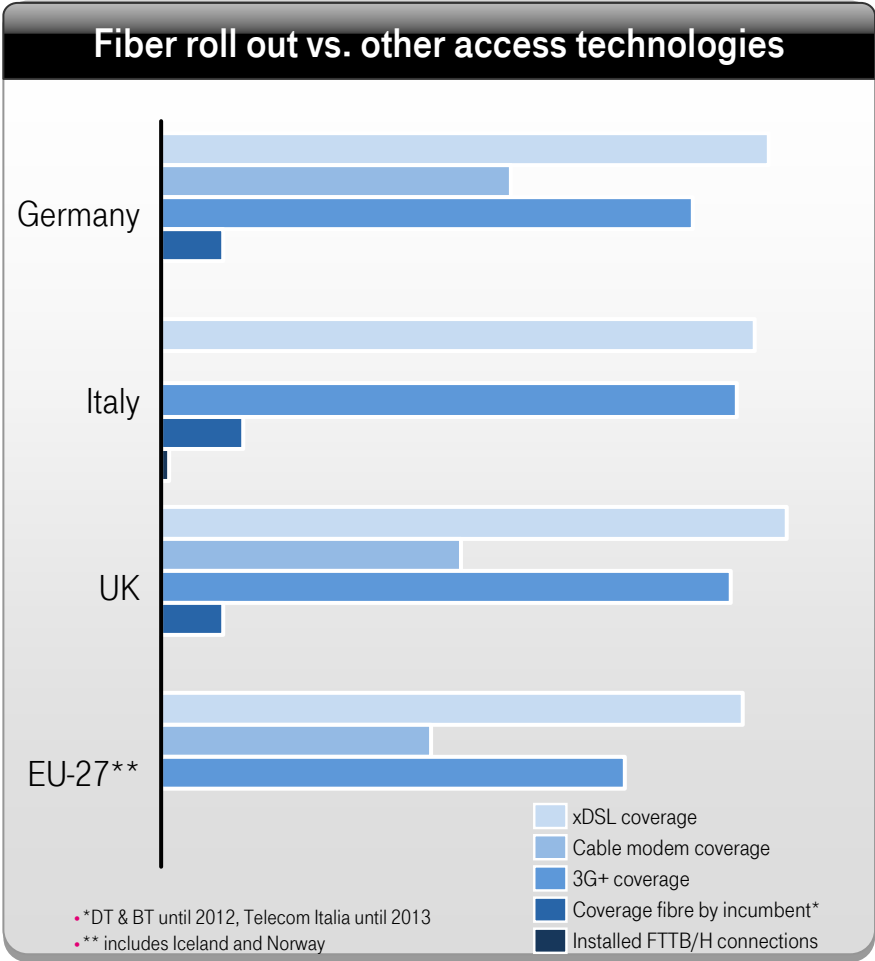


Source: Bundesnetzagentur



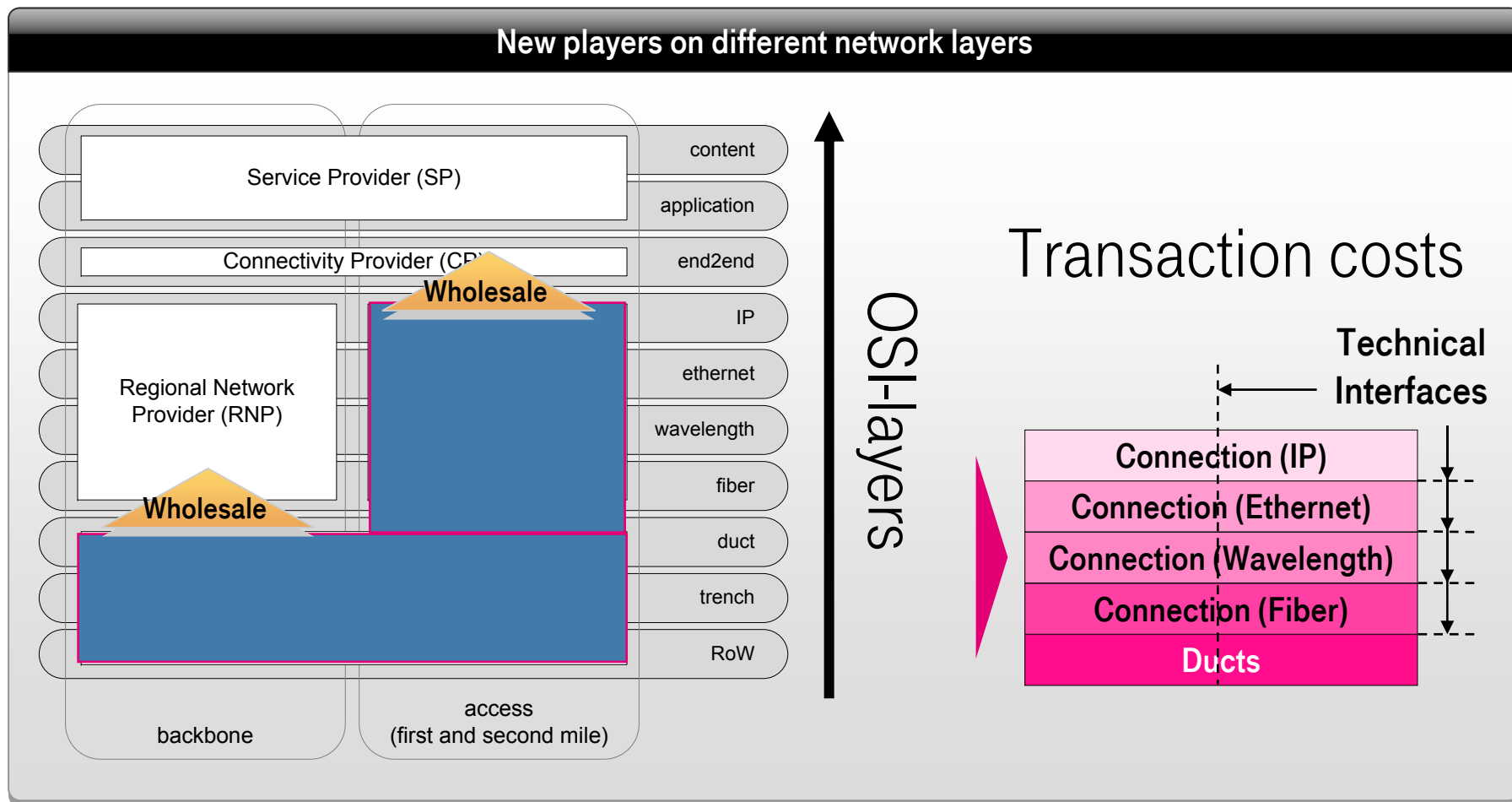
Market environment in Europe.

What is going on in fiber deployments?



Fragmented ecosystem will emerge.

A lot of different players.



Summary.

FTTH today

- Bandwidth and no. of broadband lines continue to grow
- Fiber access removes access bottleneck and enables full services portfolio
- From technology point of view a lot has been demonstrated

NGOA

- Node consolidation to further reduce TCO at still growing bandwidth demand
 - High sharing (number of customers) of feeder fiber desirable
- Protection is needed to limit the number of customers affected by a single failure
- Additional players on different network layers need to re-investigate today's business models
 - Transaction costs for co-operation need to be understood



Thank you!

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“The work leading to these results has received funding from the European Community's Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 249025”

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