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Cost-minimizing Technology Mix for roll-out of Fixed and Mobile Broadband

EMERG Workshop on Broadband Strategies
Cologne, December 2020

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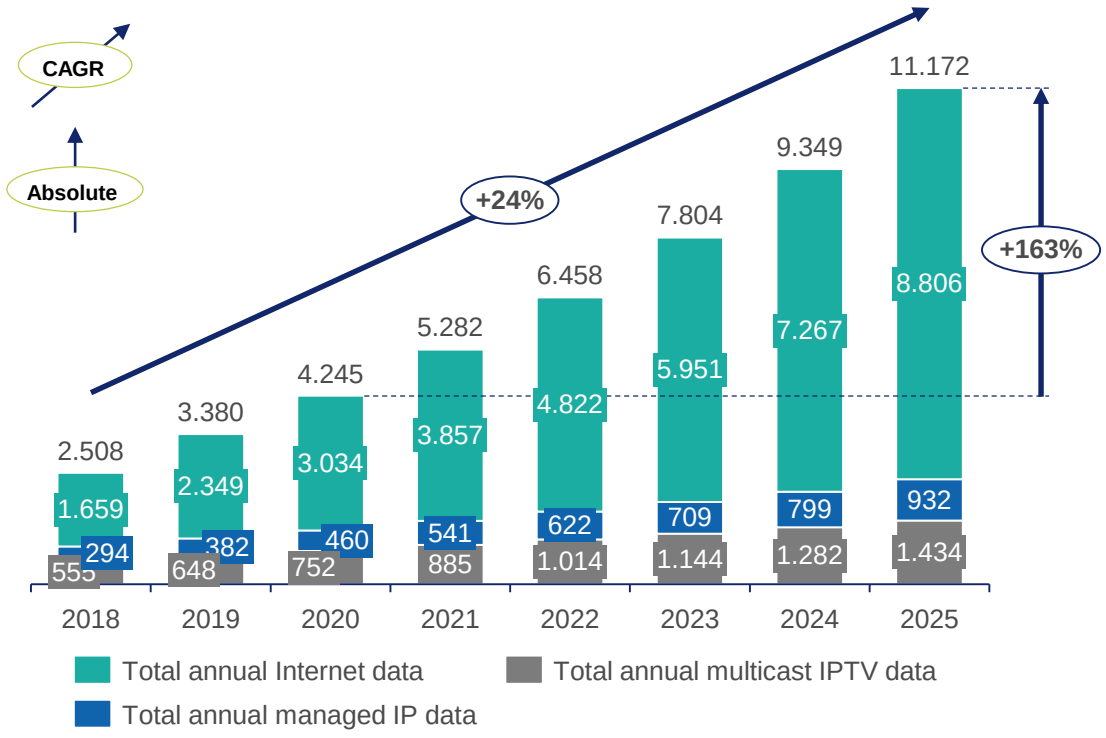
01 Broadband Technology Trends and Economics

Fixed networks carry most of the traffic, but mobile is catching up, primarily due to the steep increase expected in 5G traffic.

Worldwide total annual fixed traffic

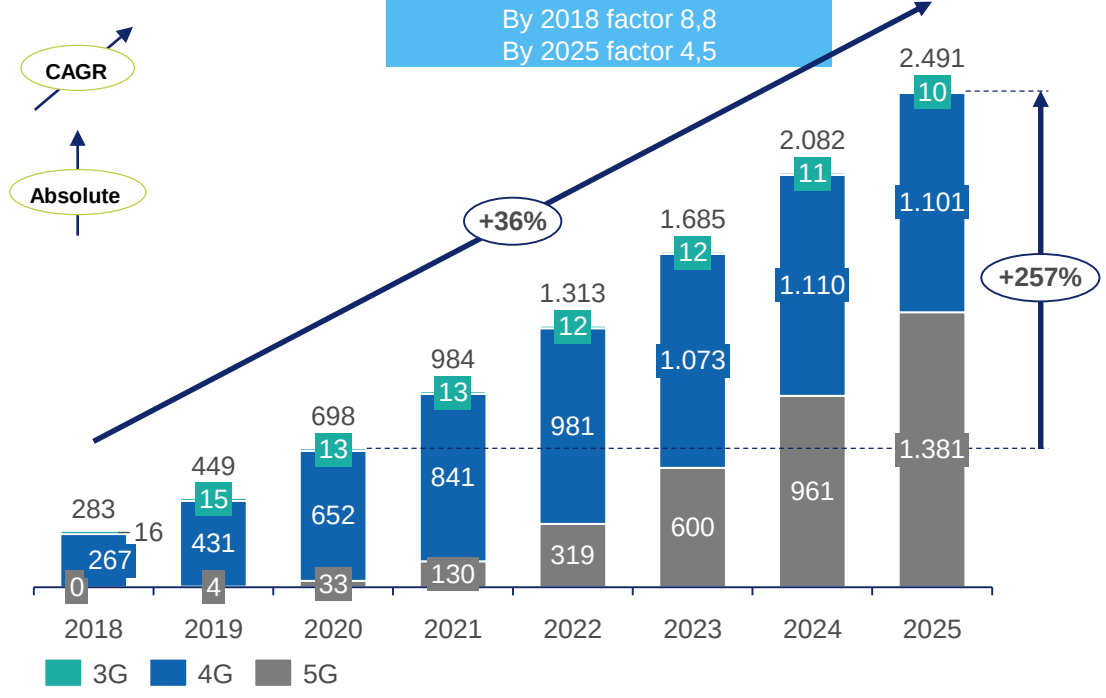
2018 – 2025, in Exabyte (EB)



Wireless network traffic worldwide

2018 – 2025, in Exabyte (EB)

Fixed traffic as a multiple of mobile traffic
By 2018 factor 8,8
By 2025 factor 4,5



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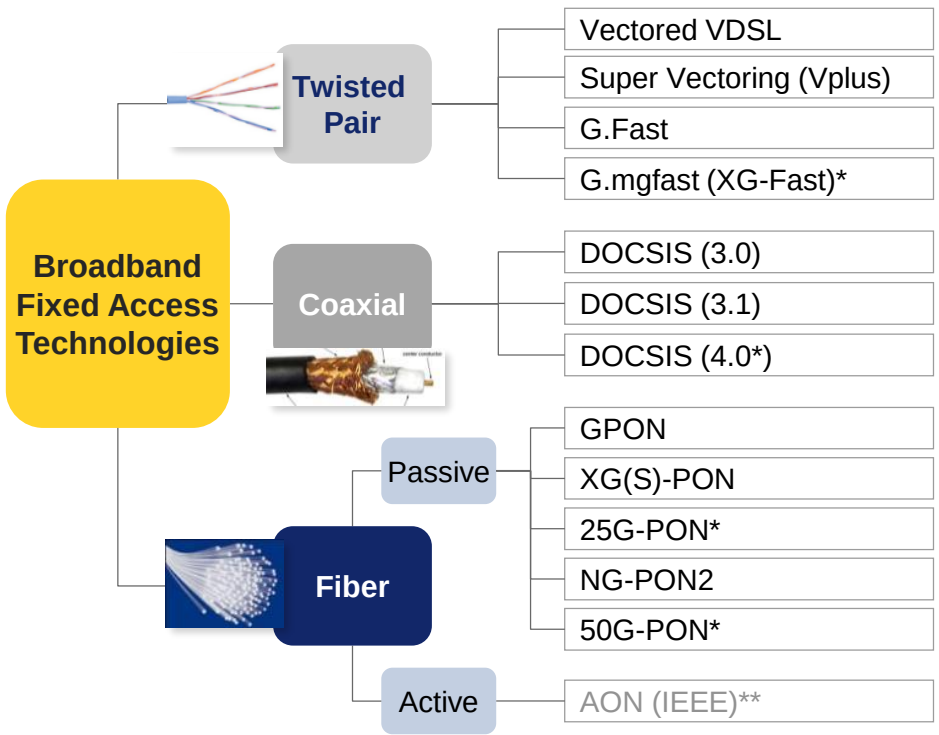
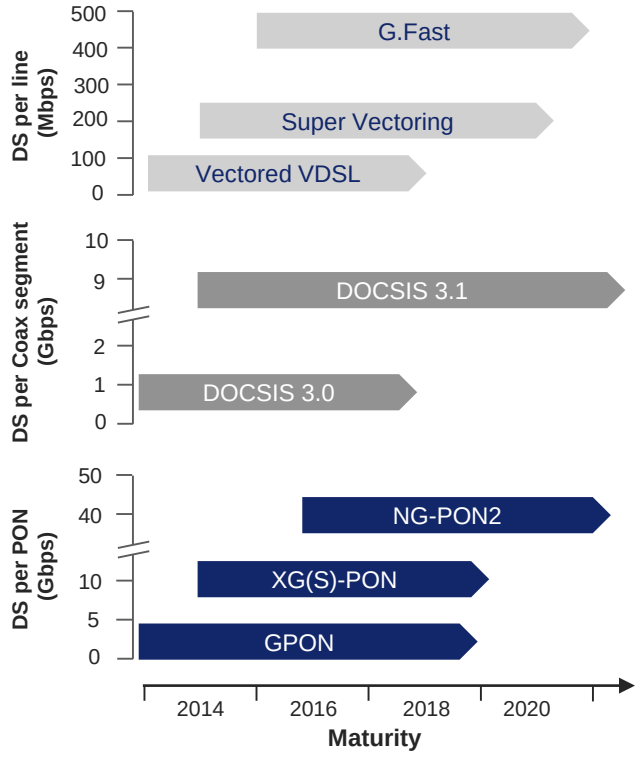
Fixed access evolution is ongoing for both copper-based and fiber-based technologies.

Fixed Access mature and emerging technologies and standards





Remarks

- Access technologies evolution is developing into following directions:
  - Copper technologies: increasing bitrates to the prolong the lifetime of legacy copper in the last mile
  - Coax technologies are increasing bitrates per coax segment utilizing a wider frequency band and improving coding techniques
  - Fiber-based PON technologies are evolving to increase reach and provide more bandwidth to the end-user, while reusing existing passive fiber infrastructure.

All technologies w/o "(IEEE)" are recommended by ITU;
** No standardization for DOCSIS 4.0 (FD), G.mgfast and 25G(50G)-PON*
*** Not considered in this assessment*

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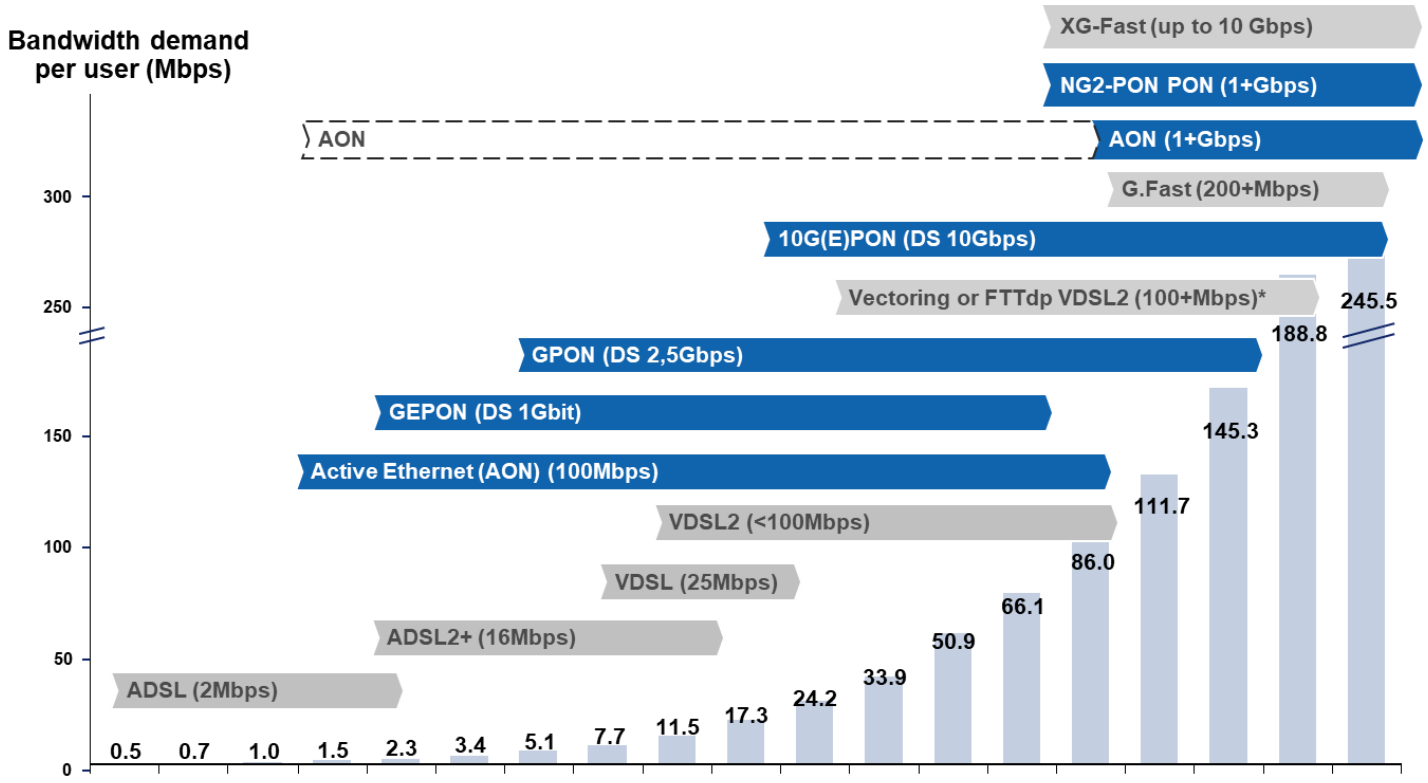
Comparisons show that copper access networks can deliver comparable access speeds to pure fiber networks.

Bandwidth requirements and fibre/copper technologies

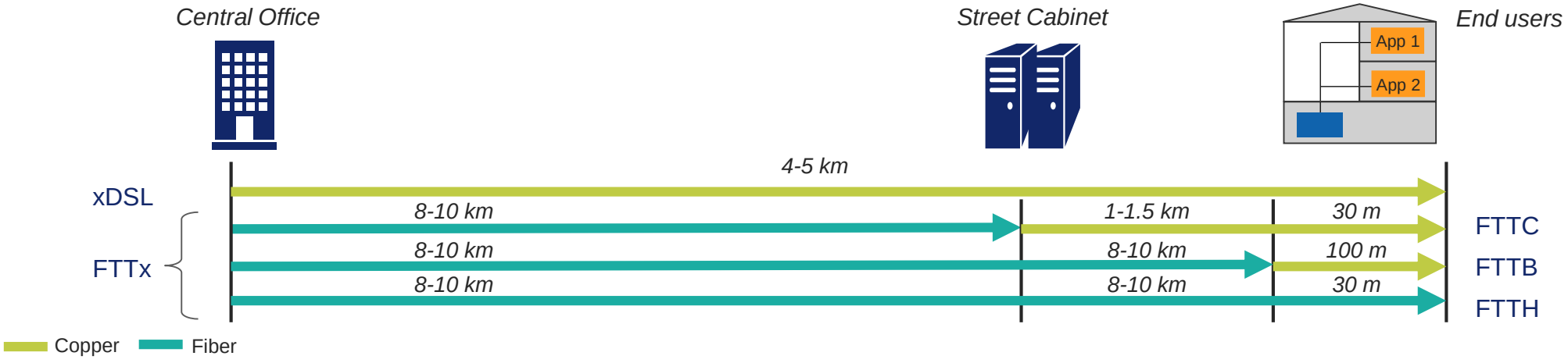


Comments

- Cable-based technology like DOCSIS 2.0, 3.0 or 3.1 not shown here
- G.Fast Interoperability with other xDSL technologies
- XG-Fast able to provide multi-gigabit backhaul for future 5G wireless networks
- Super Vectoring – Vplus (35b) allows for 300Mbps DS in loops shorter than **250m**

FTTx can be migrated stepwise with limited CAPEX for incumbent operators. The existing infrastructure and ducts can be reused.

FTTx Options



xDSL

- DSLAM or MSAN in Central Offices
- Copper between CO and subscribers
- Copper reach limited to around 4 km for higher bandwidths
- No electrical power required in field

FTTC (VDSL)

- Fiber to the Street Cabinet (Street Cabinet)
- DSLAM or MSAN in SC, copper reach limited to 800m for higher bandwidth
- Electrical power required in field
- Copper and fiber in the outside plant

FTTB (PON)

- Fiber to the Building (Termination Box)
- In-house cabling: copper
- ONU, Mini-DSLAM or MSAN in the building
- Higher bandwidth depends on used PON technology and designed architecture
- Coexistence of copper and fiber in the outside plant

FTTH (PON)

- Fiber to the Home
- In-house cabling
  - Fiber terminated in the ONT in home/apartment
  - Using copper for in-house cabling for MDUs (CAT5 or CAT6)
  - Electrical power required in the building

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Note.: Business Case and Subscriber Forecast required while analysing different deployment options

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There are three major entry barriers for fiber-investors which depend also on regulation and other legal restrictions.

Fiber Route Duplication

- Fiber is typically a first come – first served market. The first operator to roll out in a suburb or region will most likely be the predominate operator in that area
- Duplication of fiber routes is usually discouraged by governments and operators alike. While costs are nearly duplicated the market share and thus revenue will have to be shared minimizing chances to recover investments.

RoW Permission

- Right of Way (RoW) permission is an important criteria in any fiber roll out.
- If rights of way are not fixed in the Telecommunications laws individual rights granted by the NRA may be insufficient and costs or delays caused by public or private land owners may be prohibitive.
- Clear regulation of in-house access is a prerequisite (~30% of CAPEX)

Civil Works Costs

- The cost for roll out of fiber is predominantly driven by the civil works (i.e. trenching, construction equipment leasing, man power, etc)
- Civil work may constitute 60% - 70% of the actual fiber roll out cost. Costs in countries without forced underground deployment are significantly lower.
- In comparison, the actual fiber itself is cheap. Therefore regulations for spare capacity for other operators or/and mobile deployments have low cost but large benefits!

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Reducing regulatory restrictions for network sharing, in particular co-operation with public utilities may significantly boost fiber deployment.

Business Model: Co-operation with Utilities

Mode	Joint Venture	Fiber Leasing	Pole/Duct leasing	Co-investment	Integrated
Country	Ireland SIRO(ESB&VDF)	Italy (EOF&VDF, WIND)	Kenya (KPLC&SFC , ZUKU)	Swiss (EWL&SWISSCOM)	United States (EPB, OPELIKA)
Feature	• New and individual company • BT openreach-like mode	• Unified fiber ODN constructed by electricity com. • Telecom operators construct active network	• Electricity company leases power ducts and/or poles to telecom operators to build fiber network	• Invest and plan together between electricity company and operators • Construct with steps	• Electricity company provide BB services to subscribers • Usually city based small operator

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In mobile the 5G performance is higher than 4G as the aspirational targets indicate, but is associated with massive investments e.g. in Fiber.

	Capability	LTE	5G	Achievable with …
1	Radio network contribution	30ms to 50ms RTT for Layer 2	1ms (Layer 2) 4ms (Layer 2)	… massive invest in Edge Comp.
2	Peak data rates	1 Gbps in DL 0.5 Gbps in UL	20 Gbps in DL 10 Gbps in UL	… Fiber and spectrum investment
3	User experienced data rates	30 Mbps in DL 15 Mbps in UL	100 Mbps in DL 50 Mbps in UL	… Fiber, spectrum, densification
4	Connection density	10 000 devices / km2	1 000 000 devices / km2	… massive network densification
5	Mobility	0 - 350 km/h	0 - 500 km/h	
6	Peak spectral efficiency	< 2 bits/Hz	30 bits/Hz	… massive 64 MIMO
7	Area traffic	<1 Mbps / m^2	10Mbps / m2	… massive network densification
8	Energy Efficiency / bit	x1	x100	…. Cloud-RAN

Source: ITU, Detecon

02
5G and FTTX Convergence

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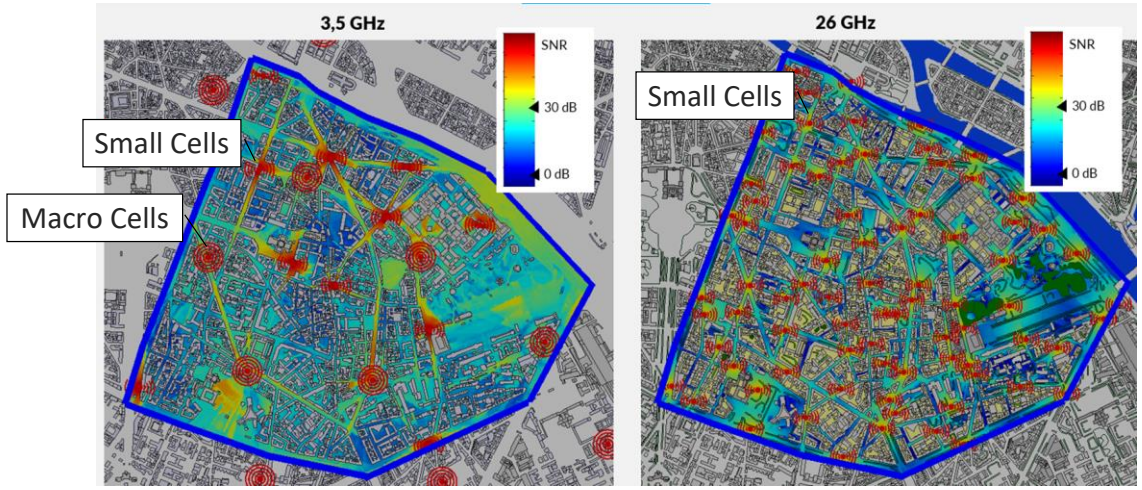
The development of 5G networks evolves from macro-cells to small-cell networks, where fiber to high density (in-building) sites are required.

Why 5G needs Fiber

- The **high throughput speeds above 1Gbps** in 5G networks can only be achieved, if fiber is massively deployed in backhaul and fronthaul.
- 5G networks also need much **more spectrum** to achieve high bandwidth, which is only available in areas above 3GHz or even mmWaves.
- High frequency spectrum can cover only small areas, which means a **massive small cell densification** will be needed for future 5G networks.

- FTTH and 5G rollouts will go in parallel and offer **synergy potential.**

Spectrum and Coverage



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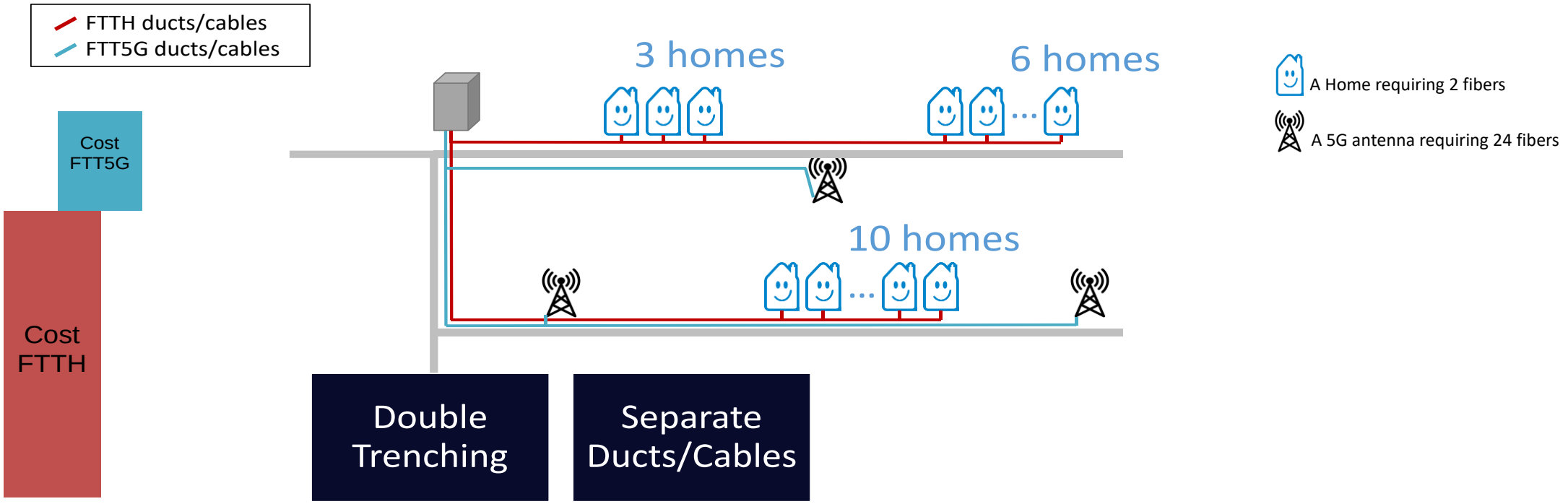
The FTTH convergence study started to quantify the synergy value by comparing one converged network with two standalone networks.

FTTH Convergence Study Approach step 1: Deployment of separate FTTH and 5G Sites



Source: FTTH Council Europe, 5G-FTTH convergence study of the 5G working group within D&O committee, 2020, Detecon

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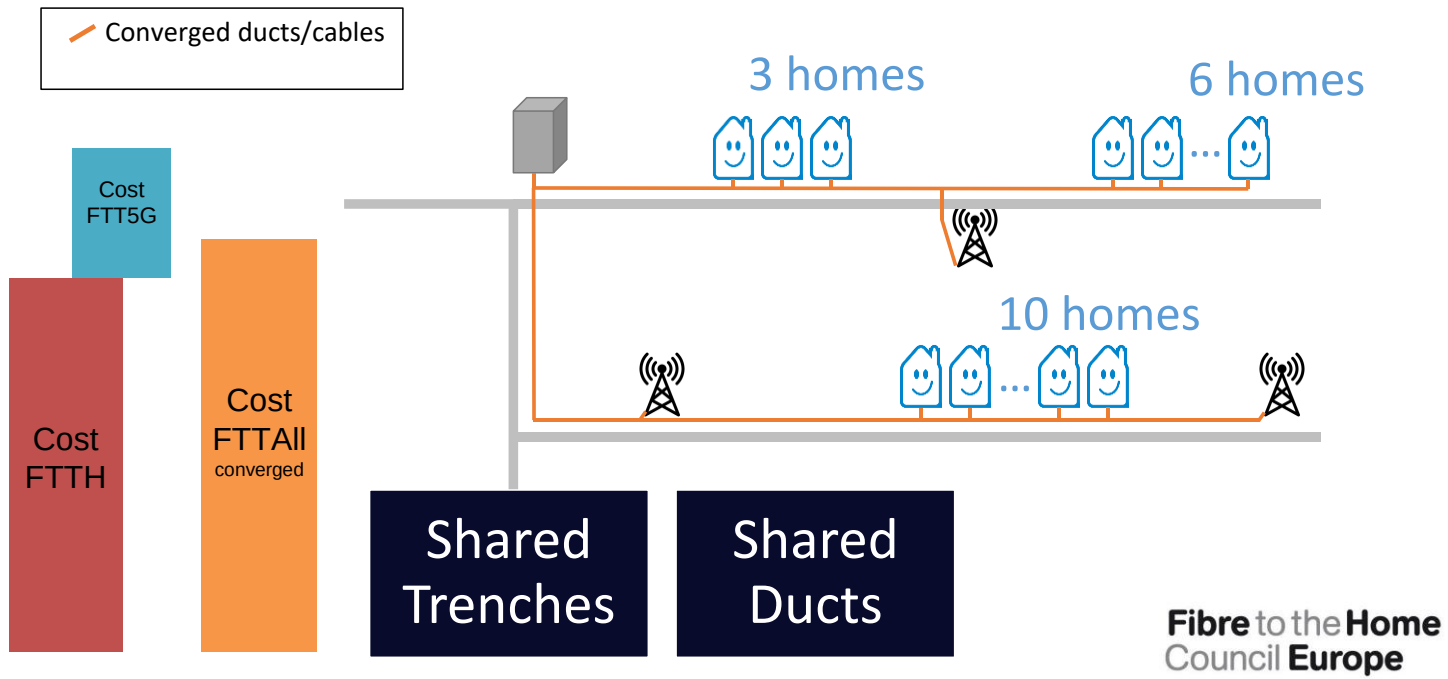
Sharing of ducts and trenches for both networks produces less total cost than separate networks.

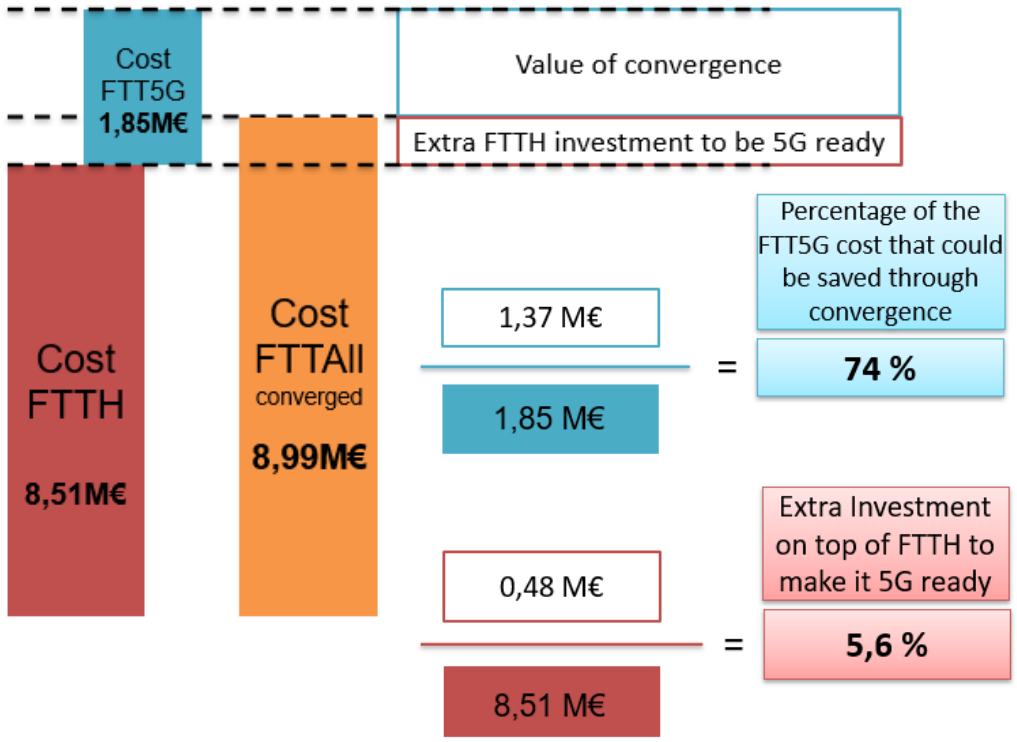
Deployment of shared FTTH and 5G Sites

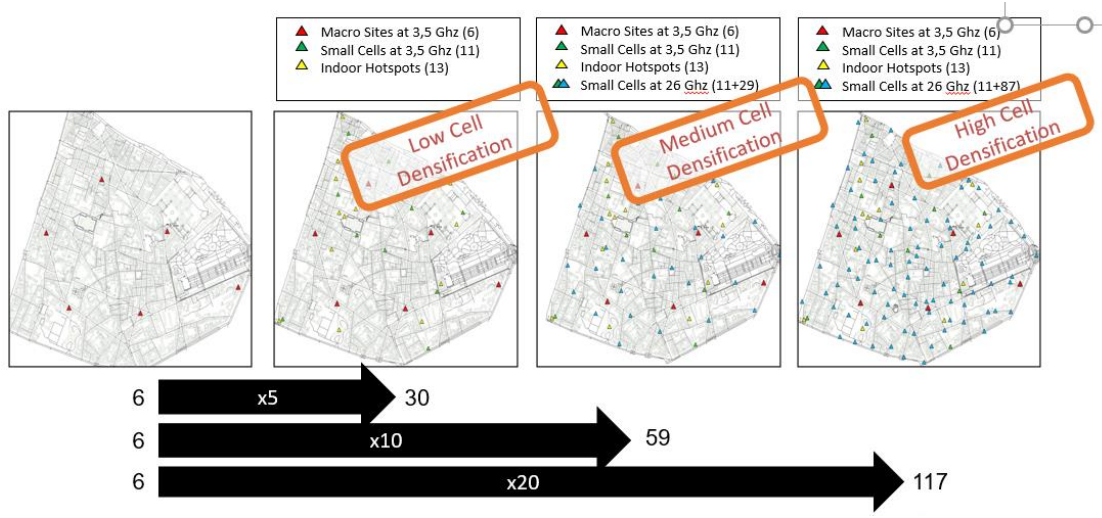


Source: FTTH Council Europe, 5G-FTTH convergence study of the 5G working group within D&O committee, 2020, Detecon

The study worked with 3 cell densification scenarios in urban, suburban and rural areas to come to examples for the amount of synergies.

1% - 7% of additional invest in FTTH networks leads to 65%-95% less investment in 5G front- and backhaul





Source: FTTH Council Europe, 5G-FTTH convergence study of the 5G working group within D&O committee, 2020, Detecon

Broadband Strategies should take a parallel implementation of FTTH and 5G networks into account, NRAs may oblige operators for spare capacity.

Opportunity for BB Strategy	5G needs Fiber connections and cell densification. This offers a big opportunity to save money by building a converged fibre network for FTTH and FTT5G at the same time
Use Case Cost Savings	Between 65% and 98% of the FTT5G standalone network cost can be avoided by deploying it together with FTTH.
5G Small Cell Rollout	5G rollout is a gradual rollout, starting in upgrades of the existing Macro Cells. But more and more Small Cells will need be introduced at some stage.
Fiber Rollout with spare Capacity	If 5G needs are not yet known, a flexible 5G ready Fiber network based on sufficient spare capacity has to be built today.

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03 Broadband Strategies and Optimal Roll-Out Mix

Different fixed access technologies can deliver “superfast” broadband services, Fiber can be deployed step-wise.

Elements to be analyzed for an optimal technology roll-out mix

1. Market development

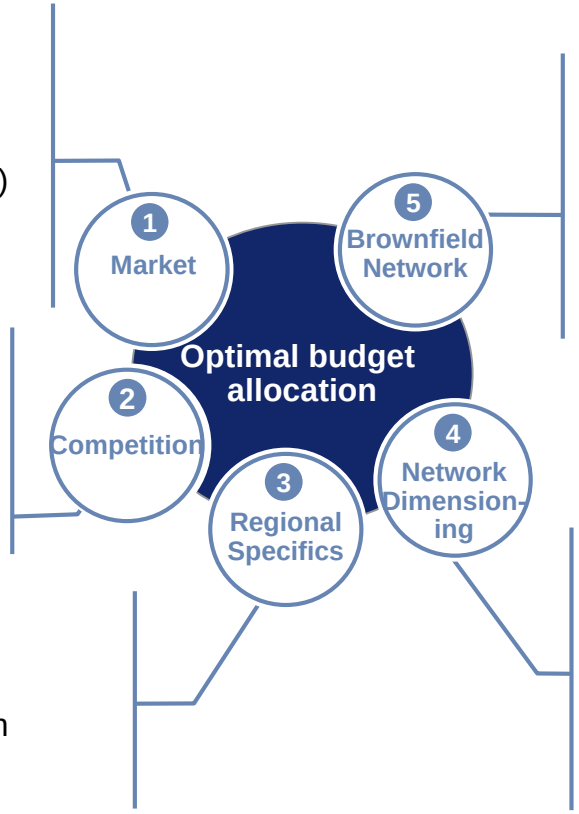
- Population development
- Household development
- Market segmentation (mobile, fixed, converged)
- Product group specification
- Penetration development

2. Competitive landscape (country wide)

- Market share development
- ARPU-/ARPA development

3. Regional specifics

- Population density
- Income level
- Infrastructure -/ regional competition
- Area distribution
- Regional pricing (ARPU-/ARPA)



5. Brownfield/Greenfield Network

- Existing network data (GPON, ADSL, GSM, HSPA+, LTE)
- Brownfield approach identifies reusability (e.g. street cabinets, sites, equipments)
- NRAs often have to plan on a Greenfield basis

4. Network Dimensioning

- Optimized network topologies
- Demand driven traffic modeling
- Geodata-based consideration

The alignment of regionalized technology and marketing targets is a key success factor for a broadband strategy.

Input Data

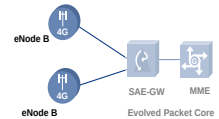
- Geographical data
- Customer Analytics
- Brownfield data
- Network Performance Data
- Dimensioning Parameters
- Type of nodes and Pricebook

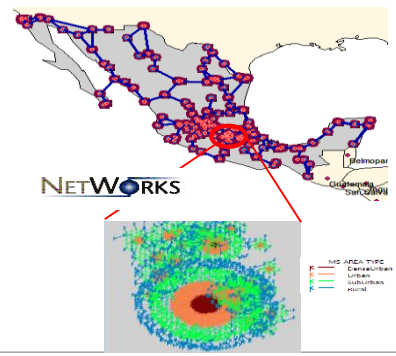
Integrated Strategy Options

Regionalized Marketing Strategy (Options)

Aligned Demand & Quality Targets (Options)

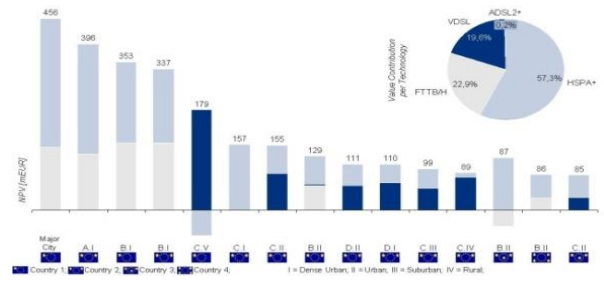
Architecture & Design (Options)





Planning Results

- Regionalized Data Strategy (NPV optimized)
- Ranking of Rollout Regions (NPV based)
- Regionalized Budget Allocation (Revenue optimization at given budgets)



Municipalities can be clustered according to population and each cluster is broken down into different area types.

Country

Municipalities

Municipality 1 426,091
Municipality 2 234,596
Municipality 3 91,650
Municipality 4 85,479
Municipality 5 80,730
Municipality 6 68,466
Municipality 7 59,014
Municipality 8 56,760
….

Municipality Clusters

- **Cluster I**
  - metropolitan cities
  - >750k inhabitants
- **Cluster II**
  - major cities
  - 100-750k inhabitants
- **Cluster III**
  - big cities
  - 50-100k inhabitants
- **Cluster IV**
  - medium cities
  - 20-50k inhabitants
- **Cluster V**
  - small cities
  - 5-20k inhabitants
- **Cluster VI**
  - villages
  - < 5k inhabitants

Area Types per Cluster

Dense Urban (DU) [%]

Urban (UR) [%]

Sub Urban (SU) [%]

Rural (RU) [%]

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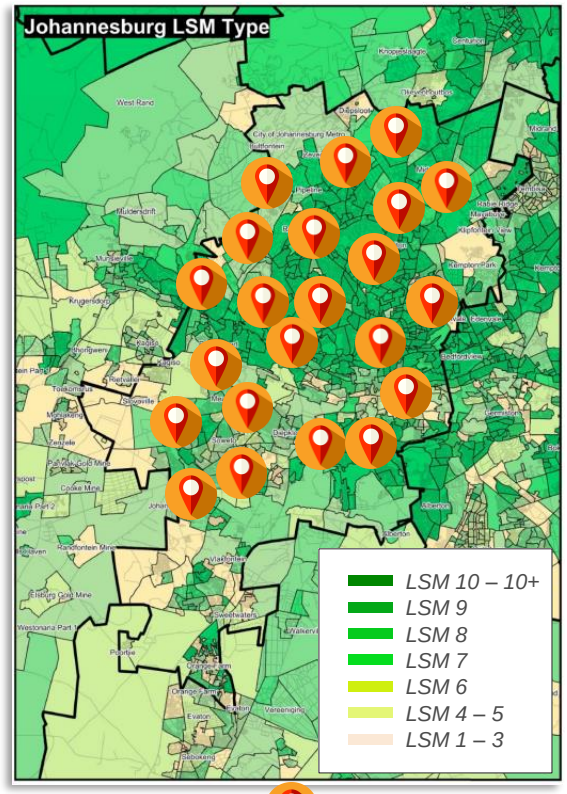
It is also important to look at the income distribution of each cluster to forecast potential broadband demand.

Example: Johannesburg South Africa



- Morningside
- Braynston
- Westclif
- Rosebank
- Greenside
- Parktown
- Saxonwold
- Parkhurst
- Victory Park
- Linden
- Blairgowire
- Killarney
- Riviera
- Fourways

Comments (LSM = Living Standard Measure)

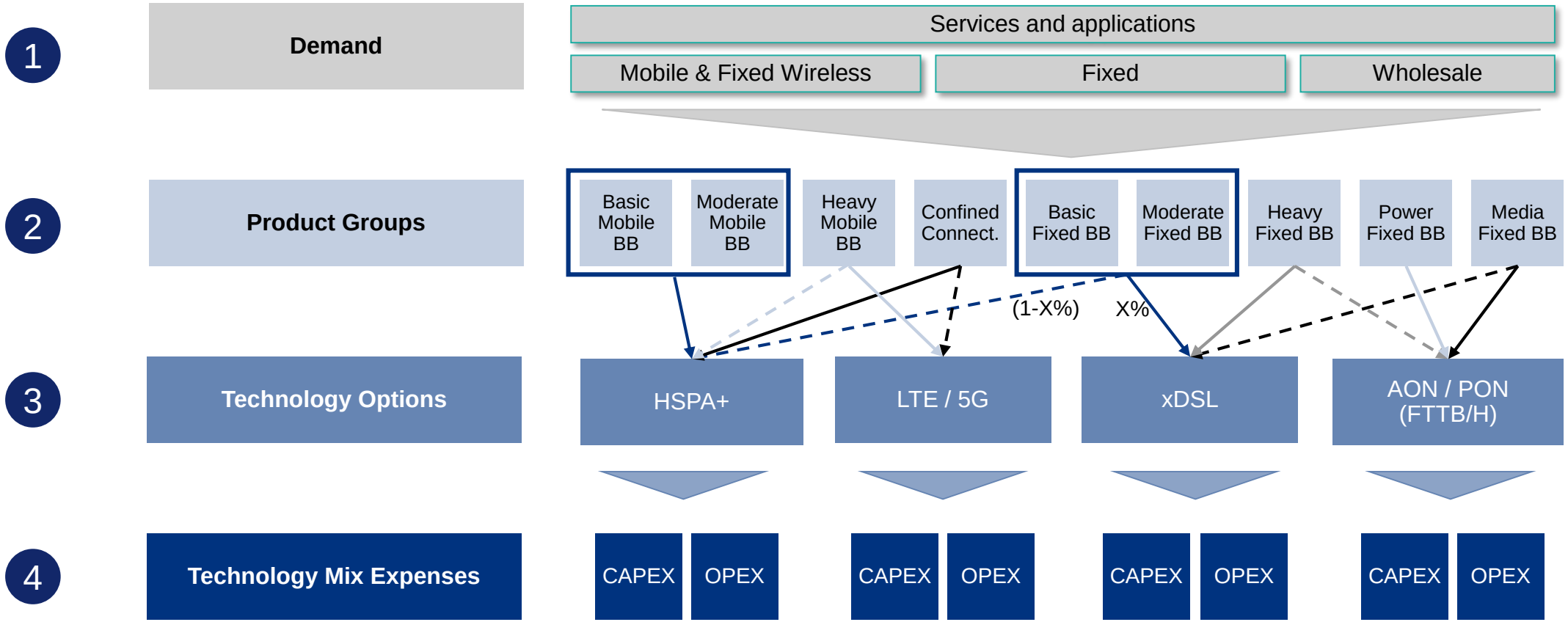
Even in the high-density area Johannesburg operators have are focusing on about 20% of households, only.

These are low-cost areas with rel. high household density and suburbs with high Living Standard Measure (LSM) to assure sufficient ARPS and quick take-up of subscriptions.

- **Total Number of JHB Households*** – 1,417,617
  - LSM 1-3 HH – 44.4%
  - LSM 4-5 HH – 13.4%
  - LSM 6-7 HH – 21.1%
  - LSM 8-10 HH – 21.1% **=> Focus Area**
- **Average Annual JHB Household Income (ZAR)***
  - LSM 1-3 HH – $1,900
  - LSM 4-5 HH – $7,300
  - LSM 6-10 HH – $62,000 **=> Focus Income**

Source: Demacom Ex Global Insight

Demand for bandwidth can be broken down to classes of products, which can be realized by different technology options with different costs.



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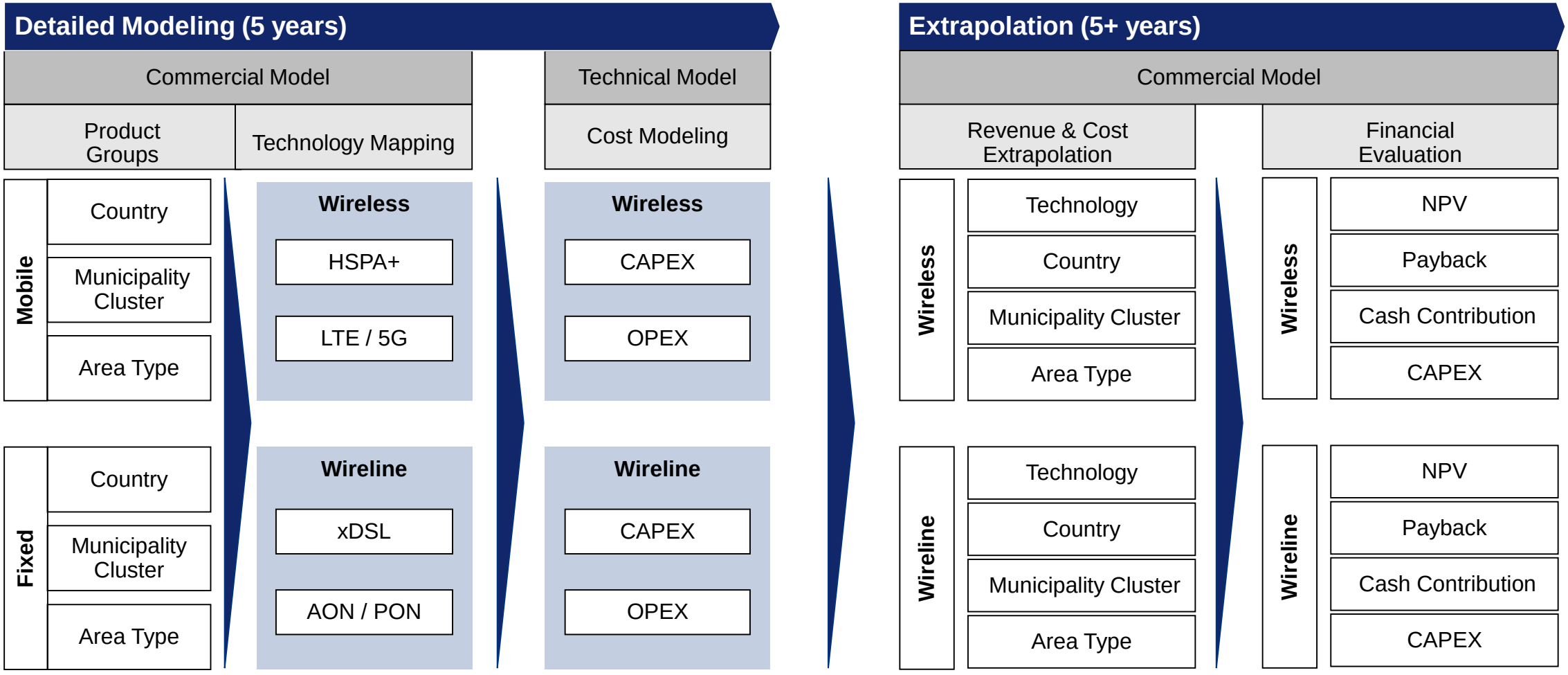
Product group demand is mapped to technologies, costs are calculated in NetWorks and regional NPVs derived.



Source: Demacom Ex Global Insight

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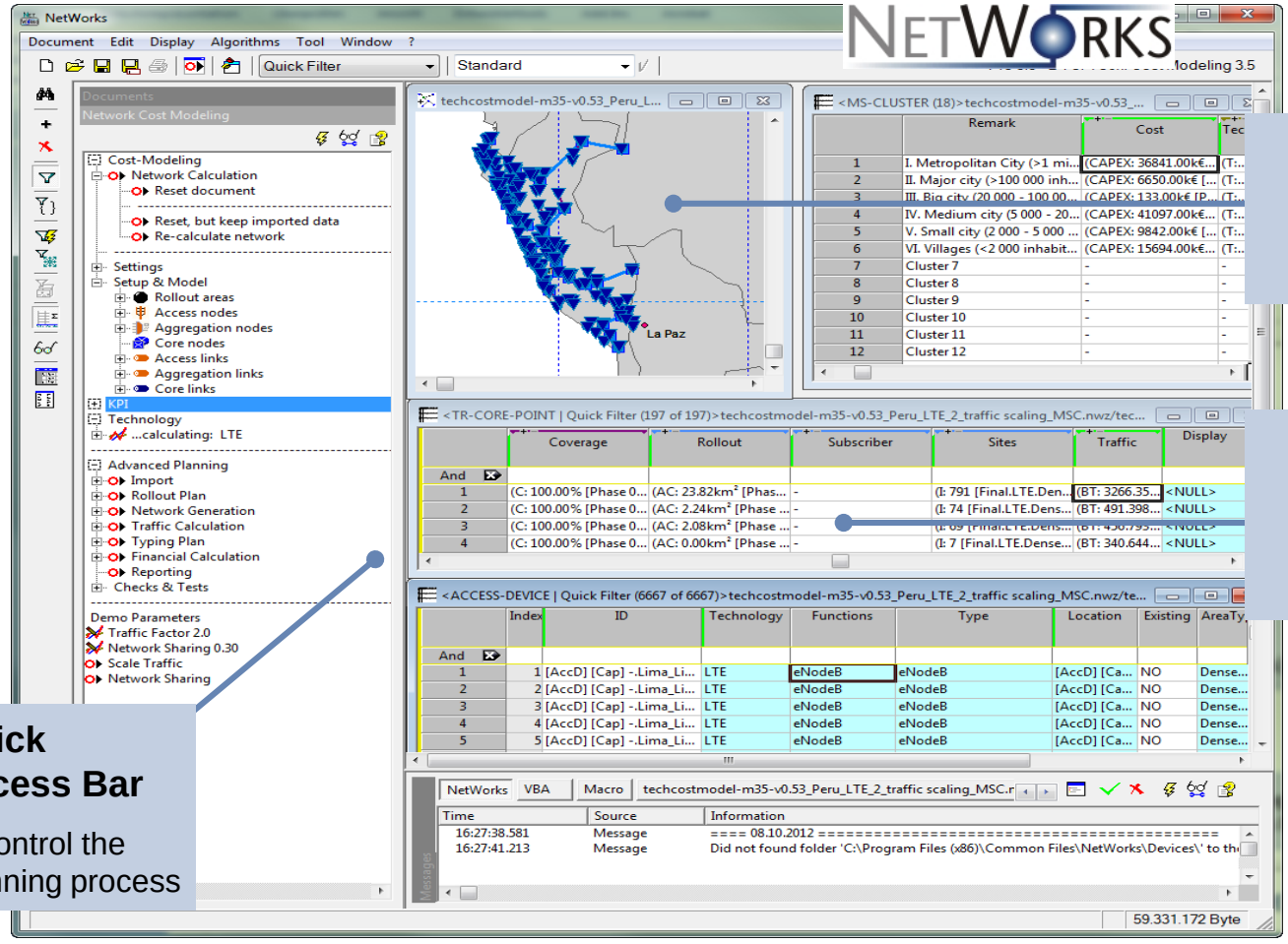
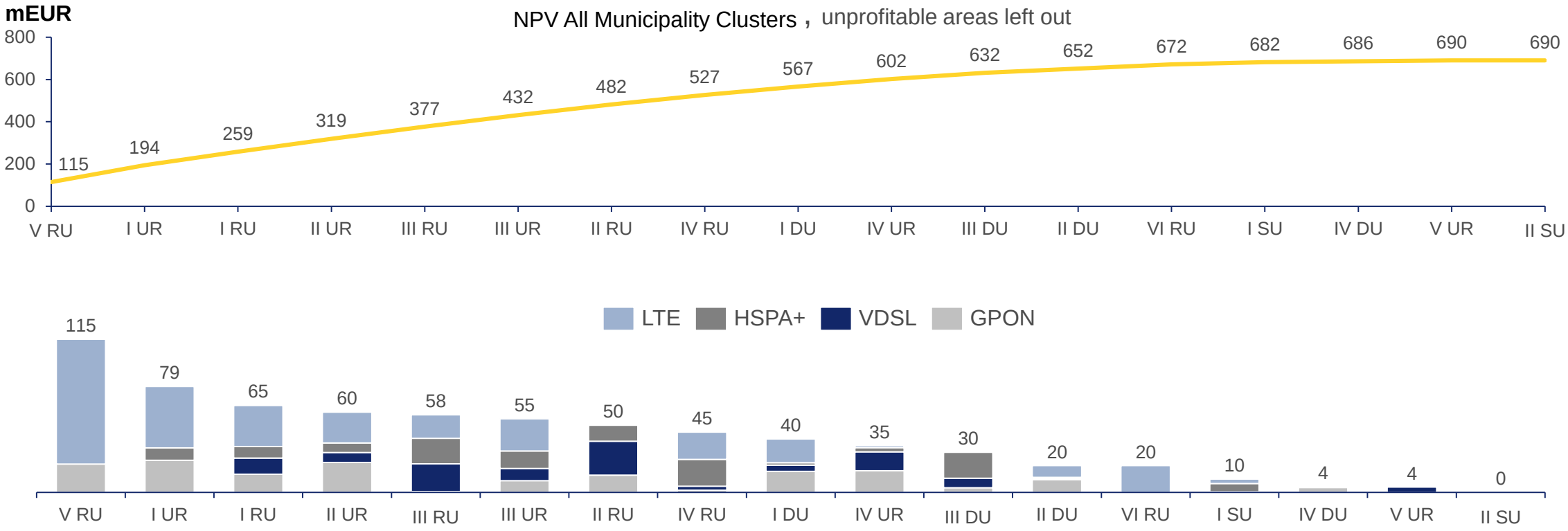
Detecon's "NetWorks" is a proprietary network planning tool allowing detailed brownfield planning of virtually all technologies.



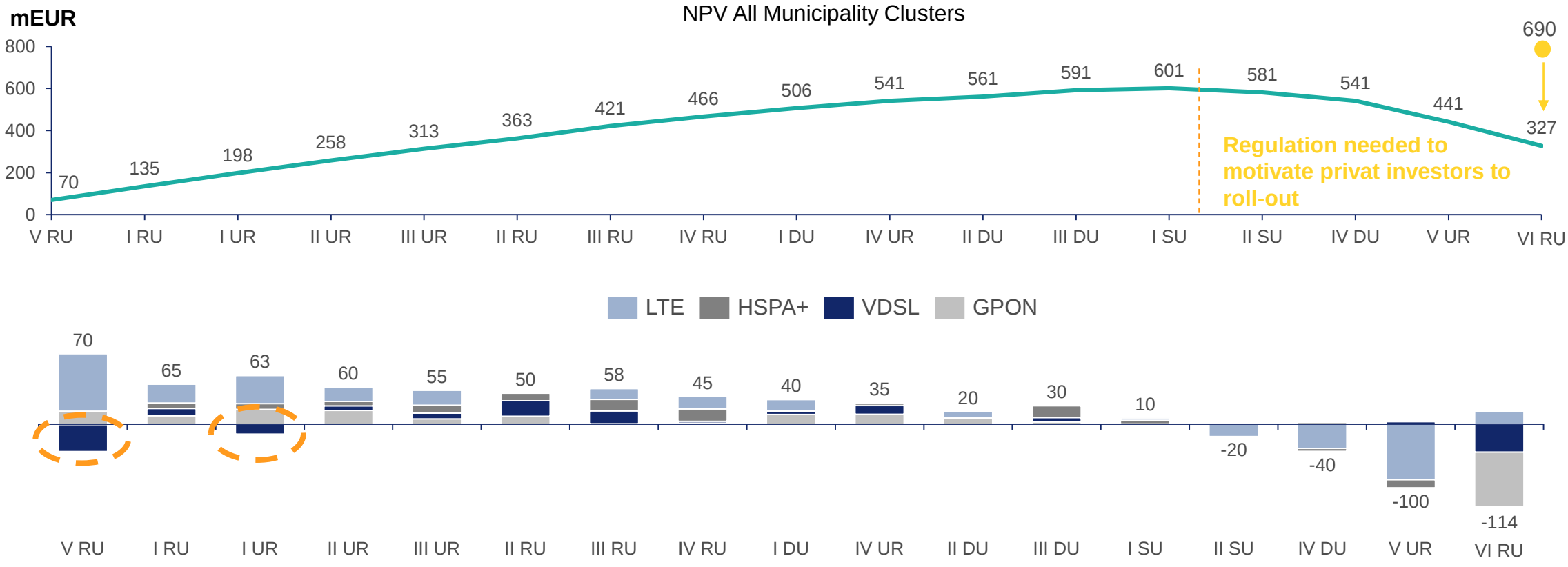
A private investor without obligations will concentrate only on NPV positive areas maximizing his enterprise value.

Case Study Europe: Sceneario “Broadband Technology Mix to maximize Profits”



A Regulator may want to oblige operators to roll out also in unprofitable areas, as long as total profit is positive. Otherwise subsidies are required.

Case Study Europe: Sceneario “Broadband Technology Mix with regulated lower Profits”



Regulation of broadband roll-out requires a deep analysis of the country specifics and detailed business plans.

- Even if a full fiber network may be the solution in the long-run, for many years the transition has to be regulated wisely.
- Transition to a full fiber network has to be done gradually. Future 5G (small Cell) mobile networks will need FTTB/FTTH front- and backhaul and may improve the Combined Business cases.
- Regulation of fiber has to take into account that the optimal broadband roll-our in any country is always a mix of different broadband technologies including mobile.
- Regulation of fiber should include the in-house segment, concentrate on wholesale rather than retail markets and allow an unbundled access of competitors on different levels.
- The implementation of broadband strategy targets should be backed by bottom-up regionalized business cases clearly showing areas that cannot be served profitably even with the best suited technology. Universal service obligations may otherwise spoil money or even delay roll-out.

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